The politics of land deals - a comparative analysis of global land policies on large-scale land acquisition

Verhoog, S.M.

published in
Proceedings of the Global Land Project 2nd Open Science Meeting, Berlin, March 19-21, 2014.
2014

document version
Publisher's PDF, also known as Version of record

Link to publication in VU Research Portal

citation for published version (APA)
Verhoog, S. M. (2014). The politics of land deals - a comparative analysis of global land policies on large-scale land acquisition. In G. L. P. Amsterdam/Berlin/Sao Paulo (Ed.), *Proceedings of the Global Land Project 2nd Open Science Meeting, Berlin, March 19-21, 2014.* (pp. 232-233). Global Land Project.

GLOBAL **IGBP** International Geosphere-Biosphere Programme CHANGE

IHDP

Global Land Project 2nd Open Science Meeting
Land Transformations: between global challenges and local realities

Berlin, Germany
March 19-21, 2014

www.glp-osm2014.org

Proceedings of the Global Land Project 2nd Open Science Meeting, Berlin, March 19-21, 2014

Edited by: Global Land Project, Amsterdam/Berlin/Sao Paulo

Contents

CONFERENCE SESSION ABSTRACTS

Conference Theme Nº1: *Rethinking land change transitions*

CATEGORY: *1.1. Research Presentation Sessions*

NUMBER	TITLE	CHAIRS	COUNTRY
0007	Monitoring global and local land transformations: how can remote sensing and GIS help?	Sina Ayanlade Adeniyi Asiyanbi	Nigeria
Monitoring and modeling global and local land cover transformations has been an environmental challenge over the past decades. Different methods have been used to assess Land use and Land cover change pattern in all part of the globe, including both conventional ground survey methods and remote sensing techniques. Studies have shown that monitoring land use and land cover change with conventional ground survey methods takes much time and it is labour intensive. It is very difficult also to monitor spatiotemporal changes with conventional methods. Remote sensing and geographic information systems are known for technological robustness to meet challenges of spatial and temporal monitoring of land use and land cover change. The application of remote sensing and GIS techniques in land use and land cover change analysis has been widely employed by researchers. It has been shown in these studies that this method is not only good for preparing precise land use and land cover maps, and observing changes at regular intervals of time, but it is also cost effective and time efficient. This session will therefore focus and accept papers on such areas as application of modern technologies to land use and land cover change to provide accurate means of measuring the extent and pattern of changes in Land cover; challenges and uncertainties in remote sensing and GIS approach in land resources management; spatial and temporal modeling of global and local land use and land cover change, among others.			
0015	Forest cover changes in mountain areas	Eric Lambin	Belgium
Land abandonment and forest recovery is often taking place on marginal lands, such as mountain environments. Assessing the rate, spatial patterns and ecosystem impacts of forest cover change in these environments is challenging given the ruggedness and inaccessibility of mountains. Remote sensing methods are the privileged tool, and yet suffer from methodological challenges linked to the topography, large study areas, and subtle changes in land cover. A detailed mapping of land cover changes is crucial to assess changes in the provision of ecosystem services in mountainous landscapes. This session will discuss recent methodological and scientific findings on the mapping of forest cover changes in reforesting landscape, evaluation of a range of ecosystem services, understanding of human-environment interactions in mountain areas, and evaluation of policy options to promote and incentivize sustainable land use practices. Three of the talks will report results from the recently completed project "Remote sensing of the forest transition and its ecosystem impacts in mountain environments (FOMO)", funded by Belgian Science Policy. The other talks will be open to speakers from other projects on a related topic. This session will mostly contribute to the theme 1 of the conference - i.e., rethinking land change transitions: drastic changes in land cover and subtle changes in land management.			
0028	Secondary forests and agro-diverse systems: dynamics of regrowth in the Neotropics	Thomas Rudel Laura Schneider Amy Lerner	USA
Throughout the tropical biome, the characteristics of the vegetation that reemerges after human disturbance has taken on increasing importance as the extent of highly disturbed landscapes has grown over time and research has more fully documented their ecological contributions to the larger ecological community. In Latin America these landscapes frequently take the form of secondary forests and agroforestry systems. They have grown in extent as			

regrowth has occurred on recently deforested lands throughout Latin America. The more tropical of these landscapes sequester much larger than expected amounts of carbon. These findings underscore the importance of understanding transitions in and out of secondary forests in Latin America. The proposed session would bring together papers that explore the different dimensions of change in these disturbed landscapes: Changes in the species composition of the recovering forests, the effect of changing disturbances on forest regrowth, the role of market prices for agricultural commodities like cacao in transforming productive landscapes, the composition of agro-biodiverse landscapes, and the emergence of silvo-pastoral landscapes in the extensive pastures of Latin America. In terms of the GLP's programmatic emphases at the Berlin conference, this session would fit into the module on critical land use transitions.

0030	Assessing land cover change in Sub-Saharan Africa	Zoltan Szantoi Baudouin Desclée	Italy

Global efforts towards sustainable development and climate change mitigation in developing countries are increasing. Countries such as the Democratic Republic of the Congo or Kenya, among others in Sub-Saharan Africa are under tremendous pressure to feed their ever-increasing population. This phenomenon requires a large increase in agricultural land at the expense of other land covers. Moreover, these changes are happening not only on lands close to human settlements but in the vicinity of protected areas as well. Information on deforestation, natural or human induced disturbances are essential to help developing countries to monitor these processes to improve the management of their natural resources. Remotely sensed information using satellite imagery enables quick, reliable and affordable monitoring of these land cover change processes. Throughout the proposed session, particular emphasis will be given to forest loss, land degradation as well as agricultural expansion in and around protected areas as well as in some specific regions which are prone not only to anthropogenic but also to ecological disturbances such as fire. Thus, the main objective of this session is to present the latest findings on land cover change evaluations for protected areas and their vicinity and some additional regions in Sub Saharan Africa, based on medium resolution imagery during the past 20 years. The proposed session focuses its attention on showing new ways of using satellite imagery and computer-mapping technologies to support long-term sustainable development in Africa. This session fits exceptionally well into main Theme #1 "Rethinking land change transitions: drastic changes in land cover and subtle changes in land management". The confirmed presentations cover topics such as fire disturbance on natural ecosystems, forest loss in the Congo basin as well as measuring land cover change in and around important protected areas in Sub-Saharan Africa. The expected additional presentations could comprise other large scale studies, monitoring land cover change processes in the vicinity of urban areas; desertification and tree cover loss in Sub-Saharan Africa.

0032	Understanding farming practices to rethink land change transitions: a research challenge	Davide Rizzo Marc Benoit Elisa Marraccini	France

Agriculture uses and manages dynamically 38% of the global land surface. Farming practices are evolving to intensify current farming systems in parallel with the expansion or the abandonment of exploited surfaces, under systems of constraints and opportunities ranging from local to global scales. Moreover, major agricultural land changes are prospected by near future scenarios for increasing in global population and improvement of standards of living for poorest regions. As a result, agriculture is undertaking a wide range of rapid adaptations whose consequences are too subtle to be consistently observed in the short-middle term by global or regional monitoring, such as remote sensing techniques. Nonetheless, these evolutions impact the land system management at increasingly wider scales. Accordingly agronomy has been called anew to integrate farming practices on grazed and cultivated fields in the wider spatial context (Benoit, Rizzo *et al.* 2012, Landscape Ecol. 27:1385-1394). In this session we will discuss how a better understanding of farming practices can help rethinking land change transitions (theme 1). The underpinning aim is promoting a greater involvement of agronomy in the evolution of a multidisciplinary approach to the land system management. We will structure our session on three main challenges. First, *reflecting on the theoretical frameworks* adopted by several disciplines in the study of agricultural land transitions at different scales and from different perspectives. We will focus on the rural landscapes management as a major cross-disciplinary study object to increase the synergy among agronomy, geography, and ecology within the

land system science. Second, *improving methods* to describe and understand agricultural land change transitions. Farming practices, with their continuous adaptability to the evolving context (e.g., climate change, price volatility, farm household strategies, etc.) translate relevantly the large variability of agricultural land changes over time and space on Earth. Nevertheless many difficulties remain to integrate them in the analysis of the land systems. For that, we will evaluate existing and emerging methods that tackle farming practices at regional and wider levels. Third, *enhancing the assessment and design* of farming systems to deal with multiple issues. Short term issues for agricultural land use (e.g., feeding the world and increasing the production of biomass for energy) are faced with long term issues of resource management (e.g., freshwater protection, biodiversity conservation). We will focus on some examples about the spatial allocation of crop patterns – and of the associated farming practices – to question how environmental and societal needs can be met.

0043	Landsat past and future: monitoring land transformation	Crystal Schaaf Feng Gao Jeffrey Masek	USA

Landsat sensors have been imaging the transformation of the Earth's land surface for over 40 years. Researchers and resource managers have long relied on Landsat's spectral bands in the VIS, SWIR, and TIR, and spatial resolution in the tens of meters to monitor the extent and health of forests, rangelands, agricultural lands and natural ecosystems. Landsat imagery has been vital in assessing the impact of natural and man-made disasters and estimating land cover conversion, urban expansion, and transportation networks. Since 2009, free access to the entire Landsat archive has resulted in an explosion of innovative remote sensing science and new multi-temporal, multi-spectral image processing techniques for use at local, regional, and even global scales. The availability of these long-term consistent observations has already resulted in an increased understanding of vegetation dynamics and the rates, causes, and consequences of land cover change due to both natural processes and human activity. This in turn has led to improved capabilities in modeling the complex interactions that occur between land cover transitions and climate variability and predicting the effect of such transitions forward in time. With the launch of Landsat-8 in early 2013, the program now continues into its fifth decade and the enhanced radiometric resolution, rigorous calibration program and two additional spectral bands of Landsat-8 are leading to improved monitoring of biophysical conditions and to new remote sensing algorithms. As such, this session will support the theme *Rethinking land change transitions*. Contributions should focus on the use of multi-temporal data from the long term Landsat archive to identify and monitor both the subtle and abrupt alterations of the natural and human environment that have occurred over the past 4 decades and also on the use of that historical knowledge, in concert with the enhanced capabilities of the new Landsat-8, to predict the impact of these transformations into the future.

0046	Progress of land change sciences in Asia	Teiji Watanabe Lin Zhen Yu-Pin Lin	Japan

Asia has been experiencing rapid and drastic changes in land systems by the rapid increase of both the economic growth in this region and globalization. The vast changes of land-use and land-cover in Asia will impact on the bundles of ecosystem goods, benefits and servicers in various temporal and spatial scales. Thus, the understanding of the Asian land system in the view points of the coupled human and environment systems is critically important to develop the sustainable options not only for Asia, but also for the other regions and global scales. The land change sciences in Asia will provide general perspectives as well as uniqueness of localities including natural environments, and social and cultural characteristics. Three GLP nodal offices in Asia conducted land change studies under global themes. In this session, each of three Asian GLP nodal offices in Beijing, Taiwan, and Sapporo will overview their progress and the future direction in land change science in Asia. Progress achieved by GLP endorsed and related research projects in Asia will be also given in both oral and poster presentations. Specifically, how do Asian land systems have been affected by and how do they respond to global factors such as global warming, increase in human population, economic growths, governance, policy, or catastrophic disturbances will be discussed. Therefore, this session will largely contribute to the OSM main theme, "Land transformations: between global challenges and local realities". We also aim that outcomes of this session contribute to the GLP synthesis.

0052	Tree-cover transitions in tropical landscapes: hypotheses and cross-continental synthesis	Meine van Noordwijk Grace Villamor	Germany

This research presentation session will share the World Agroforestry Center's (ICRAF) on-going research and results from the Sentinel Landscape Project. The aim of the presentation session is to contribute to the overall goal of the Global Land Project Open Science Meeting which is to synthesize and discuss the role of the land system as a platform for human-environment interactions, connecting local land use decisions to global impacts and responses.

0054	Climate hazards and adaptive land use management	David Thomas He Qing Huang	China

Dramatically changing climate and rapid socio-economic and political transition often bring about various forms of hazards, which can evolve into disasters, resulting in wide-range unfortunate ecological and/or socio-economic and even political consequences. By changing land use practices into an adaptive way, nevertheless, it is possible to make some disasters contained fully or to a very limited degree. The main purpose of this session is to deepen our understanding of the causes and processes underlying the development of the hazards and consequently to identify land use practices effective for disaster reduction. For the purpose results from typical field investigations will be presented to give a detailed account of the characteristics, causes and processes of hazards exhibited in different geographical areas. Consequently links between disaster development and land use forms will be examined and corresponding adaptive land use management measures for disaster reduction proposed. It is expected that the outcome of this session will contribute not only to the OSM main theme, "Land transformations: between global challenges and local realities", but also to the GLP synthesis.

0055	Urbanization and land change transitions in the Brazilian Amazon	Julia Côrtes Álvaro D'Antona	Brazil

The Brazilian Amazon is one of the largest rainforests in the world, although it has been increasingly considered as an urban territory - an urbanized forest. The deforestation and the forest transformation in different uses, including urban areas, are responsible for a significant portion of greenhouse gases emissions in Brazil. Because of the increasing deforestation rate in the country in the last decade and the significant carbon stock in this ecosystem, local management plans and human activities have a direct impact on the planet's climate and water maintenance, as well as on the chain of food production, since Brazil provides beef and soybean to the international market. Therefore, special attention to the Amazon region is needed for its implications on both local and national scales, and on global trends, given its international connection. The objective of the proposed session is to bring a new approach to our understanding of the land change transitions in the Amazon region through an integrated discussion of the urbanization process and land use-cover at different spatial scales, from regional and global factors to local land use decisions. The studies about the processes of urbanization and land use-cover change are usually separate, which is unreal given the ongoing rural re-configuration and urban stage transition in Brazil and globally. Understanding the spatial processes of population settlement, as the result of the population mobility and spatial redistribution, can promote a direct dialogue between the studies about urbanization and land transitions. This approach expands the land use-cover models by proposing urbanization stages as features of land use investigation (the transformation of a forested area in an area with high population density and infrastructure), and clarify the effects of urbanization on the land use decisions, such as agricultural intensification for food demand and forest regeneration on an abandoned land. The discussion about urbanization in the studies of land transition is important for the complete and multi-scale understanding of the factors, dynamics and trends of the uses and cover of the Amazon, as well as for measuring the regional and global consequences of the changes in this biome.

0065	Global land use datasets - status and way forward	Karl-Heinz Erb Tobias Kuemmerle	Austria

Global datasets on land use are crucial for understanding land system dynamics and its environmental and social impacts. Likewise, reliable, consistent and repeated land cover and land use datasets are increasingly recognized as indispensable inputs in climate and earth-system models to assess past and future feedbacks between land use and other earth system components. Access to satellite and ground-based data is surging and major advances in global

land use and land cover change mapping have recently been made. Nevertheless, substantial uncertainties remain. First, whereas a range of interesting indicators for agriculture exist, datasets for grazing and forestry are sparse. Second, existing data is of heterogeneous quality and sometimes difficult to access, and most existing datasets are static. Third, large knowledge gaps relate to management aspects of land use, particularly regarding the temporal and spatial dynamics of land use. Such land use intensity datasets would be essential for monitoring and informing policy making aimed at fostering sustainable intensification. Finally, most datasets capture only one aspect of land use, whereas system-level metrics of land use are needed. This session will assemble presentation on frontier research on global land use datasets, with a particular focus on land-use intensity. The session will present recent advances and new approaches, show applications of novel datasets, and identify challenges and opportunities for generating the next generation of global land use datasets. The session will consist of both oral and poster presentations.

0066	Tropical dry forests: land transformations, socio-political realities in a changing world	Arturo Sanchez-Azofeifa Carlos Portillo-Quintero	Canada

Tropical dry forests are considered not only one of the most endangered biomes in the Americas but also the first frontier of economic development in Latin America. This ecosystem is in a context influx of land transformations, producing landscapes that are a combination of primary and secondary forests, as well as agricultural (extensive and intensive) field. Although, its significant rate of change, little is know about land transformations in tropical environments. In this session we present a comprehensive overview of land transformation processes and socio-political realities in tropical dry forests across the Americas. We will present case studies from Mexico, Costa Rica and Brazil allowing for a latitudinal comparison of land transformation processes and political realities. In addition, we will link in this session on land transformation policies to losses of ecosystem services specifically those associated to water and carbon. It is clear the future conservation and sustainable management that drive land transformation policies in tropical dry forests environments need different approaches as those implemented in tropical dry forests, but the case has not been done quite clear as today. We suggest in this session that those approaches that consider water as a unifying force rather than carbon may be more successful given the current Latin American realities, which change from country to country. The session will be open to comparative studies from other regions in the Americas where tropical dry forests are located (eg. Colombia, Peru, Bolivia and Argentina).

0067	Smallholder irrigation and land transformations: dynamics, potentials and development trajectories	Lowe Börjeson Martina Caretta	Sweden

Smallholder irrigation systems meet an important part of local and regional food demands and their spatial and temporal dynamics influence land system transformations in different parts of the world. Some irrigation systems have long trajectories of historical continuity, based largely on subtle and incremental changes in management and spatial extent, while others reflect recent and sometimes drastic changes and alterations of land systems: e.g. land cover, land and water rights, labor regimes and irrigation technologies. Many systems are also located in drylands, where they play a critical role in transforming and moderating local and regional land systems, with implications for ecosystem functions as well as food production and rural livelihoods. This session invites empirical as well as theoretical contributions that engage with current and past dynamics (e.g. social, demographic, economic and environmental forces) of smallholder irrigation systems. The session aims to capture some of the diversity of how smallholders irrigation systems interact with land transformation processes in general and to what extent common trajectories and processes can be observed between cases, for example in relation to climate change mitigation (changing levels of soil carbon for example), adaptation and impacts of global environmental change and increasing demands for food, fuel and ecosystem services. A specific aim is to initiate discussion on how smallholder irrigation systems interact with land system change and development trajectories more broadly, as part of land change transition processes and societal and environmental changes in general. Contributors to the session may for example engage with questions related to the transformative potentials and limitations that can be associated with smallholder irrigation systems as a factor in local and regional land transformation processes (i.e. addressing theme 1 and 3 of the conference). We invite contributions on a wide range of methodologies (from remote sensing to participant observation) and issues related to, for example: local knowledge (e.g. its transformation, spread and maintenance by societal institutions as opposed to external initiated advice and technical support); historical insights in relation to

current developments and trajectories; sustainability and development potentials of smallholder vs. large scale systems; internal field system dynamics and cross-scale dynamics (field to local system to regional and global processes); vulnerability and resilience of local livelihoods; transformations of property right regimes; and assessments of local, regional or global trajectories of spatial expansion or decline of smallholder irrigation.

0076	Validating global land use models for improved integrated assessments	Thomas Hertel Peter Verburg	USA

Integrated Assessment Models (IAMs) are indispensable in the debate over climate change impacts and mitigation policies. Recently these models have incorporated land-based mitigation policies into their analyses. This is important, since land-based emissions account for more than one-quarter of global GHG emissions, could potentially supply 50% of economically efficient abatement at modest carbon prices, with most of this abatement coming from slowing the rate of agricultural land conversion. Therefore, projections of agricultural land use are essential inputs to climate change studies. However, the value of such projections hinges on the scientific credibility of the underlying models. And this depends on model validation – an area in which IAMs and global land use models have been notably lacking to date. Unlike climate models, IAMs and land use models must also predict human behavior, as well as market interactions between economic agents and human decision making is context dependent. Human decision making towards land use is context dependent, prone to change over time and poorly understood. And even when these relationships are known, there is a lack of global, disaggregated, consistent, time series data for model estimation and evaluation of the full modeling system. In response to this challenge, some modelers have proposed a more targeted approach to validation by focusing on a few key historical developments or 'stylized facts'. This session will focus on the validation of a variety of models against some of the most important developments in global land use over the past 50 years. For example, the past 50 years has seen a remarkable increase in crop production, with only 14% of this coming from increased area with the remainder coming from yield increases. This has greatly moderated land-based emissions. Whether or not this can be replicated in the future is a central question. Yet, to our knowledge, none of the IAMs currently in use is capable of reproducing this historical experience endogenously. Indeed, it is not uncommon for IAMs to treat crop yields as an exogenous trend, thereby *pre-determining* the answer to this important question. This session will contribute to several of the GLP conference themes, including 'impacts and responses' – a key area of contribution by IAMs, 'land governance' – an area which has been largely neglected in the IAM literature, yet will be shown to be key in model validation, as well as 'rethinking land change transitions'.

0079	Utilizing time series analyses to enhance understanding of system dynamics	Jane Southworth Harini Nagendra Cerian Gibbes	USA

The availability of repeat digital, synoptic measures of the earth's surface has resulted in remote sensing of the earth's surface forming the basis of many land change science research questions. The temporal extent of such measures is becoming sufficiently long to utilize for time series analyses and the temporal frequency of remotely sensed datasets supports linking these land cover observations to a variety of drivers of change including climate and land management practices. This session aims to explore the range of time series analyses being utilized to examine land cover dynamics and transitions as they relate to global environmental changes and land management. This session most directly relates to themes 1 (Rethinking land change transitions) and 4 (Impacts and responses) of the OSM 2013. Through presentations of how time series analyses are being used to characterize landscape changes the presentations in this session will explore current use of time series analyses of satellite imagery and the generated discussions will focus on the challenges and potentials for maximizing the use of over 30 years of land surface observations, and improving the ways in which landscape transitions are measured. Topics appropriate for this session include (though are not limited to): development of statistical tools for determining change significance, long term land cover dynamics, multi-temporal data analysis, and data fusion.

0084	Land-use transitions, legacies and regime shifts: exploring historic trajectories of land-use change from a socio-ecological	Fridolin Krausmann	Austria

	perspective

This session explores historic land use transitions on various spatial scales. It focuses on land regime shifts during industrialization, a period characterized not only by changes in the technological and economic framework conditions of land use, but also by a fundamental change in the resource base of human society from biomass to fossil and mineral materials. Industrialization triggered an increase in land use intensity and a fundamental transformation of the functioning of the agricultural production system and the role of agriculture in the economy. Although it is increasingly acknowledged in land change science that there is no uni-directional land use trajectory or intensification pathway, differences in developments among countries are still rarely studied. A comprehensive understanding of spatial and temporal variations in long term land use changes and the underlying driving forces is still lacking. This session assembles a number of long term case studies and highlights trajectories in individual countries as well as cross-country variation through time. It combines empirical case studies, applying different socio-ecological methods and indicators. The papers investigate the spatial patterns and temporal dynamics of land use change trajectories and land use intensification during the last two centuries with a focus on agriculture. They explore the characteristics of preindustrial land use systems and the evolution of the industrial land regime from a long term socio-ecological perspective, investigating the different phases of this development and the interplay of changes in resource demand, technology, institutional and economic change in past land transitions. A better understanding of historic land regime changes and the temporal and regional similarities and variations can help to better address the challenges of current land transitions in land change science and provides inputs for better policy making, because one-size-fits-all policies on spatial and environmental regulations only inadequately address spatial variations.

0087	Trajectories of change in agro-ecosystems	Diego Valbuena	The Netherlands

The objective of this session is to exchange and deepen our understanding on major trajectories of change of diverse agro-ecosystems by linking past and current trends to stakeholder realities and alternative futures. This understanding should combine and investigate intrinsic processes, drivers and alternative options to enhance the sustainability and efficiency in agricultural production in diverse agro-ecosystems accounting for potential trade-offs and synergies between stakeholders, scales and ecosystem services such as food production, water storage, nutrient recycling and bio/agro-diversity. This session aims to bring theories, concepts, study cases and tools of research at different locations and spatial scales to look at potential similar and contrasting properties and drivers of trajectories of change in agro-ecosystems across the globe. This session will align with the theme on "Rethinking land change transitions" contributing to the understanding on the interaction between drivers and land management in social-ecological systems. It also links to the theme of "Local land users in a tele-connected world" by focusing on the interaction between human decision-making, drivers and changes in agro-ecosystems.

0096	Drivers and implications of regime shifts in land-use systems	Veronika Gaube Daniel Müller	Austria

Human actions have profound and rapidly growing impacts on the environment, on terrestrial ecosystems and on the global climate system, comparable in scope with other fundamental forces of the Earth System. Land-use science principally needs to pay more attention to processes of agricultural land intensification, and in particular on the decision-making processes driving land management. The responses of land-use agents to changes in broad-scale, underlying drivers, such as national policies or global commodity prices, are difficult to anticipate a priori, because agents frequently respond abruptly to changes in underlying boundary conditions. As a result, predictions of future land-use transitions are challenging and unexpected developments in key drivers can substantially alter land systems, including shifting land systems to other regimes. Failure to foresee unexpected events as well as tipping points that set off regime shifts of land systems impede the anticipation of future food production, impacts on livelihoods and environmental effects such as alterations to nitrogen cycles and greenhouse gas emissions. The intricacies involved in analyzing and predicting the often highly nonlinear, abrupt, rapid, irreversible and surprising transitions to alternate system states of land use and land use intensity complicate the formulation of land-use policies that typically rely on insights about observed past changes and expectations about future business-as-usual developments. In this session, we seek contributions that exemplify how changes in underlying drivers led and may lead to regime shifts in land-use systems, including changes as well as modifications of land use and its implications on ecosystems.

We welcome retrospective modeling approaches that reconstruct past regime shifts as well as scenario-based investigations into alternative future pathways of land use. In sum, the insights from this session will contribute to better prioritizing monitoring investments, informing land-use planning and policy action that aim at concurrently reducing detrimental environmental outcomes and facilitate transitions towards more sustainable land use systems.

0102	Global agri-databases - requirements from a modeling perspective	Marcel Adenäuer Ruth Delzeit	Germany

Modeling global land use changes can only be as good as the underlying databases. At the same time future scenarios on global land use response gain increasing attention due to rising global food demand, decreasing yield growth or bio-fuel policies, all increasing the pressure on land. The quality of the database used e.g. in an agricultural sector model is therefore more crucial than ever. The ideal database including all requirements of a potential sector model dealing with global land use does, however, not exist. This session aims at bringing together the users and providers of databases related to land use and the agricultural sector to stimulate the dialog between both groups and learn more about the methodologies used. The starting point will be the FAOSTAT database which is one of the globally most complete databases that exist, featuring resources, agricultural production, land-use, yields and supply, as well as demand and trade for agricultural commodities and much more. A number of modeling systems use FAOSTAT data (AGLINK-COSIMO of the OCED/FAO, CAPRI from Bonn University or GLOBIOM from IASSA). However, users of the FAOSTAT database have to cope with a number of issues, like inconsistencies over the domains offered gaps or definitional jumps in the data. The idea to this session was born in the GLUES (Global Assessment of Land Use dynamics on Greenhouse Gas Emissions and Ecosystem Services) project, a part of the scientific coordination and synthesis of the call on "Sustainable Land Use Management" by the German Research ministry (BMBF). GLUES supports international interdisciplinary collaborated research projects by facilitation and coordination, by a common data platform and by developing consistent scenarios on land use, climate and socio economic change. GLUES will develop concepts for synthesizing results from collaborative re-search projects funded by this call working in different regions across the world, as well as from other related international research programs and projects.

0119	Backcasting future land uses for sustainable development	Adrienne Grêt-Regamey Thomas Blaschke	Switzerland

There is bound to be conflict over land use: Available land resources are shrinking while demand is increasing as the population increases and lifestyle changes. The development of strategies and pathways to face the growing gap between supply of and demand for land has been for a long time the subject of future studies. This is typically addressed through the development of trend extrapolations (answering the question what *will* happen) or through forecasting (answering the question what *could* happen). While the later approach especially has high strategic relevance for preparing for uncertain developments, it does not foster embracing the more radical and disruptive changes which might be necessary to adapt to the accelerated deterioration of the environment. By placing the emphasis on envisaging longer-term distant futures first, the backcasting approach allows users thinking beyond incremental changes. By answering the question what *should* happen, one can establish an explicit connection between local land use decisions to global and local stressors. Looking backwards from desired or tolerable future land uses can thus support developing agendas, strategies and pathways how to get there. Yet, while the backcasting approach has attracted attention from policy-makers in many countries, as well as from scientists outside foresight and sustainability studies, first applications in land use science emerge only recently. This session wants thus to explore the potential of quantitative backcasting approaches for sustainable land use development. We ask how land use modeling approaches can be used for simulating the human-environment transformation processes necessary to reach goals ultimately chosen by experts/stakeholders. Particularly, we want to get an understanding on how a quantitative backcasting approach can allow linking local responses to land use changes influenced by both climate-driven environmental changes and concomitant changes in local socio-economic conditions. How can conflicts between long-term changes and short-term concerns be made explicit, and how do the complex ecological, economic and social processes react to short-term shocks and long-term stresses. A major issue is how to capture the learning process triggered by the reflexive and iterative methodology. Besides contributions to the conceptual debate, this session particularly welcomes presentations on applications of the approach in various case studies and

	methodological issues.		

0126	Bridging local to global land change studies with the GLOBE Online Tool	Erle Ellis Nicholas Magliocca	USA

Land change science (LCS) is an emerging field of study aimed at understanding interactions among human systems and the terrestrial biosphere, atmosphere and other Earth systems as mediated through human use of land. Advances in LCS are needed to better quantify, predict, mediate, and adapt to global climate change, biodiversity loss, and other consequences of land use and land cover change. Despite vigorous efforts by a broad array of social and natural scientists, the cross-scale synthesis of multidisciplinary observations, models and theories on coupled human and natural systems (CHANS) that are required to advance LCS has yet to emerge. A major obstacle is the tremendous challenge in global integration and synthesis of local and regional CHANS case studies. Following the conferences overall theme of "*Land Transformations: between global challenges and local realities*", the GLOBE system presents a new online social and geo-computational tool that facilitates the collection, management, and real-time quantitative analysis of georeferenced case studies to accelerate synthesis of local land change knowledge within a global context. This research presentation session will be of interest to case-study and meta-analysts alike, as well as any researchers seeking to leverage GLOBE's unique analytic and networking capabilities tailored to the LCS community. Paper presentations will provide an update on the development of GLOBE and its prospects, as well as illustrate applications of GLOBE for local case studies and regional to global meta-analysis of land change.

0128	VOLANTE Visions of Land Use Transitions	Bas Pedroli Mark Rounsevell	The Netherlands

This session discusses advances in Theme 1 (*Rethinking land change transitions*) based on interdisciplinary research on land use, combining in-depth analysis of land use change processes in the past with scenario-based pathway definition and trade-off analyses for future land use. The session will discuss new insights into socioeconomic and ecological processes shaping land use transitions with land-use intensity and land-use functions as cross-cutting issues. Land use can subsequently be modelled in a top-down approach based on downscaling global developments to localities. This should be supplemented by and compared with bottom-up simulation of agent interactions and land use decisions. Also sophisticated ecosystem service modelling should be discussed, capable of assessing the impact of land changes on ecosystem service provision. A framework for linking exploratory scenarios to normative visions is to be considered, allowing credible and relevant indicators to be defined for modelled land use developments. Finally new methodologies for extracting stakeholder visions are to be discussed, allowing for proper pathways to be defined and trade-off analyses to be carried out. The session will discuss how this stakeholder-based identification of land use visions for the future, translated into pathways to future land use, and confronted with trade-offs between the various societal interests, could lead to policy-relevant roadmaps for future land use management.

CATEGORY: *1.2. Round-table Discussion Session*

NUMBER	TITLE	CHAIRS	COUNTRY
0036	Progress on global land change monitoring	Brice Mora Martin Herold Pierre Defourny	The Netherlands

The observation of global-scale land cover (LC) is of importance to international initiatives such as the United Nations Framework Convention on Climate Change (UNFCCC) and the Kyoto protocol, governments, and scientific communities in their understanding and monitoring of the changes affecting the environment, and the coordination of actions to mitigate and adapt to global change. As such, reliable and consistent global LC (GLC) datasets are being sought. The Global Observation of Forest Cover and Land Dynamics (GOFC-GOLD) Office is a coordinated international effort working to provide on-going space-based and in-situ observations of the land surface for the sustainable management of terrestrial resources and to obtain an accurate, reliable, quantitative understanding of the terrestrial carbon budget. The involvement of GOFC-GOLD in several international initiatives such as a series of Tasks from the Group on Earth Observations (GEO), the Land Product Validation Working Group from the Committee on Earth Observation Satellites (CEOS), the contribution to the development and update of the International Panel on Climate Change (IPCC) guidelines, and the European Space Agency (ESA) Climate Change Initiative (CCI) provides us with a unique overview of the on-going and upcoming worldwide activities in the field of land cover monitoring. The first topic of the proposed session intends to present trends and impacts of the new developments for global land change monitoring (data, methods, and products). We will present and discuss continuity and consistency of Earth observation data (Sentinel constellations, Landsat Data Continuity Mission), crowd sourcing-based field data collection, advanced remote-sensing methods for change detection (time-series analysis), and upcoming Landsat-scale GLC products and their standardisation (recommended practices). The second topic will present the progress being made on the development of the Land Cover Essential Climate Variable products within the ESA-CCI. The presentation will introduce the project, its achievements, and specific aspects to be further discussed such as quality product assessment, accuracy improvement, and continuity of the initiative. Topic number 3 will provide an opportunity to present reference datasets newly available and those under development for GLC monitoring. We will discuss their quality, consistency, and conditions for an appropriate access and use. GOFC-GOLD is currently developing a web portal intended to be a hub for the GLC mapping community to access freely reference datasets. Audience for the proposed session would comprise a wide variety of land cover information developers and users coming from the academic and research fields, non-governmental organisations and private sector.

NUMBER	TITLE	CHAIRS	COUNTRY
0068	Opportunities and challenges in land change modeling	Daniel Brown Robert Pontius	USA

This round table discussion will review and discuss the implications of key findings from a National Research Council study, convened to review the status of spatially explicit land-change modeling approaches and describe future data and research needs so that model outputs can better assist the science, policy, and decision-support communities. Future needs for higher resolution and more accurate projections will require improved coupling of land-change models to climate, ecology, and biogeochemistry models; improved data inputs; improved validation of land-change models; and improved estimates of uncertainty associated with model outputs. Modeling approaches reviewed range from cellular and machine-learning models to economic and agent-based models. The study report provides guidance on the best practices in land-change modeling in the context of Earth observation data and various Earth system models, modeling infrastructure, and research requirements needed to enhance the next generation of models. The study committee was tasked with:

1. assessing the analytical capabilities and science and/or policy applications of existing modeling approaches;
2. describing the theoretical and empirical basis and the major technical, research, and data development challenges associated with each modeling approach; and
3. describing opportunities for improved integration of land observation strategies (including ground-based

survey, satellite, and remote sensing data) with land-change modeling to improve land-change model outputs to better fulfill scientific and decision making requirements.

Following an overview presentation on the study findings, speed talks will highlight key elements of the findings and an open discussion will ensue. Discussion topics will include the following:

- the relative merits of different modeling approaches
- the limits of predictability in land systems
- the potential value of data, software, and community infrastructure in advancing land change modeling
- the role and limits of Earth observations and other data in supporting land change modeling
- the potential for improvements in participatory modeling and modeling to support decision making.

| 0077 | 'Land Grabs', 'Water Grabs', 'Green Grabs': is research accounting for differentiation in the African context? | Andreas Thiel Jonah Wedekind | Germany |

The recent rush for land, notably through investments into agricultural extensification and intensification in developing countries has generated a literature rush that commonly refers to this phenomenon as 'land grabs'. The analytical focus of the 'land grab' literature and the research behind it is predominantly centered on the variable of land. More recently the categorical labels 'water grabs' and 'green grabs' have been introduced to highlight the broader social-ecological implications and potential motivations behind the rush for agricultural land. With focus on Africa, this panel starts from the proposition that the connotations and uses of the overarching terminology of 'land grabs' and its implications for scientific research on investments into agricultural intensification and extensification have not been rigorously addressed. Indeed, the phenomenon is part of a variety of broader global and national transformations that are rushedly being analyzed but that nonetheless require greater empirical accounts of differentiation. Thus, neither are predominant motivations underlying 'land grabs' clear and consistent, nor can we in any way generalize over resulting impacts on interrelated natural resources (water, soil, biodiversity), nor broader social and economic contexts. As a result, we discuss how science needs to clarify what (combinations of) methodologies research needs to apply and at what scale if we want to arrive at more robust claims about what is at stake in 'land grabs', and what their underlying processes and impacts are. Alternatively, science may want to promote modesty and recommend caution in regard to specific approaches and claims. Under the conference theme of 'rethinking land change transitions', this roundtable will address and discuss the following related questions:

Does the label 'land grabs' and the research that employs it, effectively frame and analyze differential socio-economic and socio-ecological impacts and changes of different agricultural investments in different regions of Africa's political economy?

What is in fact the evidence on social-ecological and socio-economic implications of 'land grabs' at the local, national and international scale?

And, what cautions may need to be applied and what evidence needs to be generated how, in order to account for differentiation of the phenomenon, generally subsumed under the catch-all phrase of 'land grabs'?

Under the session format of a round-table discussion, three out of four panelists confirmed participation. Panelists were selected for their expertise on specific aspects of the roundtable. Each will have the task of providing an overview reflecting on existing research on Africa concerning one of the following issues: a) the phenomenon and its underlying global and national process of transformation, b) the actual extent and type of investment in agriculture and underlying motivations, c) socio-economic impacts and/or d) ecological impacts at the local and regional scale. Each panelist will give a 5-8 minute speed-talk based on a maximum of 3 slides. This will be followed by 20 minutes of round-table discussion before the panel discussion will be opened for 30 minutes of open discussion. The target audience comprises students, young and advanced researchers, and those with wider interdisciplinary interests in development and environment related fields.

| 0078 | GEOSHARE: Geospatial Open Source Hosting of Agriculture Resource and Environmental data for discovery and decision-making | Thomas Hertel Navin Ramankutty | USA |

The lack of time series, interoperable, geospatial data at global scale has greatly inhibited the ability of scientists,

practitioners and policy makers to address the socio-economic and environmental impacts of contemporary policy issues related to food production and the long run environmental sustainability of the world food system. GEOSHARE aims to help fill this gap. With funding from the UK government, it is currently in its pilot phase. The first speaker in this roundtable is Navin Ramankutty, who will briefly summarize the vision for GEOSHARE. He will be followed by perspectives on the sharing of geospatial data from the donors' perspective (Gates Foundation), and from the perspective of two key players in geospatial data for agriculture (IIASA and UN-FAO). The speed talks will conclude with a synopsis of challenges and future directions for GEOSHARE by Tom Hertel. We will then open the floor to audience participation regarding future directions for GEOSHARE specifically and the development of geospatial data bases for analysis of global land use more generally. We anticipate the following points to garner special attention in this session:

While perfect interoperability is likely impossible, which are the most important margins of collaboration for ensuring global data bases which will best serve the Global Land Project Open Science community?
How can we lessen the tension between attainment of individual publications and professional advancement and the provision of hard-earned geospatial data to the international community?
How can we ensure greater professional rewards for those producing geospatial data?
What types of cyber-infrastructure are likely to be most effective in promoting collaboration to improvement global geospatial databases? How has the HubZero environment performed for GEOSHARE?
What new types of data are likely to be required in order to address the challenges of the 21st century?
What are likely sources of future funding for this type of global public good?
How can we better demonstrate the value for decision makers of improved global geospatial data?

This session will be linked to the Research Session proposed by Erb and Kuemmerle entitled: "Global Land Use Datasets: Status and Way Forward". It will advance the objectives of the GLP community by contributing to the improved design of the governance and infrastructure needed to develop and maintain global databases on land use. Such data are necessary for advancing all four objectives of the GLP 2014 Open Science Meeting.

| 0934 | The Future Earth approach and its importance for understanding land use change in Africa | Melissa Leach | UK |

Global environmental changes have regional and local impacts, simultaneously undermining natural resources and ecosystem services, and endangering human well-being and security. The cross-scale interactions between human activities, large scale changes in the Earth system, and local impacts have important implications for human development and create many of the sustainability challenges facing society. Achieving global sustainability requires bridging the gap in awareness between local actions and global effects. 'Future Earth – research for global sustainability' is an ambitious international research programme bringing together IGBP, IHDP, Diversitas and WCRP, with a vision to provide the knowledge societies need to secure a sustainable future. Launched in June 2012 in the context of the Rio+20 conference, Future Earth will pioneer new approaches to international research bringing together many knowledge fields around common research challenges. It will provide an international platform for engagement and communications with policy, business and society around global sustainability challenges. As GLP is considering its transition to Future Earth, the event provides an opportunity to discuss the benefits of working across natural, social and engineering sciences and engaging stakeholder groups in defining research priorities and delivering research that can inform action. The speakers will discuss the potential of interdisciplinary and transdisciplinary work to strengthen the outcomes for sustainability through an example related to the drivers of land use change in Africa.

CATEGORY: *1.3. World Cafe Workshop*

NUMBER	TITLE	CHAIRS	COUNTRY
0075	From meta-analysis to modeling: understanding local land change globally	Nicholas Magliocca Jasper van Vliet	USA

Local land-use choices are the result of the decision-making processes of individual land users, outcomes of which influence and are influenced by a wide range of social, economic, and environmental forces at local, regional, and global scales. Understanding the motivations and rationale for the adaptive responses of land users to changing local and global conditions, and how those responses might differ across land-use systems globally, is thus necessary for understanding how local land-use and livelihood decisions respond to changing local and global conditions. In line with the conference theme of "*Local land users in a tele-connected world*", this session will explore how local land change knowledge accumulated through case studies can be synthesized with meta-analytic techniques (Magliocca et al. *in prep.*; Rudel 2007; van Vliet et al. *in prep*) and harnessed to design, parameterize, and test multi-scale models of land change that connect large-scale patterns of land-use to local decision-making processes. This workshop will be of interest to case-study and meta-study practitioners alike, as well as global change researchers and land change modelers. The session chairs will offer a brief framing of the session's objectives based on their work with meta-analyses and multi-scale modeling of land change. Group discussions will address the questions below with a particular focus on representing and integrating the diverse epistemological and methodological approaches that are involved in conducting land change research at different scales. The short reports by each group will be organized into challenges, potential solutions, and prospects for answering the focus questions, which will provide the main content for a follow-up paper.

NUMBER	TITLE	CHAIRS	COUNTRY
0121	The complex role of land system change in health and disease	Joseph Messina	USA

Land use and land cover (LULC) are often cited as the most important factor in the reemergence of infectious disease (Woolhouse 2012). However, as abstractions often only loosely or indirectly tied to relevant drivers of health and disease, the complexity and applicability of LULC data sets remains problematic for many health professionals trained from completely different methodological and conceptual histories. Some will argue that the chain of disease transmission emphasizes factors related to host and agent and that LULC is a tertiary driver. However, understanding the relationship between land cover and disease requires intimate knowledge of the dynamic relationship between the environment, people, and pathogens. This becomes increasingly complex, as several diseases exist in stages that alternate between humans and non-human vertebrates, invertebrates, or other mediating living organisms. Clearly, these diverse skills require interdisciplinary teams and attendant vocabularies. Land use and cover change systems are often manifestations of synergistic, relationships, where causality is bi-directional in that LULC not only affects socio-cultural norms, but these norms influence LULC. Unfortunately, it is almost always the case that health literatures focus on only one side of this relationship with disease response some dependent variable in a larger group level model with LULC, in some form, a one-way predictor.

CATEGORY: *1.4. Short Training Session*

NUMBER	TITLE	CHAIRS	COUNTRY
0062	Intensity analysis training session	Robert Pontius Safaa Aldwaik	USA

This training session teaches participants how to perform and interpret Intensity Analysis, which is a quantitative method that the session's chairs developed (Aldwaik and Pontius 2012). Land Change Science is a common application of Intensity Analysis, which can analyze land categories from several time points by considering a transition matrix for each time interval. Intensity Analysis has three levels, where each subsequent level exposes more detailed types of information, given the previous level. First, the interval level examines how the size and speed of change vary across time intervals. Second, the category level examines how the size and intensity of gross losses and gross gains for each category vary across categories during each time interval. Third, the transition level examines how the size and intensity of a category's transitions vary across the other categories that are available for that transition during each time interval. The method tests for stationarity of patterns across time intervals at each level. Our training sessions also presents a recently-developed method to compute the minimum hypothetical error in the data that could account for each observed deviation from a uniform intensity. In addition, the session will teach a method to automate category aggregation, so that researchers can reduce the number of categories while still focusing on important categorical transitions over time. Typical participants range from university students to professionals with decades of experience. Prior experience with Excel is necessary. The computer programs are embedded in Excel files that are available for free at https://sites.google.com/site/intensityanalysis/. Participants should load the Excel files to their own laptop computers before coming to the session. The lecture and materials are in English. This session contributes to the conference theme concerning *rethinking land change transitions*.

0070	Community- and citizen-science tools for global land cover mapping, monitoring and validation	Xiangming Xiao Steffen Fritz Wataru Takeuchi	USA

Global mapping, monitoring and validation of land use and land cover changes have been challenged by the fact that these changes occur at a local scale and it is difficult to collect time-specific and location-specific in-situ data at regional, continental and global scales. Recent advancement in GPS smartphones and digital cameras offers an unprecedented opportunity to engage researchers, students, stakeholders, and citizens in collecting geo-referenced field photos that document landscapes and their changes. Software and mobile apps have recently been developed to enable hundreds of thousands of people to participate in such a data collection exercise (http://paddy.iis.u-tokyo.ac.jp/ and http://www.geo-wiki.org). Advanced Internet technology and web technology make it possible for research communities and citizens to share and visualize these geo-referenced field photos and associated thematic data in a virtual world (http://www.eomf.ou.edu/photos). These geo-referenced field photos and thematic databases have been used to support land cover mapping at regional, continental and global scales, including both algorithm development and map product evaluation and validation. Advanced web tools have also been developed and used to enable researchers and citizens to evaluate global land cover maps (http://www.geo-wiki.org). We propose to introduce these tools to the participants at the meeting, and train them as teachers of teachers, so that they can inform and train additional people in their institutions and countries, and continue to promote community remote sensing and citizen science, a key element to support and sustain the global land project.

0083	An introduction to GEOSHARE's cyberinfrastructure: exchange and analysis of geo-spatial data through HUBZero	Nelson Villoria Thomas Hertel Navin Ramankutty	USA

The emergence of cyberinfrastructure integrating computer, information, and communication technologies to facilitate scientific practice represents a paradigm shift that enables streamlined collaboration across distance and disciplines. A main challenge in creating a cyberinfrastructure for geo-spatial data is to allow enough flexibility to accommodate users with different goals, interests and needs. To tackle this challenge, GEOSHARE's cyberinfrastructure (https://geoshareproject.org/) aims to give users the ability to manage data and create tools by

themselves, and share their research with the broad community. GEOSHARE's cyberinfrastructure is based on HUBZero (https://hubzero.org/), a well-established and popular open source platform for creating dynamic applications for research and education. Based on recent web statistics, current HUBZero-based applications are serving more than 750, 000 unique visitors annually. The existing HUBZero capabilities include social networking capabilities for research and education, and have been adopted by many domains including nanotechnology, hydrology, earth sciences, medicine, pharmacy and educational research, among others. GEOSHARE extend HUBZero by implementing tools for handling geospatial datasets, mapping and modeling. The training objectives of this session are to demonstrate how to become part of GEOSHARE, how to use its basic data capabilities, and how to share data and modeling tools with the broader community. We also seek to get feedback from participants in order to enhance GEOSHARE's capabilities to satisfy the needs of geospatial data users. Our targeted audiences are conference participants interested in having access to an open source cyberinfrastructure geared towards creating data as well as sharing analytical tools such as crop simulation models. The chair and the two co-chairs plan on each teaching one of the topics of the program described below. The three co-chairs are experienced with the teaching of lab classes, so if we have a computer lab available for the session, the instructor will guide participants as they work in their computers. Otherwise, we offer a demonstration of HubZero and the associated geospatial data sharing and simulation tools. This session is planned as back-to-back session with the round table proposed by Navin Ramankutty and Thomas Hertel "Global land use' data - the GEOSHARE project" and it will advance the objectives of the GLP community by contributing to the improved design of the infrastructure needed to develop and maintain global databases on land use. Such data are necessary for advancing all four objectives of the GLP 2014 Open Science Meeting.

0125	The GLOBE project: evolving new global workflows for land change science	Erle Ellis Nicholas Magliocca	USA

Land change science (LCS) is an emerging field of study aimed at understanding interactions among human systems and the terrestrial biosphere, atmosphere and other Earth systems as mediated through human use of land. Advances in LCS are needed to better quantify, predict, mediate, and adapt to global climate change, biodiversity loss, and other consequences of land use and land cover change. Despite vigorous efforts by a broad array of social and natural scientists, the cross-scale synthesis of multidisciplinary observations, models and theories on coupled human and natural systems (CHANS) that are required to advance LCS has yet to emerge. A major obstacle is the tremendous challenge in global integration and synthesis of local and regional CHANS case studies. Following the conferences overall theme of "*Land Transformations: between global challenges and local realities*", the GLOBE system presents a new online social and geo-computational tool that facilitates the collection, management, and real-time quantitative analysis of georeferenced case studies to accelerate synthesis of local land change knowledge within a global context. This short training session will be of interest to case-study and meta-analysts alike, as well as any researchers seeking to leverage GLOBE's unique analytic and networking capabilities tailored to the LCS community. Participants in the training session will be introduced to the suite of GLOBE capabilities, provided with real-time demonstrations of both basic and advanced applications of GLOBE, and will received additional instruction on entering their own case studies or collection of case studies.

CATEGORY: *1.5. Open Session*

NUMBER	TITLE	CHAIRS	COUNTRY
0104	Fresh from the field, young researchers and the fruits of their labour: 'Land Grab' and new patterns of investment in African agriculture	Jonah Wedekind Andreas Thiel	Germany

This 'young scholars panel' views the emerging category of 'land grabs' as a proxy-term for global large-scale investments into agriculture that drive dynamic social, economic and political changes to local land, labour and ecology. The FAO's promotion of *Voluntary Guidelines on the Responsible Governance of Tenure of Land, Fisheries and Forest* (and similar investment guidelines by the World Bank, IFPRI and UN) represent a current concern among the international community about the social, political, economic, and ecological implications of contemporary large-scale agricultural investments and land acquisitions (or leases) in developing countries, particularly in Sub Saharan Africa (SSA). These concerns encourage agribusiness promotions of market-integrating investments into smallholder agriculture (contract farming, joint ventures, plantation-type farming, etc.) rather than investments that potentially 'grab' land, displace labour and harm the environment. Here the question is raised, what do broad calls for tenure-secure investments and sustainable land governance imply in practice? As agrarian investments in SSA diversify and bring heterogeneous agrarian changes to land, the labour that works it and the ecology that sustains it, new research questions have to be asked, methods applied and frameworks developed. This round table gives young researchers the floor to compare, contrast and discuss research questions, methods and findings on new patterns of investments into agriculture in SSA and related changes to land, labour and ecology. With regards to the themes of 'rethinking land change transitions' and 'land governance' and the aim of capturing newly emerging trends and heterogeneous dynamics concerning 'land grabs' in the context of five different countries in SSA (Liberia, Rwanda, Cameroon, Mozambique and Ethiopia), this panel of young researchers is guided by the following questions:

> What research questions must/did young researchers ask to gain insights into market-integrating agricultural investments and the implications for land-use change, labour relations and political ecologies?
>
> What scientific methods and frameworks for social science research could or should young researchers employ to enrich the current 'land grab' debates, to capture the broader (vertical, horizontal and historical) social, economic and political dynamics of agricultural investments and changes to land, labour and ecology in SSA?
>
> What are the typologies of different agricultural investments and what are the socio-economic and/or socio-ecological impacts of their particular institutional arrangements on land-use change and/or labour relations, and/or the environment?

This round table corresponds to and aims to create a back-to-back dialogue with the panel from the round table titled *Land Grabs, Water Grabs, Green Grabs: Is research accounting for differentiation?* (see session proposal #0077). Thus this session not only seeks to appeal thematically to the same audience, but to go beyond this; to attract a critical mass of young scholars and facilitate discussion amongst them, as well as to seek feedback and guidance from experienced scholars working on 'land grab' issues. The format here is left open and fluid to the extent that the below listed PhD students should give power point or poster guided speed talks of ca. 8-10 minutes. The chairs should use the 'open format' to facilitate a dynamic 35 min Q&A between audience and panellists. The goal is a form of exchange or dialogue between young and experienced researchers.

0118	Transform the world in 400 seconds	Nancy Golubiewski	New Zealand

Can you convey the local realities of global challenges in 400 seconds? PechaKucha is a simple presentation format in which the presenter shows 20 images, each for 20 seconds. The images advance automatically and the speaker talks along to the images. The idea is straightforward: no getting lost in a slide and no talking too much! The premise: uncover the unexpected and tell great stories. Over the last decade, PechaKucha sessions have been held regularly in over 600 cities, each comprised of a diverse array of topics (www.pechakucha.org). This special session provides presenters and audience alike the opportunity to immerse themselves in the fascinating world of land-change science by focusing on the stories that emerge from the studies. Here's the challenge and the opportunity for the GLP OSM: Studies of land transformation are perhaps just as visually gripping as they are data rich. The

challenge in this session is to use great narratives and the visual medium to convey stories of land transformation without relying on text-heavy slides. In fact, no text allowed. How compelling can *you* be?! The presentations must fall into one of the four conference themes, with the overall concept of Land transformations: between global challenges and local realities. Nine presentation slots are available, each one of 10 minute duration (the 20x20 talk followed by discussion). Please nominate the appropriate conference theme when submitting your abstract.

0131	Intensity analysis to characterize land change	Robert Pontius	USA

The format is a 10-minute introduction to Intensity Analysis, followed by four papers each of 15 minutes plus 5 minutes of discussion. The rationale for this session is to present research specifically on the particular methodology of Intensity Analysis. Most of the four presenters are early in their careers; however they have substantial experience using Intensity Analysis, so I can assure that each presentation will be high quality and relate directly to the session's topic. Two of the presenters learned Intensity Analysis at a GLP funded workshop in Japan in 2010. These presentations are highly recommended for attendees who plan to take the Intensity Analysis training, which has already been approved by the GLP. The target audience is scientists who examine change among land categories over time. We assume audience members may have heard of Intensity Analysis but may not have applied Intensity Analysis in their research, which is why we need the introductory 10-minute primer at the beginning. This session examines the properties and interpretations of Intensity Analysis, which characterizes land change. Intensity Analysis is a mathematical framework that compares a uniform intensity to observed intensities of temporal changes among categories. The method applies generally to analysis of changes among categories during time intervals, because the input is a standard transition matrix for each time interval. The method produces results for three levels of analysis: time interval, land category, and specific transition. We use case studies to illustrate general principles. This session resides in the conference theme concerning *rethinking land change transitions*. The GLP meeting includes a hands-on training session to instruct participants how to apply Intensity Analysis in their research. Software for Intensity Analysis is available for free at https://sites.google.com/site/intensityanalysis.

Conference Theme Nº2: *Local land users in a tele-connected world*

CATEGORY: *2.1. Research Presentation Session*

NUMBER	TITLE	CHAIRS	COUNTRY
0016	Cascading interaction of global and long-term nitrogen cycles in coupled human and ecological system	Hideaki Shibata Jianwu Tang Cristina Cruz	Japan

Nitrogen is an essential nutrient for all biota, but nitrogen could behave as a pollutant when exceeding over the natural demand. Global climate change and economic globalization have strongly changed the nitrogen cycle that impacts the global, regional and local environment, e.g. increased greenhouse gas emissions, ecosystem degradations, nitrogen deposition to natural ecosystem and eutrificaiton of soil and water. The nitrogen cycle is an interdisciplinary environment parameter relating to land transformation, energy and food production and consumption, climate changes, exploitation of natural resources, pollution of air, soil and water, human health, ecosystem services, and other various natural and anthropogenic drivers. The nitrogen cycles largely fluctuate across the geographical boundary, multiple natural and anthropogenic ecosystems, and urban-rural societies with complex interaction and feedback both temporally and spatially. This session highlights the current understanding of the temporal and spatial patterns, drivers and mechanisms on the various issues of nitrogen cycles in multiple aspects, impacts of land-use and land-cover changes, air and water pollution, fates of greenhouse gasses, human health issue, changes in ecosystem processes, economic valuation, and ecosystem services. The session is expected to include many outstanding research and synthesis findings from the International Long-Term Ecological Research Network (ILTER), which is a formally endorsed network of Global Land Project (GLP). The outcomes of this session will contribute to the synthesis activities of GLP, especially on Theme 1.2, 1.3, 2.1, 2.2 and 2.3 of the GLP Science plan as follows;

> How do changes in land management practices affect nitrogen biogeochemistry and biodiversity of terrestrial and freshwater ecosystems?
> How do the nitrogen biogeochemical dimensions of global change affect ecosystem structure and function?
> What are the critical feedbacks of nitrogen biogeochemistry to the coupled earth system from ecosystem changes?
> How do changes in nitrogen biogeochemical dynamics affect the delivery of ecosystem services?
> How are ecosystem services relating to nitrogen biogeochemistry linked to human well-being?

We aim to publish a special issue in a high-impact international journal on land change science of peer-reviewed articles selected from oral and poster presentation in this session.

0024	Globalization of land use: distant drivers of land change and geographic displacement of land use	Patrick Meyfroidt Eric Lambin Karl-Heinz Erb Thomas Hertel	Belgium

Distant drivers of land change, often associated with growing urban consumer class in emerging markets, interconnections between social-ecological systems that are separated geographically, and indirect consequences of local land use changes are gaining attention in land change science. Local to national-scale interventions to promote sustainable land use may have unintended effects owing to a displacement of land use inside but also across countries, due to trade of products but also movements of people. Understanding these emerging interactions and feedbacks between distant social-ecological systems – and harnessing the new opportunities created by globalization represent major issues, as well as methodological and theoretical challenges. This session will discuss researches using various methodological and theoretical frameworks, and original combinations of different approaches, which address the challenges of linking globalization with land uses. Linking material and monetary flows across countries and value chains to actual land changes and environmental impacts is challenging. Biophysical accounting and CGE

models provide analytical frameworks for understanding the relations between trade and production, by showing the impact of trade in a specific commodity on aggregate production and land use, and the magnitude of indirect land use changes. Place-based studies provide a richer understanding of how these aggregate changes actually occur, i.e. through agricultural expansion or intensification, and whether land conversion is encroaching into forests, other natural ecosystems, or agricultural lands. Combining global economic models with place-based studies and developing a new generation of models and methods to couple local and global processes are required to better understand causal relationships linking land change, trade, policies and other underlying drivers such as population and lifestyles. Promoting sustainable land use and avoiding shifting geographically negative environmental externalities requires better integrating factors associated with the demand for land-based resources, and commodity value chains that link producers and consumers at the global level, in addition to the more traditional place-centered, supply-side view of land change. The theoretical lenses through which displacements of land use across countries can be framed will be further explored. The session will contribute to the GLP OSM themes by improving understanding of (i) the effects on land use of decisions by all actors of the supply chain, from producers to consumers (theme 2); (ii) how these new processes of land change require a redefinition of the traditional state-based command-and-control governance of land use (theme 4).

0027	The influence of global markets on land-use change in Latin America	Martha Bonilla-Moheno Ricardo Grau	Mexico

Land-use and land-cover change (LUCC) is a major cause of environmental transformation. It directly influences food production, biodiversity conservation, and ecosystem services. Recognizing the consequences of LUCC is a straightforward matter (e.g., deforestation, agricultural expansion, change in biochemical cycles, among others); however, identifying the driving forces behind that change, a prime goal of global change research, can be a challenging task. This task becomes more complex since, in many cases, land change is caused by the production of crops intended to fulfill global demands and not for local use or consumption. In fact, the raising markets for specific products are one of the principal drivers of LUCC. Crops for animal consumption, alternative energies, or particular commodities, compete among them for land, but they also compete with the remaining land devoted to biodiversity conservation. Identifying the global markets influencing LUCC will help to understand how local users are responding to a tele-connected world, as well as to understand the tradeoffs to successfully meet the increasing demand for food, energy, or commodities, while preserving land for conservation. In this symposium we will present case studies of global markets that are influencing LUCC throughout areas of Latin America, a region characterized by having high levels of biodiversity and forest biomass, and a large potential area for agriculture increase. We will address the implications and magnitude of studies from land-use change, in a region where incentives to increase agriculture production, the prospect crop expansion for biofuels, and the growing population with increasing income, are major forces for continental land change. Specifically we will discuss case studies from agriculture (e.g., crops for biofules, animal consumption, and denomination of origin commodities) and gold mining, in the light of land-use efficiency, global change, environmental deterioration, and social implications.

0041	Managing farming systems in a globalizing world: land use and environmental dimensions of agricultural trade	Graham MacDonald Kimberly Carlson Paul West	USA

Globalization of agriculture via trade is fundamentally changing the relationship between people and farming systems. Spatial decoupling of agricultural production and consumption may affect the efficiency with which our food is produced, but poses environmental concerns especially when export production coincides with agricultural intensification. For example, if agricultural production is shifted from areas with lower resource use efficiency to regions with greater efficiency, agricultural trade could facilitate net global scale conservation of land, freshwater, and other resources. Yet, increased agricultural specialization, industrialization, and shifts toward export-oriented commodities may affect farm system structure and on-farm management practices, while possibly distancing consumers from changes in local, production site provision of ecosystem services that are essential to well-being across scales. Assessing the potential costs and benefits of trade will be essential for enhancing food security while reducing the environmental burden of agriculture in the face of global change. Embracing the potential of trade to maximize food production while minimizing environmental externalities requires evaluating both the resource use

associated with different types of farming systems, as well as the market forces and environmental conditions that regulate trade patterns. This session draws upon research dealing with distinct facets of agricultural supply chains – from farm-level management to final consumption – emphasizing trade as a driver of land use dynamics and associated changes in ecosystem service provision. Specific topics to be covered include the influence of commodity chain structure and characteristics on tropical land use, and how globalization may mediate trends in forest cover across nations. Additional speakers will address the carbon, freshwater, and nutrient flows that are embodied in the production of commodities traded among representative nations, focusing on how these flows are influenced by dietary changes and prevailing farm system characteristics (e.g., yields and management). Speakers will be encouraged to view these issues through the lens of how local land systems are connected with global dynamics, including population growth, economic development, and global environmental change – emphasizing opportunities to achieve more sustainable food systems. By addressing agricultural trade from a holistic perspective that underscores cross-scale interactions, our session corresponds to Theme 2 of the Global Land Project Open Science Meeting (*Local land users in a tele-connected world*), but is highly synergistic with Theme 3 (*Impacts and responses*).

0044	Land sharing vs. land sparing debate: have we come any closer to solve the dilemma?	Cristina Vega-Leinert Otto Verkoren Vera Tekken	Germany

In a globalised world, with a projected population of 9 billion by mid-century, critical challenges are to satisfy competing demands for natural resources and improve livelihoods, while respecting planetary boundaries. Against this backdrop different approaches in land use have emerged, which seek to reconcile multiple, often conflicting needs and interests at different scales. This session focuses on two apparently irreconcilable conceptualisations of land use and their implications. First, **land sparing** centres on improving land use functionality through specialisation, and spatial segregation between agricultural and conservation areas. This implies agricultural intensification to increase land use efficiency and productivity and formally designated protected areas, where settlements and resource use are regulated or even prohibited to allow ecosystems restoration and maintenance. This model indirectly favours the concentration of rural population and rural-urban migration. In contrast, **land sharing** fosters the spatial integration of agricultural and conservation goals, framed by sustainable development. Here, different modalities of conservation agriculture and agro-forestry and pastoralism are favoured. This model has a local to regional focus and is compatible with dispersed, decentralised rural population. Scientific opinions differ on the effectiveness of these approaches in facing local to global challenges, which has led to a lively debate in recent years. A debate that is clearly influenced by disciplinary traditions, priorities in addressing global environmental change, scale, etc. The outcomes of this exchange is critical, since land use conceptualisations drive environmental and development policy, subsidies and natural resource management. These in turn strongly influence land use decisions, migration patterns and transformations in rural – urban systems. The planed session will synthesise the land sharing vs land sparing debate and discuss its salience in current state-of-the-art global environmental change science and its influence in the policy and management arena. Sessions papers will approach this controversy though different angles and present relevant case studies to contextualise and discuss strategies to enrich and further the current reflection on how to overcome this, in our opinion, counterproductive dichotomy. The session addresses a number of key conference topics, including:

        -land system changes as driver to global environmental change
        -land use policy and management as driver of human decision-making
        -rural-urban transformations
        -pathways to foster a transition to sustainable land use

0045	Can UNESCO Biosphere Reserves bridge the apparent gap between land sharing and land sparing?	Cristina Vega-Leinert Susanne Stoll-Kleemann Friedrich zur Heide	Germany

To complement the session entitled „*Land sharing vs. land sparing debate: have we come any closer to solve the dilemma?*“, we propose to a follow-up session on the potential of UNESCO Biosphere Reserves in bridging the gap between these apparently opposed land use conceptualisations. Biosphere Reserves are a protected areas model that

conceptually allows reconciling conservation with multiple land use, based on a zonation system. The latter creates a continuum between strict ecosystem protection and differentially regulated land use, which leaves room for intensification of agricultural practice, while actively supporting a transition to sustainable agricultural practice. Effectively, within a Biosphere Reserve both land sparing and land sharing occur. Critical here is the overall Biosphere Reserve legal and management framework, which fosters a comprehensive and integrated approach to conservation, land use and settlement. Since Biosphere Reserves are framed as living laboratories to promote sustainable development and good environmental governance, they are also privileged settings to experiment with and adapt land use strategies to current challenges. For example, strategies can aim at optimising critical ecosystem services rather than maximising a few ecosystem services. Thus, if agricultural intensification may succeed in increasing food and energy security over the short-term, it may endanger the capacity to reproduce agricultural systems over the long term (e.g. through decreasing pollinators). Moreover, society may want to preserve specific cultural landscapes and traditional agricultural systems (e.g. shaded coffee gardens / maize milpa systems in Latin America), which though extensive and poor in yields, preserve critical biological and cultural diversity. Further, Biosphere Reserves are often located at the periphery of important urban areas and play a critical role in securing critical natural resources and ecosystem services for urban population (e.g. water supply, recreation, etc.), while the expansion of urban areas often constitute a threat to existing protected areas. Finally, Biosphere Reserves can provide an adequate framework to foster environmental education, capacity building and local participation in land and resource decisions. The planed session will evaluate to which extent UNESCO Biosphere Reserves can constructively contribute to solve the land sharing vs land sparing debate, based on relevant case studies. The session addresses a number of key conference topics, including:

- land system changes as driver to global environmental change
- land use policy and management as driver of human decision-making
- rural-urban transformations
- pathways to foster a transition to sustainable land use

0058	Coupled human-natural system models for the assessment of the dynamics and resilience of mountain socio-ecological systems	Gregory Greenwood Thomas Kohler	Switzerland

Understanding and forecasting the dynamics and emergent properties of mountain socio-ecological systems requires the elaboration of models of the coupled human-natural systems in mountain regions. This session will explore a variety of approaches to such models and assess the likely future directions for productive research. Mountain regions provide a complete suite of ecosystem services, from supporting biodiversity to the provisioning of water, food and fiber, regulation of floods, landslides and other mass movements, and cultural services related not just to recreational activities but also to spirituality and to national and cultural identity. These manifold services are critical not only to mountain communities, but to the numerous people, societies and nations who live downstream from these systems. These services thus creating a rich network of linkages across geographic space that one might not otherwise expect for such frequently peripheral areas. These linkages manifest at multiple different scales, from the local to the continental. They are furthermore structured by the nature of the services in question and thus operate through multiple different hierarchies. They epitomize teleconnections between decisions taken at various distant centers and resource management within these important regions. Mountains regions are at the same time very dynamics, driven by a range of pressure, often but not exclusively socio-economic, and pulse phenomena, often but not exclusively biophysical. Thus the dynamics of mountain socio-ecological systems reflect a wide range of temporal frequencies, resulting in important and often unexpected transitions in resource use. Coupled human-natural system models provide a rigorous framework by which to express the multiple spatial and temporal scales of the drivers, their repercussions through the system and the resultants feedbacks. Their use permits the quantitative assessment of impacts and responses.

In addition, such models often support a detailed and quantitative assessment of resource governance in mountain regions. As with the services they provide, the governance of mountain regions is frequently multi-level, with authority dispersed across space and leading to novel dynamics itself. Coupled model thus provide a means for assessing likely future trajectories and more globally, the resilience of mountains socio-ecological systems to perturbations.

0085	Food, energy, climate - modeling and understanding land use change drivers across scales	Hermann Lotze-Campen Marcia Moraes Kirsten Thonicke	Germany

The increasing use of food and bioenergy in combination with climate change impacts and the need for biodiversity conservation will pose tremendous challenges for land use management over the coming decades. Many land use change drivers have their immediate causes in regional conditions and societal goals. But regional land use change is increasingly influenced by global interactions through international trade in goods and services, foreign direct investments, new information networks, and global policy agreements, e.g. on climate change mitigation and biodiversity conservation. Land use change has to be modeled and analyzed at different scales. Regional-scale modeling approaches have the advantage of providing detailed representations of land-use relevant boundary conditions and societal actors. However, they have to make a number of assumptions about the development of major trends outside the specific region, e.g. population growth, economic development, trade, and policy changes elsewhere. On the other hand, global modeling approaches are being used to explicitly project the dynamics of international trade, large-scale climate impacts, and other interactions between regions across the globe. Necessarily, these models have to neglect many specific characteristics at the regional scale. In this session, we will provide examples, based on current research, how the strengths of regional and global modeling approaches can be suitably combined and more widely applied across scales. This requires a specific research design. As part of the German national research program on "Sustainable Land Management", we show the interaction between the global scenario project GLUES with regional projects on land use change and management in Brazil (INNOVATE), Vietnam and the Philippines (LEGATO), China (SUMARIO), Russia (KULUNDA) and Germany (CCLANDSTRAT). This will improve the comparability of regional case studies and allow for a consistent analysis of land use change drivers and process as well as their interactions across the globe. Based on additional papers on case studies from other regions we will explore the potential for widening and continuing this overall research approach. This session will contribute to conference theme 2 (Local land users in a tele-connected world) and theme 3 (Impacts and responses).

0086	Linking place-based land science with process-based global change research	Peter Messerli Simon Swaffield Adrienne Grêt-Regamey	Switzerland

Land use transitions are increasingly shaped by global environmental, social and economic dynamics. There is increasing connectivity between processes of land change and multiple actors, decisions, and activities in geographically distant places. Examples include urbanization processes leading to a revaluation of rural areas, tourism, migration and remittances, the growing influence of urban consumer preference in emerging economies on global agricultural production, and large-scale land acquisitions in developing countries by a range of global investors. These processes represent a major challenge to land change science that seeks to combine integrative human-environment approaches with sustainability research. Integrative analysis based predominantly upon land as a bounded geographical area with fixed attributes becomes increasingly difficult when faced with distant and cross-scale driving forces as well as cascades of indirect impacts. Moreover, as sustainability and associated desirable futures relates closely to issues of equity and fairness in decision making, the condition and trajectories of land parcels must be connected to actors valuing and claiming the various goods and services provided by land. Without understanding tradeoffs between such claims and resulting winners and losers across spatial and temporal scales the sustainability research dimension of land change science is at stake. As a response, new conceptual frameworks such as 'distal land connections', 'teleconnections', and 'telecoupling' have emerged which complement place-based conceptualizations of land with a process-based understanding of land change. Insights from fields such as political ecology and economy extend the analytical focus from land parcels to consider flows of commodities, capital, people and information, and to the role of human agency, governance, power and actor networks at multiple scales. Referring to terms such as territory, networked spaces, spheres of influence etc. land change becomes commonly understood as an indicator and outcome of wider processes rather than a primary dynamic.

This session examines how placed-based and process-based understandings of land change can be linked in order to improve our knowledge of globalized land change processes. It investigates ways in which process-based insights on land change can be linked to and represented in a place-based understanding of space. Is it for example possible to

map actor networks and governance arrangements, visualize transnational claims on agricultural land, geo-reference value chain analysis, reveal the multiple functions a land parcel has to different stakeholders across scales, or delineate the spheres of influence of urbanization? Besides contributions to the conceptual debate, this session particularly welcomes presentations on relevant analytical tools and empirical evidence of applications.

0099	Northern Eurasia in transition: implications for food security and ecosystem tradeoffs	Alexander Prishchepov Daniel Müller Patrick Hostert Patrick Meyfroidt	Germany

The socio-political changes in Northern Eurasia during the 20th century resulted in drastic changes in agricultural land use. For instance, massive campaigns to expand agricultural land use during the communist period were followed by substantial contraction of the agricultural sector after the collapse of the Soviet Union. The dynamics of land use substantially altered food production, biodiversity and ecosystem services, which is of global relevance given the size of the region as well as the untapped agricultural potential in one of the world's breadbaskets. Unfortunately, empirical evidence for Northern Eurasia is scarce and knowledge of the extent of historic and recent land-use/ land-cover changes as well as their underlying causes is patchy. Little is known about the effects of ongoing recultivation of abandoned agricultural lands on the carbon cycle, biodiversity and on food. Understanding of the plausible socio-political and climatic scenarios regarding the future agricultural land use and food production in the region is necessary as well. This session will serve to synthesize the recent and expected future changes in agricultural land use in Northern Eurasia, in particular in post-socialist countries, including the analysis of underlying drivers of agricultural land-use change, assessments of environmental and economic tradeoffs of increasing agricultural production, past and future teleconnections of land-use change and the implications for global food security. The session is open to regional, national and case study investigations. We envisage integrated studies of agricultural land-use change including assessments of past and future changes, analyses of the drivers of change and of possible solutions involved in increasing agricultural production in Northern Eurasia.

0100	Land change science and historical approaches: how humanities and social science may contribute	Mats Widgren Lowe Börjeson	Sweden

Historical perspectives and trajectories of land change is a fundamental component of land change science and related approaches. To understand land transformations and land use transitions, we need historical data and insights, e.g. to develop and improve models of land transformations and theories of land use transitions (cf Dearing et al 2010). However, the sharing of expertise and communication between scholars approaching land change processes from an empirical historical angle and those dedicated to land change science agendas do in many cases present a challenge, e.g. due to epistemological and conceptual differences or simply from limited engagement between scientific communities. For example, while those working with empirical historical data (at any geographical scale) may be satisfied with explaining change on the basis of specific historical contexts, the basic ambition of land change science is to understand processes and patterns that are not unique in time and space (e.g. land change transitions). At the same time there is a growing interest from scholars engaged in empirical archaeological and historical research to contribute to sustainability and land change science agendas, while at the same time promoting truly historical methodologies, concepts, theoretical perspectives and empirical insights, manifested by a growing interest in for example 'applied archaeology' and 'applied environmental history'. This session takes as its starting point the many successful examples of how empirical historical research has contributed to and been integrated in land change science approaches. The aim of the session is to expose how empirical historical data as well as theoretical insights can be integrated with the ambitions of land change science and what implications this has. What prerequisites and challenges are involved? Do such efforts in any way change historical research practices or research agendas? In short, the focus is on how, rather than why, history is useful. Both empirical and conceptual contributions are welcome. Relevant questions that may be addressed are: 1) In what ways do the structure and format of empirical historical data hinder or facilitate its usefulness? Are there critical data gaps that empirical historical research should address? In what ways do concepts used hinder or facilitate the inclusion of historical insights and temporal dynamics in studies of current land transformations? How are epistemological differences and critical perspectives useful, or how can they be made (more) useful? Contributions may directly or indirectly address any of the first three themes

of the conference ("Rethinking land change transitions", "Local land users in a tele-connected world", and "Impact and responses").

0103	Advances in research on urban land teleconnections	Burak Guneralp Michail Fragkias	USA

Land use/cover change and global urbanization both are significant components of global environmental change. The emerging conceptual framework of 'urban land teleconnections' (ULT) sheds further light in their connection by examining land changes due to underlying processes of urbanization. ULT conceptualizes how local, regional, and global processes related to land use and urbanization link distant places through networks and commodity flows. The framework accounts for spatially disconnected impacts between the drivers of urban land change and the land change processes. The direct and indirect land-use changes are critical in the ULT framework whereby land use change at a specific location to meet a co-located demand (direct land-use change) leads to a cascade of induced land-use changes elsewhere (indirect land-use change). Therefore, the conceptual framework envisions transformative changes in i) the traditional system of land classification that is based on discrete categories and reinforces the false idea of a rural–urban dichotomy; ii) the spatial quantification of land change that ignore the connections between distant places, especially between urban functions and rural land uses; and iii) the implicit assumptions that emphasize path dependency and sequential land changes in land transitions. For these transformative changes to happen, there is a need for both theoretical and analytical advances. The ULT framework can draw upon selective use of concepts from various related theories such as the central place theory, diffusion theory, network theory, and complexity theory. The challenge is to build a coherent theoretical foundation from these that can also point to various ways for operationalization of the framework. Existing analytical approaches can be used, with varying levels of modification, to advance development and application of the concept; these include multi-level modeling, spatially-explicit life-cycle analysis, agent-based modeling, and others. However, linked to the theorization, the nature of modifications in these analytical methods that would be needed is also another critical point to explore. The objective of this session is twofold: to provide a state of the knowledge of how and where urbanization is driving land change and to assess theoretical and analytical approaches that could operationalize the concept of urban land teleconnections. Our session contributes to the Open Science Meeting in relation to its main theme on "local land users in a tele-connected world".

0111	Land change science, and political ecology and sustainability: synergies and divergences	Jacqueline Vadjunec Christian Brannstrom	USA

This session is inspired by and builds upon an edited volume of the same title (above) by Brannstrom and Vadjunec (forthcoming), which questions two phenomena that Turner and Robbins (2008) identified in their provocative review of convergence and divergence in land change science (LCS) and political ecology (PE) approaches for sustainability science. First, they argued that major divergences are present in the "problem framing" and "analytical approaches" of LCS and PE studies (299). Second, they claimed that in spite of these differences, LCS and PE studies "often reach similar conclusions about specific facets of human-environment relationships and provide one another potential insights in those cases where they differ" (302), and go on to indicate how PE and LCS "may work together in productive hybrid ways" (308). To critically evaluate these claims, and to advance synergies between land-change science and political ecology, we asked scholars from either the land-change or political ecology research traditions to engage with the "other" tradition within their own research. We also asked authors to reflect on actual and potential synergies between land-change science and political ecology, and to comment on the challenges of such arrangements with implications for sustainability science. Papers in this session explore a variety of identified themes relevant to the GLP meeting. First, the volume's editors explore potential thematic areas of LCS-PE synergy including *the role of institutions*, livelihoods, identity, and land use; *the new carbon economy and payments for environmental services (PES)*; *pasture, beef, and land grabs; and land-energy (biofuel) interactions.* Additional related conference themes include *land governance,* Radel et al. explore the role of gender, migration, and property rights on land change in Southeastern Mexico, *local land users in a tele-connected world*, where Millington focuses on the value chains of illegal coca commodities and land use in Bolivia, Colombia, and Peru, and *rethinking land change transitions*, where Lestrelin and colleagues explore the use of actor-network approaches to explain forest transitions in Laos.

| 0115 | Land-sparing versus land-sharing pathways for agricultural development | Navin Ramankutty Thomas Hertel | Canada |

There has been a resurgence of interest in the impacts of agricultural productivity on land use and the environment. At the center of this debate is Norman Borlaug's (2002) assertion that agricultural innovation is 'land-sparing'. However, the validity of this proposition rests, among other things, on his assumption of a fixed demand for food. Borlaug's hypothesis has recently been brought into questions by a series of studies of land use change which argue in favor of a competing hypothesis – dubbed "Jevons' paradox" -- which suggests that increases in agricultural productivity will be accompanied by an expansion in land area. Rudel et al. (2009) scrutinize FAO data for 961 agricultural sectors in 161 countries over a 15 year period, finding little evidence of higher yields being accompanied by reduced area. All of these studies suffer from the challenge of estimating what would have happened in the absence of such agricultural innovation. There is also a strong tendency in this literature to adopt a regional, rather than a global perspective, thereby ignoring impacts in the rest of the world, where land use and associated greenhouse gas (GHG) emissions may fall in the wake of this innovation. Accordingly, Stevenson et al. (2012) have recently revisited the land-sparing debate using a global simulation model and find that supply response in the rest of the world is a critical factor in determining the global land use impacts of technological change in one region of the world. Most of the published results addressing the linkage between agricultural productivity, land use and GHG emissions suffer from significant limitations. Some (including Borlaug's) are simply 'back of the envelope' calculations. These are instructive, but the absence of a formal model makes it difficult to generalize the findings. Others are based on global simulation models (Wise et al. 2009; Stevenson et al. 2012), wherein the robustness of results to variation in model parameters and assumptions is often called into question. In addition, there are now quite a few individual case studies of agricultural productivity and land use change, most of which leave open the question of whether the resultant findings can be 'scaled up' for assessment of national, continental and global impacts, due to the omission of impacts in the rest of the world. What appears to be missing from this literature is an underlying analytical framework that highlights critical parameters and identifies the conditions under which Borlaug's hypothesis holds – or alternatively, the parameter configuration under which we might expect to observe Jevons' paradox. The goal of this session is to help contribute to the development of more rigorous theoretical frameworks for analysis of these issues. This session will contribute to several of the GLP conference themes, including 'Local land users in a tele-connected world' (i.e. how innovations in particular localities affect global land use) as well as 'impacts and responses' (how the global food system might adapt to increasing demands for food, fuel and ecosystem services).

CATEGORY: *2.2. Round-table Discussion Session*

NUMBER	TITLE	CHAIRS	COUNTRY
0053	Tropical forests, climates and tele-connections through rainbow water	Meine van Noordwijk Grace Villamor	Germany

Tree cover influences rainfall. Around the world local knowledge is certain about that, and formal science is gradually coming round to this view, recognizing the complexity of cause-and-effect chains involved. Anyone walking through a landscape on a hot day knows that trees influence temperature, humidity and wind-speed. However, no current climate maps include these effects. When we worry about crop yield affects of a warmer climate, managing tree cover in landscapes can be part of the answer. With the focus on reducing emissions from deforestation and forest degradation (REDD), carbon accounting, emissions and global climate change, little attention is being paid to the more direct and tangible influences that trees and forests have on the temperature, humidity and wind-speed in which humans, crops and livestock live (the 'micro-climate') and on the landscape and regional patterns of rainfall ('meso-climate'). The World Agroforestry Centre (ICRAF) and the Zentrum fur Entwicklungs Forschung (ZEF) of the University of Bonn propose a round-table discussion on rainfall, the water cycle, forests and tree. Speed talks on basic concepts, emerging evidence and gaps with current carbon-focused forest-climate discourse and environmental policy are presented and followed by discussion.

NUMBER	TITLE	CHAIRS	COUNTRY
0108	Human decisions in ABM for land use - how to implement and how to document	Birgit Müller Jürgen Groeneveld Zhanli Sun	Germany

Agent-based models (ABMs) allow explicitly investigating the influence of human decisions at the micro-scale on land use dynamics and spatial pattern at the macro-scale. Different aspects of the decision making process of the land user can be incorporated, such as past experiences, limited information (bounded rationality), learning mechanisms, and the influence of the behavior of other actors. Therewith ABMs have proven to be a valuable and effective tool on understanding land use dynamics under global environmental change. However, two gaps for using ABMs to study the role of human decision in land use systems remain to be closed:

> First gap: Despite a wide range of different implementations of human decision making in ABMs for this context have been applied, these human decision models are often not sufficiently theoretically based or empirically supported but rather ad-hoc assumed. Additionally, systematic overviews of these implementations are rare in the literature. Consequently modeling novices have little orientation how an appropriate implementation of human decision in their model with respect to their specific research question and context should look like.

> Second gap: Communication of the model and its results to different audiences such as peers or model end-users is hampered to a large extent since model descriptions in general but also in particular of the human-decision part are often incomplete and non-transparent.

Based on a discussion of the state of the art, we therefore intend to tackle the two open challenges:

(1) Is it possible to create a guideline in the future, which shall support a modeler in incorporating and formulating human decision making in the ABM with respect to his specific research question and context?

(2) What are prerequisites to facilitate communication of the model and its results? Can standardized protocols for model descriptions, in particular for the human-decision part, be helpful? If yes, how should these protocols be structured?

This round-table is targeted apart from modeler (or modeler-to-be) to all researchers studying land-use change whoever is interested in successful interdisciplinary collaboration involving modelers. Envisaged outcome of the round-table would be the development of a future research agenda with respect to the topic and the identification of appropriate pathways to go ahead.

NUMBER	TITLE	CHAIRS	COUNTRY
0120	Joint and integrated management of land and water resources	Anik Bhaduri Giovana Espindola	Germany

In its terrestrial part the hydrological cycle is embedded in land cover and land use processes. Forests store and

release water, hence acting as natural flood control reservoirs. Agriculture, and especially irrigation is the most potent water requirement to be fulfilled etc. The importance of land cover/land use factors is primordial in the direct link between the terrestrial and atmospheric compartments of the hydrological cycle. Evapotranspiration is the most neuralgic, and one of the least understood processes within the hydrological cycle. Land use and its changes are closely related to water, its availability, quality and management. While integrated water resources management (IWRM) has been identified by the community of water professionals as the most promising framework to tackle the management of the resource sustainably, the necessary integration and joint management of land and water has not been emphasized according to its real importance. The obvious physical, chemical and biological links within and between land and water management necessitate that this integration is well extendedinto and accounted for in the respective governance frames and (joint) management models. As degradation of natural resources like water and land often occurs simultaneously and leading to a lower level of ecosystem services, and reduced capacity for food production and income generation. Intensification of agriculture, over or/and under use of water, fertilizer and pesticides, or in other words inefficient usage of resource and lack of proper management are often the causes of such degradation. Considering the interconnectedness of land and water and the potential of reversal of land and water degradation in increased agricultural production, the management of land and water needs to be addressed as one problem and treated jointly within a combined socio-economic and biophysical framework. In the joint collaborative session between GWSP and GLP, we aim to discuss the dynamics of the joint use of land and water, while focusing on the socio-economic and institutional factors supporting or constraining land and water management decision making. The proposed session will address the strategic opportunities available to invest in joint and integrated land and water management. This session will contribute to the OSM Theme 2, which deals with the role of human decision-making on land use as both a driver and response to global environmental change, bringing the multidisciplinary aspects of land and water management decision making.

0123	Interactions among managed ecosystems, climate, and societies	Tanja Suni Giovana Espindola	Finland

GLP and iLEAPS are currently developing a joint initiative named *IMECS* - Interactions among Managed Ecosystems, Climate, and Societies. The IMECS initiative is part of the transition phase of the GEC projects to Future Earth, having a strong multidisciplinary approach combining DIVERSITAS, IHDP and IGBP core projects. The main goal of IMECS is to jointly study managed ecosystems including, for instance, the physical and biogeochemical consequences of human management of ecosystems, urbanization, governance of land and water resources, ecosystem services, and climate impacts on food security**.** The work would include determining and comparing the sustainability, climatic impacts, and crucial ecosystem-society-climate feedbacks of the major managed ecosystem types of the world such as soybean fields and pastures in Brazil, polluted ecosystems near megacities as well as rice and palm oil production in Asia, and managed forests in the boreal and temperate zone. In addition, IMECS will look at urban environments with varying degrees of vegetation. Having this background, the objective of this session is to bring the community together to further discuss related aspects of IMECS. In this session we will especially target the role of economy and social drivers behind land use and management decisions and their interactions with biogeochemical cycles via irrigation, fertilizing, and planting and harvesting practices. This session will contribute to the OSM Theme 2, which deals with the role of human decision-making on land use as both a driver and response to global environmental change, bringing the multidisciplinary aspects of interactions among managed ecosystems, climate and societies.

0124	Open science for knowledge infrastructures	Gilberto Camara Werner Kuhn	Germany

Knowledge infrastructures raise a broad range of technical, institutional, and social issues. The immense efforts to deal with them in practice lets us sometimes overlook that they also pose major research challenges going beyond systems engineering and institutional arrangements. This round-table takes stock of key scientific challenges that need to be addressed if future infrastructures are to help us understand land change:

    -Sharing earth observations in GEOSS as a global infrastructure

    -Detecting change in large remote sensing data sets

    Analysis strategies for big data

Bridging heterogeneous semantics

The premise underlying these four perspectives and the whole panel is that land science and land information infrastructure research cannot and should not be separated, but need reinforce and advance each other. Both should be framed in terms relating to the land, its use, and the changes of them. This way, the science perspectives become usefully application-driven, while still pursuing our understanding of land change through better theories. The discourse on e-infrastructures today tends to be dominated by discussions of software engineering and standardization issues, which are essential for building infrastructures, but by themselves neither a matter of land science, nor advancing it. This panel intends to show how specific open science approaches can strike a balance.

CATEGORY: *2.3. World Cafe Workshop*

NUMBER	TITLE	CHAIRS	COUNTRY
0090	Science-policy dialogue for managing land use change: bridges and barrier	Evangelia Drakou Ilaria Palumbo Dorit Gross	Italy

Extensive land use change over the last decades has altered the global environment at unprecedented rates, with severe consequences for biodiversity and ecosystems' resilience and capacity to sustain human needs. The need for effective policies and strategies that manage ecosystem change, protect nature and local livelihoods is therefore evident. More often than not, these policies are driven by top-down approaches and are implemented differently across scales, usually not adapted to the local /regional /national level needs. Due to the high dependence of people on natural resources, the need to implement participatory approaches to land use management emerges. The implementation of these management strategies should be based on scientific and empirical evidence, while addressing policy requirements. However, few are the cases where all these aspects are taken into account and mostly the dialogue among scientific community, policy makers and local land users is a utopia. Based on an analysis of past examples we will give a first overview on the "barriers" and propose "bridges" towards a successful dialogue among the three main actors described above, on the field of land use change management for nature protection. Through round table discussions, each group of participants will address the issues of scale, terminology and technology and will identify how these should be taken into account to facilitate the above-mentioned dialogue. The expected outcome will be a peer-reviewed publication discussing the challenges and the way forward to improve the dialogue among these actors. This peer-reviewed publication will be prepared by a group of participants consolidated during the workshop. Our workshop will contribute to the GLP Conference thematic 2: "Local land users in a tele-connected world: the role of human decision making on land use as both a driver and response to global environmental change", by considering the link between land use and the decision making process in the socio-ecological system structure.

Statements and Questions

How does spatial, temporal and administrative scale affect the different steps of the decision making process, from data collection and analysis to result generation and their use to guide policy?

How does knowledge and terminology used among the different actors during the decision making process impact their communication and mutual understanding?

How can scientists, decision makers and local land users make the best use of the present technology to work towards land use change assessments?

CATEGORY: *2.5. Open Session*

NUMBER	TITLE	CHAIRS	COUNTRY
0112	Local decisions with global consequences: towards an integrated understanding of land-use decisions in the tropics and their consequences for people and ecosystems	Marcia Macedo Avery Cohn Ruth DeFries	USA
Agricultural systems in the tropics are influenced by an increasingly complex suite of institutional and market forces, ranging from local to global scales. Collectively, the property-level decisions of individual "land users" will determine landscape-level patterns of change in forest cover, fragmentation, and agricultural intensification. The move towards export-oriented production in many developing tropical regions may accelerate the pace of agricultural expansion and intensification – with consequences for both human and ecological systems. Although land change science has come a long way in describing the spatial and temporal dynamics of these changes in tropical landscapes, linking the observed patterns to particular agents, policies, or economic incentives has proven challenging. Furthermore, compared to temperate regions, we know relatively little about the relationships between landscape-level patterns, human welfare, and ecological health in tropical regions. This symposium will explore these complex linkages using case studies throughout the tropics and lessons learned from temperate systems. Panelists will examine the socioeconomic and biophysical factors that influence land-use decisions in each context, identify some of their social and ecological consequences, and highlight research approaches that facilitate integrated study of the two.			

Conference Theme Nº3: *Impacts and responses*

CATEGORY: *3.1. Research Presentation Session*

NUMBER	TITLE	CHAIRS	COUNTRY
0009	Land use change and ecosystem services in peri-urban area	Harpinder Sandhu Andrew Millington	Australia
	This session is aimed at the Conference Theme 3. Impacts and Responses: Changing land uses and climate are the main physical drivers of contemporary environmental change. The expansion of urban areas is a major driver of land-use change (LUC), which in turn is a major driver of ecosystem change globally. In 2008, for the first time in human history, >50% of the world's population lived in cities. Depending on the population projection used, this proportion will increase to between 59-66% by 2030. Most growth will be in small- to medium-size cities. The majority of this growth will be at the fringes of these smaller world cities, on land this is currently rural and generally under agricultural production. As population-driven urban expansion takes place through new housing, new economic activities and expanded transport networks, the peri-urban area (which develops between areas which are unambiguously urban or rural) migrates. Peri-urban areas are highly dynamic, but unfortunately they result in the loss of important rural production, biodiversity, amenity and cultural values and associated ecosystem services. This session will include presentations from Asia, Australia and other parts of the world which are experiencing similar pressures at the fringes of the urban centers. It will add to our current understanding of urban LUC and their impacts on ecosystem services and communities in peri-urban areas. It will address the crosscutting themes of urban development and global change and its implications. We are hoping to make this session rich by inviting talks on studies that identifies and compare LUC-drivers, evaluate key natural and socio-economic impacts and examine how ecosystem based adaptation strategies could be developed to best optimise natural resources and community well-being and be applied to other peri-urban sites.		
0012	Assessing drivers of deforestation for climate change mitigation	Martin Herold	The Netherlands
	The long-term viability of forest-related climate change mitigation actions depends on altering business-as-usual activity in sectors currently driving greenhouse gas (GHG) emissions from forests. Since international negotiations and developments related to REDD+ have triggered increasing interest in how to assess and understand drivers to implement such mitigation activities in developing countries, key questions have yet to be answered by a scientific synthesis analysis to understand: How do proximate and underlying drivers of deforestation and forest degradation relate on different scales (local, national, global)? What is the relevance of drivers in policy design and implementation of REDD+ interventions and which scale they are most effective? What is the role of drivers in forest monitoring and for developing REDD+ forest reference emission levels? The aim of the session is to present a consolidated scientific update to these policy-relevant questions. We aim to present new results and data (i.e. from the CIFOR global comparative study on REDD+) that will help to better understand forest related land change transitions, and its relationships with drivers on the national and international level. We will provide a synthesis on the relationship between proximate and underlying drivers and how REDD+ countries currently address drivers to highlight some of the shortcomings and current limitations for REDD+ to assess the key driving processes that are mainly outside the forest sector. There also are important implications for forest monitoring and the measuring, reporting and verification of REDD+ activities since regularly assessing and monitoring drivers are key for designing and performing REDD+; in particular to facilitate engagement with non-forest sectors. We anticipate that the session will stimulate scientific exchange that can lead to important conclusions to be articulated to the level of international negotiations and to support country efforts in REDD+.		
0018	The state of tropical savannas: responses to direct	Michael Hill	USA

	and indirect anthropogenic change	Jason Beringer Mercedes Bustamante	

Global tropical savannas are under increasing pressure from direct and indirect anthropogenic change. These ecosystems occupy a large part of the land mass of the southern hemisphere in particular. The three main continental homes for tropical savannas, Australia, South America and Africa, harbor savanna systems that are very different biologically, and face different mixes of anthropogenic change factors. However, they all contain the fundamental structural continuum of tree-grass mixtures in various forms, densities and spatial configurations. In all of these systems, we are still seeking to better understand the relationships between the tree-grass mixtures and ecosystem function from patch to management unit, and landscape to regional scales. Full characterization of the link between structure and function is vital for understanding the potential impacts of massive land conversion and major climate change on savanna ecosystems. For example, how will the *cerrado* ecoregion function when the majority of former savanna lands are converted to annual cropland? What will be the impact of changes in rainfall and temperature regimes on the herbivory-fire dynamics in the relatively arid Australian tropical savanna? In this session, we will present three overviews of the current state of research on ecosystem function and anthropogenic change for some of the major tropical savannas. These overviews would be best supplemented with voluntary papers addressing particular issues in these systems. The session will focus on what we know about tree-grass ecosystem function in these continental regions; what kinds of changes are currently occurring and are projected to occur in the near future; and whether there are current signs of changes in ecosystem function that could be detrimental to provision of ecosystem services for long term support of a balanced coupled human natural system. This session is cross-cutting between the OSM themes of *rethinking land change transitions* and *impacts and response*. It is concerned with *intensification* and the potential for *non-linearity and system shifts*. It is also concerned with *land-water interactions*, *land change impacts on ecosystem services and biodiversity* and *climate-land use interactions*. Tropical savannas are not receiving sufficient attention from the global community at present. If we can understand the function of the natural savanna systems, then we have the science and computational power to explore future change scenarios for savannas, and provide advice to managers and governments to help avoid large scale detrimental changes in ecosystem function that take huge investment and decades or more to mitigate or reverse.

0025	Potential of improving food security through closing yield gaps and land use expansion	Ruth Delzeit Wolfram Mauser Marcel Adenäuer	Germany

With a world population that is expected to grow from currently about 6.9 billion to 9.2 billion by 2050, as well as changing lifestyles and consumption patterns towards more protein containing diets, the Food and Agricultural Organization (FAO) estimates that meeting the world's food demand requires a 70% increase in total agricultural production. Land productivity considerably increased over the last 6 decades, since in this period the food production was doubled while agricultural land only increased by 10%. However, agricultural yields as well as production stability is threatened by a changing climate. Food security depends on the ability to produce a sufficient quantity and quality of food and also on the food price level. Thus, simulations of future food supply and prices are driven by various biophysical and socio-economic global and local parameters and assumptions. In this session, approaches to model the inter-linkages between global agricultural markets, availability of land for different uses, climate change, and land productivity are discussed. It focuses on contributing to compare and assess different approaches of modeling land use expansion and of integrating biophysical information on yields into economic models.

0035	Maintaining ecosystem functions and services under global change: identification of trade-offs in multifunctional landscapes with modern analysis tools	Ralf Seppelt Martin Volk	Germany

Land is a limited resource that has to fulfil various functions. Sustainable use of landscapes requires reconciling demands for settlements and infrastructure, production for food and fibre and protection of species and water, while maintaining ecosystem functions and services. Probabilities of conflicts grow more acute under the pressures of climate change and changing consumption patterns. Multifunctional land use strategies aim at sustaining landscape functions, integrating the often times conflicting demands of societies on landscapes – without impairing biodiversity

and ecosystem functions. Land use strategies include decisions on crop rotations, de- or reforestation measures, design of protected areas etc., and are implemented on multiple scales from hundreds of square kilometres to several thousand square kilometres involving trans-boundary issues. In this session we will discuss improved methods for identifying trade-offs and functional dependencies of land use. We see limits of simple scenario analysis for assessing the most efficient and sustainable options for land use and management. What scenario analysis for instance not reveals is information on the efficiency - the marginal costs/benefits - for investments on a certain land management. For identifying effective and most efficient strategies this information is crucial. We hypothesize that the combination of innovative analysis tools such as optimization, uncertainty analysis and spatial explicit analysis of trade-offs can overcome these shortcomings and serve as a base for a promising methodological framework. Optimization of landscapes for instance provides information on functional relationships between different goals on Pareto-frontiers. Additionally one can derive solutions, which maintain landscape functions even under climate change conditions. On the other hand, optimized landscapes might be fully unrealistic or much too complex as trade-off and nonlinearities in a multidimensional space of more than 4-5 key indicators are difficult to communicate. So the questions remain: (1) How to communicate these results and (2) how close can we get to optimized solutions, given the environment, environmental change and the legacy in the landscape. This is where the recent discussion on scenarios and storylines provides excellent input and guides to the final question of the session: (3) How to combine results of modern techniques for analysing multifunctional landscape with scenario approaches for communicating results? We expect lively discussions of recent, innovative developments in these fields of research based on case studies and by this provide input to the conference topic on land change transitions and impacts and responses.

0037	Innovative approaches to sustainable soil management	John Quinton Jose Gomez	UK

Soil is perhaps Earth's greatest environmental asset: it provides us with the food we eat, filters the water we drink, affects our health and wellbeing, forms a platform for the built environment, helps buffer us from extreme climatic events, supports biodiversity and is the biggest terrestrial store of carbon. Yet this precious resource is facing significant threats: sealing; erosion; salinization; compaction; loss of biodiversity and loss of organic matter. Protecting soils is one of world's greatest environmental challenges. This session will consider innovative approaches to protect and enhance soil functioning across landscapes, including urban and peri-urban environments, and will welcome papers from a range of perspectives. In particular we are interested in the papers which detail the development and evaluation of innovative methodologies, approaches and techniques that enhance soil functioning and highlight lessons learnt during their development. Alongside this we are interested in examining our ability to make predictions of the impacts of changes in soil management on soil functioning with a view to examining how changes in local, national and international policy towards soils may affect local and regional ecosystem service provision. The session will contribute to the conference theme of "impacts and responses" by examining how changes to the management of the land and soil mitigate global environmental change impacts, for example through enhanced carbon sequestration. Moreover, it will consider the balance between intensification of agricultural and fuel production and whether this can be maintained while protecting soil functionality and the ecosystem services it provides. It will also contribute to the theme of "Rethinking land change transitions" by considering how changes in soil management and land cover impact on ecosystem service delivery.

0038	Place-based analysis of land-use systems: approaches for synthesis across multiple scales	Ralf Seppelt Johannes Förster	Germany

Decision makers are increasingly recognizing that biodiversity and ecosystems provide vital services to human wellbeing. Ecosystem service assessments are evolving as key instruments for informing land-use decisions in various regions around the globe. Furthermore, environmental accounting systems, such as the Ecological Footprint or the System of Environmental-Economic Accounting (SEEA), are increasingly applied for measuring the sustainability of economic activities at national and global scales. Land use is a major factor influencing the state and trends of biodiversity and ecosystem services, mainly through the production of food and raw materials. Therefore, methods of measuring the sustainability of land use with regards to biodiversity and ecosystem services across local to global scales are increasingly needed to inform land-use decisions and respective accounting systems. This session is presenting approaches for integrating place-based research with regional and global

models/networks/information systems. A number of research initiatives have been created to address the challenge of synthesizing place-based analyses of land-use options with regards to biodiversity and ecosystem services across multiple spatial scales. Besides others, examples of approaches for tackling this challenge will be presented from the German-funded Sustainable Land Management initiative, the UNEP WCMC Sub-global Assessment (SGA) Network, and the Programme on Ecosystem Change and Society (PECS). Place-based research can provide critical knowledge on the sustainability of land-use options by examining the biophysical and socio-economic boundaries, and identifying opportunities and limits for land use within a given area. However, in an increasingly connected world, human demand for land-use products is becoming more distant to the place of production, exceeding the scope of placed-based research. Global drivers such as climate change, urbanization and population growth interfere with local drivers, such as the need of income by local land users. Within this complex system, synergies and trade-offs occur at various levels and need to be addressed in order to inform options for sustainable land management. Therefore, approaches combining biophysical and socio-economic disciplines are required to integrate place-based analyses into global models/information systems. Examples of such approaches will be presented in the session.

0063	Evaluating the sensitivity of mountain forests ecosystem services to the combined impacts of climate change and land use change	Harald Bugmann Manfred Lexer	Switzerland

Across the globe, mountain regions provide a range of essential ecosystem services (ES), many of which depend directly or indirectly on forest properties. Global change is predicted to impact mountain forest ecosystems by altering the biophysical processes that determine forest dynamics, as well as by altering land use and management decisions. Thus, the capacity of forests to provide the desired ES will depend on the relative importance of these direct and indirect impacts, and where on a landscape they are most influential. Mountain regions are defined by strong elevation and ecological gradients that dictate both the distribution and dynamics of vegetation, and the physical suitability and economic viability of different land use practices. Projecting future shifts in ES provisioning in these spatially complex regions requires as a first step a clear understanding of how region-specific shifts in climate will influence forest dynamics and forest-derived ES. Second, we need to quantitatively evaluate how these biophysical changes in forests will influence land use. Process-based vegetation models are a key tool for analyzing how forests will respond to these future changes. This session focuses on recent work geared towards elucidating the intertwined impacts of climate-driven shifts in mountain forest ES provisioning and changes in land management and land use. The objectives of this session are to examine the relative sensitivity of mountain forests to climate change how climate-driven shifts in forests and changes in land use will impact the spatial provisioning of forest-related ecosystem services. Thus, this session will contribute to identifying:

> how the dual drivers of climate change and land use change will influence mountain forest state, and how these factors will interact to influence future mountain forest ES
> key climate and ecosystem thresholds that will influence mountain forests
> where within complex mountain regions ES will be most at risk from climate and land use change
> when during the 21st century mountain region ES are projected to cross critical thresholds.

0081	Agricultural developments and the benefits for food security and local development in Sub-Sahara Africa	Marcus Kaplan Isabel van de Sand	Germany

The demand for food and energy is rising globally. Bioenergy crops are being promoted as an alternative source of energy, to reduce the dependence on fossil fuels and associated greenhouse gas emissions. At the same time, much needed increases in food production and productivity are jeopardised by the adverse effects of climate change, particularly in developing countries. This nexus between land, energy, climate, and food security is causing an increasing competition for land resources in many parts of the world. As a result, there has been a growing interest by mainly foreign, but also national investors in acquiring large areas of land for the production of food and/or bioenergy crops. This applies particularly to Sub-Sahara Africa with its large amount of apparently unused land. Very often, these investments are reported to result in negative impacts on livelihoods, natural resources, and ecosystem services. However, taking into account the low productivity of African agriculture, and rising challenges such as population growth and climate change, such investments may also create opportunities for food security and

rural development. While much attention in the current debate on large scale investments in land is focusing on the negative impacts, the goal of this session is to highlight positive impacts as the basis for deriving lessons for the future design and implementation of such types of investments: What kind of positive impacts have been demonstrated? What were the main drivers for fostering these positive impacts? What framework conditions are needed to realize positive outcomes and what roles can current guidelines and policies at the national and international level play in this regard?

0088	Moisture recycling - downwind impacts of land use changes	Holger Hoff Line Gordon	Germany

Land-use changes, in particular afforestation, deforestation and agricultural intensification have the potential to significantly change land-atmosphere water vapor fluxes. Through atmospheric transport, these changes may impact precipitation in - sometimes distant - downwind regions. The mechanism behind this, termed moisture recycling, is increasingly being acknowledged as an important feature of the Earth system. Thus, characterizing the extent, magnitude, and specific nature of land-use induced impacts to moisture recycling is necessary to understand what, if anything, can be done to respond to these actions. This is particularly evident in some precipitation dependent regions in the world, where pressures on land are also quickly transforming the vapor flux landscape. Researchers in this session will present work from a range of regions where moisture recycling plays an important role, including China, West Africa, and the Amazon. Research topics will include analyses of land-use impacts on downwind crop yields, consequences to ecosystems and fresh water resources, and corresponding management responses. By shedding light on this important aspect of land-atmosphere-water dynamics, this session intends to communicate the latest science to a broader land science community and facilitate a closer integration of land and water management.

0092	Carbon-water-biodiversity management in peatlands in South East Asia	Mitsuru Osaki	Japan

Tropical peatland preserves rich biodiversity and it stores huge amount of carbon (80-90Gt) in the world. Especially Indonesia has more than 60% of tropical peat carbon (50-60Gt). However, it has been changed to emission source by drainage of land development which causes serious oxidation of peat and wild fire. In 2005, 0.8Gt of CO_2 was emitted from peatland in Indonesia and it is estimated to grow more. One major area of concern in tropical region is rapid conversion of a vast area of tropical forest, which provide a natural carbon capture and storage function, into other land-cover types with low carbon value. During the past two decades both primary forest and total forest cover expanded in the Asian and Pacific region. In the same period, however, two thirds of countries in the region experienced an increase in the number of threatened species and South-East Asia lost nearly one seventh of its forest cover. As there are strong links between land cover and climate, changes in land use and land cover can be important contributors to climate change and variability (Loveland *et al*. 2004). So that, the current climate change global environment issue has put the tropical region in general as a strategic element to eliminate the impact. The networking and cooperation among parties (countries, stakeholders, etc.) is the key factor to tackle the climate change issues rather than a single player. This session demonstrates various approaches to detect the magnitude of land-use and land cover changes and predicting its implications for human system and ecosystem services. It will highlight the importance of remote sensing and GIS technology in providing good data and predictions needed for a better policy formulation. Apart from studies on terrestrial system, this session also presents a work on interaction of atmospheric carbon with ocean system, water and biodiversity. This session also will focus on current topics related to peatlands mapping, management and researches. As comprehensive carbon assessment is most important for tropical peatlands management, various researches and data management will be presented in different aspects.

0093	Land science contributions to improving modeling and mapping of ecosystem services	Neville Crossman, Benjamin Burkhard Brett Bryan	Australia

Modeling ecosystem service supply from the land system is usually done in one of two broad ways (Rounsevell et al. 2012): i) mapping land use and land cover as a surrogate for supply of ecosystem services, or; ii) modeling the underlying ecosystem functions and biophysical processes. The first approach makes the assumption that unique ecosystem service types and values are supplied by land cover/use types, i.e. ecosystem services are mapped directly

from land use/cover maps. This approach has the advantage of being relatively quick, easy and uses readily available data. The second approach aims to incorporate more biophysical realism by modeling the processes underlying the supply of services. Modeling biophysical processes has the advantage of being able to better map potential outcomes of policy and land management decisions on ecosystem service supply, and explore trade-offs among services under different policy and land management scenarios. However there are numerous areas for improvement within both broad ways of modeling ecosystem service supply. For example, there a multitude of modeling and mapping methods which may create inconsistency in what is being quantified and in the impacts of land management on ecosystem service supply (Crossman et al. in press). There are also many uncertainties associated with both types of modeling approaches, including model inputs (input uncertainty), parameter values (parameter uncertainty) and erroneous description of physical reality (model structure uncertainty). And to date, little effort has been made in linking either approaches of modeling ecosystem service supply (and change to supply) to socio-economic models such as agent-based and computable generalized equilibrium (CGE) models to produce better integrated assessment tools. We call for the land science community to play a substantial role in improving the modeling and mapping of ecosystem service supply (Crossman et al. in review) and this session will contribute to our call by discussing these areas of improvement in more detail. We strongly welcome contributions from the land system science and the ecosystem service communities and we will present our own material (e.g. from the Ecosystem Services Partnership (ESP) Thematic Working Group on "Mapping Ecosystem Services") that closely address the topic. Our session will directly address the OSM Theme # 3 because we are trying to improve techniques for modeling and mapping ecosystem services to better understand the impacts of land change on supply of services.

0097	Moving beyond the land sparing vs. land sharing debate	Tobias Kuemmerle Ricardo Grau Joern Fischer	Germany

Addressing the trade-offs between food production and biodiversity conservation is critical to identify pathways to sustainable land systems. To this end, the debate about land sparing (i.e., separation of land use and conservation) versus land sharing (integration of land use and conservation) has stimulated much important research. Yet this debate has resulted in a polarized discussion, with its framing perceived by many as an artificial choice between two mutually exclusive options. Important issues are not accounted for in the current generation of analytical tools to address trade-offs between agricultural production and conservation, including the role of environmental heterogeneity, and challenges when scaling up relevant local-scale findings to the landscape and regional scales. As global connectedness increases and trade linkages emerge between distant places, considering potential displacement effects of environmental impacts and exploring potential inelasticity in different demands for agricultural products becomes increasingly important for the assessment of trade-offs. Moreover, the current discussion on food vs. conservation fails to adequately acknowledge that agriculture and human well-being fundamentally depend on ecosystem services – which in turn, are easily jeopardized during intensification. Moreover, major social constraints and trade-offs are associated with any particular land use strategy, and choices of land use strategies are likely to influence land system resilience. This session will draw on recent conceptual and analytical advances to identify and develop land systems that successfully balance agricultural production and conservation. The session will discuss frontier research on topics such as ecosystem bundles, leakage effects, and land system resilience. More fundamentally, it will ask the question of the usefulness of searching for a global answer to context-specific conservation problems; and will highlight the importance of addressing both supply and demand when considering potential trade-offs between agriculture and conservation. The session will include both oral and poster presentations.

0098	Multi-scale integrated assessment of food, water, energy and land systems	Richard Aspinall Mario Giampietro	UK

This session presents an approach for multi-scale integrated sustainability assessments of food, energy, water and land systems as metabolic systems. The session starts with a brief illustration of the main theoretical and methodological challenges inherent in the exploration of the nexus between land use, water, energy and food security, population and wealth, and emphasizes the need for integrating quantitative analyses of coupled human and environmental systems across different scales and the different dimensions considered. It then illustrates the main theoretical concepts used for the multi-scale analysis and provides a general procedure to carry out the proposed

analysis. Analysis consists of a sequence of consecutive steps that identify (i) appropriate typologies of metabolic pattern for both the socio-economic system and ecosystem under analysis, and (ii) relative grammars used for the analysis. The session illustrates how multi-scale and multi-dimensional diagnosis of metabolic patterns linked to land systems identifies the rate and density of flows (including water, energy, food, and monetary flows) in relation to two multi-level matrices of fund elements: (i) one matrix is made up of compartments of human activities describing socio-economic processes (this matrix describes the requirement of resources as determined by socio-economic characteristics); and (ii) one matrix made up of land use and land cover (this matrix describes the local and regional supply of resources as determined by biophysical and ecological characteristics and constraints). The role of imports and exports in buffering between local requirements and supply is also included and links the approach to global and regional trade. The approach makes it possible to study the feasibility (compatibility with external constraints), viability (compatibility with internal constraints) and desirability (compatibility with cultural values and institutions) of relevant options and scenarios. The session is aligned with the GLP Open Meeting focus on land systems, and particularly Theme 3 on Impacts and Responses. The papers and authors represent interdisciplinary efforts to develop new theory supporting the integrated assessment of different dimensions of land systems and coupled human-environment interactions, the multi-scale assessment and organization of the work connecting local land use to global impacts and responses.

| 0101 | Whole system approaches for managing land-use change to deliver multiple benefits from biodiversity in tropical forest landscapes | Terry Parr Michael Schmidt Kirsten Thonicke | UK |

Land use change has been the main driver of change in tropical forest landscapes and continues to have enormous implications for policies designed to mitigate climate change (e.g. REDD+), reduce biodiversity loss (e.g. the 2020 Aichi targets under the Convention on Biological Diversity) and deliver ecosystem services (e.g. Payment for Ecosystem Services). The feedbacks between biodiversity and the vital ecosystem service of carbon storage and sequestration are vastly underexplored and are crucial to achieve the long-term sustainable management goals envisioned in the afore-mentioned policies. Working within the framework of a whole systems approach, we will use this session to discuss the research and development required to answer two very practical questions:

How can we combine models, observations and participatory approaches to manage complex multi-functional tropical forest landscapes and provide multi-scale options for mitigating climate change and reducing biodiversity loss?

How can we deliver information and knowledge to stakeholders that is relevant to different scales of decision making (e.g. local/landscape, national and multi-national)?

The session will start by presenting 3-linked papers from a new EC research project on "The Role of Biodiversity in Climate Change Mitigation in Latin America" (ROBIN www.robinproject.info). Work in ROBIN illuminates the relationships between changes in biodiversity and climate change mitigation in multi-functional forest landscapes by considering trade-offs between ecosystem services in systems undergoing land-use change. The 3 papers will show how ROBIN's socio-ecological approach is addressing the two questions above. In order to broaden the geographical scope of the discussion beyond Latin America, additional talks (to be selected by the organizers) on the links between biodiversity and ecosystem services in tropical forests are invited from other parts of the world. Our proposed session is relevant to the over-arching conference theme on land transformations. We will be discussing approaches that are designed in collaboration with stakeholders (e.g. farmers, foresters, conservation agencies, resource managers and policy makers) to work across scales. The aim is to deliver more sustainable alternatives to currently implemented management schemes which reconcile the diverse objectives (e.g. subsistence farming, market shares in timber and food production, biodiversity conservation, climate change mitigation) of these interest groups. Hence, our session fits best within the conference theme #3 on "impacts and responses".

| 0109 | Global soil carbon dynamics in coupled natural and human systems | Jianwu Tang Kate Lajtha | USA |

Soils contain more than twice as much carbon as in the atmosphere or terrestrial vegetation. The soil carbon stock is sensitive to the changing climate and human disturbance. Depending on human management, soil carbon could either act as a sink or a source to the atmospheric CO_2 concentration. Deforestation, forest fire, and permafrost thawing

could significantly decrease the soil carbon stock, while reforestation, non-tillage agricultural management, and restoration of coastal wetlands could increase the soil carbon stock. The soil carbon stock is the net result of carbon inputs from plants and outputs from decomposition of organic matters. However, the biological, chemical, and physical processes governing the dynamics of soil carbon across biomes and land use types are not fully understood. The objective of this session is to synthesize the global pattern of soil carbon and its dynamic change in a coupled natural and human system. By bringing oral and poster speakers worldwide together, we hope to establish a global working group to explore the dynamics of soil carbon, the mechanism regulating the change, and the impact of climate change and human management. We especially hope to bring together researchers across the International Long-Term Ecological Research (ILTER) network, a formally endorsed network of the Global Land Project (GLP), to synthesize long-term data on soil carbon. The session will contribute to Theme 1, Rethinking land change transitions, by evaluating the soil carbon change as a consequence of land change transition. It will contribute to Theme 2, Local land users in a tele-connected world, as changing soil carbon and its associated soil futility and nutrient levels will affect the land use. It will also match Theme 3 in that changes in soil carbon will impact the global carbon cycle and climate change as well as demands for food, fuel and ecosystem services.

0116	Landscape change and ecosystem service trade-offs: examples of spatial explicit assessments at different geographical scales	Cornelia Hett Peter Verburg	Switzerland

Landscape change and changes in the provision of ecosystem services of a landscape are close-knit. On the one hand human-induced landscape change result in synergies and trade-offs between a range of ecosystem goods and services. On the other hand, such changes are often the consequence of decisions taken at higher levels. Gaining benefits from the provision of certain ecosystem service can in turn lead to trade-offs with other ecosystem services required at the local level. The concept of ecosystem services and their trade-offs has evolved as a new paradigm for landscape management in recent years. Worldwide many landscapes are characterized by a mix of natural as well as managed and modified ecosystems. Both realms support human-wellbeing through the provision of different ecosystem services from the local to the global level. Science based decision-making should be based on knowledge about the potential of the different ecosystems to deliver the services which are claimed by different stakeholders. The spatial explicit quantification and valuation of ecosystem services is regarded as a new way to reflect and communicate landscape changes. And the integration of the ecosystem service trade-offs in land use decision-making promises to better negotiate land-use decisions amongst different stakeholders. Despite the consensus on the importance of incorporating ecosystem services and their trade-offs into resource management decisions, spatially quantifying the levels and values of these services has proven difficult. Challenges concern the selection of proxy indicators derived from empirical data to map ecosystem services, but also the use of land cover/land use data, as well as the methods for generating this data. In addition, methods for the valuation of ecosystem services are lacking, especially across spatial and temporal scales and regarding the integration of different stakeholders. Finally, for an efficient monitoring of ecosystem services, data consistency over time is needed. This imposes constraints both on the availability of data and the methods of assessment. This session contributes to the main conference scheme **3. *Impacts and responses*** and aims to provide examples of spatially explicit studies focusing on the interlinkage between ecosystem services and landscape changes as well as on the trade-offs of ecosystem-service which arise as land use and stakeholder claims on the landscape change over time.

0129	Modeling biogeophysical impact of land use changes on surface climate	Xiangzheng Deng Jiyuan Liu	China

Land use changes have altered the surface albedo, surface aerodynamic roughness, and rooting depth and terrestrial carbon balance, with resulting effects on regional-global weather, hydrology and climate. These changes in biophysical characteristics also affect ecosystem processes and their continued provision of services by altering the energy budget, radiative forcing, evapo-transpiration. Modeling biogeophysical impact of land use changes on surface climate has experienced an evolvement from single non-spatial to the combination of non-spatial and spatial model. At present, most ecological models can effectively modeling land surface processes in terms of biophysical fluxes (latent heat, sensible heat, momentum, reflected solar radiation, emitted longwave radiation) and biochemical fluxes (CO_2) that depend on the ecological and hydrologic state of the land. Further, land use change can influence

climate by modifying the physical properties of the land surface. Besides, the importance of land-surface processes within climate models for accurately reproducing the present-day climate is well known. However, their role when projecting future climate changes due to future land surface biogeophysical condition is still poorly reported. As an interdisciplinary research field, the simulation of the dynamics and consequences of land use change is very weak to integrate ecological and climate sub-models simultaneously in the simulation process in analyzing and presenting the land impact and responses. As one of the most important research components in land use-climate interactions and the potential impacts of land use, this session has three levels of contribution. Firstly, in terms of land system modeling, this session is a good opportunity to identify the gap of the current modeling system so scholars having ecological or climate modeling background can discuss and deliver ideas, thus helping to integrate land use changes, land ecosystem condition, surface climate into a comprehensive framework for systematic analysis. Further, As for the Open Science Meeting, this session can enlighten and improve the understanding of land system dynamics by identifying the biogeophysical process of land use-climate interactions and the modeling approach can improve the capability to explain and predict how land use change affect global environmental and climate changes. Last by not least, policy-related quantification of land-use influences on climate has focused largely on changes in atmospheric composition, so by emphasizing this additional major forcing of climate through changes in the physical properties of the land surface, the research strategy and quantitative approach in this session can provide research support for the Intergovernmental Panel for Climate Change.

0133	Reconciling environmental conservation and economic development in land-use planning: the value of integrated modeling	Michael Obersteiner Gilberto Camara Valerie Kapos	Austria

Policies for regulating land-use not only guide future economic development, but also have major impacts on ecosystem services such as greenhouse gas mitigation and biodiversity conservation. The balance between the cost of those policies and their economic and environmental returns is little known, while there is a growing interest from countries in optimizing their efficiency on all fronts, by planning for multiple benefits and mitigating potential risks. Along these lines, the United Nations Framework Convention on Climate Change (UNFCCC) has for instance put in place broad safeguards for Reducing Emissions from Deforestation and Forest Degradation plus conservation of forest carbon stocks, sustainable management of forests and increase of forest carbon stocks (REDD+), which include a request to 'enhance other social and environmental benefits'. Hence, understanding land use change processes and how different policy options are likely to affect economic returns and ecosystem services is essential for designing sound land use policies. Because land use change drivers and the economic and environmental context vary from one country to another, it is important to carry out a detailed and comprehensive assessment on a case-by-case basis, thanks to the collaboration between interested countries, the research community, and other public and private stakeholders. The objective of this session is twofold. First, it aims at introducing new data and modeling techniques for understanding the mechanisms of land-use change and conducting multi-criteria assessments of land-use policies. For example, a new hybrid land cover map for Brazil based on remote sensing data will be presented. Second, results of land-use models assessing development scenarios and policy options will be provided to highlight the interactions between drivers of land-use change and land-use policies and the trade-offs between economic development and environmental conservation. The case of forest conservation in Brazil and the Congo Basin will in particular be covered, with country-relevant REDD+ and land-use policies being proposed and assessed. This session fits well into theme #3: Impacts and responses: land systems changes to mitigate global environmental change impacts and adapt to increasing demand for food, fuel and ecosystem services.

0177	Changing land use and ecosystem functioning in the Mediterranean: past, present and future	Wolfgang Cramer Joel Guiot Thomas Curt	France

The objective of the proposed session is to review recent research aiming at improved understanding of the impacts of, and responses to, land change in the Mediterranean region. Ecosystems and the services provided by them have been the very foundation of human socio-cultural development in the Mediterranean basin for many millennia – both from the land and from the sea. The Mediterranean provides a unique laboratory for the integrated assessment of environmental risks, ecosystem services and trade-offs, permitting the linkage of high-quality data from the distant

and recent past with the present day, as well as the exploration of scenarios for more sustainable development of human well-being. Session themes depart from the recognition of the Mediterranean as characterized by dramatic and diverse socio-political and economic change, as one of the world's biodiversity hotspots, as a region of complex and rapidly changing agricultural land use systems, and being by significant recent climate change associated with risks of enhanced disturbance regimes. Papers are solicited for topics covering the full breadth of these issues, including the reconstruction of past changes, the modelling of land use systems under changing environmental and economic boundary conditions, and the assessment of options for more sustainable land management for ecosystem services.

CATEGORY: *3.2. Round-table Discussion Session*

NUMBER	TITLE	CHAIRS	COUNTRY
0031	Alternative farming systems and their contribution to global sustainable food security	Verena Seufert Navin Ramankutty Kimberly Carlson	Canada

Agriculture is central to human livelihoods, providing food and fuel, playing a crucial role in economic development, and supporting unique cultures worldwide. Yet, agriculture today is not only a leading driver of environmental degradation and a major force driving the Earth System beyond the 'safe-operating space' for humanity – many people also do not have sufficient access to food. By 2050, models suggest that agricultural production must double in order to provide sufficient calories to feed the changing diets of an expected human population of 9 billion. The agricultural intensification and expansion required for such increased production risks to further contribute to climate change, deplete freshwater resources, threaten biodiversity, and degrade soil fertility. Simultaneously, global climate change requires food producers to cope with altered temperatures, water availability, and frequency of extreme weather events. Moreover, ensuring physical and economic access to additional calorie production is essential for improved global food security. Novel and diverse methods of food production will therefore be required for sustainable food security, in which all people have consistent access to sufficient food produced with minimal environmental impact. Global agricultural systems are highly diverse, spanning traditional subsistence farming to technology-dependent agribusiness. This round table discussion aims to assess the potential contribution of different farming systems to sustainable food security. Specifically, a panel consisting of experts in various agricultural systems (e.g., conventional, organic, genetically modified, agroecological) will be asked to discuss the costs and benefits associated with the agronomic, social, and environmental dimensions of these systems. Discussion topics may include assessments of yield potentials, environmental impacts across temporal and spatial scales, vulnerability and adaptation to global change, contribution to economic development, and suitability for poor farmers' needs. Panelists will be encouraged to consider how novel combinations of agricultural systems might support sustainable food production. Because we aim to assess different types of farming systems and their performance in the face of global environmental change and increasing food and fuel demand, our proposed session fits into Theme 3 of the Global Land Project Open Science Meeting.

NUMBER	TITLE	CHAIRS	COUNTRY
0095	Climate change, health and infectious diseases: towards an ecosystem approach	Serge Morand Chantal Pacteau	France

The research on climate change has given the opportunity to develop elaborated models of future climate change, which helps at improving policies on mitigation of greenhouse gas emissions and adaptation to the consequences of climate change on human economics and well-being. These climatic models are easily accessible to many other research domains, and particularly for health purposes. However, the complex links between climate and infectious diseases caution the methods and then the results of several climate-based models on infectious diseases spread. The round-table aims at (first) briefly reviewing our still limited knowledge on climate change and infectious diseases, to (second) critically analyze the models developed in health, and to (finally) suggest new approaches in climate/ecosystem/health models, which may have the two major interests: (1) favoring the dialogs between researchers in climate change and health through a common ecosystem framework, responding to national and international health agencies associated in the "One Health" concept, (2) favoring the dialogs between policies, stakeholders and scientists using regional and local scenarios of land planning.

CATEGORY: *3.4. Short Training Session*

NUMBER	TITLE	CHAIRS	COUNTRY
0127	Macromodels and complexity for a green economy	Sonia Quiroga Federico Pablo	Spain

The most important drivers affecting land use are characterized for being global problems- ie. Economic crisis, global security, climate change. We are aware now that a new perspective on the economic analysis is necessary if we want to improve the knowledge on human behavior in a more and more globalized society. This session focuses on the understanding of socio-economic and biophysical linkages to prioritize policy efforts oriented to sustainable global land governance. Complexity models oriented to analyze environmental policies --such as mitigation and adaptation to climate change, water framework directive, Natura 2000, etc-- will be presented. The training workshop will be oriented to researchers on economic models willing to start up in the complexity analysis and their applications for the sustainable economic growth. Special attention will be placed in the implications of land governance for food security in a global change context. Some of the contributions can be selected to be published in a Spetial Issue on "Tools and Methods for economic analysis of agricultural impacts in a global change context". Ed. Springer.

CATEGORY: *3.5. Open Session*

NUMBER	TITLE	CHAIRS	COUNTRY
0051	Food-energy-water nexus	Rüdiger Schaldach Benjamin Stuch	Germany

New strategies are needed to meet the increasing demand for food, energy and water under climate change. This session focuses on global change impacts on food, water and energy security. On the one hand, irrigation can help land-use systems to fulfill increasing demands for food and bio-energy as well as to adapt the production systems against climate change. On the other hand, potential trade-offs due to crop irrigation could promote water insecurity. Water scarcity as well as water pollution can reduce water availability and water quality; irrigation might be spatial-temporally constrained. Also mitigation strategies and policy making such as water prioritizing or reducing water pollutions from agriculture could restrict irrigation. Therefore, it cannot be the only strategy. Additional strategies are needed to supplement irrigation in regions where trade off effects exceeds the benefits of irrigation in order to meet global demands on food and bio-energy. Bio-energy production can help mitigate global climate change and promote energy security among rural communities in less developed countries. However, land-use conflicts with food production systems increase with increasing bio-energy production. Hence, trade-off effects from achieving energy security can risk food supply, particularly for those people in rural areas that also suffer energy insecurity. Food security is essential for human well-being. In an insecure situation, agriculture might either expand on the cost of land-cover change or the use of resources intensifies. Both strategies cause trade-off effects on other ecosystem services (such as regulation or habitat functions) and further increase conflicts with energy and water supply. In the session we like to point out the importance of large scale integrated assessments for global change research. Regional differentiations regarding impacts and responds should be highlighted. We invite presenters to introduce integrated land-use assessments on food-energy-water security. Emphasize should be put on related conflicts such as trade-off effects and/or pathways to harmonize demands with land-use systems. This session contributes to the Open Science Meeting in relation to the main theme 3 "Impacts and Responses" and is open for five presentations (12+5min each). The target audience is; stakeholders and researchers that work in the context of food-energy-water security and all people that are interested in integrated modeling of complex systems.

Conference Theme Nº4: *Land Governance*

CATEGORY: *4.1. Research Presentation Session*

NUMBER	TITLE	CHAIRS	COUNTRY
0022	The land-water-energy nexus: governance challenges, approaches and experiences	Timothy Moss Benjamin Nölting	Germany

This session explores the challenges and opportunities of connecting land governance to the governance of water and energy in the interest of sustainable land system transitions. It is designed as a contribution to Theme 4 Land Governance of the 2nd GLP Open Science Meeting. The underlying rationale for the session is that both water management and energy generation have far-reaching and increasingly significant impacts on land use, for instance as a result of irrigation or rewetted peatland regimes or bioenergy crops. Conversely, land use policies and practices impinge on water quantity and quality and shape demand for energy spatially and temporally. Working across this land-water-energy nexus is proving very challenging, requiring new ways of thinking about land use policy, practice and research. There exist today rich scholarly debates on land governance, water governance and energy governance; however, little attempt has been made as yet to connect these separate strands of governance research with a view to advancing knowledge on sustainable land system transitions. The core objective of the session is, therefore, to provide a platform for discussing recent research on the distinctiveness and complementarity of land and water governance and/or land and energy governance. The papers can be of a conceptual nature, discussing for instance the different disciplinary logics and thematic foci underpinning each governance strand. They may be methodological, comparing for example diverse analytical frameworks used in researching institutional arrangements for cross-sectoral interplay. Empirical studies of governance challenges, approaches or experiences from across the land-water-energy nexus will also be very welcome. The idea for the session (including two of the proposed papers) has emerged from projects funded within the research programme Sustainable Land Management of the German Ministry of Education and Research (BMBF). The session aims to reach beyond this community to encompass contributions and participants interested in different locales of land/water/energy governance (from the Global South to the Global North) as well as different scales of action (from the local to the transnational). Depending on the response, the session convenors will consider organizing a publication and other follow-up activities on this topic after the event.

0033	Land-use simulation in support of planning and sustainability assessment	Eric Koomen Carlo Lavalle Jana Hoymann	The Netherlands

This session focuses on the application of land-use change models in support of policies and regulatory processes which have a direct and/or indirect influence on spatial planning. We invite contributions that focus on the assessment of potential future spatial developments, their impacts on various aspects of sustainability and the effectiveness of policy to steer these developments and to minimize likely impacts. Specific attention will be paid to the following prominent issues in policy preparation: which methods are available to obtain integrated assessments of changes in both socio-economic and climatic conditions?; how should models deal with the ever more complex societal and planning context in which policy preparation takes place?; which tools allow for effective science-policy interactions in these new context? The objective of this session is to share the lessons that were learned from actual policy related land-use model applications and to collect knowledge on the factors that make land-use models effective instruments in policy preparation. Joint discussions will focus on questions such as: how complex should models be?; which knowledge gaps limit their application?; how can their communicative power be improved?; is there a minimum level of uncertainty acceptable in the decision making process? By addressing the above-mentioned issues the session links to the 'impacts and responses' and 'land governance' themes of the 2014 Global Land Project Open Science Meeting. The session is deemed especially relevant to researchers who like to see their work being applied and practitioners who want to learn more about effective tools and methods.

0047	Geospatial technologies, indigenous institutions	Aliyu Barau	Malaysia

	and sustainable land governance in developing countries	A. Tanko Henry Bulley	

Geospatial data sourcing, application and management are crucial to understanding patterns of land use change, land governance and analysis of sustainability dimensions. For a long time, advanced countries particularly Europe and North America have developed many tools and institutions for entrenching sustainability and understanding landscapes at various spatial and precision scales. The situation is different for most countries in the global south in spite of globalisation of spatial technologies. One of the challenges is the failure of researchers to grasp the geo/spatial technologies within perspectives of local meanings and perspectives of landscape and land use. There are several age-long sustainable land management strategies across the developing countries which are largely under-researched or least understood. There is obvious fear that massive pressures on resources and socio-political transformations threaten such indigenous systems. Indigenous institutions of land governance entail the roles of local society's histories, cultures and political value systems, which are embedded in some cases with different meanings of sustainability. The main objective of this session is to explore potentials of geospatial technologies in projecting sustainability dimensions of indigenous sustainable land management practices in developing countries. The session draws papers from high and low population and rapidly growing areas in sub-Saharan Africa and Southeast Asia. The papers for this session identify role of various geospatial technologies such as GIS, space syntax, spatial and place psychology in analysis of indigenous urban and rural landscapes and land use systems. These tools could help researchers in the global south to develop new insights into human-nature interactions in land development and sustainability through indigenous institutions. The proposed interdisciplinary session is in line with GLP-OSM theme four, which is land governance. This session would give audience from different countries a clue into the role of integrated understanding and analysis of the dynamics of humans-land interactions.

0073	Climate-driven land use change and the institutions of local public sector engagement	Andreas Thiel Matteo Roggero	Germany

This session focuses on Climate Change as a driver for land use change. It employs Institutional Economics in order to address the interplay between established land-use governance forms and those alternative forms of coordination needed in order to the adapt to Climate Change. Climate Change introduces threats for existing urban and rural land use practices and the corresponding resources. Changed water availability and precipitation patterns, extreme weather events, longer growing periods are all likely to alter the economic and social value of key land uses such as settlements, agricultural production, or nature conservation. Institutional Economics is the most suitable tool for understand how society organizes itself in order to meet such challenges, what role different actors play thereby, and how the distribution of the costs and benefits of adaptation takes place. Among the manifold combinations of actors involved, the panel is specifically interested in the local public sector. Local administrations have many ways to approach and meet Climate Change: providing monetary incentives for private adaptation, reviewing or "climate proofing" building codes and land-use control procedures, providing tailored or adapted infrastructure, mediating between local private and economic actors, or engaging in information campaigns. Presently, little is known about the drivers underlying similar choices, the actual trade-offs considered and the motivation (e.g.: opportunistic, production-oriented, political economic, or driven by formal institutions) characterising the various decision-makers at stake. Specifically, we want to ask: which approaches are preferred for which types of land use and sectors? What are the local, institutional and place-specific determinants of these choices? How are such choices coordinated? What approach is considered "best suited" for which type of land use? What advice can academics provide on the matter? The session currently encompasses the following three contributions: 1) a contribution proposing a diagnostic framework for the alignment of climate challenges with organizational solutions; 2) a contribution on the determinants of local administrative adaptation choices from the point of view of Institutional Economics; 3) a contribution presenting a case study from the UK on institutional solutions for the currently most pressing climate challenge: floods. Further individual contributions are invited to address how different institutional and local settings and types of land use relate to the way local public actors engage in adapting land use to Climate Change.

0074	Governing land use and land allocation through markets: efficiency and failures	Martin Odening Silke Hüttel	Germany

Land is the most important production factor in agriculture. In the past decade the interest in farmland has even

increased. A main driver for growing attractiveness of investments in agricultural land is the recent boom in food prices. Moreover, the financial crisis has reduced the profitability of other financial assets leading to a (re)discovery of the agricultural sector also by non-agricultural investors. In fact, large scale land acquisitions, primarily in developing countries, have been realized and received attention under the somewhat discriminating label "land grabbing". In some parts of the world the rising demand for farmland lead to an expansion of the cultivated area, but in most industrialized countries farmland expansion is not an option. In view of these developments it is not surprising that land prices grew steadily in most industrialized countries. There is, however, an ongoing discussion whether land markets can achieve an efficient (re)allocation of land that ensures a sustainable production of food and feed for a growing world population as well as a provision of important ecosystem services. This is of particular relevance in transition economies and developing countries where rapid institutional and socioeconomic changes induced drastic changes of land use systems. Referring to potential market failures, such as an inequitable distribution of property rights and non-sustainable land use changes, governments often adopt measures that regulate access to land markets and transactions thereon. Against this background the organized session aims at understanding and discussion the recent developments of land markets with a special focus on transition economies.

0082	The role of the state in large-scale land acquisitions in Africa: mediation, tenure disputes and changed landscapes	Sandra Evers Jean-Aime Rakotoarisoa	The Netherlands

The past several decades have witnessed an unprecedented increase in foreign large-scale land acquisitions. It is estimated that over 46 million hectares of land were leased out to or the subject of potential land deals with foreign investors since 2006, two-thirds of which is located in Africa. International actors increasingly work through global structures and deploy discourses to access, acquire and exploit vast tracts of arable land in Africa for various purposes (e.g. agricultural production, bio-fuel, multinational mining and conservation). At the site of such projects, tensions emerge between divergent international and local conceptualizations of development, history, heritage, tenure, livelihood security, and sustainability. At the nexus of these land ventures is the state, which is often overlooked in analysis. The session will discuss the role of the state in creating the fertile ground for foreign large-scale land acquisitions. The state mediates between policy requirements of the World Bank, the IMF, Foreign Direct Investments (FDI) and the local populations confronted with implementation of a project on land they deem theirs but often do not hold official title to. The impacts at the local and state level and particularly the interactions between the state and its citizens will be at the limelight in this session. In 2011, with support from The Netherlands Organization for Scientific Research (section WOTRO Science for Global Development), we commenced a research programme on foreign large-scale land acquisitions at VU University Amsterdam with partner institutes in Africa. We have formed a transnational and multidisciplinary team of researchers – including those with expertise in history, anthropology, geography, GIS/spatial analysis, political science, ecological economics, linguistics, cognitive and communication sciences. The research (September 2011–September 2015) has four aims. First, we analyse the global actors, networks and interests (e.g., political, economic, social, cultural, environmental) driving foreign land acquisitions, examining the role of the state, neoliberal reforms and donor interests in facilitating land access. Second, a grounded stakeholder analysis details local impacts, perceptions and responses to land deals. Third, we map, through our theoretical model, 'zones of intermediality', the ontological grids of (inter)national - local stakeholder encounters where diverse ideologies, discourses and practices of land use and valuation are mediated. Fourth, we will use this model to capture commonalities between stakeholders and potential areas of contestation. The comparative research takes place in four settings ranging from large-scale mining in Madagascar, foreign food production in Ethiopia, REDD initiatives in Madagascar, and agricultural Chinese land investments in Uganda.

0089	Power and politics in coupled natural-human land systems	Darla Munroe	USA

In the era of the anthropocene, environmental problems can no longer be thought of as strictly "natural;" social and ecological systems are inextricably linked. Therefore, social dimensions of environmental problems cannot be examined separately from or subsequent to the environmental science; the separation between these realms appears increasingly artificial. The land-change community draws from and contributes centrally to coupled natural-human systems frameworks, which are employed to shed light on critical interconnections across social and natural

subsystems. Accepting that social and natural systems are intimately connected implicitly leads to normative considerations. In a world where society and environment are continually influencing one another, socioecological systems must then be evaluated by assessing the range of both environmental and social outcomes that result from, or are precluded by, particular types of coupling. For instance, what social challenges result from particular environmental outcomes? Assuming that we are successful in constructing the best strategies for mitigation and adaptation to climate changes, what are key societal tradeoffs and how can they be managed? In the case of positive environmental changes, such as the return of forest to formerly degraded areas, which stakeholders are likely to benefit the most from the forest's return? In this session, we explore whether current land-change coupled natural-human frameworks sufficiently account for the social complexities of global environmental change. Specifically, attention to the politics of such changes, e.g., how costs or benefits are captured and distributed across various stakeholders requires greater attention by land-change science: understanding how the system functions requires attention to the interactions among major stakeholders. There are many ways that land-change scientists can incorporate better knowledge of land politics, including the recognition of how competition for land rights drives land clearing; greater attention to the role of corporate actors in setting policy agendas; and better recognition of the role of teleconnections, or close interactions among distal actors. The proposed session cuts across two of the main conference themes: 2. Local land users in a teleconnected world; and 4. Land governance. Specifically related to land governance, decisions about land use that effectively structure land-change possibilities often happen outside the scope of formal institutions.

0113	Moving from case studies to cross-site research of urban ecosystems, institutions and governance	Rinku Roy Chowdhury Tom Evans	USA

Urbanization and urban land use and governance are increasingly critical sources of global land and ecological transformations. Yet systematic, comparative, and cross-site research on the heterogeneity of increasingly prevalent urban, suburban and exurban socio-ecological systems (SES) remains underdeveloped. Understanding, modeling and forecasting changes in urban SES and their implications for land cover and ecosystem services (ES) presents significant challenges. These challenges span theoretical, methodological and disciplinary domains, and are complicated by the multi-scalar aspects of urban governance and ecological systems (e.g., decision-making outcomes at municipal/landscape vs. individual/patch scales), the multi-sectoral nature of those systems (e.g., hydrological vs. land use components), and complex historical and nonlinear interactions (e.g., path dependence and thresholds in urban development, migration and land markets, press/pulse "natural" disturbance regimes). The development of general theories of urban SES therefore requires long term, multi-scaled and interdisciplinary analysis. This symposium presents examples of multi/interdisciplinary analyses of urban land/ecosystem responses to climate and anthropogenic changes and governance, with implications for ES. The cases represent diverse syndromes of heterogeneity and commonalities across distinct climatic-geographic regions and social governance arrangements, which can serve as a useful framework for designing systematic, cross-site and cross-scalar syntheses of urban land systems. The paper session will be linked to a round table where we will then discuss in greater depth the particular methodological challenges in advancing such integrative understanding.

0122	Moving from case studies to cross-site research of urban ecosystems, institutions and governance #2	Morgan Grove Christiane Weber	USA

Urbanization and urban land use and governance are increasingly critical sources of global land and ecological transformations. Yet systematic, comparative, and cross-site research on the heterogeneity of increasingly prevalent urban, suburban and exurban socio-ecological systems (SES) remains underdeveloped. Understanding, modeling and forecasting changes in urban SES and their implications for land cover and ecosystem services (ES) presents significant challenges. These challenges span theoretical, methodological and disciplinary domains, and are complicated by the multi-scalar aspects of urban governance and ecological systems (e.g., decision-making outcomes at municipal/landscape vs. individual/patch scales), the multi-sectoral nature of those systems (e.g., hydrological vs. land use components), and complex historical and nonlinear interactions (e.g., path dependence and thresholds in urban development, migration and land markets, press/pulse "natural" disturbance regimes). The development of general theories of urban SES therefore requires long term, multi-scaled and interdisciplinary analysis. This symposium presents examples of multi/interdisciplinary analyses of urban land/ecosystem responses to climate and

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0132	Informing land and soil policies with science based tools - practical experience	Katharina Helming Pytrick Reidsma	Germany

Land Use policies attempt to mitigate environmental change impacts and to respond to emerging grand societal challenges. They may address global issues of international trade and mitigation agreements or local issues of farm level adaption and innovation. In any case, because of the complex interactions between socio-economic and geophysical processes in land use systems, those policies are difficult to design. Providing scientific evidence in support of policy is a challenge for researchers but increasingly demanded for by policy makers. Numerous tools for policy support and impact assessment have been developed over the last decade that attempted to fuel scientific evidence into the policy process. This session will discuss experiences with the utilisation of science based tools for impact assessment and land use policy making. Examples will range from regional policies for rural development to national climate change adaptation strategies and European strategies for land take regulations and soil quality governance. Focus will be laid on practical experiences with the use of science based tools for public policy making including success factors and challenges for their use. Trade-offs between scientific credibility of tools and operational relevancy will be discussed as well as the integration of quantitative modelling with participatory approaches. The session welcomes contributions about tool development and uses for land use policy making. Integrated, complex cases as well as more simple cases are equally welcome.

CATEGORY: *4.2. Round-table Discussion Session*

NUMBER	TITLE	CHAIRS	COUNTRY
0023	Achieving sustainable intensification of land: the governance role	Richard Wakeford Alister Scott Jose Garcilajo	UK

Land is a finite natural resource, at the heart of sustaining life on Earth. The most versatile land is coming under ever greater pressure from urbanization and from increasing global demands for food, energy and other products. In all countries in the 21st Century, achieving more from land should be high on government agendas. *Sustainable intensification* would see every element of the landscape delivering its full and appropriate contribution to the ecosystems services people depend on. These services include food, water (for people and businesses), energy (from biofuels), forest products (construction timber, biofuel and carbon sequestered), minerals, biodiversity and scenic attractions. Natural factors of geography, geology and climate determine the potential for each piece of land to deliver some or all of those services. But, how owners and tenants use land in practice is also significantly influenced by legal rights, regulations, taxes and subsidies flowing from the decisions of national and local governments. The pace and direction of urbanization and infrastructure investment also flow partly from government measures, such as national, regional and local planning and zoning rules.

  Government tools include;

  Regulation and enforcement;

  Incentives through taxation and subsidy;

  Influence through leadership.

The session will focus on how governments can encourage sustainable intensification (there have been few studies of the effectiveness of different instruments in improving the delivery of land-based ecosystems services). The presenters will explain progress with an international research project under way exploring what influences owners and tenants to deliver particular combinations of private and public goods. Many national and regional governments operate in a silo approach, with each department focusing first on the needs of its own sector – an approach which makes overall strategy difficult. Valuation methods for ecosystems services can help inform a joined-up approach to land use rights, regulation, tax and subsidies. The UK Government's Foresight studies on land use and food futures provided a research-based picture of the long term land management challenge – both nationally and internationally. But there has been little follow-up, to date. Drawing on examples from around the world, the session will explore the individual and cumulative effects of regulatory and fiscal incentives in delivering the sustainable intensification of land use needed if we are to meet the increasing global demands for natural resource based services.

0048	Resilience of land systems: state of conceptualization and operationalization	Vassilis Detsis Helen Briassoulis	Greece

"Land systems" are coupled human-environment terrestrial systems (GLP Science Plan and Implementation Strategy). Resilience of these systems, alias socio-ecological systems, is a fluid concept that has been evolving in the academic circles for more than 15 years. Although intuitively appealing, the confrontation of the concept with real world situations has raised several issues concerning its meaning, definition and assessment. Despite current ambiguities, "resilience" is quickly becoming the new buzzword finding its way into policy and popular texts. The roundtable will tackle some of the important issues surrounding the concept of resilience of land systems with the aim to offer useful insights and support towards its meaningful definition and assessment that are prerequisites for responsive and effective land governance. The issues that may be addressed include, but are not limited to, the following:

  Meaning of resilience of land systems and its relationship to other relevant concepts in use.

  Normative vs. value-neutral use of the concept; i.e. the influence of diverging interests of different stakeholders on modes of use of land.

  Issues of scale; i.e. scale-free or scale-dependent assessment of resilience of land systems emerging from particular modes of use of land.

  The role of the mode of land governance in shaping resilience.

The role of resilience in land transitions, especially in the face of the dichotomies of planned vs. autonomous and globally- vs. locally-driven change.

The roundtable participants will discuss:

the state-of-the-art regarding the conceptualization and operationalization of resilience of land systems

the implications of alternative conceptualizations and operationalizations for land governance and decision making

a future research agenda to address these issues

The proposed session topic is horizontal, cutting across all four main themes of the 2nd GLP OSM 2014. It may be considered closer to main theme 4 "land governance" as it will deal with issues that are of direct relevance to alternative ways of managing land resources for the common, long-term interest. This roundtable session addresses (a) *scholars* interested in the theoretical and/or the methodological aspects of the concept as well as in its use in empirical studies, (b) *practitioners* involved in land management, spatial planning and policy and (c) *policy makers* employing the concept as a goal of policy initiatives and interventions.

0056	Can the territorial management contracts contribute to a widespread and shared new era for the sustainable future of the territory?	Adriano Ciani Walter Leal	Italy

The mechanisms that directly support the integration of income for farmers tend, for reasons of balance of pocket and fired in the principles of international agreements, to decrease. This feeds the risk of a further process of removal from the agricultural sector and the permanence of man on the ground and consequently the increase of hydro-geological disasters. In 2011 total damage by natural disasters in the world amounted to 380 billion U.S. dollars. The Round Table seeks to determine whether from the care ex post, you can go to the hypothesis of triggering of preventive measures.

-Round Table framework and questions:

The Round Table must verify if the idea of Territorial Management Contracts-TMC between Public Institutions and Farmers could be an innovative solution for the modern Governance of the Territory. The TMC it's a proposal contract, established between farmers and local institutions, that sets in motion all the mechanisms for land conservation activities with recovery of drainage, cleaning ditches, dikes, soil consolidation, trees, both on the surface properties of inference that their agricultural enterprise. The farmer and other operators, in the territory, takes care of this operation respecting technical parameters laid down behind a possible return to the surface under its jurisdiction and to the degree of riskiness of the area where it falls. In this way we can avoid the constant damage from landslides, mudslides, etc. To give greater functionality to the role of the agricultural sector, to reaffirm the role of garrison farmer, reduce the risk of permanent and temporary damage to soil, improving cash flow business, stimulate the use and dissemination of ICT for monitoring and verification activities. The questions that will be treated are the following:

-Which mechanisms put in place for preventive action for a best practice of territory management?

-Which the operating method for a preventive action limiting adverse events?;

-Where the financial commitment to budget by the National or Local Government?;

-Such as instruments for management and control.

Conclusions

The Round Table designed and made attempts to remedy with an active participation of the serious damage to agricultural hydrogeological investing around the world and in Europe itself significantly. The design of the Territorial Contracts Management-TCM is a financial instrument and tolerability of a significant effect on both the role of agriculture in terms of multifunctionality and strengthening the role as common good and that inverts the mode of dissipation of resources with post-intervention adverse events with one that stimulates the growth of a preventative nature. In this manner the Round Table send a positive contribute to the Open Science Meeting specially for the themes of Land Governance and Impacts and Response.

0069	The dynamics of urban land systems - grabbing the new complexities of urban land state and	Dagmar Haase Nina Schwarz	Germany

transition	Katrin Grossmann

As already today live more than a half of the world population in cities, a rethinking and reclassification of how urban land systems develop and change urban land will become more and more important. Thus, this speed talk – round table discussion focuses on the development/pathways and new configurations of urban land cover, land use and its intensity, the governance of land use, and social practices relates to land use over the past decades (the urban land system triangle, see Figure). Speed talk contributions will include but are not limited to: New urban land use structures such as inner-urban brownfields and transition areas, science parks, inner-city gated communities, etc. New urban social practices related to land use of land grabbing forced or initiated by urban tele-connections (Seto et al., 2012), urban-rural "non-linkages" in Megacity agglomerations in e.g. Asia or Africa, both affecting urban land at different quantity and quality, possibly causing non-linear dynamics. Moreover, new social practices include rural-urban linkages in form of regional food production, regional alternative energy production, urban farming etc., abandonment or the recycling of vacant properties. Governance of land use including land use regulation and law, programmes and policies fostering land use transitions such as growth boundaries or urban renewal strategies. Urban land use intensity changes such as spatio-temporal dynamics of "growth" and "shrinkage" including land abandonment within cities. Fast dynamics of urban land cover, use, intensity change (rapid versus slow changes), actions (decision-making) and persistence. We aim at 5 speed talks discussing/illustrating cases and examples ranging from Megacities to small cities.

0072	The role of governance in adaptation to global change in mountain regions	Gregory Greenwood Jayne Glass Jörg Balsiger	Switzerland

The objective of this session is to provoke discussions on how to apprehend the structure, function and evolution of governance in mountain regions, and how to evaluate governance as an adaptive response to global change. Governance is a central issue in land systems. As a land system can be conceptualized as the on-going interaction between an ecological and a social system, then governance is the social equivalent to the structure and function of the ecological system. Just as structure and function determine how ecological systems utilize energy to cycle material and transmit genetic information forward in time, so does governance describes how power is used within a social system to manage resources and to maintain social order. Governance is also central to normative discussions with the assumption that changes in governance can have a strong influence on the sustainability of a land system and vice versa. Systematic explorations of ecological structure and function have created a basis for forecasting in the form of models. Extensive studies of law and politics have focused less on predictive capacity but have provided rich descriptions of governance. Further systematic analysis of governance is fundamental to understanding the role of decision-making as a driver and as a response. Mountain regions are special environments where verticality creates enormous environmental diversity and often great resource richness over short horizontal distances. Occurring in virtually all major climates of the world, mountains also display great environmental differences between regions. And as mountains have often been refuges for minorities and barriers to larger civilizations, cultural diversity between mountain regions is also great. This very resource richness and peripherality has, for all the diversity of mountain regions, nonetheless led to a recurring pattern of flux in governance arrangements, often fraught with conflict, as surrounding civilizations attempt to exploit the richness of their adjacent mountains. Governance in mountain regions begins with the general concern of all descriptive governance studies - what are the institutions that govern behavior and lead, among other things, to the management of land resources - but then proceeds to the more specific questions of how the highly dynamic nature of the physical environment, the historical diversity of mountain cultures, and the on-going modernization of these regions affect governance arrangements. A better exploration of these questions is essential if one wishes to provide evidence-based, as opposed to dogmatic, recommendations for changes in governance that enhance the transition to sustainability.

0114	Bridging challenges in research on urban ecosystems, institutions and governance	Rinku Roy Chowdhury Tom Evans	USA

Urbanization and urban land use and governance are increasingly critical sources of global land and ecological transformations. However, it has proven difficult to develop generalizable findings from studies of urban systems. The unique cultural, institutional, architectural and biophysical nature of cities is sufficiently complex that it is

difficult to reduce this complexity to key, salient drivers affecting urban ecosystem dynamics. Related methodological challenges limit the ability to conduct systematic, comparative research and generalize finding across multiple urban SES. For instance, modeling and forecasting changes in urban SES dynamics, and further linking those dynamics to land cover and ecosystem services (ES) is complicated by the multi-scalar aspects of urban governance and ecological systems (e.g., decision-making outcomes at municipal/landscape vs. individual/patch scales), the multi-sectoral nature of those systems (e.g., hydrological vs. land use components), and complex historical and nonlinear interactions (e.g., path dependence and thresholds in urban development, migration and land markets, press/pulse "natural" disturbance regimes). The analysis of urban SES requires long term, multi-scaled and interdisciplinary methods. This roundtable targets (1) the critical challenges in (1) social-ecological analysis of urban SES, including how to link institutions and ecosystem services, (2) modeling multi-scaled urban SES and governance and (3) methods for explicitly cross-site synthesis of insights. The roundtable will also highlight promising avenues for bridging those challenges across distinct climatic-geographic regions and social governance arrangements, aiding systematic, cross-site and cross-scalar syntheses of urban land systems. This roundtable session is linked to a paper session more thoroughly detailing the dynamics of urban SES and land dynamics in a set of case studies.

0130	Conserved lands and people in conflict: clashes between ideal policies and real livelihoods	Guillermo Ospina Carlos Cairo	Colombia

In the last three decades, conservation became one of the most influential rationale to establish land uses at worldwide scale. Reactions to biodiversity conservation or world natural heritage include defenders as well as detractors. The important fact here is that certain kind of social situations are considered as threats to conservation and sustainability because are labeled as "irrational" uses of land or natural resources. In many cases, the definition of such threats obeys to a specific rationale model that ignores the structural causes that trigger social conflicts around protected or prioritized conservation objects. This session wants to discuss field-based experiences and practices focused on the understanding of the social conflicts triggered by the clash between local peoples (having "unsustainable" livelihoods) and the scientifically-based ideas on biodiversity conservation supporting policies. Particularly, the session is aimed at discussing different social and natural disciplinary perspectives to understand the practical effects of the specific conservation models based on splitting conservation objects as "protected areas" isolating it from their wider socio-ecosystem matrix under a control-surveillance device. By doing this, the discussions on the session want to identify other conservation possibilities focused on the social complexities within or surrounding such "protected" areas. In this way, the session will serve to review and critically understand some of the core assumptions underlying the conservation initiatives at different social and political contexts, and how they impact or produce different effects in local communities and institutions in specific places. This session is intended to contribute to the Open Science Meeting in relation to the main theme 4: Land governance and some questions to discuss in the session are: What kind of threats to conservation represents social conflicts? What innovative approaches exist to sustain alternative conservation models that include people as part of the complex socio-ecosystem realities?

CATEGORY: *4.3. World Cafe Workshop*

NUMBER	TITLE	CHAIRS	COUNTRY
0013	Governance follows function? Land governance at the urban-rural interface	Thomas Weith Annegret Repp	Germany

Land transformations, as evoked by land use demands ranging from mobility and housing to energy and food production, point to the need to (re)consider approaches towards systemic land governance. This is the basis for the German research programme "Sustainable Land Management", with its focus on a more profound understanding of interacting ecological and socioeconomic factors of land use and corresponding governance approaches. This is particularly relevant with regard to interacting land use demands and new land use patterns at the urban-rural interface, e.g. with regard to the multifunctionality of agriculture. Urban-rural connections experience changes due to new land use drivers like global commodity chains, extended commuting distances or the requirements of the knowledge economy. However, the concept of urban-rural linkages is based on different spatial delineations, understandings and settings for governance instruments in different regional and national contexts. An international discourse on the conceptual background and especially on land governance in this spatial framework is still in its early stages. To include urban-rural linkages in approaches towards sustainable land governance, the world cafe workshop therefore intends to discuss these aspects with an international and interdisciplinary group of session participants and to advance the concept of functional governance for urban-rural spaces. By doing so, especially the interaction of spatial and institutional levels and the role of the involved institutions in urban-rural contexts will be scrutinized. The session chair will gather the results of the group discussions, aiming at a synthesis of the core discussion aspects, as structured by the research questions suggested below. By using flip chart tables and illustrations, overlapping aspects and differences between the proposed perspectives will be identified during the world cafe and used as a framework for an international discourse on land governance at the urban-rural interface.

CATEGORY: *4.5. Open Session*

NUMBER	TITLE	CHAIRS	COUNTRY
0010	Ecosystem services for connecting actors in land change processes	Christine Fürst Paul Opdam	Germany

The concept of ecosystem services (ES) is an example for integrative assessment approaches that support fostering and communicating common values provided by ecosystems. Beyond their usefulness for assessing values, such concepts show great potential to deliver a reference from common actions to improve landscapes to gain value from them as a main driver in socio-ecological systems. Central question in our session is "How ES connect people in land change processes and facilitate collective action for common values?" When thinking on an answer to this question, it turns out that perception of the ES concept in planning practice and at the scale of thinking of actors in land-use planning and decision making does not exist. Though most land-use planning approaches make use of target systems that show parallels to the ecosystem services concept, differences in terminology, assessment methods and reference scale restrain the acceptance and use of the ES concept in many cases. Particularly in land-use planning and governance, the ES concept could be of high value for facilitating the exchange between actors, for consensus building on prior local or regional planning objectives and for balancing interest conflicts between private and common needs. Taking ES as a reference system in land-use planning would help to reveal trade-offs of planning decisions at the micro-scale which might be of relevance for land-use system responses and trigger land changes at the macro-scale. Furthermore, most ES depend from the interplay of several or all land-uses in a landscape context, their pattern and spatial constellation. By using ES, thinking in landscape dimensions could greatly be enhanced and contribute to better understanding why even small-scale land-use decisions may be relevant for common decisions. As a result, the need for top-down legal and administrative regulations that force land-users to perform in a way that is assumed to contribute to common benefit could be replaced or given up in favor of community based planning approaches. These would create higher acceptance of the conjointly developed land-use planning priorities and accepted trade-offs. To make full benefit of the ES concept in connecting actors and facilitating collective actions, it is essential to learn from cases where this concept has been successfully used, to analyze potential success factors and to see, how this could be transferred to other cases. The session will therefore provide a set of short inputs based on lessons learnt from case studies and then enter into discussion on transferability.

| **0106** | Land change effects of governance interventions in agricultural systems: cattle ranching in Northern Brazil | Avery Cohn Pete Newton | USA |

Format

Meetings such as GLP have great value in convening leading researchers in the same room. Our novel format capitalizes on this convened expertise by promoting pre-conference circulation of three innovative and provocative working papers, with session time devoted to a critical discussion their emerging themes. Each working paper will be prepared by an early-career researcher (postdoc or assistant professor), while in the session three eminent discussants would each use a short (5-min) presentation to identify and evaluate the key issues and questions that the papers raise. All six contributors will join the session co-chairs and participants in a closely-facilitated roundtable discussion that works toward meaningful responses to the questions raised by the presentations.

Outputs

The session co-chairs will work with the session contributors and any interested participants to develop a paper based on the discussion and ideas generated during the session. This paper and the three working papers will be submitted to a peer-reviewed journal for publication.

Theme

Our session will investigate the state of the art and forthcoming research challenges in examining the causes and consequences of changes in cattle ranching practices in Northern Brazil. Cattle systems constitute more than one quarter of the land surface in Brazil. In the Amazon and *cerrado* savannah biomes of Brazil, the close association of cattle ranching with deforestation and the low social benefits from cattle ranching have prompted efforts to intervene in cattle systems to reduce deforestation and to increase productivity. Until recently, establishing causal linkages

between cattle and deforestation and between cattle interventions and social and environmental outcomes have proven challenging. Contributing to the challenge are limited agricultural statistics and remote sensing data, a lack of evidence on the magnitudes of the multifaceted incentives to cattle ranch in frontier regions, and little evidence of effective interventions to effect change in cattle systems. Together, the convened panelists have begun address these data and science gaps through a set of innovative research and research-oriented pilot policy efforts. Efforts underway in the participant research groups include the study of the certification of deforestation-free supply chains, pilot payment for ecosystem services schemes, and efforts to explain the adoption and diffusion of mixed crop, livestock, and forestry systems. Findings from the research of the panelists will be used to develop a synthetic view of cutting-edge land change science of Brazilian cattle systems. We will focus on three sub-themes, each in relation to interventions in Brazilian cattle systems: (A) Instruments for Prompting Technology Adoption (Both production and environmental technologies, such as direct GHG mitigation). (B) Governance of Cattle Supply Chains; and (C) Cattle and Land Transitions (pasture-crop, forest-pasture, including avoided deforestation/REDD).

ORAL PRESENTATION ABSTRACTS

NUMBER	TITLE	AUTHORS	COUNTRY
0135	Mapping a millennium of North American agriculture	William E. Doolittle	USA
	This paper envisages the agricultural landscape of North America through a proverbial kaleidoscope. The continent is seen as a dynamic mosaic that unfolded over a period of nearly 1000 years. Variations in natural environments from place to place established conditions that confronted farmers with different technologies, needs, and cultures. Agricultural developments carried the seeds of yet additional changes—landscape transformations. Practices such as canal irrigation in the arid Southwest ca. AD 1000, cultivation of permanent fields in the humid Eastern Woodlands ca. AD 1500, and mixed-farming east of the Appalachian Mountains ca. AD 1800, were not static activities, they had evolved out of prior activities and were constantly evolving into new ones. Given this situation, creating maps that are by definition time-specific was a monument task that involved three types of data, archaeological, documentary, ethnographic. Field work proved to be as beneficial as the library as it provided ecological context. This presentation discusses the complexities of cartographic representation as related to climate change modeling.		
0136	Measuring nutritional diversity of national food supplies	Stephen Wood, Roseline Remans, Nilanjana Saha, Tal Lee Anderman, Ruth DeFries	USA
	Improvements in agricultural production have drastically increased grain yields in the past half-century. Despite this growth in productivity and calories available per capita, malnutrition—both undernutrition and, increasingly, overnutrition—remains pervasive. We hypothesize that the lack of diversity of nutrients in national food supplies contributes to poor nutritional outcomes beyond the oft-cited explanation of inadequate access to calories. We show a strong relationship between three metrics of nutritional diversity of national food supplies (food available for consumption from domestic production and international trade) and key human-health outcomes (wasting, stunting, and underweight incidence), while controlling for calories available per capita and other socio-economic factors. We further demonstrate that in low-income countries, nutritional diversity of the food supply depends on the diversity of foods produced domestically; in middle- and high-income countries, income and trade are better predictors of nutritional diversity. Our results provide evidence that the ability of national food strategies to provide adequate diets depends on the nutritional diversity of the national food supply, in addition to calories available per capita and macroeconomic and institutional factors. Furthermore, as countries transition from low-income to middle- and high-income wealth brackets and towards production of export-oriented agricultural commodities, achievement of human health goals depends on maintaining sufficient nutritional diversity of the national food supply either through domestic production or international trade. We suggest that national agricultural strategies incorporate metrics of nutritional diversity to monitor the adequacy of food supplies. This presentation will contribute to the selected session by using global data to show that efforts to improve food security must consider the nutritional composition of diets, not just close yield gaps.		
0137	Households' adaptation to environmental stresses: insights from saline agriculture in China	Jiali Wang, Xianjin Huang	China

Extreme drought events is affecting saline agriculture in China, potentially necessitating transformational adaptation such as institutional reforms, policy adjustments and behavioral shifts. This paper aims to present the automatic and planning adaptation practices of households, and explore the barriers which discourage various planning adaptation behaviors of households. Semi-structured interviews and group discussions were conducted with households, Village Cadres, and representatives from government sectors and institutes in 24 villages, seven counties (boroughs) of five saline-concentrated regions, involving Jilin, Jiangsu, Ningxia, Shandong, and Xinjiang in China. The results indicate that the key of households adapting environmental stresses mainly lies in multi-level actors' participation such as community, institution, and government sectors, the types and levels of household adaptation varied among villages as a result of the insufficiency of multi-level participation. This paper presents and discussed a model for multi-level actors to participate in planning adaptation to environmental stressors. It is clear that there is a need to improve governance, management and institution to ensure more consistent adaptation and co-management of environmental stressors across multiple actors in rural areas in China. Achieving sustainable saline agriculture might require transformative adaptation including changes in markets, policies, and science.

0140	Modelling the implications of landcover change on ecological services in the Niger Delta of Nigeria	Ayansina Ayanlade	Nigeria

This study evaluates the implications of the environmental change on ecological service in the Niger Delta of Nigeria. The delta, being the most extensive forest and aquatic ecosystem in West Africa, provides numerous ecological services in biodiversity both to people living in the delta and West African economy as a whole. Despite these benefits, much has not been done in terms of examining ecological services provided by the delta and modelling the impacts of environmental changes on these ecosystem services. This study therefore uses Landsat satellite data (from 1984 to 2011), remote sensing change detection and ecological services valuation methodologies to assess the impacts of environment change on the ecological services in the delta. The results show that the Niger Delta of Nigeria has experienced tremendous environmental change over the past three decades. About 9000 km^2 forest area cover has been lost in the region between 1987 and 2011 and this has a great effect on ecological services provided by the delta ecosystem. Though the results of this study showed that forest contributes the highest ecological value coefficients ($ ha^{-1} per year) for Niger Delta with total ecological services of 1102.65$/ ha^{-1}/year, followed by mangrove with 753.55$/ ha^{-1}/year. But over the years, the ecological services provided by the delta ecosystem have considerably reduced. This study concludes by examining the drivers of change and their significant implication not only on the delta physical environment but also the societal implications.

0144	Past and future land conversions effects on habitat connectivity in the Argentinean Chaco	María Piquer-Rodríguez, Sebastián Torrella, Gregorio Gavier Pizarro, José Volante, Daniel Somma, Rubén Ginzburg, Tobias Kuemmerle	Germany

Land-use change is a main driver of habitat loss and fragmentation worldwide. A region where land-use change and thus habitat loss has been particularly drastic is the Argentinean Chaco. About 23% of the entire eco-region has been converted into cropland, mainly for soybean production and cattle ranching, but it remains unclear how this affected habitat connectivity. As demand for soybean continues to rise in

places like Europe and China, and new drought tolerant soybean strains are developed, the Chaco will likely continue to face huge conversion pressure in the future. The current national forest law of Argentina (*Ley de Bosques*) intends to limit further habitat loss and fragmentation due to agricultural expansion. However: 1) the forest law assigns substantial areas for potential conversion, 2) it has been planned in a decentralized way and, 3) provincial regulations have legal gaps that allow land reclassifications for conversions even in areas that are legally protected. As a result, it is highly unclear how the implementation of the forest law may affect habitat loss, fragmentation and connectivity in the future. We studied past (1977-2010) and future (2030) changes in the extent and connectivity of natural vegetation in the Chaco. Our results show that deforestation rates have doubled in the last decade (from about 2 mill. ha in the 1990's to almost 4 mill. ha in the 2000's). Agricultural expansion led to a continuous fragmentation of the Argentinean Chaco, with increasing numbers of forest patches, higher edge area, more isolated patches and a decrease in connectivity among patches of natural vegetation. Preventing the loss of patches important for overall habitat connectivity could substantially mitigate the negative outcomes of the implementation of the forest law. Our study highlights the need for ecoregion-wide planning, particularly in dynamic regions where land transformations threaten biodiversity such as in the Chaco.

0145	Urban-ness?! A new conceptualisation of urban land use exemplified at examples across the globe"	Dagmar Haase	Germany

My presentation discusses and illustrates a newly developed framework by Boone et al. (2014) to conceptualize urban areas focusing on actors (people, institutions and their networks as agents of change), and examining dynamics and alterations in urban lifestyles and livelihoods over larger regions, regardless of whether an area is administratively or morphologically delineated as "urban" or "rural" (Boone et al., 2014). The framework draws on approaches that perceive urbanization and urban land as an integrated system, where humans, communication, energy, and matter flows are involved with urban lifestyles (related to the current second demographic transition), livelihoods, connectivity, and place (see also Seto et al., 2012). The result to be shown in the presentation is kind of a multivariable "map of the degree of urbanity" which will provide novel picture of "the urban" at our globe. The prevailing morphological and land-cover driven delineations and the new urbanity-driven delineations of urban spaces presented in the map differ considerably, both in terms of the spatial extent they cover, and the degree of continuity and interlinkages between places. The spatial extent of the multiple variables of the conceptualization—lifestyle, livelihood, connectivity, and place (see again Boone et al., 2014)—permit the detection of areas of high urbanity within administratively defined non-urban or rural areas, e.g. touristic coastlines, as well as areas of low urbanity within morphologically or administratively determined urban areas, e.g. large brownfield areas in shrinking cities or large slums in Megacities. To illustrate the framework of urbanity, next to the global map, the presentation will present two or three representative case studies —one from Europe and another from India — showing what is meant by the new approach and what makes it different from standard urban land delineation in terms of the understanding of urbanization.

0147	Prospects for conflict to spread through large-scale foreign land rights in Africa	Michael J. Strauss	France

The large-scale acquisition of land by a foreign state can be a vector for bringing conflict to the nation where the land is located, just as foreign military bases can draw conflict toward host states. This risk, recognized and accepted long ago by nations that allow foreign bases on their territory, seems ignored by those that let other countries use vast areas of their land for agriculture or other purposes. Yet when this type of arrangement strengthens the state that uses the land, it serves a function similar to that of a military base. Any adversary it has in a conflict can thus be expected to address this in its military

strategy. This is a particular concern for Africa, by far the most prolific host continent with hundreds of reported long-term international transactions for farmland and for energy or mining projects. The risk to African nations may appear small in the abstract, but with so many transactions it is probable that at least a few host countries will attract conflict to their territory by this route at some point in the future while the arrangements are still in force. The form it takes may range from political interference to military action, covert or overt, on the host state's territory, and the targets may be related to the land's use rather than military. Building on my previous research that established the existence of the risk, this paper attempts to assess and quantify it. The objective is to yield information that can aid in addressing it, and thereby minimize the potential for an African host nation to be drawn into a conflict or otherwise be harmed when its land is used in support of one of the belligerents.

| 0148 | Analysis of global land system archetypes | Tomas Vaclavik, Sven Lautenbach, Tobias Kuemmerle, Ralf Seppelt | Germany |

Land use is a key driver of global environmental change. Unless major shifts in consumptive behaviours occur, land-based production will have to increase drastically to meet future demands for food and other commodities. To better understand the drivers and impacts of agricultural intensification, identifying global, archetypical patterns of land systems is needed. However, current approaches focus on broad-scale representations of dominant land cover with limited consideration of land-use intensity. In this study, we derived a new global representation of land systems based on more than 30 high-resolution datasets on land-use intensity, environmental conditions and socioeconomic indicators. Using a self-organizing map algorithm, we identified and mapped twelve archetypes of land systems for the year 2005. Our analysis reveals unexpected similarities in land systems across the globe but the diverse pattern at sub-national scales implies that there are no 'one-size-fits-all' solutions to sustainable land management. Our results help to identify generic patterns of land pressures and environmental threats and provide means to target regionalized strategies to cope with the challenges of global change. Mapping global archetypes of land systems represents a first step towards better understanding the driving forces and environmental and social outcomes of land system dynamics.

| 0153 | Analyzing urban sprawl in the Veneto region, Italy | Stefania Tonin, Laura Fregolent | Italy |

Urban dispersion is a relatively recent phenomenon in Italy and Europe in comparison to United States. Initially, traditionally compact historical cities were characterized by a progressive growth of their outskirts around compact nucleuses, but only recently urban sprawl has become quite pervasive. The case study of this work is related to the central area of Veneto Region that is a distinctive example of urban sprawl. It covers an area of about 3,700 square km and involves 145 municipalities. During the 1970s this area begun to suffer evident urban growth transformations that continue, even if with different dynamics of growth, until now. Our paper describes the urban growth dynamics based on three different temporal patterns (1984, 1992, 2009). Geographical elaborations are obtained with unsupervised analysis of satellite images; the multitemporal analysis integrates the data of Landsat images classification and of Cartographic land cover of the Veneto Region. Our study explores a set of quantitative variables to characterize urban forms at the municipality level using patch analysis of land data for the years 1984, 1992 and 2009. Several dimensions were selected and evaluated for the case study (such as patch density, edge density, total edge, mean patch size, patch size coefficient of variation, and mean patch fractal dimension). Lately, we applied principal component analysis to extract the single component (factor) that best represented the dynamics of sprawl, as indicated by its capture of the largest amount of common variance of the different variables.

Results show that urban areas increased by 65.40% between 1984 and 2009, while population grew by

only 11% during the same period. However, in the period 1998-2007 we noticed some phenomena of new urbanizations around the existent urbanized area, especially when looking at the location and distribution of the newly developed land. In particular, in the last twenty years, a process of urban densification around the centers of the polycentric system has appeared, accompanied in the last ten years by a process of filling in the open spaces, gradually making the study area more similar to a low-density city.

0157	Improving global land cover, land use and global in-situ datasets	Steffen Fritz, Linda See, Christoph Perger, Christian Schill, Ian McCallum, Florian Kraxner, Michael Obersteiner	Austria

Global land cover is derived from remote sensing where there are now many different products available at varying resolutions and for different temporal windows. With recent open access to the Landsat archive, new 30-m resolution global land cover products are now appearing. However, studies have shown that there are many disagreements between these products and the accuracies are currently not sufficient for many applications. Land-use, on the other hand, cannot be characterized by remote sensing alone since it relies on additional information that can only be collected on the ground or through the inclusion of expert knowledge. To improve global land cover and land-use, and to build an extensive database of land cover classes based on photo interpretation and in-situ information, Geo-Wiki and the Geo-Wiki Pictures mobile app were developed. This paper contributes directly to this session, which is to discuss different ways forward to improve global land-use. Geo-Wiki is a visualization, crowdsourcing and validation tool for improving global land cover and land-use using Google Earth and Bing maps. The online application (www.geo-wiki.org) is comprised of several branches that are devoted to different types of land cover and land-use, e.g. to improve cropland, urban extent, biomass characterization and land cover more generally. Through regular crowdsourcing competitions run at IIASA, we have collected more than 250,000 samples of land cover and human impact using Google Earth. These samples have been used to validate a map of land availability for biofuel production and in the development of a global hybrid cropland map. There is also a mobile application called Geo-Wiki Pictures for Windows, Android and iPhone for the collection of in-situ data. Users can take pictures of the landscape and then classify the land cover or use the customized menu builder to gather user-defined information that is more land-use related, e.g. specific crop types or types of managed land. The most recent branch of Geo-Wiki currently being developed is Livestock Geo-Wiki, which is designed to publicize and disseminate livestock sector information in a highly interactive and easily navigable manner. Crowdsourcing will then be used to validate and improve livestock sector data using both the online application and via a modified version of Pictures Geo-Wiki that will allow for additional collection of land-use information related to livestock. An initial case study will be undertaken through the development of pig density maps and manure management, which will be presented in more detail in this session.

0158	Moving forward: land sparing versus land sharing	Joern Fischer	Germany

To address the challenges of biodiversity conservation and food production, a framework has been proposed that distinguishes between the integration ("land sharing") and separation ("land sparing") of conservation and production. Controversy has arisen around this framework partly because many scholars have focused specifically on food production rather than more general notions such as land scarcity or food security. Controversy further surrounds the practical value of partial trade-off analyses,

the ways in which biodiversity should be quantified, and a series of scale effects that are not readily accounted for. We see key priorities for the future in (1) addressing these issues when using the existing framework, and (2) developing alternative, holistic ways to conceptualise challenges related to food and biodiversity.

0159	Landsat: the foundation for mapping, monitoring, and understanding global land change	Thomas Loveland, James Irons	USA

Monitoring and characterizing land changes across the globe requires consistent observation of key variables at an appropriate resolution, long-term measurement continuity, and open and affordable access to measurements. The Landsat series of Earth observation missions, developed by NASA and operated by the U.S. Geological Survey (USGS), uniquely meet those criteria. Landsat's 30m-observation scale permits the detection and differentiation of natural versus human-caused land change. Beginning with Landsat 1 in 1972, seven Landsat missions have continuously recorded multispectral images of the Earth, provide a forty-one year long seasonal and annual record of the Earth's biotic and abiotic conditions at a scale appropriate for both scientific investigations and resource management. The USGS Earth Resources Observations Systems (EROS) is the operations home for Landsat and hosts an archive of more than four million scenes that are accessible to users around the world at no cost. The entire Landsat record is calibrated to a consistent radiometric standard and the majority of the data are orthorectified - enabling immediate assessment of long-term ecological conditions and land change. Landsats 7, launched in 1999, and Landsat 8, launched in 2013, are collecting global data and together provide 8 day coverage of a significant portion of the Earth's land surface. The amount of new daily global acquisitions is the highest in the history of the Landsat program. The historical coverage in the EROS Landsat archive is also expanding due to an effort between the USGS and international Landsat ground stations to consolidate previously inaccessible international Landsat holdings into the EROS archive. An estimated three million unique Landsat scenes are thought to be held in international archives, and in some cases, these data are at risk due to aging storage media and inadequate preservation practices. The repatriation of these data into the EROS archive could eventually double the number of calibrated, orthorectified Landsat scenes available to users at no cost and improve capabilities for long-term global land change investigations. The USGS and NASA continue working to improve the value of Landsat for land change mapping and monitoring. The highest priority is to extend the Landsat record into the future, and planning is underway to determine requirements and capabilities of future Landsat missions. In addition, the USGS is working to establish Landsat-based Climate Data Records and Essential Climate Variables suited for use in assessing and understanding land change.

0165	Global demand for steel drives extensive regional land use change: a case study of the Quadrilátero Ferrífero, MG, Brazil	Laura Sonter, Damian Barrett, Britaldo Soares-Filho, Chris Moran	Australia

The global extraction of mineral resources can completely transform the dynamics within socio-ecological systems. Little work, however, has been done on how increasing global demands for these products drives land use change in supplier countries. Instead most research has focused on understanding the extensive impacts of increasing production of agricultural products, specifically food, fiber and, more recently, bio-fuel resources. In this study, we assessed the impacts of increasing global demand for steel on regional land use change within Brazil's largest production hub, the Quadrilatero Ferrifero. To do this, we quantified 20 years of land use change and calibrated a spatially explicit land use change model to simulate the effects of future steel production on native vegetation extent. Results illustrate that steel production drives the expansion of iron ore mines and Eucalyptus plantations. We found that mine expansion caused a relatively small impact on native vegetation loss compared to other

land uses; however, mines targeted very specific ecosystems, resulting in their almost complete removal. In comparison, plantation expansion caused an extensive re-forestation of more than 20% of the region's degraded cattle pastures by 2030; an impact that will have significant implications for landscape ecology and conservation outcomes. The expansion of mines and plantations also had more indirect consequences for land use change dynamics. For example, the rapid and extensive expansion of plantations caused a regional decline in the rate of forest regowth. This was an occurrence that was fostered by the most recent changes in Brazil's Forest Code. Similarly, the expansion of these more economically lucrative land uses also increased the deforestation pressures on remaining native forests within the region. We discuss the importance and complexity of land use change driven by increasing global demands for mineral resources and compare these with those driven by global demand for agricultural products. We also identify and discuss the significant challenges that occur in managing the local to regional scale impacts of global demand for minerals. This presentation will contribute to the conference theme by addressing the tele-connections that emerge from globalization and industrialization in terms of increasing global demands for (and supply of) mineral resources. It specifically aligns with the session title as it provides a case study of Brazil to illustrate how these tele-connections have impact land use change at the regional scale.

0170	Climatic drivers of spatio-temporal changes of cropland in Northern China since the 1970s	Wenjiao Shi	China

Improving the understanding of cropland change and its drivers is currently a focus for policy decision-makers. The datasets of cropland and cropland changes during 1970s–2000s through visual interpretation of Landsat TM/ETM/MSS and CBERS-2 images were used in this study. In order to explore whether climate change has induced spatio-temporal distributions of cropland change in northern China since the 1970s, we considered two representative indicators of heat and water that are important determinants of crop growth including active accumulated temperatures $\geq 10\ °C$(AAT10) and standardized precipitation evapotranspiration index (SPEI). Ordinary linear regression was conducted to analyze the trends of AAT10 and SPEI for each $1\ km \times 1\ km$ grid in the study area. Our results showed that rapid cropland change occurred in northern China since the 1970s, and the area of cropland reclamation (10.23 million ha) was much greater than the area of cropland abandoned (2.94 million ha). In the 2000s the area of cropland located in the regions of higher AAT10 over $3000\ °Cd$ increased, but the area of cropland with SPEI over 0.25 decreased in relation to the areas of cropland distributions in the 1970s, 1980s and 1990s. It appears that climate warming has provided temperature conditions that aided rapid cropland reclamation in northern China since the 1970s, and that drier climatic conditions did not become a limiting factor for cropland reclamation especially during 1990s–2000s. About 70% of cropland reclamation areas were located in warmer but drier regions during 1990s–2000s, and about 40% of cropland abandonment occurred in warmer and wetter conditions which were suitable for agriculture during both 1970s–1980s and 1990s–2000s. This suggests that climate condition is not the only factor driving cropland change. Human influences, including policies, economy and population, are also important driving forces for cropland change in northern China. This study firstly used time series of cropland datasets derived from satellite for the period 1970s-2000s to explore the spatio-temporal change patterns in cropland in Northern China, and then identified its main driving forces behind the changes including climatic change and human influence.

0176	Role of heterogeneity in collaborative watershed management: a comparative study	Pranietha Mudliar	USA

In developed and developing countries, collaborative partnerships have emerged to address water quality and quantity. The U.S. Federal government spends over $200 million annually each year to address nonpoint source water pollution through the Clean Water Act Section 319, while states spend millions

more (Hardy and Koontz, 2007). In India, over $550 million is invested annually in water projects by the Indian government as well as international donors (Kerr 2006). A key rationale for these approaches is the notion that "community" is better than "centralized" governance. However, the reality is that communities are not homogeneous entities. Communities are divided across class, caste, race, gender, resources, interests, and values. Scholars of collective action and common pool resource management have identified heterogeneity as variously helping or hindering success. These inconsistent results stem from a lack of specificity regarding the dimension of heterogeneity, and the context. In this paper, I identify conditions and incentives for heterogeneous communities for developing effective natural resource management policies. In particular, I focus on which institutional mechanisms best enable heterogeneous communities undertake successful collective action. This research will contribute to the Common-Pool Resource Theory, and more pressingly, the design of effective natural resource management policies in heterogeneous communities. This research will be conducted in India and Appalachia, U.S., therefore, studying institution formation in different contexts will illustrate strategies developed by communities to mediate the effect of heterogeneity. This research can contribute towards formulating solutions for building stronger institutions with government support to improve rural livelihoods. Watershed Management is the integrated management of land, water, forest, fisheries, soil, etc., and not in isolation. This presentation will distill the findings from watershed management from two different contexts: a developed and developing country, and then draw broad implications on how it can be applicable to different natural resource management and governance strategies. Organizations in developed as well as developing countries are using community-driven approaches to natural resource governance. This presentation will thus contribute to these approaches to understand the role of the community and stakeholders involved in watershed management. This fits into the conference theme of land governance, and the session on the nexus of land-water-energy.

0178	Zones of intermediality as analytical and theoretical tool to examine foreign large-scale land acquisition	Sandra J.T.M. Evers	The Netherlands

This presentation introduces the session theme while proposing an innovative analytical and theoretical model 'zones of intermediality' to address how diverse, culturally-informed stakeholder approaches (including intra-stakeholder variety of assessments and practices) to the environment and land use come together on the same playing field in foreign large-scale land acquisitions. 'Zones of intermediality' are physical and ontological grids where land claims are mediated, legitimized and/or defended by various stakeholders - company, government official, local elder, NGO, etc. We approach 'zones of intermediality' in two principal ways:

- *land access and legitimization*: by investigating the media used by stakeholders to legitimize their land claims;
- *embodied valuations*: by analysing how different land practices and valuations are mediated by cultural paradigms.
  In addition, the author will report on the mid-term results of the comparative research programme on foreign large-scale land acquisitions in Africa which she is directing. She will also highlight the role of the state in large-scale land acquisitions in Africa.

0179	Linking the world system and the earth system: how can humanities help historical land use science, examples from the HYDE 3.1 data base	Kees Klein Goldewijk	The Netherlands

Land use plays an important role in the climate system (Feddema *et al.*, 2005). Many ecosystem processes are directly or indirectly climate driven, and together with human driven land use changes, they determine how the land surface will evolve through time. To assess the effects of land cover

changes on the climate system, models are required which are capable of simulating interactions between the involved components of the Earth system (land, atmosphere, ocean, and carbon cycle). Since driving forces for global environmental change differ among regions, a geographically (spatially) explicit modeling approach is called for, so that it can be incorporated in global and regional (climate and/or biophysical) change models in order to enhance our understanding of the underlying processes and thus improving future projections. This paper presents a short overview of a tool for long term global change studies; it is an update (v 3.1) of the History Database of the Global Environment (HYDE) with estimates of some of the underlying demographic and agricultural driving factors and uncertainties (Klein Goldewijk *et al.*, 2010; Klein Goldewijk *et al.*, 2011; Klein Goldewijk, 2012; Klein Goldewijk & Verburg, 2013). It is also an attempt to link the socio-economic history of the planet to the environmental history of the planet, and the co-evolution of both is the focus of increasing amounts of research. However, there are still many uncertainties and gaps in our knowledge about the magnitude and timing of land use (change) in history, and it is crucial that researchers from other disciplines are involved in decreasing these uncertainties (Costanza *et al.*, 2007; Zhang *et al.*, 2007; van der Leeuw *et al.*, 2011). Integrated records of the co-evolving human-environment system over millennia are needed to provide a basis for a deeper understanding of the present and for forecasting the future. This requires the major task of assembling and integrating regional and global historical, archaeological, and paleo-environmental records. Examples will be given of differences of HYDE 3.1 with other case studies and evidence from other disciplines such as the humanities (e.g. (Li, 1998; Lin *et al.*, 2008; Lin *et al.*, 2009; Liu & Tian, 2010; Li *et al.*, 2013)).

0180	Directing low carbon investments to facilitate the transformation of ranching in Brazil	Britaldo Soares-Filho	Brazil

In the next decade, Brazil will secure its place as the only large emerging economy to balance development with the environment, or it will miss this historic opportunity. With a 68% decline in deforestation and an associated reduction of 2 billion tons of CO_2 emissions from the historical baseline, Brazil has recently demonstrated its potential to evade this outcome. However, conflicting development and conservation policies, together with increased demands for agricultural products from Brazil, threaten the permanence of this success. Key to the future success of balancing development with conservation will be the reaction of the cattle industry. With the world's largest production herd, ranching has been responsible for a large share of Amazon deforestation, 85% percent of cleared lands are still in pasture, and yet it represents only 2% of Brazil's gross domestic product, with a stocking rate of only 1.1 animal per hectare. Currently beef production is widespread and diverse, with every smallholder to massive production farms having some form of cattle production. To avoid a superficial analysis of the sector, we must take a deep look at ranching, its past, present, and future. How will the past reconcile with the future where beef is a commodity to be produced as efficiently as possible? What will the new face of ranching be? Where can cow-calf, stocking, and fattening operations best succeed? What scales of production will survive? We know that intensification is not a simple change from 1.1 to 1.5 head per hectare, but rather will require a complete deconstruction of the industry into specialized clusters of production – but where and how will this happen? So, where should investments in selected modes of cattle raising intensification be directed? How also do the economics of meat processing affect production decisions? How will infrastructure development affect the relative profitability of ranching and thus the final price to the consumer in comparison to other substitutes? How could economic incentives for improved beef facilitate intensification? Only by answering these and many other questions surrounding the beef industry in a comprehensive, integrated, and geographical manner will we be able to identify the key levers of change within the beef industry that will move it quickly from its current extensive production to a smaller, more efficient, value-added, and environmentally balanced production system. In our presentation, we will address these questions

	discussing the state-of-art of cattle intensification studies in Brazil along with their main recommendations.		
0182	A global historical land use data set for the Holocene (HYDE 3.1): status, uncertainties and future developments	Kees Klein Goldewijk	The Netherlands

Land use plays an important role in the climate system (Feddema *et al.*, 2005). Many ecosystem processes are directly or indirectly climate driven, and together with human driven land use changes, they determine how the land surface will evolve through time. To assess the effects of land cover changes on the climate system, models are required which are capable of simulating interactions between the involved components of the Earth system (land, atmosphere, ocean, and carbon cycle). Since driving forces for global environmental change differ among regions, a geographically (spatially) explicit modeling approach is called for, so that it can be incorporated in global and regional (climate and/or biophysical) change models in order to enhance our understanding of the underlying processes and thus improving future projections. This paper presents a tool for long term global change studies; it is an update (v 3.1) of the History Database of the Global Environment (HYDE) with estimates of some of the underlying demographic and agricultural driving factors (Klein Goldewijk *et al.*, 2010; Klein Goldewijk *et al.*, 2011). It is also an attempt to link the socio-economic history of the planet to the environmental history of the planet, and the co-evolution of both is the focus of increasing amounts of research. Some researchers suggest that mankind has shifted from living in the Holocene (~emergence of agriculture) into the Anthropocene (~humans capable of changing the Earth' atmosphere) since the start of the Industrial Revolution. But in the light of the sheer size and magnitude of some historical land use changes (e.g. as result of the depopulation of Europe due to the Black Plague in the 14th century and the aftermath of the colonization of the Americas in the 16th century), some believe that this point might have occurred earlier in time (Ruddiman, 2003; Kaplan *et al.*, 2010). There are still many uncertainties and gaps in our knowledge about the importance of land use (change) in the global biogeochemical cycle, and it is crucial that researchers from other disciplines are involved in decreasing the uncertainties. Integrated records of the co-evolving human-environment system over millennia are needed to provide a basis for a deeper understanding of the present and for forecasting the future. This requires the major task of assembling and integrating regional and global historical, archaeological, and paleo-environmental records. Humans cannot predict the future. But, if we can adequately understand the past, we can use that understanding to influence our decisions and to create a better, more sustainable and desirable future. Examples will be given of improvements of the HYDE 3.1 data base and reflections will be given on possible future developments.

0183	Managed land and the climate system: Is the representation in earth-system models sufficient?	Thomas Pugh, Stefan Olin, Mats Lindeskog, Anita Bayer, Almut Arneth	Germany

Anthropogenic land-use and land-cover change has substantially altered fluxes of carbon between the terrestrial biosphere and the atmosphere, exerting a strong influence on global climate. The impacts on carbon fluxes are both immediate, through the clearing of natural vegetation, and sustained, through modifications of long-term land-atmosphere exchange. Yet only relatively recently have anthropogenic land-use and -cover change been explicitly and widely represented in global Earth-System Models (ESMs), and the sensitivity of different approaches is not well explored. Typically such models represent all crops and pasture land (~35% of global land area in 2000) as grasslands. However, crops and pasture may differ from natural ecosystems in terms of plant species, productivity, phenology, management, the annual growth cycle, and harvest; fundamentally affecting the amount of carbon stored

by the terrestrial biosphere. Further, the representation of crops and pasture brings climate models into the field of research hereto occupied by dedicated agricultural models. Details of management currently represented in these models (e.g. changes in sowing practices, irrigation, residue removals) may be of substantial importance not just for crop yields, but also the global carbon cycle, and hence climate. Thus, this issue is not just one of quantifying potential uncertainty in climate models, but also of understanding the importance of inconsistencies that exist between ESMs and agricultural models, such as those used for local scale climate impact studies. Using the dynamic global vegetation model LPJ-GUESS, recently updated to include a detailed crop model, we investigate the sensitivity of net ecosystem exchange of carbon to the treatment of crops and pasture in the model. We show that the choice of crop representation can be as influential as that of ESM on the modelled terrestrial carbon uptake, and increased detail in crop representation can increase the modelled difference between simulations with and without land-use change by as much as 100%, to the extent that the terrestrial biosphere may turn from a net sink to a net source of carbon. By investigating the sensitivity of the crop model to a range of different management options, we elucidate the key features/processes which control the uncertainty space. We discuss the significance of these results in terms of the global carbon cycle, and key processes for inclusion in ESMs and land-use scenarios.

0184	Climate change impact and adaptation assessment in agriculture requires farming systems analysis and integrated assessment	Pytrik Reidsma, Joost Wolf, Argyris Kanellopoulos, Ben Schaap, Maryia Mandryk, Martin van Ittersum	The Netherlands

Climate change impact assessments in agriculture are usually based on crop models, as the crop level is the basic level where climate affects agriculture. In economics, Ricardian approaches based on statistics are used to assess impacts on farmers' income. Although such approaches provide valuable insights, they do not consider the farm level explicitly, whereas decisions regarding management and adaptation are mainly made at farm level. Farm level decisions influence impacts of climate change and variability, and should be considered. Farm level decisions are not only influenced by climate. In the past, the influence of technological development, policy and the market was larger than climate change. Societal changes also affect the role of agriculture. While agriculture has been mainly production-oriented throughout time, increasing environmental awareness and changing societal perspectives have led to the quest for a more multifunctional agriculture. Food and fibre production is not the only output of agriculture, other economic, environmental and social indicators have also become important for the viability of agriculture. We therefore argue that farming systems analysis and integrated assessment are needed for climate change impact and adaptation assessments in agriculture. In this presentation we will illustrate this with a case study in the Netherlands (Wolf et al., 2012). Assessments were performed for 2050 at two scale levels. At the EU level, a crop model was used to assess changes in crop yields due to climate change, and a statistical model to assess changes due to technological development. Next, this information was used in a market model to assess changes in product prices. These EU level changes formed input for the regional level assessment in Flevoland, a province with mainly arable agriculture. As impacts and adaptation differ per farm type, we first developed scenarios for farm structural change. Secondly, impacts of climate change on crops in Flevoland were assessed with a crop model and a semi-quantitative and participatory method that specifically focused on the impacts of extreme events and pests and diseases. Thirdly, we assessed the impact of different drivers at farm level. Results show that impacts of climate change are generally positive, but small compared to developments in technology, policy and markets. In other case studies, our models have also been used for dairy farming, and coupled to regional environmental and agent-based models to assess impacts on environmental

emissions and regional land use change. More detail will be given in the presentation.

0187	Disaggregating overstory and understory phenology in tropical savannas using time series decomposition and linear unmixing of vegetation indices	Qiang Zhou, Michael Hill, Jane Southworth, Kelley Crewes, Peter Scarth	USA

Ecosystem function in tropical savannas involves major interplay between climate, herbivory and fire, and the phenology of the overstory woody vegetation and understory grasses and shrubs. Across global tropical savannas, the mix of vegetation and phenology is highly variable, with predominantly evergreen overstory in Australia and South America, and predominantly deciduous overstory in Africa. In addition the understory varies from grasses and bare soil in more arid savanna to complex mixtures of grasses, palms, and shrubs in more mesic savanna. Accurate estimation of the changes in fractional cover of the photosynthetic (PV) and non-photosynthetic (NPV) woody and herbaceous vegetation, as well as fractional cover of bare soil (BS) from remote sensing is critical for better modeling savanna carbon and ecosystem dynamics. This paper reports on the development of methods to separate the dynamics of over- and understory cover fractions using time series decomposition and unmixing of vegetation index responses with 8 day 500 m MODIS Nadir BRDF (Bi-Directional Distribution Function) Adjusted Reflectance (NBAR) data for 2002 - 2011. The approach utilizes two methods developed in Australia: (1) the fractional cover of photosynthetic vegetation, non-photosynthetic vegetation and bare soil is estimated by linear unmixing of Normalized Difference Vegetation Index (NDVI) and Shortwave Infrared Ratio (SWIR32) (Guerschman et al., 2009); and (2) the persistent green tree fraction is estimated from decomposition of an NDVI time series using the seasonal-trend decomposition procedure (STL). The products of the two methods are then used to extract the separate tree and understory phenology and the results are validated using ground survey data. The approach is initially developed in Australian savanna using the National Fractional Cover Database and Landsat-based Persistent Green product for validation. The two methods have been successfully applied on Australia savanna eco-regions which are mainly dominated by evergreen trees and seasonal grasses. This paper reports the results of initial analysis for southern Africa utilizing field measurements for 2009-2011 supplied by our co-authors. The approach has been modified to accommodate the seasonal greening cycle of deciduous trees by developing a temporal within season multi-frequency decomposition approach utilizing seasonal frequencies from 1 to 1/16thof a year Initial results indicate multiple frequencies of green canopy cycling and significant variation in observed patterns within and between miombo woodlands, mopane woodlands and acacia savanna. The presentation in March 2014 will outline the results of African analysis and compare these with well validated results from Australian systems.

0188	Interactions and trade-offs of ecosystem services under land use changes	Anita Bayer, Almut Arneth, Thomas Pugh	Germany

Ecosystems provide humankind with a range of beneficial resources and services. Climate change, land use and other forms of human utilization alter ecosystems, thus affecting these provisions. The concept of ecosystem services (ES) and natural capital provides a framework to evaluate the availability of environmental resources and to express them in terms that are meaningful to policymakers, economists and land managers. However, linking ecosystem function to service provision is critical and largely depends on (1) the multiple interacting functions within ecosystems across different locations, (2) the time period over which function and use are considered, and (3) how values are assigned to ES.
Dynamic global vegetation models (DGVMs) can be used to simulate the biogeochemical cycles within an ecosystem and their interactions with land use and climate over a range of different spatial and

temporal scales. Here, the DGVM LPJ-GUESS is used to model ecosystem processes, state variables and carbon fluxes that are connected to key ecosystem services and functions such as carbon sequestration, crop yield, freshwater availability, air quality and local climate mediation. We evaluate the model data in a time-sensitive manner, recognising that system lags may result in timeframe-dependent service provision, and follow existing valuation schemes to derive appropriate metrics for the considered ES. Using this framework we investigate differences in ES resulting from land-use/landcover changes or climatic changes. Through an enhanced analysis of trade-offs and synergies between services, we elucidate the potential conflicts of provisioning services (e.g. crop yield, water provision) and regulating/supporting services (e.g. carbon sequestration, climate regulation, primary production, nutrient cycling).

0189	The rise and fall of the bantu farmer's co-operative, 1947 to 1963: challenges facing smallholder irrigation schemes in Limpopo Province, South Africa	Michelle Hay	South Africa

This paper will provide a historical perspective of some of the social and environmental dynamics affecting smallholder irrigation schemes in Limpopo Province, South Africa, where the development of smallholder irrigation schemes have recently been offered as a strategy to create livelihoods and overcome rural poverty endemic to the area. Support and encouragement of smallholder irrigation schemes has a long history in South Africa. Under the 1936 Native Trust and Land Act provisions were made for the development of irrigation schemes. Over the next decades debates raged and policies changed due to the surprising unpopularity and lack of success of irrigation schemes. By the 1980s they were widely understood to be inefficient, and many were closed down or lost a large degree of state support. However, under the present Department of Rural Development and Land Reform, smallholder irrigation schemes have once again been presented as a viable rural development strategy to create livelihoods and overcome poverty. This paper looks at a history of irrigation schemes in the Letaba district (present day Mopani district) of Limpopo province. It will provide a case study of the Bantu Farmer's Co-operative which began in 1947, reached enormous success and national fame, but by 1963 was bankrupt and under administration. I will look at some of the reasons behind its success and failure, and refer to other, more recent historical examples from this area. The paper will draw on archival material, newspapers and historical government commissioned research. I will argue that smallholder irrigation schemes do need state support, but should not be seen as a strategy to create jobs and reduce poverty on a large scale. The factors leading to the failure of smallholder irrigation schemes in the past, such as drought, lack of interest in farming, poor management of irrigation systems, and marketing and logistical problems, continue to be a feature of present day South Africa, and there are additional challenges today, such as crime, that were not there on a significant scale in the past.

0192	Rural to urban transitions and the peri-urban interface: identifying, mapping, and understanding peri-urban areas in Vietnam	Jefferson Fox, Sumeet Saksena, James Spencer, Miguel Castrence, Melissa Finucane, Nargis Sultana, Duong Nong, Chinh Tran	USA

Rapid economic growth in Vietnam has created strong demand for land for industry, housing, commerce, infrastructure, as well as speculation, and huge amounts of land have been converted from agriculture to non-agricultural uses. The most significant land impacts are in peri-urban areas (defined as patchy, piecemeal development up to 100 km from cities/towns), which occupy large portions of

national landscapes and are home to tens of millions of people. Peri-urban areas face unique problems including intense pressures on resources, slum formation, lack of adequate services (water, sanitation), and degradation of farmland. The governance and management of peri-urban areas are often neglected by both rural and urban administrators because they lie beyond urban administrative boundaries (and their resources). These areas face demands from users with contrasting lifestyles and conflicting interests, which range from agriculture to residential, to industrial and commercial, and to the development of green belts and nature reserves. Because most large manufacturing enterprises now locate in peri-urban areas, these regions will continue to attract much, if not most, of the foreign direct investment (FDI) flowing to the region, along with considerable domestic investment. Using data from the 2001 and 2006 agricultural censuses that capture both the changing nature of the built environment (types of sanitation systems) and the loss of and diversification of agriculture systems (percent of households whose major source of income is from agriculture, and percent of land under agriculture, forests, and aquaculture), and a normalized difference vegetation index from 2006 Landsat images we created a national scale urbanicity map for Vietnam. We validated our model using a variety of multi-disciplinary methods including field surveys, interviews with key informants and satellite imagery. We found our model to have an accuracy of 86%. Model results suggest that over 8.4 % of the country's land area and roughly 10.7 % of its population resides in peri-urban communes, and that these areas have a statistically significant greater incidence of H5N1 strain of avian influenza as measured in chicken deaths than traditional and modern communes. Transitional neighborhoods such as these force planners to ask two questions. To what extent does the dichotomy of urban/rural makes sense in the context of Vietnam? Second, how can policy makers effectively provide for basic public goods and services in these contexts?

0193	Rural perception of climate, land resources and rural livelihoods in the Nigerian savanna	Mayowa Fasona, Felix Olorunfemi, Vide Adedayo, Peter Elias, Grace Oloukoi	Nigeria

Livelihoods in many parts the Africa savannas are tied to land resources and contribute significantly to the land change process. Addressing rural livelihoods and poverty and food security is essential for an effective land resource management. Highly variable spatio-temporal local climate forcing creates eco-climatic complexes that are important to rural livelihoods in the Nigerian Savanna (Fasona, et al. 2011). The projected drier future climate portends severe implications for the land and water resources that support food production and livelihoods. This study assesses the perceptions of rural communities on the climate (as a natural driver of ecosystems change) and on access to, and use of, land resources as a strong anthropogenic driver of land change. The methodology involves review and evaluation of policy, programme and project documents, climate data analysis, participatory rural appraisal and household surveys, land-cover and vegetal analysis and stakeholders networking. 191 households, 4 traditional rulers and 5 focal groups, and government officers were engaged across 11 communities in 10 Local Government Areas. A result disseminating and feedback workshop was held with the communities and other stakeholder. The results suggest that strategies to improve natural resources management and rural livelihoods and food security are well articulated in the policy and programme documents, but evidences on the field suggest a strong disconnect between intentions and reality. The perceptions of the communities on the changing climate substantially agree with hard data from meteorological stations. 94% believes that there have been changes in the patterns of rainfall and 60.4% believes annual amount of rainfall has been decreasing. 91% believes there has been a change in the pattern of temperature and 61.5% thinks it is getting warmer. Station data suggests a progressive shift in temporal pattern of rainfall

from the decade 1980-1990 to 2000-2010   that is consistent with the perception of the rural communities. 24 tree species (mainly indigenous species) of which *Anogeissus leiocarpus and Vitalaria paradoxa* are the most significant support the local economy. Resource use conflict put some of these indigenous species at dangers of extinction as none is cultivated on woodlot. Communities are aware of the threat to livelihood by climate and unsustainable resource use but they are not sufficiently mobilized to take action.

0196	A critical appraisal of environmental regulations implemented in hydroelectric power developmental projects - a study of hydroelectric power projects in Himachal Pradesh, India	Mohinder Kumar Slariya	India

By the end of 20th century the existing model of development proves weaken and remains unable to protect the rights of the people, environment as well as human rights. In 21st century, India is poised to play a major role in the community of nations particular in the sustainable development which implies economic growth together with the protection of environmental quality. The developmental policies dominated by theory of neo-liberalism, initiated strongly with the aims to transfer the control of the economy from public to the private sector under the belief that it will produce more efficient governance and improve the economic indicators of the nation. With this thought, the planned development has been initiated in the Himalayan region of the country. The era of the planned development particularly in hydroelectric power development has started with the installation of Pong and Bhakhra dams in the state way back in 1960s. And it has got momentum in the 1980s, when hydroelectric power generation became top priority in the state as well as national policy. At present, it is proceeding to be the 'electricity state' by constructing 401 power projects in 55,673 sq. km area. These projects are in different stage of their execution and governed by the international, national as well as state's environmental laws and taking care of the concerns of the people. The present paper is an attempt of the researcher to critically evaluate the ground realities in form of implemented environmental laws in the NHPC owned power projects in Himachal Pradesh. The allured environmental protection plan on the on hand and implementation thereof in papers on the other, makes it more critical and deceiving the policy makers as well as the funders round the globe. More ironically, the developers have got many awards and status like 9001 etc. for environment protection. But the reality at local level make the sanctity of these awards susceptible. The implantation part of it, has a different story, which has analyzed along with photographic evidences from the project area where these regulations have been implemented. In this presentation, the policy based principles of environmental protection has been analyzed by visiting the sites, conducting first-hand information based research (300 respondents), the impact of implemented EIA & CAT plan has been analyzed, interviews of responsible official of NHPC, local people and photographic evidences, participant observation and exploratory methods of research are the main sources of the analysis in the present presentation.

0197	Soybean supply chains, land use, and governance in the Brazilian Cerrado	Rachael Garrett, Christian Brannstrom, Lisa Rausch, J. Christopher Brown	USA

The objective of this study is to better understand how the structure of agricultural supply chains influences land cover, intensification, and environmental governance strategies in the Brazilian Cerrado and Amazon. We synthesize the results of several case studies in the region (conducted by the authors over the past 5 years) and examine larger spatial patterns using county level data obtained from remote sensing and the Brazilian Agricultural Census. This presentation fits well in the session "Land change science, and political ecology and sustainability: synergies and divergences" for a number of reasons.

First, we use methods appropriate to both land change science and political economy by integrating historical analysis, case studies, and spatial modeling to better understand the economic and institutional processes influencing land use in the Brazilian Cerrado and Amazon. Second, we incorporate feedbacks between the ecological and human systems to better understand the complex and fluid incentives and constraints on land use practices in a particular region. This presentation fits well in the larger theme of local land users in a tele-connected world because our theoretical framework presents land users and supply chain actors as nested within a framework of local institutions, regional structural forces, and global economic conditions.

0199	Making sense of natural resource management and climate change adaptation at district level in South-West Tanzania	Sarah D'haen	Denmark

This paper aims to contribute to the understanding of processes of natural resource management and climate change adaptation at meso-level institutions in sub-Sahara Africa. The conceptual framework builds upon various aspects of sense-making theory and more broadly upon theories of institutional change. The data originate from two districts governments in Iringa region in Tanzania. District level civil servants were interviewed and their narratives with respect to the governance of natural resources and climate change adaptation were analysed qualitatively using thematic data and narrative-based methodologies. The paper finds that, beyond official narratives, different individuals make sense very differently of national and local policies and strategies dealing with land, forest and water management and their respective intertwinement with climate change adaptation. Overall, the findings point towards several challenges to effective governance of climate change adaptation at meso-level, but also highlight de-facto institutional innovation as individual civil servants explore and push opportunities for change.

0200	Contractual alleviation of flood risk in cities by using PES schemes to manage agricultural land upstream and downstream: a UK case study	Jouni Paavola, Olivia Rendon Thompson, Xin Li, Dabo Guan	UK

Flood risk management in urban areas has traditionally been based on a combination of hard flood defenses and flood insurance. In the Northwestern Europe, climate change is likely to increase precipitation and the frequency and intensity of extreme weather events, as well as flood risk. Therefore, climate change is going to put the existing flood risk management solutions under increasing pressure. Conventional solutions to improve flood risk management are "lumpy": large investment and expenditure is typically needed to increase the level of protection against flood risk, and it becomes economically viable only when flood damages have increased. However, ecosystem-based softer solutions may offer an alternative to improve flood risk management more incrementally, at a lower cost and possibly with side benefits. The ecosystem-based alternatives include flow-regime altering land management practice changes upstream and water storage downstream. We review the latest research and evidence on the potential of using ecosystem-based adaptation measures as a response to increased flood risk in urban settlements, and the way in which these could be harnessed by using payments for ecosystem services (PES) schemes. We exemplify our argumentation by examine the potential, costs and benefits of using ecosystem-based adaptation measures to increased flood risk in the City of Leeds in the United Kingdom. To this end, we use GIS to construct land use maps, use literature derived estimates of the contribution of land use changes to flow retardation, and use benefit transfer to explore the potential for trading on watershed services. Our results suggest that the economic feasibility of ecosystem based adaptation measures is sensitive to the assumptions regarding the efficacy of land management practices in altering the magnitude and timing of peak flows. Their public acceptability is also uncertain and would need to be investigated in another project. *The proposed paper contributes to the conference theme by reviewing the state of art in research of and practice in using contractual governance solutions*

	for generation of ecosystem services that foster adaptation to climate change, here specifically to increased risk of flooding in urban areas.		
0202	Forest rights act' in India: its principles, practices and implications	Hari Charan Behera	India

In 2006 an important Act namely, "the Scheduled Tribes and Other Traditional Forest Dwellers (Recognition of Forest Rights) Act, 2006", hereafter referred as "Forest Rights Act" enacted by the Government of India that acknowledged certain rights of the communities living in and around forest areas in the country. The Act is significant to provide social and livelihood security for the tribals and other traditional forest dwellers. Many believe that the legal instrument under the new Act can certainly protect the tribals from harassments executed by forest and revenue officials due to ambiguous forest policies in the past that never apparently recognised the forest rights (include access to forest land) of the tribals. It is reported that about 100 million poorest of the poor will be benefitted out of the programme if it is properly implemented. The grass root level governance structure will be rather stronger and powerful. Emerging land use pattern in the aftermath of Forest Rights Act will have definite impact on environment. In view of above, the paper discusses in details about the FRA, its principles and practices. It also critically examines the role of revenue and forest department in processing the title generation and delivery of land titles. The paper will highlight the changes in land use pattern and livelihood pattern among other socio-economic and ecological dimensions of FRA.

The analysis is based on review of secondary data available from authentic source and public achieves. The concurrent database managed by the state and district administration and also data collected from field visits will be much helpful for the analysis. The interaction with the revenue officials, forest officials, environmental and social activists, and also the beneficiaries associated with the projects will be much helpful for assessing the impact of FRA in the country.

0203	Assessing the impacts of land cover change on climate in Southern South America	Alvaro Salazar, Clive McAlpine, Jozef Syktus, Jack Katzfey	Australia

The impact that land cover change has on modifying climate and hydrology remains a poorly known component of the climate system. Research and modeling using remote sensing and climate models have respectively found that conversions of natural vegetation into pastures, croplands and other human-dominated land uses affect surface energy balance and therefore the water cycle and surface climate. Understanding this in a variety of regional environments is critical to informing integrated research, policy and on-ground action through natural resource management programs to better manage landscapes, moderating climate variability and secure water resources. In South America, since the arrival of the first Europeans, extensive areas of natural vegetation have been transformed into land uses including crops and pastures. Vegetated areas such as the Brazilian Cerrado, Atlantic Forest, Temperate grasslands, The Great Chaco Forest and Chilean Dry Forests (all together comprising more than 4.5 million km^2) have been extensively converted into soybean and cotton plantations, pastures and exotic tree plantations. This land cover change process could have potentially modified surface fluxes of radiation, moisture and momentum further impacting on evapotranspiration rates, precipitation, surface temperatures, droughts intensity and climate extremes as has been shown in the Amazon, Australia and North America. In southern South America, at present we do not know the magnitude and mechanisms of these climatic modifications since there are major gaps related to the climatic consequences of land cover change in this region which is recognized as being at major risk of desertification. This highlights the increasing need to understand the role of historical and contemporary land cover change on patterns of climate variability and vulnerability and the potential consequences over water security.

0205	Detailed spatial demographic data in land	Andrea Gaughan,	USA

change: the AfriPop, AsiaPop, and AmeriPop projects	Forrest Stevens, Catherine Linard, Andrew Tatem	

Land-use and land-cover change has been unprecedented over the last century, largely attributed to the influence of human activities. As such, the impact of human population growth has affected all aspects of life, making accurate, contemporary data on human population distributions critical to land change studies across temporal and spatial scales. Remote sensing and GIS data are critical sources of spatially-explicit information that inform regional and global-scale population models, and in the past few decades there have been tremendous increases in the accessibility and use of remotely sensed data and GIS analyses that refine the process of producing high resolution estimates of population density. Here we introduce the AfriPop, AsiaPop, and AmeriPop projects with the intent of describing detailed, freely-available population data sets that provide timely, accurate information on population distributions in a gridded format. Precise knowledge on human population distribution is needed to define populations at risk of infectious disease and climate change impacts as well as knowing the general distribution of population in relation to other environmental, socio-economic, and political issues. The approach outlined here provides a continuum of population density spread out across the landscape, weighted according to different landscape-level variables. The modeling process combines a semi-automated classification algorithm which incorporates ancillary data using a "Random Forest" estimation technique with dasymetric mapping to generate fine-scale population datasets. The flexibility of the model allows easy integration of global, large scale data sets of both continuous and discrete covariates such as land cover, night lights, climate, distance- to health facilities, schools, roads and many other features that correlate with or are proxies for human population presence. By including these features in the modeling process, we represent variability in population density as it relates to multiple biophysical and social features across the landscape. This is important for regions where finer scale census data do not exist. The application of these datasets has been widely incorporated into health metric studies, providing a base denominator to better elucidate populations at risk. Similarly, these spatial demographic data sets provide a valuable source of population information to inform land change studies and develop strategies towards sustainable management of coupled human-environment systems.

0207	Land use dynamics in Sagarmatha National Park, Nepal: linking spatial research tools and social science in the study of the driving forces of land use and land cover change	Rodney Garrard, Thomas Kohler, Urs Wiesmann, Roger Gehrig, Martin Price, Alton Byers, Ang Rita Sherpa	Switzerland

This case study combines multi-temporal satellite imagery spanning 20 years, ground-based repeat photography spanning 60 years, and information from field studies extending over 4 years to assess the extent and causes of land use and land cover change in Sagarmatha National Park and Buffer Zone, Nepal. Agriculture, livestock herding, forests, settlements, glaciers, culture, and tourism have all experienced rapid change in their structure, extent, and interactions especially over the past 30 years in response to a variety of institutional, economic, political, cultural, climatic, and demographic processes. Land use patterns and processes are explored through a complementary application of interpretation of satellite imagery, photographic monitoring and case study analysis that explicitly addresses local-regional spatial scale change over a time frame appropriate to the identification of fundamental causal processes. The results illustrate that this combination provides an effective basis for describing and explaining patterns of land use and land cover change and their root causes in a UNESCO World Heritage Site with a rapidly evolving socio-economic context.

0208	Gender and actor perspectives on tree-cover changes in tropical forest margins	Grace Villamor, Febrina Desrianti, Ratna Akiefnawati, Sacha Amaruzaman, Meine van Noordwijk	Germany

Gender specificity in response to land-use options and agents offering new investment opportunities has received little attention to date. It may influence carbon emissions and ways to reduce those. In this presentation, we implemented a land-use role-playing game (RPG) with women-only and men-only groups in forest margin areas in Jambi (Indonesia). In the study area, the rubber agroforests supporting high biodiversity value and carbon storage are giving way to new market opportunities for monoculture rubber and oil palm plantations. When women from the upland and lowland villages played the RPGs, land-use change was more dynamic and external investors proposing logging or oil palm conversion were more positively approached. Consequently, in terms of achieving income targets, women outperformed men. Contrary to expectations and gender stereotypes, we may thus expect that the greater involvement of women in landscape level decision making will enhance emissions from deforestation and forest degradation in the area, posing further challenges to efforts to reduce such emissions.

0209	Power and politics: the case of wild boar management in Lativa	Joanna Storie	Latvia

Wild boar populations are increasing and expanding their range over the whole of Europe and, due to damage inflicted on crops and grasslands, bringing them into increasing conflict with farming communities. An investigation into the conflict in one particular wild boar „hotspot", Erglu Novads (an administrative municipality) in central Latvia, revealed the multi-level impacts of power and politics surrounding the issue and highlighted the numersous divisions among the various authorities, hunters and farmers. It also revealed the sometimes difficult transformation of Latvia to a country with democratic institutions where citizens feel able and empowered to take an active part in issues that affect their daily lives – one of the legacies of the Soviet era, where such participation was not allowed. The investigation was conducted using semi-structured interviews with famers, hunters and those in different levels of authority at the local, regional and national level, with sampling obtainined using the snowball method. The Powercube model(Pantazidou 2012) was used to structure the results of the interviews. This model, developed by the Institute of Development Studies at the University of Sussex, allows a nuanced view of power to be developed in its different levels, spaces and forms and the relationships between these. In this study it revealed examples of visible, hidden and invisible power at various levels. Visible power was, for example, manifest in a national debate over the role of hunting laws in the management of wild animal damage. Local farmers affected by the damage however, felt excluded, through perceived threats, hidden power, and the hopelessness felt by many Latvians in their ability to change the system, expressed as invisible power, a legacy of the Soviet era. While the Ministry of Agriculture believed it had created space for open debate, this was not the reality for those most affected. Allegations of corruption and an uneven application of rules, suggested the possibility of much hidden power in operation and the debate would benefit from greater transparency in the system at local and regional authority level. The interplay of power relationships and politics largely determined whose voice was heard in the debate and will ultimately determine whether there is a satisfactory outcome for those suffering the damage. Understanding the power dynamics within an issue is crucial in overcoming the challenges of motivating a largely silent and inactive population, that expects top-down solutions,to become active communities that work to find local solutions to local problems.

0210	The expansion of oil palm plantations in Latin	Irma G. Santiago-	Puerto Rico

America: 2001-2013	Rios, T. Mitchell Aide, Carlos J. Corrada-Bravo	

The impact of oil palm plantations on forests and biodiversity in South East Asia has been well documented, but much less is known about the impacts in Latin America. Although the crop has been in production in Latin America for decades, particularly for cooking oil and other products, its use as a biofuel has stimulated the expansion of oil palm plantation in many countries during the last decade. To understand the impacts of this rapid expansion on forest ecosystems and their associated biodiversity we: 1) described the extent and rate of oil palm plantations in Latin America, 2) determined what land cover/land use classes are being replaced by oil palm plantations, and 3) evaluated how country and international policies have contributed to the expansion. To address the first two objectives, we created annual land use maps for each year between 2001 and 2013. These maps were created using the ARBIMON-land mapper web application and the MODIS MOD13Q1 250m product. The land cover/land use classes used in the analyses were: urban, bare, water, trees, shrubs, agriculture, pastures, banana plantations, oil palm plantations, and other plantations. More than 5,000 training pixels were collect from high-resolution imagery in GoogleEarth using the ARBIMON-land mapper web application. These training pixels were used to create a random forest classifier, which had an overall accuracy >95%, and the oil palm plantation class also had both user and producer accuracy >95%. Our preliminary analyses show that all countries have experienced an increase in oil palm plantations between 2001 and 2013. Although some oil palm plantations have been established in areas that were previously forested, the majority of new plantations are replacing areas that were previously under some other type of agricultural use. For example, in Honduras and Costa Rica, most of the new oil plantations occurred in area previously used as banana plantations, while in Colombia most of the new plantations occurred in pasturelands. Although the direct impact on forested areas was less than expected, if countries are going to meet their internal legislated quotas for biofuel production and expand exports, the impact on intact forest ecosystems is likely to increase.

0212	Drivers affecting land use change in the Amazon basin and in rural France: comparative model and graphic representation	Florent Kohler, Guillaume Marchand, Chloé Thierry	France

The land change and land use factors and their environmental impact have been studied in the last 20 years, especially in the Amazon deforestation front (Caldas et al., 2007). Among these drivers, demographics, land insecurity, infrastructure development, social tensions, and changes in land production potential are mainly mentioned. However, the literature points the difficulty to predict long term evolution, are these drivers interweave randomly. We rely on eight case studies in rural France and in the Brazilian Amazon to test the relevance of these drivers and propose a model of chronological graphic representation, with the objective to compare localized situations. This model is based on a multidisciplinary approach (anthropology, geography and ecology), qualitative as well as quantitative, which focus on the relationship between local history, social dynamics and environmental conditions. Our results indicate that among the proximate drivers, many of them derive from the degree of isolation / accessibility, which has an impact on population, land tenure stability and land use. However, the study of proximate drivers must not set aside the structural factors, such as shifting public policies and contradiction or superposition of different legal regimes. Our purpose is, by historicizing the factors of change, to shed light on the steps of transformation and to model interactions between socio-economic factors, land uses, and landscape fragmentation, so as to contribute on the general reflection about the predictability of LUCC.

0215	Environmental regulation, decision networks	Anne Spicer,	New Zealand

| | and land change: a Taupo, New Zealand case | Simon Swaffield, John Fairweather, Kevin Moore | |

Primary production underpins the NZ economy and is marketed globally through 'clean and green' branding. NZ has a market based policy framework for both economy and environment, focused on open trade, integrated supply chains and polluter pays regulations. Local land managers however face major challenges in responding to new environmental management imperatives intended to meet the diverse expectations of global consumers in different supply chains. As a consequence, local land change outcomes may differ significantly from those predicted by theory or intended by macro scale policy. In this paper landscape biography is used to analyse relationships between globalisation processes and local land use in an innovative nitrogen 'cap and trade' management regime in the Lake Taupo catchment, New Zealand. The Taupo experiment responds to community and business concerns about rising nitrate levels in Lake Taupo, an important cultural icon and internationally recognised sport fishing location. Although the catchment is 74% in plantation forest or conservation, volcanic (pumice) soils result in long term nitrogen leaching from agriculture on the remaining land. The new regime limits nitrogen discharge from individual properties through a 'cap-and-trade' scheme, with a 'cap' based on historical data. Surplus discharge rights (intended to be created through improved land management) become available for trade within the catchment. Such market models are favoured by New Zealand's neoliberal policy makers. Compliance is monitored using a standard fertilizer management tool. Farmers however face a wicked problem: different groups of global consumers prioritise different outcomes, and therefore any price premiums for good practice are specific to particular supply chains. Alternative land use options are limited by land characteristics, farmer competencies, available capital, and the constraints of the monitoring tool. The regulatory 'cap' levels were based on nutrient discharge rates in a good production year, that has been followed by drought, so most farmers are currently under cap, and have therefore adopted a 'wait and see' approach. Some have adopted avoidance strategies - for example land purchase outside the catchment. In the longer term however, operating costs and consumer expectations are rising. farmers who are capital constrained will face a major crisis when production rates return to historical levels and trigger compliance thresholds. At that point, the local land use systems are likely to change dramatically. The Taupo experiment suggests that local contingency is likely to be a major factor in mediating wider market and policy processes with local land use change.

| 0217 | Assessement and prospective on modelling agricultural system dynamics: existing methods and future challenges | Marta Debolini, Martine Guerif, Ghislain Geniaux | France |

In the last decades many researches was developed aimed to assess land use dynamics and modeling future land patterns. Land system science currently faces new challenges in trying to connect different scales and in integrating environmental and socio-economic processes (Rounsevell et al., 2012). In this context, agricultural lands and their management are particularly relevant because they cover a third of the global emerged surface providing essential ecosystem services and they are asked to improve their performance facing the global socio-economic and environmental changes. For these reasons, it appears as essential to improve modeling strategies to assess agricultural and farming system dynamic considering the factors affecting agricultural choices and links/concurrence with other land uses, such as the urban one. This paper aims to review the existing modeling approach for understanding, describing and predicting land dynamics, in order to identify the possible development and challenges in this field, with a focus on agricultural land dynamics. To this aim, we analyzed 41 papers that we consider as the most relevant, obtained from a textual query on the main international bibliographical database. The final amount of papers was recovered after a series of subsequent selections starting from a total sample of 1117 articles. The selection aims to obtain only the papers describing agricultural land use modeling

approaches and case studies. The obtained sample of paper was analyzed in two ways: first of all we carried out a classical bibliometric analysis, in order to understand the main class of research areas and the development of the thematic bibliography during the last decades, and then we applied a reference grill considering the main characteristics of interest in the modeling approaches. In particular, we assessed: spatial and temporal scales, modeling tools (i.e. statistical/computational methods), predictive capacity, drivers considered in the analysis and output typology, namely the attended results of the analysis. Moreover, some keywords were inquired to explore their occurrence in the sample of papers. The whole sample was classified based on the computational and statistical methods applied in the modeling approach, in order to understand the connection between the applied methodology and the attended output. The bibliographic analysis highlighted the need to consider different drivers in the assessment and modeling of agricultural land uses. In particular, farming practices and cropping systems management should be better integrate in the analysis of agricultural dynamics in order to evaluate the possible impact of the future changes in ecosystem services.

| 0218 | Foreign land deals and news reportage: international media representations of local realities in Tana Delta (Kenya) | Froukje Krijtenburg | The Netherlands |

Kenya's Tana Delta area has experienced a surge of large-scale agricultural interest among domestic and foreign companies over the last few years, with potential major impacts on agriculturalist and pastoralist groups living in the area as well as on the fragile ecology of the delta. Not surprisingly, this development has raised major concern among local communities, (I)NGOs, academics and the general public. In this respect, the Tana Delta situation seems a case like many other cases of large land acquisitions in lower income countries with insecure land tenure systems. Interestingly, the role of the (international) media on these prospected, non-materialising and actual land deals is quite prominent. This paper explores how international media relate to events on the ground and which interests they (un)intentionally serve or defend, by comparing ethnographic data from Tana Delta, collected in 2012, with texts from two British quality newspapers and a video-recording from a Dutch quality news programme in the same period. It focuses specifically on the latest land deal in the Tana Delta area, in which the Canadian Bedford Biofuels acquired 126,000 has of land. The deal has received considerable attention in national and international newspapers, which generally framed it as a case of 'land grab' with its adherent negative connotations. With instances from media reportage the paper demonstrates some major driving forces behind international media framing of large-scale land deals in lower income countries in Africa.

| 0219 | Can climate change mitigation and adaptation be pursued together in agriculture and forests? | Rico Kongsager, Bruno Locatelli, Florie Chazarin | Denmark |

Adaptation and mitigation share the ultimate purpose of reducing climate change impacts but are often considered separately in projects and policies because of their different objectives and scales. Agriculture and forestry are related to both adaptation and mitigation, because they contribute to greenhouse gas emissions and removals, are vulnerable to climate variations and are part of the adaptive strategies of rural livelihoods. We assessed whether climate change projects in forestry and agriculture considered synergies between adaptation and mitigation. We selected 232 projects from adaptation funds (e.g. UNFCCC Adaptation Fund) or plans (e.g. NAPAs) and mitigation mechanisms (e.g. CDM) or standards (e.g. CCB). We analyzed whether these projects contributed explicitly to the other objective (e.g. mitigation projects contributing to adaptation) and how they could potentially contribute to it because of their activities or expected outcomes. We found that 31% of the projects reported an explicit contribution to the other objective but only half of them substantiated it. Most adaptation (78%) and all mitigation projects could potentially contribute at least partially to the other objective. Some adaptation project developers were interested in mitigation for the prospect of carbon funding, whereas mitigation

project developers integrated adaptation for increasing local acceptance and long-term sustainability or receiving a certification from the CCB standards, which consider both adaptation and mitigation. The potential to link to the other objective was similar in adaptation and mitigation projects and higher in mixed forest-agriculture projects, in mitigation projects certified by CCB, and in adaptation projects under the Adaptation Fund.

0220	The socio-ecological fit of human responses to land degradation and desertification: an integrated assessement methodology	Helen Briassoulis	Greece

Land Degradation and Desertification (LDD) are complex social-ecological phenomena. Under adverse biophysical conditions, resource-exploiting human activities, driven by place- and time-specific combinations and cross-level interactions of societal forces, set in motion processes of land degradation and desertification. Their unwanted environmental and socio-economic impacts threaten the socio-ecological resilience of social-ecological systems (SES) and have significant consequences for food, water and energy security, human welfare, etc. Human responses to LDD are receiving increasing attention because they also produce impacts, affect the socio-ecological resilience of SESs and are keys to effectively coping with LDD. Human responses to LDD are often narrowly conceptualized, defined and analyzed. Moreover, it is often assumed that the success of 'positive' measures to combat LDD is guaranteed regardless of their implementation context. The contemporary shift away from positivist/linear towards non-positivist/nonlinear paradigms and the contextualist turn in the study of social-ecological phenomena underlines the rising awareness of the contextual, contingent and multi-level nature of LDD and of responses to LDD. Two important implications are: (a) human responses to LDD should be studied at a level that can meaningfully inform lower and higher decision making levels and (b) place-based approaches acknowledging the nonlinear behavior of social-ecological systems and the contextual nature of human responses to LDD are needed to provide sensible and effective policy and planning support. In this context, an important question is to assess 'the socio-ecological fit of responses to LDD'; that is, the degree to which current or future responses to LDD are well-adapted to the biophysical and human features of a SES, thus, preserving its socio-ecological resilience and securing the continuous provision of ecosystem and human services. The presentation describes an integrated conceptual schema and methodology to analyze this question, framed by the complexity paradigm and resilience thinking. It defines certain main concepts (human responses, response assemblages, socio-ecological fit of responses to LDD), discusses selected fundamental prerequisites (focal spatial and temporal level, delineation of the SES), presents the proposed conceptual schema and methodology and offers future research directions. It contributes to Theme No.3, session No. 38 because it negotiates impacts of and human responses to LDD and it provides an integrated framework for place-based analysis of human responses to LDD in SESs, with an emphasis on the regional level, the most appropriate level for sustainable land use planning and policy making.

0221	Trade-offs between land use intensity and avian diversity in the dry Chaco of Argentina: a tale of two gradients	Leandro Macchi, Hector Ricardo Grau	Argentina

Studies to assess the relationship between agriculture production and biodiversity conservation usually focus on one gradient ranging from a natural reference land cover type (typically forest) to an intensive productive land use. However, many semi-arid ecoregions such as the dry Chaco are characterized by a mosaic of different land covers, including natural grasslands and woody vegetation with different degrees of transformation, frequently aimed at meat production. We analyzed the associations between avian biodiversity and meat productivity of forest, natural grasslands, three types of livestock production systems, and soybean crops in northern Argentina dry Chaco; an area of c. 19 million ha characterized

by high conservation value and rapid land use change. A Generalized Lineal Model analysis of reports and publications quantified a meat productivity range in which soybean (the less diverse land cover type) doubles the most efficient livestock systems, and is eight times more productive than the widespread puestos system. A multidimensional scaling ordination identified two independent gradients of bird's response to increasing land use intensity, respectively from protected forests and from natural grasslands, to highly transformed systems. Along both gradients avian richness and density sharply declined in the transition from semi-natural land covers to planted pastures and similarity to native grasslands and protected forests decreased exponentially. Along the "grasslands gradient", bird richness and density presented a unimodal response. Maximum likelihood-fitted curves of bird's guilds response to the productivity gradients showed that in the "forest gradient" most guilds decreased exponentially or linearly, whereas in the "grasslands gradient" most guilds peaked at intermediate levels of meat yield. Our results suggest that land sparing strategies can be more efficient to balance agriculture production with the conservation of forest avian diversity, but also that the prevailing "forest oriented" conservation schemes (e.g. Argentine Forest Law) do not capture the complexity of the system and both forests and grassland gradients should be considered in land use planning, possibly including a combination of conservation strategies.

| 0222 | Gender, the household, and land change in Southeastern Mexico | Birgit Schmook, Claudia Radel, Crisol Mendez | USA |

In this paper, we present an overview of our chapter in *Land Change Science, Political Ecology, and Sustainability: Synergies and Divergences* (eds. Brannstrom and Vadjunec, 2013). We consider how the expectations and micro-politics of gender can shape land change through decision-making processes at the household and community scales. As such, we illustrate how working across the boundaries of land change science and feminist political ecology can lead to new understandings of the role of particular social relations and institutions in processes of land change, and in the human outcomes resulting from those land changes. To illustrate these points, we draw on our research in southeastern Mexico, in communities surrounding the Calakmul Biosphere Reserve, where land changes in the last decades have been significant. We have been involved in land use change research in this region since the late 1990s and have carried out household survey data collection in 1997, 2003, 2007 and 2010 as a component of different research projects. The establishment of pasture is continuing to drive both forest clearing and decreased area for staple production at the household level. Labor out-migration has been identified as one crucial factor in these land changes, with male migration to the US in the early 2000 decade and younger female migration to the eastern coastal tourist centers from the mid-2000 decade onwards. Here we examine the impacts of these migration patterns on household land use and a gendered distribution of household agricultural labor, management, and assets. We organize this examination by means of four notions: (1) Land belongs to people not households; (2) land management arrangements vary and change at the household level; (3) planting pasture can protect women's moral reputations; and (4) migrant daughters' labor can shape land-use possibilities. We argue for changing from a still-largely unitary household approach to a cooperative/conflictual household model that treats gender as a dynamic social institution. We conclude with a few reflections on our evolving research methods.

| 0223 | Local land management practices in a globalized world - between pro-active construction and re-active adaption strategies | Jorgen Primdahl, Lone Kristensen, Andreas Aagaard, Simon Swaffield | New Zealand |

Land use and landscape change always occurs in a material sense at the local level in a specific location - a place. The direct agents of change include local land owners, farmers and foresters, local land managers and their employees, and local organisations. Land change and sustainability science uses

models of coupled human–ecological systems to investigate and represent the dynamics of these interrelationships, whilst landscape planners use complementary concepts of landscape and place to highlight the central role of livelihood, community and everyday practices. Landscape planning and policy practices typically include a combination of conflict management and place making processes. However local change is increasingly affected by external driving forces, particularly markets and supply chains, investment, and various types of public policy, and local landscapes are thus increasingly interconnected with other distal landscapes. This creates significant theoretical challenges in conceptualizing, representing, analyzing, and managing change. In this paper, Hagerstrand's conceptual framework of territorial and spatial competencies is applied to a Danish case study to better understand the dynamics of local land management practices in a globalized world. Territorial competencies are powers to actively change specific areas of land, through ownership, management and physical intervention. Spatial competencies are powers to influence change over wider realms through different policy instruments such as tax, regulation etc. The gap between local owners' territorial competences and policy institutions spatial competences appears to be widening, and there is also increasing transfer of territorial competencies from local to distal agents (through land purchase, lease etc). A detailed case study of the Hvorslev-Bjerringbro area in Jutland, Denmark using geospatial data from 1996 and 2008 shows how changing territorial competences are affecting rural landscapes and land use patterns at different scales within a changing social context. Complementary analysis of the effects of changing spatial competencies and collaborations of institutions involved in national, international and transnational public policy reveals their highly sectorial nature. Strategies by local agents in response to these tensions are identified, highlighting the contrast between reactive strategies (responses) to external processes versus pro-active place making activities (individual as well as community based). Implications for theory, investigation, and local management of the interaction of global and local processes are explored. Key findings include detailed mappings of land use and landscape consequences of changing territorial and spatial competences, and reflections on the wider implications of these patterns for land use research and landscape planning theory

0224	Cultivating resilient landscapes - opportunities for restoring degraded and vulnerable lands with agroforestry systems	Matilda Palm, Eskil Mattsson	Sweden

Shifts in global land use have led to loss of biodiversity, land degradation and declines in ecosystem services. In many geographical areas the deterioration is currently at a near catastrophic scale and the impact is huge, both in terms of food production and deforestation. If managed correctly ecological restoration can offer a chance to reverse environmental degradation as well as help mitigating climate change. This study identifies such opportunities by analysing how an expansion of agroforestry management onto degraded land may restore productivity and ecosystem services. Using reforestation as a restoration alternative has been widely recognized, however, the provision of ecosystem services may be limited. In contrast, agroforestry offers the possibility to generate a wide variety of both environmental and socioeconomic benefits, and through that also a higher potential of success. With a combination of qualitative and quantitative approaches the project captures a broad spectrum of drivers of degradation as well as possibilities to overcome obstacles that hinders restoration. The study includes a comprehensive assessment of opportunities and risks associated with ecological restoration of degraded land. More specifically, the aim of the study is to propose practical solutions for restoration of degraded land with a focus on multiple ecosystem services. The results and recommendations will be based on comparative field research from Sri Lanka and Vietnam. The presentation will be well in line with the conference theme of land transformation on a local level with potential impact on a larger scale. The session will benefit from this multidisciplinary field based case studies with examples of how degraded land can be rehabilitated aiming for climate change adaptation and mitigation.

0225	Global web-enabled Landsat data	David Roy, Valeriy Kovalskyy, Indrani Kommareddy, Lin Yan, Petr Votava, Rama Nemani, Alexey Egorov, Matthew Hansen	USA

The NASA funded Web-enabled Landsat Data (WELD) project has systematically generated 30m weekly, seasonal, monthly and annual composited Landsat mosaics of the conterminous United States (CONUS) and Alaska for 10+ years (http://weld.cr.usgs.gov/). The WELD products and select product applications that take advantage of the consistently processed WELD time series are showcased including CONUS 30m land cover and land cover change classification and automated agricultural field extraction. Global Landsat processing is a "Big data" issue and the WELD code has been ported to the NASA Earth Exchange (NEX) super computer to generate global WELD products from contemporaneous Landsat 5 and 7 data. Prototype global monthly 30m WELD products and plans to expand the production to provide Landsat 30m information for any terrestrial non-Antarctic location for six 3-year epochs spaced every 5 years from 1985 to 2010 are presented.

0226	The vanishing croplands of Jordan: spatiotemporal analysis of past, present, and future urban growth patterns impacts on cropland loss in Irbid Metropolitan area, Jordan	Rana Jawarneh	Jordan

Urbanization growth has become one of the most alarming phenomena that are transforming landscapes and shifting ecosystem services. However, undesirable growth patterns (exurban sprawl) and their environmental consequences have drawn more attention to study this phenomenon. Exurban sprawl land uses have been growing along the rural-urban fringe, occupying more areas than urban and suburban densities (Theobald, 2005). Such growth pattern is taking place mainly on agricultural lands, putting more pressure on other natural resources and threatening food security at local and global scales. Irbid, a major urban center in northern Jordan and the second largest metropolitan area in the country, has been experiencing exurban sprawl patterns at striking rates. The primary goal of this research is to analyze past, present, and future urban growth patterns and cropland transitions in the study area for four time periods: 1972-1984; 1984-1998; 1998-2013; and 2013-2050. The forecasted patterns and transitions were generated using the Cellular-Automata (CA) Urban Growth Model SLEUTH. This model was primarily used because of its capability to incorporate environmental and socioeconomic drivers of urbanization and to implement different scenarios to forecast future urban growth. Secondary goals are to build a continuous long-term land cover timeline for the study area and evaluate the socioeconomic and environmental drivers and impacts of land transitions in the study area. The products from this research have wide range of applications in land management and sustainable development. This proposed research goes well with the theme of the session I selected (Land use change and ecosystem services in peri-urban). My research heavily focuses on peri-urban growth patterns and the consequent pressure created along the rural-urban fringe. I believe that this research will enrich the session and add invaluable findings on these undesirable growth patterns because it provides spatially-explicit evidences on future pathways of growth under different scenarios, which allows for more accurate, efficient, and comprehensive land management policy-making process.

0227	Risk of the residents, infrastructure and water bodies by flash floods and sediment transport in relation to land use - assessement in the scale of	Tomas Dostal, Josef Krasa, Pavel Rosendorf, Martin	Czech Republic

	the Czech Repiblic	Hanel, Miroslav Bauer, Ludek Strouhal, Jan Devaty, Barbora Janotova, Petr Koudelka, Vaclav David, David Zumr, Martin Dockal	

The research project is presented, where risk of residents, infrastructure and water bodies by flash floods and sediment transport is assessed for whole territory of the Czech Republic. The methodology is based on GIS approach. In the first step flow accumulation over actual DEM and landscape pattern is applied for determination of critical points, where concentrated surface runoff is accumulated and driven into sensitive areas. In the second step, WATEM/SEDEM model, based on RUSLE approach, has been implemented, to select those of critical points, characterized by high sediment transport. Then the profiles are classified, according to flood and sediment transport probability and vulnerability (the magnitude of water and sediment transport and sensitivity of structures coincided with runoff trajectories). Simple scenarios of conservation measures are then applied to analyze possible future strategies to avoid harmful effects. The presentation introduces innovative methodology, how the input information data layers for modeling can be acquired based on generally available data sources and how to deal with surface runoff driving through landscape. In conclusions, the criteria of potential risk and its categories are summarized, potential effects of agro-technical and technical control measures are presented and their effectiveness is discussed.

0228	A unified human-environment: a hybrid LCS-PE approach for sustainability science	Jacqueline Vadjunec, Christian Brannstrom	USA

In this paper we discuss recent trajectories in Land Change Science (LCS) and Political Ecology (PE) from our experiences with an edited a book project entitled "Land Change Science, Political Ecology and Sustainability: Synergies and Divergences." The book explores phenomena that Turner and Robbins (2008) identified in their review of similarities and differences in LCS and PE approaches for sustainability science. In an effort to better nurture studies for, with, and about a unified human-environment, we asked scholars from both LCS and PE communities to write chapters that engage with the other tradition within their own research. We also asked authors to reflect on actual and potential synergies between land-change science and political ecology, and to comment on the challenges of such arrangements with implications for sustainability science. Here, we synthesize overall lessons learned. First, we explore the historical development of LCS and the missed opportunities for PE's involvement. Second, we discuss the linguistic turn occurring in PE at the time, and explore the reasons why PE diverged heavily from LCS. Third, while exploring the various opinions and conflicting conclusions of the book's contributors, and drawing on case studies from our edited volume, we call for a synthesis of the two approaches in order to solve complex socio-environmental problems. We argue that a hybrid LCS-PE practical problem-driven approach would re-invigorate both subfields. Lastly, we identify thematic areas of relevance to the GLP meeting for potential LCS-PE synergy: interrelations among institutions, livelihoods, identity, and land use; the new carbon economy and payments for environmental services (PES); pasture, beef, and land grabs; and land-energy (biofuel) interactions.

0229	Comparison of changes in land use and land pattern in the Czech Republic and Austria and their effects on rainfall-runoff relation, soil	Tomas Dostal, Josef Krasa, Rosemarie Hoesl,	Czech Republic

	erosion and sediment transport processes	Peter Strauss, Miroslav Bauer, Jan Devaty, David Zumr	

The land use and land pattern in post-communist countries was driven by political forces. It was not reflecting natural conditions neither historical evolution of landscape structure. The policy pressure led to enormous increment of sizes of individual parcels of arable land and unsuitable crops produced in individual regions (high preference of cereals). Similar historical changes in landscape structure are also known in Austria, however, land-use and land-pattern development here has been driven by natural forces. All these changes had deep impacts on soil properties and resulted in many negative effects, e.g. changes in rainfall-runoff characteristics, soil erosion and sediment transport. In Czech Republic since political changes in 1989, development of land use and land pattern is very progressive, but still it does not follow typical trends known in Western Europe, represented by Austria. Individual parcel size stays high and crop rotation is driven mainly by economic forces related to both of EU and national subsidies. Systematic implementation soil conservation practices and other measures are very slow in both countries. General trends of changes within periods 1945 – 1989 and 1989 – 2013 were characterized and documented for catchments in Czech Republic and Austria, which were nearly identical from point of view of land-use and land pattern until 1947, but their development dramatically diverted afterwards and stays very different until now. Main impacts of land use and land pattern on soil erosion, rainfall-runoff conditions and sediment transport have been estimated using simple GIS based approaches, WATEM/SEDEM model and EROSION3D model. Simple extrapolation of recent trends into future has been provided and potential benefits or negative effects for near future are forecasted using the models.

0231	200 years of land cover change in the Carpathian region: re-thinking change trajectories	Catalina Munteanu, Tobias Kuemmerle, Martin Boltiziar, Urs Gimmi, Domink Kaim, Géza Király, Éva Konkoly-Gyuró, Jacek Kozak, Juraj Lieskovsky, Matej Moses, Daniel Müller, Krzysztof Ostafin, Katarzyna Ostapowicz, Oleksandra Shandra, Patrick Culbert, Volker Radeloff	USA

Theoretical models of land change, such as forest transition theory (FTT), highlight that land cover and land use changes follow gradual long-term trajectories, as a function of political and socio-economic change. However, change trajectories in areas where socio-economic and political shocks occurred at short time-intervals are less understood. The FTT may therefore be inappropriate for the post-socialist countries in Eastern Europe, where political shocks occurred repeatedly over the past 200 years, causing periods of rapid and nonlinear land change. Furthermore, clear land-change models are missing for other land covers. Our goal was to assess land-change trajectories for forest, agriculture, grassland and urban covers and to explore the effects of repeated political shocks and subsequent economic shifts on

change trajectories. We conducted a spatially explicit, broad-scale analysis of temporal and regional variation of land change in the six countries of the Carpathian Region in Eastern Europe. We used time-series of land cover maps from the 1860s, 1930s, 1950s, 1980s, 1990s, 2000s and 2010s. Land cover data for 1890s and 1930s was derived from historic maps, for 1950s from declassified Cold War satellite imagery, and for 1980s to 2010 from pan-Carpathian Landsat TM/ETM+ composites. We used post classification comparison and ANOVA techniques to quantify land cover change and it's variability by time period, country, and eco-region. We show that the FTT generally holds true in Eastern Europe but highlight instructive regional variations. The transition from decreasing to increasing forest cover occurred between the two World Wars. Agricultural land contracted since World War I, urban land grew exponentially over the past century and a slow transition from decreasing to increasing grassland occurred in recent decades, following conservation policies and EU accession. The successive socio-economic and political shocks affected the magnitude of change during distinct time periods. Historically, agriculture expanded mostly at the expense of grasslands and wetlands (~50% change between 1860s-1950s), while forest cover increased on abandoned meadows and arable land since the collapse of the Soviet Union. Our findings contribute to the main conference theme of rethinking land change transitions by showing that land-use legacies can persist for a long time and that longitudinal studies are essential in understanding their effects for recent change. Our results advance land-use science by providing new empirical evidence for FTT in Eastern Europe and proposing transition curves for agriculture, grasslands, wetlands and urban land in areas that experienced multiple socio-economic and political shocks.

0232	Community-based climate change vulnerability assessment in Kribi-Campo coastal area, south Cameroon	Evariste Fediung, Denis Jean Sonwa	Cameroon

Population pressures and increased exploitation of coastal resources are currently shaping coastal lands transformation and degradation. Mangrove systems, despite their values have been degraded and destroyed throughout their ranges. Worldwide, their rates of loss are faster than that of tropical rainforests or coral reefs. This situation contributes to global warming and the resulting effects of relative sea level rise are the primary impact of concern, with a number of severely detrimental effects on coastal communities. The ability of coastal communities to remain resilient is rooted in understanding their potential exposure and vulnerabilities. Since 2009, CIFOR along with its partners have been investigating on climate risks and impacts on coastal communities of Cameroon. The aim of this present study was to investigate climate change vulnerability in the Kribi-Campo coastal area. The study used existing vulnerability assessment frameworks, combined with focus group discussion and surveys with 150 household in 13 villages. Variables of exposure and sensitivity to climate risks and impacts on coastal communities were described and assessed based on the community perception and evidences and on biophysical evidences. The preliminary analysis of the results indicates that the local populations assign high-scores on the following landscapes for the provision of goods and services: atlantic forests (59.5%), beach (16%), farmlands (12.5%) and sea (9%). They are already experiencing some climate related threats such as changes in seasons, coastal storms, flooding, and coastal erosion. The impacts are observed in sectors like agriculture, fishing, beach, housing, health and infrastructure. The most severe effects perceived by local people are flooding in farmlands and crop rotting (reported by 57% of respondents), low fish capture and fish shortage (25% of respondents), beach erosion and inland movement of coastline (20% of respondents), rapid roof degradation due to salt corrosion (30 % of respondents) and high occurrence of malaria and typhoid (33% and 30% of respondent respectively). Analysis of coastal elevation data shows that most of the settlements are located in areas with altitude ranging from 0 to 10 m, which have been described as at significant risk to the effects of sea-level rise. The research concludes with a critical analysis of the socioeconomic determinants of vulnerability and

0233	Growing crops on foreign land: leasing process and the power of the state. a case study of Ethiopia	Myra Posluschny-Treuner	Switzerland

Rapidly increasing large-scale agricultural land investment agreements have been catching much attention during recent years. In this context, foreign investments are often identified as reinforcing factors for local food security but also conflicts. However, host governments actively support agricultural investments in order to push modernization, development and economic growth. Thus, providing investor friendly environments, like tax exemption, duty-free import of machineries and low land rents. Such leasing processes, especially in the global South, might consist of power imbalances between the decision-making elites and the affected rural populations, leaving the latter mostly worse off. Although it is obvious that host governments play an essential role within large-scale land investments, little attention has been given to understand their meaning. This paper analyzes land leasing procedures in Ethiopia and the linked role of the government. A closer look will be taken at the relation between the federal, zonal and district levels as the Federal Republic of Ethiopia transfers land lease power to the respective regions. In order to complete the picture, the power balance between affected local populations and local authorities will be examined. Based on this analysis, the paper contributes to the general conference discussion, especially to the session "The role of the state in large-scale land acquisitions in Africa: mediation, tenure disputes and changed landscapes" since it stresses in depth relations on various governmental levels in Ethiopia.

0234	Climate-human interactions in regions with a long history: the example of the Mediterranean	Joel Guiot	France

Present and future climatic changes will significantly impact on natural and agricultural resources available to societies. The Mediterranean basin has been a key area of human-environment interactions for thousands of years, representing significant risks as well as huge opportunities for sustainable development. Its history is rich of events where climate was a possible trigger or at least an amplification of society decline or collapse. Numerous studies are devoted to such correlations. We may cite the end of the Bronze age (3200 years ago), the end of the Roman period, the Little Ice Age... A combination of paleoclimatological and archaeological studies is the key of this type of correlations. It is important to develop modeling approaches to study the evolution of societies in response to climate change through the available resources, and their ability to adapt according to their decision making mode (collective, centralized, hierarchical, etc), the level of their development and their prosperity. Even if the level of technological development is continuously increasing, these data provide an opportunity to test the ability of our models to respond to some important questions : what were the dominant climatic factors driving the agro-ecosystems at the scale of the last millennia? How do these changes affect ecosystem services, such as those directly relevant to societies, for example, food, fibre, water quality? May we get some useful qualitative information for the present and future change from these past experiences, in particular concerning adaptation to climatic stresses? This talk will present preliminary results and overall a methodology for such investigation. It is based on natural archives data, archeological information and a modeling approach. The proxy data used are the pollen series stored in the European Pollen Database (EPD) for the Mediterranean Basin. Combined to a vegetation model approach, these data provide quantified information on the variations of pas vegetation and climate over the last 10 ky. The climatic variables of interest are winter, summer temperature and precipitation, as well as soil water which is the most limiting factor for Mediterranean vegetation and which is also an indicator of water stress for agriculture. The model used is a vegetation model (BIOME4). We will present gridded maps of climatic change for typical periods where Mediterranean civilizations have known important declines and maps of bioindicators related to wood and food resources needed by these

societies.

0235	Conceptualizing the land change transitions with a territorial approach	Davide Rizzo, Teresa Pinto-Correia, Lone S. Kristensen, Elisa Marraccini, Sylvie Lardon	France

Humans occupy the space in different ways. The practices through which they deal with local biophysical potential to pursue their goals shape the space forming the "land". We consider the land as the spatial entity whose character is defined by these human and natural interactions at a given time. "Land changes" occur when at least one of the following land components is modified: the shape of this spatial entity, its cover/use, the practices operated on it, its tenure or its accessibility. . Taken together several partial or individual changes may show common dynamics that can be named "land change transitions" (LCT). Intentional (i.e., planned) and unintentional changes coexist in the real world eventually driving these transitions according to local and global dynamics. Rethinking LCT is a way to address drastic and subtle land changes to understanding and steering them. Indeed, this is a twofold challenge for research. On the one hand research has to bridge the gap with the complex array of actions taking place on land, on the other hand understanding LCT requires to work across disciplinary boundaries. For that, our communication aims at conceptualizing LCT stressing out the "territory" as a relevant inter- and trans- disciplinary perspective. In this context territory is meant as the level of organisation for local actions in response to wider global drivers. We focus on rural territories – placed in-between the more permanent urban and natural areas – the spaces on Earth where probably the most important LCT are taking place. Changes of land cover (e.g., from agriculture to urban), so as of the land system structure (e.g., the increasing mix of urban and agricultural areas) or of the practices (e.g., the conversion to organic farming of producers located in peri-urban areas or their coordination with consumers' associations) occur unevenly in space and over time, eventually making the land character evolving more rapidly than in the past and more deeply than in urban or natural areas. Undesired side-effects for these lands are widely documented in literature, such as the loss of the cultural character or the threatening of natural resources. We will discuss the relevance of a territorial approach to articulate local and global land change transitions, and to make explicit how the relations between different land users and managers with the local biophysical potential shape and can be used to design different land system architecture.

0239	Investigations on urban ecosystem services (UES) on the local level of urban green spaces in Salzburg	Jürgen Breuste	Austria

Ecosystem services are provided on different scales. The local level is the basic unit for ecosystem services. These are landscape elements or basic ecosystems differing from their neighborhood by structure and functions. The actual urban challenges, land use change, adaptation to climate change, demographic change and cultural diversity demand a systematic evaluation of urban ecosystem services with constant monitoring. In urban areas the concept of urban (ecological) structural units (USU) has been approved to differentiate micro-climatic, biotic, soil and hydrological conditions. These USU can be used as basic concept of providers of urban ecosystem service. The USU dominated by biotic elements, the urban green spaces are investigated in their ability to provide these services in different qualities and quantities. The different urban green structure types like lawns, bushes, different tree covered areas etc. are effective to use for a semi-quantitative evaluation of its services based on reported measurements (Breuste et al. 2008). The study is based on general available knowledge on urban green functions and on example studies especially in Central Europe. This allows qualifying different urban

green space types by its internal structure of vegetation, size, shape and location in relation to at least a semi-quantitative scaling of its urban ecosystem services under different locational circumstances. The evaluated urban green spaces are in urban parks (1), urban forests (2), allotments (3) and urban agricultural areas (4). The assessed urban ecosystem services are recreation (1), water infiltration (2), habitat service (3), and temperature reduction (4).

0242	Technology or policy? Drivers of regime change in NW Spain before and after the accession to European Economic Community	Eduardo Corbelle Rico, Van Butsic	Spain

Regime shifts in land use can result from distant political, social, and environmental forces. Over the last 50 years, massive technological and political innovations have transformed agriculture in Europe, with the net result being a large decrease in the area of farmland. The relative importance of technological advances and agricultural policy to these changes is not well understood. Because of its unique political context, Spain offers an ideal laboratory to investigate the combined impacts of technological and political innovations to regime change in land systems. During the time of maximum agricultural innovation (1950-1980) Spain was not part of the EU.The Spanish agricultural community then experienced a shock by joining the European Economic Community in 1984. Using historical aerial photographs, land use maps, and farm surveys as our reference data along with spatially explicit multinomial logit models, we compare changes in land use in Northwest Spain between pre (1956-1984) and post (1984-2005) EU accession to quantify the relative impacts of regime shifting forces - technological and political innovation - on agricultural and forest lands. In our study area, agricultural innovation between 1956-1984 lead to increased specialization of the farming and forestry sectors, but amounts of land in each use stayed relatively stable at the district level. However, there was variation between municipalities: areas of high productivity expanded agriculture and forestry in response to increased technology, while less productive areas were even less used. After EU accession all municipalities lost agricultural land, even those with a highly productive and specialized farming sector. We attribute this to farms' inability to be competitive in the new European market, in which a milk quota system had just been established, as well as to the incentives to reduce agricultural output that resulted from the reform of the CAP in 1992. Interestingly our modeling exercise shows that the impact of biophysical and land ownership drivers do not vary across time periods - under both the Spanish and EU regime productive areas and land tenure systems were most likely to remain in intense use. Of particular importance are areas of land consolidation which were resilient to agricultural abandonment in both time periods. Our research shows that political changes can have massive impacts on land use, perhaps even greater than technological change.This is a particularly relevant story in relationship to the recent expansion of the EU in Eastern Europe and the CAP reforms of 2013.

0243	Multi-scale land system dynamics and integrated assessment of food, water and energy	Richard Aspinalll	UK

In this paper I use a model of the spatial, temporal and hierarchical organization of land systems and land system dynamics as part of a multi-scale approach to analysis and accounting for food, energy, water and other ecosystem services. The model is a specification of land systems as coupled human and environmental systems, linking natural, technological, and human capital and flows across scales, supports understanding of system dynamics and processes producing the dynamics. This multi-scale understanding, including structural and functional inter-dependencies between scales, is used in an accounting framework to explore food, energy and economic inputs and outputs in land systems. The work is relevant to a full range of relationships that produce ecosystem goods and services, and evaluates the many processes by which ecosystem services are realised in land systems. The work is presented using examples from agricultural land systems throughout the UK and includes analysis of costs, benefits and trade-offs for services for different types of value. The inter-relationships of scales

(farming systems, farm type and land management; regional land systems and environmental variability; national and international policies and markets) reflect the multi-scale nature of system function. The approach has application to both the roles of land systems in sustainability science and application of land systems science to sustainability. This paper is integral to the presentation of an approach for multi-scale integrated sustainability assessments of food, energy, water and land systems as metabolic systems in this session. The session illustrates how multi-scale and multi-dimensional diagnosis of metabolic patterns linked to land systems identifies the rate and density of water, energy, food, and monetary flows in relation to both human activities describing socio-economic processes and land use and land cover describing the local and regional supply of resources as determined by biophysical and ecological characteristics and constraints. The session and paper are aligned with the GLP Open Meeting focus on land systems, and particularly Theme 3 on Impacts and Responses. The work represents interdisciplinary efforts to develop new theory supporting the integrated assessment of different dimensions of land systems and coupled human-environment interactions, the multi-scale assessment and organization of the work connecting local land use to global impacts and responses.

| 0244 | Shifting irrigation: a study on local knowledge on how to preserve soil fertility in two small holder irrigation systems of East Africa | Martina Angela Caretta | Sweden |

Irrigation is most commonly conceptualized as a fixed enduring investment in order to intensify agricultural production. This paper will disclose the "shifting irrigation" methods used in the small holder irrigation communities in the dry lands of Sibou, Kenya and Engaruka, Tanzania. Plots in fact are used on a rotational basis and left to rest for several seasons ensuring the replenishment of their fertility. Such dynamic requires for the irrigation channels and furrows web to be adjusted season after season thanks to a skillful management system. Local knowledge is also manifested in the uptake of new plots, far from the channels intake, during years with abundant rain. Such "opportunistic expansion" is the expression of the adaptive capacity of these systems. Additionally, centuries of constant irrigation result in soil salinization and in the subsequent loss of soil fertility. While these local irrigation systems have existed for at least two centuries, tests on soil revealed low salinity. The premise presented in this article, and corroborated by both qualitative and quantitative data, is that farmers put in place not only a system of shifting cultivation, but mostly importantly, one of "shifting irrigation". An analysis of farming practices made in fact emerge the use of only organic fertilizer and the custom of rotating plots every 3 to 5 years as two crucial elements in the local strategy to maintain soil fertility. This is particularly impressive in Sibou where soil analysis reveal a generally low organic content. The attentive and knowledgeable management on these two irrigation systems have allowed for continuous agricultural production in drylands characterized by soils with low organic content. While the literature calls for a new African Green Revolution through the employment of inorganic fertilizers (e.g. Otsuka and Larson 2013; Matsumoto and Yamano 2013) and for the recapitalization of degraded soils (e.g. Lehmann 2009; Breman et al. 2001), this case study shows the centrality of local knowledge in shaping indigenous refined agricultural practices ensuring long lasting soil fertility and consequently sustainable farming livelihood.

| 0245 | Long-term forest cover changes in the Polish Carpathians and the Swiss Alps: comparison of trajectories and drivers | Urs Gimmi, Jacek Kozak, Matthias Bürgi, Monika Dobosz, Ginzler Christian, Dominik Kaim, Natalia Kolecka, Krzysztof Ostafin, Katarzyna | Switzerland |

Ostapowicz,
Achilleas Psomas,
Aneta Szablowska-
Midor

The Polish-Swiss joint research project "Forest cover changes in mountainous regions – drivers, trajectories, implications" (FORECOM) aims at identifying long-term trends in forest cover changes and related drivers for the Polish Carpathians and the Swiss Alps. Based on these findings FORECOM intends to refine existing land-use scenarios for the Swiss Alps, to apply and adjust them to the Polish Carpathians and to combine land-use with climate scenarios in order to model potential future forest cover changes for both mountain regions. Finally, the project will assess the impact of observed and predicted forest cover changes on key ecosystem services (carbon pools and biodiversity). In our contribution we will introduce the methodological framework of FORECOM and present results from the first project phase. Results include (1) long-term (150 years) and large-scale forest cover reconstruction based on historical and recent topographic maps, (2) aerial imagery and airborne laser scanning interpretation to detect succession processes in case study areas, and (3) analyses of the underlying climatic and socioeconomic drivers of observed forest cover changes on different temporal and spatial scales. Our results show similar large-scale trends in both study regions but significant differences in the timing and the related driving forces resulting in different spatiotemporal patterns of forest cover change. Forest transition can be observed in both study regions but turnaround from net loss to net increase occurred earlier in the Swiss Alps. Forest expansion developed more linearly in the Swiss Alps in consequence of the persistent legal framework in forest policy and relatively stable land use system whereas for the Polish Carpathians we could identify post-war periods with accelerated forest expansion related to major changes in the political and socio-economic system. In both regions land abandonment related drivers were dominating, whereas climate change is not a relevant factor for explaining forest expansion in the Carpathians and plays only a minor role in the Alps. The long-term historical perspective provides important additional information for the development of sound scenarios for the more realistic prediction of future forest cover changes. We will present our approaches regarding to scenario development and predictive forest cover modeling.

0247	An update on global forest change monitoring: trends and impacts	Martin Herold	The Netherlands

Information on where and how change is happening is in high demand. Prominent policy processes and land-based activities are causing or trying to influence how land changes occur for many societally relevant areas. The field of global land and forest change monitoring and analysis has been evolving in particular since it is trying to better track dynamics and changes, and works more closely with policy processes and through engagement of wider communities. For example, the monitoring tropical forest change is such a worldwide issue of broad relevance since both the drivers causing forest loss and the resulting impacts are related to both local and global scales and linked to major policy and societal engagements (i.e. Reducing Emissions from Deforestation and Forest Degradation - REDD+). This is driving also the Earth Observation community and I will try to highlight some of the factors that change the way that related science and impacts:

- First, there is increasing amount of free-and-open remote sensing datasets for the past and in the future. This creates increasingly longer and denser time-series of observation data available to allow for synoptic, more consistent and transparent global view on the human activities on the land surface and related changes on a detailed local level.
- To use and properly analyze land change requires further investments in the areas of time-series processing and multi-sensor time-series feature extraction track dynamics and its impact on key

	land surface properties.		

- A fourth point, the need for robust ground data is increasing the more quantitative and detailed remote sensing analysis become. This is probably the largest data gap today for remote sensing science but many ground-surveying strategies do not have the integration with remote sensing observations in mind; and vice versus.
- Thirdly, this level of information and transparency created by satellite observations will offer unprecedented interactions of satellites, science and society. This goes beyond citizen observer networks that play an increasing role in the improvement of remote sensing studies through providing local information and knowledge.
- A final point to raise is that technological progress and methodological sophistication alone is often not sufficient to implement forest assessments effectively; both nationally and globally. It is as much about the process than the product and more emphasis is needed on fostering more saliency and legitimacy in addition to technical credibility.

0248	Multi-scale integrated assessment of the nexus between land use, water, energy and food security	Mario Giampietro, Sandra Bukkens, Richard. J. Aspinall	Spain

In this paper we describe a new approach for integrated analysis, the Multi-Scale Integrated Analysis of Societal and Ecosystem Metabolism (MuSIASEM), and its application to the nexus between land use, water, food and energy. We show that MuSIASEM allows the simultaneous use of agronomic, technological, economic, social, demographic, and ecological variables in the analysis of the metabolic pattern of socio-ecological systems, even if these variables are defined within different dimensions of analysis and non-equivalent descriptive domains and refer to different hierarchical levels and scales. Hence, MuSIASEM integrates such heterogeneous factors as population dynamics, greenhouse gas emissions and land-use changes at the national or sub-national level. Indeed, quantitative analysis of complex adaptive systems must necessarily go beyond the naïve simplifications of reductionism typically adopting one scale and one dimension at the time. MuSIASEM thus represents a post-Newtonian approach that studies the desirability, viability and feasibility of the actual metabolic pattern of rural and urban socio-ecological systems (diagnosis) and of proposed scenarios and policy options (simulation). As MuSIASEM is based on the use of grammars rather than models, it can be easily coupled to participatory processes so as to generate useful quantitative analysis (integrated set of indicators) for governance through the involvement of social actors. This paper illustrates methodological aspects (solutions to epistemological challenges) of multi-scale integrated assessment of food, energy, water and land in the analysis of socio-ecological systems seen as metabolic systems. In line with the scope of the session, it illustrates how a multi-scale and multi-dimensional diagnosis of metabolic patterns linked to land systems can be used to identify the rate (flows per hour of human activity) and density (flows per hectare of land) of water, energy, food, and monetary flows. The rate of the flows refers to socio-economic processes and provides information on the feasibility and desirability according to the human perspective. The density of the flows provides information on the specific characteristics and profile of land uses and land covers describing the availability of resources (both on the supply and sink side) as determined by biophysical and ecological characteristics and constraints. The session and paper are aligned with the GLP Open Meeting focus on land systems, and particularly Theme 3 on Impacts and Responses. The work represents interdisciplinary efforts to develop new theory supporting the integrated assessment of different dimensions of land systems and coupled human-environment interactions.

0249	Governing the Amazon: public policies and market mechanisms can reduce tropical	Eugenio Arima, Paulo Barreto	USA

		deforestation		

Reducing carbon emissions from deforestation and forest degradation now constitutes an important strategy for mitigating climate change, particularly in developing countries with large forests. We address the recent reduction of deforestation rates in the Brazilian Amazon during a period of economic growth in that country by conducting statistical analyses to ascertain if policies and market based mechanisms implemented and enforced in 2008 had any impact on deforestation rates and amount of fire over the three subsequent years (2009-2011). We also estimate the amount of avoided carbon emissions and ecoregions that would have been deforested in the absence of those policies. We discuss the circumstances that led to the policies implementation success and prospects for its implementation in other tropical countries. We conclude the paper by discussing the challenges that remain for Brazil's success in continuing reducing deforestation and forest fires.

0250	It's all about semantics: the use of grammars for the multi-scale integrated assessment of the nexus between energy, food and water	François Diaz-Maurin, Juan Cadillo Benalcazar, Zora Kovacic, Cristina Madrid, Tarik Serrano-Tovar, Jesús Ramos-Martín, Mario Giampietro	Spain

The analysis of the metabolic pattern of energy, food and water of socio-ecological systems requires handling non-reducible quantitative assessments:

1. Outside vs. inside views – To characterize the requirement on the supply side, one has to observe the flows going from the context to the black-box: (i) primary energy sources (e.g. tons of oil, tons of coal, falling water, wind); (ii) primary agricultural products (e.g. tons of rice, tons of beef, tons of vegetables); (iii) ecological water funds (e.g. rivers, lakes, underground water); whereas to characterize final consumption one has to observe the flows describing the interactions of the parts inside the black-box: (i) energy carriers (e.g. electricity, fuels and heat); (ii) nutrient carriers (e.g. carbohydrates, proteins, fats); (iii) typologies of water appropriation (e.g. blue water, green water);

2. Gross vs. net supply of carriers – There is an unavoidable difference, in the inside view, between gross supply and net consumption of carriers (food, energy and water) determined by the losses taking place in distribution;

3. Forced internal consumption of the autocatalytic loop vs. final consumption (not applicable to water) – In the energy sector a fraction of the energy carriers generated must be consumed to produce energy carriers. In the same way, in the food sector a fraction of the food produced (eggs, seeds, and feed for animal production) must be reinvested to make food products. The characteristics of this internal loop of energy and food carriers are important as implying a non-linear relation between what has to be produced (gross supply) and what can be consumed by the end user.

These non-equivalent assessments require a system of accounting based on grammars. Grammars are different from models as they provide meta-descriptions based on an expected set of relations over semantic categories. Then these grammars can be calibrated on specific instances by establishing an expected set of relations between semantic and formal categories (data and formal systems of inference). In line with the scope of the session, the paper illustrates the concept and the practical use of grammars in the multi-scale integrated analysis of the nexus between energy, food and water in relation to land-uses. The session and paper are aligned with the GLP Open Meeting focus on land systems, and particularly Theme 3 on Impacts and Responses. The work represents interdisciplinary efforts to develop new theory supporting the integrated assessment of different dimensions of land systems and

coupled human-environment interactions.

0253	Forests fires under climate, social and economic changes in the Mediterranean area	Thomas Curt, Donatella Spano, Ricardo Valentini, Ramon Vallejo, José-Manuel Moreno	France

Wildfires are major disturbances in Mediterranean ecosystems (MTEs) since millennia, and they are a part of the natural landscape and vegetation dynamics. Fire regimes result from interactions between climate, land-use and land-cover (LULC), and socio-economic factors, among other. Temperatures, drought and heat waves are predicted to increase during the next decades, while socioeconomic changes will affect LULC. Thus should result in increased fire danger and fire hazard. The EC funded FUME project has made progress in several directions:

- *learning from the past to understand future impacts of fires*: the objectives of FUME were to understand the interplay of these factors, and their role in controlling fires and fire regime in order to have a reference period that integrates fire regime and their causes, socioeconomic and climatological factors, as basis to project future changes;

- *Projecting future impacts on fire under changes in climate and socioeconomics:* The objectives of FUME are to produce scenarios of climate, socioeconomic drivers, including land-use/land cover, and vegetation relevant for predicting future impacts of fire. We used existing scenarios, updated and adjusted to the requirements of fire. Based on these we established for Europe and the Mediterranean basin how such changes will directly affect fire climate-related danger conditions and shifts in fire regime;

- *Assessing our capacity to adapt to future changes and evaluate future vulnerabilities:* The objectives of FUME were to appraise and develop protocols and approaches for fire prevention and fire planning capable of dealing with longer and more severe fire seasons and with new areas exposed to fire risk. Managing and restoring fire-prone landscapes, including new fire areas under the new changing conditions have been investigated. Finally, the costs associated to the expected changes to cope with fire, the damages in some ecosystem services as a result of the new fire regime, and the revision of policies at European level in the light of future risks were also researched;

- *Make fire data available and easy to access, and favour knowledge transfer*: Models need to be validated at sites where information from all sources is available. Additionally, training, knowledge transfer and outreach and dissemination are additional elements to the project. Conditions are already changing, and policy makers and managers need to be informed from this initiative as early as possible. This presentation aims at a better understanding of how fires will change with global changes in the Mediterranean area.

0254	Modelling the supply and demand of ecosystem services by linking the representation of land use decision making with ecosystem functioning	Mark Rounsevell, Almut Arneth, Calum Brown	UK

We argue for a new generation of land use models that represent explicitly the role of human behaviour and decision making (Rounsevell & Arneth, 2011) within an ecosystem functioning and services framework. These models should: a) link the supply and demand of ecosystem services with land use decision processes, b) address multiple-scale levels beyond case studies, and c) contribute to the sustainable use of land resources and natural capital in a changing environment. Individual-based models of human behaviour and decision making, such as agent-based models (ABMs), are applied at the local scale level, but are not practical for larger-scale applications. A model representing several billion individual agents might be feasible technically, but parameterising the attributes of those

individuals is not possible in practice. Up-scaling ABMs could, however, be achieved through a more limited set of generic agent types. Typologies allow generalisations of the attributes (traits) of individual agents in a system that simplifies model development and application, providing a transparent representation of agent decisional processes and behaviour. The challenge, however, is how to achieve this operationally. Dynamic global vegetation models (DGVMs) provide a template for a typology based approach, since the DGVM community faced a similar problem to the up-scaling of ABMs. Representation of all individual plants in DGVMs, or even individual plant species is inappropriate when attempting to generalise modelled process representations from local to global scale levels. The solution to this problem was based on the plant functional type (PFT) concept. Thus, we postulate that the diversity of human systems could be represented by meaningful approximations based on agent functional types (AFTs) in an analogous way to PFTs in DGVMs. We will demonstrate the use of the AFT concept to model land use change within the context of the supply and demand of ecosystem services at broad scale levels. In doing so, we contribute to the session objectives by demonstrating how models of ecosystem functioning and human behaviour and decision making can be combined. We will also show how the ecosystem service concept provides a suitable framework for such analysis by matching what services society demands with what can be supplied by land managers within the context of institutional policy incentives and regulations. This addresses the trade-offs between land users who compete for capital resources as well as the impact of land use decisions on ecosystem functioning and the stock of natural capital.

| 0255 | What are the urban-rural socioeconomic contexts for the changes of ecosystem services? Case studies from China and Germany | Ying Hou, Shudong Zhou, Felix Müller, Benjamin Burkhard, Franziska Kroll | Germany |

Ecosystem services are a promising concept to capture human-environmental interactions as it connects the biophysical properties of natural systems and the socioeconomic characteristics of human systems. Up to now, researchers have provided many empirical studies to identify, quantify or visualize different ecosystem service types and their spatial or temporal changes in urban-rural contexts. Regrettably, few case studies have addressed the linkages between ecosystem service flows and socioeconomic conditions. To contribute filling this gap, we performed two empirical studies with the framework of Driver-Pressure-State-Impact-Response (DPSIR) and the principle of urban-rural gradients in Jiangsu province of China and the municipality of Leipzig in Germany, respectively. For the first case study in Jiangsu, we proposed a conceptual framework coupling the ecosystem service "cascade" and the DPSIR model and established an indicator set for the DPSIR model. By using correlation and factor analyses, we found the primary socioeconomic influences on changes in ecosystem service flows. The results show that urbanization and industrialization in the urban areas and economic development of the whole area are the predominant positive affecting factors for the increases of agricultural production and tourism services. Additionally, the knowledge, technology and finance inputs for agriculture also have generally positive impacts on these two services. Concerning regional carbon storage, non-cropland vegetation cover apparently plays a positively impacting role. Contrarily, the expanding of farming land and the increase of agricultural economy are two important negative influences on the ecosystem' capacity of agricultural production and the regional tourism income. Concerning the second research in Leipzig, we quantified three provisioning ecosystem services: food, water and energy supplies and three regulating services: net primary production (NPP), above ground carbon storage and surface emissions and discerned the changes of these services along the urban-rural ring-shaped gradients. Additionally, we sketched five socioeconomic gradient items. The quantitative linkages between the ecosystem services mentioned above and the socioeconomic aspects were revealed by correlating their gradients:

population density, average housing area and urban fabric proportion are highly negatively correlated with the three provisioning services and positively correlated with above-ground carbon storage and surface emissions. In contrast, unemployment rate has a significantly positive correlation with the three provisioning services and negative correlations with surface emissions. Our work can contribute to the selected session and the general conference theme by providing empirical evidence from local realities to prove the causality between land use transformation and ecosystem service changes and reveal the underpinning socioeconomic contexts.

0256	Adapting institutions: institutional economics and segregative vs. integrative climate adaptation	Matteo Roggero, Andreas Thiel	Germany

We approach climate adaptation from the perspective of institutional economics. We focus on local administrations and explore their role as bureaucratic organizations dealing with nature-related systems where a changing climate create new interdependencies. We conceptualize adaptation by public authorities as a choice between integrated, encompassing adaptation strategies and the "mainstreaming" of adaptation, where different administrative units adapt autonomously, within their respective areas of operation. We apply the concept of integrative vs. segregative institutions to the interplay between an administration's own informal institutions and the formal institutions determining its official competences. Through a qualitative comparative analysis (QCA) based on evidence from 14, climate-sensitive municipalities in North Rhine-Westphalia, Germany, we observe that integrative adaptation happens when both formal and informal institutions are integrative. If either or both of them show segregation, the boundary between integrative adaptation and mainstreaming becomes less clear. This presentation contributes to the governance theme of the conference as it addresses climate-related interdependencies across administrative units at the local level. Climate adaptation measures typically create spatial conflicts between different objectives of local authorities: green areas and wind corridors can't be used for new housing, retention basins can't be used for business parks, dikes and flood walls make river banks more difficult to access, for example. Local authorities process such conflicts through the type of cooperation that takes place among their different units. By understanding how administrative units approach their mutual interdependencies, we can grasp what sort of adaptation we can expect from them – whether, in particular, the costs of additional integration across units are too large compared to the costs of neglecting such interdependencies or vice versa. In the first case, units shall adapt autonomously, until their formal duties are fulfilled. In the second case, adaptation shall span across formal competences and produce integrated plans.

0258	Improving observation of land transformations: Copernicus land services in Europe	Tobias Langanke, Hans Dufourmont, Ana Maria Ribeiro de Sousa, György Büttner	Denmark

Most research on land transformations is at least partly based-on, or makes reference-to, existing observations and monitoring of the dynamics of land characteristics. Frequently updated land-cover and land-use (LC/LU) information is important not only for land-change research, but also more broadly for the monitoring of environmental change, the creation of environmental indicators and reporting and related policy support. On the European level, with CORINE Land Cover (CLC) an established time series of land-use/land-cover information exists since 1990 (with updates in 2000 and 2006). Although CLC is widely and successfully used, its limitations are also known, in particular the coarse spatial resolution, mixing of LC and LU classes in its nomenclature and a few problematic mixed classes. More demanding requirements, including increased update frequencies for environmental information, urge for complementary information services. In the context of Copernicus (the programme for the

establishment of a European capacity for earth observation - previously GMES), the European Environment Agency (EEA) is currently implementing the pan-European and local components of the GMES/Copernicus Initial Operations land (GIO land) that include the mapping of 5 High Resolution Layers (HRL) on land cover characteristics. These HRLs are mapping 1) degree of imperviousness, 2) forest (tree cover density and forest type), 3) permanent grasslands, 4) wetlands and 5) permanent water bodies, for 39 countries (almost 6 Million km^2) in Europe, for the 2012 reference year. The HRLs are being produced at 20m x 20m spatial resolution, and distributed as validated 100m x 100m products. The HRLs will complement and provide additional information to the existing CLC datasets. Furthermore a new CLC-change layer (CLCC2006-2012) and status layer (CLC2012) will be produced. We outline the context of the HRLs, both as being part of the European Copernicus land services, but also in a broader sense as being part of a trend towards higher spatial and temporal resolution LU/LC products. This trend is being enabled partly by better RS data availability, in particular with the upcoming Sentinel-2 satellite. In fact future Copernicus land-services products are planned to be based mainly on Sentinel 2 (projected launch date in September 2014).
We also update on status of production for the HRL's, show first ideas or examples for use both for the land change monitoring community, and in a European policy context, and briefly discuss future developments and plans.

0259	Bridging local to global land change studies with the GLOBE Online Tool	Nicholas Magliocca	USA

To understand global changes in the Earth system, scientists must generalize globally from observations made locally and regionally. In land change science (LCS), local field-based observations are costly and time consuming, and generally obtained by researchers working at disparate local and regional case-study sites chosen for different reasons. As a result, global synthesis efforts in LCS tend to be based on non-statistical inferences subject to geographic biases stemming from data limitations and fragmentation. Thus, a fundamental challenge is the production of generalized knowledge that links evidence of the causes and consequences of local land change to global patterns and vice versa. The GLOBE system was designed to meet this challenge. GLOBE aims to transform global change science by enabling new scientific workflows based on statistically robust, globally relevant integration of local and regional observations using an online social-computational and geovisualization system. Consistent with the conference's overall theme of "*Land Transformations: between global challenges and local realities*", GLOBE has the capability to assess the global relevance of local case-study findings within the context of over 50 global biophysical, land-use, climate, and socio-economic datasets. We demonstrate the implementation of one such assessment - a representativeness analysis - with a recently published meta-analysis of changes in swidden agriculture in tropical forests. The analysis provides a standardized indicator to judge the global representativeness of the trends reported in the meta-analysis, and a geovisualization is presented that highlights areas for which sampling efforts can be reduced and those in need of further study. The effects of point-based versus spatially explicit representations of case-study geographies will also be assessed to understand how area-weighted assessments influence the generalizability of meta-study findings. GLOBE will enable researchers and institutions to rapidly share, compare, and synthesize local and regional studies within the global context, as well as contributing to the larger synthesis goals of the Global Land Project.

0260	Spatio-temporal dynamics in crop sequence patterns at national scale: the French case study based on historical land survey data	Ying Xiao, Catherine Mignolet, Jean-François Mari, Marc Benoit	France

While the identification of dynamics of land management remains a challenge (Rounsevell et al., 2012),

our study contribute to improve the understanding of land-cover modification which is partly driven by changes in agricultural land management practices. The objective of this research was to investigate the subtle changes in cropland in relation to crop sequences in French mainland. All of 430 French agricultural districts were incorporated in this investigation. A powerful statistical method, Partial Triadic Analysis (PTA) was applied to assess the spatio-temporal patterns of crop sequences. The historical land-cover data (1992-2003) that we used, Teruti, consisted of 555,382 sampling points across the entire territory and used a detailed nomenclature (81 land-covers) among which 41 crops were distinguished. Crop sequences were analyzed by dividing the twelve years into three sub-periods (1992-1994, 1997-1999 and 2001-2003). The division of the whole period into three sub-periods was defined considering the potential evolution of cropping systems related to the common Agricultural Policy reforms in 1992 and 2003. The occurrences of 3-year crop sequences were then counted within each district and each sub-period. We further explored the dynamics of crop sequence patterns by applying PTA on the crop sequences datasets. PTA allowed extracting the crop sequence patterns that were common to 3 sub-periods and identifying which sub-periods differed from the common model and which crop sequences were responsible for these discrepancies. The result of PTA on both permanent and annual crops included crop sequence datasets showed that crop sequence patterns were roughly structured in vineyard-based, maize monoculture-based and annual crops-based cropping systems. The second PTA on annual crops related crop sequences (maize monoculture not included) datasets revealed cropping systems diversity across the territory. The occurrence of stability and dynamics of crop sequence patterns during the study period was greatly contrasted between cropping systems e.g. more temporal dynamics revealed in the districts where cropping system was based on oilseed crops (sunflower and rapeseed) and wheat than the districts where the cropping system was based on maize. It revealed a common temporal dynamics of crop sequence patterns in districts belonging to the same cropping system e.g. the increase in rapeseed-wheat based crop sequences areas during the first two sub-periods could be observed in most of rapeseed cultivation zone. Our approach may have implications for assessing production system performance by monitoring the cropland change in other countries. It could be also applied using time series remote sensed data.

0262	The land/energy nexus in agricultural land use: nature conservation caught between two stools?	Andrea Bues, Götz Uckert, Johannes Schuler	Germany

The land/energy nexus is of pivotal importance in facing the challenges of climate change and fostering the transition towards low-carbon economies. The German Advisory Council on Global Change names land use and energy among the three most important topics to be addressed in endeavours to de-carbonise the economic system (WBGU 2011). So far, however, land and energy have been treated as separated governance strands. This becomes particularly apparent with regard to agriculture-related nature conservation. Agricultural policies (*land*) and climate change-related policies directed at agriculture (*energy*) both impact more or less implicitly on nature conservation. It can be observed that these governance strands mutually influence and possibly impede each other. The question arises as to which extent those two governance strands can best lead to synergies regarding biodiversity, or, how the concept of the land/energy nexus can lead to optimised outcomes for agricultural nature conservation. This contribution explores the land/energy nexus regarding agriculture-related nature conservation in Germany. Germany is one of the frontrunners of energy transition and provides multiple incentives for the generation of power from biomass. At the same time, agricultural policy fosters nature conservation. We analyse existing land use policies regarding land-based energy generation and evaluate to which extent they take into account issues of nature conservation. We find that policies devised for climate change mitigation in agriculture compromise many regulations for nature conservation, leading to cross-level effects. We conclude that policy making needs to better consider the interaction between energy

policies and land use. The conceptual study of the land/energy nexus can contribute valuable evidence.

0263	Land use and land cover conversion dynamics in the southeastern Roraima using change detection techniques	Maristela Xaud, José Epiphanio	Brazil

The study of land use and land cover dynamics is relevant to understanding the processes involving territory occupation and consolidation, as well as land change transitions in the Amazon region. Remote sensing and its tools for data analysis, such as change detection techniques, have high exploratory potential in quantifying and qualifying land use and land cover changes, in addition to understand land conversion and modification processes. With the overall objective of analyzing land use and land cover change dynamics in altered areas, through the study of conversions presented in agricultural colonization areas in the southeastern region of Roraima (in northern Brazilian Amazon), the present study attempted to develop a consistent methodological approach, based on the use of change detection techniques applied to Thematic Mapper/Landsat optical images. We tested different supervised classification algorithms and the results showed better conversion discrimination performances when the Bhattacharyya classifier by region was applied, with the use of difference images of linear spectral mixing modeling fractions as input to the classifier. The clustering of conversions according to the characteristics of biomass gain and loss provided better classification performance, represented by the significant increase of Kappa (from 0.67 to 0.78). Thus, the land use and land cover change dynamics in altered areas was analyzed by a study of the existing conversions during the 1997-2004 and 2004-2010 periods. Conversions were analyzed in relation to colonization projects and distance to roads (BR-210 and vicinal). The results showed differences between the two periods, characterizing 1997-2004 as a period of intense clearing activity in forested areas in relation to the subsequent period, when conversions related to the previous land use prevailed. Regarding the distance to roads, the results showed a concentration of conversions up to 1500 meters from roads and, between one period and the another, a decreased presence of conversions in the range closest to roads (0-500m) and increased presence of conversions in more distant ranges, suggesting penetration of conversions within the properties, characteristics that was observed in the field interviews. From one period to another, increasing forest-pasture conversions in two projects (Entre Rios and Caroebe) may indicate a rising trend in the region's cattle activity.

0264	Transforming land and water use patterns and gender relations in a small scale irrigation system in the region of the Saiss in Morocco	Lisa Bossenbroek	The Netherlands

Drawing on a case of a small scale irrigation system situated in the region of the SAISS in Morocco, we argue that land privatization and the use of drip irrigation, as part of larger agrarian transformations, change land and water use patterns and existing gender relations. Current transformations of land and water use offer new ways of being and making a living for some, while forcing others to give up farming altogether. As such, new winners and losers emerge, with a wide range of social "classes" across scales that are connected in complex and multi-stranded relations of production, trade and consumption.

0267	Time series analysis in a Central Indian Tiger corridor: relating forest dynamics to institutions	Harini Nagendra, Shivani Agarwal, Rucha Ghate	India

In recent decades, forests across India have witnessed accelerated rates of clearing and degradation. Although protected areas have been the cornerstone of Indian conservation efforts, multiple studies now indicate that parks are becoming increasingly isolated. Thus it is increasingly critical to study forest dynamics at a regional scale, encompassing protected areas as well as forests governed by a range of institutional mechanisms including parks as well as community forests. Such analyses can help us understand the mosaic of governance mechanisms that can address diverse social, economic and

conservation objectives. We focus on forest change in a critical tiger corridor in central India that connects two Tiger Reserves, the Tadoba Andhari Tiger Reserve and Pench Tiger Reserve in Maharashtra State. The study area is located in the vulnerable dry tropical forests of central India, an important location for wildlife conservation. MODIS imagery was used to assess seasonal and annual vegetation dynamics in the region, and to identify periods of regional greening and drying. At a more detailed spatial scale but with coarser temporal resolution, we used Landsat imagery from 1977 to 2011 at decadal intervals. Six categories of land cover change were delineated, with a focus on identifying areas of stable forest, deforestation, degradation, reforestation and regrowth in the forest corridor. Forest was stratified into fringe areas (located within a distance of 1km from the outermost forest boundary) and interior forest (areas of forest that were not part of the fringe). Focusing on villages primarily experiencing deforestation and reforestation in their surroundings, we conducted field visits to a randomly selected set of villages (stratified based on population density), to assess the drivers of positive and negative forest change. Results indicate the high degree of flux in this critical tiger corridor over a 34 year period. Dry tropical forests are especially susceptible to climatic, ecological and human impacts. This landscape thus constitutes an especially dynamic, shifting mosaic of land cover, land use and governance mechanisms that is impacted by regional tends in rainfall, forest policies and urbanization as well as local factors including land use, infrastructure, and the emergence and disappearance of local institutions. The results demonstrate the need for linking high spatial resolution imagery (e.g. Landsat) with high temporal resolution imagery (MODIS), and for using an integrated social-ecological systems framework to understand the factors driving forest change at regional and decadal spatio-temporal scales.

0269	Carbon emissions from land use change embodied in bilateral trade of agricultural products	Sabine Henders, Martin Persson	Sweden

Global markets for agricultural commodities such as oil palm and soybeans are increasingly important as drivers of tropical forest conversion. If we are to be successful in reducing global carbon emissions from deforestation and forest degradation (e.g., through a REDD mechanism) methods are needed to assess potential displacement effects of national mitigation efforts, as historically many countries that underwent a forest transition have done so by displacing domestic land use abroad. However, analyses of carbon emissions from land use change (LUC) embodied in international trade are very scarce to date due to a lack of data and methodological challenges in allocating emissions to multiple products and over time. Here we present results from a new methodology for estimating carbon emissions from deforestation in the tropics embodied in international trade of agricultural products. We do so by first calculating indicators (carbon footprints) for LUC emissions associated with the different proximate causes of tropical deforestation (e.g., beef, soy, and palm oil production) that vary between countries and over time due to changes in production systems and land use change dynamics. Using bilateral trade data on these products and a methodology for tracing environmental impact from producers to final consumers, we quantify the share and magnitude of LUC emissions that are embodied in the agricultural exports of Brazil and Indonesia, as well as identify which countries are the major importers of these embodied LUC emissions. This presentation fits in directly to the session on "Globalization of land use-distant drivers of land change and geographic displacement of land use" as it contributes to the current scientific debate on how to address land-based leakage effects that are associated with global demand for agricultural commodities (Meyfroidt et al. 2013). Our method to quantify LUC emissions embodied in international trade contributes to understanding remote drivers for land change and can illustrate displacement patterns between countries. This presentation also falls under the overall conference theme of "Land transformations: between global challenges and local realities" as it connects distant, global demands and local deforestation effects to identify current driving forces behind land change processes.

0270	Climate sensitivity of smallholder farmers across multiple agro-ecological zones in India	Pinki Mondal, Meha Jain, Ruth DeFries, Gillian Galford, Christopher Small	USA

Agriculture is the largest employment sector in India, ranging from traditional village farming to modern agriculture. Food productivity, and thus food security, in India varies greatly with inter-annual climate variability and is highly dependent on seasonal rainfall and temperature. Less frequent but intense rainfall events, along with increasing temperature is predicted to have a negative impact on crop productivity in India in the coming decades. Indian smallholder farmers are among some of the most vulnerable communities to climatic and economic changes due to differential access to technology, infrastructure, markets, and institutional or financial support in the case of adverse climatic events. Severe groundwater depletion resulting from excessive use of groundwater irrigation in the north-western part of India will also affect future crop productivity in the absence of effective adaptation strategies. Baseline information on agricultural sensitivity to climate variability could provide useful information for farm-level strategies and policies that promote adaption to climate variability. This study takes an integrated approach to understanding food-water-climate-land dynamics using remote sensing data (2000-01 – 2012-13) for cropping patterns, climate data and census data for human management practices. We find that seasonal crop cover anomaly varied between -25% and 25% of the 13-year mean in different agro-ecoregions. Predominantly climate-dependent regions such as central India show high anomalies up to 200% of the 13-year crop cover mean, especially during winter season. We also find that despite access to groundwater irrigation, crop cover in western India showed substantial fluctuations during the monsoon, probably due to changing planting strategies. This region is, however, less sensitive to precipitation indices compared to other regions with predominantly climate-dependent irrigation. In western India a greater number of rainy days, increased intensity of rainfall, and cooler daytime and nighttime temperatures lead to increased monsoon agricultural productivity, compared to in central India where monsoon timing and amount of total rainfall are the most important factors of crop productivity. Winter daytime mean temperature is the overwhelmingly important climate variable for winter crops despite the differences in biophysical and socio-economic conditions across India. Our findings indicate that better access to sustainable irrigation and heat-tolerant high-yielding crop varieties will be crucial for future food production. This study intends to contribute to the conference theme of 'Impacts and responses' by examining how cropping patterns across agro-ecological zones in India respond to variations in precipitation and temperature, and how smallholder farmers with different socio-economic characteristics respond to climate variability.

0272	Future change in forest fire risk due to future land cover change: a simulation based approach	Eric Maillé	France

Forest fire risk results from a spatial relationship between fuel vegetation and vulnerable stakes, either natural or anthropogenic (houses, infrastructures, etc.), in particular within wildland urban interfaces (WUI, Davis 90). It may be controlled by land management and planning policies. In order to be able to plan future land management measures to limit the risk, decision-makers need decision support tool aimed at representing future risk levels at medium term. Simulation tools are particularly suitable to do that. They require the specification of dynamic *models* designed to represent the processes that determine change in forest fire risk. Two main processes determine change in forest fire risk: climate change and land cover change. Both general climate models and land cover change models are now available. However, generic land cover change models are usable for general purpose, but limited for specialized applications such as forest fire risk management: they are designed to represent simple land cover classes dynamic (classes with only one land cover component – wildland, agriculture, urban).

WUI dynamic, main responsible of land cover change, results from two kinds of processes: social process (discontinuous urban spread) and natural process (vegetation spread and growth). Moreover, forest fire management has to be performed at local scale, and require simulation model at this scale. We developed a set of two models, called *Macropolis* and *Micropolis*, specialized in WUI change simulation for forest fire risk management and planning.

Macropolis is a cellular automata-based model, developed in a raster GIS environment (both GRASS and ESRI ArcInfo Grid) specialized in WUI spatial dynamics representation at macro-local scale. Its particularity is that variables of the transition functions include spatial (contextual) analysis index of WUI (entropy, vegetation aggregation, buildings density, etc.), calculated by the GIS system.

Micropolis is an agents-based model aimed at representing social and ecological processes at the origin of spatial changes in WUI at micro-locale. It implements a scheme of specific land cover branched trajectories: from agricultural used to land abandonment, then to built-up areas or to burnt areas. It is composed of different specialized modules, each either being or not multi-agents based sub-models: an agricultural model for land abandonment representation, a land tenure models for land exchanges representation, etc. It also includes a global agent based forest fire model, with an ignition module, a propagation module and a firefighting module.

In the framework of the FUME European research project, many simulations were performed in different Mediterranean contexts (Southern France, Spain, Sardinia). Results of simulations of different scenarios at both macro-local and micro-local scales show a great inertia of spatial processes with a low efficiency of regulation policies. However, it seems that in the future, occurrences of very large fires might decrease, while occurrences of smaller fire might increase.

0273	The ecosystem service transition in mountain socio-ecosystems	Sandra Lavorel, Bruno Locatelli, Ulrike Tappeiner, Davide Geneletti	France

Land use is one of the main drivers of ecosystem service provision. The forest transition theory has provided a productive framework for the analysis of land use dynamics worldwide, based on development trajectories leading from contraction to expansion of national or regional forest area. We propose that a similar generic framework can be developed to analyze and predict changes in the delivery of multiple ecosystem services, going beyond the simple consideration of changes in area of different land cover types to consider changes in their qualities in terms of ecosystem service supply. This framework depicts trajectories of provisioning, regulating and cultural services, and the resulting trade-offs when moving from agrarian societies focused on self-sufficiency to resource-extraction economies and amenity seeking societies. We illustrate the framework in the case of mountain socio-ecological systems, as key multifunctional systems which have undergone and are expected to undergo large changes in land use and ecosystem services as a result of global change. The analysis of case studies selected to picture the global diversity of mountain socio-ecological systems reveals how the interplay between ecological constraints and changes in demand as a result of societal change and specific policy instruments underpins past, current and expected ecosystem services. Finally we discuss expected impacts of drivers of global change such as climate or policy, and how the framework can be applied to understand transformations of mountain coupled human-environment systems.

0274	The importance of time, trade, and scale when assessing agricultural production and conservation trade-offs	Van Butsic, Tobias Kuemmerle	Germany

The classic land sharing vs. land sparing (LSLS) model (Green 2005) to analyze trade-offs between agricultural production and biodiversity conservation is static, scale independent, and does not allow for interactions between different land uses across space. Most empirical examples of LSLS have followed

this lead by looking at study areas which are assumed to be static over time and take the extent of the study area as the ecologically and economically relevant scale of study. However, researchers in land use science and conservation science do not typically describe agricultural land use decisions or biodiversity patterns as static or scale independent. Similarly, the classic LSLS framework does not allow land uses in distant places to impact on local study sites although land use science increasingly acknowledges that few places are isolated and that globalization increasingly links distant places via teleconnections, resulting in displacement effects. Thus, we feel there is a disconnect between the classic LSLS framework and how many researchers view land change processes. Whether or not this disconnect is important scientifically or policy wise is unknown. Here we use simulation models to explore how the theoretical model and its results by Green (2005) change when we allow for (1) temporal uncertainty in biological response and agricultural yields, (2) scale dependence in conservation decision making, and (3) trade linkages between countries. Using the conservation planning software RobOff we run three experiments. First, we ask if classic LSLS theory hold when uncertainty is introduced to agricultural yields and biodiversity response over long temporal horizons. Second, we ask if the extent of the decision maker impacts the results of classic LSLS theory (i.e., does the 'optimal' strategy change if each landowner acts for himself versus one decision maker managing the full landscape)? Third, we ask if classic LSLS theory holds when trade is allowed between (a) two areas with similar species and yields, and (b) Two areas with different species, but similar yields. Our research will contribute to the ongoing discussion of how to move beyond the LSLS debate by investigating how the nature of this debate changes when assumptions from the classic model are relaxed. By relaxing these assumptions we will improve our understanding of the generalizability of the LSLS framework as powerful idea for both science and policy.

0275	Livelihood impacts of climate-driven agricultural land use change: an integrative analytical framework	Patrick Hitayezu, Edilegnaw Wale Zegeye, Gerald Ortmann	South Africa

Climate change is a major underlying driver of land use change in the dryland farming systems, particularly in the regions where the farmers' adaptive capacity is largely defined by their land resource base. However, climate-driven land use change occurs within specific socio-economic and ecological contexts and impacts them significantly. Therefore, the understanding of effective agricultural land use change strategies requires integrated approaches to impacts assessment. The objective of is article is to make an analytical synthesis between the land use change impacts assessment and sustainable livelihoods (SL) frameworks. Based on the land use functions (LUFs) framework, a brief literature review helps identifying the key indicators of the economic, social and ecological impacts of climate-driven land use change. Drawing upon the hypotheses of the asset-based approach, an adapted Driver-Pressure-State-Impact-Response (DPSIR) framework is used to link climate variability and change (CVC), agricultural land use change, livelihood assets and LUFs, and provides an entry point for feedbacks. The notion of risk chain in environmental risk management is used to underlie a hypothetical climate change scenario in the construct of adaptive livelihoods process. The attempt yields a descriptive model of adaptive land use management, underscoring the centrality of people's ability to achieve their livelihood objectives. The process-based model facilitates eclectic discourses on the maladaptation issue in agro-ecosystems and the land use transition associated with the endogenous socio-ecological feedbacks. It is hoped that the proposed analytical synthesis would open up innovative grounds in the sustainable development and climate change adaptation policies debate.

0277	Using normative visions to explore the future of land use change in Europe	James Paterson, Marc Metzger, Marta Pérez-Soba,	UK

		Anne Jensen, Michael den Herder, Theano Terkenli, Ariane Walz, Anouk Cormont, Manuel Winograd, Irene Bouwma, Evangelos Pavlis, Tina Kollaske	
	Assessing European environmental change in the next few decades requires a method that quickly and comprehensively analyses different plausible and salient futures. In recent years, scenarios (explorative futures) have become popular in environmental assessments (e.g., MA, UK NEA); here we look at a method of using normative visions drawn from a range of sources including published documents and stakeholder workshops. We assess their utility and application (including providing data for land use change models), discuss how several visions can be consolidated into fewer clusters and then compare them to explorative scenarios. Finally we suggest how visions can be useful for other land use studies. This presentation will present research on the use of visions on the future of land use transitions in Europe. It explores several of the potential topics under this theme including agricultural intensification and alternative pathways, rapid versus slow changes and land abandonment.		
0279	Relating global agricultural land use intensity and biodiversity patterns	Laura Kehoe, Tobias Kuemmerle, Carsten Myer, Christian Levers, Holger Kreft	Germany

Given the rising demand for food, fibre and bioenergy of a growing world population, understanding how different land-use intensities influence biodiversity is increasingly important. While agricultural expansion and deforestation effects have received much attention, effects of land use intensity (LUI) remain less clear, especially at broad geographic extents. The majority of studies investigate LUI effects on biodiversity by focusing on single indicators (i.e. fertilizer use) but LUI is a complex and multidimensional issue. We compiled an array of LUI indicators, pertaining to input intensity (e.g., fertilizer use), output intensity (e.g., yields), and system-level metrics (e.g., human appropriation of NPP). We then compared the spatial patterns of land use intensity and biodiversity to explore the relationship amongst them. Our results reveal areas where high biodiversity and land use intensity coincide, and emphasize that patterns of LUI in relation to biodiversity may change according to what indicator is utilised. Hotspots of high biodiversity and current and potential future high LUI are identified and measures to reduce pressure on biodiversity are discussed.

This presentation aims to contribute to the session theme "Land sharing vs. land sparing debate: have we come any closer to solve the dilemma?" by gaining a deeper understanding of the patterns of LUI and biodiversity and thus address the pertinent conservation questions running through the sparing vs. sharing debate.

| 0281 | Using dynamic factor analysis to model the combined spatial and temporal effects of environmental covariates on NDVI in southern Africa and to develop new land change analysis techniques | Jane Southworth, Miguel Campo-Bescos, Rafael Muñoz-Carpena, David Kaplan, Peter Waylen, Likai | USA |

		Zhu, Erin Bunting	

Understanding the drivers of large-scale vegetation change is critical to managing landscapes and key to predicting how projected climate and land use changes will affect regional vegetation patterns. This study aimed to improve our understanding of the role, magnitude and spatial distribution of the key environmental factors driving vegetation change in southern African savanna, and how they vary across physiographic gradients. We applied Dynamic Factor Analysis (DFA), a multivariate times series dimension reduction technique to ten years of monthly remote sensing data (MODIS-derived normalized difference vegetation index, NDVI) and a suite of monthly environmental covariates: precipitation, mean, minimum and maximum air temperature, soil moisture, relative humidity, fire and potential evapotranspiration. Monthly NDVI was described by cyclic seasonal variation with distinct spatiotemporal patterns in different physiographic regions. Results support existing work emphasizing the importance of precipitation, soil moisture and fire on NDVI, but also reveal overlooked effects of temperature and evapotranspiration, particularly in regions with higher mean annual precipitation. Critically, spatial distributions of the weights of environmental covariates point to a transition in the importance of precipitation and soil moisture (strongest in grass-dominated regions with precipitation < 750mm) to fire, potential evapotranspiration, and temperature (strongest in tree-dominated regions with precipitation > 950mm). This developed model was then used to determine land cover change regions by highlighting areas where our developed model failed to accurately predict vegetation amount across the ten years of study. This biophysical led model therefore highlights regions of human induced changes across the landscape. This study quantified the combined spatiotemporal effects of a complete suite of environmental drivers on monthly NDVI across a large and diverse savanna region. The analysis supports known drivers of savanna vegetation but also uncovers important roles of temperature and evapotranspiration at this fine temporal scale. Additional analysis of land cover change methods by applying the model back across the landscape in a predictive manner helped highlight human-induced landscape level change. Results highlight the utility of applying the DFA approach to remote sensing products for regional analyses of landscape change in the context of global environmental change. With the dramatic increase in global change research, this methodology augurs well for further development and application of spatially explicit time series modeling to studies at the intersection of ecology and remote sensing.

0284	Agricultural management choices in an integrated assessment model	Allison Thomson, Page Kyle, Tristram West, Marshall Wise, Katherine Calvin	USA

Integrated Assessment (IA) models can be applied for investigating large scale land use change patterns in response to changes in future population, GDP and greenhouse gas emissions mitigation policies within the context of the global economy and energy systems. IA models represent all economic sectors that contribute to greenhouse gas emissions, and in order to remain computationally efficient, the representation of these sectors and the geographic scale of analysis is typically at a relatively coarse scale. The benefit of using IA is to consider, in one comprehensive framework, the interactions between land use, energy use, human demands, and climate mitigation. Here we apply the Global Change Assessment Model (GCAM) which contains a comprehensive representation of land uses and land cover over the entire world in 151 subregions that are delineated based on both geopolitical boundaries and underlying climatic characteristics. GCAM divides croplands into major crop categories but does not specify farm management choices for those crops. Here we will discuss a pilot study where we parameterized GCAM with multiple farm management practices that may play a role in global carbon mitigation. When provided with alternate tillage intensity, residue management and crop sequencing, GCAM adopts all available options at differing rates. The adoption of alternate practices is influenced by the stringency of the climate mitigation target, the underlying economic tradeoffs in alternate management practices, and the mitigation activities occurring in

other sectors and regions of the model. We will present results from this pilot study and discuss the model behavior over the 21st century in response to the expanded choices of land management. We will also discuss ongoing work to expand the representation of agricultural practices throughout the global GCAM model, including representation of irrigation technologies and the implications for water resources. These developments represent an opportunity for the community to utilize IA models as one methodology for describing and understanding land use transitions in response to socio-economic drivers over large spatial scales that can be better informed by agronomic research and local to regional scale modeling. This talk will contribute to the conference theme of land use transitions and to the discussion of the role of agricultural practices in land use transitions, and the implications for future cropland extent required to meet food and fuel demands.

0287	Detecting land use-water quality relationships from the viewpoint of ecologicalrestoration in an urban area	Yu Deyong, Shi Peijun, Liu Yupeng, Xun Bin	China

Urbanization increases impervious area, generates pollution and transforms the configuration, composition and context of land covers and thus has direct or indirect impacts on aquatic systems. Detecting land use-water quality relationships is of significance for both urban sustainable development and environmental risk management. We first selected suitable landscape metrics at landscape and class levels as well as productivity as land use indicators; second, we integrated ten water quality indicators into a comprehensive pollution index (CPI) that serves as the primary water quality indicator for measuring the effects of diffusive pollution in an urban area; finally, taking water quality indicators as dependent variables and land use indicators as independent variables, we detected land use-water quality relationships using both ordinary least squares (OLS) and geographically weighted regression (GWR) models. The main findings are (1) the CPI is a good water quality indicator for detecting land use-water quality relationships and the performance of the GWR model is superior to that of the OLS model and (2) landscape metrics have potential for predicting water quality; however, improving the productivity of natural vegetation is a more tangible and reliable way to promote water resources restoration than rearranging the configuration of land use types.

0288	Australian land use futures	Brett Bryan, Martin Nolan, Jeff Connor	Australia

The introduction of climate (e.g. a carbon market) and energy policy may provide significant opportunities for landholders to adopt a range of land use and management options (e.g. bioenergy, carbon forests, minimum tillage, livestock management) for greenhouse gas (GHG) mitigation. However, these changes may generate collateral impacts (positive and negative, direct and indirect) for regional development, energy security, food production, land and water resources, biodiversity conservation, and other ecosystem services. There is a need for the ex-ante evaluation of the impact of alternative policy options under a range of biophysical and economic scenarios on ecosystem services in Australia's agricultural landscapes. Consideration of the uncertainty underpinning the range of input data and models and the impacts of future scenarios is essential to understand the robustness of decisions and outcomes. This information is required to inform decision-making for Australia's transition to a low carbon economy. We present some outcomes of land use scenarios from the Land Use Trade-offs (LUTO) model—part of the Australian National Outlook. Global economic and climatic trends are taken from an integrated assessment model. LUTO itself integrates a wide range of biophysical and economic data and models in a spatio-temporal model of potential land use change in Australia's intensive agricultural zone out to 2050. LUTO itself is a high resolution partial equilibrium model of the agricultural sector. It allocates land use including existing agriculture but also new land uses such as environmental plantings, carbon plantings, woody perennials and cereal crops for bioenergy and biofuels. The implications of policy options and changes in external drivers on land use and the impact on across a range of ecosystem services is assessed including food and fibre production, carbon, water,

energy, and biodiversity. We analyse four global scenarios—one low emissions, two medium emissions, and one high emissions pathways. We consider climate change projections from three GCMs. Also, assessed are three biodiversity payment policies, three productivity scenarios. Selected outcomes from these national land use outlooks will be presented.

0292	Australian savannas: dynamics, processes and responses to anthropogenic change	Jason Beringer, Lindsay Hutley	Australia

The wet-dry tropics of northern Australia feature extensive tracts of savanna vegetation which occupy approximately 2 million km^2. This area is equivalent to 12% of the world's tropical savanna estate, making this savanna biome of global significance. The savanna land surface is the interface for the exchange of radiation, heat, moisture, CO_2, and other trace gases with the atmosphere. These important exchanges are modulated by ecosystem characteristics such as structure, species composition, and physiological function (which vary marked across the natural expanse of savannas). Ecosystem characteristics in turn influence biophysical processes and biogeochemical cycling at a range of scales. Locally, variability in ecosystem characteristics modify surface–atmosphere exchanges, which then influence the overlying atmosphere and boundary layer. Over larger scales, spatial variability in ecosystem characteristics can generate contrasts that drive mesoscale to regional-scale climate (i.e., monsoon). Therefore alterations to the savanna land surface that arise though disturbance will modify the biophysical and biogeochemical exchanges. Here we examine the current state of research on ecosystem function and anthropogenic change in Australian savannas. We then illustrate the influence of disturbance on land surface atmosphere exchanges with a focus on feedbacks and interactions. Australian savannas have a high degree of canopy intactness and relatively low levels of fragmentation with little topographic relief, compared to those of South America and Africa. Nevertheless there are significant and mounting pressures on these savannas where understanding the coupling with the human system is crucial. We examine the impacts of land use and land cover change (namely the conversion of savanna to pasture and then to hardwood plantations) on CO_2 and trace gas emissions and the greenhouse gas budget. Then we assess the role of other disturbance factors (fire, termites, cyclones) in terms of frequency and intensity of impact on the carbon cycle. Lastly, we explore possible future changes in Australian savannas (mainly rainfall and increased atmospheric CO_2) on woody thickening, changed fire regimes and feedbacks to climate.

0293	Exploring global crop yield impacts of changing climate and agricultural management	Nathaniel Mueller, James Gerber, Deepak Ray, Navin Ramankutty, Jonathan Foley	USA

Continued agricultural intensification and accelerating climate change are two of the most important trends determining the future of global agricultural production. Understanding the interplay between these trends is of great importance, particularly the degree to which changes in agricultural management could help overcome projected decreases in crop production from climate change. Here we present an exploratory global analysis of how the yields of maize, wheat, rice, and soybean are affected by the combination of climate change and agricultural intensification. For A1B 2050 scenarios of climate change, we find that the production gains from agricultural intensification would be much larger than the projected impacts of the new climate conditions. Under A1B 2050 climate change conditions and no intensification, we project approximately -7, 3, -1, and -3% changes to global maize, wheat, rice, and soybean production, respectively. With intensification of low-yielding areas to 75% of attainable yields (closing yield gaps) we find approximately 20, 35, 17, and 3% overall increases in production. However, the capacity for intensification to overcome climate impacts erodes considerably under uniform global temperature increases of 4-5°C, and we estimate net yield losses for maize, soybean, and rice with a 5°C

increase even with yield gap closure to 75% of attainable yields. This analysis demonstrates that joint consideration of climate and agricultural management change is critically important. Increasing investment in management strategies would reduce the impact of climate change on global agricultural production.

| 0294 | Evaluation of land-use strategies for climate change adaption and mitigation in urban areas in Germany: land-use scenarios 2030 with the CC-LandStraD modeling approach | Jana Hoymann, Roland Goetzke, Fabian Dosch | Germany |

Land surface in Germany is used intensively. Land fulfils many societal requirements including the production of food, energy and wood, or provides area for settlement and transportation infrastructure and recreation. Global changes such as climate change and globalisation of economic systems will increase the competition for the limited land resources that exist between the various societal demands in Germany and in many other regions of world. How to integrate aspects of preserving an intact environment, climate protection, and sustainable resource management into this complex realm of land use conflicts is the research focus of the joint project CC-LandStraD "Interdependencies between Land use and Climate Change – Strategies for a sustainable land use management in Germany". In the subproject "Land-use scenario 2030" changes in land use are simulated spatially with a set of land use models. The GIS-based model Land Use Scanner is applied for Germany to simulate land use changes on a 100m grid. The demand for land, that is used by the model as input information is provided by the environmental econometric model Panta Rhei Regio. Additionally, bio-geographic and socio-economic drivers determine the local suitability, which influences the land use change decision. To identify a climate adapted spatial land use pattern, especially with respect to urban development, these drivers include beyond others spatial planning data as well as information on potential climate change impacts (flooded areas, heat islands). The model is used first, to develop a business as usual scenario and secondly, to apply land use measures that contribute to climate change mitigation and adaptation. Many measures affect the regional planning regulations. All processing steps of the modelling procedure as well as the results are discussed with local and national stakeholders. The objective is, to implement their perception of the climate change challenges and thus to provide them with solutions/ideas how to cope with these challenges. The expected results will show the land use pattern in Germany of the year 2030. It will be analysed to which extent climate change mitigation and adaptation measures influence the land use pattern and to which extent they contribute to climate change mitigation and adaptation goals. The evaluation of the climate change mitigation and adaptation measures and their discussion with stakeholders will reveal the effectiveness of the regional planning regulations with respect to climate change aspects and identifies opportunities for a proactive development of these regulations.

| 0295 | Innovative approaches to assess the impact of historic land changes on our climate - a case study of Europe for the last century | Richard Fuchs, Martin Herold, Peter Verburg, Jan Clevers | The Netherlands |

Human-induced land use changes are nowadays the second largest contributor to atmospheric carbon dioxide after fossil fuel combustion. Existing historic land change reconstructions on the European and global scale do not sufficiently meet the requirements of greenhouse gas (GHG) and climate assessments, due to insufficient spatial and thematic detail and the consideration of various land change types. Well-known historic land cover reconstructions, such as Goldewijk et al. (2010; 2011), Ramankutty & Foley (1999) and the data set used for the next assessment report (AR5) from Hurtt et al. (2011) are based on assumptions rather than a data driven approach. Furthermore, these reconstructions tend to underestimate occurred land changes by using the reported net difference of land changes per country between two time steps (net land changes) as input for their models rather than taking all the

changes into account, which happened within these administrative boundaries, so the absolute sum of all gains and losses (gross land changes). Here we want to present an approach called HIstoric Land Dynamics Assessment (HILDA) (Fuchs et al. 2013) that accounts for gross changes in land cover during the period 1900-2010. It has a reduced uncertainty compared to earlier historic land use estimates by using a unique data driven collection of historic land use maps, such as remote sensing products, national and international inventories, historic aerial photos, old encyclopaedias (e.g. Encyclopaedia Britannica) and historic maps (e.g. of the Austrian-Hungarian Empire, Prussia, etc.). This allows to improve the estimation of land change quantity, land conversion types and their spatial allocation. The HILDA approach operates on a 1km scale for Europe (EU27+CH) for five land categories (settlements, cropland, forest, grassland and other land). Comparisons of our approach with global land change models, such as the AR5 data set (Hurtt et al. 2011) showed for the same area and period that the consideration of gross land changes and a consistent data driven approach lead to significantly more land changes than currently assumed. Differences in these approaches are not exclusive for Europe and are likely to appear globally. Since land cover change data have an important impact on the study of land management, legacy effects of soil carbon, future projections, GHG estimations and climate feedbacks and related mitigation options it is necessary to rethink about existing approaches and the overall impact of historic land changes on our climate.

0297	Post-soviet agricultural abandonment and recent recultivation: trade-offs between food production and biodiversity conservation	Johannes Kamp, Ruslan Urazaliev, Paul Donald, Norbert Hoelzel, Andrei Tolstikov	Germany

The collapse of the Soviet Union in 1991 led to land-use changes of unprecedented magnitude: Agricultural abandonment, massive declines in livestock numbers and changing grazing patterns were observed on a continent-wide scale. The impacts of these changes on biodiversity and ecosystem services, such as carbon cycles, are still poorly understood, but recent evidence suggests mostly positive responses. With increasing demand for agricultural land worldwide, the land-use trends of the post-Soviet period have been reversed recently in some areas. Currently, a reclamation of abandoned land is observed as well as a modernisation of agriculture, leading to desirable rural development and higher food outputs. At the same time, these trends threaten the recovery of habitats, depleted species and ecosystem functions. Using new field data from two study areas in Western Siberia and Kazakhstan we evaluated current and potential future trends in land-use and the impacts of these on plants, animals and carbon stocks. We will present the results at the workshop and address trade-offs between food production and biodiversity conservation. We will also discuss resulting management options (both on a site level and within existing political frameworks) for the grasslands and forest steppes of Eurasia.

0298	Land use innovation at the interface of wastewater reuse and renewable energy generation: the case of North-Eastern Germany	Katrin Daedlow, Matthias Naumann	Germany

The paper asks for possibilities of innovative forms of land use, i.e., their institutional barriers and infrastructural challenges on land governance, at the interface of wastewater reuse and renewable energy generation. It draws on findings from the research project "Development of integrated land management through sustainable water and resource use in Northeast-Germany (ELaN)" funded by the German Ministry of Education and Research (BMBF). ELaN aims to develop a regionally differentiated and sectorally integrated perspective on the transition of land use systems based on decentralised energy systems and wastewater disposal technologies. The project investigates the use of treated wastewater in rural areas in Northeast-Germany and exurban fringes of Berlin and its potential for biomass production in short rotation coppices for the energy supply of cities. By analysing connectivity and transactions

between new decentralised forms of energy supply and wastewater disposal, the paper investigates the reconfiguration of existing regional infrastructures and governance structures towards sustainable land use systems and the reordering of urban-rural relations in this process.

| 0299 | Lessons learned from tool use in land policies - outcomes from case studies at the EU, member state and regional level | Tarja Söderman, Sanna-Riikka Saarela | Finland |

Land use policies at different scales reflect both global challenges and local needs and traditions. Typically European land use in certain area is controlled by different supranational, national, regional and local regulatory frameworks and political and administrative decisions. Global challenges, like the climate change, resource and energy efficiency and the structural change of the agriculture, are issues that are and will in the future be more and more accentuated in land use policies. The challenge is to assess the impacts of different policies and their alternative options on the land use and on the ecological, economic and social sectors for designing sustainable land use policies. Furthermore, it appears that global challenges are difficult to manage both vertically across different jurisdictional scales and horizontally across different sectors at certain level of land use planning. In this paper we examine different governance options and policy fields that affect land use at different scales and discuss the role of assessment tools in designing sustainable land use policies. We will focus especially on the knowledge needs and the process of tool use in the impact assessment of specific land use policies and sectorial policies affecting land use decisions. Lessons will be reflected from six case studies dealing with selected policy problems at different decision making levels and jurisdictions from regional, national and the EU level. The results demonstrate that the cyclic assessment process, constant interaction between knowledge producers and knowledge users and multiple communication actions appear to be the most significant factors for successful tool use and impact assessment.

| 0307 | Effects of agricultural transition on soil protection in post-Soviet countries: the case of soil protection from erosion in Ukraine | Nataliya Stupak | Germany |

At the beginning of 1990s, following the collapse of the Soviet Union, most of the Central and Eastern European countries initiated substantial agricultural reforms which aimed at the transition of agricultural sector from planned to market economy. While major efforts focused on structural change in agriculture and land reform, much less attention was paid to the change in institutions which ensure *sustainable* agricultural production. That is why today, when agricultural transition in post-Soviet societies seems to be thoroughly described and investigated, we are still surprised about the far-going effects of the process. This paper aims to draw attention to the impact of agricultural transition on soil protection in post-Soviet countries. The discussion is built on the example of soil protection from erosion in Ukraine. First, the paper addresses the way soil protection was organized in the Soviet Union; after, the effects of agricultural transition on soil protection, and soil protection in contemporary Ukraine are considered; finally, the reasons for ineffective soil protection in Ukraine are discussed. Ukraine is widely known as a country rich in black earth soils which are subject to sever degradation by erosion due to their fine structure and other physical characteristics. Having recognized the erosion problem already at the beginning of 20th century, an elaborate institutional structure to protect soil resources was established in the Soviet Union. The Soviet soil protection institutions were integrated into planned economy, were research-driven and characterized by top-down implementation. After the collapse of the Soviet Union independent Ukraine continues to consider protection of soil resources as an important constituent of national development strategy and a precondition for economically viable agricultural sector. However, after destroying the Soviet soil protection system in the course of agricultural transition, the Ukrainian public authorities have not yet managed to suggest new effective soil protection institutions. The paper looks closely at the effects of agricultural transition on soil protection in Ukraine, and suggests the

reasons as to why it is difficult to organize soil protection in post-Soviet societies.

0310	Chocolate cities: cosmopolitan consumers and the fate of cacao landraces	Ximena Rueda, Eric Lambin	USA

Several high-value agricultural commodities are produced in tropical regions under agro-forestry systems and have important impacts on the land use of small-holders. Cacao is a case in point: with a global trade of over 3M tons per year and involving millions of smallholders in the tropics. Demand for cacao for the chocolate manufacturing industry has incentivized the cultivation of high-yielding varieties, endangering the survival of less productive wild varieties and landraces, which today make only 20% of the global market. Traditional landraces are usually cultivated in diverse agro-ecosystems, using little external inputs. High-yielding varieties are more frequently produced using clones of low-quality cacaos, and are highly dependent on external inputs. The diversity of the landraces produces a rich and complex palette of taste profiles that is being discovered and appreciated by chocolate makers and enthusiasts in wealthy urban areas around the world. The recent appetite for rare cacaos is part of a larger trend of market differentiation, also seen in other markets such as coffee and tea. Differentiation in the cacao market is happening through two alternative business models: i) the bean-to-bar model; and ii) the differentiated-within mainstream model. Based on value chain analysis, interviews with chocolate makers and household surveys conducted in Ecuador, this study appraises the impacts of global demand for high-quality cacao, particularly through these alternative business models, in improving farmers' livelihoods, fostering more diverse land uses, and protecting cacao's diversity. This study contributes key empirical evidence on the linkages between globalization and land use change, while at the same time offering methodological innovations to bridge global-scale drivers and local land use changes.

0311	Bioproductive space and regional resilience: development of an analytical framework	Frederik Lerouge, Hubert Gulinck, Liesbet Vranken	Belgium

The current spatial planning approaches to open and rural spaces are outdone, especially in areas under strong urban pressure and under agricultural retreat. The current predominant principle of pragmatic land use allocation to vocal sectors (agriculture, housing, conservation, etc.) - in the assumption of continuing stability, affluence, and availability of resources - should give way to an alternative paradigm of organization, taking into consideration multiple challenges like climate change, high footprints, demographic growth, economic instability, etc. A key question faced by planners looking decades ahead is: how resilient is our space for changes, shocks, and more in general uncertainties for the future? Do systems show sufficient adaptive capacity to reach new development paths when required and continue to provide valued services? The resilience question is of high complexity and should be approached for different strategic themes such as food security, ecosystem services and related matters, which we position under the umbrella concept of "bioproduction". It is an important target to provide strategic planners with new insights in the capacities of a territory and its existing layout to secure certain levels of bioproductivity in a resilient way, and across its current and customary categorizations such as urban versus rural areas, agricultural versus conservation areas, or private versus public areas. This presentation proposes a framework whose key components are are: i) the concept of bioproductivity (as an expansion of agricultural productivity), ii) resilience as trade-offs between space, productivity and associated bioproductive services, iii) scenarios of regional self-provision of bioproductive services, and iv) alternative categorizations of land use more suited as an analytical framework for translating such scenarios into spatial organization. Various scenario's of interdependence between difference forms of bioproductive land use, which can be in direct competition for land, but sometimes also complement or supplement each other, can be explored. A distinction is made between '1st order' resilience, which depends on the degrees of freedom within components of the system to adapt, and '2nd order' resilience, which might emerge by intelligently reforming and positioning interacting land use categories, making

better use of complementary and supplementary effects, (re)strengthening networks and knowledge systems, etc. Hence, building resilience into spatially explicit social-ecological systems can follow a gradient of approaches, from straightforward monothematic improvements to complex improvements using complementary and supplementary multifunctionality. The presentation applies this concept to the case of the region of Flanders, Belgium, where land use transitions are strongly affected by urban pressure.

0312	Understanding the drivers for the use of nitrogen fertilizer	Maria José Ibarrola Rivas, Sanderine Nonhebel	The Netherlands

The use of synthetic nitrogen fertilizer has had enormous global and local environmental effects in the last decades. However, present global population cannot be fed without it, and nowadays half of the world eats because of its use. Several studies have identified different drivers for the use of nitrogen fertilizer which are the type of diet, the type of agricultural system (using different application rates: kg N/ha), and the value of population density. Here we aim to understand the interrelationships between these three drivers, assess the differences amongst countries, and the changes in the last decades. We develop a descriptive model to understand the interrelationships of these three drivers. The model shows that both the increase of population density and the consumption of animal products per capita increase the application of nitrogen fertilizer per area. We use FAO country level data of 110 countries to validate our model with the values of 1960, 1980 and 2010. In general, the data fits with our model. During this period, most countries increased their population density and their consumption of animal products leading to an increase in the application of nitrogen fertilizer per hectare. Most countries have followed the trend of our model. However, in some cases the data do not fit with our model, and we see some cases of inefficient use of nitrogen with a pattern that has been repeated. In 1980, some European countries had large application of nitrogen due to subsidies and low prices of fertilizer causing local environmental problems. By 2010, these countries had reduced their application rates because of governmental policies. This pattern is repeated, and in 2010 some Asian countries like China had high nitrogen application rates because of subsidies. But, their population density is higher than the values of the European countries in 1980 which means that their land pressure for food production is higher. Still, many studies have shown that these Asian countries are using nitrogen fertilizer inefficiently causing large local environmental problems. For the coming years, global food demand will increase due to an increase of population and change in diets. The food demands and land pressures will be different throughout the world. Our model can help to assess the future use of nitrogen fertilizer to achieve food supply for different land pressures (different values of population density) and different type of diets.

0313	Analysing mutual influences of settlement development and land use changes using backcasting	Markus Biberacher, Eva Haslauer, Sabine Gadocha	Austria

Developments in Geoinformation-science particularly in spatial databases, spatial analysis, positioning technologies, or geo-visualization, improved vastly throughout the 1990s. Today data mining to search for anomalies or patterns, drawing conclusions or testing hypotheses is implemented in Geoinformation-systems (GIS), through various modelling techniques. Progress in these modelling techniques enables the combination of GIS with Backcasting approaches, to explicitly add a spatial component.

The objective of the current study is the development of a spatial Backcasting approach in order to model the development of settlement structures together with land use changes. In terms of settlement development the spatial changes of population and residential structures are examined. The settlement development is modelled in combination with variations of grass and arable land and cross linked correlations. We define fictive end-point scenarios, based on a predefined rule-set, as starting points for the Backcasting approach. These scenarios represent a pool of future states of land cover, with focus on

settlement structures and the effects on grass and arable land development. The Backcasting approach uses a predefined rule-set based on assumptions on the range of possible land use changes within different time steps. Based on these rule-sets the land use development is described backwards – starting from an end-point scenario. Thereby trajectories are identified, which describe possible temporal development paths of land use. This results in a scenario-pool of end-point scenarios with associated trajectories towards the current situation. Development paths show what has to be fulfilled when, in order to reach a certain end-point scenario. The Backcasting model will be implemented with the ESRI ArcGIS Agent Analyst based on Java and Python scripts. In the presented spatial Backcasting approach the development along the time axis poses the most significant challenge. Especially the methods developed to describe the correlation of different locations during the course of development represent the core within the presented approach. The spatial Backcasting approach provides the opportunity to support spatial planners and political authorities in strategic decision making processes, to foster a sustainable settlement and regional development.

0316	Land needed for food, feed and fuel in the near future	Sanderine Nonhebel	The Netherlands

The production of food puts a large claim on global land use. In the coming decades an increase in the need of food is expected since global population will increase to 9 billion people. Next to this all over the world consumption patterns are changing to more luxurious diets including meat. These luxurious diets require more land than the diets based on staple food. Finally several clean energy policies exit that aim at an increased use of biomass as feedstock for energy generation. The needs for food, feed and fuel differ in various parts of the world. We first analyze historical trends and then develop a simple model for assessing global biomass needs in the near future. We distinguish between developing countries, transition countries and developed countries. While the first group of countries will need extra food for their growing populations, the second group will require extra animal feed, since increased average income levels lead to higher demand for animal products. Many developed countries will need additional biomass to meet their clean energy targets, aimed at reducing CO_2 emissions of energy use. Our analysis shows that the future extra needs for biomass as fuel are in the same order of magnitude as the needs for food and feed (around 1000 MT each). In the coming decades the need for food/biomass will than double from the present 2800 MT to 5500 MT per year. When no changes in yields are expected this would imply a doubling of the land needed for biomass production. If we assume an annual increase in productivity of 2% on a global scale, we still need 50% more land. It is obvious that this is not a route to walk. Our very simple model however provides some insights in how this can be prevented. It is obvious that we cannot change the food needed, since the more people that are expected on earth need to have food. A reduction of the meat consumption, however, is an option since smaller shares of meat and other luxurious products can reduce land needed for food substantially. The third route to walk is not using biomass as clean energy source. Photovoltaic systems provide far more energy per unit area than crops/plants. Obtaining energy from solar panels will reduce the area needed for energy supply with a factor 10!

0318	Application of HNV farmland indicators across scales in Portugal: data quality, scaling issues, and implications for national reporting and monitoring	Angela Lomba, Carlos Guerra, Joaquim Alonso, Davy McCracken, Rob Jongman, João Honrado	Portugal

Over recent years there has been increasing convergence between nature conservation and rural development policies within the EU. The High Nature Value Farmland (HNVf) concept acknowledges the importance of many rural landscapes and agro-ecosystems for the conservation of biodiversity and

the provision of multiple ecosystem services in the wider European countryside. Thus, efforts have been invested in the EU (and in most of its Member States) to identify accurately and efficiently rural landscapes with high value for nature conservation, with the intent that these can then be supported and maintained through Rural Development Programs (RDP). Among other initiatives, this has involved the establishment of a common set of HNVf indicators for identifying, mapping, evaluating and monitoring those landscapes in the context of the implementation (and evaluation) of RDPs. Although a first set of indicators has been established at the EU level, the implementation and operationalization of such HNV farmland indicators by Member States has been challenging. Caveats regarding the ecological concepts underlying the definition of HNVf as well as the heterogeneity of high conservation value landscapes across the EU, together with the lack of accurate and spatially-explicit data on farming systems and land-cover, are only some of the problems underlying the operational use of this indicator set within a reporting context. Various methodological approaches have been proposed, combining distinct sets of information at multiple spatial scales aiming to provide a more accurate and realistic HNVf identification and mapping that could support future prioritization of such landscapes for support in the context of the Common Agricultural Policy. Here, a set of nested case-studies of the implementation of the HNVf concept and common indicators in Portugal is presented, following a bottom-up framework that it is suggested could be followed in other Member States and thereby improve the mapping of HNVf across the EU. Specifically, distinct datasets and data types (e.g. land-cover, farming systems data), with variable spatial, temporal and thematic quality, were applied in an hierarchical approach (from local to regional scales, coincident with NUTS statistical units), to assess the distribution and diversity of HNVf areas and thus contribute to a more accurate and realistic mapping of those landscapes. Issues related to data quality, integration and up-scaling are discussed in the wider context of regional and national reporting on the state and trends of HNV farmland areas.

| 0319 | Looking back to move forward: evaluating global agricultural land use in integrated assessment models | Uris Baldos, Thomas Hertel | USA |

As Integrated Assessment Models (IAMs) are broadened to encompass agricultural land use, it is becoming increasingly important to validate these models and identify critical areas for improvement. In this paper, we illustrate both the opportunities and the challenges in undertaking such model validation using the SIMPLE model of global agriculture. We look back at the historical period 1961 to 2006 and, using a few key historical drivers: population, incomes and total factor productivity, we find that SIMPLE is able to accurately reproduce historical changes in crop price, production, cropland use and average crop yields at global scale. Equally important is our investigation into how the specific assumptions imbedded in many IAMs influence these results. We find that those models which are largely biophysical – thereby ignoring the price responsiveness of demand and supply – are likely to understate changes in crop production, while failing to capture the changes in cropland use and crop price. Likewise, models which incorporate economic responses, but do so based on annual time series estimates of these responses are likely to understate land use change and overstate price changes. Our results provide guidance to IAM scientists interested in model validation, as well as those seeking to identify priority areas for future improvement of IAMs.

| 0320 | Land use and landscape transformation by smallholder farmers in semi arid area of Cameroon: prospect and implication for livelihood enhancement and adressing global challenges | Victor Aimé Kemeuze, Denis Sonwa, Bernard-Aloys Nkongmeneck, Pierre Marie Mapongmetsem | Cameroon |

In their fight against poverty and hunger, smallholder farmers of the semi-arid areas of the Far-North Cameroon are gradually transforming the landscape and managing different land uses. These transformation and management are directly/indirectly affecting the efforts of Cameroon to satisfy some of the requirement related to global challenges (Biodiversity conservation, climate change mitigation and combat desertification).The key challenges for different stakeholders in the semi-arid area of Cameroon is about achieving the Millennium Development Goal (MDG) related to food security and at the same time implementing activities related to the 3 main Rio conventions: the United Nations Framework Convention on Climate change (UNFCCC), the United Nations Convention to Combat Desertification(UNCCD) and Convention on Biological Diversity (CBD). In the UNFCCC, it is evident that fuel wood collection and other pressure related to land use are affecting forest resources. The REDD+ (Reducing Emissions from Deforestation and forest Degradation including conservation, sustainable management of forests and enhancement of forest carbon stocks) or any Clean Development Mechanism (CDM) could thus be a good way to reduce/ending deforestation/degradation. Mapping and profiling of the current land use could be a useful step in addressing the above challenges. This study was conducted to understand landscape transformation and management by smallholder farmers in semi-arid areas of Cameroon. A survey of 512 Households was conducted using a semi structured questionnaire. Preliminary results reveal six main land use systems: (1) cropped field (managed by 91% of local households), (2) fallow (36%), (3) grassland (43%), (4) orchard (37%), (5) tree parkland (39%) and (6) savanna (79%) that significantly contributes to local livelihoods. In 58% of cropped fields, annual crops (particularly cereals) are mixed with some perennials species such as: *Acacia* spp.*, Azadirachta indica, Balanites aegyptiaca, Mangifera indica, Tamarindus indica* and *Ziziphus mauritiana.* Beside the land use typology, the study also describes their vegetation and shows how the activities of smallholder farmer are shaping landscape transformation. The study concludes with a critical discussion on the way land use management in semi-arid areas can help to achieve food security and global challenges such as Biodiversity conservation, climate change mitigation and combat desertification

0321	The impact of rural out-migration on land use transition in China: past, present and trend	Ruishan Chen	China

Although rural out-migration has significantly transformed land use at local to regional scale, the links between rural out-migration and land use change are not well understood. This paper connects Zelinsky's mobility transition model to land use transition theory and identifies the impacts of rural out-migration on land use transition. Then it explores the great influences of rural out-migration on land use transition in China. China is a country on the move with the open door policy which was initiated in 1978. Massive rural out-migration transforms China from a land attached agricultural society to an urbanized and industrialized society. This produces several contrasting land use trends: increasing land demand in urban areas at the expense of high quality cultivated land; increasing settlement areas and emerging "hollowed villages". China's experiences and policies to address these problems can draw lessons to other developing countries, such as restricting frontier clearing through land zoning and other ecological protection policies; encouraging nonmigrants to adjust their agricultural land holding; protecting farmers' interest through subsidizing agriculture and improving rural infrastructure and farmers' living conditions. China should also address a trilemma among the land for food security, environment protection, and urban and industry development from paying more attention to the impact of rural out-migration on land use transition. We proposed that in order to facilitate policymaking, further research should take a multi-scale perspective. Cross-country research should be based on an understanding of the dynamics of rural out-migration and land use change among countries with different urbanization level; country level research should focus on the land issues caused by rural out-migration and its spatial characteristic; community and household level research should examine what are the subsequent effects

of having a long-term out-migration on rural origin-area household and what are the effects of out-migration of household members to agriculture, household, land use and consumption. My presentation is well matched the conference theme "land transformations: between Global challenges and local realities", because rural out-migration is the currently reality of most developing countries, understanding the future land system change, we should know the process of rural out-migration and the relationship between rural out-migration and land use transition. The selected session is "Understanding farming practices to rethink land change transitions: a research challenge", because rural out-migration have great impact on farming practices, such as cultivated land fragmentation, transform from subsistence agriculture to industrial agriculture. In turn, these practices affect land use transitions.

0322	Implications of agricultural productivity for global cropland use and GHG emissions: Borlaug vs. Jevons	Thomas Hertel, Navin Ramankutty	USA

There has been a resurgence of interest in the impacts of agricultural productivity on land use and the environment. At the center of this debate is Norman Borlaug's assertion that agricultural innovation is 'land-sparing'. However, the validity of this proposition rests, among other things, on his assumption of a fixed demand for food. Borlaug's hypothesis has recently been brought into question by a series of studies of land use change which argue in favor of a competing hypothesis – dubbed "Jevons' paradox" - - which suggests that increases in agricultural productivity will be accompanied by an expansion in land area. Rudel et al. (2009) scrutinize FAO data for 961 agricultural sectors in 161 countries over a 15 year period, finding little evidence of higher yields being accompanied by reduced area. All of these studies suffer from the challenge of estimating what would have happened in the absence of such agricultural innovation. There is also a strong tendency in this literature to adopt a regional, rather than a global perspective, thereby ignoring impacts in the rest of the world, where land use and associated greenhouse gas (GHG) emissions may fall in the wake of this innovation. Therefore, this paper introduces a general framework for analyzing the impacts of regional and global technological change on long run agricultural output, prices, land rents, land use, and associated GHG emissions. In so doing, it facilitates a reconciliation of the apparently conflicting views of the impacts of agricultural productivity growth on global GHG emissions and environmental quality. As has been previously recognized, in the case of a global change in farm productivity, the critical condition for an innovation to lead to diminished land use is that the farm level demand for agricultural products is inelastic. However, in the more common case where the innovation is regional in nature, the necessary condition for a reduction in global land use and associated GHG emissions is more complex and depends on the relative yields, emissions efficiencies and supply conditions in the affected and unaffected regions. While innovations in agriculture are most commonly land-sparing at global scale, innovations in regions commanding a small share of global production, with relatively low yields, high land supply elasticities and low emissions efficiencies can lead to increased global land use change emissions.

0323	Spatial modeling of agricultural land-use change at global scale	Prasanth Meiyappan, Michael Dalton, Brian O'Neill, Atul Jain	USA

We present a recently developed econometric land-use allocation framework meant to downscale coarse resolution (continental scale) agricultural land use information (crops and pastures) to finer resolution (0.5-deg spatial resolution) for use in Integrated Assessment Models. The method relies on understanding the quantitative relationship between existing land-use patterns and its socioeconomic and biophysical drivers (or their proxies). The method accounts for heterogeneity in the nature of driving factors between geographic regions. The allocation is modified by autonomous developments and

competition among land-use types. Using spatially explicit historical information on a range of biophysical and socioeconomic drivers of agricultural land use, we show that the developed framework can reproduce the past 100 years of changes in the spatial patterns of cropland and pastureland with good accuracy. To our knowledge, this is the first retrospective analysis that has been shown to be successful in reproducing the historical experience at a global scale. We use the developed framework to identify the regions where the derived regression relationships are prone to change significantly over time and also evaluate the time frame within which the model can be applied reliably for future projections. We apply the model to identify the causes of changes in historical agricultural land-use patterns in certain key regions of the world, such as the abandonment of cropland in eastern US and a subsequent expansion to the mid-west US. This presentation will focus on the scientific basis behind the developed allocation framework and motivations behind selecting specific statistical techniques to implement the scientific theory. Specifically, we will highlight the application of recently developed statistical techniques that are highly efficient in dealing with problems such as spatial autocorrelation and multicollinearity that are common in land-change studies. However, these statistical techniques have not been previously used in land-change studies and have largely been confined to medical literature. We will present the validation results and an example application of the developed allocation framework within an Integrated Assessment tool. We conclude with study implications, limitations and directions for future research. This presentation directly overlaps with the interest of the session titled "Validation global land use models for improved integrated assessments (Ref No: 0076)".

0324	A remote sensing assessment of the effectiveness of smallholder irrigation to buffer against climate shocks across India	Meha Jain, Ram Fishman, Pinki Mondal, Ruth DeFries, Gillian Galford, Chris Small	USA

Climate change is projected to negatively impact agricultural production across the tropics, especially in South Asia where over fifty percent of the population depends on smallholder farming as their main source of livelihood. Previous studies have suggested that irrigation, particularly climate-insensitive groundwater, can reduce the sensitivity of agriculture to climate variability. However, groundwater tables are falling rapidly (primarily in Northwest India), and in response, farmers and policy-makers have called for increased construction of canals as a supplemental form of irrigation. Yet it is unclear how effective canal irrigation is as a method for mitigating the impacts of climate variability because surface irrigation itself may be sensitive to climate. This study assesses how effectively different types of irrigation (groundwater, canal, shallow well) reduce the negative impacts of climate variability on crop productivity across India, which may help smallholder farmers reduce their vulnerability to climate change and improve food security. To measure crop productivity, we developed a product using MODIS satellite data that quantifies the amount of cropped area in each growing season from 2000 to 2005 at a scale of 1 x 1 km across all of India. We then used multivariate statistics to quantify how cropped area varied through time based on different rainfall (monsoon onset date, total amount of monsoon rainfall), irrigation (amount of land under each irrigation type), and biophysical (soil type) metrics at the village scale across all of India (n = 6000). Our unique scale of analysis allows us to assess the specific effect of each irrigation type because we can compare the sensitivity of agriculture in neighboring villages that receive water from different types of irrigation. This paper fits well within this session given that understanding the relative buffering capacity of different irrigation types is important to identify the best ways to develop and transform smallholder irrigation in the face of climate change.

0327	Multi-scalar analysis of the power and politics behind large scale land acquisitions	Julio Postigo	USA

Large-scale land acquisitions (LSLA) are overriding local governance for sustainable coupled natural-human land systems, causing a need for scientists to link global processes into existing frameworks for understanding local land governance. Using a coupled natural-human (CNH) framework combined with insights from political ecology, this study examines the increasing global LSLA by corporations and governments—i.e., 'land grabbing'— in order to analyze the role of power and politics in land change in different local CNH systems. Analyses of data from the Land Matrix Project will shed light on patterns of LSLA, as well as the political economy and power relations underpinning the LSLA at multiple levels. For instance, global narratives of financial, food and climatic crises coupled with national discourses of development through agrarian modernization will be discussed. At the local level, poverty, marginalization and insufficient power spur loss of access and control of resources. Results indicate that global crises triggered LSLA rendering local CHN systems more vulnerable to food price and climatic fluctuations, and 'land grabbers' more secure in terms of food, financial stability and profits. By combining a political ecology multi-scalar analysis with a CHN framework, this study offers method for analyzing mechanisms by which multi-level power and politics challenge local governance of CHN land systems. Additionally, CNH understanding of interactions among resources, users and governance is enriched by including the social, economic and political settings driving the LSLA. Furthermore, it illuminates the perverse nature of teleconnections, in which outsourced needs stress systems already under enormous local socio-environmental pressure.

0328	The gold mining boom: Increase in global demand for gold and its consequences for land change in Latin America between 2001 and 2013	Nora Álvarez-Berríos, T.Mitchell Aide	Puerto Rico

Gold mining brings significant alteration to the environment due to its intense impacts on landscapes and resources. In many regions of Latin America, mining activities have impacted large bodies of land through removal of vegetation and forests, mass movements of soil, and transportation of mined materials. Collateral effects of mining include the construction of roads and the subsequent establishment of new settlements along them. They have also lead to high rates of population migration due to new workforce demands and the abandonment of previously occupied lands. The major objective of this study is to provide an assessment of land change in the top gold-mining producing sites in Latin America. Specifically, we analyzed the patterns of land change around gold mines during the period 2001-2013. The land use land cover maps were produced using ARBIMON-Mapper web application and images from the MODIS satellite MOD13Q1 Vegetation Indices 250 m product. Land change was calculated as the 13-year trend in tree, shrubs, agriculture, urban, herbaceous and bare classes surrounding >200 mining sites. Initial analyses showed an overall net decrease in woody cover around mines within the Tropical Moist Forest biome in Perú, Suriname, Venezuela, Brazil, and Nicaragua. Most of the woody loss was associated with placer mining and open-pit/underground mining techniques. These results suggest that woody change has been an important environmental consequence of the recent gold rush in Latin America. We illustrate the importance of analyzing the consequences of the increase in the global demand for gold for the conservation of Latin American ecosystems.

0332	Global patterns and long-term processes in nitrogen biogeochemistry of the coupled human and ecological system	Hideaki Shibata, Cristina Branquinho, William McDowell, Myron Mitchell, Don Monteith, Jianwu Tang, Lauri Arvola,	Japan

Cristina Cruz,
Cristina Máguas,
Daniela Cusack,
Lubos Halada, Jiri
Kopacek, Samson
Sajidu, Hendrik
Schubert, Naoko
Tokuchi, Jaroslav
Záhora

Nitrogen (N) is an essential nutrient for all biota, but may also act as a pollutant when exceeding biotic demand. The N cycle is intrinsically coupled with various global-scale processes and factors including the transformation of land-use, energy and food production and consumption, climate change, exploitation of natural resources, air, soil and water pollution, human health, ecosystem services, and other various natural and anthropogenic drivers. Current understanding of the long-term biogeochemical behavior of nitrogen (N) in coupled human-ecological systems around the globe is drawn largely from long-term ecological research, such as is undertaken across International Long-Term Ecological Research network (ILTER). ILTER currently comprises over 600 sites organized within 40 member networks in the world. Its extensive coverage of geographic regions and integrated socio-ecosystems studies provides unique opportunities to contribute to the understanding of global patterns and long-term effects of N biogeochemistry in an integrated way that links environmental, social and economic issues. We review, using local- to global-scale examples, how this work is helping to elucidate: recent trends in reactive N emissions; the complexity of interactions between N and carbon and other elements; impacts of N on biodiversity and the potential of biota as ecological indicator; the role of climate variability in influencing seasonal and long-term trends in N; quantification of the N cascading process from terrestrial to coastal ecosystem; and the societal challenges from ecosystem services to human health. Increased international collaboration and integration across ILTER network offers the potential for further significant scientific advances, particularly with respect to the elucidation of the various issues (N_2O emission changes, biodiversity changes, spatial and temporal heterogeneity of N deposition, and N leaching from the catchments with different land-use type, altitudinal gradient and inter-annual climate variability). ILTER framework offers the potential for the closer integration of disciplines and datasets that will be necessary to inform future management of this vital but problematic element.

0333	The impact of grassland use/management system on composition and dynamics of ecosystem evapotranspiration in Inner Mongolia steppe	Li Yuzhe, Fan Jiangwen, Hu Zhongmin	China

Evapotranspiration plays an important role in ecosystem water budget, especially in arid or semiarid areas. Land-use changes in the agriculture-pasture transition zone between Inner Mongolia steppe and north China agricultural region occurred frequently, and involved large range of area, probably due to the increasingly conflict between environmental stress and economy food demand. These changes, including reclaiming(R) and grazing excluding (GE), induced impacts on water budget of the original grazing (G) grassland. Through atmospheric transport, the changes may affect local environmental condition and precipitation in downwind regions. Obtaining greater insight into how human land-use pattern affects water budgets and their components in grassland is important for adapting grassland land-use management and reasonable interposing water losses. To examine the effects of different human use/manage pattern including grazing, grazing excluding and cultivation on grassland evapotranspiration (ET) and its components, evaporation (E) and transpiration (T), simultaneous measurements were conducted in three adjoined typical grassland ecosystems with different land use/management patterns, in northern China steppe. Evaporation and its components were divided by experimental treatments, and

determined by chambers connected to a portable infrared gas analyzer. Observations and experiments were conducted in August, when the grassland biomass peaked. Recording was done every 1 hour all day long and continued for 12 days. Our results showed that the ET obtained with portable infrared method was in good agreement with the eddy-covariance measurements regarding both the diurnal accumulation and the dynamics. Results indicated that in the adjoined area, compared to grazing community, ET in grazing excluded and reclaimed community increased significantly ($P<0.05$), 9.42% increase in grazing excluded, and 14.65% in reclaimed community. And the compositions of ET in the 3 communities were also changed; the daily E/ET radio increased with the community leaf area index (LAI). As the LAI increased from 0.42 ± 0.05(G) to 0.67 ± 0.10(GE) and 1.33 ± 0.26(R), the companied E/ET increased from 32.8% (G) to 39.4%(GE) and 45.6%(R). In addition, the E/ET radio was higher at night, and decreased significantly during the daytime ($P<0.05$) in all 3 communities. Despite environmental conditions varied evidently in these communities with different use pattern, which control the vapor exchange, since the community characteristics (e.g. biomass, LAI, species composition and divinity) changed significantly($P<0.05$), the grassland manage pattern also effect the environmental factors sensitivities of the vapor exchange(E/T/ET), that may simultaneously contribute to the changes occurred in water budget.

0335	Combined biophysical and carbon-cycle effects of large-scale forestation in China	Lin Huang, Jiyuan Liu, Jun Zhai, Quanqin Shao, Jiangwen Fan	China

The promotions of afforestation have often been cited as a key climate-change mitigation strategy to slow global warming. Afforestation absorbs the atmosphere CO_2 and results in the sequestration of carbon, which exerts a cooling influence on regional climate. However, biophysical effects of afforestation that include changes in land surface albedo, evapotranspiration and roughness also affect climate. Afforestation can therefore result in net climate warming, particularly at high latitudes. Here, we analyzed the temperature benefit of afforestation, through comparisons on the key biogeochemical and biogeophysical parameter of forest, farmland, grassland and urban. We find that southern afforestation has a net cooling influence on regional temperature, because both the cooling carbon-cycle effects and biophysical effects. However, we show that warming reductions per unit afforested area are higher in the subtropics than in the temperate and northern arid regions. We find that afforestation in northern aird region has a weak cooling and even warming influence, because the cooling carbon-cycle effects of afforestation are overwhelmed by the net warming associated with higher net radiation and lower evapotranspiration. Therefore, afforestation projects in the southern subtropics would be clearly beneficial in mitigating regional warming and effective forest-management strategies from a climate perspective, but would be counterproductive if implemented at northern arid regions, and would offer only marginal benefits in temperate regions.

0336	Impact of large-scale reforestation on temperature and rainfall in eastern Australia	Clive McAlpine, Jozef Syktus	Australia

A number of studies show that reforestation in the tropics and sub-tropics could be beneficial to mitigating global warming as well as having other benefits such as carbon sequestration and maintenance of ecological services including biodiversity, clean air and water. Restoring native vegetation at a regional scale also has the potential to reduce the impact of climate extremes. This is particularly important for eastern Australia, where recent studies have demonstrated that climate extremes, in particular droughts and heat waves have been accentuated by historical deforestation. This oral presentation presents the results of a multi-ensemble climate modelling experiment which evaluates the potential role of the large-scale restoration of native woody vegetation in eastern Australia to

mitigate climate change resulting from global warming. It uses the high resolution (~20 km) stretched grid CSIRO climate model (CCAM) to model different scenarios for targeted reforestation in eastern Australia. We conducted bootstrapping statistical analysis of the model outputs to identify potential of the reforestation scenarios to mitigate/ameliorate climate extremes. We found that reforestation has the potential to reduce the mean annual and summer temperature, and the number of days >35 $^{\circ}$C. The number of dry days is also reduced. The results of the modelling experiments highlight the benefits of implementing reforestation as an effective measure to mitigate the regional impacts of global warming, including climate extremes. We conclude that reforestation of low-productivity agricultural lands, although a policy-sensitive option, is a high-priority mitigation approach that can be adopted in tropical and sub-tropical regions of Australia.

| 0341 | Combining remotely-sensed, national and local level data and GIS: the impacts of land use decisions on deforestation and forest degradation in the Peruvian Amazon | Judith Schleicher | UK |

In order to tackle the current global environmental challenges associated with land cover changes, such as deforestation and forest degradation, it is crucial to understand how local land use decisions and land use designations affect such land cover changes. In the case of the Peruvian Amazon however, little is known about (1) how state and privately protected land affect deforestation and forestation degradation rates compared to other regional and national land use designations and (2) how local land use and management decisions affect the outcomes of protected land on deforestation and forest degradation rates. In this study we therefore aim to show how remote sensing and GIS can contribute to address these questions by integrating data across levels (from remote to local), space and time. We processed and analyzed LANDSAT satellite images to map deforestation and forest degradation across the Peruvian Amazon between 2006 and 2011 using CLASlite 3.0, a software specifically tailored for this purpose showing high levels of accuracy[1]. We then integrated the remotely-sensed and ground-truthed data with national level datasets into a GIS-analysis to compare deforestation and forest degradation between the following main categories of land use designations in the Peruvian Amazon: (1) state protected land, (2) privately protected land, (3) logging concessions where commercial timber extraction is allowed, but conversion is prohibited and (4) land designated for mining extraction. Based on the GIS-analysis, we modeled land use change and applied the statistical method of propensity score matching to control for bio-physical and socio-economic factors that were found to affect deforestation and forest degradation as well as land use designations, such as agricultural suitability, access, and population density. Finally, we integrated local data on land use and management decisions collected through a questionnaire survey and semi-structured interviews with land managers and concession holders to determine how these decisions affect deforestation and forest degradation in protected lands. Overall, the results of the study contribute towards the session and conference theme by highlighting how modern technologies can be applied and integrated in a novel way to (1) monitor deforestation and forest degradation accurately and time efficiently across the Peruvian Amazon, (2) determine how these land cover changes vary between state and privately protected land, and logging and mining concessions, and (3) assess the impact of local land use and management decisions on deforestation and forest degradation.

| 0343 | Regionalized the potential climate impacts of land use-induced land cover changes: a critical review | Xiangzheng Deng, Jiyuan Liu, Xiaodong Yan, Quanqin Shao, Jiangwen Fan, Jinyan Zhan | China |

It has long been known that the land use changes caused by human activities such as deforestation, and agriculture practice have some effects on the climate. This presentation comprehensively analyzed the primary scientific issues about the impacts of land use and land cover changes (LUCC) on the regional climate and reviewed the progress in relevant researches on modeling. Firstly, it introduced the influence mechanism of LUCC on the regional climate, and reviewed the progress in the researches on the biogeophysical process and biogeochemical process. The land use changes can alter various physical characteristics of the land surface, including the land surface parameters such as albedo, upward long-wave radiation and roughness and the vegetation parameters. All the changes in these parameters can influence the energy budget and water budget through the land-surface process, have an effect on the atmospheric boundary layer and further impact the free air. Secondly, the model simulation of effects of LUCC on regional climate was introduced, and the development from global climate model to the regional climate model and the integration of the improved land surface model and the regional climate model were reviewed in detail. Since the atmosphere and the land surface integrate into an inseparable whole system through the exchange of energy, dynamics and moisture, it is the key to the successful simulation with the regional model to construct a land surface model that can accurately and precisely simulate the interaction between atmosphere and land surface. Finally, this review discussed the application of the regional climate models in development and management of agricultural land and urban land. The impacts of land use changes on the climate are the synthetic effects of biogeophysical process and biogeochemical process. But which of the two kinds of processes makes a greater contribution to the climate change at the regional scale, or which one plays a dominant role? The climate model is an effective tool in the study of climate, but how should it be applied to the research on the regional effects of LUCC? What effects will the improvement of the regional climate model have on the LUCC simulation? By answering these questions, this review work can strengthen our understanding of the potential climate impacts of land. In addition, by emphasizing on regional climate modeling and its regionalized implication, it can inspire model suitability and integration.

0344	Long term land system change across Europe: drivers, time-lags and ecosystem implications	Maria Niedertscheider, Simone Gingrich, Thomas Kastner, Martin Rudbeck Jepsen, Angheluta Vadineanu, Daniel Müller, Tobias Kümmerle, Karl-Heinz Erb	Austria

Analysis of historic trajectories of land use transitions provides insights into the general principles of land system change. Studying long-term trends of socio-economic change and their feedbacks on land systems is crucial for improving our understanding of the society-nature nexus and helps preparing for transitions towards more sustainable futures. We here present a consistent and comprehensive database on long term changes in land use/-cover, including changes in area and land-use intensity, biomass flows and human appropriation of net primary production (HANPP) for 9 European countries. This period covers several distinct phases of socio-ecological change, such as the shift from subsistence towards market-based production, the gradual industrialization of land use, and European integration. We show that shifts between such phases were related to general patterns of land system change, albeit with large temporal variability across the continent. After WWII large scale intensification of land use and huge gains in the efficiency of biomass production systems, in terms of output per unit land were found

virtually across all European regions. These trends overruled differences in institutional settings (e.g., West vs. East Germany) and differences in climatic conditions (e.g., Italy's North vs. Italy's South). Our results show that intensification of land use was the most prominent characteristic of post-WWII European land systems, allowing for surges of biomass outputs with forest areas (re-)expanding simultaneously. Intensification practices, in turn, had unintended environmental impacts, such as large scale eutrophication of ecosystems, which led to concentrated European efforts to protect terrestrial ecosystems.

| 0345 | Rural tinkering of the land and water governance interface: conceptual findings and empirical experiences of Tajikistan | Frederike Gehrigk | Germany |

Water availability and accessibility determine the value of agricultural land in many regions. It seems obvious that land and water resources are interlinked once addressing mutual quality affects between both resources. However, sector reforms and policies on the national level rarely address the interface of regulating agricultural land and water resources jointly. Though, on the local level, agricultural land and water for irrigation are often regulated and managed together under customary principles and the resource users´ perception on their individual bundle of rights over the resources. The dualism in legal recognition, set up by land and water laws, has lately been criticized in the debate on the so called water grabbing, which implies the diversion of water resources resulting from foreign land acquisition.

The issue of water grabbing can as well be observed in Tajikistan, where foreigners and local elites rule the post-soviet farm restructuring and with this the land reallocating process. Here, ongoing farm restructuring challenges the per se weak water governance system resulting in new water allocation mechanisms from an institutional and technical perspective. The presentation investigates that the reasons for weak water governance resulting in water grabbing can also be analyzed from the angle of changes induced by land reform and ongoing land reallocation. The aim is to investigate the interface and changes induced by the land regime with a static, private resource influencing the water regime, with a dynamic, common pool resource. Following this, the presentation will draw on conceptual findings using the social-ecological systems (SES) framework (OSTROM 2007). Concretely, the presentation explores two questions: first, how can the land and water interface be depicted in the SES framework? Second, which variables of a land governance regime are leading to water grabbing or benefiting water availability within an irrigation system? Besides the conceptual foundation, the presentation is substantiated by first empirical findings of a farm household survey (n = 380) and qualitative interviews from field work conducted by the author in 2013 in Tajikistan. The post-Soviet case offers a unique opportunity for studying the interface of land and water resources, where the land and water governance trajectory is now placed between incremental changes through ongoing land and water reforms on the national level and continuity of local elites' remaining soviet power mechanisms in allocating resources. As a result, peasants tinker their own joint local governance systems for land and water allocation and management.

| 0348 | Quantification of 2nd gen. bioenergy land-use change emissions | Florian Humpenöder, Alexander Popp, Jan Philipp Dietrich | Germany |

Considering biomass use as carbon-neutral is wrong. Sure, carbon is sequestrated by bioenergy plants in their growing phase and returned back to the atmosphere during the combustion of biomass. But this line of argument for carbon-neutrality of biomass use makes a "baseline error" because it does not account for the carbon that would have been detracted from the atmosphere and stored in bioenergy plants in the absence of bioenergy production. This "accounting" or "baseline error" related to bioenergy has been recently addressed by Haberl et. al. (2012) from a theoretical point of view. In this study we adopt the

theoretical framework of Haberl et. al. (2012) and use the global land-use model MAgPIE (Model of Agricultural Production and its Impacts on the Environment) for a quantification of (1) land-use change emission that can be attributed to 2nd gen. bioenergy production and (2) the "baseline error" related to bioenergy when ecological succession is not accounted for. We show that 2nd gen. bioenergy land-use change emissions (1) as well as the "baseline error" related to bioenergy (2) are highly dependent on the assumption regarding investments in technological change (TC). With 2nd gen. bioenergy deployment considered as driver for investments in TC (endogenous TC) bioenergy land-use change emissions and "baseline error" are substantially lower compared to a world with investments regardless of bioenergy deployment (exogenous TC).

0349	Using FAOSTAT data in the agricultural sector model CAPRI	Marcel Adenäeuer	Germany

The CAPRI (Common Agricultural Policy Regionalized Impact analysis) modeling system consists of specific data bases, a methodology, its software implementation and the researchers involved in their development, maintenance and applications. Models and data are almost not separable. Methodological concepts can only be put to work if the necessary data are available. Equally, results obtained with a model mirror the quality of the underlying data. The CAPRI modeling team consequently invested considerable resources to build up a data base suitable for the purposes of the project following the idea to create wherever possible sustainable links to well-established statistical data and to develop algorithms which can be applied across regions and time, so that an automated update of the different pieces of the CAPRI data base could be performed as far as possible. The main guidelines for the different pieces of the data base are:

- Wherever possible link to harmonized, well documented, official and generally available data sources to ensure wide-spread acceptance of the data and their sustainability.

- Completeness over time and space.

- Consistency between the different data (closed market balances, perfect aggregation from lower to higher regional level etc.)

- Consistent link between 'economic' data as prices and revenues and 'physical data' as farm and market balances, crop acreage, herd sizes, yields and input demand.

Among others, an important data sources entering the CAPRI modeling system is the FAOSTAT database which is one of the globally most complete databases that exist, featuring resources, agricultural production, land-use, yields and supply, as well as demand and trade for agricultural commodities and much more. This presentation aims at describing which steps are necessary to convert the FAOSTAT data such that it suits the needs of the CAPRI modeling system. Furthermore the strengths and shortcomings of the FAOSTAT database from a modeling perspective will be discussed.

0350	Impacts of future urban expansion on regional surface climate in the Northeast Megalopolis, USA	Yingzhi Lin, Anping Liu, Xing Li, Enjun Ma, Xinli Ke	China

Urban expansion is one of the most noticeable effects of human activities that cover a very small fraction of Earth's land surface but notably affect climate. In this research, some evidences for influences of future urban expansion on regional climate in the Northeast megalopolis, USA, are presented. It is showed that study at the scale of megalopolis helps to understand the integrated effect of combination and interaction of multiple cities and their surrounding areas which may crucially determine regional climate pattern. And the model-based analysis shows that future urban expansion

will significantly result in regional climate change. An average annual temperature increase range from 2℃ to 5℃ in new urban area and an average annual temperature decrease range from 0.40℃ to 1.20℃ in the south of the megalopolis will be caused by future urban expansion. The average annual precipitation of the simulation area will decrease due to future urban expansion by 5.75mm, 7.10mm and 8.35mm in the periods of 2010-2020, 2040-2050 and 2090-2100, respectively. This finding differs from previous conclusions such as Dias et al. (2013) arguing urban expansion resulting in an increase of urban precipitation. The warming effect of future urban expansion in original and new urban area and drought effects in nonurban area will be more serious in summer than in winter. And a cooling effect will turn up in original urban area in winter. All these indicate that the future urban expansion in the Northeast megalopolis will be a serious climate signal. And it can be further concluded that more importance should be attached to the integrated effect of combination and interaction of multiple cities and their surrounding areas. The research is an important research component for this *Conference Session*. Firstly, it can enrich case study of biogeophysical impact of land use changes on surface climate at regional scale. Although the impact of land use and land cover on global average surface has been included in international climate change assessments, the role of land use change and variability in altering regional temperatures, precipitation, and other climate variables has been mostly ignored. Secondly, the newest version of Weather Research and Forecasting Model (WRF) coupled with Urban Canopy Model (UCM) is used for our simulation. As for model coupling strategy, this can enlighten members in of this the *Conference Session* on model integration.

0352	The nexus in global and European agricultural investments: empirics and challenges for implementation	Christine Wieck, Bettina Rudloff	Germany

This presentation contributes to the conference session by providing empirical evidence on existing nexus-related investments into land and water in developing countries and by debating consequences for the political governance of these investments. Our work builds on the debate about the importance of agri-investments for the agricultural sector and the land-water-energy-food nexus in general (see for example the recently developed guidelines for responsible and sustainable investments on land by the FAO). Initially, we will show how different types of investments (foreign like Foreign Direct Investments (FDI) or domestic like national agricultural subsidies; public investments like ODA or private ones like farmer's investments) already address the different nexus dimensions with emphasis on land and water investments as in the recent past the bulk of new international agricultural investments took place in land. After the presentation of the investment patterns, governance needs and political challenges to improve the nexus-orientation of investment will be addressed from different perspectives. As investment target countries, the focus will be on food-vulnerable countries (FAO, 2012:3, Column A) and on the investor side we will use the EU outgoing investments (FDI and ODA) as an example. For both perspectives, it is analyzed how investments target the nexus dimensions and if investments contribute to a more sustainable development. For the vulnerable countries this is a relevant question as after the last food price crisis one of the recommendations was to increase investments into agriculture in order to improve the preparedness against future price crises. The EU as investor region plays a large role not only as relevant ODA donor but as well as an investor into foreign land. Additionally there occur some institutional changes at EU level that may lead to more responsible governance of investments, as investment policy is a new European wide policy that will replace existing national approaches. This institutional window of opportunity may be used for a changed investment approach integrating sustainability as a decision element. As a result, a landscape on land and water-related investment patterns emerges explaining how the different investment patterns interact with the nexus dimensions. This knowledge is then used to develop recommendation for governance of nexus-related investments, i.e. for the specific implementation and for the relevant actors so that the investments

enhance the "sustainability transition" of the agricultural sector.

0353	Trends in land use intensification in 19th century Austria: a socio-metabolic perspective on agriculture prior to industrialization	Simone Gingrich, Michael Neundlinger, Fridolin Krausmann	Austria

The greatest transformation in European agriculture has certainly been the green revolution in the 20th century. But long before this time, European farmers were concerned with increasing agricultural productivity. We use Austrian case studies to tackle the issue of land use intensification in the century before industrialization reshaped agriculture. During this period, Austrian agriculture underwent fundamental changes: traditional intensification practices included the shortening of fallow periods and the improvement of nutrient management based on a broad scientific discourse. In addition, the abolishment of the manorial system in 1848 set new social and economic framework conditions to agricultural production, finally freeing farmers from servitude but burdening them with financial debt.

Based on the concept of socio-ecological metabolism, we assess how intensification shaped biomass extraction during the long 19th century (i.e. from the late 18th to the early 20th centuries), how fertilizing practices changed soil nutrient balances, and how the new social structure after 1848 altered land management and working conditions. We evaluate previously unused historical sources to explore agricultural modernization processes and land use change in Austria on the local and regional level. Work with these sources allows to grasp temporal developments and spatial differences. We interpret our data adopting the idea of land regime shifts caused by specific socio-economic, political and technological drivers and put the development in Austria in the larger European context. We raise questions such as: Did the abolition of the manorial system in Austria affect land use practices, and if so, in which way? How did the new social and economic conditions affect biophysical aspects of land use, such as crop yields or nutrient balances? Were the changes that can be observed in the decades prior to and after the end of serfdom greater than in other periods of the 19th century? And finally, how did Austrian agriculture compare to other European land use systems at the time, undergoing similar social change? With this research we shed light on the previously little understood socio-metabolic dynamics in Austrian land use prior to agricultural industrialization. This challenges the idea of static agriculture before the introduction of fossil-fuel-based machinery and the large-scale use of mineral fertilizer prevalent in much of the socio-ecological literature.

0355	Wood harvest: another driver of global land-cover change	Jelle van Minnen, Elke Stehfest, Liesbeth de Waal, Christoph Müller	The Netherlands

The world's total forest area is currently about 40 million km^2. This forest resource is used by man for a multitude of purposes, such as timber, fuel, food, water and other forest related goods and services. None withstanding this value of forests, the forest area is still declining worldwide, with distinct differences over world regions. It still occurs in large parts of Latin-America, Africa and South East Asia, while net forest expansion takes place in regions like Europe and China. The main pressure driving deforestation processes is agricultural expansion. Next to forest area loss, degradation processes occur due to human use of forests. Managing the global forest resource in a more sustainable way may help to preserve forests, reduce or revert the degradation process, and simultaneously conserve the biodiversity and carbon store within forests.

Here we present the implementation of wood demand and supply in the integrated model IMAGE3. The demand is specified for different wood products, i.e. timber, pulp & paper, traditional fuelwood and modern bio-energy. The demand varies over time and among 24 regions across the world, driven by

socio-economic developments. IMAGE3 includes three types of forest management to meet the worldwide demand of wood, all having different consequences for forest services like wood produced, the carbon storage and biodiversity of forests. These three categories are c*lear cut, wood plantations and selective logging*. In addition, several improvements are implemented within selective logging management collectively called Reduced Impact Logging (RIL). This is sustainable forestry system with reduced harvest damage, stimulated forest growth and maintained biodiversity.

When applying the different settings with the IMAGE3 model, we find a clear dominant effect of land-use changes on the global forest area, and their ecosystem services like biodiversity. Different assumptions on forest management have, however, also a clear additional effect. When assuming only clear cut across the world, less forest is needed to fulfill the wood demand. This is reflected in the area of primary forest which decreases about 10% less between 2000 and 2050 than when including also selective logging. But more selective logging lead to only limited disruptions of ecosystems, showing an overall positive effect on biodiversity across the world.

0356	Land use modeling in action: trade-offs in landscape perceptions and political settings	Enrico Celio, Adrienne Grêt-Regamey	Switzerland

Landscape configurations, compositions, and its scenic beauty are inherently dependent on institutional arrangements supporting different land uses such as the care of different landscape characteristics or the development of building zones. At the same time, stakeholders' have preferences for certain landscapes. Understanding how stakeholder preferences for political measures and different landscapes are linked is not straightforward and debated in agricultural, environmental or touristic policy-making (to mention only a few sectors). To understand this link we weigh the robustness of landscape and policy preferences against each other. We use a Bayesian network land use modeling approach (BLUMAP) to elaborate the link between political drivers and the outcome in terms of land use. BLUMAP builds on a structured expert process for setting up the networks as well as the combination of geodata and spatially-explicit questionnaire data capturing local actors characteristics. The spatially-explicit output of our modeling for a future state of land use is the starting point for the creation of 3D landscape visualizations. These visualizations are used to set-up a three-step experimental setting: (1) test persons rank landscape visualizations, (2) test persons rank political settings, (3) test persons rank combined sets of landscape visualizations and political settings. The experimental setting investigates (1) stakeholders' preferences for the visualizations and political measures and, (2) if stakeholders are coherent and robust in their choices of landscape and political measures. Results show trade-offs made by the local population concerning landscape preferences as well as for preferences for political and economic settings which are used to support local spatial development processes.

0357	Reversal of the land biosphere carbon balance under climate and land-use change	Christoph Müller, Elke Stehfest, Jelle van Minnen, Bart Strengers, Werner von Bloh, Arthur Beusen, Sibyll Schaphoff, Tom Kram, Wolfgang Lucht, Kees Klein Goldewijk	The Netherlands

One of the important services of ecosystems is the sequestering of carbon (C). In the past three decades, terrestrial ecosystems have reduced anthropogenic climate change by sequestering about 2 Pg C yr^{-1} annually. In order to define future reduction targets of CO_2 it is important to understand this balance.

Global warming and land-use change have the potential to substantially alter the land biosphere's capacity to sequester carbon, possibly establishing a positive feedback if turning the biosphere into a net source of CO_2. We coupled the integrated assessment model IMAGE with the process-based DGVM LPJmL to assess the land biosphere C balance of the 21st century under multiple climate and land-use assumptions, accounting for the direct feedbacks in the terrestrial biosphere carbon balance. We find that the terrestrial ecosystems may become a C source later this century. This sink-source shift is mainly determined by two large uncertainties in climate change projections: the spatial pattern of climate change and the climate sensitivity. Systematically varying climate sensitivity and GCM patterns of climate change, we show for two different socio-economic scenarios that at a climate sensitivity of 3.5°C, there is a about 50% likelihood that the land biosphere turns into a net carbon source between 2040 and 2100. At a climate sensitivity of 4.5°C or more, the land biosphere very likely turns into a net carbon source between 2040 and 2080. The reversal of the terrestrial C balance is possible at a broad range of global mean temperatures (2.3 to 6.8°C) and atmospheric CO2 concentrations (475 to 936 ppm), with a broad overlap between scenarios that lead to a carbon reversal and those that don't. The rate of temperature increase, however, is clearly distinguished between scenarios with and without C balance reversal. The threshold temperature increase rate ranges between 0.04°C/year and 0.08°C/year depending on the GCM pattern.

0358	UNESCO (urban) Biosphere Reserves as an integrative concept towards resolving the land sharing vs. land sparing debate	A. Cristina de la Vega-Leinert, Susanne Stoll-Kleemann	Germany

UNESCO Biosphere Reserves (BR), a protected area model, conceptually reconciles conservation and multiple land use, based on a zonation system embedded within an integrated management approach. The World Network comprises currently 621 BRs located in 117 countries, which in principle are managed within this overall framework. Effectively, within a BR both land sparing and sharing occur. Land sparing centres on improving functionality through specialisation and spatial segregation between agricultural and conservation areas. BRs leave room for the intensification of agricultural practice in peripheral zones, while clearly demarcating areas of strict conservation (core zones), where neither settlements nor land use are permitted to allow ecosystems restoration and maintenance. In contrast, land sharing fosters the spatial integration of agricultural and conservation goals, framed by sustainable development. BRs actively support a conversion to sustainable agricultural practice and ecologically sound activities in transition and buffer zones. Since Biosphere Reserves are framed as living laboratories to promote sustainable development and good environmental governance, they are privileged settings to experiment with, and adapt, land use strategies to current challenges. Necessary trade-offs between long-term maintenance of regulating ecosystem services (e.g. pollination) and short-term maximisation of provisioning ecosystem services (e.g. agricultural yields) may be identified to ease prioritisation in decision making. Moreover, in BRs, biologically diverse cultural landscapes may be protected by maintaining traditional, extensive agricultural systems (e.g. shaded coffee gardens / maize milpa systems in Latin America; European alpine meadows, traditional rice terraces in Southeast Asia, church forests in Ethiopia). BRs stimulate processes of conversion to organic cultivation methods, support applications for a range of certification programmes, help to apply to establish regional brands / quality labels and support the emergence of green job markets. Biosphere Reserves can provide an adequate framework to foster environmental education, capacity building and improve local participation in land and resource decisions. Finally, since they are often located at the periphery of important urban areas and play an important role in securing critical natural resources and ecosystem services for urban population (e.g. water supply, recreation, etc.), while the expansion of urban areas often constitute a threat to existing protected areas. This talk introduces the session and analyses to

which extent the concept of UNESCO Biosphere Reserve may suitably contribute to overcome the land sharing vs. land sparing dichotomy. Key conference topics will thereby be addressed, in particular: potential pathways to foster a transition to sustainable land use in conservation area.

0359	A land use model as a social learning tool in the development of climate adaptation strategies for rural areas	Merel van der Wal, Joop de Kraker	The Netherlands

The CARE project aims to develop climate adaptation strategies for the rural areas of the Netherlands. It follows a participatory, case study area-based approach. In one of these areas, Baakse Beek, we studied social learning among the actors involved in the project. These actors included representatives of the regional and local authorities, regional water board, farmers' organization, and scientific institutes. During the course of the project, we measured social learning of these actors, defined as a convergent change in their perspectives on the problem and possible strategies to solve it. Social learning is considered important as it creates the basis for integrated solutions that require collective support or concerted action of multiple actors, which is typically the case for climate adaptation strategies in land use. The objective of our study was to determine the contribution of participatory modeling to the social learning process. This concerned the development and application of an agent-based land use model for the case study area, in which the actors were involved through a series of workshops. Our expectation was that an interactive modeling process, during which actors discuss the inputs, structure and outcomes of the land use model, would contribute to a convergence of the actors' perspectives on the preferred adaptation strategy. To evaluate this expectation, we measured with a standardized protocol (Van der Wal et al., under review) at various instances during the participatory process whether actors' perspectives converged, recorded and analyzed the workshop discussions, and conducted follow-up interviews with the actors. In our presentation, we will discussour findings concerning the role of the model in the actors' social learning, in the wider context of other features of the participatory process in Baakse Beek. We will link these findings to the implications for the potential contribution of participatory land use modeling to social learning for climate adaptation.

0361	The impact of agricultural policies and different socioeconomic developments on future agricultural production in Finland	Anne Biewald, Heikki Lehtonen, Jan Philipp Dietrich, Hermann Lotze-Campen	Germany

Agricultural crop production in currently climatic disadvantaged countries like Finland will undergo a decisive change during the decades to come. There are several reasons for that. First, changes in population growth, as well changes in consumption patterns might lead to different demand for food and feed crops, such as rapeseed and cereals. Second, the subsidies of the European Union, which are especially generous for Northern countries such as Finland, will decrease in the future and eventually cease. Third, the human induced climatic change might improve yields in these regions, but also increase the uncertainty in yield expectations. We will use Finland as an example of a small, developed country with difficult climatic conditions for agricultural production to show how a change in national consumption patterns and global population growth will influence local production. In order to do so we will use two different models. First, an agricultural sector model for Finland, which simulates agricultural production by maximizing producer and consumer surplus. Second, a regionally adapted version for Finland of a global, spatially explicit, agroeconomic land-use model, which minimizes overall production costs for a given regional food demand.We will use both models to investigate the impact of population growth and livestock consumption until the year 2055, implementing three different Shared Socioeconomic Pathways (Moss et al. 2010). As a baseline we use SSP2, which can be interpreted as a continuation of the current socioeconomic conditions and compare this to SSP1, a

scenario where the world is making progress towards sustainability while population growth is low and livestock consumption decreasing, and SSP3, a scenario of a fragmented world which is characterized by rapid population growth and high livestock consumption. We combine these results with a scenario where agricultural area payments decrease over time in order to estimate the impact of decreasing subsidies under different assumptions of population growth and meat consumption on agricultural production in Finland. It appears likely that under some of this scenarios rapeseed will not be produced in Finland in forty years anymore and that area of cereal production will decrease. We therefore conduct a sensitive analysis determining the amount of additional investment (and respectively the increase in yield) and the amount of national subsidies necessary to sustain the production of rapeseed and cereals in Finland. At last we will discuss if and to which price it is worth supporting agricultural production and farmers in Finland.

0362	Linking changes in European land management regimes to changes in the land system, 1800-2010	Martin Rudbeck Jepsen, Maria Niedertscheider, Simone Gingrich, Thomas Kastner, Karlheinz Erb, Fridolin Krausmann	Denmark

An environmentally sustainable land system is crucial for securing provision of food and fibers for current and coming generations. In order to design smart transitions towards agro-ecosystems which deliver sufficient resources to society, while having minimum impacts on the biophysical system, an understanding of the processes causing change in the land system is needed.

This study applies the notion of land management regimes, understood as bundles of co-occurring land system change drivers, to nine European country cases in order to compare and synthesize similarities and differences in the ways in which land management has varied through the past 200 years. Further, by combining qualitative information on long-term trends in land management regimes with quantitative information on long-term development in the land system, represented as Human Appropriation of Net Primary Production (HANPP), the following questions are addressed:

1. How can the systematic analysis and combination of qualitative and quantitative information add to our understanding of land system dynamics? 2. What are the differences and commonalities in land management regime shifts between country cases? 3. Do national policies and peculiarities matter for land change? 4. Are differences between countries in timing of land management regime shifts mirrored by time lags in HANPP trends between countries?

The answers to the research questions will provide insights into country-specific transitions in the land system and point to spatio-temporal diffusion patterns of management regimes or drivers of change between country cases.

0364	Climate change adaptation: governance challenges and policy instruments	Jochen Hinkel, Alexander Bisaro	Germany

This contribution belongs to Research Presentation Session 0073: Climate-driven land use change and the institutions of local public sector engagement. Conference Theme No. 4: Land Governance. It contributes to this session and the conference theme by proposing a framework for aligning policy instruments to diverse governance challenges arising in the context of land use change and climate change adaptation. Attention to adaptation governance amongst scholars, policy makers and stakeholders is growing now that climate change adaptation has become a practical necessity. The nascent field of adaptation governance, however, as yet lacks a consistent terminology to distinguish the diverse governance challenges associated with adaptation, which would support the formulation of

salient research questions, and the design of appropriate policy instruments. Governance scholars, generally working across the disciplines of economics, law, political science and sociology, have well-developed terminologies in other specific problem domains. Scholarship on governance of the local commons is particularly relevant to adaptation governance for two reasons. First, adaptation often involves commons-type challenges through either maintaining common-pool resources (CPR) threatened by climate change or provisioning public goods. Second, recent commons scholarship has made a concerted effort to integrate properties of natural systems into the characterisation of governance challenges. This perspective is particularly useful for adaptation because climate change affects natural systems and thereby alters or introduces governance challenges. This paper brings this perspective to climate change adaptation in order to: a) distinguish different governance challenges that arise; and ii) to reflect on organisational solutions and policy instruments relevant for addressing these challenges. Governance challenges are distinguished according to different types of natural-system related interdependence between adapting actors, climate change effects on these, and interdependence involved in the private provisioning of public goods serving as adaptation measures. We illustrate this using several adaptation cases studies where climate change impacts on land use or requires land use change adaptation measures. These include: farmers managing common-pool water resources threatened by climate change; private actors greening their roofs for reducing the urban heat island effect; farmers establishing migration corridors for maintaining biodiversity threatened by climate change; and farmers providing flood protection of downstream urban infrastructure by removing flood impediments on their land. We make use of the commons literature to suggest that independent private provisioning can be addressed by relatively "simple" economic incentives, while interdependence in provisioning requires attention to social norms and legitimacy in the design of instruments.

0366	Modelling biomass energy availability: how to integrate stakeholders' decisions?	Julie Wohlfahrt, Laura Martin, Kamal Idir, Davide Rizzo	France

To limit climate change, the use of renewable energy is increasing worldwide. Biomass energy presents great development opportunities, environmental sustainability and also economic and social suitability. Biomass based energy projects are developing rapidly in forms of, for example, electricity generation plants, biogas plants or local heating plants. Biomass resources for energy can either be provided by energy crops and residues or by forest products. Biomass resource availability studies are mostly based on large scale data (national or regional scales) and take into account mostly biophysical drivers (soil types, climate, etc.). Agricultural and forest biomass availability depends also on stakeholders decision (e.g.: farmers, forest owners) regarding practices choices (e.g.: choice of the crop, wood exploitation timing). The massive use of biophysical based models to assess biomass energy potential leads to misestimates that could either harm the food/non-food balance or the global energy supply system. The challenge is then to integrate stakeholder decisions in biomass availability models in order to describe more precisely the processes involved to assess a more realistic biomass potential and to manage to yield large scale results (Verbruggen et al., 2010). This integration raises methodological questions: on the one hand the integration of biophysical and human based processes and, on the other hand, the integration of multi-scale processes as stakeholders' decisions can be made at different level of organization (farm, cooperative, energy plant, etc) and influenced by different level of factors (farm management, global markets, etc.). Two examples of biomass availability assessment methods will then be presented. The first model deals with a perennial energy crop (miscanthus) potential spatial location and the second with forest biomass availability. The first model is based on a statistical approach (supervised learning) allowing taking into account the real miscanthus location practices of farmers. The other model is based on the comprehension of municipalities' strategies regarding their municipality-

owned forest. The first method is then more generic in terms of outscaling potential. The second one is more adapted to identify lever for action that could be applied to other cases. The complementarity of those two methods to assess land use changes linked with energy issues taking into account different scales will then be discussed.

0367	Dimensions of political influences on bureaucratic decision-making in land management policy in India's forest departments	Forrest Fleischman	USA

Government bureaucrats are often at the center of environmental governance debates, making crucial decisions about who can use land, how the land will be used, and what prices (legal or extra-legal) they will have to pay. Studies of land-use change often note the importance of government officials in exercising power over land-use change, but there is a tendency to rely on one of two models which make strong assumptions about the nature of administrative interactions with other actors: the first model, common in political ecology as well as in traditional public administration, assumes that government officials are unquestioning agents of larger state processes, and thus that they are acting in the interests of "The State" or of powerful actors who control "The State." The second model, more common in economics and political science, assumes that government officials are out to maximize their private benefits. In this paper I draw on ethnographic evidence from research on the implementation of forest policies in Central India to develop a typology of the forms of political influences on bureaucratic decision-making which synthesizes insights from a broad array of literatures in political economy and development studies. This typology demonstrates that the two common models coexist with a broader array of administrative behaviors. Drawing on the diversity of program implementation situations Indian foresters face, I show that whether officials are effective implementors of centrally designed programs, corrupt work shirkers, or community organizers depends on the political context in which they are placed in particular government programs. In particular, I find that while the successes of local resource governance regimes have led many to advocate for community-based natural resource management, community-based natural resource management programs can only be effective when the bureaucrats responsible for implementing them face both top-down political pressure to implement the programs, as well as bottom-up demand for their implementation.

0368	Agricultural development and biodiversity in the Great Lakes of Africa	Arnout van Soesbergen, Elizabeth Farmer, Andy Arnell, Marieke Sassen, Claire Brown, Neil Burgess, Sarah Knight, Brian O'Connor, Ruediger Schaldach, Jan Gopel, Val Kapos, Jorn Scharlemann	UK

Competition for land is increasing as a consequence of the demands for food and commodities and for conserving biodiversity and ecosystem services. Land conversion and the intensification of current agricultural systems continues to lead to a loss of biodiversity and trade-offs among ecosystem functions. Stakeholders active in conservation, and the many aspects of development and planning, need to understand these trade-offs in order to better balance different demands on land and resources. There is an urgent need for spatially-explicit information and analyses on the effects of different trajectories of

human-induced landscape change on biodiversity and ecosystem services. This paper presents a novel analytical framework that can be implemented at multiple scales to evaluate priorities for conservation. This framework includes spatially-explicit consideration of the drivers of land use change, including population change, trends in commodity markets and agricultural production. Scenarios applied within the LandSHIFT model were used to project plausible futures of potential landscape change due to likely changes in these drivers. Modelled land use/cover scenarios were then used to assess the potential future status of biodiversity, the impacts on biodiversity and on ecosystem functions in the landscape. The magnitude of projected changes in biodiversity and ecosystem functions can subsequently inform the prioritisation of conservation actions. The framework has been applied at multiple scales in the Great Lakes region of Africa. Models were based on both the global scale GEO4 scenarios and regionally specific scenarios developed in consultation with local stakeholders. The potential impacts of predicted land use change, and within-region variability of these impacts (at a watershed scale), were assessed for (a) biodiversity as calculated by the proxy biodiversity importance, a metric based on the distribution of suitable habitat for species in the region, and (b) the (change in) potential of a watershed to provide ecosystem functions where, potential provision is a consequence of the land use/cover composition and landscape characteristics of a watershed. Results highlight the watersheds with the highest and lowest potential impacts on biodiversity and ecosystem functions under future scenarios of land use change. Analyses at multiple scales, under different scenarios, enables the influence of scale on decision making outcomes to be assessed. Such results aim to support decision makers in (a) assessing and visualising likely future impacts on biodiversity and ecosystem functions, (b) assess trade-offs and (c) make more informed choices balancing conservation and development needs.

0369	Livestock and deforestation: potentials of dietary choices and changes in production systems to reduce pressures on forests	Isabelle Weindl, Benjamin Bodirsky, Alexander Popp, Hermann Lotze-Campen, Susanne Rolinski, Anne Biewald	Germany

The assessment of mitigation strategies aimed at emissions from terrestrial systems to reach ambitious climate protection targets is currently rising up the scientific agenda, with potentially considerable implications for the agricultural and notably the livestock sector. As estimated by Steinfeld et al. (2006), global livestock production is responsible for 18% of global anthropogenic greenhouse gas emissions, where 34% of these emissions are generated by deforestation. According to FAO, grazing land for ruminants accounts for almost 30 % of Earth's land surface. Including land requirements for the production of complementing ingredients of feed baskets, overall land use associated with livestock production is estimated to be in the range of 80% of total agricultural land use. Changes regarding the size of the livestock sector are widely expected to alter agricultural land use and to significantly affect deforestation rates. These changes may be caused by future demand trajectories for livestock products as well as modifications of feeding efficiencies and feed composition. In this study, we assess different possible developments of the livestock sector both on the supply and the demand side with respect to the resulting deforestation and the ratio of cropland and pasture. The aim of this multi-scenario analysis is to deepen our understanding to what extent and under which boundary conditions global livestock production may act as a driver of future deforestation and land use. For this purpose, we apply the global land use model MAgPIE which features a detailed representation of the livestock sector and integrates socio-economic regional information with spatially explicit biophysical data into one unifying modeling

framework.

The results indicate that demand side measures have a huge potential to spare land for nature and reduce deforestation. On the supply side, feeding efficiency gains also offer a remarkable potential to decrease demand for land and overall biomass requirements. Since efficiency gains are accompanied by a shift to feed baskets with higher nutrient densities, prime crop areas are increasingly used to feed animals. Rising demand for products from cropland results in expansion of arable land at the expense of mainly pasture area but also formerly unmanaged land.

0371	Land use futures that combine the shared socio-economic pathways and the representative concentration pathways in a conditional probabilistic framework	Kerstin Baumanns, Stefan Olin, Dave Murray-Rust, Mark Rounsevell, Almut Arneth	Sweden

Land use scenarios are important to estimate the trade-offs between future food provision by agriculture and other ecosystem services provided by natural vegetation. Future land use is highly uncertain, being shaped by large uncertainties, such as alternative socio-economic development pathways, and biophysical responses to climate change. This work aims to find robust strategies across scenarios that lead to sustainable land use futures that maintain the provision of food and other ecosystem services. Land use scenarios need to account for the strong influences on the land system of dynamics in the socio-economic system and the natural system. Here we apply a parsimonious, global scale model of agricultural land use (the Parsimonious Land Use Model; PLUM) in combination with yield time-series derived from the dynamic global vegetation model LPJ-GUESS. We interpret the Shared Socio-economic Pathways (SSPs) in order to derive the PLUM input parameters for each SSP. We also estimate uncertainties for each parameter (i.e. parameter ranges) that are conditional on each SSP. For each SSP the input parameter and uncertainty are used to create a probability distribution function from which the value for the input parameter was sampled during multiple runs. For each of the four Representative Concentration Pathways (RCPs) LPJ-GUESS was run with climate patterns derived from five different General Circulation Models (GCMs). The yield time series and uncertainties derived from LPJ-GUESS were used as input to PLUM. PLUM was then run multiple times for each SSP combined with all plausible RCPs. Preliminary results suggest that a number of different SSPs and RCPs combine in the conditional probabilistic framework to generate sustainable land use futures. The impact of economic development and life-style choices, such as the consumption of animal products, can be outweighed by technological development and yield increases. Also, the inclusion of the climate dependent yield time series from the global vegetation model showed that assumptions about technological development and yield increase outweigh climate related yield changes.

0373	Coupling cells and agents for modeling urban growth in Shrinking regions – a simulation of the Ruhr 2030	Andreas Rienow, Roland Goetzke, Gunter Menz	Germany

Urban sprawl and the ongoing process of soil sealing is still a challenge in terms of a sustainable development in Germany. The aim of the German federal government claiming a reduction of land take to 30 ha per day until 2030 is not realizable by now. Even in shrinking regions like the old industrialized agglomeration of the Ruhr one can observe an increase of settlement areas and traffic infrastructure. The causes are manifold and rooted in demographic, social, economic and regional planning trends. Remote sensing images and methods are one important measurement technique to quantify the spatial dimensions of urban sprawl. However, the projection of urban growth or the analysis of the processes behind the emerging pattern is rather limited. The study aims to couple two artificial intelligence (AI) models for simulating the 'shrinkage sprawl' of the Ruhr for 2030. The coupled modeling approach consists of the cellular automata (CA) SLEUTH and the multi-agent system ReHoSh. The well-

established urban CA SLEUTH simulates urban growth using four simple but effective growth rules. In order to improve its performance, SLEUTH has been modified by reducing the input data sets, using a new calibration routine, and combining it with a robust probability map created by using support vector machines. In the opposite, ReHoSh (Residential Mobility and the Housing Market of Shrinking City Systems) is designed for modeling residential mobility in a shrinking city agglomeration. The model focuses on the dynamic of interregional housing markets implying the development of potential dwelling areas. The contribution presents the modeling results and analyses the outcomes in terms of the spatio-temporal urban land use pattern in a polycentric region. In that regard, the advantages and limitations of linking pixels and people in urban system modeling, the combination of divergent AI solutions as well as the issue of calibration and validation challenges in multi-scale and multi-model geosimulation will be addressed. The approach includes the possibility to integrate scenarios like increasing energy prices or demographic change and their effects on urban development. Thus, it can serve as spatial decision support in regional planning and facilitate the comprehension of decision makers regarding the implications of land take in shrinking agglomerations.

| 0374 | A new global data set of agricultural land use during the last Millennium | Mats Widgren | Sweden |

Different data sets are now used for modeling the history of human land use on a global scale. HYDE and KK10 are the most commonly used for climate and vegetation modeling. They have in common a high spatial and temporal resolution, reliance on simple back projections, reconstructed population data and assumptions on fixed or linearly changing per capita acreages. Moreover they are based on a minimum and rudimentary input from agrarian history. What is presented here from the project Mapping Global Agricultural History represents a different approach. It has a course spatial resolution (mapping regions with different of agricultural systems) and a course temporal resolution (AD 1000, AD 1500 and AD 2000). But in contrast to the established data sets this one is firmly based on empirical studies in archaeology, agrarian history and paleoecology, rather than modeling. It will be shown that in some parts of the world, notably the Americas, the established data sets grossly underestimates the role of early agriculture and at the same time, in some areas of late agrarian colonization (notably the eastern part of Eurasia, the model-based data-sets tend to exaggerate the age of cropland expansion. Bringing real historical studies (instead of modeled history) into land change science is urgent.

| 0375 | High-resolution modeling of climate change impacts on the agricultural potential of Lower Saxony, Germany | Jan Degener, Martin Kappas | Germany |

Lower Saxony (total land area about 46,500 km^2) constitutes one of the most important agricultural areas in Germany and thus within Europe. However, no comprehensive account on the impacts of climate change on the current crop system exists today. Therefore the following approach was devised tackling the problem. A large regional climate dataset (WETTREG data) comprising temperature and precipitation data for the entire 21st century in a spatial resolution of 100m x 100m and a temporal resolution of 10 days was used as the input for the recently developed crop model BioSTAR (Bauböck, 2013). BioSTAR is a robust carbon-based crop model that uses input variables (precipitation, temperature, global radiation, air-humidity and wind speed) and the prevalent soil moisture system (field capacity) for the computation of crop biomass. Effectively four winter crops (wheat, barley, rye, triticale), three maize varieties (differentiated by their respective date of maturity) and three more crops (sunflower, sorghum & spring wheat) where modeled on a total of 90.000 agricultural sites all over Lower Saxony for each year of the 21st century. The modeling took the changing atmospheric CO2 concentrations as described under the IPCC Scenario A1B and their assumed fertilization effect into account. Much will depend on this actual fertilization effect, as the results show stagnating or positive

developments if it is fully included and throughout all plants negative development pathways if neglected. This presentation will contribute to the conference and the session in particular through showing how such modeling approaches will help in assessing future chances or risks in the fields of food, energy and climate. The study shows that the investigated area will probably see a shift towards plants like Maize, Barley and maybe Sorghum. This may indicate a shift towards more bioenergy use or probably an increase in processing industry and away from raw food cultivation. The presented approach will be applicable to areas around the world, helping in generating similar assessments for various regions. It can also be seen as a study on how applicable or suitable the modeling of large datasets currently is or if limits (concerning data structure or processing time) still do exist, thus limiting the potential number of modeling sites.

0376	Extended impact assessment of European Union's legislative and non-legislative measures: applications of the Land Use Modelling Platform (LUMP) for integrated assessment of policies	Carlo Lavalle, Claudia Baranzelli, Ana Barbosa, Filipe Batista e Silva, Chris Jacobs Crisioni, Sarah Mubareka, Carolina Perpina Castillo, Ine Vandecasteele, Ricardo Barranco, Eric Koomen, Maarten Hilferink	Italy

Based upon the principle that the changes in the cover and use of the surface of the earth depend on natural processes and are, at the same time, shaped by demographic, economic, cultural, political, and technological drivers, the Joint Research Centre has developed the Land Use Modelling Platform (LUMP) to assess the consequences of policies with direct or indirect spatial impacts. LUMP supports the policy design of different services of the European Commission and provides a comprehensive, consistent and harmonized analysis of the impacts of policies and/or specific proposals in the context of environmental and socio-economic changes in Europe. LUMP is based upon the combination of a spatially explicit land use model and its linkages with other modelling activities in thematic fields such as hydrology, agriculture, economy, forestry, etc.

The Land Use Modelling Platform (LUMP) is continuously applied in ex-ante and ex-post impact assessment of European policies that influence, directly or indirectly land use/cover change. The forecasted land use/cover changes are not only analyzed per se. Land use/cover is an important factor for many ecosystem services such as provision of food; fibre and timber; biodiversity; water flows and climate regulation; carbon sequestration; provision of recreational opportunities; etc.

LUMP's modelling framework allows the translation of policy questions into alternative scenarios that could be compared through a set of indicators that capture economic, environmental and social issues.

To date, LUMP has been applied in the following impact assessments and related exercises:
• Integrated Coastal Zone Management;
• Green measures of the Common Agricultural Policy post-2013;
• the EU 2012 Blueprint to Safeguard Europe's Waters;
• Resource efficiency.

Further applications are being conducted in the fields of energy, regional and cohesion policies, bio-economy and adaptation to climate change.

The presentation will highlight the process of translation of policy options and regulations into drivers for land use/cover changes. Also, it will show how planning processes occurring at different

	administrative and government levels (e.g. European, National, Regional and Local) interact and are accumulated to predict the impact of European policies. Finally, a set of examples from the performed application will explain methods and criteria for wider sustainability assessment.		
0377	Coffee forest use and conservation in Ethiopia: local land transformation dynamics in the view of global markets and protected area approaches	Till Stellmacher	Germany

Ethiopia is the worldwide origin of Coffee arabica. The montane rainforests in South-western Ethiopia still comprise naturally regenerating coffee populations with a genetic diversity that is globally unique. Local smallholders living in or adjacent to these coffee forests highly depend on the forest coffee as a cash crop. Beyond they utilize a great number of other timber and non-timber forest products. However, Ethiopia's coffee forests witness high rates of depletion and deforestation, mainly due to the expansion of smallholder agriculture and intensification of coffee production in the forests. Since 1975, all land in Ethiopia has been nationalized, a policy that still remains in place today. In the 1970 and 1980s, most of the Ethiopian coffee forests have been designated as protected areas, namely "National Forest Priority Areas", however, with very limited conservation effectiveness.

In the last years, the Ethiopian state, NGOs and international donors have made attempts to promote the sustainable use and conservation of the Ethiopian coffee forests as human-environment systems by taking the complex human-forest-coffee dynamics into consideration. In 2010 and 2012, three UNESCO Coffee Forest Biosphere Reserves were established in Southwestern Ethiopia with the aim to promote sustainable development based on local community involvement.

The paper is based on local-level empirical field research conducted in coffee forests in South-western Ethiopia as part of the transdisciplinary BMBF research project "Conservation and use of wild Coffee Arabia in the montane rainforests of Ethiopia". Methodologically, a combination of household interviews with forest users, semi-structured expert interviews with local decision-makers, NGO representatives and state agents on district, regional and national level, as well as focus group discussions and visual communication techniques, was used.

The presentation will contribute to the conference and the session by empirically showing detailed land transformation dynamics in complex human-environment systems in a rural African development setting. The findings demonstrate how local land use decisions in rural Ethiopia are being influenced by the path-dependent persistence of traditional land tenure systems and legal pluralism and the global demand for high-quality coffee, and how that impacts on forest use, management and conservation in formally protected areas.

0378	Development of a land cover change monitoring system for protected areas in Sub-saharan Africa	Zoltan Szantoi, Andreas Brink, Dario Simonetti, Andrea Lupi	Italy

Protected areas monitoring is increasingly important as their natural resources, biodiversity and landscape are under increasing anthropogenic pressures. Thus, the monitoring of land use/cover change, particularly deforestation and de-vegetation, are crucial for managing protected areas and their surroundings. Furthermore, a well designed protected areas monitoring system is able to identify the important problems for longer-term decisions, assess the current and future values, status and threats of these areas. The European Union pledged significant support toward management and conservation of protected areas in Sub-Saharan Africa. The Joint Research Centre (European Commission-JRC, Ispra, Italy) developed a semi-automatic approach, which detects and measures land use/cover change for the period of 20 years, starting from the 1990's. Additionally, the system is capable to handle new, incoming satellite imagery (Landsat 8 and Sentinel 2).

The system has the necessary pre-processing stages, such as radiometric calibration and normalization,

cloud and cloud shadow masking, topographic correction, de-hazing and mosaicing. The Tropical Ecosystem Environment Observation by Satellites (TREES) project of the JRC is based on a systematic sampling of satellite imagery and reports estimates on land cover change over the ACP (African, Caribbean, and Pacific Group of States) regions since 1990. The latest results of the TREES (2010) project showed that many protected areas and their vicinity lost tree cover; their natural landscape became more fragmented. Accordingly, our main objective was to detect, map and quantify the occurring losses/gains in the investigated period by using medium resolution imagery and object based classification. The following land cover classes were assessed and differentiated to map the protected areas and their 20 km buffer zones: (1) tree cover, (2) tree mosaic, (3) other wooded land, (4) other land - non woody land cover such as herbaceous, pasture and crop-, (5) bare or artificial (6) water and (7) cloud and shadow. Additionally, using a "hybrid" approach, local experts can modify the produced maps, by correcting/updating land cover types, including hardly detectable classes such as agriculture, using a web based application.

In this presentation, the monitoring system will be shown with results for several protected areas and their vicinity. The detected land cover dynamics are presented as change detection maps for selected parks with different levels of change, and quantitative results will reveal specific information on tree loss, vegetation degradation, fragmentation and agricultural expansion or in some cases reforestation throughout the studied years. The detected changes in these areas are then discussed within the framework of tropical deforestation, habitat loss, trends in these protected areas, agricultural intensification and urban development.

| 0379 | Protecting your forests while outsourcing forest exploitation: the unexpected case of Bhutan | Isaline Jadin, Patrick Meyfroidt, Eric Lambin | Belgium |

With globalization, virtual exchanges of natural resources and land use embodied in traded commodities redistribute geographically the socio-economic and environmental impacts of land-based activities. Regional and global benefits of environmental policies may be undermined by leakage generated through international trade. This applies to the protection and restoration of forests, but we still lack a detailed understanding and quantification of transnational impacts of forest protection policies. In Bhutan, a country with a rather closed economy, protection of forests has always been a high priority for the government. The aim of this research is to assess the environmental impacts of the policies implemented in Bhutan over the past 30 years to protect national forests after accounting for potential land use displacement through trade. First, forest-related policies were reviewed. Second, the evolution of forest cover was reconstructed based on results from various studies and forest resource assessments. Third, data on trade of wood products were compiled and analysed to identify and quantify the main international flows and their changes over the past 30 years. Fourth, trends in domestic consumption and production were reconstructed based on a large and detailed dataset assembled for this project. Finally, we integrated all results by converting the data on trade, consumption and production into forest area equivalent, and analysed changes in forest cover and in trade flows of wood products in relation to the implementation of forest policies. While the nation-wide forest cover of Bhutan did not increase considerably since the 1980s, it has remained at about 70% of the national territory thanks to strict conservation policies. These restrictions, combined with a growing demand for timber construction, led to a shortage of roundwood that was compensated by a ban on timber export in 1999 and increasing timber imports. This study highlights the necessity to integrate cross-border displacement - or leakage - in the evaluation of forest conservation policies. The same analysis framework is now being applied to other tropical countries that have pursued different strategies to protect and/or increase their forest cover.

| 0380 | No root, no fruit – sustainability and ecosystem services in land change science | Nicolas Dendoncker, | Belgium |

Sander Jacobs,
Hans Keune

Current research and practice is advancing in trade-off analysis, comparing potential and actual delivery to various societal demands. However, this 'efficiency' is only one of the three central ecosystem services (ES) values (and of the three components of sustainability). Optimizing efficiency is important, but determination and consideration of (1) limits to the use and (2) equitable sharing of the earth's resources is central in root literature of both sustainability and ES, but underrepresented in current research and practice. This presentation confronts the ES concept with the theoretical and practical sustainability context. The origin of the research field and concept of biodiversity, natural capital and ES is indeed rooted in sustainability thinking. The explicit link between sustainability and ES assessments stresses the importance of three values of ES: ecological sustainability, social fairness and economic efficiency. Conclusively, the final goal of ES valuation is to achieve a more sustainable resource use, contributing to wellbeing of every individual, now and in the future by providing an equitable, adequate and reliable flow of essential ES to meet the needs of a burgeoning world population. Until now, there is reluctance to fully embrace the message that by ignoring the dependence on our 'natural capital' we are literally living at the expense of the poor and the future generations. Still, the ES concept could be an effective lever to contribute to sustainable development with more than just lip service. This concept has been picked up widely, percolated in many policy documents and is being implemented in a variety of contexts including for the management of multifunctional landscapes. As the time left to effectively tackle sustainability challenges is running out, urgent refocusing of ES research and -more importantly- practice on its strong sustainability roots is essential. This conclusion directly arises from the methodological and conceptual challenges for ecosystem service valuations developed in the recent book entitled "Ecosystem Services – Global Issues, Local Practices' (Jacobs et al. 2013), echoes in many reflections from practice, and mirrors current scientific opinions on the topic. In this presentation, we will develop four points that should be kept in mind and transparently addressed if ES research and practice has to contribute to a truly sustainable multifunctional landscape management. We believe these are crucial items that should be considered before engaging in trade-off analysis and the development of tools, and this presentation could therefore be a pertinent introduction to the above-mentioned session.

0382	Incorporating human decision-making, institutions and ecosystem services in a model of European land use change	Calum Brown, Jasper van Vliet, Dave Murray-Rust, Shah Jamal Alam, Peter Verburg, Mark Rounsevell	UK

Land system science has developed rapidly in recent years, as interdisciplinary questions concerning the effects of climate change, population growth and policy intervention on Socio-Ecological Systems (SES) have gained importance. Land use models provide a powerful method of addressing these questions, but must respond to several challenges: the difficulty of identifying coherent systems, trade-offs between various services and spatial scales, the importance of ecosystem services, variations in intensities and multifunctionalities of land uses, the effects of human behaviour and the role of diverse institutions. These have often prompted the combination of 'top-down' models that describe distinct processes and scales, and are particularly successful at simulating international trade flows and land demands at large scales. However, they are less suited to accurate description of small-scale processes that may have substantial effects on land use change, particularly the behaviour of land managers, institutions, and the feedbacks between environmental conditions and land use. We present an agent-based model of land use change in Europe designed to address some of these issues and combine place- and process-based understandings of land system dynamics, while retaining the ability to operate at large spatial scales.

Land managers are a key component of any SES, and their behaviour is heterogeneous and influences the system as a whole. We therefore base the model on accurate and efficient description of human behaviour, but also incorporate a full range of services produced by land uses, including ecosystem services, and develop an institutional agent typology defined by scale and form of intervention. We allow variations in the intensities and functions of land uses, and include both large-scale environmental change and local-scale environmental feedbacks to influence agent behaviour. Similarly, demands for goods and services across spatial scales are considered, in order to investigate trade-offs between these and the supply of ecosystem services. The model is ultimately intended to complement top-down models in informing the development of European land use policies, and we compare the results of such models with our own to highlight areas of divergence. We describe the structure of this model and give examples of its application, including at the European scale. We discuss the advantages and difficulties of this approach, and its potential for investigating land use change across spatial and sectoral scales. As a result, the potential for incorporating factors that are strongly linked to particular locations into models that deal with general processes is assessed.

0383	Integrated assessment of the effects of climate change on land use and ecosystem services: predictions and uncertainties	Evan Brown, Calum Brown, Dave Murray-Rust, Mark Rounsevell	UK

Models of climate change and its environmental effects play an increasingly important role in policy development, and a great number of such models have been developed. Many of these operate at distinct scales and focus on different biological, ecological or socio-economic processes, providing powerful tools for exploring possible futures and adaptations. In isolation, however, such models cannot address the complex interactions that occur across scales and sectors, limiting their ability to address broad questions concerning land uses and ecosystem services that are of particular relevance to policy-makers (Turnpenny *et al.*, 2004). This has prompted the development of integrated assessment methods, which allow the combination of many diverse, focused models. While integrated assessment offers a very powerful basis for explorative modelling, it also suffers from concomitant difficulties. In particular, the combination of models implies the combination of model uncertainties, with consequences for interpretation that are substantial but difficult to predict. It is therefore crucial to develop a thorough understanding of the uncertainties involved in any such assessment and to provide clear information on them to model users. This information illuminates the behaviour of the models and, potentially, the studied system itself. Here, we present an uncertainty analysis carried out on a particular Integrated Assessment Platform (IAP) developed in the EU-funded CLIMSAVE project. This is a cross-sectoral, regional-scale IAP dedicated to the impacts of climate change and the adaptation and vulnerability of socio-ecological systems. The IAP integrates several meta-models, each of which focuses on a particular sector, and allows for interactions between these under a number of stakeholder-designed scenarios of future change across Europe. We perform a numerical uncertainty analysis on the meta-model network and explore the consequences of this uncertainty for model projections. We use our findings not only to discuss the likely effects of climate change on Europe's interlinked natural and human systems, but also to identify areas where additional knowledge is required. We focus on the sustainability of particular land uses with respect to their vulnerability to climate change and effects on ecosystem services, and so consider the supply of ecosystem services at different spatial scales. Finally we discuss methodological developments that will aid the study of land use systems and identify significant uncertainties, in order to provide a better basis for the development of coherent climate change policies.

0385	InViTo: interactive visualization tool for Brownfields redevelopment	Giulia Melis, Stefano Pensa, Elena Masala,	Italy

		Matteo Tabasso	

After the manufacturing crisis, Europe is going to face the issue of brownfields management.

The EU "Circular Flow Land Use Management" Project (CircUse in short) involved partners from 6 Central Europe countries working together to propose a strategy focused on a temporary - but uninterrupted - use of dismissed areas, avoiding new land consumption by economically, environmentally and functionally sustainable solutions. Thinking of new scenarios for heavily damaged areas, interactive visualization tools can be helpful for decision processes: they are able to undertake a huge amount of variables in order to make the decision makers much more aware of the complexity of urban dynamics and facilitate the debate by showing maps of future scenarios.

The research institute SiTI (Politecnico di Torino and Compagnia di San Paolo), collaborating as technical partner with Asti Municipality in the CircUse Project, applied "InViTo" , a visualization tool created to help the decision makers in formulating their choice, to define the transformation of some former industrial dismissed areas.

The contribution describes the InViTo experience in the framework of the CircUse philosophy, moving its steps from an overview of brownfield reuse at European level and the state-of-the art developed by international researches on the SDSS technology (Spatial Decision Support System), and describing then the application of such a tool to an Italian case study.

0386	Model output evaluation as a validation test for land use models	Markus Bonsch, Jan Philipp Dietrich, Alexander Popp, Hermann Lotze-Campen, Susanne Rolinski, Benjamin Bodirsky	Germany

Model output evaluation plays an important role in land use modeling. It mainly serves two purposes: model validation and model calibration. Using a self-developed toolkit, we undertook an exemplary model output evaluation exercise with the Model of Agricultural Production and its Impacts on the Environment, MAgPIE (Lotze-Campen et al. 2008). Based on this example we discuss the suitability of model output evaluation as a validation test for land use models. We find that hidden uncertainty in comparison data and the simultaneous use of model output evaluation for calibration and validation are major limitations to the usefulness of model output evaluation for land use model validation.

0388	Forest-cover change in the Andes: a multi-scale analysis of Northern Argentina in comparison with the other tropical countries	Ricardo Grau, Ezequiel Araóz, Jorgelina Gutierrez Angonese, Sofía Nanni, Priscila Powell, Julieta Carilla, Mitchell Aide	Argentina

Broad scale analyses using MODIS suggest that the dominant recent trend in South American montane ecosystems has been an increase in woody vegetation (Aide et al. 2013). Furthermore, there is evidence of woody vegetation encroachment into the grassland ecosystems of the paramos, altiplano, and puna. Here, we analyze forest cover dynamics in northern Argentina in comparison with other tropical Andean forests (Bolivia, Perú, Ecuador, Colombia, Venezuela) at different elevational zones. While the continental MODIS analysis provides an extensive and updated description of patterns, the local case studies allow to better relate changes with human and biophysical controls and driving forces, and to extend the time horizon to several decades. In all the tropical Andean countries, forest expansion

exceeded deforestation. Low elevation forest expansion was prevalent in Colombia and Bolivia. The low-elevation studies in Argentina (<1000 masl) indicate that forest expanded mostly over abandoned agriculture in association with population urbanization. Pre-abandonment agriculture use influenced secondary forest composition, and peri-urban forests were characterized by the dominance of exotic invading species. In Ecuador, forest expanded more intensively at intermediate elevations. Argentine case studies between 1200 and 2500 masl indicate that forest expansion dynamics is mediated by interactions between increasing rainfall, decreasing grazing, and fire frequency (in turn controlled by human fire ignitions and fuel availability depending on grazing and climate). High elevation forest expansion prevailed in Peru. Above 2500 masl in Argentina (*Alnus* and *Polylepis* woodlands) forest growth and expansion appear to be largely controlled by temperature increase and its interactions with water budget. The Argentine cases suggest that forest cover change along Andean elevational gradients reflects changes in the relative importance of driving forces. Trends in agriculture land use control changes at lower elevation, and climate variability become more important at high elevation. At intermediate elevations forest cover dynamics is controlled by the interactions between land use, climate and fire, which largely depends on grazing practices. We explore this hypothetical framework with coarse scale data for all the Andes. The presentation will contribute to the session by combining the most updated analysis of forest cover change in the tropical Andes (the mountain range with highest biodiversity and watershed conservation value globally) with detailed local scales on biophysical and human controls.

0389	Farming systems, land use intensity, productivity and efficiencies in Central Asia	Ihtiyor Bobojonov, Aden Aw-Hassan	Germany

This study gives description of the biophysical and socio-economic environments of different farming systems in Central Asia (CA) which were surveyed in the project. Understanding the particularities of agricultural production in these countries is essential for assessing the complexity of climate change impact on agricultural production. The main objective of this study is to explore options to increase the resilience of farming systems in Central Asia by identifying policy options for improving agricultural productivity and production efficiency. Furthermore, the study fills information gap on the socio-economic characteristics of agricultural production systems in CA which could be used to investigate vulnerabilities of farming systems to climate change and subsequently exploring feasible adaptation options in wide range of studies.

The analysis provided in this study is based on the data collected though household surveys in different agro-ecological zones (AEZ) of CA covering 1600 households. For the first time, we describe farming systems in CA based on information collected from household surveys. Information on production endowments in different agro-ecological zones (AEZs) is based on econometric analysis of household data collected during the survey. We have investigated how agricultural productivity and efficiency could be increased in order to increase resilience of agricultural producers to climate change. Spatial extrapolation of household data to GIS maps is implemented.

Analysis of household data shows high differences in crop yields and technical efficiencies in different regions in CA. Findings show that crop yields is usually higher in Uzbekistan when compared to other countries which could be important for food security and agricultural income in that country. According to our analysis, the highest efficiency in wheat production was registered in Kazakhstan. This is mainly explained by high access to machinery services and existence of large scale rainfed farms in Kazakhstan. Uzbekistan has shown highest technical efficiency in cotton production which is mainly explained by better access to extension services. Improving crop yields and increasing production efficiency are essential for improving adaptation capacity of agricultural producers in the region. Especially improving the production efficiency of small scale farmers is urgently needed in order to improve their coping capacities under climate change. Improving the quality of extension services and input supply

infrastructure should be a priority policy in CA in order to improve crop yields without offsetting production efficiencies; this will enhance system resilience and reduce vulnerability to the negative impacts of climate change.

0391	Land use policy effects on land uses change around urban sprawl: comparison with remote sensing and landscape analysis between France and Spain (1980 - 2010)	Michel Mouléry, Esther Sanz Sanz, Claude Napoléone	France

This communication seeks to assess effects of public management on land use change form, especially in farmland conservation issue. In this aim, we used remote sensing tools in order to describe the urban-agricultural interaction at the urban fringe, on two study cases with a high level of urban sprawl but a different policy and history context. No longer rural but neither urban, per-urban territories experiment particular dynamics between city and farming. We assume that each type of dynamics should be explained by key factors determining the land use change: public politics, planning practices, land market, landscape structure, farming practices or economic crises effects.

Two study cases: Madrid (Spain) and Avignon (France). Madrid metropolitan region is the most populated in Spain with its 6 million habitants over 300 000 ha. With a centre-periphery developing model, urbanisation pressure around the city is hard. Concurrently, Avignon is a smaller urban area in Southern France of half a million habitants. Working as a net of connected small cities, agricultural land is decreasing rapidly.

Various case studies have been developed in the last years to identify notably the main landscape dynamics acting in the per-urban areas. We'll use landscape indicators as a mean enabling the comparison of both territories by spatial image interpretation. We'll explain our technical innovations (software of matrix of transition as LUCKY, Land Use Change Knowledge by Years. LUCKY is software developed in R by the research team INRA-Ecodeveloppement (Developer M.Mouléry ; analysts C.Napoléone, E. Marracinni and E. Sanz Sanz). Finally, we'll propose a prospective vision of different scenarios by the means of Clue (Verburg & al, 2002. Modeling the Spatial Dynamics of Regional Land Use: The CLUE-S Model. Environmental Management 30, 391–405).

0392	A nonparametric method for evaluating soil characteristics: an application to Kenyan smallholder farmers	Simone Pieralli	Germany

Even though soil quality is one of the most critical factors of agricultural production, an agreement on the best way to evaluate specific soil-quality characteristics has not yet been achieved. While a series of efforts have tried to develop a market for evaluating carbon, we propose a general nonparametric method to quantitatively evaluate soil-quality characteristics, including the possibility of soil characteristics to have negative marginal effects on agricultural production. We aggregate nonparametrically quantitative soil characteristics to retrieve their shadow prices. Shadow prices can be used to obtain disaggregated values of soil characteristics, including also soil carbon. A carbon trading market has been developed lately to compensate farmers for adoption of more costly, but more environmentally friendly, farming practices. Because in developing countries this is considered as an alternative source of income, it is important to appropriately compensate farmers depending on their different local conditions. Different conditions cause soil characteristics to have different importance and potentially different values. A ton of soil carbon in a very carbon-poor soil might have a much higher value in yield potential than in another location where soil carbon is much more abundant. Appropriate localized compensation of farmers is important to attribute the correct value to different soil characteristics, and finally to the land resource itself. Compensation, moreover, could be proposed not only for soil carbon but also for other soil characteristics to achieve a better integrated soil-quality management. Summarizing, we propose a method to obtain a localized value of specific soil

characteristics. These values could potentially be used as the basis for developing localized compensation mechanisms for the preservation of the most valuable soil characteristics. We apply our method to the case of Kenyan smallholder farmers.

0394	Patterns and drivers of tree-cover change in benchmarks of Asia, Africa and Latin America	Sonya Santoso, Valentina Robligio	Indonesia

Characterization and quantification of tropical deforestation (and reforestation) processes have been the object of a major analytical effort over the last three decades. Operational definition of forest, which all results and discussions rely on, has rarely, if ever, been made explicit in the literature. This causes serious issues since "deforestation" rate can widely range with a slight differences in forest definition. In Indonesia case, country wide, deforestation rate can swing between -0.5% to 3% by applying different definition of forest on the same dataset. Rates and patterns of cover changes can easily lead to misinterpretation if not put in a consistent perspective. To address this confusion and misconception this study designs the legend of the land use/cover maps from satellite image interpretation based on tree cover types differentiated by: natural forests (undisturbed and logged-over), planted monoculture forests (fiber and timber), monoculture tree crops (oil palm, rubber, cacao, etc.), agroforest/mixed tree species (jungle rubber, rattan garden, home garden etc). We use the generalization of forest transition theory into tree cover transition theory in eliciting the nature of drivers and consequences from both sides of the curve and bringing the understanding into application domain of improving forest governance. Our study covers two scales. Firstly, for the extent of the entire tropics we add two layers of information, i.e., ecological zones and watershed boundaries, in order to make the theory operational for policy or other interventions in maintaining and enhancing ecosystem services. Ecological zones are used as a proxy to control for the variation in biophysical characteristics that shape natural forests. Watershed is being adopted as the unit of analysis, assuming that processes and impacts are mostly operating and interrelating at this extent. We produced typologies of watersheds with regards to tree cover transition stages. Secondly, we look deeper into the patterns and drivers of tree cover changes at benchmark sites in Asia (Indonesia: Papua, East Kalimantan, Jambi), in Africa (Cameroon: Southern and Eastern provinces) and in Latin America (Peru: region of Ucayali). Patterns and drivers of tree cover changes across the benchmark sites are interpreted and compared by considering their typologies in the tropics. Potential intervention to slow down the downturn of natural forest cover and speed up the recovery of tree cover are discussed. The extrapolation domain of the findings in the benchmark sites is inferred also through the typologies.

0395	The role of the nitrogen cycle in global agricultural systems, today and tomorrow	Stefan Olin, Almut Arneth, David Wårlind, Guy Schurgers, Mats Lindeskog	Sweden

Since the mid 19th century, the accumulated contribution of CO_2 to the atmosphere from land use and land cover changes (LULCC) have been of the same magnitude as those from combustion of fossil fuels. Land use has also affected the nitrogen cycle with the use of nitrogen fixing plants, usage of manure and the use of mineral fertilisers. Agricultural nitrogen use has not only increased the production, but has had a profound impact on the global nitrogen cycle by adding excess reactive nitrogen to the Earth system. This, together with climate change, has changed even remote ecosystems. In addition, emissions of nitrous oxide (N_2O) have also been contributing to global change.

In order to assess the effect global change has on ecosystems and the services we get from them, dynamic global vegetation models (DGVMs) have been employed for the last two decades. Here we present a version of the DGVM LPJ-GUESS that take full account of LULCC as well as the nitrogen cycle. Integrated in the model is management of crop lands and pastures such as fertilization and

irrigation. The global nitrogen and carbon cycle were simulated for the period 1850-2010, showing for natural ecosystems that were nitrogen-limited during the 19th and early 20th century to shift towards larger net primary production due to increased nitrogen deposition and increased temperatures in the future. Different future management strategies for preserving nitrogen within agricultural ecosystems is explored.

0398	Ex-ante assessment of pesticide use reduction strategies in Thai Highland agriculture	Christian Grovermann, Matthias Siebold	Germany

Agricultural commercialization in Asia has led to an increased dependence on synthetic pesticides, especially for high-value fruit and vegetable crops. Related problems for farmers, consumers and the environment require action by policy-makers. The present study uses the multi-agent modelling software MPMAS to *ex-ante* assess the impact of different pesticide use reduction policies. The model is parameterized with farm and plot level data from intensive and diverse production systems in the mountainous north of Thailand, where the adoption of cash crops has been accompanied by very high levels of pesticide use. The objective of this study is to compare different policy interventions in terms of their impact on pesticide use, farm incomes and land use. MPMAS allows exploring the diffusion of policy-driven innovations in the farm population as well as the effect of policy interventions on heterogeneous farm households and the landscape. The adoption of Integrated Pest Management (IPM) for leaf vegetables is assessed in combination with tax instruments and with various incentives, such as bio-pesticide subsidies, area payments and price premiums. Econometrically estimated adoption probabilities are used to assign innovativeness scores to agents and simulate the diffusion of IPM. After five simulation periods, taxes on pesticides ranging from 10% to 70% achieve reductions in pesticide application levels between 2% and 9%, but negatively affect income by 2% to 8%. The introduction of IPM along with taxes allows for higher reductions and abates income losses; however IPM adoption remains below 12% and pesticide use reduction below 20%. A mix of high proportional taxes - permitting to better target toxic pesticides - and incentives for using IPM results in much higher adoption levels, pesticide use reductions and income gains. A subsidy for bio-pesticides of 40% and area payments of €200 per plot (0.16 ha) for three years after IPM adoption can to a great part be financed through tax revenues. Combined with a 10% price premium paid by consumers it is possible to achieve an overall pesticide use reduction of 37%, even 52% for extremely toxic pesticides, with 30% of the agricultural area under IPM. The results show that the challenge of promoting sustainable farming practices and rural livelihoods can be achieved by a policy mix tailored to local conditions. The approach emphasizes the role of knowledge and illustrates how to assess the diffusion, the impact and the accompanying policies of a sustainability innovation. This is essential to inform planning and decision-making.

0399	The GLUES-GDI - a geographical data infrastructure for agri-environmental data	Stephan Mäs, Lars Bernard, Matthias Müller, Christin Henzen	Germany

The role of scientific information infrastructures in contributing to research progress and innovation to address global challenges has been widely recognized and addressed in research and funding initiatives like the European Strategy Forum on Research Infrastructures (ESFRI) and the Cyberinfrastructure Vision of the US National Science Foundation (NSF). Such infrastructures can stimulate the sharing and reuse of scientific data and resources, support the creation of new scientific communities and the interdisciplinary collaboration to solve common scientific issues. They also improve the documentation of research results and therewith they increase sustainability of scientific work.

An example of such an infrastructure for land use and agricultural data is the GLUES Geodata

Infrastructure (GDI). As part of the scientific coordination and synthesis of the "Sustainable Land Management" funding measure of the German Ministry of Education and Research the GLUES project (Global Assessment of Land Use Dynamics, Greenhouse Gas Emissions and Ecosystem Services) implements a scientific GDI [Bernard et al. 2013] in order to facilitate data-intensive interdisciplinary research. Within the funding measure twelve so called regional collaborative projects (RPs) are researching the impacts of climate and socio-economic changes and a corresponding optimization of the use of land and natural resources in different countries and regions. The major aims of GLUES are to support the communication, coordination, facilitation of data exchange and integration of results, by developing a common data platform and consistent scenarios on land use, climate and social-economic change. The GLUES GDI provides the RPs a data pool for common use and a set of consistent global scenarios for the medium and long term projections. Therefore the GDI realizes a network of Web services enabling standardized access to scientific data in combination with visualization and analysis functions. The provided data comprises outputs of modeling systems like MAgPIE of the Potsdam Institute for Climate Impact Research (PIK), DART of the Kiel Earth Institute and CAPRI of the University of Bonn. The presentation will provide a discussion of technical and organizational issues, requirements and solutions from a perspective of scientific data exchange.

| 0400 | The importance of irrigation water reuse for smallholder irrigation security in South-Central Chile | Christian Troost, Thorsten Arnold, Thomas Berger | Germany |

We discuss the role of surplus irrigation water reuse for irrigation water security for small holders in a watershed in South-Central Chile. In the last 20 years, the area has undergone a profound change towards export oriented fruit production. The agricultural sector of the area is characterized by a heterogeneous agricultural sector, where large export-oriented fruit plantations and commercial cereal farms reside side-by-side with smallholder farms. The irrigation system of the area is managed by local water user associations, who distribute water according to formalized rights to river flows. Nevertheless, informal access to water prevails: Though, nominally, water rights allow extraction of a specified, physical flow of water, this flow is not guaranteed and reduced proportionally in the case of water shortage. The only way to guard against water shortage in dry years is to hoard water rights. This behavior leads to considerable amounts of unused water in normal and wet years, which constitute an important source of water for many smallholder farms. In dry years, the supply of surplus water breaks down, making these farmers more vulnerable to water shortage than others. This higher risk also presents an obstacle for the participation of these farmers in fruit production with high upfront investments.

Together with the reuse of irrigation water return flows, surplus water reuse leads to highly interconnected water system, where decisions of irrigators influence the access to water of other irrigators. Modeling the interactions for irrigators' decisions presents a challenge for agricultural economic and hydrological modeling.

Combining information from water user associations, public water authorities and extension services in the area, we construct an integrated multi-agent model, which combines an agricultural economic model of production and irrigation decisions with a hydrological balance model. To deal with model and parameter uncertainty, we use a GLUE-like (Beven & Freer 2001) calibration and validation strategy. With our simulations, we are able to quantify the importance of surplus water reuse for agricultural production in the area and illustrate the vulnerability of small holders to dry years.

| 0401 | Monitoring trends in vegetation greenness over Northeast Brazil from 30-year NDVI3g time series | Stefan Erasmi, Anne Schucknecht, Marx Prestes Barbosa, Reinaldo | Germany |

Antonio Petta, Jörg
Matschullat

The north-eastern part of Brazil is characterized by a semi-arid climate with high interannual variability of rainfall, high evapotranspiration and the occurrence of extensive drought periods. The vegetation in the region is characterized by a xeromorphic formation known as Caatinga. The whole region is highly vulnerable to desertification processes due to land use pressure and climatic conditions and is reported to be one of the desertification hot spots in the semi-arid regions worldwide. However, there is only little evidence on the spatio-temporal dimension of land degradation and desertification in the area.

The analysis of normalized difference vegetation index (NDVI) time series data from global earth observing satellite systems is a well-established method to monitor annual, interannual and long-term variability of vegetation greenness as a key indicator of land degradation. But, the analysis of trends from long time series is always critical since it is very sensitive to the length of the observation period.

In this study, we analyzed a 30-year NDVI time series from AVHRR data (NDVI3g) in order to test the hypothesis that north-east Brazil suffers from land degradation related to droughts and decreasing rainfall. First, we used a trend analysis of the NDVI data to show patterns of greening / browning in the investigation area. In a second step, we used linear modeling to investigate the relations between vegetation and rainfall variability. Rainfall data were taken from the GPCC Full Data Reanalysis (V.6) gridded precipitation data product and the data were validated for north-east Brazil using long time series of rainfall data from stations available in the study area.

First results indicate that wide parts of the region show significant trends of greening for the period 1982 to 2011 which is in contradiction to the main working hypothesis. However, results have to be interpreted carefully since the beginning of the time period covers a major drought in the study area (82/83). The presentation will summarize the findings of our ongoing study. We will critically review our results within the context of global land degradation estimates and compare them to other studies.

0402	Fire observation as an indicator of land cover change in Eastern Africa	Ilaria Palumbo, Jean-Marie Grégoire, Andreas Brink	Italy

Land cover and land cover change are the most evident and detectable indicators of land surface characteristics and the associated human activities and natural resources. Hence, monitoring land cover changes over time provides important information on natural resources, habitat status (ex. landscape fragmentation, carbon storage, ecosystem services..) and the effectiveness of land management plans in controlling threats and pressures on biodiversity.

In many regions worldwide, particularly in Africa, fire is used as a land management tool and has a specific role in shaping and maintaining some ecosystems and natural resources. Fire is also commonly used for the conversion of large areas to pasture or agriculture land and can have an important role in land cover change dynamics.

In this study we analyzed multi-annual satellite-derived data about fire occurrence and land cover to understand if and how fire is associated to natural vegetation dynamics in eastern Africa.

The information on the land cover change was derived from the TREES-3 project developed by the Joint Research Centre (European Commission) in collaboration with the FAO FRA2010 Remote Sensing Survey. The project used high resolution satellite images over the period 1990-2010 to derive the 'loss' or 'gain' of natural vegetation at each half degree of the geographical latitude and longitude rectilinear grid. The samples, 20 km × 20 km in size, were analyzed for three reference years: 1990, 2000 and 2010.

The information on the fire activity was derived from the MODIS active fire product (NASA FIRMS) over the period 2002-2012. From this product we derived the fire occurrence over the 20 km × 20 km

sample boxes used for the land cover change analysis.

Our results we will show the relation between fire occurrence and land cover change in eastern Africa; we will discuss the role of fire as a possible driver of land cover change and also identify those areas which show increasing fire occurrence and can potentially be affected by natural vegetation loss in the future. This study contributes to the conference theme by providing insights on the land cover change drivers in Africa.

0403	Application of risk models to assess farmers' land use decision-making in Mato Grosso, Brazil	Matthias Alexander Siebold, Felipe Greco	Germany

During the last decades, Brazil's agricultural sector has been boosted by a supportive federal industrialization policy, modern, science-based technology and farmers' entrepreneurship (Pereira et al., 2012). Statistical data prove that one of the most dynamic agricultural areas in Brazil is the Center-West region, which contributes 46% to the country's total soybean production, 30% in the case of maize and 60% for cotton, with the largest shares produced by the state of Mato Grosso (MT). According to the 2006 agricultural census, 78% of the agricultural land in MT is cultivated by only 7.8% of the farms, which means that large, highly capital-intensive farm holdings using state-of-the-art technology dominate agricultural production. This production is prone to mainly four risk types: Market/price, production, financial and institutional risks.

The study applies three risk programming techniques (Quadratic Programming, Minimax and target-MOTAD) to typical farm holdings in MT to analyze the impacts of risk on land use and total farm income.

A baseline LP model defined the profit maximizing farm plan as the reference. Results show that, compared to the conventional soy-maize system, greenhouse gas emissions reducing integrated livestock systems (ICL) and specialized cattle systems are economically not competitive. Furthermore, as governmental credit supply is insufficient farmers need to rely on private/informal credit to finance agricultural production.

The results of the three risk models coincide in showing that by sacrificing a relatively small amount of total farm income (compared to the baseline), farmers' exposure to risk can be reduced significantly. This is mainly achieved through diversifying the production pattern and decreasing the share of rented land. From the methodological point of view, the target-MOTAD approach turned out to be the most practical one for the analyzed research questions, as no strong assumptions are required and the data demand is relatively low. Although very powerful and extensively used, the assumptions for quadratic programming (normally distributed returns or quadratic form of farmer's utility function), are not always tenable. As Minimax requires solving one LP for each year, which makes this procedure cumbersome for large datasets and a high number of scenarios.

The present research demonstrates the appropriateness of risk models for land use change analysis and assessment. It provides a theoretical framework to increase the synergies between agronomy, ecology and economics within the farming systems analysis approach.

0404	Closing the yield gap: the interaction of biophysical and economic factors	Florian Zabel, Wolfram Mauser, Birgitta Putzenlechner, Ruth Delzeit, Gernot Klepper	Germany

The growing world population from currently about 6.9 billion to 9.2 billion by 2050 with rising incomes is going along with an increasing demand for biomass, composed of four different uses: food, feed, fuels and fiber. The Food and Agricultural Organization (FAO) estimates that meeting the world's

food demand requires a 70% increase in total agricultural production. Land productivity considerably increased over the last 6 decades, since in this period the food production was doubled while agricultural land only increased by 10%. However, agricultural yields as well as production stability is threatened by a changing climate. At the same time, socio-economic changes, such as increasing incomes and changes in consumption patterns already lead to increases e.g. in demand for animal feed that outgrows food demand for direct consumption. The answers to whether these new demands will lead to scarcity of food, biomass or fertile land and the conclusions drawn vary widely across different studies. These variations can be attributed to different conceptual approaches, modeling strategies, and normative assumptions. In principle, land can be challenged by three functions: urbanization and related sealing (which can largely be ignored on a global scale), biomass for human use, and ecosystems services. While biomass competes with these functions, biomass production for food is also in competition with biomass production for feed, fuel or fiber on the limited resource of suitable land for agricultural use. At the same time, food security depends not only on the ability to produce a sufficient quantity and quality of food, but also on the food price level. Thus, projections of future food supply and prices need to consider various biophysical parameters, but also global and local socio-economic aspects. We present a new approach to estimate global land use and biomass production potentials, by combining high spatial resolution bio-physical plant growth characteristics with region specific economic and technological indicators. Our approach therefore recognizes the importance of economic factors on land use potentials. It offers the potential to simulate the reaction of actors in the agricultural sector to changing conditions, be it natural such as climate change or economic such as the support of bioenergy products or changing demands as a result of changing life styles.

| 0406 | The study on land use conversions over Northeast China during the past 300 years | Beibei Li, Yu Ye | China |

The precise evaluation of carbon sink changes of terrestrial ecosystem are under the influence of the accuracy of land use data, which is of important on the researches of land and atmosphere energy exchange and global carbon cycle. The Northeast China experienced dramatic land use changes during the past 300 years. Through assessing the data accuracy of land use data form various-sources over Northeast China, it is found that the representative global land use datasets, RF and HYDE, have significant errors on historical cropland reconstruction in this study region. Social factors, especially agriculture policy, economic and political environment co-impacted land use and land cover change. The historical curve of cropland change is hard to estimate through linear-backwards modeling, while the empirical study based on historical documents contributes to improve the accuracy of historical land use data on regional level. Thus, the land use conversions over Northeast China are established using the regional empirical materials on land cover and the drivers of historical land use change. The land use conversion types include forest reclamation, grassland reclamation, shrubland reclamation, wetland reclamation and deforestation. The land use conversion database will improve the understanding of the dynamics of land use change process and their impacts on the biogeochemical cycle.

| 0408 | Bridging knowledge and communication gaps through participatory land-use simulations: insights from Reunion Island | Guillaume Lestrelin, Xavier Augusseau, Daniel David, Pascal Degenne, Danny Lo Seen, Agnès Bégué, Jeremy Bourgoin, Erwann Lagabrielle, Jean-Baptiste Laurent, | France |

		Pierre Todoroff, François Vitry, Jean-Philippe Tonneau

This presentation examines linkages between land-use modelling, scenario planning and social learning. Reflecting on collaborative landscape research conducted in France's Reunion Island, it describes an approach to land-use simulation aimed at both exploring future land-use dynamics and facilitating dialogue across institutions. On this 2,500km² tropical island of the Indian Ocean, policymakers and planners must compose with important tensions over land and natural resources. Limitations inherent to insular environments are exacerbated by high population densities (328/km² in average), rapid demographic growth, partly uncontrolled urbanisation, and the inscription of 40% of the territory as UNESCO's World Heritage. Conflicting views and poor coordination between the agricultural, environmental and urban sectors add further challenges to the practice of land-use planning. For instance, agricultural land conversion and uncontrolled urban sprawl can be conceived, depending on actors, as the consequences of urban planners' lack of interest for agriculture and its functions or the reluctance of the agricultural sector to reconsider current land-use policies and models. Within the framework of the Descartes research project, series of contrasted 10-year exploratory scenarios of urbanisation and agricultural change were co-constructed with representatives of a wide range of organisations in order to mediate and advance the debate. Modelling workshops were also organised with selected experts that focused on urban and agricultural dynamics – both planned and uncontrolled – and their role in regulating water quality, runoff and landscape services. More than the design of highly accurate predictive models, emphasis was put on the heuristic and catalytic values of land-use simulations: triggering information exchange, structuring debates, questioning and integrating knowledge on land-use change and interactions. Based on the above scenario planning and modelling activities, land-use simulations were implemented using Ocelet, an open source language dedicated to the modelling of spatial dynamics and the interfacing with GIS data and software. We present here some key research results regarding coupled urban-agricultural simulations. In particular, we discuss how coupled simulations can help exploring land-use interactions and unravelling future conflicts and impacts associated with different land-use scenarios, some of which actually reflect current policies and plans. Building on notions of actor-network and boundary objects, we analyse also how land-use simulations, designed collaboratively and disseminated as dynamic spatial data, can contribute to reshape individual perspectives and actors' interactions. Finally, it is expected that the overall approach and experience will contribute to advance social learning and assist decision-makers and planners towards more sustainable land governance and land-use arrangements.

0412	Geotechnologies for the characterization of coffee agro-environments and their relation to coffee quality in space and time	Helena Maria Ramos Alves, Tatiana Grossi Chquiloff Vieira, Margarete Marin Lordelo Volpato, Marilusa Pinto Coelho Lacerda, Flavio Meira Borem	Brazil

The paper presents the results of a research project that relates the quality of coffee beverage to the environment in a major coffee producing region of Brazil, providing the scientific basis required for obtaining a Protected Designation of Origin for the specialty coffees produced in this region. Coffee has

been historically strategic for Brazilian exports. With an annual production of around 48 million bags and cultivated area estimated at 2 million hectares, the product has ensured the country's first position as a producer and exporter and second position as a consumer in the international market. However, throughout its history, Brazilian coffee has undergone cycles of rise and fall and currently faces a moment of crisis, with low prices that impact primarily the family farms in mountain regions of Minas Gerais, the country's main producing state. In this mountainous landscape, the region of "Serra da Mantiqueira", considered one of the most important regions of specialty coffees in Brazil, which have been achieving growing recognition in the international market, stands out for the high sensory quality of its coffee. This reflects the growing demand for gourmet coffees whose characteristics are related to their geographic origin. In this scenario, in which the productive sector and the market establish a transparent business relationship based on consumer preference and added value depending on the quality of the product, Protected Geographical Indications represent a new production philosophy which is now beginning to be explored in the country. In order for the Serra da Mantiqueira region to benefit from this new perspective of adding value, making its coffee more competitive and sustainable, new technical and scientific information that establish the relationships between the factors that determine coffee quality is required. Geotechnology can have a significant contribution in filling this gap. Coffee is a beverage potentially influenced by its planting site. Environment, genotype and agricultural management create the identity of the drink. Mapping the quality of coffee produced in the region, with the delimitation of homogeneous environments, the *terroirs* with the potential to produce gourmet coffees, to direct agricultural activities and the preservation of natural resources, provides the necessary inputs for the formulation of public policies aimed at stimulating competitiveness and sustainability for the coffee farmers in the 25 municipalities that make up the region.

0414	Land abandonment, urban sprawl and renewable energy as drivres of land-use change in Switzerland: five scenarios for the future	Bronwyn Price, Felix Kienast, Irmi Seidl, Peter Verburg, Christian Ginzler, Janine Bolliger	Switzerland

Socio-economic processes are strong drivers of land-use change across European landscapes. Land abandonment, relating to a decline of agricultural significance, has been a dominant process affecting European landscapes, and in particular mountainous regions such as in Switzerland since the mid 20th century. Urbanisation in Switzerland is increasing at a rapid rate as population increases and, in particular, with increasing demand in living-space per capita. Decrease in public support for nuclear power stations is driving a push towards increased production of renewable energy within Switzerland. These inter-related and sometimes competing processes have significant implications for land-use and patterns of land-use change within Switzerland, yet the extent and location of anticipated land-use changes remain unknown, as does the impact on landscape services. This project defines 5 scenarios of future land-use demands for Switzerland under different projections for urban-sprawl, land abandonment and land use for renewable energy production. Using three time steps of the Swiss Land-Use/Land-Cover Statistics (1985, 1997 and 2009) we mapped and measure past land-use and land-use type transitions. We then modelled the probability of land-use transitions for the whole of Switzerland with respect to a suite of biophysical explanatory variables. Using the Dyna-CLUE land-use change modelling framework (Verburg and Overmars, 2009) we applied the 5 future scenarios to determine and visualize (map) future land-use patterns in a spatially explicit manner. The resulting spatially explicit land-use scenarios will be freely available for download by researchers and policy makers. These scenarios will provide key base information for future work including assessing conflicts and synergies in land-use planning or assessing impacts of land-use change on landscape services. This presentation

offers a contribution to the research presentation session 0128 'VOLANTE visions of land use transitions' in the theme area 'Rethinking land change transitions'. Our work combines in-depth analysis of past land-use changes with scenario-based analysis of future land-use change with particular attention to socio-economic drivers of land-use change processes. The spatially-explicit scenarios resulting from our project will provide the basis for assessment of implications of land-use change on ecosystem service provision at the Swiss-wide scale. These have been specified as key areas of interest for the session.

0416	Grazing and ecohydrological interactions in African Savannas: a Sahelian case study	Niall Hanan	USA

Water-limited savannas of Africa, and elsewhere, function as strongly coupled social-ecohydrological systems. Rainfall and soil moisture availability exert bottom-up controls on vegetation structure and composition, but vegetation also strongly influences the redistribution and infiltration of rainfall. The presence and duration of surface waters in the landscape, however, determine livestock and large herbivore access to and consumption of pasture resources, with potentially amplifying top-down controls on vegetation structure and hydrology.

We will discuss evidence for transformation of coupled social-ecological systems in arid and semi-arid grazing lands. Field and remote sensing data, and model analyses, will be used to explore ecohydrological interactions across a range of bioclimatic, edaphic and land use conditions in West Africa. Watershed-scale vegetation density, geomorphology and rainfall control surface water dynamics, as predicted by theory. Watershed-scale responses to livestock and cropping intensity also emerge but can be difficult to discern using available data at regional scales. While in general the vegetation of the Sahel recovered with increasing rainfall following the Sahelian droughts of the 1970s and 1980s, in some watersheds drought-mediated vegetation mortality may have been severe enough to trigger profound ecohydrological and socioeconomic reorganization.

This paper is closely related to the "State of Tropical Savannas' session and the functioning of tree-grass systems in response to varying climate and human land-use, with particular emphasis on ecohydrological interactions, provision of ecosystem services, non-linearities and state-changes.

0417	Combining crowdsourced mapping of African croplands with pattern recognition to improve agricultural landcover maps	Lyndon Estes, Stephanie Debats, Kelly Caylor, Dennis McRitchie, Thomas Fuchs	USA

In order to anticipate land use changes it is necessary to understand the distribution and extent of existing land uses. Current landcover maps for Africa have numerous inaccuracies[1] that are likely to bias agricultural area estimates in much of Africa. To address this shortcoming, we have developed a method that combines human image interpretation capabilities, pattern recognition (PR) algorithms, and high-resolution satellite imagery to assess the degree of bias in existing landcover maps, and to create a new generation of improved maps. The human component of this project is a crowdsourced mapping system (which complements the geowiki.org project) that pairs Google's high-resolution satellite imagery with Amazon.com's Mechanical Turk platform, an online service that provides a large, global pool of workers ("Turkers") who perform "Human Intelligence Tasks" (HITs). Using open-source R and python software, we select a random sample of 1 km^2 grid cells placed over satellite imagery of our study area (currently South Africa and Zambia), stratified by probability of field occurrence (derived using logistic regression), and send these in batches (via an OpenLayers Interface) to Mechanical Turk for mapping. Our procedure includes an initial qualification test and quality control measures, which allow us to quantify overall mapping accuracy, and to pay Turkers accuracy-based bonuses. The PR component uses a statistical machine learning technique (random forests) to classify image pixels into cropland and

cropland categories, which are then grouped into coherent regions using graph cuts, a computer vision technique. This technique improves the ability to distinguish field boundaries. For this approach, we combine the high spatial resolution images with the spectral depth of the Landsat archive, which offers the ability to map both current and historical cropland distributions. We are integrating the crowdsourcing and pattern recognition elements into a system that continually updates and improves crop field maps. The resulting data have several uses. The spatially extensive PR maps provide improved crop cover estimates, while the human-generated maps provide a high quality, representative sample of crop field extent and size-class distributions, which may be used in conjunction with environmental and socioeconomic data to provide novel insight into agricultural systems, food security, and other land use-related questions. We present initial results that demonstrate the applications and insights provided by these data.

| 0418 | Forest degradation monitoring over the Congo Basin | Baudouin Desclee, Frederic Achard, Philippe Mayaux | Italy |

Operational methods are needed to monitor forest degradation in tropical countries as one main component of future REDD+ MRV systems. Such systems require efficient tools for providing accurate and updated information on small forest cover changes. Whereas existing operational forest cover monitoring tools focus mainly on the assessment of deforestation, advanced tools are required for detecting and measuring forest degradation, namely assessing areas within forest land where forest carbon stocks have decreased during a short time period (yearly to 5 years).

Pan-tropical quantitative measurements of changes in forest cover have been provided through the GLOBE-TREES project of the European Commission's (EC) Joint Research Center since 1993 in connection with environmental issues and global forest. Our main role in the EC is to support such policies by developing tools for the monitoring of forest ecosystems and providing up-to-date information on the status of tropical forest resources at regional to pan-tropical scales that rely mainly on data from Earth Observing satellites. In this framework, the GLOBE-TREES project generates forest maps, identifies areas of sudden forest change and provides global estimates of forest cover change, for the current and previous decades (from 1990 to 2010). Such maps were produced essentially using medium resolution satellite images (Landsat and DMC).

Recently, a large dataset of SPOT images (about 820 images) acquired between 2008 and 2012 has been made available over the Congo Basin for REDD initiatives. This new dataset gives us the opportunity to implement change detection approach targeted at finer scale forest cover change processes thanks to large high resolution (from 10 to 20 m) image coverage. A degradation monitoring system has been designed for analysing multi-date SPOT images. Based on a combination of segmentation and change detection, this processing chain allows detecting small forest cover changes from image pairs. This research aims at assessing forest cover degradation over the Congo Basin exploiting this SPOT dataset for providing regional and consistent figures. The monitoring system has been implemented for detecting degradation based on the available multi-date SPOT images. Resulting maps provide figures of areas where forest cover changes have occurred. This study provides the base for a first regional estimate of forest degradation. The most considered degradation processes include (1) selective logging and (2) shifting cultivation. Analyses over some case studies also provide understanding of forest cover change processes to better differentiate degradation from deforestation processes and validation of the detected changed areas.

| 0419 | Evaluating agriculture and land use decisions in an integrated assessment model: Hindcast experiments using the GCAM Model | Marshall Wise, Kate Calvin, Page Kyle | USA |

The Global Change Assessment Model (GCAM) is an integrated assessment model linking global

energy, agriculture, land use, emissions, and climate systems. GCAM currently divides the world into 151 land subregions determined by geopolitical boundaries and agro-ecological zones within those boundaries. Within each of the land subregions, GCAM allocates land among crop production, forests, pasture, and several non-commercial land cover categories. Land use allocations are based on the relative profit rates, both market-based and implied, with a market equilibrium approach using a set of non-linear functions to model profit rates and choices. Model parameters are calibrated to reproduce a historical base period. Future model period behavior is not constrained but instead evolves from history when changes in key economic drivers such as technologies, policies, climate, and other conditions change the relative profits of alternative land uses. Although GCAM is designed to function as a long-term model, typically operating in 5-year time steps over a century scale, we have found it to be informative to operate it on an annual scale for the purposes of providing insights for validation and evaluation with respect to recent history. Here, we will construct scenarios to validate and evaluate GCAM modeling of global and regional economic land use decisions and agricultural production against the last two decades of historical data. Specifically, we will perform our standard calibration process with historical data for the year 1990, and then run GCAM forward annually through the year 2010 without updating the calibration for more recent data. We will compare the time trajectory of modeled global and select regional results for land use and crop production to historical data. We will identify reasons for any major differences from history and explore what differences are due to short-term effects and what may be more relevant for long-term integrated assessment modeling. We will finish with a discussion of what we have learned in terms of constructing a useful evaluation and what insight we have gained on possible improvements to GCAM long-term land use modeling structure or parameters. This talk will contribute to the conference theme of validating land use in integrated assessment modeling.

0421	Effects of urbanization on patterns of land surface phenology across the U.S. Great Plains	Jessica J. Walker, Kirsten M. de Beurs, Geoffrey M. Henebry	USA

Urban areas are expanding across the Earth's terrestrial surface at an accelerated rate. The replacement of vegetated or associated permeable land cover with high fractions of impervious surface area drives the urban heat island (UHI) phenomenon, which results from different rates of atmospheric and surficial energy exchange in urban and nearby rural areas. The UHI can influence the timing of vegetation growth and development within and around cities. We examined patterns of land surface phenology (LSP) across the U.S. Great Plains region, which includes diverse metropolitan areas embedded in a matrix of predominantly herbaceous vegetation. To provide a synoptic and temporally-rich view of the landscape, we assembled a time series (2002-2012) of MODIS surface reflectance data (MCD43A4) and land surface temperature data (MOD11A2) at 500m and 1000m spatial resolution, respectively. We derived measures of the vegetated land surface and the thermal regime of the growing season at 8-day intervals using the Normalized Difference Vegetation Index (NDVI) and Accumulated Growing Degree-Days (AGDD). A convex quadratic LSP model of NDVI as a function of AGDD yielded several model parameters and phenometrics for each growing season: start, end, and length of growing season; thermal time at start of season; thermal time to peak NDVI; peak NDVI; and coefficients of determination for the LSP model. We linked the phenometrics with urban composition and configuration to (1) determine the UHI impacts across the Great Plains, and (2) explore scaling relationships between the phenometrics and the extent of each urbanized area. In addition, we investigated the rate of greening and the length of the growing season in urban versus nearby rural areas under a variety of climatic conditions. This presentation contributes to **Conference Theme No. 3: Impacts and Responses** through its examination of the impact of land cover change on seasonal patterns of vegetation growth and development. The

long-term and widespread alteration of such patterns may affect the provisioning of ecosystem services such as carbon sequestration, pollination, and local climate modification. As such, this presentation would be most relevant within session 0009, "Land use change and ecosystem services in peri-urban areas".

0422	Sustainable intensification: in the context of the land sharing versus land sparing debate	Thomas Rudel	USA

Clearly, sustainable intensification is now something of a buzz word in the development community. The one gut sense that seems widely shared is that the Jevons pattern (possibly consistent with Land Sparing) characterizes the developing world where yield gaps (differences between actual and potential yields in a place) are large and the desires for scaling up production and consumption are so pervasive. The other pervasive gut sense is that ecological modernization (possibly consistent with land sharing), with its 'full belly' connotations, characterizes already intensified production in the developed world. This characterization seems too acontextual to me. The rapid spread of conservation agricultural practices (no-till etc.) suggests to me that the adoption of these new technologies is done more to maintain already high levels of production (e.g. a defensive action), so the adoption of new technologies does not prompt an expansion of already large enterprises (a la Jevons), but it is done as a way of maintaining high profit rates in the face of disturbances in climate and the economy. In this latter circumstance innovations (e.g. ecological modernization) would not increase levels of consumption, but they would not be as a result of a full belly dynamic, rather they would emerge out of a struggle to maintain already high levels of production and consumption in an increasingly uncertain environment. You get more land sharing, but without ecologically benign overtones. In sum we might get at a global scale something like sustainable intensification, but most of the intensification would occur in the developing world and the most of the sustainable initiatives would occur in the wealthy nations. All of this assumes, of course, fairly inert states.

0423	Availability, constraints and trade-offs to re-use potentially available cropland in the Former Soviet Union	Patrick Meyfroidt, Tobias Kuemmerle, Daniel Müller, Alexander V. Prishchepov, Florian Schierhorn, Eric F. Lambin	Belgium

Land is becoming a scarce resource globally, subject to competing demands for food, biofuels, carbon sequestration and provision of other ecosystem services, and other pressures. Under most scenarios, additional conversion to croplands will be a necessity.

Potentially available cropland (PAC) is defined as "the moderately to highly productive land that could be used in the coming years for rainfed farming, with low to moderate capital investments, and that is not under intact mature forests, legally protected, or already intensively managed" (Lambin et al. 2013, Global Environmental Change). Previous estimates of PAC relied on global-scale climate, soil and terrain data, largely ignoring local ecological and socio-economic realities.

With the collapse of the Soviet Union in 1991, large-scale land abandonment occurred because of the removal of state subsidies for agriculture, inefficient production systems, and increased competition with other regions or countries. As a result, the Former Soviet Union (FSU) is often thought to hold a large fraction of the global PAC.

This study is based on a recent assessment of the area and geographic distribution of abandoned land that constitute potentially available cropland in FSU (Schierhorn et al. Global Biogeochemical Cycles, in review). The objectives are to characterize spatially, in Russia, Ukraine, Kazakhstan and Belarus: (i) the socio-economic, political and biophysical constraints on putting these lands under agricultural use,

including infrastructure, labour force, markets access, land tenure, local biophysical constraints, and (ii) the trade-offs associated with recultivation in terms of carbon stocks or sinks and biodiversity value, and possible effects on livelihoods.

We show that beyond accessibility and biophysical aspects, socio-economic factors constrain the recultivation of these abandoned lands: over 2006-2009, more recultivation occurred in areas with higher human fertility and rural population density, and in provinces whose neighbors also had higher recultivation. By contrast, there was less recultivation in areas with a higher share of ethnic minority population, consistent with the idea of marginalization of ethnic population. Foreign investments in grain production had a positive effect on recultivation in Southern European Russia and in the Volga region.

The amount of PAC which is at least moderately suitable for agriculture, and is not associated with major socio-economic constraints or tradeoffs in terms of carbon or biodiversity is lower than the figures often reported. But FSU remains a significant source of PAC. Whether it is reclaimed through large agro-holdings or small-scale farming would have very different socio-economic implications.

| 0424 | Multiple pathways of expansion of commodity crops in tropical forest landscapes | Patrick Meyfroidt, Kim Carlson, Matt Fagan, Victor Gutiérrez-Vélez, Marcia Macedo, Lisa Curran, Ruth DeFries, George Dyer, Holly Gibbs, Eric Lambin, Douglas C. Morton, Valentina Robiglio | Belgium |

Increase in agricultural production comes from higher yields but also from cropland expansion, mainly into tropical forested lands. This deforestation dynamic can be particularly linked to the production of commodity crops destined for exports through global markets as well as domestic urban markets. Expansion of these commodity crops may occur through conversion of diverse lands, including forests, existing agricultural lands, and a range of other lands including abandoned lands, fallows, low-intensity grazing lands, and so-called "marginal" lands. These various pathways of land change bear distinctive environmental and social impacts.

This study examines the factors influencing the pathways of expansion of tropical commodity crops. Specifically, we ask whether expansion occurs by conversion of forest or existing agricultural lands. For the latter case, we examine whether conversion of former land use may lead to land use change elsewhere, i.e. displacement or indirect land use change.

We use a comparative analysis of published case studies of tropical commodity crop expansion: (i) soybean in Mato Grosso state in the Brazilian Amazon; (ii) oil palm in Pucallpa and Aguaytia in the Ucayali department in the Peruvian Amazon; (iii) pineapple and banana in the Sarapiqui-San Carlos region in northeastern Costa Rica; (iv) coffee in Dak Lak and Dak Nong provinces in the Central Highlands of Vietnam; (v) rubber in Dak Nong province in Vietnam; and (vi) oil palm in Ketapang district in West Kalimantan, Indonesia.

We compiled land use/cover change variables including gross deforestation, post-clearing land uses, and sources of new commodity cropland, as well as associated factors comprising pools of land available for commodity crop expansion; population variables; land use zoning schemes restricting agricultural expansion; clarity and security of tenure rights, agents of land use; agricultural intensification; and constraints in terms of biophysical quality of the land and accessibility and infrastructures.

Based on this analysis, we propose hypotheses, including that (i) land use policies can effectively direct expansion over already cleared lands or forests; (ii) capital-intensive infrastructures requirements can promote expansion of large-scale production over existing agricultural lands and displacement of smallholder land uses; (iii) by contrast, large-scale actors may prefer to expand over forests to minimize transaction costs and social conflicts when consolidating smallholders lands. Firmly establishing displacement requires empirical evidence of causal links between conversion in one place and expansion in another place. Understanding pathways of commodity crop expansion is crucial for developing effective strategies for land sparing, bioenergy crops and REDD+.

0430	Integrating population distribution projections in a fine spatial resolution land-use model to assess European policy impacts on urban densities and urban expansion	Chris Jacobs-Crisioni, Filipe Batista e Silva, Sarah Mubareka, Carlo Lavalle	Italy

Expanding urban areas have a major impact on land resources in Europe and are a cause for sustainability-related concerns. The degree of urban expansion is largely influenced by the level of population density that can be achieved within existing urban areas, and whether urban densities can be maintained or increased is therefore a key concern of policymakers. Policymakers for the European Commission are no exception, and recent ex-ante evaluations of European funding policies have brought forth the need to assess the impact of those policies on the future development of urban densities. To assess the impact of various spatially relevant European policies on land use we have used a land-use model that allocates a range of land-use classes to 100x100 meter pixels, taking into account the projected regional demand and the empirically derived suitability of pixels for a given land-use. To better model the reciprocities between regional population change, urban densities and urban expansion, we have integrated a population allocation mechanism in this land-use model. This approach explicitly models regional population projections, housing supply and housing preferences. It derives empirically from a fine resolution map of population in Europe in 2006, and from the estimated effects of driving forces and neighbourhood dependencies on population distribution. Its chief result is a map of expected number of people per hectare in Europe. Those population numbers subsequently affect the allocation results of the land-use model by imposing that areal units where population counts exceed specific thresholds will become urban or abandoned urban land use. To our best knowledge this approach is a novel way to integrate urban densities within a class-based land-use model. It provides new, much needed information to European policy makers. In our presentation we will outline the applied population allocation mechanism, concentrating on the assumptions and the empirical results that underpin the model. Subsequently, the match between the capabilities of the developed model and the wishes of the involved policy makers will be discussed. We conclude with results of this model extension by showing the modelled impacts of regional European investments on population distribution and on urban development, under different hypothetical national planning regimes.

0431	Landsat 8, a year in orbit: performance and operations	James Irons	USA

February 11, 2014 marked the first anniversary of the Landsat 8 satellite launch. A 100-day in-orbit commissioning period followed launch during which each satellite subsystem, instrument, and operating mode were tested, the satellite was boosted to it's nominal operating orbit, and the performance of the two-sensor payload was assessed. Analyses of data from the two sensors, the Operational Land Imager (OLI) and the Thermal Infrared Sensor (TIRS), demonstrate that each sensor is meeting or exceeding performance specifications in most respects. At typical levels of radiance, for example, the signal-to-noise performance of the OLI ranges from over 140:1 to over 350:1 depending on the spectral band and these ratios exceed requirements by at least a factor of two for all bands. Similarly, the noise-

equivalent-change-in-temperature is less than 0.1K for both TIRS bands compared to the less-than-0.4K requirement. Further, satellite stability, accurate satellite-to-sensor alignment, and geometric calibration have resulted in Level 1 data products with less than one-tenth-pixel uncertainty for band-to-band registration and less than 5 m uncertainty in the geographic registration of the OLI 30 m pixels and less than 35 m uncertainty in the geographic registration of TIR 100 m pixels.. The only exception to full specification compliance lies with the TIRS radiometric calibration. Uncertainty in calibrated at-sensor radiance is less than 5% for the two TIRS thermal bands while specifications require an uncertainty of less than 2%. Some of this uncertainty results from non-uniformity in calibrated response across the TIRS focal plane. Calibration efforts are underway to resolve the non-uniformity and bring the results within specification. Following commissioning, the satellite began nominal operations on May 30, 2013 at which time the lead for operations transitioned from the National Aeronautics and Space Administration (NASA) to the United States Geological Survey (USGS). The USGS immediately opened their Landsat data archive for the distribution of over 22,000 Landsat 8 Level 1 data products with data going back to the satellite's first day at its operational orbit, April 12, 2013. The satellite has been adding over 400 Landsat scenes per day to the USGS archive every day since nominal operations began and the USGS distributes data products for free upon request. Overall, the performance of the Landsat 8 satellite and its two-sensor payload has been excellent since its first day in orbit. This presentation will address the current state of the Landsat program and its critical role in understanding global land transformation.

0432	Response of maize cropping system to climate warming in Northeast China in the past 30 years	Zhengguo Li, He Yin, Peng Yang, Huajun Tang, Wenbin Wu, Zhongxin Chen, Zhenhuan Liu, Jieyang Tan, Zhang Li	China

Understanding the historical trajectory and response of agro-ecosystems to climate warming is essential. Using climatic data, maize phonological observations, and maize statistical data in the last 30 years, we investigated the response and adaptation of maize cropping system to the changing climate in the major maize-growing areas (latitudes 39–48°N) in Northeast China (NEC). A zoning scheme was formulated to classify the zones with relative stable or dynamic temperature conditions for different maize maturity types. We integrated arable land distribution, crop statistics, agricultural irrigation, and crop suitability information in Spatial Production Allocation Model (SPAM) to derive spatial distribution of maize planting area and production since early 1980s. The results showed that the maize cropping systems of NEC might have successfully adapted to warming over recent decades. However, actual area expansion and yield improvement did not always occur as expected in the areas with transitional maturity types. The expansion in the areas with stable types became more important with a contribution of > 65% after 2000, and no significant difference in unit yield was found between the zones with transitional types or with stable ones. Our results demonstrated that the responses of maize cropping systems are consistent with the previous theoretical climatic estimation, while each maturity type shows different response process to the historical warming trends. It can be inferred that differentiated adaptive action can be adopted by adjusting the early/middle maturing to middle/late types to fully utilize the prolonged growth period under climate warming.This work tries to understand how agro-ecosystem was modified in the past decades and how the climatic factors drove the modifications in a regional context. This work fits the session "Trajectories of change in agro-ecosystems" well and gives perspectives to understand the regional agro-ecosystem response to global environmental changes.

0435	Urban densification and green infrastructure trade-offs for urban cooling in Sydney, Australia	Brenda Lin, Jacqui Meyers, Guy Barnett	Australia

In many parts of the world, climate change is likely to result in increasing summer temperatures and more frequent and severe heat wave events. In urban areas, this impact will be further exacerbated by the Urban Heat Island (UHI) effect, presenting challenges for thermal comfort with potentially large human health impacts. Green infrastructure is widely touted as a solution to the urban heat problem because of the climate regulation services conferred by vegetation through evapotranspiration processes and the provision of shade and shelter. However, private and public green infrastructure cooling will benefit different segments of the population and provide different outcomes. In this case, where should future green infrastructure investments be focused? In this study, we investigate the spatial distribution of green infrastructure within Sydney, Australia to identify the role of private versus public green infrastructure in conferring cooling benefits. Tree cover that shades residential homes will provide private cooling and energy-reduction benefits to households, while tree cover in public areas, such as streets and parks, will provide cooling benefits to a wider community with several ecosystem service based health benefits (e.g. increased exercise potential, air filtration, noise reduction). As Australia's biggest and most populous city, Sydney is at significant risk from heat-related health impacts. However, increased urban development and densification is leading to greater dwelling density with subsequent reductions in private green space access. This indicates that future housing will have reduced land for green infrastructure cooling, and cities will be more dependent on public spaces to provide green infrastructure for cooling benefits. Using a variety of remote sensing and spatial urban environmental datasets, we evaluate the effect of green infrastructure on cooling benefits and examine the socio-economic aspects of private and public green space access in order to understand patterns of distribution of green infrastructure ecosystem services. This presentation will contribute to the conference theme by presenting the impact of heat events on cities and the ability of urban green infrastructure to mitigate these impacts. This presentation will further contribute to the session by presenting a specific landscape change (urban densification and loss of private green space) and the trade-offs of private versus public green infrastructure cooling potential. We believe the results will be essential for future landscape planning of green infrastructure in cities in order to protect communities from the detrimental effects of heat waves.

0440	Land use dynamics, irrigation availability, yield gap and food security: an econometric analysis in South India	Balasubramanian R	India

Food security in South India is of paramount importance as major Indian rice production environments are located in South India. However, recent land use changes such as increase in fallow lands, and diversion of fertile agricultural lands for non-agricultural purposes together with stagnation in yield levels are threatening food production and food security. The area under water-intensive crops such as coconut, sugarcane and banana is increasing steeply causing severe water and land constraint for cultivation of food crops. This in turn poses serious threats to sustainable use of groundwater and food security. The issue of groundwater use in the context of stagnating and uncertain supply of surface water resources, and its consequences for agricultural land use, productivity enhancement are critical. Therefore, there is a dynamic interrelationship between land use, water use, crop yields and food production, and hence optimal use of land and water resources assumes greater significance in the context of food security. This paper presents the results of panel data econometric analysis for 11 districts over a period of 50 years in the south Indian state of Tamil Nadu which quantified the impact of land use changes and yield trends on food production. A two-stage modeling approach was implemented to estimate the effect of demographic, irrigation and climate variables on land use in the first stage, and

its consequent impact on food production in the second stage. Fixed effects panel data model and panel corrected standard errors approach were used. Incorporating various drivers of land use changes such as demographic shifts, irrigation availability, industrialization and urbanization, and climatic variables, this paper finds that irrigation availability, increasing demand for non-agricultural lands, and stagnation in yield levels contribute for food (in-) security. Irrigation availability is in turn affected by climatic factors such as rainfall and temperature. Hence, this paper argues for a broad set of policies encompassing water harvesting and water conservation in agriculture, yield-enhancing technologies including new crop varieties, new farming practices viz., precision farming, and land conservation and preservation policies to ensure food security in future. As there is unfettered diversion of fertile lands for non-agricultural purposes, it is necessary to put in place an effective land governance and land zoning system.

0448	Adapting to extreme climate events? – the case of agriculture and floods	Robert Finger, Johannes Sauer	The Netherlands

We present a conceptual and empirical framework to analyze farmers' responses to extreme climate events. We show that experiencing a flood event increases farmers' subjective risk perceptions and thus triggers the use of risk reducing strategies. The presented analysis extends earlier research by investigating measures taken at the whole farm level including on- and off-farm decisions as well as their interactions. Our empirical analysis focusses on the case of floods in UK agriculture and makes use of farm-level panel data for the period 1990-2011. Dynamic panel models are estimated following an Arellano and Bover/Blundell and Bond GMM system approach, for off-farm income, the diversity of on-farm portfolios (e.g. accounting for land use) and the use of chemicals. In these models, the effect of floods as well as interactions between farm characteristics and risk reducing strategies are estimated, by controlling for other biophysical and economic conditions. We find that both on- and off-farm risk management strategies are followed by farmers in response to flood occurrences. These strategies are, however, not independent from each other. Higher off-farm employment is found to be associated with less diverse, i.e. more risky, on-farm portfolios. Along these lines, off-farm employment also implies lower levels of chemical use which may be also caused by smaller on-farm labor availability. Our results imply that the assessment of flood impacts on farms should also consider changes in off-farm income sources because it seems to be likely that farms re-allocate their resource use after experiencing a flood. Furthermore, our analysis reveals more general implications for adaptation behavior. Increasing risks and the more frequent occurrence of extreme climate events may not necessarily lead to more diverse production systems (e.g. characterized by a more diverse land use). In contrast, if farmers can allocate more resources off the farm, adaptation behavior may even results in less diverse production systems. Thus, expectations that climate change, by increasing production risks for the farmer, may shift farmers towards more ecological valuable may be misleading.

With respect to the session 'Climate hazards and adaptive land use management', our contribution underlines that adaptation responses with respect to land use decisions are not always clearly directed. The conceptual and econometrical framework explaining this behavior allow taking an alternative perspective on adaptation decisions.

0450	Hydro-meteorological risk and socio-economic development: future land cover scenarios of an alpine valley	Žiga Malek, Dagmar Schröter, Thomas Glade, Luc Boerboom	Austria

European mountain areas have been experiencing significant socio-economic transformation with a vital decrease in population and agricultural activities, and improved accessibility and development of recreational areas. This presents a major break to long-term landscape evolution and has important consequences on the provision of important ecosystem services, providing valuable resources in these areas and making them safe and habitable. One of the areas experiencing particularly intense socio-

economic changes in the last, and most likely also in the coming decades is the Mountain community of Gemona, Canal del Ferro and Val Canale in the Eastern Italian Alps. Owing to its border position and infrastructure network, the area was an important trade and customs center with important industry. The economy of the area however changed substantially after global socio-economic changes: expansion of the European Union and the introduction of the Schengen regime. Following a collapse of industrial and trade activities, tourism came to focus, which also defines future development goals of the area. Compared to other regions in the Italian Alps and in the neighborhood, tourism here is still at a relative early stage and small scale, however current development suggests significant expansion. The area has so on one side witnessed one of the highest depopulation and population aging rates in the Alps in the last 30 years, and large scale infrastructural projects such as the highway high speed railroad and a major pipeline on the other. All this made the area closer to the neighboring regions and bigger cities in the vicinity, resulting in accelerated real estate development. This intense increase of assets has however resulted in catastrophic consequences to hydro-meteorological events, among them flash floods and debris flows. In order to understand the consequences of different development pathways, we will generate future scenarios of land use, by incorporating remote sensing, GIS and spatially explicit land use modeling with qualitative research, and evaluating these scenarios in the context of hydro-meteorological risk. Modeling at a detailed local level enables simulating local scale interactions and decisions – among them risk regulations – and taking into account local limitations like topography and accessibility. This way, we will be able to investigate, how different spatial regulations (or lack of them) could shape the land use pattern in this area. Moreover, it will allow us to explore how global driving forces and resulting local land use changes open new challenges for mountain communities.

0451	Illegal commodity chains and land use: a political ecology of coca-cocaine and land change science in South America	Andrew Millington	Australia

The analysis of value chains of commodities is a key research theme in land change science arising from the drivers-responses framework of LUCC. However, with the exception of illegal timber extraction, illegal commodities have generally not been tackled as drivers of land change. This paper brings together primary and secondary research, primarily from, Bolivia, Colombia and Peru focused on the coca-cocaine supply chain. Currently coca growing is restricted mainly to these three countries, but the areas of cultivation (changing the loci and spatial distribution of land changes) and the rates of cultivation (changing the rates of land change, particularly forest conversion) have changed during over the last century. An economic analysis of value chains (from coca growing though cocaine paste production to 'export') does not account for the shifting patterns of land change. This failing is due to the spatial and temporal evolution of the values chains brought about by constraints on by global- to local-scale political actions, meshing with the ecological possibilities for legal and illegal coca cultivation and covert paste production. I will argue that the political constraints act in a similar manner to cartels; embargoes and taxation on legal value chains and the resulting land change patterns are the result of the politics and ecology of opportunity.

0452	When century-old irrigation systems meet strong land transformation processes: two cases from the Valais (Switzerland)	Rémi Schweizer, Karina Liechti, Raimund Rodewald, Peter Knoepfel	Switzerland

As in other dry mountain regions, supplying water to the Swiss Alpine canton of Valais has always posed major challenges, leading to the construction of century-old irrigation schemes characterized by spectacular water channels (*bisses* in French, *Suonen* in German). Showing long trajectories of historical continuity, these smallholder systems still provide a wide range of services that are crucial not only to

the mountain communities, but also to the people living downhill: water provision, regulation of floods, biodiversity support, landscape formation, socio-cultural and touristic services. Built by local communities or users' groups, *bisses* have been traditionally characterised by negotiated governance structures and community water-right systems the robust, enduring and sustainable nature of which has been highlighted many times (e.g., Ostrom 1990). Consequently, the Valais provides a unique opportunity to study such irrigation and water-right systems on the long-term, in a context that has gone through strong reconfigurations during the last century (from an agro-pastoral to a modern western society, in chorus with a diversification of water and land uses and the arrival of new actors in previously enclosed arenas). Against this background, our contribution offers a selection of the final results of a three-year project related to the development trajectories of these *bisses* systems. More specifically, we address three interconnected questions: the interplay between these systems and the land transformation processes experienced in the Valais (agricultural land transformation and partial abandonment, second homes construction); the development of, and interactions between, the embedded community and private property schemes (related, respectively, to the irrigation water and the irrigated lands); and, finally, the impacts of the latters in terms of sustainability. To do so, we compare insights from two longitudinal in-depth case studies (*bisse Vieux de Nendaz* and *Suone in Ausserberg*), with the objective to identify empirical regularities related to these questions. Relying on a qualitative (participant observations, semi-structured interviews) and interdisciplinary (at the crossroad of political sciences, human geography, and institutional resource economics) approach, we apply a resource-based and actor-centred perspective that directs the attention towards the interconnection between natural (water, land) and artificial (irrigation network) resources, and towards the evolution of the services, user actors, and related institutional rules (public policies and property right system).

| **0458** | Cropping pattern change in Kerala's farm sector | Agnes Pohle | Germany |

My presentation aims to contribute to the conference and the specific session on land change transitions by investigating the incitements of farmers to maintain or change their cropping pattern. Farmers in Kerala use a variety of strategies to make agriculture profitable such as investment in new technologies as well as cropping pattern changes. The study to be presented analyzes the shift in cropping pattern to increase income and draws conclusions with regard to food production. Kerala's agricultural sector faces a number of challenges, especially the lacking profitability of food crops and water shortage. Labour shortage and high labour costs represent major problems in the farm sector. Besides, the area and productivity of food crops are declining, while the area and productivity of non-food crops are increasing. Against this background my presentation addresses the following research questions: (1) Which are the main drivers of cropping pattern change? (2) How does cropping pattern change impact food security?

For investigating these questions, a survey was conducted among 400 farm households during 2010 and 2011. Data is analysed by means of descriptive statistics and logistic binary regression. The results show that 22% of the farm households changed their cropping pattern, mostly towards rubber (16%), and abandoned food crop cultivation. The number of farmers who cultivate rubber increased by 27%, and the area increased by 21% from 2006/07 to 2010/11. In contrast, the area of rice cultivation declined by 14% and the production by 18% in the same period. Econometric findings indicate that the market price is the main driver for cropping pattern changes. The change from food to non-food products has severe implications on food security. On the long term this might be amplified by the continuously rising market price of rubber. Since the small rubber plants grow between banana and coconut trees in the first five years after starting rubber cultivation, the production of banana and coconut will further decline in future, which makes the region increasingly dependent on food imports. Furthermore, our data points to a shift of water consumption through changing cropping patterns which has direct repercussions on local

eco-systems. The presentation concludes by giving recommendations to governments and national/international agencies that face socio-economic and environmental challenges regarding the impact of land use change in the farm sector; the regional and national government, for example, should support food crop cultivation with subsidies, loans as well as managerial and technology support.

0462	Simulating yield gaps in a global computable equilibrium model for the world economy	Ruth Delzeit, Gernot Klepper, Wolfram Mauser, Birgitta Putzenlechner, Florian Zabel	Germany

Land is a scarce resource that provides important services for humanity. Under the current process of global change, which includes climate and demographic changes as well as increasing international interaction in economic affairs, but also political support of biofuels, the demand for different land uses is increasing. Socio-economic changes, such as increasing incomes and changes in consumption patterns already lead to increases e.g. in demand for animal feed that outgrows food demand for direct consumption. On the supply side, agricultural yields as well as production stability is threatened by a changing climate. Food supply depends not only on the ability to produce a sufficient quantity and quality of food, but also on the food price level. Thus, projections of future food supply and prices need to consider various biophysical and socio-economic global and local parameters. Changes in agricultural productivity are driven by regional factors, but at the same time agricultural productivity is also driven by economic factors such as the profitability of certain crops in certain areas. In this paper, we use information on changes in agricultural productivity under a changing climate, while at the same time analyzing different scenarios on the demand side. In doing so, we combine a high spatial resolution bio-physical plant growth model with a computable general equilibrium (CGE) model. In a first step, the bio-physical plant grow model simulates potential yields which depend on bio-physical parameters such as climate, soil, and inclination. The effect of climate change on yields and cropping area can be displayed. In a second step, by using information from the economic model, potential yields that in addition consider profitability of different crops and therefore their competition for land are calculated (see presentation by Florian Zabel, same session for details). Based on this information, the change in agricultural productivity is implemented into the CGE model, and impacts on global agricultural markets under different scenarios that affect the demand side are simulated.

0465	The knowledge-action interface in sustainable land management in Kyrgyzstan and Tajikistan: challenges and recommendations	Bettina Wolfgramm, Zhyldyz Shigaeva, Chad Dear	Switzerland

In Soviet times, the main aim of agricultural research was to increase yields to meet centrally-planned production quotas and the rapidly increasing demand for food and fodder. There were tight interconnections between research institutions and state farms. With political independence in 1991, the research institutions of Kyrgyzstan and Tajikistan became independent national institutions and subsequently suffered significant losses of resources. State farms have mostly been privatized and today independent family farms are managing small plots of land. Links between research and practice now hardly exist. While the new situation calls for new approaches, the structure of the local academic institutions is conservative disciplinary. The main goal of this study is to assess the knowledge-action interface in Kyrgyzstan and Tajikistan today as it relates to sustainable land management, and to propose context-specific recommendations.
The study consists of a structured literature review including 131 publications and a feedback session

with stakeholders from research, policy and practice. Conceptually, this study applies the framework of the Global Land Project (2005). The feedback session identified barriers preventing exchange between researchers, policymakers and practitioners, as well as recommendations to improve their interaction.

The study results show that knowledge of different stakeholder groups is often very much disconnected and the academic knowledge has subsequently not been affecting change. Extension services are critical institutions for spreading new agricultural practices, but are not functioning well. Government strategies are not showing the expected effects and are only partly implemented. This is also true for legal frameworks that have been modernized.

Furthermore, the study highlights the underlying challenges when informing land and soil policies with science based tools in a transition context. Today, there is a gap in the conceptual approach of "Sustainable Land Management (SLM)" applied by international researchers working in Central Asia, and "Rational Use of Land Resources (RULR)" originating in Soviet times and still applied today by researchers and policy makers from Central Asia. This has far reaching consequences when setting research goals, deciding on research approaches and disseminating research results. In order to successfully implement evidence base decision making in Kyrgyzstan and Tajikistan, this gap first needs to be bridged. Based on the results of our literature review and feedback session, we make recommendations for improving research approaches of both local and international scientists in order to informing land and soil policies more effectively.

0467	Going beyond enforcement: institutional change and the path to a sustainable logging industry in Brazilian Amazon	Sergio Rivero, Oriana Almeida, Rodrigo Fernandez, Fabio Castro	Brazil

In this work we analyze some scenarios to move the forest industry to comply with legislation and use reduced impact logging (RIL). We do not analyze only forest concessions, because most of the viable timber stock in Brazilian Amazon is actually in private properties and not in government owned lands. The timber extraction in private properties is harder to control and most of the illegally extracted logs are from private lands . We used a model that couples a forest growth model and an Economic Decision Model based on Net present value (NPV). Our model examines the profitability of the forest extraction with different extraction times and technologies combined with a set of alternative financial conditions intended to promote the adoption of reduced impact logging. Using different interest rates and taxation schemes we try to understand the long term impact on the timber industry of credit and taxation policies that impose the compliance with RIL and sustainable logging practices. Our model use a combination of a matrix growth model with a profit function based on net present value, to understand which kind of regulation strategy would be better to promote RIL. We have done two series of simulations, combining changes in two economic variables related to the logging policies: the tax level and the interest rates to the capital borrowed by the industry. We supposed that an economic policy to promote RIL would give lower taxes and lower interest rates to the firms that used RIL. Our simulations showed that, in all experiments that lower interest rates have much more impact than any taxation schemes. Differences in interest rates will have more impact in the decision of the forest industry to adopt RIL technologies than any other policy. The Atlantic Rainforest is considered one of the world's biodiversity *hotspots*, with only 15% of its original cover left. The Ribeira Valley, in southeast Brazil, is its biggest remnant, sheltering also several indigenous populations. Among these, we refer to the Quilombolas, the Afro-descendent rural populations who were formed during the 18th Century by slave societies. From 18th – 20th centuries, the Quilombolas developed a productive system based on shifting cultivation, with peripheral involvement in market economy, at the margin of State's development policies. This picture has been recently changing: a process of agricultural adaptation and intensification is transforming land use system among the Quilombola territories. At the same time, the sustainability of shifting cultivation

has been the focus of hot debate in the literature. It is identified as the main culprit behind the disappearance of tropical forest; on the other hand, it is noted that under certain conditions, landscapes submitted to shifting cultivation present structural diversity, potentially leading to biological diversification. The aim of this study is to discuss the drivers of recent changes in Quilombola agricultural system and to understand their role in forest landscape formation. Semi-structured interviews were applied to the community's eldest individuals, old agricultural patches were visited and time series aerial photographs were analyzed. We show that, in the past, shifting cultivation system was influenced by household-centered socioeconomic, geographic and demographic factors, and contributed to landscape structural heterogeneity. A more evident land use change began in the 1970s, when regional isolation diminished, followed by land grabbing, the creation of Natural Protected Areas, and local and national political articulations towards Quilombolas land property rights. All these facts have led to: agriculture intensification, decreasing in agricultural labor force, reduction of plot rotation and fallow periods, and the loss of crop diversity and its associated local knowledge. However, the total area occupied by agricultural activities did not change between the period of 1962 and 2000 (13% of the territory), but pasture and commercial crops have severely reduced the amount of land dedicated to subsistence agriculture. The territory remains covered by mature forest, but the current trend is towards the simplification of forest structure, possibly causing a process of biological and cultural impoverishment. Instead of being banned, if shifting cultivation continued to be practiced under low population density, with long fallow periods and a high level of plot rotation, it could enhance forest structural diversity rather than worsen Atlantic Forest fragmentation.

0470	Social memory and landscape: agriculture and landscape change in Quilombola communities, in Atlantic Rainforest areas of the Ribeira Valley, Brazil	Lucia Chamlian Munari, Cristina Adams, Rui Sergio Sereni Murrieta, Celia Futemma	Germany

The Atlantic Rainforest is considered one of the world's biodiversity *hotspots*, with only 15% of its original cover left. The Ribeira Valley, in southeast Brazil, is its biggest remnant, sheltering also several indigenous populations. Among these, we refer to the Quilombolas, the Afro-descendent rural populations who were formed during the 18th Century by slave societies. From 18th – 20th centuries, the Quilombolas developed a productive system based on shifting cultivation, with peripheral involvement in market economy, at the margin of State's development policies. This picture has been recently changing: a process of agricultural adaptation and intensification is transforming land use system among the Quilombola territories. At the same time, the sustainability of shifting cultivation has been the focus of hot debate in the literature. It is identified as the main culprit behind the disappearance of tropical forest; on the other hand, it is noted that under certain conditions, landscapes submitted to shifting cultivation present structural diversity, potentially leading to biological diversification. The aim of this study is to discuss the drivers of recent changes in Quilombola agricultural system and to understand their role in forest landscape formation. Semi-structured interviews were applied to the community's eldest individuals, old agricultural patches were visited and time series aerial photographs were analyzed. We show that, in the past, shifting cultivation system was influenced by household-centered socioeconomic, geographic and demographic factors, and contributed to landscape structural heterogeneity. A more evident land use change began in the 1970s, when regional isolation diminished, followed by land grabbing, the creation of Natural Protected Areas, and local and national political articulations towards Quilombolas land property rights. All these facts have led to: agriculture intensification, decreasing in agricultural labor force, reduction of plot rotation and fallow periods, and the loss of crop diversity and its associated local knowledge. However, the total area occupied by agricultural activities did not change between the period of 1962 and 2000 (13% of the territory), but

pasture and commercial crops have severely reduced the amount of land dedicated to subsistence agriculture. The territory remains covered by mature forest, but the current trend is towards the simplification of forest structure, possibly causing a process of biological and cultural impoverishment. Instead of being banned, if shifting cultivation continued to be practiced under low population density, with long fallow periods and a high level of plot rotation, it could enhance forest structural diversity rather than worsen Atlantic Forest fragmentation.

0472	Potentials and limitations of biomass management in farming households in Tajikistan's Hill-Zone	Sebastian Ruppen, Bettina Wolfgramm, Ruth Scheidegger, Hans-Peter Bader, Hans Hurni	Switzerland

A healthy and fertile soil is essential, since it is the resource basis on which many rural livelihoods directly rely on. Land degradation resulting from unsustainable land management practices endangers this provisioning function and consequently threatens people that depend on their agricultural products. Soil organic matter is a key to soil health and fertility. It comprises multiple benefits and is an essential source of nutrients in resource-poor small-scale agriculture, where inorganic fertilizer is scarce or not affordable (Liniger et al., 2011). In rural Tajikistan, soil conservation through on-farm biomass recycling often competes with household needs. Plant residues are commonly fed to animals and manure is used as fuel for cooking and heating. Thus, little organic matter returns to soil, although this would be of importance to maintain soil services and assure human benefits.

The present study interrelates the self-supply of rural households, regarding food, fodder and fuel needs, to on-farm biomass recycling. Using mathematical material flow analysis (MMFA), the biomass management of subsistence-oriented mixed farming households in Tajikistan's hill-zone is modeled and assessed.

As earlier studies using MMFA showed, few or no regional statistical data is generally available in transition and developing countries. Therefore, a field study consisting of semi-quantitative interviews with farmers was conducted, in order to define the system in question, identify crucial biomass stocks and flows and classify household groups. Based on this system characterization, a dynamic model representing the household's biomass management was developed. For the elaboration of scenarios, existing local practices available as documentations from the online database of the World Overview of Conservation Approaches and Technologies (WOCAT) were integrated. The scenario development aimed at an improved self-supply and enhanced biomass recycling of the households in question.

The model results indicate shortage of self-supply and a low potential to recycle organic matter on-farm in small and medium households. Highly productive land use types such as orchards or perennial forage crops combined with energy efficiency strategies can improve self-supply, enhance the on-farm recycling potential of organic matter and reduce deforestation. However, small households remain endangered. Food and energy stocks are depleted within a few months after harvest and fodder is scarce. As a result, the recycling potential of organic matter remains low, which threatens soil health and fertility and livelihoods relying on it.

The elaborated model supports a systemic approach. This is essential for developing and testing soil conservation strategies, as it interrelates cyclical conservation strategies to household needs.

0473	A geospatial analysis of land transformations in the megacities of Southeast Asia	Ronald C. Estoque, Yuji Murayama	Japan

During the second half of the 20th century or so, many countries achieved remarkable economic developments, which led to the rapid land transformations and urbanization of many cities around the world. Since the turn of the 21st century, however, issues on sustainable development, as well as on

environmental security and quality of life in urban areas, have been gaining more attention. The advancements of remote sensing and geographic information systems technologies enable us to monitor land changes at various spatial and temporal scales, and analyze the implications of such changes from different perspectives. This study explores and compares the spatiotemporal patterns of land changes in the megacities of Southeast Asia, namely Bangkok, Jakarta and Manila, using geospatial tools and techniques. Our goal is to gain better understanding of the land transformation process in each megacity, which may be useful especially in the context of sustainable landscape and urban planning. Remote sensing data were used to develop land cover maps for the megacities across three epochs, i.e. t1-1990, t2-2000 and t3-2010. A hybrid classification method that integrates pixel-based and object-based techniques was employed in land cover classification. Transition matrices for the two time intervals (t1-t2 and t2-t3) were computed in order to detect the quantity of land changes (built-up expansions) for each megacity. Landscape metrics and geospatial techniques were used to reveal the spatial patterns of land changes. Moreover, based on the satellite-derived land cover data, we determined the spatiotemporal changes in the ecological footprint of each megacity using the estimated impervious surface area and population data as proxy measures. This was done by using a simple regression model based on the impervious surface area per person and the ecological footprint per person of 148 countries. Finally, we discussed the implications of our findings for future landscape and urban planning in relation to the sustainable development of the three megacities. We believe this study contributes to the progress of land change sciences in Asia.

0475	Contribution to land appropriation by foreign companies - Madagascar case	Jean Aimé Rakotoarisoa	France

The issue of the African land appropriation by foreign companies is often seen as something bad for local peasantry but no substitutive solution is proposed. This comes as a somewhat hypocritical answer given by the international community and it must be denounced. As a matter of fact it avoids the problem and does not take into account the fact that the situation comes as the result of a policy that has been kept developing for the last fifty years by those who want to save the world. Those administrators put forward statistics showing that the world has globally grown wealthier and much improvement has taken place. This is quite true but it does not take into account the way this wealth has been distributed. After having controlled the raw materials in the world for decades, the next step will be to make the fertile lands their own whatever the price.

I intend here to give detailed examples of such a process that can be seen in Madagascar. It will appear somewhat interesting because this phenomenon of land massive monopolizing has not yet been effective despite the efforts realized by big companies. How would it be possible to yield thousands of hectares to foreigners in a country where those lands still belong to the ancestors according to the traditional links existing between the living and the dead? Which could be the tools, the techniques of pressure (direct or indirect) to realize such projects and have them accepted by the population?

Despite the great number of meetings taken with the peasantry everybody knows that they will be the losers in the long run. They do not have the means to fight. It is true some of them know there are laws that could protect them but the application of those laws and the money that is needed to go to the court of justice (which they do not trust) is in no way encouraging them to open the case. So this land appropriation process seems difficult to stop. Maybe it would be more useful to think about means of finding a mid-way fair solution that would at the end be favorable to the peasantry. However the peasants being so poor it leads them to accept short-term compensation which will shortly bring them to still harder times.

0480	Identifying farming systems at regional scale using remote sensing: challenges and opportunities	Agnes Begue, Elodie Vintrou, Damien Arvor,	France

		Valentine Lebourgeois	

All around the world, cropping systems are constrained by environmental and socio-economic conditions. Cropping system classification can thus be considered as a preliminary step for agro-environmental and productivity assessments. At local scale, an increasing number of cropping practices can now be identified and monitored high resolution remote sensing data. At regional scale, where ground or expert information is generally not sufficient to access all the necessary cropping system variables, the question of how cropping systems can be described and located within large and/or heterogeneous areas remains open. To overcome this difficulty, the cropping system concept is generally restricted to its primary characteristics which are the cultivated species and the species rotation. The cropping system can also be identified through its determining factors (factors that are involved in their spatial organization) that are easily geo-referenced. A third way is to use the capacity of the remote sensing data to catch the landscape patterns, and to interpret these patterns in terms of agricultural practices. In a recent publication, Vintrou et al. (2012) successfully related remotely-sensed spatial and temporal patterns to different types of agricultural systems in South Mali, using data mining techniques.

The goal of the presentation is (i) to give a brief review on the use of remote sensing data to identify and map cropping systems at regional scale, (ii) to present a conceptual framework to address this issue, based on the assumption that agricultural systems shaped the landscape through human cropping practices, and that the resulting landscape can be described at the regional scale with a set of coarse resolution satellite-derived metrics (spectral, textural, temporal, and spatial metrics), and (iii) to illustrate that approach by presenting a case study on Mali that makes use of MODIS coarse resolution satellite images to map the fragmented agricultural systems in the Sudano-Sahelian environment of Africa (Vintrou et al., 2012).

Through this presentation, we show that the question of identifying agricultural systems at the regional scale using remote sensing, environmental data and expertise, is still challenging, especially in countries with limited data availability. In the conclusion, we present a set of recommendations for future research approaches and methods in the field of remote sensing for farming systems mapping.

0481	The impact of land sales Ban on the term structure of land rental contracts in Ukraine	Viachslav Esaulov	Germany

After independence in 1991, Ukraine started a long process of redistribution of the land under large collective farms to small private fragmented plots of land (up to 15 ha). Moreover, Ukrainians were denied the possibility to officially sell agricultural land in 2002. Nonetheless, an unofficial market remained in place until 2006.

Because traditional Ukrainian farms had been much bigger before the land redistribution and because of the official ban on agricultural land property transfer, the agricultural land rental market started to play a greater role after 2002. The presence of a land rental market allowed the creation of large agricultural companies (agro-holding) which rent areas exceeding thousands of hectares.

Presently in Ukraine, about 53.5 % of the total arable land is leased. While in the past land rental lease contracts were in the majority for short periods (up to 3 years), 83% of all agricultural land lease contracts are presently concluded for 4 to 10 years.

One possible explanation of this shift is the continuous delay in removing the ban on agricultural land property transfers. The aim of this contribution is to see the effect of this continuous delay on the term structure of land rental lease contracts.

0483	Making the Latin American city - land development in peri-urban La Paz, Bolivia	Paul van Lindert, Otto Verkoren	The Netherlands

With an average 75 per cent of its population already living in cities, Latin America is by far the most urbanized region of the Global South. The big metropolises and intermediate towns have expanded

beyond their established boundaries, often encroaching upon a range of surrounding municipalities. At the same time, these large cities witnessed a relocation of population and economic activities from city centres to the outlying districts. Urban low-income groups who are excluded from formal labour- and housing markets are being driven into slums and squatter settlements that are most prone to the effects of climate change, such as floods, landslides and other natural hazards. This paper provides an account of urban expansion through rural-urban land conversion in the metropolitan city-region of La Paz, Bolivia. The process that leads the transformation in land use is the subdivision of rural land and its occupation by low-income groups. Through their incremental self-build housing activities, the urban poor are the ones who are the real land developers. The paper documents land use changes over the past three decades.

0484	Tree cover transition in Chinese forest and agricultural lands	Jianchu Xu, Robert Zomer	China

China has the largest tree planting programs in the world. Chinese conservation policies significantly contributed to increasing tree cover. We mapped tree cover changes in both forestland and agricultural lands using the remote sensing data (MODIS VCF 2000 and 2010), which identified areal distribution of tree cover within a combination of climate (aridity Index) and demographic status (population density) in 2000 and 2010 by geographic/ecological sub-regions. Trend analysis was used to normalize and extract the variation of tree cover in the agricultural and forest landscape over increasing population density and climate conditions. Our results suggest that the increase in tree cover in the past decade was initiated by government policies that encompass regulative approaches in forestland as well as incentive payments for tree planting on sloping agricultural land. More recently, emerging economic opportunities from tree crops spurred farmers to switch their land use portfolio towards tree-based cultivation even in populated areas. Tree cover trajectories in China hence resulted from a combination of exogenous policy-induced incentive payments and endogenous adaptation of land use strategies to changing market conditions and population dynamics.

0485	Farmers' climate adaptation and deforestation in the Mexico-Guatemala Selva Maya	Claudia Rodriguez	USA

The development of adaptation strategies to minimize the impact of climate variability on farmers' livelihoods is crucial and can be expected to become more common as climate changes. However, if farmers' climate adaptation strategies erode ecosystems' ability to produce environmental goods and services through deforestation, their adaptation can turn ineffective, inequitable and counterproductive. Such adaptation strategies may help farmers to cope with climate effects in the short run, but hurt their livelihoods and adaptive capacity in the medium and long run. Alternatively, farmers' adaptation strategies can help to minimize climate impacts on livelihoods and also lead to changes in human-environment relationships that support ecosystems' capacity to deliver environmental goods and services. Such strategies would help farmers to adapt, produce their livelihoods in the long run and even contribute to climate mitigation through reduced deforestation.

This paper studies whether farmers' climate adaptation drives deforestation in a frontier region in Mesoamerica, and what are the social-ecological and institutional factors influencing farmers' choices for adaptation strategies. This analysis aims to provide empirical evidence about the unintended outcomes of farmers' climate adaptation and to contribute to the dialog between the literature on adaptation and land use change. The paper draws inferences by statistically analyzing 353 households from 46 communities in the Selva Maya. Calakmul and the Maya biosphere reserves integrate the Selva Maya, straddling the Mexico-Guatemala border. The Selva Maya is the second largest tropical forest in the Americas, holding great international importance due to its biological diversity and the vulnerability of its population. Communities in the Selva Maya strongly rely on seasonal agriculture and natural resources. Loses in crops derived from what farmers perceive as changes in historical precipitation

patters have encourage most farmers in the Selva Maya to implement adaptation strategies.

The results suggest that farmers' climate adaptation can tame and also foster deforestation, depending on the governance and socioeconomic context within which they occur. Households' access to benefits from natural resources and participation in decision-making at the community and biosphere reserve levels are critical for the selection of climate adaptation strategies associated to forest conservation. Shorter distances to commercial and administrative centers, as well as government aid after disasters provide incentives for the selection of adaptation strategies linked to deforestation.

This paper will contribute to the land governance theme by shedding light on how governance and institutions influence deforestation directly, as well as indirectly by providing farmers incentives to choose climate adaptation strategies with different implications for forest conservation.

0489	Validating the current critical levels for ammonia in a Mediterranean forest area	Laura Aguillaume, Esteve Llop, Pedro Pinho, Paula Matos, Anna Avila, Cristina Branquinho	Spain

Ammonia (NH3) is a toxic gas with great impact on biodiversity and ecosystem function. Critical levels (CLE) for this pollutant are established at $1\mu g/m3$ for Europe. This was based in several case-studies developed in North Europe ecosystems and just 2 case-studies from Mediterranean areas (Portugal and Italy). Clearly, there is a lack of information from Mediterranean areas in what concerns the validation of NH3 CLE. From several works developed both in Europe and USA we know that lichen diversity is consistently the most sensitive ecological to NH3, and for that reason was used for the establishment of the lower CLE. Recent studies have shown that rather than lichen species richness, considering functional groups provides more accurate results as ecological indicator of NH3 effects at the ecosystem level (Pinho et al., 2012). However, lichen functional groups are known to respond to other ecological factors besides NH3 pollution. Thus, one open question is to know whether current methodology is valid under completely different ecological conditions and displays similar results of NH3 CLE. For that we tested the NH3 CLE in a Mediterranean holm-oak forest site where light is a limiting factor and where altitude also changes (619-690m). We characterized annual NH3 atmospheric concentrations and lichen functional diversity along a gradient of distance to a NH3 source in a site with complex orography. The results showed a very significant response of lichen functional groups to NH3, mostly as an increase on the frequency of the nitrophytic species. We conclude that the previously established NH3 CLE still protects biodiversity in these Mediterranean areas and that despite the different type of forest and complex orography the use of lichen functional groups is valid.

We aim to contribute to session "Cascading interaction of global and long-term nitrogen cycles in coupled human and ecological system" by validating NH3 critical levels based on lichen functional groups in Mediterranean areas. We aim to contribute to the understanding of the temporal and spatial patterns of ammonia dispersion in a heterogeneous landscape to ensure the effectiveness of future mitigation strategies in the Mediterranean ecosystems.

0491	Changes of vegetation-covered area under different pasture-use seasonality in the Alai Valley in the post-Soviet time	Jie Liu	Japan

This study aims to analyze the changes of vegetation-covered area of pastures under different grazing seasonality in the Alai Valley, the south of Kyrgyzstan. Landsat (1990) and ALOS (2009) satellite imageries were digitalized and used to analyze the changes of the vegetation-covered area by GIS. Based on the different grazing seasonality, the pastures in the study area can be classified into: (1) spring and autumn pasture (usually located near a settlement), (2) summer pasture (remote pasture) and (3) all-

season pasture that is used for whole year (near a settlement). For the analysis, 3 spring and autumn pastures, 3 summer pastures and 2 all season pastures were selected. The information of the pasture-use seasonality was acquired by interview. The result shows that the vegetation-covered area in all 3 spring and autumn pastures decreased by -27.0%, -11.8% and -0.1% from 1990 to 2009. The increase of the livestock number may have led to this result. In the post-Soviet time (after 1991), there became no limitation on the livestock number to possess privately in Kyrgyzstan while in the Soviet-time, the privately-owned livestock number was under strict control by the Soviet government. The individual livestock number has increased gradually especially in the last decade, although the enormous number of livestock that had been kept by the government had been disappeared in the area. The increase of individual livestock number led to uneven and intensive use of the pastures near the settlements. The vegetation-covered area in one of the 3 summer pastures decreased by -10.0% while in the other 2 increased by 5.1% and 9.4%. Moreover, the vegetation-covered area in 2 all-season pastures decreased by 4.8% and 11.0%. Since the 1991 independence from the Soviet Union, the individual livestock farmers have not obtained financial support from the government, so parts of the local households have abandoned remote summer pastures, which had been intensively used by the state and collective farms in the Soviet time. Instead of grazing in remote pastures in summer, they began to use the pastures near a settlement all year round to save money and energy. This change resulted in less user number in summer pastures and stronger grazing intensity on the pastures near the settlement.

0492	Identifying regime shifts in land-use systems	Martha Bakker, Yang Chen, Arend Ligtenberg, Guus ten Broeke, Arnold Bregt	The Netherlands

Regime shifts and *tipping points* have become popular notions in ecology, where they serve to describe a sudden, rapid transition of an ecosystem from one stable state to another. Well-known examples are the shift from low to high algae concentrations in shallow lakes and the shift from grassy to woody savannahs. These are examples of ecosystems (Sheffer *et al*. 2003), but the principles of tipping-points and regime shifts may apply to land-use systems as well. Like ecosystems, land-use systems are complex adaptive systems characterized by multiple feedbacks across scales. They exhibit strong autonomous dynamics: gradual changes in circumstances often result in unforeseen non-linear responses. The concept of regime shifts can elucidate these responses, and help predict how land-use systems will react to e.g. policies and global change.

Regime shifts in land use system can become manifest in many different ways. A relatively sudden conversion from one dominant agricultural sector to another may occur; but the change may also concern system properties such as average farm size, or a shift in the economic base of the land use system (e.g. from agriculture to tourism). Not all such observations would classify as regime shifts. If we want to remain true to the complex-systems origin of the term, a land use transition has to exhibit certain characteristics at both macro and micro level in order to be classified as a regime shift. At macro level these would have to be the following characteristics: bistability, an accelerated transition from one state to another (caused by positive feedbacks), and hysteresis or irreversibility; at micro level these would be interactions between agents and the existence of feedbacks from aggregate system properties to the individual agents. Moreover, typical for regime shifts is the non-linear response of a system property to a gradual change in an exogenous driver or forcing, which is not necessarily the same as a non-linear system response in time.

Based on this set of requirements, we discuss a range of examples of land use transitions that fulfil these characteristics to varying degrees. In doing so we distinguish quasi regime shifts from semi regime shifts and real regime shifts. We propose modelling principles for each of the distinguished types, whereby

quasi regime shifts can be sufficiently modelled with a linear model; semi regime shifts require agent-based models without feedbacks; and real regime shifts require more complex agent-based models that incorporate feedbacks.

0493	Changes in ecosystem services provision in reforesting landscapes	Veerle Vanacker, Vincent Balthazar, Jaclyn Hall, Romaike Middendorp, Armando Molina, Eric Lambin	Belgium

Land use systems are exerting a growing pressure on the Earth system and its functioning. As landscape elements are intimately connected to ecosystem functions, global impacts of land conversions are affecting a wide range of goods and services that ecosystems can provide to answer health, social, cultural and economic needs. Two contrasting land cover trends are currently observed worldwide. While the continuing increase in global food demand accelerates the conversion of natural ecosystems into agricultural lands, an increase in forest cover is now observed in some developing countries where livelihood strategies diversified. The potential to recover ecosystem functions after forest transition is currently highly debated. The Pangor watershed in the Ecuadorian Andes is recently experiencing a forest transition, as a result of the rapid increase in forest plantations. In this study, we analyze land cover change and its pathways over a 50 year time period to assess the potential impact of the land cover change trajectory on the provision of ecosystem services. In this mountainous terrain, we focus on four major ecosystem services: pollination and seed dispersal of native trees, regulation of water quantity and quality, climate regulation (through carbon sequestration and storage) and protection against natural hazards. The impact of forest transition on ecosystem services and functions highly depends on the existing land cover prior to the forest transition. By analyzing this bundle of four ecosystem services, we observe that there exist important trade-offs between ecosystem services that depend on the tree species diversity after reforestation.

0494	Modelling climate change impacts on mountain forests, ecosystem services, and rubber production in Xishuangbanna Prefecture, Yunnan Province, China	Robert Zomer, Antonio Trabucco, Jianchu Xu	China

Xishuangbanna Prefecture, in southern Yunnan Province, is often referred to as China's treasure house of biodiversity. There are over 5000 flowering plant and fern species, including 153 endemic species and 56 rare and endangered species. The region contains China's largest area of diverse types of mature tropical forest, and is home to the northernmost tropical rainforest in the world. Likewise traditional mountian agricultural systems harbor high levels of agro-biodiversity. As is evident in other parts of SE Asia, both natural forests and traditional agricultural systems, as well as other ecosystem services such as watersheds and wildlife habitat, are being threatened by the rapid expansion of rubber production. Recent research in Xishuangbanna has shown that rubber plantations had almost 20% higher evapotranspiration rates compared to rain forest. Our analysis of landuse change shows rubber production increasing from 8% to 22% of total area from 2002 to 2010. However, further expansion of rubber plantations is currently limited by climatic constraints, i.e. cold conditions associated with increased elevation. As a result, plantations are now mainly found below 1000m asl. An analysis and modeling approach, based on the statistically derived Global Environmental Stratification (Metzger et al 2013), and developed within the framework of the GEOSS Biodiversity Observation Network (GeoBon), has been used to explore the potential impact of projected future climate conditions on ecosystems, landuse change, hydrology, and biodiversity in Xishuangbanna by the year 2050.

Significant changes in the extent and distribution of bioclimatic conditions are projected by the year 2050, with the average annual temperature increasing by 2.0°C. By 2050, there are significant geographical shifts in all delineated bioclimatic strata, with an average upward shift of 287 m of elevation per strata. The area conducive to rubber plantations, currently limited by climatic conditions, expands to over 97% of the total area of Xishauangbanna. Climatic change potentially removes the barriers to further expansion of rubber plantations and increases pressure on remaining forests. The analysis provides the basis for evaluating the sensitivy of moutain ecosystem services, including both managed and unmanaged ecosystems, and landuse change trends, within the context of ongoing rapid change and agro-industrial expansion in the area. Current efforts to conserve forests, biodiversity and traditional landuse systems require improved understanding of these potential impacts if conservation, adpatation, and mitigation efforts are to be effective.

0495	Advanced remote sensing methods to map forest cover changes in mountain areas	Patrick Griffiths, Vincent Balthazar, Derek Bruggeman, Patrick Hostert, Eric F. Lambin, Anton Van Rompaey, Steven Vanonckelen	Germany

Mountain areas provide a wide array of ecosystem services and are highly susceptible to global environmental change, making systematic monitoring a necessity. Remote sensing can provide synoptic and spatially explicit observations that routinely allow monitoring of land change. However, mountain regions are particularly challenging environments to be monitored based on remote sensing. Rugged terrain generates illumination effects that need to be properly addressed to reduce analysis errors. Topography also creates persistent cloud coverage that seriously limits the number of images available with low or no cloud cover. These problems are amplified when monitoring approaches target larger mountain regions at medium to high spatial resolutions, where a multitude of images have to be used to create a complete coverage. Recent changes regarding data policies along with progress in processing and analysis algorithms have enabled new methodological pathways to overcome these limitations and will ultimately allow assessing the full range of land change processes occurring in mountain areas.

This presentation summarizes the methodological achievements and some key scientific results of the remote sensing components of the Fomo project. First, we present detailed assessment of topographic normalization approaches and their potential to improve classification and change detection approaches. Second, we present compositing algorithms for Landsat data that allow for creating regional, cloud free image datasets. We further present an implementation of a topographic normalization method into an automated compositing workflow. Creating application specific time series of image composites (e.g. for forest disturbance mapping, agricultural change mapping) as well as spectral-temporal variability metrics allows to retrospectively assess land changes at high thematic detail. Our results address key aspects of forest changes in mountain environments: we assessed forest disturbances, recovery and changes in forest types but also cropland abandonment, forest expansion, grassland conversion and recent recultivation. The achievements presented include results from three study sites: Bhutan in the Himalayas, the Carpathians in Eastern Europe and Ecuador in the Andes.

0497	From landowner to landscape: the influence of forest ecology and ecological knowledge on the management decisions that drive landscape change	Monica Dorning, Ross Meentemeyer	USA

In the face of intense and rapid landscape change, it is important to understand how the attitudes and

actions of individuals and societies affect the persistence of biotic communities, as well as potential feedbacks that may encourage further change. Private landowners face difficult decisions regarding forest management in urbanizing environments. While it is apparent that individual and economic values are important factors in those decisions, the influence of the biotic environment and the landowner's knowledge of that environment remain unclear. We aim to improve our understanding of land management decisions and landscape change by coupling social and ecological data from multiple scales as it relates to individual landowners. We conducted a revealed preference survey of 76 private forest owners along a gradient of urbanization in a rapidly expanding metropolitan area in North Carolina, U.S.A. Included in the survey were questions about forest use and management, knowledge of the forest's ecological and economic values, sense of place, and attitudes toward their forest and nature in general. Each survey was followed by a site visit where we measured forest structure and biodiversity. Combining these survey and field data, we developed an ecological knowledge index that represents the landowner's understanding of their forest's ecology. Survey results indicated that many of the woodland owners have a strong sense of place and highly value the services provided by their land's biodiversity. Landowners were also aware that the changes occurring as a result of urbanization are influencing the values they place on their forests. In order to understand relationships among various factors underlying private forest owners' management decisions we analyzed individual (revealed preferences, forest ecologies, and ecological knowledge) and regional (socio-economic, natural, and built geographies) level spatially explicit data within a structural equation modeling framework. We found that forest ecology, landscape context, and ecological knowledge each play a significant role in landowner decision making processes, and that these factors are further influenced by individual landowner characteristics and values. These results indicate the potential for a positive feedback between landowner decisions and continued landscape change and point to the important role that the education and knowledge of landowners can play in sustaining privately owned forests in urbanizing areas. By coupling social and ecological data related to individual landowners, we have revealed how changing biotic environments are affecting management decisions and may collectively influence urbanization processes.

| 0498 | Using dense time series of Landsat images to assess spatial and temporal pattern of agricultural land abandonment and natural forest re-growth | Katarzyna Ostapowicz, Volker C. Radeloff | Poland |

Land cover and land use change are one of the main drivers of global environmental change. Abandonment of farmland and slow processes of forest succession which take place on the abandoned land are among many types of land use and cover change, with a significant influence on the state and change in ecosystems. Land abandonment is often driven by changes in political, economic and social structures and is spread within different regions of Europe, e.g. in mountains of Mediterranean and Central and Eastern Europe. Satellite images and remote sensing techniques have the potential to provide information on the land cover and its change which could be caused by land abandonment. Particularly, the number of, and improvements in satellite sensors over the past two decades have fundamentally altered the capacity to observe and monitor land change. The aim of this study is to create a spatially explicit model of agricultural land abandonment and forest re-grown pattern using dense time series of satellite images. Our study area is located in the northern part of the Carpathian mountains. For this area, we collected a near-annual time series of Landsat TM and ETM+ for the period 1984-2012, for three scenes (188/26, 187/26 and 186/26). Mostly images from the peak growing season (early June to early September) have been selected for analysis but for same years due to intensification of cloud cover also images from spring and autumn have been incorporated. The agricultural land abandonment was defined from the remote sensing perspective as agricultural land that is not used at least three years for crops, hay cutting or livestock grazing. Models of land abandonment and forest re-grown pattern were

obtained from collection of Landsat images by extracting key characteristics of spectral trajectories of forest and agriculture land change with use of temporal segmentation (modification of Kennedy et al. (2010) methodology). Our findings contribute to the main conference theme of "Rethinking land change transitions" showing that dense time series of satellite images allow to detail assessment of spatial pattern of trajectories of agriculture and forest changes and to catch early states of analysis processes.

0503	Can we continue to feed the world from crop yield increases alone?	Deepak Ray, Jonathan Foley	USA

Using a newly developed crop yield and area harvested dataset we recently found that 23-38% (1) of global maize, rice, wheat and soybean crop areas were either witnessing yield stagnation, or collapse. Instead of doubling, production in these top four crops was likely to increase only 38-67% from yield improvements. This raises the important question whether global food security can be maintained from crop productivity gains alone; will the loss of our pristine lands – tropical forests, and savannas continue or even increase to grow more food – an issue that is at the heart of the Global Land Project? In this presentation we will report on the top 16 global crops responsible for nearly 90% of harvested crop calories. Productivity changes in all these crops will continue to strongly influence land use dynamics. Where our remaining natural lands are converted and where global food security is met will be strongly influenced by local to global scale crop productivity changes that our dataset and analysis hopes to capture. We will start our presentation with a brief description on the development of this global dynamic crop statistics database that addresses the session (0065) goal. This presentation addresses the challenge of building dynamic global land use datasets. Specifically, we bring to the session one dynamic land use data: where crops are grown globally and what is their productivity. It is quite clear now that agriculture is one the largest global drivers of land use change and thus its dynamics influences land system dynamics. We hope that collaboration with colleagues who are building dynamic datasets on other aspects of the land system would result. Our presentation addresses the theme "Rethinking land change transitions" as we are building and analyzing global crop productivity and harvested area statistics at high resolution.

0505	Reordering access to water: how land and market reforms have impacted irrigation in southern Ukraine	Brian Kuns, Ihor Pylipenko	Sweden
0507	Trajectories of land use and land use efficiency in Africa - an analysis based on the Human Appropriation of Net Primary Production framework	Tamara Fetzel, Maria Niedertscheider, Karl-Heinz Erb, Veronika Gaube, Simone Gingrich, Helmut Haberl, Fridolin Krausmann, Christian Lauk, Christoph Plutzar	Austria

This paper discusses the changing geography of irrigation in the southern Ukrainian region of Kherson, and the consequences for agriculture and local populations when irrigation is no longer a possibility. Southern Ukraine has fertile soils, but a dry climate, making irrigation essential for intensive agriculture. Securing its own food security was a difficult challenge for the Soviet Union, one that it never really overcame. In the late Soviet period, massive resources were devoted to land improvement projects

throughout the country, including the construction of extensive irrigation works in southern Ukraine, which boosted agricultural production considerably. Much of this irrigation investment was concentrated in Kherson Oblast. Today, while the larger part of the irrigation system in Kherson remains intact and in use, irrigation has disappeared in different areas in the oblast as part of a post-Soviet trend towards agricultural extensification. Irrigation has also appeared or intensified in new areas. For example, small-scale household farmers with access to water have begun to irrigate their household plots located within or near the settled areas of villages. Mapping out where and why irrigation has appeared and disappeared in Kherson Oblast is the primary aim of this paper. A related question concerns how Soviet era irrigation assets have changed under market conditions. The irrigation system was designed under Soviet economic assumptions – cheap fuel, electricity and other farm inputs – within the context of a command economy and with large-scale farming units in mind (i.e. collective farms). Today these factors have changed and the question is how the irrigation assets have changed. Though there are still many large scale production units active in post-Soviet Ukraine, small-scale household farms have begun, where possible, to irrigate, and the different trajectories of change and conditions for irrigation between large-scale and small-scale farms will also be explored in this paper. Finally, this paper endeavors to place these developments in a world historical context. Different civilizations have sought to intensify food production through making land improvements (Widgren 2007). These civilizations undergo at some point significant socio-cultural change, which calls into question who has access to and receives the benefits of land improvements, and how those investments are put to use to secure food security.

| 0508 | Determinism and uncertainty of successional trajectories following different land uses | Robin Chazdon, Natalia Norden, Héctor Angarita | USA |

Development of effective conservation and reforestation strategies requires an ability to predict forest structure properties and their successional trajectories in regrowing forests. Forest succession has been traditionally viewed as a highly predictable process. Most successional studies are based on chronosequences, where temporal changes are inferred from single-time censuses of a set of forest plots of different ages since disturbance, assuming that successional pathways follow a single deterministic trajectory over time (Chazdon 2008). This assumption is often violated, however, as variation in initial conditions and landscape composition can alter successional trajectories of community structure, even among sites that share similar environmental conditions and disturbance history.

We assembled a unique dataset comprising annual vegetation census data from multiple successional forests in seven sites spanning four Neotropical countries (Brazil, Costa Rica, Mexico and Nicaragua). Regenerating forests followed different types of land use including shifting cultivation, cattle pasture, and extensive hurricane damage. We modeled successional trajectories in forest structure using a dynamic model based on initial conditions of three interacting community attributes: stem density, basal area and species density of trees. Overall, successional pathways were highly idiosyncratic within and across sites and had low coefficients of determination. The deterministic models generated within each region failed to reproduce accurately the successional trajectories observed in several cases. Stand identity was far more important than stand age in explaining successional variation in forest structure. Moreover, the wide disparity found in the fitted parameters suggests that the mechanisms underlying succession differed across sites.

To evaluate the relative importance of determinism and uncertainty in shaping successional pathways, we formulated site-specific models expressed as the sum of a deterministic and a stochastic component (random noise). Even when deterministic and stochastic components were weighted equally, our model did not capture the whole set of time series describing changes in stem density, basal area and species density. By doubling the relative importance of the stochastic component, the predictability of the model increased but was still far from embracing all of the observed trajectories. Overall, our results

demonstrate that uncertainty is an inherent property of forest regrowth in the Neotropics. Although successional trajectories cannot be predicted with high precision, incorporating uncertainty into models of succession can enhance overall predictability of potential future states of forest following different types of land use.

0509	Modeling regime shifts of land systems in Southeast Asia	Zhanli Sun, Daniel Müller	Germany

Land systems are coupled social environmental systems (SESs) and characterized by intrinsic complexity entailing non-linear dynamics, self-organization, multi-scale feedbacks and emergence. Understanding the dynamic evolution of land systems is a pivotal task of land change science and has profound policy implications for sustainable management of land resources and ecosystem services. Yet, this is notoriously challenging, particularly, when land systems exhibit regime shifts, defined as a persistent, radical, abrupt, and often surprising change to an alternative system state with distinct structure and functions. The concept of regime shifts has been increasingly applied in ecology but has only received little attention in land system science despite the frequent occurrence of abrupt, nonlinear change and surprising change of land use types and land use intensity. Moreover, empirical modeling of regime shifts of coupled SESs, such as land systems, has proved to be extremely challenging.

In this paper, we present evidence of regime shifts in land systems in four case studies in Southeast Asia: Xishuangbanna Prefecture, China; Huaphan Province, Laos; Nghe An Province, Vietnam; Kutai Barat District, Indonesia. Land systems in all four sites were dominated by largely subsistence-based shifting cultivation in the early 1980s but land system change later embarked on distinctly different pathways with different agricultural production strategies and divergent outcomes in terms of livelihoods and ecosystem services. To further reveal the causes of these regime shifts, we use an integrated modeling framework that combines bottom-up agent-based modeling (ABM) with top-down system dynamics. The system dynamics allow us to endogenize and simulate many aggregated variables on macro level, for example, increasing land use demands for particular commodities driven by higher price in regional and international markets. Land users, modeled as autonomous agents in ABM framework, make land-use decisions based on their socioeconomic endowments, biophysical factors, as well as the changing economic (e.g., prices) and institutional factors, modeled in system dynamics. The emergent land use pattern may also influence some variables on macro level as feed backs into the system dynamics. The combination of the two contrasting modeling philosophies hence allows us to simulate the dynamic processes of regime shifts and explore how regimes shifts are triggered by subtle change of some critical variables and interactions among them. Such integrated modeling approaches enhance our understanding of retrospective regime shifts of land systems and facilitate scenario-based investigations of potential future land system evolutions. In that way, it can support proactive decision making to prevent (or foster) land systems tipping towards undesirable (or desirable) regimes.

This contribution is closely aligned with the session by contributing insights into abrupt and nonlinear land system change. It also contributes to the conference theme at large by deepening our understanding of land system dynamics over long time horizons and in four specific case study sites.

0512	Evaluating the effectiveness of protected areas in reducing tropical deforestation: a quasi-experimental analysis using remote sensing data	Xiao-Peng Song, Joe Maher	USA

Deforestation accounts for 12-20% of global carbon dioxide emissions to the atmosphere – the second largest source after fossil-fuel combustion. In current climate change discussions, efforts that aim to reduce emissions from deforestation and forest degradation and enhance forest carbon stocks (REDD+) are being considered as a cost-effective strategy for mitigating global greenhouse gas emissions. In the past decade, billions of dollars in international funds for have spurred governments in tropical regions to establish vast networks of Protected Areas (PAs). However, the *PA effect* – the causal link between PA

designation and avoided deforestation – is widely debated. The controversy surrounding the PA effect mainly stems from the non-random placement of PAs which tend to be established on marginal lands with pre-existing low pressure for deforestation, thus biasing comparisons between protected and unprotected areas. The key question is: how much deforestation would have occurred without protection? Overcoming the inherent complexity of this question requires reliable data on deforestation coupled with experimental techniques that can test for counterfactuals. In this analysis, we develop and demonstrate a two-step integrated approach to quantify the PA effect: (i) creating spatially explicit annual deforestation data from remote sensing that fit econometric analysis, and subsequently (ii) applying innovative quasi-experimental matching methods on the time-series deforestation data. Tested in a large area in the Amazon basin, our initial results suggest that different IUCN categories of PAs have various impacts on changes in deforestation rates over time. Indigenous areas have the lowest rates of deforestation across all IUCN categories. However, the formal designation of indigenous protection status does not cause any change in deforestation activity, suggesting that indigenous areas are located in regions that are unlikely to be targeted for deforestation. The outcome of this ongoing research is expected to provide policy suggestions to combat deforestation and mitigate climate change due to deforestation, which echoes the "land use based mitigation options" of the conference themes as well as the session title "assessing drivers of deforestation for climate change mitigation ".

| 0513 | Mapping agricultural abandonment across Europe using MODIS time series | Stephan Estel, Camilo Alcantara, Patrick Hostert, Tobias Kuemmerle, Daniel Mueller, Alexander Prishchepov | Germany |

Large-scale agricultural abandonment occurs mainly in temperate climate zones of developed and emerging countries. The abandoned land can potentially be used to increase crop or bioenergy production but also provides opportunities for ecological restoration and biodiversity conservation. Unfortunately, little is known about the spatial patterns and rates of abandonment, especially at broad geographic scales. This knowledge gap mainly relates to the lack of data and suitable methods to monitor agriculture abandonment over large areas.

Remote sensing datasets such as the Moderate Resolution Imaging Spectroradiometer (MODIS) with high-temporal frequency and coarse-spatial resolution provide considerable potential to improve large-scale mapping of land use change. Using Europe as an example, we developed classification methods to quantify agricultural abandonment. We compiled a smoothed time series of the Normalized Differenced Vegetation Index (NDVI) from both MODIS Sensors, Aqua and Terra for 2000 to 2012 with a temporal resolution of 8 days and classified fallow and active agriculture for each year. The resulting active/fallow maps had overall accuracies between 78% and 90% and allowed, for the first time, to map agricultural abandonment for entire Europe.

Hotspots of agricultural abandonment occur frequently on land less suited for agriculture (e.g., mountain regions such as the Alps or the Pyrenees, the Mediterranean, northern Europe). In Eastern Europe land abandonment is more widespread and show higher rates, mainly caused by the shrinkage of agricultural sectors after the collapse of the Eastern Bloc. The maps allow quantifying the spatial and temporal distribution of abandoned land and hence support more accurate assessment of drivers and outcomes of land use change and allow pinpointing areas where production increases are possible at low environmental costs.

This research contributes to the conference theme at large and the selected session by providing new insights into important and widespread land use change process of agricultural abandonment. Moreover,

	the research suggests that there is a considerable potential to deepening our understanding of land system dynamics over large areas using MODIS time series.		
0514	Climate change signals and the likely influence on future agricultural land use trajectories in the Nordic region	Doan Nainggolan, Mette Termansen, Marianne Zandersen	Denmark

It has been increasingly acknowledged that the agricultural sector faces both opportunities and constraints due to a changing climate, whose direction and magnitude vary from one region to another. Accordingly, land managers will need to adapt in different ways to climate change and the associated drivers, which may involve shifts in their agricultural land uses. The extent of such likely land-use changes will be simultaneously shaped by other important factors including the heterogeneous biophysical and socioeconomic characteristics within which land managers operate. Inevitably, local agricultural adaptation involving land-use changes will in turn shape regional agro-ecosystem trajectories. In this paper, by coupling the strengths of Geographic Information Systems and econometric methods, we develop a spatially explicit model to investigate the influence of existing climatic variation (along with biophysical and socioeconomic factors) on rural/agricultural land use patterns. The model is then used to explore how anticipated future changes in climate may trigger important shifts in rural/agricultural land use and hence influence agro-ecosystem trajectories at a regional level. The timescale of the modeling extends to up to the year 2060 and intermediate multi-temporal agricultural land use projections will be used to highlight likely trajectories of agro-ecosystem change. The fundamental assumption of the model lies on a profit maximization decision making in which, given the circumstances they are in, land managers choose to allocate a certain combination of a particular land area proportion and a particular land use option that would give the highest economic return. Enforced by the resolution of the accessible data, the spatial units of our analysis correspond to Municipality levels. The model is applied to the Nordic region encompassing four countries (Denmark, Finland, Norway, and Sweden) which represent heterogeneous agricultural production (both types and intensities), biophysical and socioeconomic characteristics, and policy influence. The outcomes of the model are expected to provide important empirical evidence on the likely impacts of climate change on future trajectories of agro-ecosystem across the Nordic region with potential applications elsewhere. It is anticipated that the model will provide an analytical platform for further investigating the possible consequences of different future scenarios not only in terms of future climate change but also in terms of potential environmental and policy directions for sustainable agro-ecosystem management.

0517	Perception of changes of the cultural landscape of rural areas of Kłodzko District in Poland	Paulina Dudzik	Poland

The main objectives of the research project was to determine the impact of changes in the cultural landscape of the rural areas of Kłodzko district, located in the south-western part of the Poland, area that has very rich multicultural history and has a clear geographical boundary separating it from neighboring areas, on reception of surrounding environment by the inhabitants, to determine what value it represents at present time and also the level of social awareness of the problem of cultural landscape transformation. In addition, the degree of coherence between landscape valuation analysis made by person skilled in the art and a chosen group of respondents was determined, as well as how assessment and suggestions of surveyed residents in chosen representative areas may affect the subsequent processes of planning and conservation in rural areas in the Polish reality where such approach is still fairly rare.

Because the focus was mainly on the visual aspect of cultural landscape (which is very often consistent with the other values - usually visually harmonious agricultural landscape is also an area of high natural and ecological values and has a measurable economic value), the process of valuation of the cultural

landscape is mainly basing on the comparison method that used a large archive of historical photographs and images taken today. The method used for comparisons was a method of sectoral panoramas analysis, developed by Niedźwiecka-Filipiak (2009). Residents of the pre-selected representative areas (chosen in terms of location, history, shape and direction of the current development) were also confronted with a simplified method of valuation, which was designed to determine the degree of perception and understanding of the changes that have taken place in the cultural landscape of the current Kłodzko district. The cultural landscape of the area, formed for many centuries by the Czechs, Germans and Poles is disappearing and these unfavorable changes were initiated in the postwar period. Many of the changes in the landscape is caused by social ignorance and irresponsible management of space, oriented mainly to obtain results in the present, leading to irreversible changes, characterized by a decrease in the value of landscape.

0519	Damage patterns after Hurricane Dean (2007) in the southern Yucatán: has human activity resulted in more resistant forests?	Laura Schneider, Megan McGroody, Deborah Lawrence, John Rogan, Irene Zager, Birgit Schmook	USA

We investigated how patterns of hurricane damage were related to windspeed, stand characteristics, and land use in a region where forest composition and structure have been strongly influenced by human activities. In 2007 Hurricane Dean hit the biological corridor between the two largest biosphere reserves on the Yucatán Peninsula as a category 5 hurricane. Land use mostly agricultural activities in the corridor have altered both landscape and forest stand structure. Compared to the upland protected areas, forests in the study area were significantly shorter and characterized by smaller stems. Nine months after the hurricane we assessed the damage in a set of 91 plots to test the effect of local stand structure on hurricane resistance. For each 5 x 100 m plot, we calculated the proportion of both stems and basal area damaged using 7 classes (no damage, small branch, major branch, stem bent, stem snapped, tree uprooted and tree death). Interviews with land- owners provided recent land-use histories for the past 30 years for most study plots. We tested the effect of median stem diameter, canopy height, stem density, basal area and tree species density on damage. Despite the strength of the storm, on average 27% of stems at the stand level showed no signs of damage and only 5% across the study were killed by the hurricane. In step-wise linear regression models, 13 to 52% of the variation in damage frequency was accounted for by windspeed and stand structure. Canopy height, basal area and median dbh were significant predictors. For moderate to severe damage classes, measures of stand size were generally positively correlated with damage frequency suggesting that stands with higher canopies and/or greater basal area or median dbh suffered the most during this storm event. A land-use history including clearing in the previous 30 to 50 years was associated with significant decreases in stand basal area, median dbh and canopy height as well as frequency of specific damage classes within the dominant forest type.

0520	Seasonally-adjusted vegetation change trajectories in differentially-managed transboundary dryland ecosystems in southern Africa	Narcisa Pricope, Andrea Gaughan	USA

Increasing temperature trends and wildfire incidence and more variable precipitation in southern Africa are predicted to have a variety of impacts on the ecology, structure, and function of semi-arid savannas which provide innumerable livelihood resources for millions of people. However, detecting long-term trends in vegetation change and attributing those changes to various underlying factors can be obscured by the strong seasonally-coupled precipitation and vegetation greening relationship. To account for this,

we use a NDVI-based residual trend method that utilizes a downscaled Geographically Weighted Regression (GWR) model to correct for wet-season rainfall effects on savanna vegetation. The model is regionally parameterized with MODIS 13a1 NDVI and Tropical Rainfall Monitoring Mission 3B43 precipitation data. We apply the model at a local scale using Landsat TM, ETM and OLI-derived NDVI to distinguish vegetation patterns after controlling for the seasonal influence of rainfall. The local analysis compares vegetation change in two community-based natural resource management (CBNRM) communities in Namibia and one in Botswana that are centrally located within the world's largest transfrontier conservation area (Kavango-Zambezi) in southern Africa. We examine vegetation changes between 1984 and 2013 using image differencing techniques and identify locations where changes in NDVI have occurred that are not explained by seasonal precipitation changes, indicating other underlying processes and management decisions operate on the landscape. We further investigate these areas using spatial coincidence analysis to understand the spatial correlation between changes in fire regimes over the last 14 years using the MODIS MCD45A burned area product (Pricope and Binford, 2012), ancillary cattle and human population density data and ground control data from previous field visits. Results highlight an overall increasing greenness and also distinct differences resulting from underlying land-use management decisions for fire and cattle grazing over the past 30 years with higher woody vegetation encroachment and more heterogeneous land covers in Namibian areas than in Botswana. Our work provides an important step in attributing observed vegetation changes to factors other than seasonal variability and a step in the direction of disentangling long-term climate change from changes induced by management on the landscape.

Our talk directly addresses the first major topic of the meeting, integrating research on land cover transitions in an area with historically-different management regimes and resulting landscape-level changes. Furthermore, our work contributes a southern African perspective to session 0030 by presenting a comparative, seasonally-adjusted model of long-term vegetation change that accounts for changes in fire regimes in a complex drylands ecosystem.

0522	Agricultural changes in European Russia: implications for food security	Kirsten de Beurs, Grigory Ioffe, Geoffrey Henebry	USA

Following the major setback of the 1990s in Russia as a whole, agricultural output has rebounded in recent years even though the area under crops and the number of cattle continue to decline. Against this backdrop the dynamics of agricultural sectors in Russian regions have diverged. For example, in the Non-Black Earth (Non-Chernozem) zone occupying the northern half of European Russia, the downward trend continues almost everywhere outside the most urbanized regions. The developments in Kostroma oblast exemplify this trend. But in Russia's south the socio-economic situation is very different. First, the shocks of the 1990s were not as deep as in the north. Second, the area under crops has stabilized, and there has been no further decline in cattle stock since 2000. The developments in Stavropol exemplify this situation. Stavropol is among the most important agricultural regions in Russia; it is second – after neighboring Krasnodar – in terms of output of grain. In this study, we used satellite data at two spatial resolutions (30m Landsat and 500m MODIS) and field observations to determine arable lands in the grain belt of European Russia After distinguishing arable land from other land uses, we mapped cropping intensity between 2002 and 2012 to get a better understanding of the activity occurring on arable lands. The intensity of crop management is a critical management decision that affects soil carbon stocks, weediness, and grain yield in croplands. Besides the ongoing land abandonment as a result of agricultural reform and rural depopulation, European Russia's grain belt is predicted to experience significant climate change. We identified potential changes of aridity in the grain belt and their effects on future food production.

0526	Urbanization in rural areas: population dynamics	Julia Côrtes, Álvaro	Brazil

	and land use change from a local perspective, Santarém - Brazilian Amazon	D'Antona	

Since the early 1980's, many studies have tried to understand the Amazon land use change and, particularly, the dynamics of conversion of forest, agriculture and regeneration areas. The studies offer a deep understanding about the deforestation dynamics, but the challenge to incorporate the urbanization process in land use models still remains. From the local perspective, researchers have to deal with a theoretical limitation to understand the transition from a rural property to an urban area. This lack of knowledge indirectly induces researchers to not consider the urbanization trajectory in studies at regional scales. In a few instances when the researchers attempt to incorporate urbanization processes, they face a technical limitation to identify initial forms of urbanization using satellite imagery. We intend to work on this theoretical limitation and analyze land use change transitions including urbanization as a cover class to minimize the gap in the theory of land change. The study area corresponds to the influence area of the highway BR230 and BR163, in central western of Pará State, encompassing eight cities. The analysis combines data from the Demographic Census and surveys in rural properties of Santarém (2003 and 2009 follow up). The results indicate that population mobility and spatial distribution are important elements in the rural urbanization process, and as consequence, in the land change studies. The family dynamics and agrarian structure changes are important elements of analysis that improve the understanding of the population dynamics and enable the development of the empirical model. The approach that includes urbanization is not only consistent with a global trend of increasing urbanized areas, but also proposes a better understanding of the role of population in the dynamics of land change. Considering this holistic point of view, it is possible to present a broader framework about land transitions, which also contribute to the construction of a multi-scale.

		Teresa Dias, Maria	
0527	Effects of increased nitrogen availability on the structure and functioning of a Mediterranean basin ecosystem	Amélia Martins-Loução, Lucy Sheppard, Cristina Cruz	Portugal

Increased nitrogen (N) availability, resulting from agro-industrial activities, affects ecosystems' stability. Mediterranean Basin ecosystems are biodiversity hotspots threatened by N deposition, however, little or no information is available on their responses to increased N. We develop an integrated system-level approach to study the responses of a Mediterranean Basin maquis to increased N availability. Since 2007, the form and dose of N available at the experimental site (ambient N deposition 5.2 kg ha^{-1} yr^{-1} and soil N 0.1%) was modified by addition of 40 kg NH_4^+-N ha^{-1} yr^{-1}, 40 and 80 kg NH_4NO_3-N ha^{-1} yr^{-1}. Control plots were not fertilized. Over the following years, the effects on plant and soil microbial diversity and some ecosystem services were assessed: soil N retention, below and aboveground C sequestration, and soil protection.

Over the first year, the added N was retained by the system and detected in the autumn as soil inorganic N. The increased N promoted plant and soil microbial diversity.

On the third year of treatments, soils from the control and litter from the four treatments were collected for a laboratory decomposition study. The leaf litter produced under the high N treatment was enriched in N and lignin. This study suggested that increasing N in Mediterranean maquis selected for plants with lower litter decomposability, potentially increasing soil organic matter. In agreement, after 5 years, soil organic matter had increased under the higher N dose. Also, on the fifth spring of N additions, plant richness increased with enhanced N and was more related to the cumulative ammonium than with the cumulative nitrate. Exposure to 40 kg NH_4^+-N ha^{-1} yr^{-1} (either alone or with nitrate) enhanced plant richness, but did not increase aboveground C sequestration or soil protection; soil N retention even decreased under 80 kg N ha^{-1} yr^{-1}. The treatment containing less ammonium, 40 kg NH_4NO_3-N ha^{-1} yr^{-1},

did not enhance plant diversity but promoted aboveground C sequestration and soil protection. The dataset permitted the first estimation of an N critical load for this European habitat (20-30 kg N ha^{-1} yr^{-1}). Data suggest that agriculture, the main source of NH$_y$, may affect the structure of the neighboring maquis, promoting soil erosion and N leakage. In contrast, industrial and urban activities that increase N availability as NO$_x$ may increase fire risk. This is of significant importance for land-use management in biodiverse and fragmented ecosystems such as the Mediterranean ones, especially in Natura 2000 sites.

0528	The efficiency of voluntary incentive policies for restoring forests: evidence from Vietnam	Man Li, Alessandro De Pinto, Timothy Thomas	USA

As a country characterized with rich forest resource, Vietnam has witnessed rapid decreases in natural forests over the past few decades. Vietnam had 14.3 million hectares of natural forests in 1943, covering 43% of the total land area of the country. The forests have fallen rapidly and by 2006 were just 10.4 million hectares, a 27% reduction. In response, the Vietnamese government has initiated forest rehabilitation and plantation programs since 1995, aiming at increasing forest cover to 44%−45% in the year of 2020. While its designation is clear, the strategies for achieving the goal are ambiguous. This is because in a rapid growing economy like Vietnam, land use would become more responsive to economic incentives than to administrative planning. The major objective of this paper is to explore the possible strategies to achieve the government's 2020 target. For this purpose, we construct a spatially explicit panel data set based on MODIS 500-meter Land Cover Type product of Collection 5.1 of 2001−2009, the commune-level Vietnam Household Living Standard Surveys of 2002, 2004, 2006 (Phung and Nguyen, 2008), and other ancillary data. We develop an econometric land use model that integrates micro-level household survey data with spatially explicit remote-sensing data. This modeling approach is capable of representing land use change responding economic incentives. With this approach, we design possible voluntary incentive policies to achieve the government's 2020 target. We also consider some low emission development strategies. The benefits and costs of various policies are evaluated and compared. This study would contribute to the conference No. 3 (Impacts and responses), especially to the section 0035, because it not only explores determinants of land use decision but also presents a method to identify the trade-offs of land use and investigate the most efficient strategies for restoring forests. The results of this study should provide valuable information to policymakers responsible for the design of land use and low emission development policies.

0529	Collapse and restorationof ecosystem networks	Norio Yamamura, Shoko Sakai, Noboru Fujita, Takao Itioka, Reiichiro Ishii	Japan

Most ecosystems on the planet have become seriously degraded due to human activities, and now in a critical condition. In order to cope with this problem, we proposed the concept of *ecosystem network* in a research project "Collapse and Restoration of Ecosystem Networks with Human Activity (Research Institute for Humanity and Nature, Japan, 2007-2012)". The ecosystem network has a nested network structure involving interactions between and within subsystems, including human societies. The goal of this project was to promote understanding of environmental problems associated with managing ecological resources and to contribute to their solution using the concept of the ecosystem network. In this talk, we present a summary of the project as several individual topics are presented in poster sessions. We addressed two tangible environmental problems under contrasting ecological setting: tropical rainforests in Southeast Asia (Sarawak, Malaysia) and grasslands in Central Asia (Mongolia), focusing on the degradation of pastures and the loss and degradation of forests, respectively. Research in both Sarawak and Mongolia comprised three core stages: (1) Identification of ecosystem network

structures underlying the problems: We first proposed hypothetical ecosystem network structures and then confirmed and evaluated these links through field surveys, remote sensing, literature surveys, and modeling; (2) Scenario analyses: We constructed multiple scenarios for each case study and estimated land cover and network structures for each scenario, evaluating the predicted ecosystem and social status using various indices; and (3) Implications for ecosystem conservation from the ecosystem network perspective: By comparing the case studies of Mongolia and Sarawak, we correlated the ecological characteristics of the ecosystems or ecological resources with the structure of the ecosystem network and the associated environmental problems. An important difference in the ecosystem networks of Mongolia and Sarawak was the relationship between enterprises and local people. In Mongolia, the local people use the grassland and its products are sold to enterprises, while enterprises may directly exploit the ecological resource of the forests in Sarawak. We suggest that the ecosystem network concept may be useful in coping with similar environmental problems of natural resource use. The study could contribute the conference theme of "Rethinking land change transitions". Since our research sites are in Mongolia and Malaysia, the presentation may best fit the session "Progress of land change sciences in Asia".

0530	Bayesian networks on social-ecological systems: a different way to skin the cat	Miguel Equihua, Michael Schmidt, Octavio Maqueo, Nashieli García, José Luis Álvarez, Christian Delfín-Alfonso, Pedro Díaz, Julián Equihua, Melanie Kolb, Sergio Ibáñez-Bernal, Manuel Maass, Griselda Benítez-Badillo	Mexico

Ecosystems envelop a wide array of processes; they are the arena where biodiversity is produced and developed. They are governed by the interlinked effects of many factors as well as randomness. Since the factors influencing these processes can only be partially observed, modeling aimed at decision support needs to capture these uncertainties. Bayesian networks (BN), trainable statistical multivariate probabilistic models, are still uncommon in environmental sciences. We propose a conceptual framework and apply it to a case study in tropical Mexico to test the ability of BN to quantify trade-offs between biodiversity, climate change mitigation, other ecosystem services (ES) and human well-being at different spatial scales under scenarios of climate and land use change. Our framework further develops existing socio-ecological constructs to fully integrate the human components and to create explicit direct links inside the BN. Parting from a broad sub-continental scale scheme from an international research project financed by the European Commission that investigates the Role of Biodiversity in Climate Change Mitigation (ROBIN), we produce spatially and thematically detailed quantitative datasets with the aim to supply useful information for decision making in Mexico on a landscape and national scale.
In this case study we show how we integrate the different parts of our socio-ecological framework, as we connect biodiversity indicators and indicators of degradation from human activities and the various socio-ecological system responses in a BN of ecological integrity (EI) and derive a set of several dose-response relationships. A BN encompasses the patterns of association among all the variables included in the network, so it models the conditioning effects operating in the system represented. We define EI

as the fundamental ability of an ecosystem to self-organize with expressions in biological diversity represented in four composite indicators: structural diversity, functional diversity, compositional diversity, landscape level characteristics and a linkage to human impacts. The first three are measures of biodiversity, while landscape captures structural diversity attributes on a broader scale and human impacts represent conditioning factors of integrity. ES have been selected for their relevance for climate change mitigation and based on existent quantitative data. The ecosystem services are modeled using the ARIES conceptual framework that is also based on Bayesian networks. Finally, in our proposal the different components are related in only one BN that allows us to quantify the relation of drivers and biodiversity (degradation curves), biodiversity and ecosystem services (provision curve), ecosystem services and human outcomes (benefit curves) and the whole socio-ecological system to sustainability (sustainability curves).

0531	Brazilian savannas: dynamics, processes and response to anthropogenic change	Mercedes Bustamante, Alexandre Pinto, Sabrina Miranda, Frederico Takahashi, Gabriela Nardoto	Brazil

The Brazilian Cerrado comprises one of the most diverse savannas in the world and is undergoing a rapid loss of habitats due to changes in fire regimes and intense conversion of native areas to agriculture. Variation in temperature extremes and in total amount of rainfall and altitude throughout the Cerrado determines marked differences in the composition of species. Functioning of Cerrado ecosystems is controlled by interactions between water and nutrient availability. In general, nutrient cycles are very conservative, while litter, microbial and plant biomass are significant stocks. In terms of C cycling, root systems and especially the soil organic matter are the most important stocks. Typical cerrado ecosystems function as C sinks on an annual basis, although they work as source of C to the atmosphere close to the end of the dry season. Fire is an important factor altering stocks and fluxes of C and nutrients. The relationship between total precipitation and dry season intensity with aboveground biomass variation in the Cerrado was examined. Dry season precipitation amount in cerrado areas in severe drought regions explained a significant part of the variation in aboveground woody biomass. This finding is important in the face of the predictions of longer and more severe dry seasons in the region due to climate change. Predicted changes in temperature, amount and distribution of precipitation due to global climate change vary according to Cerrado sub-regions with more marked changes in the northeastern part of the biome. Higher temperatures, decreases in rainfall with increase in length of the dry season could shift net ecosystem exchanges from C sink to source of C, intensify burning with reduction of nutrient stocks. Interactions between the heterogeneity in the composition and abundance of biological communities throughout the Cerrado and current and future changes in land use make it difficult to project the impacts of future climate scenarios at different temporal and spatial scales and new modeling approaches are needed.

0533	The impacts of land use change on regional climate change	Jiyuan Liu	China
0534	Agriculture adjustment, land cover re-distribution and rural population dynamics in a subtropical watershed	Ana Sofía Nanni, H. Ricardo Grau	Argentina

Patterns of land use and land cover change are usually grouped into one of two categories defined by the dominant trend: (1) deforestation resulting from expanding agriculture and (2) forest expansion, usually related to the

abandonment of marginal lands. At regional scale, however, both processes can occur simultaneously even in the absence of net change. Given the focus on net change, such redistribution of agricultural and natural and seminatural lands, has been generally overlooked. The interaction between agriculture modernization, human demography and complex topographic gradients of northwestern Argentina has resulted in processes of both forest recovery and deforestation; thus providing the opportunity to analyze patterns and driving forces of land cover redistribution. We analyzed 20 years (1986-2006) of land cover change in a subtropical watershed in relation to topographic and demographic variables. Although net forest change represented less than 1%, complex forest dynamics emerged when moist and dry forests were considered separately, as the expansion of moist forests over grasslands offset dry forests conversion to crops and pastures in lowlands. There was a consistent geographic segregation of deforestation and forest recovery, with forests expanding over steep highlands and agriculture expanding over lowland irrigated areas. Demographic trends explained 25% of land cover change: forest cover change was negatively correlated with population increase and, more importantly, with local rural immigration. Highland forest expansion and lowland deforestation respectively imply conservation opportunities for humid montane forests and the environmental services they provide (e.g. watershed conservation) and threats for the conservation of dry forests and its biodiversity. The presentation will contribute to the session by exemplifying the importance of land use re-distribution (rather than net change) as a framework for analyzing land use transitions, with relevant environmental consequences at regional scale.

0535	Potentials of VIIRS observations on Suomi-NPP and future JPSS Satellites in monitoring global and local land transformations	Xiwu Zhan	USA

The Suomi National Polar-orbiting Partnership satellite (S-NPP) was launched by NASA partnering with NOAA on October 29, 2011. Among five instruments Suomi-NPP carries is the Visible Infrared Imaging Radiometer Suite (VIIRS) that provides a bridge between NASA EOS Moderate Resolution Imaging Spectroradiometer (MODIS) and the future operational Joint Polar Satellite System (JPSS, formerly called National Polar-orbiting Operational Environmental Satellite System - NPOESS) VIIRS. Although the primary goal of the VIIRS instrument design was to the meet the needs of NOAA's operational weather predictions, much of the MODIS capability for land science has been retained. One of the four VIIRS land science foci is land cover land use change. The Surface Type Environmental Data Record (EDR) from VIIRS is currently generated for monitoring short term land transformations such as fire, snow and burned areas. New and enhanced data products will be needed for studies of long term land transformation or land cover changes resulting from climate change, which requires integration of VIIRS observations with data from MODIS, the Advanced Very High Resolution Radiometers (AVHRRs) on past and current NOAA Polar satellites and EUMETSAT MetOp satellites. Combined use of VIIRS, MODIS, AVHRR data with finer resolution observations from Landsat satellites and the Landsat Data Continuity Mission (LDCM) will enable the detection and quantification of local scale land cover land use changes. This presentation will demonstrate the potential uses of VIIRS data in monitoring global and local scale land transformations. Examples of using VIIRS data before and after a natural disaster event for impact extent monitoring will be presented. Approaches to combining VIIRS, AVHRR and MODIS data for long term trend monitoring will be tested.

0537	Agricultural trends in twenty-first century Latin America	Jordan Graesser, Navin Ramankutty, Mitch Aide, Ricardo Grau	Canada

Since 1961, plentiful land resources and sparse rural population have allowed Latin American and Caribbean (LAC) farmers to cultivate new agricultural land faster than the rest of the planet. Twenty-first century LAC agricultural expansion and production increased at the highest rate since the 1960s (FAOSTAT 2012). The unprecedented growth was largely sparked by global food demand for human and livestock consumption; currency devaluation, technological and infrastructure improvements, land

availability, and the growing biofuels industry were also key drivers. Consequently, agricultural expansion has replaced natural forests and savannahs. We used twelve years of MODIS satellite imagery to assess the rapidly evolving agricultural footprint in LAC. Specifically, we analyzed annual cropland and herbaceous vegetation trends from 2001 to 2012 to obtain a comprehensive continental-scale picture of regional agricultural trends. Our results show that the majority of significant agricultural changes occurred in a few LAC countries. Pastureland dominated expansion along the southern Amazon perimeter, while cropland (driven by soy farmers) directly contributed to frontier expansion in northern Argentina. Though overall expansion was the major theme of the twenty-first century, significant contraction of agricultural land was found in Mexico, Central America, and southern Brazil. The most rapid cropland areal changes in the twenty-first century occurred in the Argentine and Uruguayan Pampas, as well as in the Argentine Chaco. Herbaceous vegetation expanded most rapidly in eastern Nicaragua, the eastern Amazon border, near Santa Cruz, Bolivia, and in western Paraguay. The results show a landscape transformation in LAC led by cattle ranchers and soy farmers, both closely tied to national and global market demands.

0538	China's land use transition: a historical view for the past 300 years	Feng Zhu, Zhanli Sun, Yangfang Hou, Xuefeng Cui	China

To meet the challenge of thorough understanding the causes and processes of land use change and its implications for global environment and sustainability of human society, the concept of land use transition emerges as one of the efforts to identify some regularities for modeling and prediction from the complex land-use system. Studies have revealed that China has experienced the forest transition in 1980s, but most researches were based on a relative short period. While such approaches can successfully reveal the proximate causes of land use transition, some underlying drivers and slow variables (e.g., population change, climate change etc.), which are pushing the land use transition, and interactions between social and environmental systems can be easily overlooked or difficult to be addressed without investigating the process from a long-term perspective.

Basing on the synthesis of the available data of land use and population of China, we attempted, on a macro level, to demonstrate how the land use changes in China for the recent 300 years and to investigate whether, when and how the transition in land use occurred. The main possible underlying factors of land use transition were discussed: population, agricultural intensification, and government policies. We argued that the population is the ultimate underlying forces and always acted as an important factor in the reconciliation of the food security and environment protection, but its effect on land use is decreasing over the years as the yield increase resulting from the agricultural intensification could support more people with limited land. Thus the agricultural intensification made it less urgent and necessary to expand the land for food, providing the necessary condition for land use transition in China. The government policy aimed at quickly turning around the deteriorating environment formed the direct driving force of promoting the occurrence of land use transition in 1980s.

0539	Using the FORE-SCE model to project land-cover changes in the Pyrenees mountains (France)	Laure Vacquie, Terry Sohl, Ryan Reker, Sayler Kristi, Michelle Bouchard, Thomas Houet	France

Over the last centuries, land cover and land use of European mountains have experienced strong transformations. These changes added to the diversity of current agro-pastoral activities affect nowadays their spatial organization. Dynamics of natural reforestation have been observed for the past sixty years

due to a decline of production activities and a massive rural exodus. Land abandonment in the French Pyrenees is a complex process occurring at various temporal and spatial scales, with interlinked environmental, societal and economical stakes. Forest encroachment is globally predicted to increase in the next fifty years at the expense of agro-pastoral lands (e.g. grasslands and pastures), due to socio-economic transformations. Stakeholders have come to the realization that the analysis of complex geographic systems requires the use of spatially and temporally explicit models. In this context, the US Geological Survey (USGS) has developed the FORecasting SCEnarios of future land cover model (FORE-SCE) to spatially allocate land cover changes in the conterminous United States (Sleeter et al., 2012). Applied to the French Pyrenees, the FORE-SCE model uses ecoregion-based extrapolation of historical changes to project futures proportions of land cover. Using a wide range of known drivers of land-cover change, a logistic regression provides with probability-of-occurrence surfaces for each land-cover type. This paper presents an integrated approach to the construction of forecasting scenarios to assess the magnitude of landscape closing in the Pyrenees Mountains in regard of socio-economic trends and climate change. The scenarios are derived from (1) land covers trends from contemporary (1990-2006) land-cover changes to simulate the consequences of further land abandonment dynamics on LULC and from (2) storylines from the intergovernmental panel on climate change (IPCC) special report on emission scenarios (SRES) to assess the vulnerability of agriculture to Common Agriculture Policy (CAP) reform and the impact of climate change on reforestation dynamics.

As part of the "Trajectories of change in agro-ecosystems" session, this oral presentation intends to present the major trajectories of land cover and land use changes in French agro-pastoral ecosystems. It aims to expose various drivers of change and their impact on agriculture activities and provide stakeholders with a deeper understanding of agro-ecosystems sensitivity to human decision-making on land cover and land use.

0541	Time series analysis to detect trends in post disturbance vegetation patterns in a savanna system	Cerian Gibbes, Jane Southworth, Peter Waylen	USA

Savanna ecosystems are undergoing rapid changes in composition and structure which greatly influence the socio-ecological functioning and value of these systems. African savannas in particular are projected to be under risk of extensive changes in vegetation composition and distribution. Regarded as a mixed tree-grass system, the response of vegetation to disturbances in these systems is central to maintaining socially and ecologically valuable characteristics and functions such as biodiversity, and carbon storage capacity. The availability of long term systematic observations (30+ years) of the earth's surface from satellite imagery, holds significant potential for measuring vegetation changes in response to disturbances at regional scales. This work incorporates time series analysis of such data to examine vegetation dynamics in response to disturbances in southern African savannas. In this study region climate and human land use practices are the dominant factors shaping vegetation patterns. Changes in precipitation mean and variability are examined at the regional scale and long term trends in vegetation in response to these changes are identified using AVHRR and MODIS data from 1982-2009. Additionally, the regional scale experimentation with a wide range of land use strategies, offers an ideal location for testing the contribution of human decision making to the complexity of vegetation changes. This work intentionally intertwines qualitative social data analysis with the quantitative analysis of climate, land use, and vegetation patterns to investigate the interrelations between the social and natural systems. Results from this work form the basis for scenario modeling of savanna system interactions. The results indicate that at a regional scale significant drying occurred across much of the study region from the mid 1970's through 2010, and that the drier environment when combined with landscape modifiers, such as fire (anthropogenic and natural), has significantly altered vegetation patterns thus affecting land use strategies at a local scale.

0543	Simulating the yields of bio-energy and food crops with the crop modeling software BioSTAR in the context of a sustainable development in the agricultural sector	Roland Bauböck	Germany

With a growing world population and rising prices for fossil fuels, the production of food and energy on agricultural land is increasing. In an intensively used agricultural landscape, like the one prevalent in central Europe, the use of agricultural land is subject to a diverse spectrum of demands put upon it by different stakeholders. Agricultural lands are producing food, energy, raw materials for the industry and, they also need to provide the space for ecological functions and services. Excessive or lopsided uses of a landscape can easily tip sensitive balances, like retaining a good soil carbon balance or, keeping nitrate leaching low. In some parts of Lower Saxony, a more or less uncontrolled boom of bio-energy facilities has already led to such imbalances. Nitrate in the ground water is on the rise, soil qualities are declining and, a reduction in biodiversity can be observed. The research project "Sustainable use of bio-energy, bridging climate protection nature conservation and society" (BIS) is attempting to find solutions for some of the problems associated with bio-energy facilities today. One of the key findings of the project is that only a sustainable development of bio-energy, which includes ecological, economical as well as social sustainability, will lead to a successful and accepted development of bio-energy in a region or a state. One part of this sustainable development is the integrated energy crop production. The integrated energy crop production avoids mono cultures, broadens the spectrum of crops in a landscape, implements measures of soil and water conservation and tries to integrate other ecological functions into a farming system. Planners, farmers or other stakeholders often don't know about alternatives to the well-known cultures and crop rotations and avoid possible economical risks associated with them. With the new crop model, BioSTAR (Bauböck, 2013), a tool for large and small scale biomass prediction has been developed. With BioSTAR (**Bio**mass **S**imulation **T**ool for **A**gricultural **R**esources) yield changes induced by new crop rotations or the implementation of new crops can be simulated and hence economically evaluated. The paper presented here gives an introduction to the model BioSTAR and outlines the advantages of such a tool for the implementation of sustainable planning in the agricultural energy sector.

0544	Ecosystem services responses to changes in land-use in the peri-urban fringe of Adelaide, Australia.	Harpinder Sandhu, Andrew Millington, Robert Keane, Shuvra Roy, Andrew Boyd, Kathryn Bellette	Australia

Peri-urban land use change in a significant global phenomenon that is considered in many contexts such as planning, food security and biodiversity. Peri-urban change is a significant issue in Australia because the five major metropolitan areas (housing over 60% of the population) have expanded onto very scarce agricultural land assets. Yet the issues is under-researched. Nowhere is this more of an issue than around Adelaide – the case study we present – where encroachment since the 1950s has taken very valuable land out of cereal, stone fruit and vine cultivation and now threatens two globally-recognised wine regions – Barossa Valley and McLaren Vale – that economic-valuable to the Australian economy. We concentrate on McLaren Vale and use a (i) combined land-cover change and ecosystems services approach to show the impact of the recent change in land use and its impact on ecosystem services; and (ii) examine the role that ecosystem services can play in better informing decision makers in this region (and elsewhere in Australia) and in enabling legislation to protect historically-important wine growing regions like McLaren Vale and Barossa Valley to be effective in managing peri-urban land-use change.

0546	The 'hidden agenda' of land reclamation in	Oyuntuya	Germany

	Mongolia: the role of civil society in mine site inspection and monitoring	Shagdarsuren

Mongolia has experienced an unprecedented mining boom since the Minerals Law of 1997 and the government's ambitious "Gold" program. Here, land was historically commonly owned and the institution of private land ownership first became possible only after transition to market economy in the early 1990s. Land privatisation reforms are presently contentious with traditional land rights as well as recently introduced mining rights. Tensions are especially high among different actors competing to gain access to land and the valuable mineral resources. Over 6000 deposits of 80 different minerals have been discovered and exploration licences covered 40 per cent of the land territory of Mongolia during the peak period in the late 2000.   However, mining in Mongolia has caused land surface degradation due to the lack of environmental reclamation. Efforts to improve land reclamation from mining activities are ongoing and yet progress and results need to be investigated and assessed. On the other hand, mining sector growth was coupled with the strengthening of civil society who is actively engaged in monitoring land use by mining companies.

This presentation will discuss the role of civil society in mine site inspection and monitoring and the politics of land reclamation. Environmental NGOs in Mongolia visit mine sites on regular basis and report on various aspects of the mining cycle such as the production size, sales of mining products, status of payments to the government including the fees for the use of mineral resources, land and water among others. In addition, environmental NGOs check the company's environmental reclamation plan and monitor its implementation. On-site inspection reveals "the hidden agenda" of the mining companies which are not visible in the official reports. The uptake and up-scaling of this monitoring practice by the government of Mongolia will be critical for enforcing its policy of promoting responsible mining. Failure to do so will further threaten the fragile ecosystem of Mongolia and accelerate the desertification process while the vast land resources traditionally used for pastoral livestock production will be in danger of losing its value for human habitat.

The aim of this presentation is to contribute to GLP 2nd Open Science Meeting "Land Transformations: between global challenges and local realities" and discuss a practical case study where the so-called environmental reclamation companies were mining for gold in areas where mining was prohibited. I will discuss the socio-political situation in order to provide a realistic picture for researchers and policy-makers alike.

0549	Impacts of the setting up young farmers measure on agricultural land	Thomas Bournaris, Christina Moulogianni, Fedra Kiomourtzi, Basil Manos	Greece

The "Setting up Young Farmers" measure supports the entry of young persons into the agricultural sector by moving land from older to younger farmers. This paper aims to assess the impacts on agricultural land from the implementation of this measure in Greece during the 2000-2006 and 2007-2013 programming periods. For this reason, a sample of young farmers who have participated in the "Setting up Young Farmers" measure during 2000-2013 in Northern Greece was chosen. The study was made in two parts. The first part includes the analysis of the young farmers' farm plans for both programming periods. The second part includes the implementation of an MCDA model for farm plans optimization and the comparison of agricultural land use with the results estimated in the first part of the analysis.

0551	Analyzing patterns of land use change in Europe: integrating changes in land cover and land-use intensity	Christine Kroisleitner, Christoph Plutzar,	Austria

		Claudia Bulgheroni, Karl-Heiz Erb	

Patterns of land-use and land-use intensity in Europe have been changing considerably in the last few decades. While land use intensity is increasing in some regions, other regions are experiencing extensification or even land abandonment. Concomitantly, the extent of cropland, grazing land and forested areas is changing, resulting in complex patterns of landscape changes that differ substantially between regions. However, a consistent analysis of major patterns of the interplay between area changes and changes in land-use intensity is lacking.

We apply a 4-field-approach that classifies regions into (1) areas of simultaneous land use expansion and intensity increase, (2) regions with expansions of land use but declines in intensity, (3) regions with declining cropland extent, but yield increases and (4) areas where land-use extent as well as yields decline. We else depict "cold spots", i.e. regions that show little changes in yields or cropland extent. This combination of area and yield changes delivers quick insights into the spatial patterns of land-use change while requiring manageable data input.

We will present this analysis at a spatial resolution of 1km² for 25 European countries for the time slices 1990/2000 and 2000/2006, separately for the major land-use types cropland, permanent cropland, forests and grazing land. The maps are based on a consistent and comprehensive land-use dataset created in the VOLANTE-project from a variety of input data, including spatially explicit data (e.g. Corine, Dynaspat), census data (e.g. CAPRI, EFI) cross-checked with international statistics provided by FAO and Eurostat and integrated in a GIS. The resulting 4-field maps allow to map and quantify changing land-use and land-use intensity patterns on a pan-European scale. We find considerable variation across individual regions, influenced, among others, by political processes such as EU integration. Processes such as land-use intensification or land abandonment are visualized consistently across the EU-25. We discuss the suitability of the 4-field-approach for analyzing land-use changes with a high resolution dataset. This will provide useful insights for a deeper understanding of European land system change.

0553	Understanding trade-offs across time and scale by linking process-based land use changes with local stakeholders knowledge through 3D-based collaborative platforms	Adrienne Grêt-Regamey	Switzerland

Given the growing needs for services provided by nature, our challenge is to understand and thoughtfully manage the trade-offs among them. Particularly suburban landscapes are transforming with high dynamic, generating complex new patterns, which lack urban quality in terms of urban form, social structures, and ecological sustainability. Past and current policy strategies have not managed to mitigate the impacts of these trends yet, calling for more disruptive changes in society and in the management of these systems based on a sound understanding of the requirements for adequate ecosystem services functioning and trade-offs among the services over time and scales. Especially, when cultural services have to be weighed against provisioning services or the development of infrastructures, key for securing socio-economic development, new approaches for resolving complex trade-offs are necessary. We present several examples of interactive 3D visualization tools linked to GIS-based modeling in urbanized landscapes providing an essential interface for explicitly considering often unintentionally ignored landscape services trade-offs. A crucial factor in the success of such tools is the communication of the relevant information to decision-makers in a credible and comprehensible manner. Virtual decision environments have been suggested for controlling variables within a decision context made real by tangible inducements. Interactive and immersive 3D landscape visualization tools combining visual and non-visual information seem to be valuable for assessing different landscape change scenarios in stakeholder processes. We conclude about the effectiveness of the approach as a means of encouraging

lay people and stakeholders to get involved efficiently in the development of land use patterns securing the long-term provision of needed services.

0558	How pervasive is export-oriented deforestation across the tropics?	Ruth DeFries, Martin Herold, Louis Verchot, Marcia Macedo, Yosio Shimabukuro	USA

Identifying and implementing effective approaches to reduce deforestation for climate mitigation hinge on understanding the drivers. Market mechanisms such as moratoria and certification of supply chains can be effective for reducing deforestation driven by agricultural exports, whereas these mechanisms would not be effective for deforestation driven by local pressures. We assess how pervasive national-level drivers of export-oriented deforestation are across tropical forest countries, using Brazil as the example where export-oriented agriculture has been a key driver of deforestation in the past decade. About half of deforestation in 2000-05 occurred in countries with high agricultural exports and urbanization similar to the drivers in Brazil (DeFries et al 2013). However, very few countries have governance and capacity similar to Brazil, indicating the difficulties of replicating that country's success with reducing deforestation in the second half of the decade. The prominence of deforestation driven by international and urban demand for agricultural commodities calls into question the standard model of forest transition as agricultural land is not likely to be abandoned.

0560	Social and environmental transformation in the Indian Peri-urban landscapes - an overview	Seema Purushothaman	India

India is witnessing expansion of nearly 431 Class-I cities[1] acting as nodes of domestic and global capital. Growing economies in these expanding cities thrive on their peripheral areas, using them both as source and sink of natural and human resources. Population in the peri-urban interface of major cities often grows more than that of their urban cores (Sivramkrishna et al 2005). In this interface that lies geographically contiguous with the rural, a speedy transformation in livelihoods and consumption styles come with diverse externalities. These constitute the peri-urban socio-ecological subject that appears to fall through the cracks of rural *versus* urban approaches in policy making, governance and disciplinary academics.

The definitions of peri-urbans vary, but there is some consensus on the need to move beyond a pure spatial definition in demarcating peri-urbans. The paper discusses characterization of Indian peri-urban interface in cross-disciplinary literature, representing spatial, functional and process-oriented transformation. It will also cover case studies illuminating larger socio-economic implications of livelihood changes, land conversion and acquisition, waste water management and governance. Finally the paper discusses mechanisms to harness potential of these vibrant socio-ecological buffer spaces to create synergetic rural-urban development.

0564	An integrated approach to understanding the effects of increased nitrogen availability in a Mediterranean basis ecosystem	Teresa Dias, Maria Amélia Martins-Loução, Lucy Sheppard, Cristina Cruz	Portugal

Increased nitrogen (N) availability affects ecosystem stability at local and global scales. However, most of our knowledge of effects of increased N deposition on ecosystems comes from northern Europe and America. Mediterranean-type ecosystems appear on the 'neglected ecosystems list' despite being a global conservation priority. In fact, little is known about the effects of N deposition on such ecosystems

in the Mediterranean Basin, which have experienced intensive human development and impact for millennia, and where N deposition is expected to increase threefold by 2050.

The most distinctive features of Mediterranean ecosystems, in terms of potential responses to increased N, are: climate; soils; dominance of dry N deposition; asynchrony between N availability and biological activity; and spatial and temporal heterogeneity. On the basis of these distinguishing features, it seems likely that Mediterranean ecosystems may respond rather differently from north temperate ones. For these reasons, in 2007 an N-manipulation (dose and form) field experiment was established in a severely nutrient-limited Mediterranean Basin maquis. N availability has been modified by the addition of 40 kg NH_4^+-N ha^{-1} yr^{-1} (mimicking agriculture), 40 and 80 kg NH_4NO_3-N ha^{-1} yr^{-1} (mimicking agricultural and urban/industrial activities). For over six years, a unique integrated system-level approach has been continuously complemented and improved to assess the impacts of increased N availability. The cascading interaction between structure and functioning of above- and below-ground communities has been evaluated to demonstrate whether:

- Changes in N dose and form affect N biogeochemistry and biodiversity;
- Alleviating N limitation may exacerbate other limitations (e.g. phosphorus and water);
- Changes in ecosystem structure translate into changes in ecosystem functions and services; and whether these structural and functional changes can be related to land use.

To our knowledge, this is the only and longest N dose and form field manipulation experiment running in the Mediterranean Basin. Also, our results contrast most studies due to the low N status of the system (ambient N deposition 5.2 kg ha^{-1} yr^{-1} and soil N 0.1%), which makes this experiment particularly relevant within the European context since N deposition in most ecosystems has already reached a threshold beyond which diversity has declined. The uniqueness of this N-manipulation experiment has already attracted international collaboration but would benefit from collaboration with experts in modelling, microbial ecology, plant anatomy, entomology, plant-animal interactions, genomics, transcriptomics, ionomics and metabolomics.

| 0565 | Rush for cash crops: implications for pressure on land, access rights and REDD in Laos | Rikke Brandt Broegaard, Thoumthone Voungvisouk, Ole Mertz | Denmark |

Laos witnesses a strong rush for cash crops as a response to market demands for agricultural products, especially from the neighbouring countries. The opportunity for increased economic income attracts manifold actors to forward the growing interest in agricultural production. In north eastern Laos, maize is currently the boom crop, grown under a system of contract farming for the Vietnamese market. The Lao government simultaneously promotes policies towards increasing economic development through increased engagement in concessions and increased production of cash-crops and towards increasing forest-cover and prepare for participation in REDD projects. Lao farmers make considerable income from the contract farming, but there are also economic and other interests from investors and government representatives at different levels. The rush for cash crops is also visible in the resulting land use patterns. The increased pressure on land also has implications for how the villagers in the case-study villages think about rights to access and use land allocated to the village. This paper explores how the recently booming of cash crops effect traditional land use of local communities and encroachment of forest in the case-study areas, and how different authorities react to these changes in land use, considering that they face contradicting policy-goals. Through its focus on cash-crop production, REDD-preparation and interactions among donors and NGOs, civil servants from different sectors and different levels, and famers, the paper links the global environmental concern and global food interest to local land use changes and negotiations over authority. Furthermore, it looks at the contestation of

different claims to rights and resource use, and of different policies, and how relations of authority and power are (re-)created simultaneously with the distribution of rights and obligations. The district authorities have recently entered into a contract with a Chinese company, promising the availability of 56.000 ha. of land (equivalent to a quarter of the entire district) for biofuel plant cultivation. This production is also supposed to be organised on a contract-farming basis. The paper analyses the detailed series of actions, permits and interests that lay behind this extraordinary approval in Houa Meuang District, Huaphan Province, as well as who can reap the benefits of the new agreement – and who will pay the cost in terms of reduced access to land? Is there any space left for REDD? And if not, how does civil servants working with REDD readiness respond to this?

0566	Trajectories of change in agro-ecosystems: sustainable intensification in maize-based smallholder faming systems in Kakamega, Kenya	Diego Valbuena, Jeroen Groot, Bruno Gérard, Pablo Tittonell	The Netherlands

Understanding the diversity of current states and past trajectories of livelihoods and agro-ecosystems can generate relevant knowledge to better contextualise and support discussions regarding the impact of promising agricultural innovations on the livelihoods and adaptive capacity of different smallholder farming systems, and on the SI of agro-ecosystems. In Western Kenya, for example, the interaction of agro-ecological (e.g. climate and topography) and socio-economic properties (e.g. population dynamics and markets) have generated diverse livelihood strategies and soil fertility management practices among households influencing potential future SI pathways. Trajectories of livelihoods and agro-ecosystems include changes and interactions of various processes at different spatial and organisational levels. The objective of this presentation is to explain trajectories of change at different spatial levels to better contextualize opportunities for SI pathways of livelihoods and agro-ecosystems in a maize-based system in Western Kenya. The multi-level analysis of trajectories was based on the collection and comparison of data and indicators on drivers, livelihoods and soils in 2003 and 2013. Indicators on the major changes in biophysical and socio-economic drivers were collected by gathering secondary data of that period to better contextualise changes in livelihoods and farming systems. The results show that the trajectories of change of selected households has been large influenced by the interaction and dynamics of biophysical and socio-ecological drivers. Nevertheless, local dynamics of the agro-ecosystems and individual households have largely determined how these drivers have influenced livelihoods and farming systems and how households have adapted or coped with such changes. Although agriculture intensification remains a major strategy for food self-sufficiency among rural households, income diversification have become a fundamental strategy enhancing the resilience of smallholders farmers within a more market-oriented context. This presentation emphasise the importance of trajectories of change in better contextualising SI in cereal-based agro-ecosystems.

0569	Tree-cover transitions as hypotheses about space, time, actor and policy interactions	Meine van Noordwijk, Anja Gassner	Indonesia

The forest transition concept has captured the imagination of many at the science-policy interface. However, it may be the result of an oversimplification of multiple types of tree cover change, which depending on forest definition used, give the impression of reappearance of what was lost. A new effort to set up a pan-tropical system of Sentinel Landscapes by the CGIAR Research Program on Forests, Trees and Agroforestry, will allow more rigorous testing than currently feasible of a set of twelve hypotheses that relate to tree cover transitions as temporal, spatial and/or institutional phenomena, that influence the full spectrum of ecosystem services and hence lead to stakeholder concerns and preferences, modulated by governance (sticks, carrots and sermons). Within the overall tree cover transition concept, more specific forms such as tree diversity transitions focus on the qualitative

difference between trees retained, spontaneously established or planted. Current interest includes the logical connections between concurrent changes in all phases of the curve, including the options of attractors outside of the forest margin reducing pressure on remaining natural forest. This presentation will set the scene for the subsequent case studies, and will include various approaches to stratify study landscapes for more detailed sampling. Sentinel landscapes are set up to allow monitoring of change over time, and thus need to deal with changes in the land cover, the actors/drivers/levers, the resultant functionality and services, as well as institutional context. Design principles for the surveys will be articulated and early results discussed.

0570	Re-thinking transitions in rainfed farming landscapes in sub-Saharan Africa	Deborah Bossio, Fred Kizito, Justine Cordingley, Lulseged Desta	Kenya

In most sub-Saharan African countries, ecosystems and ecosystem services, and the ways people benefit from them, have changed markedly in the past 60 years, primarily driven by rapid changes in society, yet agricultural intensification policies and programs have kept their focus primarily on increasing production of cereal crops through conventional intensification pathways. Recent thinking has called instead for ecological intensification of farming within agricultural landscapes (Tittonell, 2013). In a new research program, a paradigm shift is proposed that will unite agriculture and nature in a landscape approach to sustainable intensification. In this presentation we pose the question 'If an ecosystem based approach was taken, how might that alter intensification trajectories and entry points?' Using land use and land cover change analysis, ecosystem service assessment and participatory modeling, examples from contrasting environments will be presented in which conventional verses ecological intensification trajectories are mapped, illustrated and assessed. The focus will be on landscapes that have suffered land degradation, and restoration is part of the necessary strategy for sustainable intensification. This presentation contributes to the conference theme 'Rethinking land change transitions' by exploring alternative pathways towards agricultural intensification that start with a focus on delivery of the multiple ecosystem services that society now requires from our agricultural landscapes. It contributes to the session 'Trajectories of Change in Agro-Ecosystems' by deepening our understanding of possible trajectories of intensification, grounded in learning from the past and current trends, and particularly how ecosystem services approaches can help build consensus surrounding possible trade-offs in future scenarios. A landscape perspective provides a framework so that trade-offs and synergies between various ecosystem services are made evident.

0573	Shifting cultivation dynamics within an ecosystem service hotspot of pronounced global interest - a first step towards negotiating trade-offs in North-East Madagascar	Julie Zähringer, Cornelia Hett, Sandra Eckert, Bruno Ramamonjisoa, Peter Messerli	Switzerland

The north-eastern escarpment of Madagascar has been labelled a global biodiversity hotspot due to its extremely high rates of endemic species heavily threatened by accelerated deforestation rates and landscape change. The traditional practice of shifting cultivation on which the majority of local land users depends to produce subsistence rice, is commonly blamed for these threats. A wide range of stakeholders ranging from conservation to development agencies, and from the private to the public sector has therefore been trying to turn around the predominant landscape trajectories for decennies, mainly through the establishment of protected forest areas and intensification of commercial agriculture. Altough a recent study shows that deforestation along the north-eastern escarpment has slowed down over the last 15 years, up to date it remains unclear how this phenomenon is linked to shifting cultivation

dynamics and thus to the livelihoods of thousands of highly impoverished local land users. Because of their high spatial and temporal dynamics which present significant challenges to commonly used remote sensing techniques, shifting cultivation systems do not appear on recent land cover maps of the region. As long as these regional landscape dynamics are not well understood, trade-offs between provisioning, regulating and socio-cultural services and between multi-level stakeholders remain ambiguos. This study therefore aims at improving the knowledge base regarding shifting cultivation dynamics at the regional level and proposes to link generalised landscape units with multi-level stakeholders through their claims on ecosystem services.

A novel GIS approach termed "landscape mosaics approach", developed for the assessment of shifting cultivation dynamics in Laos was transferred to Madagascar and adapted to the local context. Through this moving-window approach generalised landscape mosaics were generated and shifting cultivation systems spatially delineated. Change maps of landscape mosaics for three points in time between 1995 and 2011 allow for a better understanding of changes in land use intensities and to explore the impact of protected area establishment on landscape trajectories. The proposed presentation will thus contribute to this session by illustrating change trajectories within a highly dynamic and widely condemned agroecosystem in a biodiversity- and carbon-rich region of pronounced global interest. In addition, an outlook will be given on how in a next step of this study these generalised landscape units could serve as base to link multi-level stakeholders with ecosystem services to improve the base for negotiating trade-offs towards sustainable development of north-eastern Madagascar.

0578	Soybean and deforestation in Argentine Chaco: environmental market initiatives and regulation in a context of soybean export concentration to China	Ignacio Gasparri, Ricardo Grau, Yann Le Polain	Argentina

The Argentine Chaco is facing profound challenges related to global demand for soybean, especially from China and Europe. In view of these challenges, new initiatives for environmental governance are emerging, among which a new national forest law, responsible soy standards, and a potential carbon market (REDD+).

Since the 1990's, soybean cultivation turned into a major driver of deforestation in the Chaco. This situation was reinforced in 2002 with the irruption of China as major market for Argentinean soybean exports and the local stimulus resulting from currency devaluation. In contrast to Brazil (with adopted transgenic cultivars in recent years), Argentinean agriculture adopted transgenic cultivar of soybean in 1997. As a result, during the past two decades, Brazil oriented export to the European market with restrictions for transgenic and Argentina oriented its exports to Asia but especially to China. The Argentine exports orientation to non-European market opens questions about the potential impact of label initiatives impulse from Europe (e.g. RTRS). Additionally, two national situations create uncertainty about the impacts from soybean labeling: a) the main soybean production (80-90%) is from the Pampa region where there is no deforestation and have areas with production practices easy to satisfy label standards and b) the national soybean sector has strong links with cattle ranching; and deforestation could be driven by soybean economy but implemented to pastures expansion.

Argentina recently passed a new forest law that includes forest zonation and payments for ecosystem services that could be reinforced with REDD+ initiative. REDD+ has the potential to promote conservation of the Dry Chaco with alternative approaches and co-benefits. One option is to reduce emission from deforestation, which implies payments to one of the most concentrated economy sectors of Argentina. The alternative option is to reduce emissions from forest degradation by discouraging extensive cattle ranching in forests. This second option would affect a greater number of smaller-scale producers, and could therefore bring greater social co-benefits, but it might actually only delay

deforestation, since underlying market forces driving deforestation will remain unaffected.

Land use change governance in the Argentine Chaco is based on zonal regulations. However, it is also necessary to incorporate aspects related with drivers of change, not captured at local level: a) the link of the Chaco agricultural frontier with the core agricultural region of the Pampas, and b) the orientation of soy exports towards the Chinese market, without significant requirements for environmental standard.

0580	Vulnerability, resilience and sustainability of the land systems	Teiji Watanabe, Hideaki Shibata	Japan

GLP Sapporo Nodal Office is addressing synthesizing vulnerability, resilience and sustainability of the land systems. For this goal, the office has conducted various activities. This presentation first briefly introduces the major activities conducted by the Sapporo Nodal Office, and then discusses a few case studies on land use related to livestock grazing in Asia.

The first case study was conducted in the Alai valley, southernmost Kyrgyzstan. Kyrgyzstan has experienced three phases of the major land-use changes on pastures by sheep and goats: (1) intensive land-use in the Soviet time from the 1930s to 1991; (2) drastic decline of land-use immediately after the independence form the Soviet Union in 1991; and (3) 'new' land-use after economic recovery/growth since around 2000. The intensive land-use of the pastures in the Soviet time is attributed to the strict governmental controls, which had often caused overgrazing. The drastic changes in the 1990s have been directly related to privatization of the livestock under the extreme poverty conditions. Further, there were no effective legal framework and no institutional supports in that phase. In the past decade or so, the number of livestock has increased in the area, especially that owned by outside uses, who have brought their livestock from their residing villages far away from the Alai valley. Free land-use but non-controlled land-use led to uneven pasture use. The local livestock farmers have not realized great uncertainty and danger of such uneven pasture use. Yaks have been also grazed for meat in the area, although the magnitude is much smaller.

In the high Nepal Himalaya, yaks and their hybrids have been involved in trekking tourism at least since the 1980s. The current roles of the livestock became much greater than before. The use of such livestock has completely changed land-use patterns, so that the extensive pasture degradation has been developed. In the Khunjerab National Park, northern Karakorum, Pakistan, local livestock farmers have used yaks and their hybrids for adventure tourism since 2009. Meanwhile, in Central Asian countries such as Kyrgyzstan and Tajikistan, introduction of ecotourism is expected for establishing sustainable mountain societies. However, livestock in these countries have not been utilized for touristic purposes yet. Further, dynamics of the pasture use in Kyrgyzstan would be greatly influenced by recent (2009 onward) decentralization of the pasture management.

0582	De-spatialization of land use change? A displacement analysis of cattle farming in the Amazon	Florian Gollnow, Tobia Lakes	Germany

The Brazilian Amazon has developed to one of the world's most important deforestation hotspots in the last decades. Cattle farming has frequently been identified as a major proximate driver of deforestation. Others, however, argue that deforestation is associated with the expansion of soy cultivation into pastoral areas and thereby displacing cattle ranching to peripheral zones associated with deforestation. Such a de-spatialization of drivers of land use change and more specifically indirect land use change (ILUC), meaning that activities displaced from one region are reconstituted in another region, are increasingly being discussed.

The aim of the study is to find evidence for the displacement of cattle farming along the BR-163 within the arc of deforestation (Mato Grosso & Para, Brazil). We conduct a panel analysis to statistically link the dynamics of land use change between regions using census, biophysical and market related data between 2000 and 2010. Source and target region of potential ILUC are defined based on major

agricultural production characteristics within the districts in Mato Grosso and Para state.

Using the panel analysis we estimate the influence of soy expansion in Mato Grosso on deforestation and cattle production, while controlling for additional factors influencing deforestation dynamics, i.e. biophysical-, market-, socio-economical-, and transportation related factors relying on earlier studies on deforestation. Additionally we use lagged variables, to account for the temporal gap between replacement and reconstitution of cattle farming.

Our results suggest a strong link between the expansion of soy cultivation and cattle ranching between the two regions. ILUC can be understood as an underlying driver of deforestation, where soy expansion displaces cattle ranching, which in turn becomes a driver of deforestation. These results are underpinned with qualitative research on the migratory history of cattle farmers within the region. However, other factors, such as the increase in prices for Brazilian beef and growing export orientation of beef production also affects the dynamics of cattle ranching within the Brazilian Amazon. Our results allow new insights into the temporal and spatial heterogeneity of dislocation processes.

This paper is intended to support the session with a regional example of analyzing land use displacement and revealing distant drivers of land use change. We contribute to the understanding of displacement processes and de-spatialization of land use change at a regional scale.

0585	Implications of land-system regime shifts for business-as-usual scenarios in REDD+	Daniel Müller, Zhanli Sun, Thoumthone Vongvisouk, Dirk Pflugmacher, Jianchu Xu, Ole Mertz	Germany

Reducing emissions from deforestation and forest degradation plus enhancement of forest carbon stocks (REDD+) relies on the prediction of future land use under business-as-usual conditions to ensure that emission reductions due to carbon credits are additional. However, land systems often exhibit periods of nonlinear and abrupt change that invalidate predictions calibrated on past trends. For example, rapid agricultural expansion can take off when previously unknown thresholds in broad-scale underlying drivers such as national policies or global commodity prices are surpassed. As a result, land systems shift to new regimes with different economic and ecological characteristics, including possibly substantial impacts on forest carbon stocks. Yet, the anticipation of tipping points that trigger regime shifts of land systems is extremely challenging because future trends in underlying drivers are uncertain, which compromises the validity of business-as-usual predictions of land-system change.

We demonstrate how gradual changes in underlying drivers caused rapid, surprising and widespread land-use responses by drawing from case studies in four countries in Southeast Asia (Xishuangbanna in China, Huaphan in Laos, Nghe An in Vietnam, and Kutai Barat in Indonesia). Our results show that crossing tipping points led to regime shifts in land systems that were difficult to anticipate and would be costly to reverse, if at all possible. Rising commodity prices (China and Indonesia) and national policies (Vietnam) were the main underlying drivers that set off regime shifts. It is very likely that future developments are also not 'usual' and regime shifts may be imminent particularly in Laos and in Vietnam.

The difficulty to foresee such regime shifts compromises the identification of forest reference levels in REDD+. Hence, the additionality and permanence of carbon credits are highly uncertain, as are associated outcomes of land-system change such as impacts on biodiversity and livelihoods. This implies that long-term initiatives of payments for ecosystem services such as REDD+ need to account for the substantial uncertainties inherent in future predictions of land-system change. One way to do so is to characterize explicitly the necessary conditions that likely confine land systems within specified

boundaries and to identify the risks that may instigate rapid nonlinear change.

This contribution closely links to the session topic and the overall conference theme by demonstrating how gradual changes in underlying drivers can trigger rapid and widespread land-system change and lead to the emergence of new land-system regimes. We discuss implications of such regime shifts for the development of forest reference levels under REDD+ and give suggestions on how to accommodate uncertainties.

0587	Biodiversity, land sparing and land sharing: what the data say	Andrew Balmford, Rhys Green, Malvika Onial, Ben Phalan	UK

Meeting human food demand at least cost to other species and the benefits they provide is one of this century's greatest challenges. Is it better to adopt wildlife-friendly on-farm practices (land sharing), to maximise farm yields and spare land elsewhere for conservation (land sparing), or some intermediate? We built a model to quantify the consequences of these strategies for species population sizes. We then collected the data to parameterise the models for over 600 species of birds, trees and butterflies in Ghana and India. We discovered that in both areas and across all feasible levels of demand, the majority of species in each taxon – and especially those of conservation concern - would fare much better under high-yield farming provided provided policy and governance regimes deliver associated land sparing. Next steps are to extend this work to Europe and other regions, to incorporate ecosystem services into the analysis, and to explore ways to deliver land sparing.

0588	Agricultural sectoral demand and crop productivity response across the world	Matt Johnston, Deepak Ray, Emily Cassidy, Jon Foley	USA

With an increasing and increasingly affluent population, humans will need to roughly double agricultural production by 2050. Continued yield growth forms the foundation of all future strategies aiming to increase agricultural production while slowing or eliminating cropland expansion. However, a recent analysis by one of our co-authors has shown that yield trends in many important maize, wheat and rice growing regions have begun stagnating or declining from the highs seen during the green revolution (Ray et al. 2013). Additional research by our group has shown that nearly 50% of new agricultural production since the 1960s has gone not to direct human consumption, but instead to animal feed and other industrial uses. Our analysis for GLP looks at the convergence of these two trends by examining time series utilization data for 16 of the biggest crops to determine how demand from different sectors has shaped our land-use and intensification strategies around the world. Before rushing headlong into the *next* agricultural doubling, it would be prudent to first consult our recent agricultural history to better understand what was driving past changes in production. Using newly developed time series dataset – a fusion of cropland maps with historic agricultural census data gathered from around the world – we can examine yield and harvested area trends over the last half century for 16 top crops. We combine this data with utilization rates from the FAO Food Balance Sheet to see how demand from different sectors – food, feed, and other – has influenced long-term growth trends from the green revolution forward. We will show how intensification trends over time and across regions have grown or contracted depending on what is driving the change in production capacity. Our analysis contributes to the overall conference themes of (1) Rethinking Transitions – by demonstrating historic drivers of agricultural production and how they impact intensification trends – and (4) Land Governance – by better understanding how consumer growth, affluence and behavior impact agricultural production and land-use decisions. Our analysis contributes to the session theme by introducing new time series intensification trend data, segmented by different use sectors. This data can be used to examine past land-use and environmental

	change and inform forward-looking strategies for continued agricultural growth.		
0589	Governance of land allocation in Colombia: developments and challenges of the land markets	Sarah Tadlaoui	Colombia

The paper seeks to analyze the recent developments of land markets in Colombia. Colombia has one of the highest rates of land concentration of the continent (the Gini Coefficient for land was 0.85 in 2011 according to the United Nations). Starting in the 1930s, successive waves of reforms' attempts have been made based on the traditional model of State direct intervention. In 1994, with the support of the World Bank, Colombia adopted a Market-Assisted Land Reform (MALR) model, which reduces direct State intervention and creates market mechanisms to redistribute land through subsidies for the purchase of land by peasants, based on a willing-seller wiling-buyer principle. However, due to the interests at work and the negotiation between the actors' coalitions, certain mechanisms of direct State intervention were maintained for specific cases. Therefeore, the land allocation system is a combination of various mechanisms and modalities of market and state actions.

This system overall failed to balance the inequality of land ownership and bring underutilized land into productive use, due to two main sets of causal factors: the imperfection of the Colombian land market (prices are higher than their agricultural profitability, the market is determined by the supply, the market is segmented geographically and between small landowners and big properties, etc.) and the profound asymmetry of power relationships that characterizes the rural areas (the best productive lands are concentrated in the hands of a few powerful landowners, uneducated peasants do not have the negotiation power to bargain with the large landowners, they do not have access to the market information, etc.).

This market-based negotiation system still prevails today but recent developments have affected the land market. As an attempt to put an end to the ongoing-armed conflict, the government is implementing a large land restitution policy that seeks to restitute dispossessed land to the victims of the conflict through administrative and judicial processes, which has affects the land market in different ways considering the proportion of the land under dispute. Additionally, in the past decade, Colombia has witnessed increasing large-scale land acquisitions by national and international actors for agricultural production and multinational mining. In this context, this communication seeks to discuss whether the specific arrangements of State intervention and market mechanisms can achieve a reallocation of land that ensures social justice and economic efficiency in an transition economy affected by an armed conflict.

0591	Between fuel and food production: shifting roles of small farming in the Eastern Amazon Region, Brazil	Celia Futemma, Fabio de Castro, Ana Claudia Braga	Brazil

There are three important facts behind small-scale farmers in Brazil. Fact one, the Brazilian Agricultural Census of 2006 shows that approximately 50% of food eaten by the Brazilian inhabitants were produced by small-scale farmers. Thus, these figures indicate the key role of these farmers in food production at national level. Fact two, small-scale farmers are frequently exposed to sudden changes in economic and political structure of incentives; in some cases, these incentives worked and in some cases they failed. Fact three, small-scale farming systems were blamed for deforestation (Brondízio et al., 2009) throughout the country. The Eastern part of the Amazon region in the state of Pará, Brazil – the Tomé-Açú region – it is illustrative of these three facts. Small-scale farmers from this Amazonian region have undergone major changes in their agricultural systems in the past 60-70 years. From shifting cultivation system towards mainly subsistence, they invested in black pepper production as a cash crop and cattle to, finally, Agro-Forestry System (AFS), the latter mainly among Japanese-Brazilian farmers. Thus far, these agricultural systems have always been involved predominantly in food production. In 2010, the

government launched one program towards palm oil production in the Amazon region – The National Program of Sustainable Palm Oil Production (PPSPO), mainly for biodiesel production. The biodiesel public policy in Brazil seeks to enhance small-scale agriculture because one of its main mission is the social responsibility, through creation of Certification of Social Responsibility that was launched in 2005 – The National Program of Biodiesel Production and Use – PNPB (Federal Decree 11.097). These programs brought two novelties: (1) usage of degraded land (abandoned pastures) instead of opening new forest areas in an attempt to reduce deforestation rates; and (2) incentive to small-scale farmers to produce bioenergy crops rather than food crops, despite of recommendations of keeping production of subsistence crops (e.g., manioc and corn) within their properties. This study searches for analyzing the performance of family-based agriculture in the production of oil palm – dendê *Elaeis guineensis* – and food crops as well dynamics of regional landscape in relation to forest coverage and use of degraded lands for palm plantation. Our preliminary results indicate involvement of some small-scale families in oil palm plantation but with some difficulties in conciliating palm with subsistence crop plantations within a small property, which might threaten food security. We also observed trends of simplification of landscape with increasing of homogeneous palm plantations in the region.

0592	Italian crop rotations from FADN data-base	Sergio Albertazzi, Guido Baldoni, Concetta Cardillo, Giuliano Vitali, Maurizio Canavari	Italy

Crop rotation schemes are an agronomic tool to maintain soil fertility, but they are also one of the most important aspects of rural landscape. Rotation schemes are affected by market rules, by administrative policies, by farmer knowledge and, not last by climate and slope. All of these factors defines available crops and related practice. For all these reasons is not simple to characterize rotations adopted in a given region or country.

One of the several available methodologies is spatial approach. The assumption is that each rotation scheme is completely represented in a year on a farm arable land and that crop cover ratio corresponds to time share of the same crop classes.

The collection of farms where the investigation has been carried has been extracted from Italian FADN database (RICA) of 2007. They have been grouped by homogeneous phyto-climatic zones with fixed slope (plain, hilly, mountain). Under the hypothesis that each crop has the duration of one year or more, crops classes (FADN) have been used to identify space share as integer ratios.

Successively an analysis has been performed to identify the exact crop grown in each zone in relation to the crop class appearing in the rotation and finally rotations have been assessed with the aid of experts. An attempt have been made to integrate farmer attitude and local traditions, DOC brands and regional policies, market influence and crop profitability.

The analysis show that continuous crops are frequent on arable fields on plains where climate and irrigation dominate the choices, whereas in areas with a lower agronomic potential as hill and mountain zones, rotation schemes become complex and dependent on local realities where market supports tradition.

0593	Characterizing pasture dynamics in the Brazilian Amazon: using the full depth of Landsat archive (1984-2012)	Hannes Müller, Patrick Hostert	Germany

Landsat time series are of major importance to monitor long term land use and land cover change (LULCC). The Brazilian Amazon rainforest is a hotspot of LULCC, dominated by deforestation and the establishment of pastoral systems. Subsequently these areas undergo stages of pasture intensification, vegetation dominated pasture degradation, land abandonment and secondary forest succession. These

stages are of major importance to quantify regrowth of the Amazon rainforest, which has huge implications for the global carbon budget, functional aspects within Amazonian ecosystems and the regional social/economic development. Since 2013 L1T corrected Landsat time series of the Amazon rainforest are available in the USGS-archive, which heavily promotes novel possibilities for studying LULCC in this region. In your work, we provide a new methodological approach for investigating pasture dynamics using the full depth of Landsat archive from 1984-2012. Results derived from a case study in southern Pará show that Landsat time series allow to map the processes of intensification, degradation, land abandonment and secondary forest succession on pastoral lands. It underpins the possibilities of long term time series based data analysis, which has even more potential with upcoming data from Landsat 8 and Sentinel missions. This talk intends to enrich the session on its methodological parts. We communicate our experiences in time series analysis on Landsat data, how we deal with conceptual limitations and which possibilities we see in the future. We also emphasize the importance of the newly available data for investigating land use dynamics in the Brazilian Amazon to improve understanding of ecosystem conditions and drivers of land use change.

0597	Spatial modeling of ecosystem services in support of ecosystem accounting for Limburg province, the Netherlands	Roy Remme	The Netherlands

Ecosystem accounting is receiving increasing interest as a way to systematically monitor the conditions of ecosystems and the services they provide. It provides opportunities to combine biophysical and economic aspects of ecosystem services and monitor these relationships. Ecosystem accounting makes it possible to address changes in the human-nature relationship frequently and at regular intervals. To further develop this concept, the United Nations has recently published the System of Environmental-Economic Accounting Experimental Ecosystem Accounting (SEEA EEA). A critical element of this approach is understanding the annual flows of ecosystem services from a spatial perspective. We follow the spatial ecosystem accounting approach of the SEEA EEA and test it at a provincial scale. The provincial scale provides an informative scale of analysis because it includes a large variety of ecosystems, and also enables detailed spatial analysis. Furthermore, many land planning decisions are made at this administrative level, which can be facilitated by ecosystem accounting. We study Limburg province, the Netherlands, which is densely populated and heavily managed, providing an intense human-nature relationship. Seven ecosystem services are spatially analyzed, both biophysically and monetarily. These ecosystem services are crop production, fodder production, drinking water extraction, hunting, air quality regulation, forest carbon sequestration and recreational cycling. We have developed spatial models for each service, which allow for biophysical and monetary analysis in line with ecosystem accounting. Annual biophysical flows are quantified and spatially modeled. Using a diverse set of valuation techniques the monetary value of ecosystem services are estimated. The relation between land use and the modeled services is analyzed, assessing whether land use is a good starting point for monitoring changes in ecosystem services. In addition, potential bundles of ecosystem services and trade-offs are studied. To date, the role of biodiversity within ecosystem accounting has received little attention. Therefore, we aim to further explore spatial relations between biodiversity and ecosystem services within the context of ecosystem accounting. This study will focus on the spatial relations within ecosystem accounting, focusing specifically on ecosystem service flows, land use and biodiversity.

0598	Modeling the functioning of Mediterranean agroecosystems to assess impacts of global change on ecosystem services	Simon Decock, Alberte Bondeau, Sinan Shi, Wolfgang Cramer	France

Mediterranean agricultural and semi-natural landscapes are subjected to pressure from climate, land

use change and other forcings. The expected decrease in rainfall, population growth and intensified farming practices may threaten the capacity of agroecosystems to provide ecosystem services in a sustainable way for the future. To estimate the role of changing agricultural practices in a context of climate change on the supply of these services, we have modified the dynamic global vegetation model LPJmL to specifically account for Mediterranean land use systems. LPJmL simulates mechanistically the biophysical and bio-geochemical processes that govern the productivity of the most important crops, representing them by 14 crop functional types (CFT). Agricultural practices are considered through parametrisations for irrigation, fertilization, residue treatment, sowing dates (etc.), thereby allowing to evaluate their effects on yields, productivity, soil organic carbon, water use, greenhouse gas emissions, and the carbon removed from the ecosystem.

In order to better represent the full range of economically important Mediterranean perennial crops (olives, grapes, fruits) the model has been extended with additional CFTs. Studies covering the range of different Mediterranean agricultural practices have been evaluated with respect to their impacts on physical and chemical soil parameters and soil-water-plant interactions. This provided a typology of specific managements such as agroforestry, intercropping and mixed cropping, tillage practices, organic farming, etc., based on their impacts on the carbon and water exchanges of agroecosystems. For each system, appropriate parameters for use in LPJmL are derived, and new functions to simulate the effect of these practices are developed. Simulations, carried out around the Mediterranean basin, allowed to estimate effects on services that are directly dependent on agroecosystem functions and farm practices. First results indicate significant regional variation of the sustainability and resilience of agroecosystems facing water stress and soil degradation. Future global change scenarios and past climate reconstitution are used to simulate the performance of Mediterranean agriculture and the role of different practices on its ability to deliver services under climatic change.

0599	Global to local conditions controlling intensification of tropical agriculture	Gillian Galford, Ruth DeFries, Meha Jain, Pinki Mondal	USA

Land-sparing or land-sharing are not emergent properties of agricultural intensification. They are a result of specific conditions, often global in nature, that support intensification and can range from free market incentives, government policies, to foreign direct investment. We present empirical evidence in tropical agricultural development on the global and local levers of intensification. The Brazilian Amazon of the early 2000s experienced intensification and extensification. Croplands and pastures filled newly deforested regions and intensification of agricultural practices rapidly occurred. Starting in 2006, there was a shift to land-sparing, intensification-only practices. First, global prices for soy bean dropped, making new land clearing less profitable. Second, international markets have raised demand for beef and soy products certified deforestation-free. Producers responded by joining voluntary verification programs. Third, there are international investments in forest stands to offset carbon emissions elsewhere.

In the sub-Saharan country of Malawi, 70% of the land is dedicated to food production yet yields of the primary staple crop, maize, stagnated around 1 ton ha^{-1} (developed nations' maize yields are 12-16 tons ha^{-1}). Due to the limited land area, improving yields through intensification is a necessary objective of development Poverty and food insecurity were a way of life for smallholder farmers until a government intervention, with foreign aid support, that subsidized small amounts of fertilizer and improved seed.

Food insecurity has been reduced from 5 million to half a million. We present indicators that levels of poverty have also been affected by the subsidy. Nationally, yields have doubled. We present new remote sensing results delineating social and economic correlates to changes in yields. In Malawi, intensification is a necessity and provides us with points for debate on issues of sustainability.

In India producing a second or third crop after the monsoon and into the winter season is very dependent on climate and, in turn, irrigation. Increased variability in winter weather, including the amount of precipitation, length of the rains and temperature threaten the viability of multi-cropping intensification. It is expected that the climate, particularly temperature increases, will increasingly be a limiting factor on smallholder cropland intensification in India in the absence of adaptation measures.

These tropical regions illustrate that land-sparing or land-sharing are not emergent properties of intensification but rather a result of specific conditions, generally global in nature, supporting intensification. Based on these studies, tropical agricultural intensification is limited by climate, commodity prices, financial incentives and nutrients and seed stocks.

NUMBER	TITLE	AUTHORS	COUNTRY
0600	Evaluation of the Brazilian environmental legislation for the small holder in the State of Pará, Brazil	Helen Cunha, Oriana Almeida, Sergio Rivero, Adebaro Reis	Brazil

Deforestation has increased dramatically in recent years in the Amazon and have reached more the 748.52 Km^2 or 14.56% the Amazon region (up to 2011). One of the most complex and strict environmental legislation for rural landholders was established in Brazil *(*Forestry code) with specific additional restrictions for the Amazon. Since 1995, this law requires the maintenance of 50% of the natural vegetation of the properties (increased to 80% and then reduced back to 50%) located in the Amazon region. The costs to comply with this legislation is large, especially for the small holders. More than 650 thousands small holders are established in the Amazon. The aim of this study was to evaluate the environmental compliance of the environmental legislation for the small farmer in Pará State. The study was conducted in two communities in the municipality of Paragominas, Pará State. A questionnaire was applied to the families about knowledge and compliance of the law. It was also estimated the costs of compliance of legislation for the implementation of several activities based on the costs charged by the environmental agencies and the price charges by private companies to elaborate the projects. The costs were estimated for the projects of several activities (Raising large animal, Forest management, Deforestation, Acai berry management and Reforestation project. The results of this study showed that the knowledge of small farmers of environmental laws is reduced in both communities and very few comply with the law. At the same time, costs for compliance were quite high. Depending on the activity to be implemented, costs could vary from R$ 1,244 to pay for the property land use maps to R$ 28.737 to develop a Reforestation Project as required by the government. This value is very high compared to the estimate of income showed in the literature for small producers and might explain why the farmers don't know or comply with the legislation.

0601	Mapping ecosystem services: a trajectory of flood regulation supply and demand in Europe	Julia Stürck, Peter H. Verburg	The Netherlands

Human land uses alter ecosystem processes and functions, and ultimately affect the quantity of ecosystem services (ES) provided. To identify and support pathways to sustainable land systems, it is important to understand the implications of (past) land use change on these processes, services, and flows.

Today, river floods are among the costliest natural hazards in Europe. Past developments and current trends in land use change suggest that flood risks increase due to increasing exposure of assets and people to river floods. Simultaneously, socio-economic developments in the 20th century lead to large-scale environmental transitions in Europe, causing natural ecosystems providing flood protection to be transformed or depleted. It is important to understand the role of land use and land use change in the interplay of flood regulation demand and supply in order to facilitate and enhance sustainable flood risk management.

We developed indicators for flood regulation supply and demand and applied it to a land use change trajectory over Europe. Land properties beyond land cover can quantitatively affect hydrological processes. Thus, we developed and applied proxies for land use, land use intensity and management to be able to spatially explicit identify more subtle changes in land use and management. We applied the proxies to four snapshots in time from 1900 to 2000 and four projections of land use change for 2040 to quantify and map their impacts on flood regulation supply. We localize hot spots of change for flood regulation supply as well as for flood regulation demand.

The resulting maps link ES supply with remote ES demands and give an indication of their *balance* in space and time across Europe in dependence of land system change. Our study integrates both drastic land cover conversions as well as subtle changes due to shifts in land management and land use intensity. By this, we contribute to the conference theme 1: "Rethinking land change transitions". We examine and explore past and projected land system change and its impact on flood regulation. Based on our results, we are able to identify opportunity areas for sustainable land use planning targeting flood risk alleviation. This study is a step towards a sustainable land system management and harmonizes well with the chosen conference session topic.

0606	Contribution of MODIS land cover product to the analysis of the agricultural domain between 2001 and 2011 in West Africa	Louise Leroux, Bernardin Zoungrana, Agnès Bégué, Danny Lo Seen, Christian Baron	France

In a context of growing population pressure and climate variability, populations of West Africa are highly vulnerable to food insecurity. During the last decade, even though national statistics data showed an increase in crop production, the region resorted to importation to fill the growing gap between supply and demand. Thus, a solid understanding of agricultural production in this region of the world is necessary in order to prevent food crisis, and help in decision making for public policies related to the development of agricultural production. Studies carried out on crop production in West Africa are mainly based on statistical data that are quantitatively and qualitatively limited because of the weak means of data collection, storage and distribution. The emergence of satellite-derived global land cover products allows the identification of land use and land cover classes at continental scale. However, these global products are generally more focused on large ecosystems than on agricultural systems, and they are not expected to be suitable or reliable for the analysis of fragmented and heterogeneous African rural landscapes, because of subpixel heterogeneity (Vintrou et al., 2012).

Getting accurate spatial information on the agricultural land extension is thus an important element for monitoring agricultural production in West Africa. However, if many remote sensing studies deal with land use analysis, too few attempt comparison with agricultural statistics data. The aim of this presentation is to demonstrate how the spatial information from remote sensing can help in the analysis of food security in West Africa, by performing a joint analysis of global land use and land cover products (MODIS Land Cover product MCD12Q1), and statistics data (national FAOSTATS, and sub-national COUNTRYSTAT and AGHRYMET data) between 2001 and 2011 in West Africa. Dynamic

analysis of MODIS-derived agricultural land product allows the identification of areas with increase of agricultural domain (i.e. Mali), and areas with a decrease in agricultural domain (i.e. South-West of Niger). The comparison between remote sensing product and statistics data shows that agricultural statistics at sub-national level are unable to express the spatio-temporal heterogeneity of situations. For example, for the Region of Tillaberi in Niger, statistics data show an overall increase of cultivated areas between 2001 and 2011, whereas the MODIS product highlights some areas with decreasing agricultural land. Finally, the result of this work allows identifying areas for which a special attention is needed within a context of food security.

0608	Managing land use at Musi historical riverside settlement in Palembang, Indonesia: a strategy to achieve a sustainable development at urban historical area	Widya Fransiska Febriati Anwar	Indonesia

The new modern life style is inevitable for an old area in a city. However, the old area is a historical asset that should be maintained for the education of future generation. On the other side, its historical value is threatened by the economic forces driven by the tourism potency embedded in it. The threat is attacking the old historical elements as well as the ownership of the old buildings. It effects the land use at this historical site. This paper aims to investigate the factors that potentially contribute to maintain the historical value and also to manage the inevitable economic forces towards the physical development at historical riverside settlement. This aims is achieved by examining the structure of the settlement as well as the ways it accommodates the current lifestyle, including the current function accomodated by the settlment structure. By using space syntax , the structure of the old riverside settlement in Palembang is analysed to explore its ability to accomodate the cultural activity of the residents. To complement this, an qualitative analysis of the past and current resident's lifestyle is also elaborated. Results shows the ordering system of the riverside settlement was driven by the cultural activity of the residents. The existence of its physical and spatial order, including buildings, alleys, and open space, is determined by the existence of the cultural life of the residents. Findings affirms that in order to determine the current and future land use of the historical sites, the existence of cultural activity should be taken into account along with the architectural, cultural, and econimical value. Therefore, the sustainable land governance in historical riverside area can be achieved.

0611	Swidden cultivation among two Chepang communities in the Central Hill Districts of Nepal: local perceptions and factors influencing change	Sharif Ahmed Mukul, Anja Byg	Australia

Nepal, being situated in the Himalayas has been experiencing rapid land-use changes in the last years mainly due to changing governmental policy, local developments, growing concern about environmental issues and changes in local perceptions. For decades, swidden agriculture - locally known as *bhasme* or *khoria kheti* – has been a common land-use practice in the mountains of Nepal. Despite decades of policy disputes, ignorance and misunderstanding of that age-old system, swidden agriculture is still the mainstay of livelihoods for many rural farmers, particularly those who live in or on the periphery of forests. Until recently, policy makers and conservationists viewed this system as unfavorable for biodiversity conservation and ecosystem functioning, a view still dominating in some countries. Some development activist, on the other hand, considered the system from the standpoint of traditional human right and ethics. The present study was aimed to investigates the changes, local understanding and perceptions of swidden agriculture amongst swidden farmers (N = 51) in two central districts of Nepal, namely *Dhading* and *Chitwan*. Data were collected through focus group discussion, a questionnaire survey and field observations from

Jogimara and Shaktikhar Village Development Committee focusing on the indigenous *Chepang* communities, to whom swidden agriculture is more than a way of subsistence. Study revealed that, although the land-use practice is changing rapidly in both of the study areas, and cash crop based sedentary agriculture is becoming the prominent land-use practice, the role of swidden agriculture in food security is still important to most of the farmers. The main reasons why farmers in the two areas practice swidden agricultural are, in an order of importance: lack of secure tenure; poverty and unemployment; cultural identity; absence of alternative land-use options and as their traditional right. On the other hand, swiddening is negatively affected by its labor intensiveness; lack of manpower available for work; negative government policy and attitudes; low economic returns and shrinking land-base for swiddening. There were however, differences in views within and among the study sites. Farmers' themselves regarded swiddening as having negative impacts on the local environment and biodiversity. The findings of the study emphasized the role of more equitable land-use options, tenure security, access to government support and in allowing rural *Chepang* farmers to perform long-lasting, environment friendly land-use (here for example, sedentary agriculture in terraced land, agroforestry in lease-hold forestry land and community forestry) in the studied regions.

0616	Changing plant litter dynamics controls soil C sequestration, but in unexpected ways	Kate Lajtha	USA

Global climate change, changes in forest management practices and changes in pollutants in the atmosphere will all interact to alter forest productivity and plant litter returns to the forest floor. However, we do not know whether soil organic matter pool sizes in ecosystems will change in direct proportion to changes in litter input rates, or whether non-linear interactions will lead to disproportional shifts in the amounts of carbon (C) stored in soil. Global models can accurately predict C stores in vegetation in response to land management, but models are significantly less accurate in predicting soil C stores in response to vegetation change. Understanding those processes that will either increase or decrease soil C stores is critical for understanding the global C balance, as organic C stored in soil is a major component of the global C cycle, containing more C than plant biomass and the atmosphere combined. The network of DIRT (Detrital Inputs and Removal Treatments) experiments is a multi-decade study that manipulates litter inputs to forests and is designed to address such questions as: what controls the long-term storage of carbon in forest soils? What chemical and physical fractions of SOM are the most stable carbon pools? Can added inputs of detritus increase soil carbon storage, or is maximum soil carbon storage determined exclusively by climate and soil mineralogy? Results to date show that pools of C do not respond linearly to increases/decreases in litter inputs and forest productivity. The most stable pools of C take decades to respond to decreased C inputs, and significant priming of soil C has been observed in both deciduous and coniferous forests, where increased litter inputs lead to increased soil respiration and thus decreased C stores. These interactions are critical to incorporate into models of forest management and climate change if global C dynamics are to be modeled accurately.

0617	Challenges in the forest ecosystem restoration in the upland watersheds of Philippines	Sharif Ahmed Mukul, John Herbohn	Australia

Watersheds constitute about 75 percent of the total area in the Philippines and are vital for providing key ecosystem services and benefits. In last year's, like many tropical developing countries substantial deforestation has occurred in many critical watersheds in the Philippines, resulting in severe social and environmental problems. There have been many efforts to restore the degraded watersheds in the

country. Most recently the government has launched the National Greening Program (NGP), one of the largest projects in the country so far, with an aim to reforest 1.5 million hectares of degraded landscapes in critical watersheds over a five year time span. This paper highlights the key challenges that might hinder the success of the National Greening Program. We found that, it is unlikely to achieve the desired project goals if rural communities dependent on such upland landscapes are excluded from the reforestation program through plantation development. Bringing larger amount of areas and greater number of people under community based forest management (CBFM) initiatives for the reforestation program, with clearly defined rights as well as timely access to timber harvesting permits to communities involved in maintaining the plantations could boost up the project outcomes. The paper also tries to provide a critical review of the past rehabilitation efforts in the Philippines, and direction of possible research and development in order to achieve a win-win situation in case of watershed management that will benefits both the local livelihoods and the environment, and could be useful for other tropical developing countries.

| 0618 | Land systems architecture, ecosystem services and the temporal dimensions of agricultural landscapes | Lowe Börjeson | Sweden |

A basic metaphor for articulating temporal depth of landscapes is the notion of landscapes as a palimpsest, i.e. a mosaic of features and layers of land use produced through a diversity and complexity of historical processes (both long-term and short term). Similarly, the built environment and its architecture can be referred to as a palimpsest. When redesigning a landscape, a landscape architect may for example modify the design of new features on the basis of historical landscape structures. In contrast to the historical metaphor of a palimpsest, the concept of 'land systems architecture', i.e. "the composition and spatial structure of the mosaic of land units across an area of assessment, consisting of different land covers and uses, their size, shape, distribution, and connectivity" (Turner et al. 2013), place emphasis on the structural and spatial complexity of landscapes (as they are configured at the present and their potential for being redesigned for future needs and demands). It is specifically the different types of ecosystem services generated by a certain land systems architecture that motivates the notion of 'architecture', as many landscapes are indeed profoundly designed to produce specific services. Taking agricultural landscapes as an example, this paper argues that the concept of ecosystem services implies an analytical perspective that is geographically explicit (e.g. patch, local, regional, global etc), but temporally and historically unclear. A basic reason for this is the definition of ecosystem services in relation to natural capital. But, as the notion of 'land systems architecture' suggests, ecosystem services does not simply flow from nature, but also from a historical and recursively produced social-ecological landscape. Hence, despite its lack of historical engagement the concept of 'land systems architecture', as formulated by Turner et al, is implicitly linked to an understanding of ecosystem services as associated with specific historical landscapes, designed to produce specific services at the expense of others. Another concept that captures both the 'architecture' and the temporal dimensions of agricultural landscapes is 'landesque capital'. This concept represents the antithesis to land degradation and was defined by Blakie and Brookfield (1987) as: "any investment in land with an anticipated life well beyond that of the present crop, or crop cycle". The paper concludes by suggesting that the concept of landesque capital, in combination with the concepts of ecosystem services and land system architecture, provides a useful analytical lens that includes both temporal and spatial complexities of agricultural land systems.

| 0619 | Implications of city-to-city networks in Asia for urban land change | Peter Marcotullio | USA |

This paper reviews the concept of urban land teleconnections, highlighting both the direct and indirect linkages between urban areas and distal locations. We use the notion of City-to-City Networks to

examine the teleconnections. Specifically the focus is on flows of trade, investment, information and technologies in Asia. We use 3-4 specific case studies to highlight how these linkages have affected land use change in either or both locations and the role of the City-to-City Network in the process.

0620	Dynamics of ecosystem conservation on the forest frontier of Madre de Dios, Peru	Jason Scullion, Kristiiina Vogt, Andrea Odle, Alison Sienkiewicz, Stephan Gmur	USA

Expanding forest frontiers provide unique opportunities to explore the dynamics and interactions of forest-cover change and forest conservation policies. In the SE Peruvian Amazon the dynamics of land-cover and ecosystem conservation were studied in the expanding deforestation hotspot of Madre de Dios for the periods 2001-2006-2011. Using a Landsat time series analysis of land-cover change, as well as field interviews and extensive geo-statistical analyses, this research shows that despite an increase of mining area by 239% (+23,000 ha), lands designated for conservation were largely effective in preventing ecosystem loss. The largest areas of ecosystem loss occurred in indigenous lands -4,314 ha (-0.63%) and the lowest levels in national parks and reserves +54 ha (0.05%). Across conservation designations, both the drivers of land-cover change and the policy effectiveness of each designation were highly variable. The variable effectiveness of lands designated for conservation results from a combination of local factors, including the overlap of mining concessions inside conservation areas, variable levels of enforcement, and differences in the type and degree of land-cover vulnerability. During the study, regional land-cover dynamics transitioned from primary forest loss driven mostly by agriculture to one of secondary forest recovery in former agricultural lands and the widespread loss of primary forests due to mining expansion. Additionally, field interviews of local farmers show their interest in proposed forest conservation policies varies depending on the program proposal - trading technical assistance for private forest conservation ranked the highest and conservation payments equivalent to REDD+ pricing was ranked the lowest. Field interviews with local miners indicate that most are interested in alternative employment in place of mining and that most plan to continue working the land for the foreseeable future. Collectively the conservation and land-cover dynamics of Madre de Dios suggest that effective forest conservation in frontier landscapes is contingent on the strategic management of land-cover drivers across multiple spatial scales, the implementation of place-based conservation policies matched to land-cover dynamics and local needs, and the close collaboration of local land users, government agencies, and domestic and international partners.

0628	Synthesising place-based ecosystem service assessments for informing land-use decisions across multiple scales	Johannes Förster	Germany

The number of place-based assessments of ecosystem services (ES) increased over the last decades. With this also the heterogeneity in the data generated by ES assessments increased, making a synthesis of the information difficult. There is a growing demand for a systematic synthesis of the diverse ES information for supporting decision-making across different scales, from local to national and international level. However, there still remains the challenge of linking the very case specific information of place-based ES assessments to the information needs at regional, national and international level for different user groups. This presentation will give a brief overview of existing approaches towards synthesizing information of place-based ES assessments. It will share insights from the Sustainable Land Management Programme, an initiative funded by the German Federal Ministry of Education and Research (BMBF), and one of the initiatives organizing this session. A proposal for a synthesis framework will be presented aiming at providing a starting point for developing a common

	approach towards structuring the often complex information inherent in ES assessments.		
0631	The land grab as a network	Jonathan Seaquist, Kimberly Nicholas, Emma Li Johansson	Sweden

Growing demands for food, fuel, and feed, coupled with increased population pressures, require copious amount of land but in the 21st century, land is becoming scarce. The issue of trans-national large-scale land acquisitions (often dubbed "land grabbing") has rocketed to the top of the sustainability agenda in the last five years. Large-scale land acquisitions refer to the recent leasing or purchasing of large tracts of land by both public and private sectors, including foreign government and agribusinesses, in mainly developing countries mostly located in the global South. Indeed, the global land trading system is a rapidly evolving sub-system of global land change drivers. In order to uncover patterns of large-scale land acquisitions and develop explanatory typologies for these patterns, we apply network analysis to visualize and analyze relationships within a comprehensive data set of > 1300 recent acquisitions. Data are analyzed at the country level where the network consists of 126 countries and 471 trade links. Our results show that very few countries are responsible for the majority of trade agreements, and that although countries that act purely as investors and purely as targets (for investments) compose the minority of cases, most countries behave primarily as an investor or as a target. We also report that target countries cluster into four main regions, concentrated in the Global South and Eastern Europe, while investor regions are concentrated in Europe, North America, and Asia. Land trade partnerships show weakly asymmetrical tendencies that lead to the development of hub countries (either in the Global South or North) that provide land trade links to the network for an otherwise isolated periphery. Another finding is that the land trade network is well-integrated, a testament to the rapid globalization of land resources. The talk is well suited to the session "Globalization of land use: distant drivers of land change and geographic displacement of land use" because it presents a methodology for a succinct quantification and understanding of the term "globalization" in the context of land use. It also provides a very effective framework for visualizing how virtual land can be displaced from one part of the globe to another.

0633	Biosphere reserves in Chile: towards an integrated system of sustainability field laboratories	Andres Moreira-Munoz	Chile

Chile's biosphere reserves (BRs) system consists today in ten units, encompassing 112,000 km2, and representing most of the biogeographic provinces along this ecologically high diverse country. The BRs coincide with one third of the national protected areas system, since from the beginning, same as everywhere, they where created in already established national protected areas. Since 1996 after the Sevilla meeting, Chile's biosphere reserves entered a second phase and are being arranged following the usual three "rings" zonification. But this spatial arrangement is rarely accompanied by concrete facilitation provisions towards private activities and actions towards sustainability, and there is still aneed in generating social, political, and governance conditions to move further. Since each unit occurs at different biogeographic and social contexts, the improvement conditions need to be built from the base with the local communities. Till now, most decisions about Chile's BRs have been declared in a top-down decision process, with some basic level of social participation for the zonification. Only after 2009 the local committees are being operating more systematically, but the advances are being modest; still four reserves are lacking a zonification, due to the difficulties of the participation process, due to the complicate integration of the terrestrial/marine interphase or because of the lack of a social critical base. The other six reserves are operating with different levels of advancement. Most of Chile's biosphere reserves are mainly located in pre-Andean and high Andean territories. The main activity that is being

developed in relative harmony with the reserves objectives is ecotourism (also encompassing specific actions with mapuche indigenous people). At the same time, local actors are opposing mining and hydroelectricity projects that are contrary to the reserves' goals. In the very South, RB Cabo de Hornos, the southernmost reserve of the world, has successfully integrated marine and terrestrial socio-ecological systems. In such a geographically diverse country, each BR has its unique socio-ecological processes, so its approach to sustainable development will also be unique. Although, one of their strengths is that groups of actors can learn from one another. We are assessing the historical land use changes in the BRs and we need also to address the potentials and pitfalls of every BR if we want to advance to a phase in which they really turn to field laboratories for assessing potential impacts of climate change on biodiversity loss, relations within socio-ecological systems, land degradation and restoration.

0635	Land-based carbon emissions embodied in agricultural trade	Kimberly Carlson, Lisa Ribaudo, Graham MacDonald, Navin Ramankutty, Jonathan Foley	USA

Food systems, including conversion of tropical forests and peatlands to agriculture, are estimated to be the source of ~20-30% of total annual anthropogenic greenhouse gas emissions (Vermeulen et al. 2012). While a growing proportion of agricultural production is traded internationally, land-based carbon emissions embodied in these trade flows remain un-quantified at a global scale. Such assessments are necessary to identify the carbon emissions efficiency - tons or calories of production per ton of carbon emitted - of internationally traded agricultural products, and to attribute emissions not only among food producing countries or regions, but also across diverse agricultural commodities, intermediary processing hubs, and food consuming nations.

Here, we provide the first spatially explicit global estimates of net carbon dioxide emissions from cropland change from 2000-2005. Our analysis incorporates emissions from clearing live aboveground and belowground biomass, sequestration from land abandonment and growth of perennial crops, soil carbon stock changes from land cover transitions, and emissions from peatland burning during land clearing. To estimate emissions across the globe, we couple optical and LiDAR derived satellite products of above-ground biomass, spatially-explicit estimates of deforestation, cropland maps, and sub-national agricultural census data. Using detailed bilateral trade databases that identify agricultural producing nations, intermediary re-export hubs, and final consuming countries, we then apportion annual land-based carbon dioxide emissions embodied in international agricultural trade flows.

Our research contributes to the conference theme by presenting new data on how international demand for agricultural products drives greenhouse gas emissions. This analysis provides a basis to design strategic interventions to mitigate land-based carbon emissions embodied in agricultural trade. Moreover, our work offers insight to the session by delivering maps linking carbon emissions from forest and peatland loss to agricultural expansion, a primary non-forest sector cause of global deforestation.

0636	Informal network structures and land use change: a case study from the transition zone of Ghana	Marney Isaac	Canada

A recent debate contrasts two land management paradigms aimed at achieving production and conservation goals, land sparing and land sharing, the latter of which favours an approach where agricultural production occurs within complex multi-functional landscapes. The outcome of such debates will be highly dependent on landowner decision-making and land management response. By and large, rural producer networks are important in the transfer, decision-making and adoption of innovative

management required for a land sharing approach. We have previously shown that dense, homophilous networks, which often promote collective action, may be less effective in innovation driven agricultural systems. Here, this study aims to determine correlates of agrarian network structures with land management and land use transition (theme 1) as well as chart the persistence of multifunctional agroecosystems. This study contributes to research on embedded social-ecological systems and specifically contributes empirical evidence for linked social-agro-environmental change at a local scale. The main questions are: i) what is the network structure and actor positionality of producers who manage diverse land use types and ii) are network topologies related to land use change? This work draws on network studies with producers in the transition zone of Ghana with primary outcome variables of land use diversity and transformation Actors in these information networks manage three distinct land use types [crop cultivation, tree crop cultivation (cocoa) and an array of timber plantations], resulting in irregular vegetation cover. I show that land use diversity is positively linked to centrally located actors in local informal information networks and that these actors undertake land transformation at much greater rate, thus coupling actor position with both individual and community level land use outcomes. Social network diversity appears as a strong structural indicator for the persistence of agricultural landscapes with high environmental services. Further work will relate land use types and patterns of land use change to actor position in order to scale up to the 'landscape'. As the transition zone of Ghana continues to fluctuate in vegetation cover, this region not only provides a unique study scenario but also requires detailed data on land use change to avoid the land degradation occurring in neighbouring regions.

0637	Impact of the implementation of Agro-extractive Settlement Project (PAE) in the participatory management of land resources in Amazon Floodplain	Shaji Thomas, Oriana Almeida, Fábio de Castro, Elysângela Pinheiro	Brazil

Floodplain, although occupy 2% of the Amazon basin, is a rich environment with fertile soils which maintains abundant natural resources. Throughout the history of human occupation, the floodplain played a central role in the economy of the region. In spite of the importance of the region, the land tenure of the Amazonian floodplain has always been ambiguous (BENATTI, et al., 2005). Since 2006 the government created 15 Agro-extractive Settlement Project (PAE) in the region of the Lower Amazon floodplains to regulate land ownership and to encourage the process of community participation in the management of natural resources. The main objective of this paper is to analyze impact brought by the creation of PAE in the governance of common natural resources in the Lower Amazon floodplain communities, considering the different levels of social organization existing in the region. The research data of this paper was obtained through field work and literature review, Focal Groups and interviews. 86% of the communities of PAEs analyzed had some kind of community land resource management agreements which internally regulated the use of common resources in the communities. The interviews with community leaders in the region, 82% demonstrated some kind of dissatisfaction by the way the process of PAE being implemented in the region where the realities of the communities were not taken into consideration. The lack of dialogue between the community and the government entities like Institute of Agrarian Reforms (INCRA) responsible for the implementation of PAE created some kind of dissatisfaction in the communities. Some basic questions regarding the occupation of land by the landlords in the PAE are not yet resolved. The study shows that the success of governing land use and land allocation through PAE is very much related to the effective participation of the shake holders in the process of implementation of the new system.

0638	Assessing multiple ecosystem services from agricultural landscapes around the Mediterranean, based on a process-based	Alberte Bondeau, Simon Decock, Sinan Shi, Mattia	France

| | | ecosystem model | Trabucchi, Wolfgang Cramer | |

Mediterranean agricultural landscapes provide multiple ecosystem services, ranging from agricultural products through the regulation of water and carbon fluxes, and the control of disturbances, to other benefits such as opportunities for tourism, local recreation, and the conservation of biodiversity. The sustainability of these services is at risk due to rapid land change (urbanisation, agricultural abandonment, driven by various socio-economic forcings around the Mediterranean) and changing climate (warming, rainfall reduction, sea-level rise). More sustainable management of agricultural landscapes for mitigation of these risks is possible, but the socially and economically viable options for such management are poorly quantified. We propose an approach for process-based assessment of the outcome of different land management policies, applicable to the major land use systems around the Mediterranean, based on the agro-ecosystem model LPJmL. This approach takes into account the influence of changing temperature, moisture availability, atmospheric CO_2, agricultural practice and landscape-level biodiversity on the functioning and stability of agricultural ecosystems and their associated landscapes. Primary outputs include the anticipated yields of the major agricultural crops for the region, the stability of key soil parameters relevant for productivity and carbon sequestration, and the retention or release of water in agricultural landscapes including the runoff of major rivers and water availability for irrigation. A preliminary set of land change scenarios, applied across the entire region, is used to assess the tradeoffs between different management intensities on the provisioning of ecosystem services.

| **0639** | Monitoring deforestation and forest degradation in dynamic landscapes of Southeast Asia using dense Landsat time series | Dirk Pflugmacher, Kenneth Grogran, Belinda Freiheit, Patrick Hostert | Germany |

Improved monitoring of deforestation and forest degradation is a key requirement for on-going climate mitigation efforts such as REDD+. In recent years, much progress has been made in the development of remote sensing methods and protocols for mapping deforestation in forest frontier landscapes. However, monitoring tropical forest degradation has been a far bigger challenge. Traditional bi- and multi-temporal change detection methods do no adequately capture the subtle spectral changes associated with forest degradation processes such as selective logging or highly temporal dynamic processes such as shifting cultivation. In addition, forest degradation in Southeast Asia often occurs in regions characterized by long land-use histories and fine spatial mosaics of natural forest vegetation at different successional stages, agriculture, and/or managed forest plantations.

In this study, we use dense Landsat time series between 1985 and 2012 to characterize and map forest changes caused by deforestation and forest degradation at different test sites throughout Southeast Asia. Our test sites represent different land-use systems under a range of socioecomic, political, and ecological conditions. We use all orthorectified Landsat images with less than 80% cloud cover available from the USGS archive. We perform atmospheric correction using the Landsat Ecosystem Disturbance Adaptive Processing Systems, and cloud and cloud-shadow masking using the automated Fmask algorithm. The resulting time series are spectrally enhanced using the tasselled cap (TC) transformation and the normalized burn ratio (NBR), and aggregated to annual time steps using median and maximum value composites and composites based on acquisition day of year. To detect changes in forest cover we use temporal segmentation and thresholding of the annual time series. We evaluate the results based on recent high-resolution imagery and visual interpretation of Landsat image chips.

The study demonstrates the utility of Landsat time series for monitoring tropical forests in dynamic landscapes. Long historic and frequent observations improve detection of subtle and dynamic change processes and improve the separation of natural and managed systems in the region. As such the

presentation will contribute to the conference theme rethinking land change transitions: drastic changes in land cover and subtle changes in land management.

0641	Water depletion of watersheds worldwide: local drivers and global connections	Kate A Brauman, Brian Richter, Sandra Postel, Martina Florke, Marcus Malsy, Jonathan Foley	USA

On a global scale, people consume on the order of 20% of total renewable fresh water, yet local and regional water shortages cause serious economic, social, and environmental impacts. Water is thus an important limitation of land use. Assessing the distribution and causes of water depletion can inform both understanding of land change trajectories and management strategies to address water scarcity. Connecting watersheds in geographically separate regions that face similar obstacles could spark new approaches to management and adaptation.

We consider water depletion – the volume of water consumed in a watershed scaled by the volume of water that would be naturally available as runoff – generated from outputs of the WaterGAP2 model. WaterGAP2 and similar process-based models are powerful tools, but local and regional managers and policy-makers often demand simple models that are less data and computationally expensive to assist them in scenario scoping to evaluate likely impacts of a range of possible policy decisions. Thus, we develop a simple regression model using the basic drivers of climate, irrigation, and population to predict depletion. To group watersheds that have similar responses to these base drivers, we then employ regression tree techniques, including as predictors a large suite of additional biophysical and socio-economic information about each watershed. Watershed classification serves two purposes. First, by identifying and mapping these watershed classes, we hope to facilitate cross-basin information transfer and learning among decision-makers that might not otherwise think to communicate one another. Second, watershed classes can be evaluated for their relative vulnerability to various stressors. We found, for example, that because of interactions among climate, irrigation, and population, water depletion is likely to increase in some subsets of watersheds as population grows but to decrease in other watershed subsets. Finally, we assess potential vulnerabilities of global food production to water shortage by comparing tradeoffs among production of various crops with water consumption and other demands for water in different watershed subsets. Doing this, we aim to evaluate the resilience of food production to potential climate and population change. By evaluating local sensitivities in the context of global trends, and focusing on water as a specific resource limitation to land change, we aim to increase knowledge for managing water sustainability and food security at both global and local scales.

0648	Scenario-based assessment of future challenges for crop production and food security in the Middle East	Florian Wimmer, Jennifer Koch, Janina Onigkeit, Rüdiger Schaldach	Germany

Countries in the Middle East strongly depend on imports of staple crops, such as cereals, in order to meet the nutrition demand of their population. At the same time, the net export of fruits and vegetables constitutes a major part of the agricultural economic output in these countries. Hence, the future development of world market prices for agricultural goods will be crucial for food security in the region, in particular for the poor.

Due to the dry climatic conditions, irrigation agriculture plays a major role in the Middle East. As it is more profitable to produce vegetables and fruits rather than cereals, most of the scarce irrigation water resources are used for the cultivation of export crops, while staple crops are grown mostly in rainfed agriculture. Hence, increasing food demand due to population growth, urban expansion on former crop

land, and climate change impacts on crop yield present a major challenge to countries in the Middle East who want to improve food security by increasing their self-sufficiency rate of staple crops.

In the paper, we discuss the results of a scenario assessment investigating the impact of global change on land use, crop yields, and irrigation water requirements and their implication for food security in Israel, Jordan, and the Palestinian Authority. We applied the spatially explicit model LandSHIFT.JR to develop a set of four consistent land-use change scenarios until 2050. The model was driven by projections of population growth and future crop demand based on the results of a global agro-economic model. LandSHIFT.JR was used to simulate the expansion of urban area and irrigated/rainfed crop land under consideration of climate change impacts on crop yields and irrigation water requirements, assuming a constant ratio of irrigated-to-rainfed crop production. Uncertainty related to climate modeling was addressed by an ensemble of simulations based on five regional climate projections.

The simulated area expansion of urban land and irrigation agriculture displaced rainfed agriculture to marginal lands, which lead to a drop in potential rainfed yields by up to 60% on average, not considering climate change. In addition, climate change reduced potential yields by another 15-25% on land used for rainfed agriculture in 2050. In particular for scenarios projecting a strong increase in crop demand, the simulated irrigation water requirements exceeded the available water resources. We conclude that a larger share of staple crops in irrigated agricultural production is needed to improve the region's self-sufficiency rate.

0650	A multi-level approach to modeling rapidly growing mega-regions as a coupled human-natural system	Jennifer Koch, Wenwu Tang, John Vogler, Wenpeng Feng, Douglas Shoemaker, Ross Meentemeyer	USA

The FUTure Urban-Regional Environment Simulation (FUTURES) integrates information on nonstationary drivers of land change (e.g. per capita land area demand and site suitability) into spatial-temporal projections of changes in landscape patterns (Meentemeyer et al., 2013). One striking feature of FUTURES is its patch-growth algorithm that includes feedback effects of former development events across several temporal and spatial scales: cell-level transition events are aggregated into patches of land change and their further growth is based on empirically derived parameters controlling its size, shape, and dispersion. Here, we augment the FUTURES modeling framework by expanding its multilevel structure and its representation of human decision making. The new modeling framework is hierarchically organized as nested subsystems including the latest theory on telecouplings in coupled human-natural systems (Liu et al., 2013). Each subsystem represents a specific level of spatial scale and embraces agents that have decision making authority at a particular level. The subsystems are characterized with regard to their spatial representation and are connected via flows of information (e.g. regulations and policies) or material (e.g. population migration). To provide a modeling framework that is applicable to a wide range of settings and geographical regions and to keep it computationally manageable, we implement a "zooming factor" that allows to enable or disable subsystems (and hence the represented processes), based on the extent of the study region. The implementation of the FUTURES modeling framework for a specific case study follows the observational modeling approach described in Grimm et al. (2005), starting from the analysis of empirical data in order to capture the processes relevant for specific scales and to allow a rigorous calibration and validation of the model application. In this paper, we give an introduction to the basic concept of our modeling approach and describe its strengths and weaknesses. We furthermore use empirical data for the states of North and South Carolina to demonstrate how the modeling framework can be applied to a large, heterogeneous

study system with diverse decision-making agents.

0651	Water management in the Nduruma catchment, Tanzania - an analysis of competition over water between smallholder irrigation communities and foreign horticultural companies	Chris de Bont	The Netherlands

This presentation aims to describe and analyse the local reality of water competition between foreign horticultural companies and smallholder irrigation communities after a change from inactive coffee estates to water consuming horticultural production in the Nduruma catchment in northern Tanzania. The case is situated in the middle of the current international debate on "land and water grabbing" and the benefits of foreign investment in agriculture in developing countries. However, the existing reality is not only the result of the tendency of Western companies to move production to the South; rather it is shaped by land dispossession in colonial times, recent national policies and local contestations between smallholders and companies.

The presentation is based on three months of fieldwork in Tanzania, combining methods of observation and semi-structured interviews. Analysis relies on the echelons of rights analysis framework (Zwarteveen et al., 2005), aiming to describe contestations around resources, rules, authorities and discourses.

The study shows how both smallholders and agribusinesses use their own, specific strategies to secure their access to water. In Nduruma, this has led to downstream smallholders securing more river water at the expense of the agribusinesses. At the same time, agribusinesses are increasingly using groundwater. This is the result of devolution of authority to a smallholder-originated river committee by state-led water organisations, leading to compulsory local negotiation over water allocation. Within this negotiation, smallholders are more successful in claiming river water by emphasising the rich and foreign character of the agribusinesses and their ability to access groundwater. Agribusinesses counteract by claiming efficiency and contributions to development through employment. This illustrates how arguments used by local actors reflect international and national discourses on land grabbing, foreign direct investment for development, irrigation modernisation and neoliberalism.

This case study will contribute to the conference by drawing attention to the water aspect of recent land changes in Tanzania and elsewhere, emphasising the argument that land grabs are also water grabs. It at the same time engages with the international debate on development and the discourses around smallholder irrigation, illustrating how this resonates on the ground. It provides insight in how smallholder irrigation communities with a history of more than a hundred years interact with the most recent land use changes in their catchment, illustrating and emphasising the point that the impacts of land transformations are not static and that contestation over land and water should be studied as an on-going process.

0652	A fused disturbance model for land management analysis in New Zealand	Braden Owsley, Kirsten de Beurs, Jason Julian	USA

Land management is a key driver of land change in many parts of the world. Activities such as livestock farming and timber production can have a dramatic impact on the environment and are often guided by local and regional policies. Evaluation of these impacts is easier in a country like New Zealand, where since 1991 the regional boundaries have been defined to coincide with catchment boundaries. In this study we look at the entire north island of New Zealand and attempt to identify disturbance trends at high spatial and temporal resolution using widely available remote sensing data, with the eventual goal of being able to analyze the effect of land management practices on local ecosystems.

Existing remote sensing capabilities are limited in the type of analysis they allow. Free access to the

entire Landsat archive provides a valuable resource for analyzing land change across large areas and extended time periods. Landsat imagery, at 30m spatial resolution, provide a useful tool for monitoring small changes in land cover; however, the 16-day temporal cycle, which can be lengthened considerably by cloud cover, limits the observation of short term changes that can result from disturbance events. The revisit cycle of the MODIS sensors aboard Terra and Aqua provides a surface reflectance dataset at much higher temporal resolution, yet at 500m spatial resolution, it lacks the detail necessary to accurately track small changes in the landscape. A combination of the two products offers researchers the ideal tool for disturbance analysis.

Here we fuse Landsat TM/ETM surface reflectance data covering the north island of New Zealand (13 Landsat scenes) with MODIS Nadir BRDF-adjusted reflectance (NBAR) for the period 2000–2012. We calculate a disturbance index for both datasets based on normalized values of the Tasseled Cap transformation. We then investigate the 8-day, 30m disturbance time series to assess the subtle changes in the landscape caused by livestock grazing and the abrupt changes brought about by plantation forestry.

0654	Land use policies and sustainability impact assessment of sugarcane expansion in Southwest Goiás, Brazil	Heitor Coutinho, Selma Castro, Ana Turetta, Joyce Monteiro, Silas Trindade, José Pietrafesa, Benjamim Vilela, Hannes König	Brazil

Land use policy makers should be able to assess the sustainability impacts of different policy configurations. Handling with sustainability impact issues derived from land use change processes requires informed decision making to ensure the sustainable management of the territory occupation and the well being of local populations. This article is part of a research endeavor to develop tools to assess the sustainability impacts of land use change related policies at the local scale (municipalities and state levels). The research strategy is based on the concept that, for a society to reach a satisfactory degree of development, economic growth, environmental preservation and social equity must co-exist. The methods used are based on the participatory methodology FoPIA (Framework of Participatory Impact Assessment; Morris et al. 2011), developed to assess the sustainability of land use change policies, and applied to analyze the case study of sugarcane expansion policies and its impacts in the Planning Region of Southwest Goiás (PRSG), in Brazil. An expert-based workshop brought together knowledge on different economic, social, and environmental impacts of sugarcane expansion in the state of Goiás, and resulted in a structured interdisciplinary discussion over sustainability issues of sugarcane expansion in Southwest Goiás, the proposal of policies to base scenario constructions, and definition of the land use functions and indicators best suited to be applied in the PRSG. This presentation will bring results of expert and stakeholders participatory assessments and a critical analysis of the potential for implementation of sustainability impact assessment tools in support of land use policy formulation in Brazil.

0659	Integrated modelling of land use change impacts on ecosystem services in Latin America	Kirsten Thonicke, Alice Boit, Michiel van Eupen, Kasper Kok, Anouk Cormont, Marta Pérez-Soba, Laurence Jones,	Germany

		Patricia Balvanera, Sandra Quijas-Fonseca

Land transformations are changing the face of the Earth at unprecedented pace with enormous implications for policies designed to mitigate climate change, reduce biodiversity loss and the continuous delivery of vital ecosystem services.

Despite the urgent need for science-based methods and tools to conduct integrated ecosystem service assessments, little is known about the feedbacks between biodiversity and carbon-related ecosystem services under climate and land-use change.

Vegetation models could be powerful tools for investigating these relationships in combining land-use and climate-change scenarios, but so far, most of these models do not yet appropriately represent biodiversity across spatial and temporal scales. While local to regional vegetation models are increasingly applied to questions in ecosystem management including scenarios of land use change, global dynamic vegetation models (DGVM) are especially useful to predict the role of vegetation in the global carbon cycle undergoing climate change. Using the output of land-use-change models as additional forcing for DGVMs combines the strengths of these two different modelling approaches to assess the potential of natural vegetation and agricultural areas in maintaining ecosystem services related to biodiversity conservation, water management and climate change mitigation.

For this purpose, we develop an integrated modelling framework consisting of three models to quantify effects of land use change scenarios linked to implementation of REDD+ and Climate Change Mitigation (CCM) policies in Latin America. The are the dynamic, spatially explicit land use models, CLUE and DINAMICA, the LPJmL DGVM to model the past, current and future vegetation of Latin America, and ecosystem service models using the ARIES methodology. We use a novel framework incorporating biodiversity indicators (taxonomic, functional, structural and landscape composite indices) to assess the trade-offs among different land-use options and vegetation dynamics and assess their impact on biodiversity and on the provision of ecosystem services. .

The integration of these models enables to meet local-to-regional requirements, e.g. biodiversity conservation and water management while addressing the global challenge for climate change mitigation through the quantification of carbon stocks and fluxes at the same time. Models are validated against existing land cover databases, field observations and products from remote sensing. The integrated modelling framework is part of the indicator framework combining field data, statistics and model outputs.

Our integrated modelling approach will advance whole-ecosystem theory and its applications in ecosystem service assessments and is highly relevant to a range of end users including conservationists, agricultural practitioners and policy makers involved in CCM programmes (e.g. CBD, REDD+).

0660	Modeling impacts of land-use/land-cover change and variable precipitation on hydrology and water quality of a coastal watershed in Texas	Cesar Castillo, Inci Güneralp, Burak Güneralp, Anthony Filippi	USA

Land use/land cover change (LULCC) and variations in precipitation can interact to alter the quantity and quality of freshwater flows. The Mission-Aransas (M-A) estuary in Texas depends on inputs of freshwater and material from streams in order to maintain its ecological integrity. Freshwater inflow estimates for the M-A estuary have previously been established, but no analyses using scenarios of LULCC and precipitation variability have been conducted that inform how freshwater inflows could be impacted. In this research, we asked the following question: How are streamflow, sediment flow, and nutrient transport into the Mission-Aransas estuarine system impacted by interactive variations in precipitation and land-use/land-cover change?

We conducted a land change analysis for the M-A region by classifying portions of two Landsat images for the years 1990 and 2010. A large degree of LULCC occurred within the M-A region during this time; with 27.1% of the land area experiencing LULCC. Furthermore, developed land experienced an increase of 44.9%. To study the dynamic changes in quantity and quality of freshwater inflows, we calibrated and validated a SWAT hydrological model of the study area. We conducted a simulation analysis to analyze how stream/channel flows and loads of sediment, total nitrogen, and total phosphorus were impacted under different LUCC and precipitation conditions in the past and how these impacts are likely to evolve by 2040.

A general increase in all output variables was exhibited as the amount of precipitation and developed land increased; with impacts from precipitation variability outweighing impacts from varying amounts of developed land. Sediment loads were the variable the most impacted by differing amounts of developed land. Impacts to watershed hydrology and water quality from increased amounts of developed land tended to be more local in the vicinity of where the expansion of developed land is occurring, while impacts from precipitation variability were more evenly distributed across the basin.

This study provides information on how LULC and precipitation can influence watershed hydrology. Our findings will facilitate sustainable management of the M-A estuary and the watersheds upstream. Furthermore, this research contributes to the body of knowledge on the changes occurring in coastal regions of Texas and therefore, can inform coastal planning in the state. Thus, our presentation, with its emphasis on land-water interactions and land change impacts on biodiversity, contributes to the Meeting in relation to its main theme on "impacts and responses".

0661	Land abandonment in Europe: assessing the effect on agricultural landscapes in Europe	Emma van der Zanden, Peter Verburg, Christian Levers, Tobias Kuemmerle	The Netherlands

In Europe, there is a wide variation of rural cultural landscapes, ranging from traditional to industrial landscapes. These landscapes are, for the most part, the result of a succession of different historical land-use stages. Intensification of agricultural production has largely influenced the European landscape in the past 40 years, e.g. in the form of scale enlargement, field heterogeneity and linear landscape element removal. On the other hand, more pressure on traditional and low input land use types has lead to a clear decrease in agricultural areas, especially of extensive or small-scale systems. Both developments have a clear effect on the current spatial landscape patterns, as well as their related ecosystems, ecosystem services and (agro-) biodiversity. We present a new landscape typology for agricultural landscapes, that complements land cover data with information on the different dimensions of agricultural intensification; fertilizer input rates, field size and linear landscape element occurrence. A comparison is made between two major methods of landscape classification; expert-based mapping and highly automated mapping. The former uses information from the literature and national classifications as guideline, while the latter is based on the unsupervised learning and clustering algorithm of self-organizing maps (SOMs). Both mapping approaches are compared and their performance is tested using an expert-based validation. The information on the different agricultural landscapes in Europe is used as one of the inputs in a spatial trade-off analysis of the effect of land abandonment in Europe. Land use change predictions show significant levels of farm land abandonment for the coming 20-30 years. It is theorized that the effect of land abandonment is twofold; while it can have a negative impact on certain ecosystem services, such as cultural services in the form of traditional agricultural landscapes, abandoned areas can also provide potentially beneficial consequences, e.g. enhancing (agro-) biodiversity in highly fragmented landscapes. We identify the current European areas where these trade-offs are occurring, with a focus on the effect on traditional agricultural landscapes and (agro-)

biodiversity. Furthermore, we use scenario-based land use predictions for the coming 30 years to theorize the future areas of spatial trade-offs related to land abandonment in Europe.

0662	Abrupt changes in ecosystem services and wellbeing in Mozambican Woodlands?	Casey Ryan, Janet Fisher, Genevieve Patenaude	UK

We present research from a large (£2 million) research project, recently funded by the Ecosystem Services for Poverty Alleviation consortium (www.espa.ac.uk, UK government), focused on Mozambique. Miombo and mopane woodlands in southern Africa present a unique social-ecological system characterised by relatively high population densities, rapidly growing populations, shifting cultivation, a reliance on biomass for energy, and complex ecological interactions involving multiple disturbances. There are extremely tight linkages between social and ecological components of the system: rural households derive much of their wellbeing from the woodlands and associated agricultural systems, and ecosystem services (ES) have a strong role in mitigating poverty. Whilst this dependence on ES is relatively well described, little is known about change: how the impacts of woodland loss and agricultural expansion affect rural wellbeing. Gradual land use change can cause abrupt or non-linear changes to ecosystem services and rural livelihoods (e.g. Rodrigues *et al.* 2009), but given the complexity of the system, the key ecological and social processes remain opaque. We hypothesise that there are abrupt changes in wellbeing as ecosystem services change with woodland loss. We report on our project, which uses a space for time substitution to examine the relationship between woodland loss, and household wellbeing, along gradients from low to high woodland cover. Our project will also investigate adaptive responses, which may allow households to sustain their wellbeing in the short term as woodland resources decline. Being able to identify such thresholds of abrupt change, and adaptive responses, is crucial to inform management of land use change to minimise poverty, especially given the absence of social safety nets. At this early stage of our research project, the rationale of our presentation will be to seek feedback on our conceptualization of these issues, and the operationalization of our recently published conceptual framework for empirically investigating the relationship between ecosystem services and poverty alleviation. This presentation will contribute to the conference theme of 'impacts and responses', and more specifically to the chosen session, by presenting a conceptual and methodological framework by which the contribution of ecosystem services to household wellbeing in Sub-Saharan Africa can be investigated.

0663	Analyzing global threats to ecosystem service provisioning based on combined land use and dynamic ecosystem modeling	Ariane Walz, René Sachse, Peter Verburg, Kirsten Thonicke	Germany

Land use transition and climate change will be the main reasons for changing provision in ecosystem services worldwide over the coming decades. Both processes impact human-environment systems from local to global scale, but ecosystem service assessments have so far been mainly investigated on local to regional scale. However, global scale analysis will be able to provide estimates for supply of selected ecosystem services across all major managed and unmanaged ecosystems worldwide. In particular, it will be able to make some first estimates of the effects of various, partly competing global policy directions, e.g. the Convention of Biodiversity, Climate Mitigation Policy, and the need to feed an increasing global population.

To better understand the impacts of these main land pressures on ecosystem service provisioning, we follow an ecosystem model based approach. By combining the dynamic global ecosystem model LPJmL (Bondeau et al., 2007) with global scale land change modeling, we pay respect to the rapidly changing land use systems. Here, the dynamic global land use change model will help to simulate global

distribution of land use under various scenarios taking up alternative global development pathways. Furthermore, by deducing ecosystem services from the dynamic ecosystem model, ecosystem provisioning of managed as well as unmanaged ecosystems will be strongly linked to the state of the ecosystems in place and their changes over time. Compared to more land cover dominated deduction of ecosystem services, this helps us investigating changes over longer periods, in which climate change might alter the ecosystem and their provisioning of ecosystem heavily.

In this study, we will analyze and compare the impacts of the key global pressures on land use until 2050. First results for the deduction of ecosystems services of global importance from the global dynamic ecosystem model LPJmL will be presented including outcomes based on initial land use change simulations.

0665	Spatial co-variation of capacity and flow of ecosystem services and biodiversity: options for efficient designation of conservation areas	Matthias Schröter	The Netherlands

Ecosystem services and biodiversity can show high variation across space. With the help of spatially explicit models we can analyse to what degree ecosystem services co-vary with each other and with biodiversity. A variety of methods to analyse this co-variation has been applied in studies that map multiple ecosystem services, including simple or weighted overlay, correlation analyses and principal component analysis.

We review and test spatial co-variation methods and interpret their analytical strengths and weaknesses for a dataset of nine ecosystem services in Telemark county, Southern Norway (Schröter et al., under review). We base our analysis on medium to high resolution models for both capacity to provide services and actual flow of ecosystem services (moose hunting, sheep grazing, timber harvest, forest carbon sequestration and storage, snow slide prevention, residential amenity, recreational hiking and existence value).

Capacity and flow of ecosystem services in Telemark differ both in spatial extent as well as in quantities. We aim to analyse what effect these differences have on the spatial co-variation among the models. Flow models might show a higher co-variation than capacity models because flow is more related to human infrastructure and thus spatially concentrated. Another aim is to analyse the spatial relation of ecosystem services to biodiversity. For this purpose we model biodiversity with the help of two models (GLOBIO, Norwegian Nature Index). This enables us to test the often reproduced but yet to be tested hypothesis of the relation between different levels of biodiversity and categories of ecosystem services (Braat and ten Brink 2008).

Such information can help to determine which bundles of services are lost when one land unit is transformed. Spatial differentiation between capacity and flow might be an analytical improvement when determining whether current conservation areas are efficiently designated in order to manage for multiple ecosystem services and biodiversity.

This paper takes a systems perspective on land-use by addressing multiple ecosystem services. It focusses on method development in the field of spatial analysis of synergies and trade-offs among ecosystem services and biodiversity.

0667	Decision-making on land use intensification in an (pre)alpine region 1830-2030	Veronika Gaube, Alexander Remesch, Karlheinz Erb	Austria

Until the development of the Haber-Bosch process in the early 20th century, N was scarce in agro-ecosystems, the only sources being natural deposition, fixation through leguminous plants, manure from livestock and human faeces and therefore insufficient at that time to provide food for a growing global population. Since the early 20th century, synthetically produced N fertilizers have been applied in

increasing quantities in agriculture. Changes in intensification in terms of N management result from day-to-day decision-making processes of farmers, consumers and other actors. Biophysical and socio-economic framework conditions are the main drivers and constraints for the option space for each of these decisions. We here present an agent-based model developed for the Upper-Austrian part of the valley of the river Enns. The Enns valley follows a north-south direction. Its southern parts are alpine, characterized by a dominance of forest cover, high precipitation rates, low average temperature, and livestock-centred agriculture. Towards the north, elevation and precipitation decline, mean temperatures rise and arable land plays gains importance. The most northern part is characterized by the largest city of the region, Steyr and by the dominance of intensive cropland agriculture, with larger fields and industrial modes of cultivation. The region has provided 20-30% of all European iron in the late 17th century. Mining industry and manufacturing resulted in huge environmental pressures on the region's forests and agro-ecosystems, due to the high demand for fuel wood and nutritional demands of non-agricultural population. Large-scale coal use, railways, industrialized metal smelting and metallurgy, let to the abandonment of most mines in the region. Most of the agricultural lands are of marginal agricultural productivity. These changes also resulted in fundamental transformations of the local food system away from a locally managed demand-supply system to system where regional demand and supply of food became independent from each other due to surges of transport capabilities. Intensification has allowed the reduction of per-capita land requirements for food production, despite growing calorie and animal product intake, but at the expense of decreasing productivity (the ratio of input to output fell in energetic terms). The model endogenously represent (a) decisions of relevant actors of the Enns valley, (b) spatially explicit changes in land use and (c) socioeconomic as well as ecological stocks and flows of substances like nitrogen (with adequate spatial as well as temporal resolution).

0668	Using agent based models and a backcasting exercises for understanding social and environmental trade-offs	Derek van Berkel, Leslie Horner, Kendra McSweeney, Becky Mansfield, Darla Munroe	USA

Land use modelers are increasingly adopting participatory policy design techniques. One technique that is used is Backcasting. Backcasting aids stakeholders in formulating nonlinear conceptions of future events, and developing normative goals that prescribe ideal future states, to conceptualize interventions that could achieve prescribed futures. One challenge with incorporating stakeholder participation is that backcasting outcomes are largely influenced by participants' interests, knowledge and perspectives. Stakeholders may not consider path dependencies related to heterogeneous land management and decisions, which can result in policy design that does not incorporate spatial and temporal trade-offs. Agent based models (ABM) can represent heterogeneous decision makers in land change simulations, propagating their influence to examine resulting spatial and temporal land changes. ABM simulations may therefore be used to derive aggregate outcomes not considered by local stakeholders. In this paper we present the findings of focus groups with forest stakeholders in southeast Ohio. We explored community and forest futures using agent based models to inform formulation in a backcasting exercise. This region has undergone significant environmental changes over the last two centuries. Once completely denuded of its forest cover due to extractive industries, today, the secondary forests are among the state's oldest. This has occurred on land that is privately owned, making local decision an important component of forest resurgence. An increase in exurban migrants and subsequent subdivision of forestlands has increased the diversity of actors now using the forest. This is seen as a threat to forest health with the potential for increased fragmentation, a point source of invasive species and possibility for future mineral extraction (fracking). The proximity to Columbus, a major urban population, makes

the region a tourism destination. This may entice some landowner to engage in the tourist industry with cabin rentals. Gauging regional visions for the areas and formulation of future goals is important for understanding what is wanted for the future. Embedding this discussion in awareness of potential future trade-offs (i.e. negative spillover effects) may aid in formulations of actions and policies that achieve spatially sensitive results. In the presentation we investigate stakeholder learning and a systematic procedure to assess the forest stakeholder uptake of presented spatial information.

0669	Diverted waters - inequalities is access to water resources in Taita Hills, Kenya	Johanna Hohenthal, Paola Minoia	Finland

Access to water resources in the local communities of developing countries depends on various issues including the physical availability of water, condition of supply infrastructures and networks, livelihood structures, gender and power relations and water prices. Conflicts between upstream and downstream water users appear easily without effective local water management.

In the Taita Hills, South-East Kenya, cutting down of indigenous cloud forests has decreased water resources significantly during the recent decades. Irrigation on small subsistence farms has also been practiced especially in the upper parts of the hills since long before colonial times and it is still the largest water user in the area. In the past, the irrigation systems were built and maintained collectively by the users and overseen by a village elder. Nowadays the supervision has shifted to a chairman recognized by Ministry of Agriculture.

In this study, we look at how the changes in land and water resources and in irrigation practices and supervision have affected the livelihoods of the local farmers in the Taita Hills. The methodology of this study bases on the theoretical framework of political ecology, which analyzes human-nature relationships combining social and ecological theories. Two catchments, Wundanyi and Mwatate, were chosen as case study areas. The data was gathered in semi-structured interviews that targeted local water users, such as farmers, town dwellers and small entrepreneurs, as well as water and land resources management authorities. Workshops that contained participatory mapping and timeline exercises were also organized for different community groups in both catchments.

The results show that there disparities in access to water for irrigation and domestic use between the people in the highlands and people in the lowlands are produced by the complex context of historically and socially embedded development trajectories that entail both current and past power structures as well as environmental changes. The local water institutions are aware of this disparity, but face various challenges for intervention in practice, including aging infrastructure, increasing water demand and diminishing resources and lack of financial and human resources. Resources management is also complicated by the land property rights and incoherencies between local governance and customary rules. Local people's access to water is also increasingly determined by the ability to pay for it, a result of commercialization of the national water sector. Also those who have a higher social status have more power to affect the local water distribution.

0673	Cascading potential synergies among multiple ecosystem services during tropical dry forest regrowth	Ilyas Siddique, Mayra E. Gavito, Patricia Balvanera, Francisco Mora, María del Carmen Godínez, Diego Pérez	Brazil

Tropical dry forest conversion to pasture may degrade regulating ecosystem services, but also reduce access to diverse forest products, which could economically enhance human well-being. Under such conditions of agricultural land degradation widespread in the seasonally dry tropics, multiple stakeholders could benefit from land change transitions that increase multiple regulating and

provisioning services simultaneously, for instance during spontaneous or managed secondary forest regeneration (Maass et al. 2005).

To foster the restoration of multiple ecosystem services, our objective was to contribute to our understanding of (a) how drivers of vegetation change cascade to modify multiple services simultaneously, and (b) whether unexplored provisioning services could potentially contribute to economically sustain the recovery of forest cover.

We quantified ecosystem properties that are crucial to sustain multiple regulating and provisioning services along a space-for-time chronosequence from active pastures through secondary forests of different ages to old-growth forests on the Pacific coast of Mexico. We measured basal area per woody species, litter layer mass, soil carbon concentration and woody species richness. We estimated the availability of timber and non-timber forest products actually utilized in the region (based on semi-structured, semi-directed interviews with local smallholder farmers), and those potentially utilizable (based on all uses reported in the ethno-botanical literature). Using Structural Equation Modeling in a Generalized Linear Mixed Model framework we evaluated cascade effects of age along the land change transition via woody basal area on the litter layer and soil C and via woody species diversity on the proportion of locally used versus potentially useful woody species and on the multiplicity of actual versus potential uses of the secondary vegetation.

We found synergies between the mitigation of soil erosion and greenhouse gas emissions, biodiversity conservation, as well as provisioning of diverse forest products, when secondary forest succession is allowed to proceed. We highlight the potential of currently unexplored economic uses of secondary forests, although tradeoffs are likely to emerge, especially between intensified timber and firewood exploitation and regulating ecosystem services.

We intend to contribute to the conference and session by demonstrating how local-level processes drive tropical dry forest ecosystem resistance and resilience associated with drastic changes in land cover (deforestation and forest recovery). We highlight how subtle changes in land management (utilization of secondary forest products) could cascade to generate multiple synergies among regulating and provisioning ecosystem services, thereby projecting pathways for agro-diverse secondary forest management as alternatives to land abandonment.

0674	Sharing and sparing: addressing "adequate" land-use configuration through the biosphere reserve zonation at Lake Tana, Ethiopia	Friedrich zur Heide	Germany

The land sharing vs. land sparing debate revolves around arguing whether or not and how the two interwoven objectives of food production and biodiversity conservation should be spatially separated. Through its zonation into core, buffer and development zones, the concept of UNESCO biosphere reserves aims at finding the most adequate land use configuration while integrating land-use and conservation based on the ecosystem approach. Adequate refers to balancing food production with ecosystem integrity, externalities and local benefits. Accordingly, land sharing and land sparing are inherent parts of biosphere reserves; its suitability highly depends on the local social-ecological context.

The Lake Tana basin in Ethiopia is largely characterized by densely populated agro-ecosystems, wetlands, aquatic systems and remnant forests, which provide livelihood sources for smallholder agriculture, livestock, fisheries and forestry. The overall ecosystem integrity and capacity to provide ecosystem services for agriculture is increasingly being undermined by population-driven ecosystem encroachment for food, fuel and fodder. This results in massive soil erosion, siltation and eutrophication of the lake, degradation of wetlands and habitat fragmentation, undermining food security in return. As a designated national growth corridor the area is currently undergoing massive land-use transformations for agricultural intensification and large-scale irrigation to boost an agriculture-led industrialization (ADLI). Through the climate-resilient green economy (CRGE) strategy the government has committed

to an environment-friendly approach. Based on the case study of the planned Lake Tana Biosphere Reserve this presentation will demonstrate how these two approaches should be coupled in a biosphere reserve by outlining an ecosystem-based land-use classification and addressing environmental tradeoffs. The author argues that because of the prevailing strong ecological connectivity and thus interdependencies among these systems, such as upstream-downstream linkages, as well as the socio-cultural smallholder settings, land sparing (e.g. through area closures) is only a viable option if embedded into a broader land-use concept. For the adequate land-use allocation, landscapes need to be considered as open multifunctional systems, and co-benefits as well as tradeoffs should be taken into consideration.

The presentation provides a case study to contribute to the session´s question by giving concrete examples of the land-use and ecological settings and dynamics of a highly interconnected lake basin.

The presentation will thereby address following conference themes:

Changing rural-urban connections

- Agricultural intensification and alternative pathways
- Land change impacts on ecosystem services and biodiversity
- Land-water interactions

0675	Agricultural land-use change: environmental impacts and trade-offs 2000-2010	Lisa Ribaudo	Canada

Agricultural lands cover over one third of the earth's ice free land area and significantly shape both global and regional environmental services and functioning through their impact on biodiversity, water quality, and greenhouse gas emissions (Foley et al., 2011). Agricultural intensification and expansion may generate different environmental tradeoffs depending on the region in which they occur. In recent years, various sources, including regional case studies and national level statistics, have reported on rapid shifts in agricultural land use characterized by an overall shifting of agricultural production from the global north to the global south. However, very little information currently exists to quantitatively evaluate recent changes in agricultural land use at a global scale or to evaluate the net effect of these changes on the environment.

Our work presents findings derived from the compilation of over 200 agricultural censuses and surveys reporting on components of agricultural land use at a sub-national level between 1998 and 2013. This dataset allows us to evaluate how changes in land allocated to crops and pasture in the 21st century have impacted ecosystem services, as measured by changes in carbon stores, water availability, and biodiversity.

Our research contributes to the conference theme by presenting the first global synthesis of agricultural land use change. In addition, our analysis of the relationship between lands currently undergoing agricultural land use change and their ecosystem service value aims to provide a basis for the development of more informed agricultural policy interventions that minimize negative pressures on natural resources. By presenting our work on a global scale, we hope that our work will pull together findings presented by other conference participants and draw on their expertise to stimulate discussion on the relationship between drivers of agricultural land use change and their subsequent impact on ecosystem services.

0676	Warfare effects on land system dynamics	Tobias Kuemmerle, Matthias Baumann, Van Butsic, Anja Shortland, Volker Radelof, Tilman Brueck	Germany

Land use transitions are commonly portrayed as slow shifts from one land use regime into another (e.g., from subsistence to industrialized farming), driven by gradually changing socio-economic or institutional conditions. Yet, there is increasing evidence that land systems change often rapidly in response to shock events such as economic crises or revolutions, and that such events may trigger regime shifts in land systems. Warfare or armed conflict are among the most extreme socioeconomic and institutional shocks affecting land systems and are unfortunately widespread. Armed conflict can affect land systems substantially and in diverse ways, including both relaxing land use pressure (e.g., land abandonment where people are displaced) and intensifying land use (e.g., illegal logging). Overall, our understanding of warfare effects on land system dynamics remains weak, mainly due to a scarcity of empirical case studies that quantify the impact of armed conflict on land systems, and a lack of synthesis work on existing case studies.

We carried out three analyses to provide new insights into the relationship of warfare and land use transitions. First, we gathered available global-scale data on armed conflict and on land systems, highlighting clear associations of conflict types and land use regimes. Second, we conducted a systematic literature review to identify empirical case studies assessing warfare effects on land systems in order to synthesize (a) LUCC trends and trajectories associated to different types of armed conflicts, (b) indicators of potential regime shifts in land systems due to armed conflict, and (c) bias in conflict types, land systems, and geographic regions covered by existing case studies. Finally, we carried out two empirical case studies to exemplify how remote sensing and quasi-experimental econometric methods can quantify the impact of warfare on land systems. In our first example we assessed the importance of armed conflict on deforestation in the Democratic Republic of Congo, showing that conflict was an important driver of deforestation in this region. The second exampled focused on armed conflict between Armenia and Azerbaijan in the Caucasus, highlighting that warfare led to both farmland abandonment and increasing land use pressure through the displacement of people. Collectively, our results emphasize the strong impact armed conflict can have on land systems, including the potential to trigger regime shifts.

0677	Mapping and quantifying spatio-temporal patterns of land system change: a spatially explicit HANPP dataset for Europe 1990 to 2006	Christoph Plutzar, Christine Kroisleitner, Karlheinz Erb, Tamara Fetzel, Claudia Bulgheroni, Tim Beringer, Dietmar Moser, Maria Luisa Paracchini, Sibyll Schaphoff, Peter H. Verburg, Pieter J. Verkerk, Helmiut Haberl	Austria

Despites its key importance for analysing land system change, there is a lack of consistent datasets on land-use intensity. Land-use intensity can be measured as changes in inputs or outputs to land, or as changes in system level parameters of ecosystems such as net primary production (NPP), carbon stocks or biodiversity.

We here present a spatially explicit dataset on the integrated indicator HANPP (human appropriation of net primary production). HANPP measures changes of biomass flows in ecosystems resulting from land use and is defined as the difference between the NPP of potential vegetation and the actually prevailing

vegetation in the same ecosystem after accounting for the part of the actual NPP harvested by humans or destroyed during harvest. Consequently HANPP represents an integrated indicator of the land-use intensity in terms of ecosystem energetics that allows to trace changes in output (harvest) as well as the associated land-use induced ecological system level changes. Although HANPP is a biophysical indicator it can be linked directly to socio-economic processes, underpinning its applicability to address policy relevant as well ecological questions.

We are now able to present a spatially explicit HANPP assessment for Europe (EU27) at a resolution of 1x1 km, for three time cuts (1990, 2000 and 2006). To derive HANPP, we calculated three items, consistently integrating data from various sources such as results of global vegetation modelling and census data of various spatial resolutions: potential Net Primary Production ($NPP_{orig-veg}$), actual NPP (NPP_{act}), and harvested NPP ($HANPP_{harv}$). HANPP then is the difference between $NPP_{orig-veg}$ and the sum of $HANPP_{harv}$ and $HANPP_{luc}$, which is the difference between $NPP_{orig-veg}$ and NPP_{act}. We calculated these items separately for six broad land use classes (cropland, forestry, grazing land, built-up and infrastructure, non-productive and wetlands, and wilderness) by reconciling the spatial pattern (1km) with census data (NUTS-2 or national level) on area covered by these classes and carbon flows associated to them.

This assessment allows to analyse spatio-temporal changes of land use, integrating area and intensity changes, and will be employed to discuss processes driving land use change as well as its ecological impacts.

0678	Hotspots and archetypes of land system change in Europe	Christian Levers, Tobias Kuemmerle, Karlheinz Erb, Stephan Estel, Christine Kroisleitner, Daniel Müller, Christoph Plutzar, Anette Reenberg, Martin Rudbeck Jepsen, Julia Stürck, Peter H. Verburg, Pieter J. Verkerk, Emma van der Zanden	Germany

Assessing the environmental footprint of land use and identifying pathways to sustainable land systems will to a large part depend on better understanding the patterns and drivers of past land use change. Major knowledge gaps relate particularly to intensification pathways, because adequate datasets to capture the multidimensionality of land use intensity are largely lacking. This represents a major obstacle for understanding the drivers, hotspots, and outcomes of intensity changes, although intensification pathways may represent the bulk of land use change in many world regions. One such region is Europe, which furthermore is an interesting region to study land system change, because its spans a range of environmental gradients and has experienced strong policy (CAP) and structural (EU accession) changes recently.

Here, our goals were (1) to understand patterns of recent land use change, pertaining to both area and intensity changes, (2) to identify hotspots for different land change processes, and (3) to identify archetypical combinations of drivers and outcomes of land change. We generated a comprehensive data set of land conversions and intensity changes pertaining to cropping, grazing, and forestry at two spatial scales (NUTS2 and 1km² grid level) for the EU27 by using remote sensing data and dasymmetric

mapping to disaggregate statistical data. We produced 16 indicators of land system change pertaining to both changes in area (e.g., changes in cropland area) and intensity (e.g., changes in fertilizer input or yields). Using this geodatabase of land change indictors, we identified hotspots of land system changes by mapping the upper deciles of in- and decreasing trends for each indicator. We overlaid these maps to identify co-occurring and spatially separate land change processes and dynamic regions where many land change processes take place. To understand the mechanisms behind the observed land change patterns, we assessed drivers of change for selected processes in forestry and agriculture. Finally, we combined drivers and land change outcomes by using an automated spatial clustering technique to highlight distinct pattern-process combinations of land system change across Europe.

Our results highlight divergent directions and patterns of the different indicators, e.g. increasing (Western Europe) and declining (Eastern Europe and the Mediterranean) cropland intensity concurrently to general contraction of cropland area. Strong differences in spatial patterns of different cropland intensity indicators highlight the system complexity by revealing that increasing input intensity is not necessarily related to higher output intensity.

Our work was carried out as a part of the EU-funded project VOLANTE, and seeks to contribute to an improved understanding of land use transitions, thus contributing to conference theme 1.

0679	Assessing multi-stability using global land cover data: an empirical exploration of alternative agricultural regimes	Daniel Ospina, Garry Peterson, Reinette Biggs	Sweden

Using a novel methodology to analyze global land cover data in search for signatures of alternative regimes, we assessed the potential multi-stability of agricultural landscapes. We applied this methodology to a set of 34 countries, which account for more than 80% of the global production of the main crops, and cover a range of relevant socio-economic variables. Our approach is based on similar methods used to successfully analyze potential regime shifts in forest-savannah and forest-tundra systems. Specifically, if alternative regimes can exists, one expects multi-modality in the frequency distribution of a state variable that is not explained by discontinuities in key controlling factors. We searched for such multi-modality in cropland cover data, controlling for key exogenous factors, such as agricultural suitability and market access. Our results suggest that alternate regimes in agricultural landscapes likely exist in many countries. This study highlights the ubiquity of multistability of agricultural landscapes, suggesting that land-use agents may respond in very different ways under the same conditions, and potentially respond abruptly to gradual changes in those conditions. Despite the high context-dependent variation found, the identification of some general patterns appears to be possible. Steps towards the identification of such general patterns associated with alternative regimes should be a research priority to understand future land-use transitions in a context of global change. Given the scientific and policy challenge posed by these non-linear, abrupt and persistent changes potentially underlying land-use transitions, it is necessary to expand the methodological toolbox, building on interdisciplinary dialogue. By presenting this method and results, I also expect to contribute to this conference theme and session by fostering the discussion about the nature, strengths and weaknesses of different approaches to the study of land use transitions.

0680	Land cover-climate interactions in the past for the understanding of current and future climate change: the LANDCLIM project	Marie-José Gaillard, Gustav Strandberg, Anneli Poska, Anna-Kari Trondman, Florence Mazier, Jed O. Kaplan	Sweden

The LANDCLIM (LAND cover – CLIMate interactions in NW Europe during the Holocene) project has

the overall aim to quantify human-induced changes in regional vegetation/land-cover in northwestern and western Europe North of the Alps during the Holocene (the last 11 500 years) with the purpose to evaluate and further refine the dynamic vegetation model LPJGUESS and the regional climate model RCA3, and to assess the possible effects on the climate development of two historical processes, i.e. climate-driven changes in vegetation and human-induced changes in land cover, via the influence of forested versus non-forested land cover on shortwave albedo, energy and water fluxes. Accounting for land surface changes may be particularly important for regional climate modeling, as the biophysical feedbacks operate at this scale. The aims of the LANDCLIM project are achieved by applying a model-data comparison scheme. The REVEALS model is used to estimate land cover from pollen data for 10 plant functional types (PFTs) and 5 time windows of the Holocene - modern time, 200 BP, 500 BP, 3000 BP and 6000 BP. The REVEALS estimates are then compared to the LPJGUESS simulations of potential vegetation and with the ALCC scenarios of Kaplan et al. (KK10) and Klein-Goldewijk et al. (HYDE). The alternative descriptions of past land-cover are then used in the regional climate model RCA3 to study the effect of anthropogenic land-cover on climate. The model-simulated climate is finally compared to palaeoclimate proxies other than pollen. The REVEALS estimates demonstrate that the study region was characterized by larger areas of human-induced openland than pollen percentages suggest, and that these areas were already very large by 3000 BP. The KK10 scenarios were found to be closer to the REVEALS estimates than the HYDE scenarios. LPJGUESS simulates potential climate-induced vegetation. The results from the RCA3 runs at 200 BP and 6000 BP using the LPJGUESS and KK10 land-cover descriptions indicate that past human-induced deforestation did produce a decrease in summer temperatures of >0 - 1.5°C due to biogeophysical processes, and that the degree of decrease differed between regions; the effect of human-induced deforestation on winter temperatures was shown to be more complex. The positive property of forests as CO_2 sinks is well known. But afforestation (i.e. planting forest) may also have the opposite effect of warming the climate through biogeophysical processes. Careful studies on land cover-climate interactions are essential to understand the net result of all possible processes related to anthropogenic land-cover change so that relevant landscape management can be implemented for mitigation of climate warming.

0683	The potential of subsistence rice production for biodiversity conservation in intensively managed cultural landscapes: insights from Vietnam and the Philippines	Vera Tekken, Susanne Stoll-Kleemann	Germany

In South East Asia rice cultivation has shaped cultural landscapes over many centuries. The technical approach of the *Green Revolution* launched in the 1960s aimed to expand staple crop yields by applying an agricultural model based on monocultures in order to overcome structural and chronic hunger crises, and to maximise agricultural yields. Increasingly, the amplified cultivation intensity in industrial rice production causes adverse effects. Soil degradation despite the use of chemical fertilizers, or pest infestations despite the massive use of pesticides, enhances incidental costs, reduces yields and causes economic losses. In the face of global challenges such as climate change and increasing population growth, new approaches for a sustainable food production are urgently needed. Still, subsistence rice cultivation represents a main pillar of regional food security in many regions in Vietnam and the Philippines, in particular in rural areas which are unsuitable for intensive industrial farming. Difficult production conditions (e.g. small-sized rice paddies, steep topographies, sophisticated irrigation systems) require a high degree of know-how and man-power. The resilience of these small-scale agro-ecosystems is closely linked to human well-being and societal stability. The project LEGATO (www.legato-project.net) aims to analyse respective influences in irrigated rice cropping systems in order to elaborate, test and implement appropriate tools for sustainable land management in Vietnam and the Philippines. The complex functional linkages and feedback processes of their particular socio-

ecological systems are evaluated by the assessment of locally-relevant ecosystem services. One significant outcome is the role of ecosystem services not directly connected to the rice fields but of utmost importance for harvest results, e.g. areas of cultural importance such as sacred (protected) forests, or private gardens with higher biodiversity. Further, a discernible link between landscape structures with higher species diversity and habitats and stable yields is assumed. But, as small-scale subsistence farming has a rather limited mechanisation potential, currently a production increase is mainly realized by clearing of forests to expand the cultivation area (e.g. North Vietnam). Thus, if the importance of environmental assets for agro-ecosystems is not recognised and areas of higher species diversity are not conserved, subsistence rice production and with this a pillar of regional food production will be severely threatened.

The presentation gives insight to the project features, its overall approach and applied methodologies. Tentative results will be outlined and discussed.

| 0684 | Vulnerable in the face of drought? Pastoral land use in the High Atlas Morocco | Birgit Müller, Romina Drees, Anja Linstädter, Karin Frank | Germany |

Transhumant pastoral land use in mountains supports the livelihoods of the households but is facing multiple changes including increased number of droughts. Often, herdsmen mentioned specific drought events as the reason for their abandonment from pastoralism. The purpose of this study is to assess the relevance of drought as a driving force for losses of livelihood security in a land use system with an altitudinal gradient.

We present and apply a framework for systematic analyses of the socio-ecological functioning of pastoral resource use that consists of the following components: (1) A spatially socio-ecological model for analyzing the system dynamics, esp. in face of drought (2) an operationalized measure for assessing livelihood security and (3) a strategy for systematic vulnerability assessments by scenario comparison. Exemplarily, this approach is applied to the land use system of the transhumant pastoralists in the High Atlas Mountains of Morocco.

The results indicate that, only in few cases, drought is the main threat to livelihood security forcing households to exit from pastoralism. Household characteristics such as income needs and the level of pastoral mobility determine the susceptibility towards drought.

We discuss implications on the role of drought in interplay with other processes of global change such as social change and land use change for livelihood security in pastoral systems. We conclude that pastoralists are quite well adapted to meteorological droughts but concurrent population growth and thereby increased income needs, and restricted mobility pose a greater challenge to fulfill livelihoods in the future.

| 0685 | Water governance in dryland irrigation systems: the role of data and information in institutional dynamics | Tom Evans, Paul McCord, Jampel Dell' Angelo, Kelly Caylor, Drew Gower, Linden McBride | USA |

Climate and other physical drivers of environmental systems are modifying the global availability of water for irrigation. At the same time population growth is placing an increased demand on water resources as local municipalities promote agricultural production as a mechanism to support human welfare and development. Substantial has research focused on household-level agricultural decision-making and adaptation. But equally important are institutional dynamics, or the rules implemented to allocate water resources across different user groups. Previous work has identified design principles for

common-pool resource systems that tend to lead to sustained governance regimes. Likewise, past research has addressed the issue of "institutional fit", or locally adapted governance arrangements characterized through governance structure. However, much of the complexity behind institutional dynamics and adaptive capacity lies in the translation of data to information to knowledge, and how this sequence contributes to effective cross-scale water management and decision-making - an arena that has arguably received less attention in the institutional literature.

We apply a diagnostic framework (Ostrom 2007) to investigate the interplay between governance regimes, data/information and institutional dynamics in irrigation systems in semi-arid regions of Kenya. In particular, we articulate the role of knowledge and mental models in institutional dynamics at multiple levels of analysis. How do users at different decision-making levels incorporate social and hydrological information in water governance? What data is needed to develop the information and knowledge users need for effective management? While governance structure is certainly a critical component of water management systems - we emphasize the interplay between the data-information-knowledge sequence and institutional dynamics. We present findings from household and manager-level surveys examining irrigation practices and the institutions designed to equitably allocate water within and across communities. Coupled socio-hydrological analysis is used to characterize the temporal availability of water and perceptions of water supply in sub-catchments dependent on groundwater vs. snowmelt sourced streamflow. Initial indications are that current institutional regimes are suitable for current hydrological and social conditions, but that multiple forces (including climate and social change) may limit the capacity for the current governance regime to maintain sufficient allocation of water for all users in the future. Advantages and disadvantages of the coding framework are presented as a step towards synthesizing case study research to generalizable findings.

0686	The politics of land deals - a comparative analysis of global land policies on large-scale land acquisition	Suzanne Verhoog	The Netherlands

Due to current crises, large-scale land acquisition is becoming a topic of growing concern. Public data from the 'Land Matrix Global Observatory' project demonstrates that in low- and middle-income countries, since 2000, 1,419 large-scale land deals (transnational and domestic) have been concluded, covering an area of almost 40 million hectares. The majority of these land transactions, also referred to as 'land grabs', took place between 2008 and 2010, peaking in 2009. The global land grab is largely driven by emerging economies in search for alternative ways to secure food and fuel supply in the nearby future. Large-scale land acquisitions often go hand in hand with issues of displacement, weak governance structures, corruption, conflicts, and environmental damages.

Global land policies on large-scale land acquisition could be a solution to regulate the global land grab. Several international institutions have taken the initiative in developing 'voluntary' principles and guidelines, also known as 'codes of conduct' to combat the global land grab. The *effectiveness* of these so-called 'soft law' instruments is however increasingly being questioned.

This paper therefore offers an in-depth institutional analysis on the effectiveness of global land policies on large-scale land acquisition, as developed by the European Union, the World Bank Group and consortium, the Food and Agriculture Organization, and the African Union.

Based on theories of *soft law*, and interrelations with *transparency*, *accountability* and *legitimacy*, twelve hypotheses were tested on a 5-point scale dependently as well as independently. The research implies that the African Union Framework and Guidelines, and the FAO Voluntary Guidelines, are theoretically most likely to succeed in effectively regulating large-scale land transactions in the near future.

With this presentation / my research I would like to open the debate on the effectiveness of these Global Land Policies on Large-Scale Land Transactions 'from theory to practice'. My research is purely

theoretical and I would like to discuss how these Global Land Policies, as established by four major institutions, could actually be translated into practice. Research for example shows that in Africa most land deals are initiated and facilitated by the African governments themselves.

Another interesting subject of discussion is whether these voluntary guidelines have 'teeth', in other words do these principles need to have sanctions on non-performance?

0687	Using remote sensing for monitoring of soil degradation by erosion in the Czech Republic	Josef Krasa, Marketa Vlacilova, Daniel Zizala, Tomas Dostal	Czech Republic

Most frequently used method for risk assessment of soil degradation by erosion is application of USLE or its derivatives on large scales. Many studies allocating erosion/deposition areas in catchments by simple models based on raster GIS were applied throughout Europe in last decades. Only few studies have been provided for verification of spatial accuracy of such models. We believe that soil degradation by erosion can be effectively monitored or quantified by modern tools of remote sensing with variable level of detail accessible.

Most detailed data can be obtained using unmanned aerial vehicle (UAV) providing stereoscopic images and ortophotos in high resolution (1-10 cm/pixel). The locations of rill erosion and higher erosion forms are mostly targeted. Volumetric analyses are applied to estimate the transported volumes of soil. Laserscanning is considered for the purpose as well. Similarly sediment cones in thalweg toes are identified.

Using hyperspectral data and multispectral data from satellite sensors (and UAVs) is also considered for soil texture and soil moisture changes driven by erosion. The main goal of the project No. QJ330118 is development and verification of procedures for the identification and evaluation of actual degradation of agricultural land by water erosion. Data from testing areas will be presented.

0689	Urbanization in the context of an expanding agricultural sector: using nighttime lights and cropping data to measure the relationship between agriculture and urban growth	Peter Richards	USA

To date, research on land use and land cover change in Brazil's Amazon region has broadly implicated agricultural expansion with environmental degradation or economic gain. In this work, which focuses on the State of Mato Grosso, we consider another direct impact of the expansion of commodity agriculture, namely the growth of mid-sized urban areas. Here we show that urban population and economic growth has paralleled the expansion of the region's agricultural sector, noting that urban population and economic growth across the soybean districts of central and eastern Mato Grosso has averaged as much as ten percent per year since 2000. In this paper we argue that agricultural growth is not only resulting in new rural economic production but also the expansion of urban based service sectors. We directly explore this relationship by taking an innovative approach that utilizes remotely sensed data products on crop distribution and economic activity. Specifically, we utilize a gravity model and measures of travel costs between urban and rural locations to situate urban growth within the context of regional economic activity. In this research we focus on two spatially explicit data products: (a) trends in nighttime light emissions, an alternative measure of economic activity or population growth; and (b) incidence of single and double cropping for broad-acre agricultural crops.   In our analysis we argue that agricultural expansion in Mato Grosso can be clearly identified as a positive and significant driver of regional urban expansion. We conclude with the argument that Mato Grosso's agricultural expansion has brought not only profound changes to the region's rural landscapes and land covers, but as a magnet for skills and expertise in the service and support sectors, has also precipitated the emergence of a rapidly growing constellation of regional cities.

0692	Integrating land and water use characteristics of global agricultural trade networks	Graham K. MacDonald, Kate A. Brauman, Paul C. West, Deepak K. Ray, Nathaniel D. Mueller, Shipeng Sun, Kimberly M. Carlson, Jonathan A. Foley	USA

Understanding the farm management characteristics that underlie agricultural trade relationships is increasingly important as global demand grows and consumption patterns change. Past research has explored aspects of the land and water footprints of international trade. Yet, the role of agricultural export production as a driver of cropland requirements, water quantity, and water quality at different scales is less clear. We present more holistic indicators to describe trade networks that incorporate agricultural management characteristics, possible environmental tradeoffs, and components of food security by fusing detailed international trade databases with spatially explicit global agricultural datasets. Our results illustrate national patterns of crop water productivity, water resource sustainability, fertilizer nutrient application, and harvested area requirements embodied in key global food and animal feed trade linkages. We also investigate how subnational variability in agricultural management intensity and crop yields influences estimates of the overall caloric efficiency of agricultural export production from different regions and uncertainties about the environmental tradeoffs embodied in different trade configurations. Finally, we discuss how characteristic dietary patterns and global demand for specific commodities links consumers with agroecological outcomes in specific 'hotspot' commodity-producing regions. This work sheds novel insight on the potential role of trade as a lever for mitigating environmental tradeoffs and enhancing food security among regions in an increasingly interconnected world. Accordingly, our research contributes to the conference theme by addressing the influence of globalization, farm management, and diet on land systems.

0693	Towards robust adaptation to climate change in the agricultural sector	David Leclère, Tatiana Ermolieva, Petr Havlík, Aline Mosnier, Erwin Schmid, Sabine Fuss, Hugo Valin, Jana Szolgayová, Michael Obersteiner	Austria

Despite significant climate change impacts expected by 2050, the food system could – through large adjustments - keep pace with an increasing demand for agricultural products at reasonable prices. Adaptation to climate change requires a large relocation of production systems across and within continents, and large changes in the specialization of producers as well as in trade configurations. Such a change in agricultural systems is increasingly recognized as being of a transformational nature, to be opposed to decisions which would remain within historical boundaries. However, this in-depth transformation of supply capacities presents large rigidity and irreversibility. In this context, the large uncertainty concerning climate change impacts implies a high risk of maladaptation of agricultural systems, through embarking upon a too rigid and inadequately anticipated transformation (Leclère et al., 2013). Single scenario analysis of adaptation to very uncertain climate change impacts is thus misleading, as there is a high probability that adaptations under one scenario could increase the

vulnerability of the food system, e.g. if another climate change scenario is materialized. New methods providing robust solutions for agricultural systems are critically required to increase the resilience of the food system. In this paper, we propose a modeling approach diagnosing the nature and the economical value of robust adaptations of agricultural systems to climate change. We use a set of alternative climate change scenarios, whose impacts on crop yield and input requirements were estimated in the frame of an inter-model comparison project (ISI-MIP) with a biophysical process model (EPIC). We introduce them into a stochastic version of the Global Biosphere Management (GLOBIOM) partial equilibrium model of the agricultural, forestry and bioenergy sectors. We test for various behaviors toward risk concerning outcomes such as food security by imposing explicit constraints with different risk measures. We quantify how robust adaptations would differ from the range of adaptation portfolios under single scenario analysis, and by how much they increase the resilience of food systems by reducing the risks associated with maladaptation.

| 0694 | Residential tourism as urban growth and 'water grab' machine | Angela Hof, Macià Blázquez-Salom | Germany |

Since the onset of mass tourism in the 1960s, tourist demand has been a distant, but overt driver of land change in destinations around the world. More recently, residential tourism has become a major component of tourist modernization in Spain and other major classic destinations in the Mediterranean, the world's largest tourist area. Residential tourism generally refers to property ownership and short-term residence of people from more affluent societies in tourist areas (O'Reilly 2007). The more permanent or long-term environmental impacts and the implications of this tourism-related migration and geographic displacement of land use are under-researched, in particular in relation to urban growth driven by residential tourism, and the real estate nature of the process. The paper links international monetary flows to urban land change and residential tourism as fluid lifestyle, taking the Balearic Islands (Spain) as an example. These islands have the highest percentage of real estate sales to foreign people out of all Spanish autonomous communities. The re-framing of the regulatory urban planning framework has been a contributing factor to the urban growth process that is driving, and driven by, residential tourism. Related to residential tourism, the creation and social-ecological transformation of urban land is characterized by low-density development with irrigated landscaping and swimming pools as artifacts that represent a new urban land regime associated with 'water grabs', vulnerability to water scarcity induced by climate change, and inequity in distribution and use of this essential resource. After promoting urban growth through the production of urban land for the construction of property, residential tourism causes water use shifts for the maintenance of a permanent infrastructure (gardens, swimming pools) irrespective of occupancy. The paper contributes to the GLP OSM theme #2 and session #0024 (chair: Dr. Patrick Meyfroidt) by conceptualising residential tourism as a phenomenon of interlocking spatialities that cannot be understood through traditional analytical frameworks of tourism or urban studies. In this respect, a theoretical framework is presented that understands residential tourism as both a new model of capital investment in urban spatio-temporal fix that is shifting the urban model and that turns natural resource constraints, such as water scarcity, into expansion opportunities; for instance, through water supply privatization and public megaprojects to expand sea water desalination plants to accommodate increasing water demands in the urban sector. Residential tourism thus accentuates the potential of tourism to outcompete agriculture for water, posing new questions of sustainable urban-tourist trajectories.

| 0697 | Relating evolving complexity of forest property regimes, social dependencies and resource production to the forest transition in the Lower Amazon from 1975 to 2010 | Nathan Vogt | Brazil |

Over recent year deforestation in the Amazon appears to be slowing, raising calls for more analysis linking case studies conducted at greater temporal depth to regional patterns of land cover change to understand the change or transition (Hecht 2010). Herein we conduct a case study in the lower Amazon where policy makers have faced the challenge of ensuring ways to use natural resources consistent with mitigation of climate change and preservation of cultural and biological diversity and, simultaneously, promote economic growth through industrialization and commodity export. Although local populations have often been threatened by and dependent upon more powerful actors invading their landscapes for other economic interests, (e.g., predatory timber extraction, ranching, and mining), they have also claimed and received political and territorial recognition through multicultural policies and global environmental agendas. As a result the lower Amazon has been divided and regularized into a patchwork of formal property regimes with varying rights to use the same land base, in ways that often overlap actors with different economic interests and values in land resources. A complex social-territorial matrix is evolving over tropical lands that represent, concomitantly, symbols of local cultural identity and territorial rights, national and global agendas of conservation and climate change mitigation, and the economic frontiers of global resource chains. To understand how resource use and landscape direction may be shaped by the emerging complex of forest governance institutions, and the social impacts, we use archival, ethnographic and remotely sensed images to investigate the co-evolution of property regimes, resource production and social means to produce them, and land cover in the Lower Amazon at greater historical depth.

0701	Towards better assessments of trade-offs and synergies between conservation and agriculture	Ben Phalan	UK

There is increasing recognition of the need to understand trade-offs and synergies between multiple landscape-level objectives. Some objectives can be readily combined on the same land, while doing this for other objectives is difficult or impossible. Recent assessments of two objectives – biodiversity conservation and food production – indicate that in some places, land sparing (dedicating separate areas for each objective) could be more effective than land sharing (combining both objectives on the same land). However, there is much scope for improving such assessments, by (i) incorporating more information on the spatial structure and heterogeneities within existing landscapes, (ii) considering a wider range of objectives including ecosystem services, cultural values and the priorities of different groups of people, and (iii) identifying realistic pathways and leverage points for shifting specific landscapes towards more favourable states. I will discuss research needs in each of these three areas, with examples to illustrate how conservation scientists are beginning to address them in different parts of the world.

0704	Agent-based mapping as an extension of existing assessment tools of coupled human-environment systems – first results from Switzerland	Tobias Luthe, Romano Wyss	Switzerland

Following a complexity approach, resource-dependent regional production systems can be understood as a network of interrelated actors (as e.g. Bodin and Crona 2009). The uncertainty about the future development of key global change indicators and the resulting concrete effects on social and natural systems, a priori preclude eyes the application of theoretical concepts which are based on the assumption of full information and full rationality of economic or social actors, and the methodological frameworks derived from them. In this context, complementing the existing framework with evolutionary and behavioral components for a deeper understanding of the adaptive capacities of social agents embedded within complex human-environment systems, which take into account a) the factor time, and therefore the inherent path-dependencies and b) the regional institutions and traditions which affect the action potential of the individual agents, should yield interesting results.

Agent-based mapping can be understood as a methodological tool to strengthen the empirical understanding of the action potential of individual actors within different human-environment systems in the face of change. It can be employed within the broader theoretical debate on resilience, (social) transformation and vulnerability.

Following these rationales, agent-based mapping allows to analyze structural and action-related variables under one unified methodological framework by combing structure-based network analysis with action-related behaviour analysis and therefore should help to further unravel the dynamics of agent-based processes in resource dependent human-environment systems, while allowing to identify possible barriers to sustainable adaptation paths.

We present empirical results from agent based mapping in three Swiss mountain communities, where tourists as agents map the socio-economic dependencies between the businesses of the tourism supply chain. Results reveal the economically most central business actors and provide further insights for resilience analysis, extending such solemnly based on social network analysis.

0707	Understanding the political economy of land grabbing: theoretical underpinning, a typology and empirical support	Lennart Olsson, Chad Boda, Turaj Faran, Anne Jerneck, Barry Ness, Yengoh Tambang	Sweden

Large scale transnational land acquisitions (often referred to "land grabbing" in the literature and we will use it in this proposal for simplicity) have suddenly emerged as a salient characteristic of our time. The total reported area of land being acquired in these transnational deals corresponds to approximately twice the total area used for cereal production in the EU, or > 200 mha since 2000.

The immediate drivers of "land grabbing" are often discussed in relation to national, regional and international policies on energy, agriculture, climate change and environmental conservation. The food price hike in 2008 coincided with an increase in transnational land acquisitions. But the cause and effects are still contested. The same applies to the causal links between the food price hike and biofuel policies. The lack of empirical data is a weakness of many of the previous studies on the relationship between food prices, energy production and land grabbing, for example the infamous World Bank report stating that 70% of the food price increase was due to biofuels production.

Studies based on economic modelling or land use modelling are important for generation of hypotheses but fall short of disentangling the complex web of causes and effects. In this paper we will present a more profound analysis of the political economy of drivers of land grabbing. Our methodology includes the development of a Weberian typology of ideal types of land grabbing underpinned by social theories. This typology is subsequently tested using empirical data on reported land deals.

We end by discussing the implications of our findings on the development prospects of rural societies in the global South.

0710	Proposing global and long-term ecological indicators for the effects of nitrogen on ecosystems	Pedro Pinho, Cristina Maguas, Cristina Branquinho	Portugal

Excessive nitrogen deposition in natural and semi-natural ecosystems is having detrimental effects on species diversity and a number of cascading impacts on ecosystems functioning. It is therefore critical to know and even anticipate these effects. However, the knowledge of the characteristics of nitrogen pollution is held back by the high spatial heterogeneity of the deposition of the different nitrogen forms. In fact, current monitoring stations are clearly insufficient to properly characterize nitrogen deposition in space. This issue has been partially tackled by modeling approaches, which provide estimates of

nitrogen deposition. However, they provide poor measures of impacts on ecosystems, especially where those are most needed, at a local scale.

The use of ecological indicators can be used to fill this gap. In fact, biodiversity is clearly linked to an adverse effect on ecosystem structure and functioning and can thus be the target and indicator of the effects of nitrogen on ecosystems. Of all extensively monitored organisms, lichens were shown to be amongst the most sensitive to nitrogen. For that reason, they have been used to establish the threshold concentration that aim at protecting ecosystems, the critical levels (for nitrogen atmospheric concentration) and critical loads (for nitrogen deposition). Due to the high sensitivity of lichens, they can be regarded as early-warning tools, to anticipate more intense and sometimes irreversible effects on ecosystems.

Our objective is to put forward a common method to assess the effect of nitrogen on ecosystems based on the use of lichens as ecological indicators. This method should be universal and provided spatial explicit information. In this work we will support the use lichens as universal ecological indicators for the effects of nitrogen on ecosystems structure and function. Although lichen richens has been used to monitor the impact of industrial pollution, nitrogen has more subtle impacts. Thus, we expect the use of functional response groups may significantly enhance our current knowledge of the effects of nitrogen on ecosystems and at the same type be universal indicators: although species may change across biomes, functional groups will not.

Thus, lichen functional groups could be used as universal indicators for the effects of nitrogen at the ecosystem level, even across different environmental, social and climate areas. This could be used to establish regional or global critical levels and loads for nitrogen all over the world. And because lichens are also responsive to climate alterations, the establishment of a long-term network for the monitoring of lichen functional groups could allow an insight in the interaction between climate change and nitrogen pollution. Furthermore, unlike other species with special requirements, lichens are present on most coupled human-ecological systems. Thus, the proposed long-term global lichen monitoring network could also be used to understand the complex interactions which govern those systems.

0711	Lichen functional groups as tools to identify drivers of changes in microclimatic conditions in urban and forest areas	Pedro Pinho, Silvana Munzi, Cristina Branquinho	Portugal

Climate change predictions are mainly focused on changes on precipitation regimes and temperatures. Changes on air humidity are more difficult to characterize than precipitation. In dry lands the level of moisture is key for a series of life events namely vegetation cover and in some situations can even be more important than precipitation. These changes are partially couple to the ongoing global changes but are also influenced, at a local scale, by the alterations on the land-use. Vegetation is strongly dependent on atmospheric moisture, thus changes on vegetation could be used to study the effects of alterations on moisture availability. The aim of this work is to use ecological indicators to characterize the changes associated to air humidity at a local scale. Lichens are organism that results from the symbiosis between a fungi and a photosynthetic partner. Because they rely entirely on the atmosphere for nutrition and water they are ideal monitors all modification on the atmosphere, including moisture. Mediterranean ecosystems are especially adequate to study the effects of changes associated to moisture. They present a strong fragmentation of habitats and a complex orography and are expected to suffer the strongest effects of the ongoing changes. We have tested the effects of microclimate alterations on lichens on two contrasting situations of fragmented forests, within a semi-natural matrix and within an urban matrix.

In a fragmented forest located in a hilly area, with multiple exposures to the sun we characterized lichen functional groups related to drought-tolerance (cyanolichens-hygrophytes versus green-algae lichens-xerophytes) and potential solar ration (as a long-term and integrated measure of microclimate). We

observed that lichen function groups responded to the microclimate gradient and surrounding land-cover. These lichens group's abundance could be mapped using geostatistics inside the forest, indicating different microclimate conditions, including moisture.

In a Mediterranean city we characterized lichen response functional groups related to tolerance to water stress (hygrophytes versus xerophytes) on forest fragments. Forest fragments were surrounded by different land-cover types, including high and low density urbanization, roads, gardens and agricultural areas. The response of lichen showed that lichens functional groups related to drought tolerance responded significantly to effects of urbanization, namely that xerophytes were promoted by nearby dense house density. This was likely related to the so-called urban heat-island, which increases nearby temperature and decreases humidity. Microclimate measures of relative humidity confirmed that dense urbanization was associated a drier atmosphere.

Thus, we could show that lichen functional groups related to tolerance to water stress can be used to characterize the amplitude of the effects of climate alterations driven by nearby changes in land-cover. This can be used to map the areas with ongoing alterations, and by taking into consideration the effects observed on cities, anticipate the areas more prone to future changes caused by climate alterations.

0715	Patterns and perceptions: the impact of climate and environmental variability on people and vegetation in the savanna landscapes of Southern Africa	Erin Bunting, Jane Southworth, Jessica Steele, Eric Keys, Shylock Muyengwa, Brian Child	USA

The United Nations and Intergovernmental Panel on Climate Change deem many regions of southern Africa as vulnerable landscapes due to changing climatic regimes, ecological conditions, and low adaptive capacity. Within the semi-arid and arid savannas of southern Africa people are strongly tied to the lands, meaning alterations of such landscapes would greatly impact livelihoods. This study analyzes both people's perceptions of environmental change and patterns of vegetation change through a risk-hazards framework. During the summer of 2010, 330 surveys were completed within seven villages in northern Botswana and the Caprivi Strip of Namibia. During the survey respondents were asked to list the biggest threats / challenges to their livelihoods. Utilizing this data a risk mapping procedure was conducted for which indices of severity, incidence, and risk were calculated. Furthermore, spectral indices (eg. NDVI, EVI, GNDVI) were produced using Moderate Resolution Imaging Spectroradiometer (MODIS) products MOD09A1 and MOD09Q1 from 2000-2011 at two spatial extents: 250 and 500m. Utilizing both linear and non-linear regression the relationship between vegetation fractional cover and vegetation indices (VIs) was statistically analyzed for the time series. This analysis was undertaken to develop a schema for operation monitoring and classification of vegetation. Initial results of the risk perception analysis indicate that problems related to natural and financial assets are the greatest source of risk to livelihoods. Furthermore, flood, drought, and other measures of climate variability are perceived as highly influential to livelihood strategies. Results from the remote sensing portion of the study, illustrate that several VIs are near-linearly related to photosynthetically active radiation, and therefore photosynthesis. However, linking vegetation indices, to variables of fractional cover is difficult as the statistical analysis shows only a moderate relationship. Preliminary results indicate that measures of woody vegetation fractional cover are statistically linked with the end of wet season NDVI, GNDVI, and SR; while herbaceous vegetation is more strongly correlated with the coefficient of variation or standard deviation of SAVI or EVI during the end of wet season time steps. This research supports the view that strong narratives on climate variability and landscape change exist in the local communities and that monitoring / management should consider both patterns of change and people perceptions of the environment as this will impact landscape modification

patterns.

0716	A network perspective on the governance of the land-water-energy nexus in Ethiopia	Christian Stein	Germany

The so called, 'land-water-energy nexus' has recently received considerable attention. Essentially, a nexus approach is about understanding how land, water and energy systems interdepend, with the ambition to reduce trade-offs and generate co-benefits through more integrated governance approaches. While the nexus approach may seem intuitively compelling it has also been criticized for not sufficiently taking into account the socio-political context in which further integration should be achieved. What is generally missing in the discussion on the nexus, are empirical research examples that show how a nexus approach can be operationalized and what challenges might be associated with its implementation.

In this paper we are presenting initial results from a scoping study that seeks to highlight some of the opportunities and challenges associated with a nexus approach. The case study is the Tana and Beles sub-basins in Ethiopia, an area that is currently undergoing a rapid transformation in terms of land, water and energy developments.

We use social network analysis, a well-established method from sociology, to empirically map how the various actors relevant for the governance of the nexus interact across sectors, geographic space and various jurisdictional levels. Using questionnaires and semi-structured interviews, we generated social network data from more then 80 organizations. We will highlight how existing networks of collaborative relations shape governance dynamics, and why they need to be recognized and built upon.

0720	Driving forces of the expansion of small scale farming at the upper agricultural frontier in the tropical Andes	Julia K. Smith	Venezuela

This presentation aims to show how different driving forces influence land use dynamics in agricultural systems where small scale farmer are producing for a national market. In Venezuela, the high tropical Andes have an important role in providing crops like potatoes, carrots and garlic, which do not grow in the lowlands, to the national markets. These crops are grown by small scale farmers using an intensive agricultural system including irrigation, large amounts of organic and mineral fertilizers, regular applications of pesticides and mainly oxen drawn ploughs due to steep slopes. In the last two decades the agricultural land use in the upper Chama valley (2700 – 4600 m asl; 325 km^2), one of the important potato growing areas in Venezuela, has intensified and expanded. To investigate, where this expansion is taking place and what the driving forces are, two land use maps (2001 and 2010) for this valley were elaborated from satellite images, aerial orthophotos and panoramic photographs and semi-structured interviews were carried out on farming practices, markets, labor force, etc. For the land use maps different categories were established differentiating land use according to its intensity, from intensive to long fallow agriculture and abandoned areas. The results show a 47% increase in intensive agricultural mainly through intensifying fallow agriculture and the reploughing of old wheat fields abandoned in the middle of the last century. The advance over the natural paramo ecosystem is relatively low 1% due to the existence of two national parks and that the higher páramo areas are of utmost importance for the provision of irrigation water, as they are home to many lakes and wetlands and community initiatives are seeking to protect these environments from overgrazing. The analysis of the driving forces show that farm practices as the introduction of organic fertilizers (chicken manure and rice hull), the wider application of crop rotation, the decrease of water used per field by the reduction of sprinkler sizes and governmental policies that stimulate agricultural production (e.g. credits) as well as life quality improvement (education and health services) in rural areas influence migration and stimulate small scale farmers to expand.

0721	Rural transformations and urban growth in the Brazilian Amazon	Leah VanWey, Peter Richards	USA

This work brings together research on large-scale land changes, and on urbanization in the Brazilian Amazon. It directly addresses the theme of the session by examining how recent rural land transformations, associated both with agriculture and with other resource use, are related to urbanization. We address the conference theme of *Rethinking Land Change Transitions*. Traditionally, urbanization has been seen as a driver of rural land use change through increasing demand for food and fuel, or through expansion of urban extent. We argue the reverse, that rural land use change is a key driver of urban growth.

Forest transition theory argues that the regrowth of forests in previous frontiers can follow from the decreasing returns to labor in the rural sector (relative to urban areas), and resulting rural-urban migration. This stylized transition is argued to follow from both urban employment growth and mechanization of agriculture. Research in the Brazilian Amazon has similarly argued for a hollowing out of the frontier, characterized by rural exodus to regional cities, as production systems are shown to be unsustainable and/or smallholders are bought out by largeholders. These imply that declines in size and incomes of rural population are associated with proximate urban growth, and that mechanization of large farms leads to rural exodus. They also suggest that urban employment becomes progressively disconnected from rural hinterlands and is the primary draw for migrants to cities.

We use data from four sources to search for the expected patterns at multiple scales. We examine patterns of urban growth (in population) across the legal Amazon using population census data from 2000 and 2010. We use microdata from the long-form census sample to identify origins of recent in-migrants or movers. We relate these patterns to changes in agriculture and land use from the agriculture census in 1996 and 2006. Results show the importance of mid-sized cities, transitions to mechanized soy production, and rural infrastructure projects. We further explore these utilizing detailed data from three cities: Altamira and Santarém, Pará; and Lucas do Rio Verde, Mato Grosso. In each, we have social survey data with detailed information on migration histories, and time series of classified remotely sensed data on land cover from the 1970s through the 2000s. Analyses of all these data together show the coupling of rural land use to urban fortunes and the value of those rural-derived fortunes for urban-urban migration from elsewhere in Brazil to the Amazon.

0722	Impacts of agricultural land management on human well-being and ecosystem services	Derek Robinson, David Murray-Rust, Eleni Karali, Mark Rounsevell, Eleonore Guillem	Canada

Due to the potential of agricultural land use to impact ecosystem services and simultaneously produce society's food, the desire to quantify crop/livestock inputs and outputs and changes in ecosystem services is high. Traditional approaches used to assess the impacts of agriculture on ecosystem services apply benefits transfer or simple equation-based models to a single time-slice or compilation of data. We demonstrate how an ABM can be used to extend these approaches by incorporating a range of ecosystem service indicators that enable their estimation over time and farmer responses their change over time. In addition to benefits transfer and equation-based indicators, we also demonstrate how conversion factors can be used in combination with benefit transfer methods to derive additional metrics (e.g., saleable meat yields from livestock), how rule-based indicators can be used to derive a qualitative representation of changes in location characteristics (e.g., soil quality) or processes (e.g., intensity of erosion), and how indices and metrics (e.g., diversity and aesthetic quality) can provide a single numerical representation of one or more factors. Furthermore, we set the stage for a tight coupling between the ABM and dynamic vegetation models that complement existing loose-coupling approaches. To improve our understanding of how agricultural land-management decisions can lead to subsequent changes in ecosystem services we designed a suite of ecosystem indicators and incorporated them into

an existing ABM, named Aporia. This presentation contributes to Theme 3.1 and the session on improving modeling and mapping ecosystem services by demonstrating how different ecosystem service indicators provide can be integrated with ABM and we provide those presented as an initial working set of computational libraries that are available for use and expansion by others. We use this extended version of Aporia to evaluate the effects of agricultural land-management decisions by empirically derived farm-household types from Aargau, Switzerland, on changes and the rate of change in ecosystem services. By representing the impact-response cycle of agricultural decisions in an ABM that harnesses a suite of ecosystem service indicators, we can better assess the cobenefits and tradeoffs among different services over time. Furthermore, the result of this work enables the use of the model to answer a variety of substantive questions; such as how do different socio-economic contexts alter the provision of ecosystem services in rural landscapes?

0723	Farmer decisions on land use and climate adaptation from the local to global scale	Kimberly Nicholas	Sweden

Local and global assessments often address similar issues, but come to different conclusions that cannot inform one another. To explore this phenomenon, and create frameworks to link these disparate approaches and inform management decision-making in the context of promoting food security, I undertook both local and global analyses of two pressing issues: land-use decisions on where to grow crops, and climate impacts on crops, focusing on farmer decisions in determining and responding to these impacts.

For the land-use issue, at the local scale I examine the emerging phenomenon of urban food forestry (UFF), which links principles of urban agriculture and urban forestry to grow food trees in cities, and present calculations demonstrating the potential for UFF to more than provide for all residents' recommended daily minimum fruit intake, or meet the deficit caloric intake of the city's very food insecure population, in a case study of Burlington, Vermont. At the global scale, I present an analysis of the crops being grown on land-grabbed land, finding that the food crops being grown are often poorly suited to the local climate, and that calorie production could be increased by up to 40% by switching to more locally-suited crops.

For the climate impacts issue, I present a local observational study of the effects of light and temperature on winegrape chemistry and yields in California, demonstrating critical periods and thresholds for environmental impacts on grape quantity and quality, and the agronomic options for growers to manage for high-quality winegrapes under environmental stresses. In a global study using statistical analyses of climate model products and a process-based crop model to project future yields of wheat in Australia and maize in Iowa, I find high-yielding years for maize in Iowa have historically been associated with wetter summer conditions, which are likely to become less frequent in the future.

Finally, I develop a typology for acceptable adaptation based on both empirical surveys and modeling of farmer behavior, which can be used to examine the potential for adaptation to environmental stresses in agriculture.

0726	The global tequila boom: impacts on land-use in Mexico	Martha Bonilla-Moheno, T. Mitchell Aide, Carlos Corrada	Mexico

Tequila is a traditional Mexican distilled beverage made from blue agave plant. According to international laws, Mexico is granted the right to the word "tequila", which has had important economic implications. During the last decade, tequila has become a trendy drink around the world; only in 2012 more than 250 million liters of tequila were produced; more than 50% of this production was exported. According to Mexican laws, to be recognized as tequila the distilled should come from agave cultivated only in regions considered as "designation of origin", which include the state of Jalisco, and

specific municipalities from the states of Guanajuato, Michoacan, Nayarit, and Tamaulipas. To understand the implications of the combination of an accelerating demand and the site specificity of the product, we studied land use and land cover change in these regions of Mexico. According to the agricultural department, in the last 30 years the land devoted to cultivation of agave has increased more than 1,000% (from 8,806 ha in 1982 to 137,626 ha in 2012). Most of this increment has occurred during the last decade in the regions recognized as "designation of origin" (~80%; 118,194 ha). In addition, from 2000 to 2012 the number of countries where it was exported increased from less than 10 to over 100 (Tequila Regulatory Council); during the same period the production of the crop increase in more than 15 million dollars. This dynamic has affected agricultural and conservation land. It has reduced the potential area to produce food crops, but has also increased deforestation in dry forest and arid regions, which are important biomes. The results from this study demonstrate how global demands influence land use at the local scale, compromising alternative land uses.

0727	International trade patterns and the land use effects of technological progress in agriculture	Nelson Villoria, Thomas Hertel	USA

Economic theory suggests that increases in regional agricultural productivity can increase regional deforestation by raising the returns to agricultural land; meanwhile, it also suggests that the environmental damage from such regional deforestation may be offset as pressure on forests is relieved in other parts of the world. While there is some evidence linking localized agricultural intensification to deforestation, the historical evidence on the linkages between localized and global land use changes suggested by the theory is still unexplored. This lack of evidence has led some influential voices to question the use of agricultural research to achieve environmental outcomes (Rudel et al. 2009). There remains, therefore a critical need to empirically identify the linkages between local technical change and global land savings. In the absence of such evidence, the debate on the appropriateness of agricultural intensification as a means to save forests will remain polarized and current cost-benefit analysis of programs to improve productivity will continue to fail to account for global supply responses, impeding the design of more efficient mechanisms to achieve the twin goals of increased agricultural output and forests protection. Our central hypothesis that increases in productivity in one region offset pressures on forest conversion to land use in other regions leading to global positive environmental benefits (reduced carbon emissions from deforestation) which magnitude will depend on where in the world land savings occur. We test this hypothesis by econometrically evaluating the global environmental effects of localized agricultural intensification --- as measured by region-specific changes in aggregated yields as well as total factor productivity during the last five decades --- using a formal model of bilateral trade that closely replicates observed facts. This work tackles the most direct link between demand and supply at distant locations. i.e. international trade, and thus is of direct relevance for the session. More generally, this presentation will contribute to the GLP Conference themes by offering a strong empirical basis to better understand the effects of technological progress in agriculture and land use change. Such understanding may facilitate the design of more efficient policies to achieve increased agricultural production while protecting the environment.

0729	Greenhouse gas emissions from agriculture	Jianwu Tang	USA

Unintended environmental consequences of agriculture have profound impacts on greenhouse gas (GHGs, including CO_2, CH_4 and N_2O) emissions. We have limited ability to predict the future GHG emissions from agriculture, particularly for N_2O emissions, a powerful greenhouse gas. With projected increase in crop demand on the global scale, sustainable agricultural intensification requires optimal agricultural management to maximize the yield to ensure food security while minimizing GHG emissions and other negative consequences to the environment and to climate. The objective of this project is to assess how climate change and agricultural management practices affect GHG emissions in agro-ecosystems. We developed a cutting-edge technology in measuring trace gases on both the

landscape scale with the eddy covariance technique and the point scale with the chamber approach. We developed a model to estimate GHG emissions in response to climate and management. We measured GHG emissions from soils in the Michigan State University's Kellogg Biological Station (KBS) in Michigan, U.S. and the University of Massachusetts's Agricultural Station in Massachusetts, U.S. The treatments include different fertilizer types, water levels, and tillage/no-tillage management. Through these field-based measurements, we analyzed the variation of GHG fluxes in response to temperature, moisture, soil carbon content, and fertilization.

This work will contribute to the conference theme by understanding impacts of land transformation on GHG emissions on the local and global scales, and also contribute to the submitted session by improving our knowledge in nitrogen cycling in human-managed ecosystems.

0731	Social-ecological boom and bust: the nexus of urbanization, zoning, and sustainability in Phoenix 2002-2012	Abigail York, Joseph Tuccillo, Kevin Kane, Lauren Gentile	USA

Zoning, rezoning, and variances are some of the primary means through which municipalities in the USA influence their growth, land use, and economic development trajectories. From 1999-2000, the City of Phoenix worked to incorporate sustainability measures into its General Land Use Plan, including transit services and transit oriented development, infill redevelopment, hazardous waste and blight reduction, and Sonoran Desert conservation. More recently the city has begun to work toward inclusion of ecosystem services within the land use policymaking efforts. In this paper, we evaluate whether Phoenix's current on-the-ground practice of rezoning altered its land-use patterns in accordance with these principles. Phoenix has set forth additional "urban village" plans with various sustainability goals; first we code these village plans for sustainability principles. Then we evaluate whether land-use change in some villages conforms to sustainability goals more than others. We assess the stability of change and the stability of change over time. These methods have primarily been used with remotely sensed imagery and land use and land cover change. Because of our focus on change in policymaking, we adopted and adapted these methods to assess how rezoning decision-making changed over time and within particular urban villages in the Phoenix metropolitan area. The varying development trajectories of Phoenix's urban villages paired with the present boom and bust cycle provide an interesting case for identifying barriers and benefits to the implementation of sustainable urbanism.

0735	Spatially explicit ecosystem service modelling and mapping approaches - experience from various case studies	Benjamin Burkhard, Marion Kandziora, Anja Müller, Ying Hou, Felix Müller	Germany

Ecosystem services have become a major issue in ongoing research and decision making. What is lacking so far are practical frameworks, respective indicators and tools that are applicable in landscape management and policy making, quantifying and visualizing the services appropriately. Appropriate ecosystem service indicator quantifications are needed in order to understand, indicate and map stocks, demands and flows of ecosystem services on different spatial and temporal scales. Therefore it is necessary to know and to indicate where ecosystem services actually are supplied and what is the geobiophysical base (biodiversity and related ecosystem functions) for this provision. Information and data on ecosystem service demand, their actual rates of consumption and how these components are interconnected (flows) are needed if ecosystem service budgets are to be quantified.

Relevant policy instruments such as the new Biodiversity Strategy of the European Union, Payments for Ecosystem Services (PES), carbon offsets and trading as well as conservation or compensation auctions,

depend on robust quantification and information about goods and service supply, demand and flows. As each piece of land can be dedicated to a limited (or single) amount of land-uses only, decision makers need to understand where and what goods and services are provided on this given piece of land, landscape, region, state, continent and globally. Then, budgets of supply and demand and trade-offs between selected or whole bundles of goods and services can be estimated. Maps and spatially explicit models allow the assignment of ecosystem service supply and demand data to particular multifunctional landscape units. Both are good models of real conditions and powerful tools to process complex data of interdisciplinary research into sound and easy to understand information.

The presentation will show methods and indicators of quantifying, modelling and mapping ecosystem services. The chosen indicators and models behind their quantification integrate geobiophysical information as well as social and economic data. The approach has been applied in different international case studies (e.g. in Germany, Bulgaria, Finland, China, Southeast Asia) in diverse landscapes and on various temporal and spatial scales. The medium-term target is the development of common ecosystem service assessment guidelines and models. This is carried out in a respective working group of the international network "Ecosystem Service Partnership" (www.es-partnership.org).

0736	Results and structure validation in global land use modeling	Petr Havlik, Hugo Valin, Aline Mosnier, Michael Obersteiner	Austria

Large scale economic models are regularly used for forward looking analysis and their projections are gaining importance in the context of both climate change mitigation (biofuels, REDD) and climate change adaptation. Policy makers are increasingly tempted not to not only draw on the qualitative insights about interactions in complex systems but also to use the modeled numbers directly – often in the context of legal documents. The question about validity of these projections is hence more pressing than ever. Comparing projected values with historical data provides a reality check to which modeling teams are now being asked to avail themselves. However, "the future is not what it used to be", and hence the validation against the past should be complemented by validation against the future. One of the few elements we can reasonably foresee for long term projections spanning to 2050 and beyond is the following: the basic laws of nature will still hold. In this context, we discuss the role of economic assumptions and theoretical frameworks chosen to look into the future, including: econometric models, equilibrium reduced form models, and bottom-up optimization models. We emphasize in particular: (i) the importance of biophysical linkages between systems is critical for representing properly development of a certain number of indicators; (ii) the representation of local policies and institutional changes can have high implications for the results, in particular for agriculture and land use change where markets are not the only driving forces; (iii) systems boundaries are structurally absent from many reduced form models, whereas they constitute a key component of many environmental issues. We look at each of these issues and explain why validation also requires structural consistency in order to ensure insightful scenarios of agriculture future. Illustrations are drawn from our work with the GLOBIOM model.

0737	Forest transitions in Southeast Asia: synergies and shortcomings in land change science and political ecology	Guillaume Lestrelin, Jean-Christophe Castella, Jefferson Fox	France

In their inspiring review of convergences and divergences in land-change science and political ecology, Turner and Robbins (2008) propose that the two schools of thought achieve consensus on forest transitions. They also suggest that political ecology and land-change science "may work together in

productive hybrid ways" to improve understanding of human-environment interactions and potentially enhance the outcomes of development interventions. With this presentation, we attempt to engage critically with these observations and propositions by reflecting on forest transitions in Asia and, in particular, Vietnam and China. We discuss some of the key domains of convergence and divergence between political ecology and land-change science with regard to the advancement of forest transition theory, the socio-political and ecological impacts of forest transitions, and the conceptual and practical propositions put forward by researchers to address land-use displacement (leakages) issues. From there, we introduce the case of Laos. We show how deforestation leakages from China and Vietnam to Laos are magnified by new political-economic arrangements and changing scales of land and forest governance. On this basis, we argue that actor-networks may constitute important nexuses for synergy between political ecology and land-change science, provide critical insights into the complex arrangements of actors and scales involved in deforestation-reforestation dynamics, and allow for a better targeting of proposed interventions.

0739	Moisture recycling in the Amazon basin and impacts of deforestation	Delphine Zemp, Ruud Van der Ent, Henrique Barbosa, Jonathan Donges, Jens Heinke, Anja Rammig, Gilvan Sampaio, Carl-Friedrich Schleussner	Germany

In the Amazon region, high evapotranspiration rates serving as a source of moisture for local rainfall and downwind precipitation form an important feedback between vegetation and climate. Deforestation of Amazonian rainforests may reduce atmospheric moisture locally by lower evapotranspiration rates from cleared areas leading to a drier regional climate. Increasing dryness in turn decreases forest cover which may in the end cause a transition from forest to savanna ("Amazon rainforest dieback") through a self-amplifying process. We determine here the key regions in which deforestation may induce cascading effects on vegetation based on the analysis of remote sensing, reanalysis and radar data (MODIS, ERA-Interim, TRMM). The grid-based Water Accounting Model (WAM) determines the fate of the evaporated water for each grid cell in the Amazon region. Thus, all relative sources of moisture that contribute to rainfall can be attributed to a particular location. Using complex network analysis, we identify central regions for major cascade moisture recycling in South America under current conditions. Based on the relative frequency distribution of distinct vegetation states (treeless, savanna and forest) in different precipitation regimes, we determine the probability of vegetation transition with increasing dryness. We estimate changes in evapotranspiration rates that would follow vegetation transitions for particular climatic conditions. Combining these analyses, we are able to model cascading effects of deforestation scenarios in the Amazon on moisture recycling and forest resilience.

0740	Price formation in agricultural land markets: review and empirical evidence from the New Federal States in Germany	Silke Huettel, Martin Odening	Germany

In Germany land prices increased in 2011 by 14 %. In view of that, discussion continues about whether land is still affordable for active farmers; this is particularly relevant for East Germany, where tenants often need to buy their land to prevent losing it within the privatisation process. Given this relation, farmland values have an impact on the solvency of farmers and their access to capital, which in turn directly affects the structural development such as the dynamics of growth but also the exits. The hedonic pricing literature implicitly assumes that land prices are formed on a competitive market where

price differentials reflect the differing valuation of land characteristics by market participants. This ignores, however, that agricultural land markets are often subject to various regulations that have an influence on the price building process. Apart from that, governments or state authorities may influence land markets via direct market participation. In East Germany, part of the agricultural land is still state-owned and the state or assigned agencies often act as major land suppliers. Such sales of formerly state-owned land are usually carried out in the framework of a first-price sealed bid auction but auction conditions vary among the different sellers. The two most important differences are that lot size limits are introduced, and tenants may obtain pre-emption rights, that is, they may buy the land by paying the highest bid without participating at the auction, which reflects the different objectives of the sellers. These auctions co-exist with traditional or so-called private markets on which prices are fixed by direct negotiations between the seller(s) and potential buyers. The influence of the market mechanism has been documented in the real estate literature but not for farmland values. The objective of this research project is to explore the price formation for agricultural land in different segments of the land market. The data for East Germany offers a natural experiment for this purpose and two major market segments may be distinguished by differing market mechanisms: the privatization market and the private land sales market. Currently, the land prices in these different market segments differ considerably within East Germany. Spatial correlation of land prices is considered by applying a spatial econometrics approach. A first analysis shows that apart from land characteristics, the number of bidders and the share of non-agricultural bidders have an impact on the land price in East Germany.

0741	Tools for impact assessment of soil policies on soil functions at European level	Wim de Vries, Nadia Glæsner, Paul Römkens, Jan Peter Lesschen, Rudi Hessel, Jan van den Akker, Johannes Schuler, Katharina Helming	The Netherlands

Soil protection plays an evident role for grand societal challenges, such as food security, climate change mitigation, and increased resource efficiency. Despite this, a common legally binding framework for soil protection does not exist at European level. In 2006, the "Thematic strategy for soil protection" [COM(2006)231] was proposed by the European Commission, including a proposal for a legally binding soil framework directive [COM(2006) 232]. The final adoption of the proposed directive was opposed by a minority of EU member states with arguments of excessive administrative burden and alleged violation of the subsidiarity principles. Furthermore, the scientific evidence was not convincing to decision makers at that time, and particularly monetary information related to soil degradation was not sufficient. At present, ongoing activities within the EU Soil Thematic Strategy are limited to awareness raising, research and policy integration [COM(2012) 46].

We believe that action at European level is necessary for meeting upcoming grand societal challenges. Our study aims at revisiting the 2006 impact assessment [SEC(2006)620] in view of new insights on the need to perform Impact Assessments of soil policy options in terms of: (i) context/ paradigm change, i.e. a new focus on soil functions/ services in addition to soil threats in relation to Societal Challenges, particularly food security and sustainable agriculture, climate change mitigation and increased resource efficiency and (ii) related policies including challenges described in the Resource efficiency road map, aims described in 7th Environmental Action Programme and the upcoming on EC communication on land as a resource.

The presentation fully complies with the aim of the conference session, i.e. "Informing land and soil policies with science based tools". It will make clear how science can inform soil policy impact assessment with regards to the linkage of soil policies/land management with water, food and energy security. We aim to give an overview of the current scientific knowledge on indicators, data and methods/tools for the assessment of the impact of land management on soil threats and related soil functions in view of the water, food and energy nexus, according to a common framework. This will include an overview of (i) land management measures affecting different threats, (ii) relevant soil threat indicators in view of the related soil functions, (iii) data and methods to calculate and spatially visualize the relevant indicators, (iv) tools to quantify the linkage of land management options to soil threats and soil functions and (v) examples of results of such quantifications.

0742	Modelling ecosystem service impacts from integrated land and water resource development in northern Australia	Neville Crossman	Australia

Robust quantification of changes to the supply of ecosystem services from land and water resource development and the documentation of subsequent trade-offs requires good modelled data. This is because water resource development for new irrigation will have significant impacts on ecosystem services. On the positive side, irrigation development supports agricultural intensification which increases food production and may allow land sparing for enhancing supply of ecosystem services. On the negative side, the changes in land use and the capture and extraction of water from relatively undeveloped ecosystems may have impacts on water quality, aquatic and terrestrial biodiversity, soil provision, and cultural, recreational and amenity services, among others. However, good data is not always available, especially in locations undergoing development.

The Australian and Queensland Governments have contracted CSIRO to investigate the potential trade-offs of water resource development in far north Australia, a geographic area that is relatively under-developed but which has substantial water resources. Both Governments have a strong interest in developing the water resources of remote northern Queensland Rivers for food production to supply growing demands from Asia. The problem we face is that modeled and mapped ecosystem service data is limited and the potential development of water resources is highly contested. We therefore propose a methodology that uses Bayesian Belief Networks (BBNs) to elicit stakeholder opinion about the important ecosystem services supplied (and demanded) in the region and the potential impacts to those services from water resource development. We then use the BBN to integrate this stakeholder information with quantitative modeled ecosystem service data where it is available, and identify the trade-offs in supply of ecosystem services following land and water development.

0746	Simulating urban densities in the face of local flood risks	Dani Broitman, Bart Rijken, Eric Koomen	The Netherlands

The Netherlands is situated in a delta region, with about one third of its land area below sea level. At the same time, it has a very high population density, especially in the low-lying Randstad area. So both the chances of flooding and the resulting potential damage have been an issue of great concern in past centuries and continue to be so because of the expected sea level rise and urban development in low-lying areas. Strategies aimed at reducing flood risk have hitherto focused on reducing the chances of flooding, e.g., by building extensive flood defense systems (levies etc.). These systems, however, are never completely flood-proof. Further increasing their defense capacities is getting increasingly difficult and costly. At the same time, the economic value and population concentrated behind these barriers is growing, thus further increasing potential flood damage. Indeed, especially if the indirect effects (i.e., beyond the value of individual lives and buildings) are taken into account, this damage could be

devastating. Depending on the (political) question of what chances and damage would be 'acceptable', this may well justify a shift of focus from (regional) chances to (local) effects.

Local adaptation measures aimed at minimizing damage and casualties at the parcel or neighborhood level may thus be needed. In combination with urban renewal plans that strive to upgrade the quality of life in older neighborhoods such adaptation measures may help to also achieve other public (or private) objectives. The (cost) effectiveness of such measures strongly depends on the resulting local land-use patterns in relation to potential flooding. These dynamics can be explored using the Land Use Scanner model and potential flood water depth maps from a hydrological model. At present, Land Use Scanner only simulates the dominant local land use (residential, agricultural etc.). In order to properly assess these measures, we need to go beyond this and simulate the characteristics of the actual structures (building types, density, value etc.) occupying the land. This paper presents a conceptual model of the main drivers of local residential density change, describes their initial implementation in a land-use change model and discusses the first results in the context of flood risk assessment. It aims to shed light on the cost effectiveness of local climate adaptation measures, preparing the ground for future modeling efforts based on more formalized, validated version of the model.

0748	Using results of an integrated land use model to assess the biodiversity impacts of REDD+ policies	Rebecca Mant, Valerie Kapos	UK

Policies for achieving REDD+ goals will have major impacts on land use and resulting land cover. Land-use and land cover in turn affect biodiversity, and the potential for achieving the goals of the Convention on Biological Diversity (CBD). Thus, understanding how different policies could influence land use and biodiversity is essential to support informed decision-making and identify REDD+ policies that can safeguard biodiversity and help meet the goals of the CBD. The REDD-PAC project uses a global economic and land use model (GLOBIOM; described in detail elsewhere in this session), to project future land use and changes in land cover. We then use the model results to assess the biodiversity impact of the predicted land cover change, focusing on Brazil and the Congo Basin.

The impact on biodiversity is investigated using two broad approaches. Firstly, potential land cover change is assessed within in areas identified through national and regional processes as priorities for biodiversity conservation. Land use change and its biodiversity impacts within these areas are assessed spatially, both in terms of total conversion from natural land cover through productive use (agriculture, grazing or forestry) and in relation to particular types of conversion (for example deforestation). Secondly, impacts on biodiversity of potential future land cover change are assessed in terms of habitat changes within current species ranges. Assessing such changes across species provides a combined assessment of the amount of range species may lose under different future policy scenarios. For example, assessing the impact across threatened species allows an assessment of the possibility for achieving the global CBD Aichi target 12 on reducing extinction of threatened species.

0749	Making use of the ecosystem services concept in regional planning - trade-offs from reducing water erosion	Susanne Frank, Christine Fürst, Anke Witt, Lars Koschke, Franz Makeschin	Germany

In this presentation, we demonstrate how to integrate the ecosystem services concept into regional planning using the example of a case study region, Upper Elbe Valley/Eastern Ore Mountains, in Saxony, Germany. We analysed how the reduction of water erosion as a regulating service impacts seven other ecosystem services. Ecological integrity, provisioning services (provision of food and fibre, provision of biomass), regulating services (soil erosion protection, drought risk regulation, flood regulation), and the cultural service landscape aesthetics are taken into account. With the help of the

software GISCAME we found that the greening of preferential discharge paths can reduce the water erosion compared to "business as usual" by 2 - 7 %. The introduction of hedgerows and changing the management system from tillage to no-tillage practices revealed a reduction of the total soil loss by 33 % and 89 %, respectively. A combination of the three erosion control measures greening of preferential discharge paths, introduction of hedgerows cutting the slope length, and the application of no-tillage management systems reduced the soil loss most efficiently by 92 %.

In general, we found synergies between the measures for reducing erosion and the provision of ecological integrity, of regulating and cultural ecosystem services. In contrast, the impact on provisioning services was slightly negative. For the land use management in the case study region we recommend a combination of greening, hedges, and management change. For the purpose of implementing the ecosystem services concept into regional planning methodology, we detected the need for a guideline that facilitates a common, standardized assessment ecosystem services. We recommend the application of tools for integrated ecosystem services assessment in order to support trade-off analyses at the regional scale.

The presentation contributes to the conference theme and the session "impacts and responses" regarding the following topics:

- climate-land use interactions,
- adaptation,
- land change impacts on ecosystem services and biodiversity, and
- land use based mitigation options.

The need for erosion control measures in the case study evolved due to increasing erosion risk in consequence of Climate Change. The study region is highly vulnerable towards water erosion, which required adaptation measures in the land use and land management. Such adaptations are supposed to have impacts on the provision of ecosystem services. Hence, a trade-off analysis was carried out as ex ante assessment of land use change in order to support regional planners in decision-making.

0752	Estimating supply and area elasticities for the Brazilian agricultural sector	Angela Kopmann, Mareike Lange	Germany

The world population will be growing to up to 10 Billion over the next few decades. Income in the emerging markets will continue to grow at high rates implying changing nutritional habits towards a higher consumption of animal-based, and thus land intensive products. It also increases the need to provide alternative energy sources which requires, in the form of bioenergy sources, considerable additional biomass production. On the other hand, an accelerating climate change demands an increasing management of global carbon sinks and soil and water resources. These developments will put tremendous pressure on scarce land resources world-wide. This pressure will materialize through an increase in agricultural prices which will set incentives to increase agricultural production areas. By how much these price increases result in agricultural expansion can be expressed via land supply elasticities. Such elasticities can be used for example in general equilibrium models to simulate the land use effect of policy shocks such as biofuel policies for example.

We calculate local supply elasticities for Brazil which has become one of the biggest producers and exporters of agricultural products in the world. Brazil has experienced large expansion dynamics of its agricultural production area together with a local development of an industrialized agricultural sector. At the same time Brazil is one of the most biodiverse countries in the world and stores a tremendous amount of carbon in its natural biomass. Thus, in order to establish environmental protection strategies it is important to know by how much the local land use reacts to world-market driven changes in agricultural prices. However, due to data restrictions, information on area elasticities for developing and emerging countries such as Brazil is limited.. This paper aims at contributing to the literature 1) by analyzing recent developments in the modeling and estimation of agricultural supply elasticities in the

literature and (2) by using a system of output-supply and input-demand equations to simultaneously estimating agricultural supply and area elasticities based on state level data from 1980 to 2010 for the Brazilian Agricultural Sector.

0754	Comparing spatial allocation patterns of global land change models and exploring validation of spatial allocation patterns	David Eitelberg, Peter Verburg	The Netherlands

The utility of land change models lies in the degree of spatial and temporal accuracy with which they project patterns and transitions of land use. For many modelers the rationale for creating these land use models is to inform both the scientific community and decision makers regarding possible scenarios and outcomes of the changing demands on land and its resources. Therefore, confidence in the modeled scenarios is essential. One way to establish confidence and evaluate the results of land use models is to compare the results of multiple models with the goal of understanding why spatial and temporal differences occur. This study specifically compares the spatial allocation patterns of land use scenarios of various global land use change models and seeks to explain the differences. Increases and decreases in area of land use classes are calculated and compared across time steps within models, and within time steps across models. To correct for differences in baseline scenarios, percent change relative to respective baseline scenarios is also calculated. Where it is possible, a comparison of modeled intensities of land use classes and land use systems is performed. Validation of future scenarios is difficult due to there being no 'real' data to compare scenarios against. An exploration of potential validation techniques will be done through comparing the consistency of spatial patterns and their preservation or alteration through time, as well as whether or not they make sense based on process understanding and evidence from documented historic changes. Another technique will be to compare the paths of transition through land uses over time to discover any commonalities across models (e.g. grassland > subsistence agriculture > intensive crop). Caution is taken when model results converge on a similar pattern because this convergence does not constitute accuracy. It is expected that different spatial and temporal patterns will primarily be the result of applying different baseline land use data, as well as having different foci for model development.

0755	Trade-offs between food security and ecosystem services through tropical deforestation	L. Roman Carrasco	Singapore

Growing global demands for food and biofuels are providing strong economic incentives for deforestation across the tropics. Using satellite data of tropical deforestation from 2000 to 2005 and a spatial meta-analysis of ecosystem services economic vaues, we demonstrate that the economic externalities due to CO_2 emissions and the lost benefits of CO_2 sequestration are 1.5 times greater than the direct economic benefits derived from the agricultural land uses replacing those forests. Marked differences occur regionally, with a large proportion of deforested areas of Southeast Asia presenting net agricultural gains and the majority of areas in the Amazon presenting net losses. When considering the value of all ecosystem services, on the other hand, conversion of tropical forests to croplands incurred net losses in all regions and was overall 8-9 times higher than agricultural benefits. Our results suggest that payments based on CO_2 emission reductions would not be able to stop deforestation in Southeast Asia and that the value of all ecosystem services would need to be considered for these payments to be effective.

0757	REDD+ projects in the Democratic Republic of Congo: impacts on future emissions, income and biodiversity	Aline Mosnier, Geraldine Bocqueho, Rebecca Mant, Michael Obersteiner, Val Kapos, Petr Havlík,	Austria

| | | | Steffen Fritz, Leo Botrill | |

The Democratic Republic of Congo (DRC) encompasses a large rainforest area which has been rather preserved up to now. However, pressure on the forests is increasing with high population growth, transition toward political stability and the abundance of minerals in the country. REDD+ is a developing mechanism under the UNFCCC that aims to support developing countries that want to make efforts to reduce their emissions from deforestation and forest degradation. The REDD+ strategy in DRC combines an independent national fund and independent REDD+ projects at the local level that are at the initial stage of implementation. The objective of this paper is to assess whether i) selected REDD+ project areas are at high risk of future deforestation and forest degradation, ii) to which extent REDD+ projects could lead to an overall reduction in deforestation and forest degradation at the national level taking into account potential leakage and iii) to which extent REDD+ projects could bring co-benefits in terms of biodiversity and rural income. We use the land use economic model GLOBIOM-DRC which represents land-based activities and land use changes at a 50x50km resolution level. It includes domestic and international demand for agricultural products, fuel wood and minerals which are the main deforestation drivers in the Congo Basin region.

0761	REDD-PAC: building an integrated land-use model for assessing REDD+ policies	Géraldine Bocquého, Mosnier Aline, Mant Rebecca, Câmara Gilberto, Valerie Kapos, Michael Obersteiner	Austria

Understanding land-use change drivers and the effects of land use on economic returns and ecosystem values is key in planning for a sustainable development. We introduce an integrated model cluster that allows simulating land-use change over a fifty-year horizon, and assessing the impacts of land use change both in economic and environmental terms. The core of the cluster is a spatially-explicit global economic model (GLOBIOM) that matches supply and demand for competing agricultural, bioenergy and forest commodities. It is linked upstream to three biophysical models for crop growth model (EPIC), forestry growth (G4M) and livestock systems (RUMINANT). The land use change results are then processed to assess the potential effects on ecosystem values and biodiversity.

One application of the integrated model is the testing of land-use policy options such as REDD+ (Reducing Emissions from Deforestation and Forest Degradation plus conservation of forest carbon stocks, sustainable management of forests and increase of forest carbon stocks) policies (Mosnier et al., 2012). Identifying those with the potential to be economically efficient, socially fair and to safeguard and enhance ecosystem values is one of the objectives of the REDD-PAC project. We present a set of REDD+ policy scenarios specifically relevant for Brazil and the Congo Basin that will be tested in the framework of REDD-PAC. We also detail the criteria we will use to assess the trade-offs between greenhouse gas mitigation, economic returns and biodiversity conservation.

0763	Long-term changes in socioeconomic energy systems and land-use intensity: insights from European cases	Helmut Haberl, Maria Niedertscheider, Karl-Heinz Erb	Austria

Patterns of energy use are of fundamental importance for land systems. For example, the transition from an area-based energy system of agriaran society to the mainly fossil-fuel based energy system of industrial society has brought fundamental changes in the functions of land for socioeconomic metabolism. In agrarian society, land use (agriculture, forestry) delivers almost all energy available to a

society, including not only food and feed but also almost all technical energy. Physical work is to a large extent performed by animate prime movers, i.e. humans and draught animals. Agrarian societies require a positive (approximately 1:5 to 1:10) energy return on investment (EROI) in order to maintain their metabolism. By contrast, the main energy source of industrial society are fossil fuels, supplanted by hydropower, nuclear energy and some renewables. Of course biomass is still used, mostly for food and feed. Industrial society can afford to energetically "subsidize" land use, resulting in a much lower EROI, but - thanks to technological innovation and direct as well as indirect energy inputs - higher yields per unit area and spectacularly increased labour productivity. This changing role of land use for society's metabolism has contributed to fundamental changes in land use. Using data from long-term case studies performed within the VOLANTE project, this lecture will outline the fundamental changes in land-use related to agrarian-industrial transitions. Moreover, it will speculate on possible future changes in land use that might result from large-scale attempts to increase the role of area-based renewable energy sources, in particular bioenergy, could have for European and global land systems.

0765	Building a land system classification for land use modelling: the case of Laos	Christine Ornetsmüller, Andreas Heinimann, Marleen A.H. Schouten, Peter H. Verburg	The Netherlands

The Lao PDR has experienced a pronounced land grabbing trend with a fifty-fold increase of land concessions and leases in the last ten years. With an 'open-door policy' towards foreign investors the Lao government aimed at improving economic development and poverty alleviation. However, the establishment of large scale agricultural plantations at the expense of small holder systems erodes the basis for the livelihoods of a large part of the population and consequently introduces socio-economic and ecological challenges. In order to assess the current state of Laos' land systems a new land system classification has been created to quantify and locate the places of change. Using an expert based classification we linked a recently released inventory of agricultural concessions with land systems mosaics and data from an agricultural census. The new land systems classification will serve as a basis for modeling land system transitions under different scenarios. Moreover, it contributes to informed discussions with governmental decision makers on the sustainability of land deals in Laos.

0766	Industrialization and the transformation of land use: scrutinizing the drivers of carbon sinks in returning forests	Karlheinz Erb, Thomas Kastner, Maria Niedertscheider, Simone Gingrich, Helmut Haberl	Austria

Terrestrial ecosystems play two roles in the global carbon balance: (a) By using the land, human society drastically alters global ecological carbon stocks and flows, resulting in annual net emission of carbon to the atmosphere of ~1.1 PgC yr-1. Currently, net flows between atmosphere and land are dominated by emissions due to deforestation mainly in the Southern hemisphere, whereas in the Northern hemisphere forests are found to currently grow in area and stocking density, resulting in a substantial sink of atmospheric carbon. (b) The global carbon balance requires a substantial residual terrestrial carbon sink (~2.5 PgC yr-1), determined by difference from the other terms in the global carbon balance, i.e. atmospheric carbon concentration, emissions from fossil fuel combustion and land use, known sinks on land and in oceans. The residual sink has been attributed to the effects of environmental change (e.g., climate, CO2, N deposition) on terrestrial carbon storage, but its location, causes, and exact magnitude

are uncertain. In this presentation, based on long-term analyses of land-use change at the national scale, we elaborate on the underlying drivers of carbon sinks in vegetation. We show that the key to an understanding of the observed carbon sink is to understand the changing role of land use during industrialization: In the late 19th and early 20th centuries, forests in Europe were largely overused and forest area areas were much smaller than today. With industrialization, fossil-fuel-powered surges in the productivity of agro-ecosystems facilitated the production of growing amounts of agricultural biomass on shrinking agricultural areas, allowing for the 'return of the forests'. Furthermore, the availability of fossil fuels allowed reducing fuelwood demand and reducing or abandoning practices such as forest grazing and litter raking in forests. The availability of fossil fuels thus holds directly responsible for the emergence of the carbon sink in vegetation. Our systematic analyses indicate that the change of these land-use practices, largely underresearched today, significantly contributes to the emergence of the recent strong carbon sink in Europe's vegetation, and indicates that the role of environmental change is probably significantly smaller than previously thought. Integrated, interdisciplinary oriented research on the systematic interlinkages between the socioeconomic energy system and land use is critical for developing robust recommendations for land-use related climate change mitigation and avoiding possibly ineffective, if not counterproductive, measures.

0770	Impacts of land use zoning policy on deforestation and forest degradation in the Cameroonian humid forest zone	Derek Bruggeman, Patrick Meyfroidt, Eric Lambin	Belgium

In 1994, Cameroon enacted a new forest law, providing the basis for a land use zoning plan separating forested areas in a permanent (PFE) and non-permanent forest estate (NPFE), which was progressively implemented within the humid forest zone of the country. The PFE must remain exclusively forested and includes protection and production forests. The NPFE comprises remaining forestlands that can be cleared although it can also be managed by local communities through community forests.

The objective of this study was to assess the effectiveness of the land zoning plan in Cameroon for reducing deforestation and forest degradation. The analysis was mainly based on remote sensing data, and accounted for forests inside zoning units and surrounding them, to evaluate possible leakage. Community surveys were undertaken to assess the local perceptions of the efficacy of the land zoning plan. In addition, the study separated units that are legally prescribed from those actually implemented during the study period, to capture the actual effects of the land zoning plan. A study site was selected within the Cameroonian humid forest zone based on the presence of all types of units defined by the land zoning plan. Landsat ETM+ images were used to analyze land cover changes between 2002 and 2010, a period coinciding with the implementation of the plan. The land cover change detection combined seven change detection methods, including a post classification comparison to identify trajectories of change.

By design, units of the PFE are not randomly distributed across the landscape but are located preferentially in remote and unpopulated areas. Matching was thus used to control for the effects of these other variables that may play a role in forest cover dynamics, and obtain unbiased estimates of the actual effectiveness of the land zoning plan (Blackman, 2013).

Comparison of matched samples of points shows that the land zoning plan in Cameroon has effectively curtailed deforestation in the PFE. In particular, deforestation and forest degradation was reduced in units aiming primarily at forestry production. Community forests, whose main objectives are to contribute to livelihoods improvements, didn't contribute to forest protection. These results are corroborated by the community surveys. Finally, no leakage was detected by comparing deforestation in the surroundings of the PFE with farther areas.

This presentation contributes to this session by measuring forest cover changes inside and in the vicinity of protected areas but also of production forest for a Congo basin country.

0771	Integrated models and scenarios of climate, land use and common birds dynamics	Jean-Sauveur Ay, Luc Doyen, Raja Chakir, Frédéric Jiguet, Paul Leadley	France

Reconciling food, fiber and energy production with biodiversity conservation is among the greatest challenges of the century, especially in the face of climate change. Model-based scenarios linking climate, land use and biodiversity can be exceptionally useful tools for decision support in that perspective. Here we present a modeling framework that links climate projections, private land use decisions including farming, forest and urban uses and the abundances of common birds as an indicator of biodiversity. One of the major originalities is to integrate the effect of regionalized projections of climate change (IPCC SRES A1B) on the economic drivers of land use using fine-scale data from France. In addition, incentive-compatible conservation policies are simulated and compared to others scenarios in terms of land use and biodiversity over the next four decades. Our analysis indicates that the effect of climate dominates the effects of land use and conservation policy on bird abundances at the aggregate scale. Moreover, these global environmental changes turn out to be globally detrimental for biodiversity. Only a moderate number of bird species and locations appear to profit from habitat-based conservation.

0773	An ecological-economic modelling procedure for the design of ecologically effective and cost-effective agri-enviromment schemes for biodiversity conservation measures in grasslands	Frank Wätzold, Martin Drechsler, Karin Johst, Melanie Mewes, Astrid Sturm	Germany

In the EU each year several billion Euros are spent on payment schemes which compensate farmers for carrying out land use measures which are costly to them but have a positive impact on biodiversity conservation. It is of great importance to design such agri-environment schemes ecologically effective (conservation goals are achieved) and cost-effective (for given costs conservation goals are maximised). An ecological-economic modeling procedure is presented which is able to design ecologically effective and cost-effective agri-environment schemes for grassland conservation in the German Federal State of Saxony. At present its database encompasses 15 endangered bird species, 15 butterfly species and 7 habitat types as well as 976 different land use measures (different mowing and grazing regimes and combinations of mowing and grazing). The procedure contains an ecological model to assess the impact of measures on species and habitat types, a cost assessment module to estimate the opportunity costs of the measures in terms of foregone profit and an optimization module to assess cost-effective agri-environment schemes.

The modeling procedure is novel in several ways. (I) It considers a comprehensive set of land use measures as well as species and habitats of conservation concerns on a spatial scale which is relevant for policy design. (II) The effects of land use measures on species and habitats as well as their costs are not only assessed in a spatially differentiated way (on a grid cell level of 250mx250m) but also in a temporally differentiated manner (on the scale of quarter months). (III) The modeling procedure is used as the basis for a software decision support tool which was developed with stakeholders and can be used to optimize Saxon agri-environment schemes. We apply the modeling procedure to evaluate existing grassland programs in Saxony and find that for the existing budget of 11.8 million Euros significant improvements can be made with a different set of measures and payments. The alternative set of measures would not only conserve a larger set of species and habitats but also all species that are protected with the old programs to a greater extent (for a few species improvements of up to a few hundred percent are achievable).

This topic fits well into the session "Governing land use and land allocation through markets: efficiency and failures" as it shows how compensation payments as a market-based instruments can be designed in an ecologically effective and cost-effective manner through the integration of knowledge from different disciplines.

0774	Land-use legacies in shifting cultivation: links between poverty, forest regrowth, and landscape configuration in the Peruvian Amazon	Jeanine Rhemtulla, Sylvia Wood, Oliver Coomes	Canada

Swidden-fallow cultivation is a major driver of tropical deforestation, but secondary forest regrowth during the fallow period has the potential to restore important ecosystem functions such as biodiversity, carbon storage, and soil fertility. In a subsistence peasant community in the Peruvian Amazon, we are investigating how asset poverty (defined in terms of total household land holdings) affects land-use practices (crop choice, length of swidden cycles), and therefore forest dynamics at the landscape scale. Moreover, we are testing whether differences in land-use history (resulting from differential land-use practices) create persistent legacies in plant species composition and soil nutrient cycling, and thus the sustainability of the system.

We conducted detailed household surveys (n=50), and visited, mapped, and reconstructed yearly land-use/cover history for fields and forest fallow (n≈350) from the mid-1960s to 2011 in a small community (886ha) near Iquitos, Peru. Changes in land cover mapped through field histories were compared to independent land-cover maps derived from historical airphotos and satellite imagery from 1965, 1972, 1978, 1991, and 2007. Finally, we sampled soils and tree species composition in a subset of forest fallows with varying land-use histories and owned by both poor and non-poor farmers. Results show that poorer farmers have shorter average cultivation cycles, younger forest fallows, fewer fields with tree crops, and a higher average number of previous cultivation cycles per field. Fields with more intensive cultivation history had decreased soil fertility. Surprisingly, species richness of fallows was not affected by intensity of previous management, but was rather related to total time since original clearing, with the greatest number of species being lost upon initial cultivation. Distance to nearest primary forest also significantly affected species composition. Results suggest that while preventing initial clearing may be critical to maintaining high levels of biodiversity, pressure to clear forest or intensify cultivation may increase as soil fertility declines through time.

The presentation fits with conference themes 1 (Land Change Transitions) and 3 (Impacts) by examining how subtle differences in land-use management driven by poverty affect land-cover transitions and impact biodiversity, soils, and other ecosystem services. In particular, the presentation will contribute to the selected session (Secondary forests and agrodiverse systems) by describing the effects of swidden-fallow management and landscape context on species composition in secondary forest, and discussing possible interactions and tradeoffs between conservation outcomes and agricultural productivity.

0777	Modelling of large-scale-farm expansion for bio-fuel production: on mono-cultures, ecological impacts and smallholder competition	Ernst Nuppenau	Germany

The expansion of bio-fuel production is currently a much discussed process and, from an economic point of view, frequently considered a welfare increasing option for land use in developing countries. However, it is under public debate because it is feared that food security is impeded, ecological problems (as related to mono-culture) emerge, and that distributional consequences will be a result. Bio-fuel expansion usually means that land is bought for production by large-scale farm operation and these farms take over whole landscapes by deploying monocultures like sugar cane, palm oil, soya bean plantations, etc. There is an emerging critic that small-holders will loose their food basis and that landless people will be exploited. But also the environment is threatened because large farms rely mostly on chemical input whereas smallholders rely on ecosystem services (ESS). In particular, in this line of

thought, it is feared that modern technologies will destroy the environment and livelihood of million of rural people at expense of foreign currency favouring elites.

From a perspective of modelling the process it can be expected that comparative static models have only a limited capability to provide sufficient insight in dynamics and options for contingent policy interventions. In particular these models are weak to the control the process. In as much, as requests to control the dynamics in favour of recognition of the environment and balanced development are emerging, it can be put into doubt whether assumptions of simple land markets will be appropriate in forecasting dynamics and imbed policy.

We show how to model the land redistribution and transition through dynamic behavioural equations of large- and small-scale sectors which compete for land and labour. Further on we introduce adjustment and investment costs related elements which display the short and long term effects on the competitiveness of the sectors. In particular skill and knowledge acquisition are modelled as dynamic processes. Additionally transaction costs on land registration and land development are taken into account and land transfer is explicitly taken as a control variable compared to stock variables which are land in either sector, capital and soil fertility. Soil fertility in smallholder farms is based on ESS and labour. Then labour switching from small-holder sector in order to become part of work force at large estates is explicitly recognized.

Especially in modelling we take into account that ecologist and some agronomists have announced worries about negative impacts on ESS and soil fertility; they see degradation form monocultures and threats for ESS requesting more chemical inputs. In this regard the model includes a dynamic forecast of soil fertility which depends on investment in fertility and ESS which is recognized as temporal costs to maintain fertility. Smallholders will offer, for instance, manure from livestock and labour which is part of their production and needs incentive schemes. Also they offer a diverse landscape and maintain natural vegetation for ESS. In the paper we will show how a policy of taxing and cross subsidization between the bio-fuel and smallholder sector can help to overcome ecological and distributional concerns in the long run.

0780	Climate change and forest fires in the tropics: impacts and adaptation	Hety Herawati, Bruno Locatelli	Indonesia

Forest ecosystems provide essential ecosystem services, such as food, medicines and fuel wood for local communities and carbon sequestration for mitigating climate change. Fire is a natural part of the ecological processes of some tropical forests, but it often represents a threat to societies, ecosystems and their services. Climate change may affect fire regimes by modifying weather patterns (e.g. precipitation and wind) and long-term average climate, affecting forest composition and structure. This paper reviews literatures on factors influencing forest fires in the tropics and impacts that climate change may have on these factors. It also compares and synthesizes results of studies on future impacts of climate change on tropical forest fires. Finally, it identifies adaptation measures for forest and fire management that can be used to sustain tropical forests and their services under changing climate. In general, the reviewed impact studies predict increased fire risk under future climate change in some tropical areas, but uncertainties remain for other tropical areas. The reviewed literature also describes various adaptation approaches available to anticipate increasing fire risk under changing climate. These include managing fuel in forests; addressing non forestry activities; managing and monitoring ignition sources; improving social conditions, education and community involvement; and sharing and improving knowledge. This presentation will enrich discussions and provide more knowledge in "Impacts and responses" oral presentation sessions especially for the topic of climate change, its impact on forests in the tropics and adaptation options.

0781	The importance of equity in the design of PES schemes	Nonka Markova	Germany

Research on the market-based instrument of payments for ecosystem services (PES) has received considerable attention in recent years. A main issue of interest has thereby been the efficient design and implementation of PES schemes. Increasing attention has also been paid in the last few years to the distributional effects of these policy instruments. Opinion on whether to integrate distributional impacts when designing PES schemes is divided: Some scholars argue that PES can and also should be used to alleviate poverty and therefore the consideration of equity issues should be an integral part of PES design along with efficiency. In contrast, economists tend to argue that the main goal of PES is improved efficiency of natural resources management and distributional goals should be achieved with other policy instruments. This, however, requires a functioning government which is able to formulate policy goals and successfully implement corresponding policies, and which does not exist in many developing countries.

From an economic perspective the preferences of the "buyers" of the ecosystem services have to be considered and, therefore, it is important to know to what extent "buyers" take into account equity issues. In the case of payments for ecosystem services in developing countries "buyers" are often taxpayers or donors whose money is used to finance projects to conserve ecosystem services and biodiversity.

To identify the preferences of these buyers choice experiments were carried out to elicit willingness-to-pay of residents of the city of Cottbus, Germany, as potential "buyers" for ecosystem services through donations. The PES scheme to be financed with these donations refers to the conservation of dry spiny forest in the Mahafaly Plateau region in Madagascar which is inhabited by many endangered endemic species. The respondents were confronted with choices among alternative PES schemes characterized by different levels of conservation and different distributive impacts.

Results show that buyers do have preferences for an equitable distribution of payments thus suggesting that the PES schemes should include distributional aspects if governments are weak.

A presentation of this study can give some insights into the equity-efficiency trade-off involved in implementing PES schemes and can thus enrich the discussion on efficiency and failures in governing land use and land allocation through markets in the corresponding Session of the 2nd GLP Open Science Meeting.

0782	The effect of atmospheric and topographic correction methods on forest cover classification accuracy in mountain areas	Anton Van Rompaey, Steven Vanonckelen, Stefaan Lhermitte, Patrick Griffiths	Belgium

Accurate mapping of land cover change in mountain areas is crucial for the understanding of its underlying causes and drivers. Remote sensing is a privileged mapping tool but is obstructed by atmospheric and topographic distortions in mountain environments. A variety of atmospheric and topographic correction methods has been proposed to minimize atmospheric and topographic effects and should in principle lead to a better land cover classification. Only a limited number of atmospheric and topographic combinations has been tested and the effect on class accuracy and on different illumination conditions is not yet researched extensively. The purpose of this study was to evaluate the effect of coupled correction methods on land cover classification accuracy. Therefore, all combinations of three atmospheric (no atmospheric correction, dark object subtraction and correction based on transmittance functions) and five topographic corrections (no topographic correction, band ratioing, cosine correction, pixel-based Minnaert and pixel-based C-correction) were applied on two acquisitions (2009 and 2010) of a Landsat image in the Romanian Carpathian mountains. The accuracies of the fifteen resulting land cover maps were evaluated statistically based on two validation sets: a random validation set and a validation subset containing pixels present in the difference

area between the uncorrected classification and one of the fourteen corrected classifications.New insights into the differences in classification accuracy were obtained. First, results showed that all corrected images resulted in higher overall classification accuracies than the uncorrected images. The highest accuracy for the full validation set was achieved after combination of an atmospheric correction based on transmittance functions and a pixel-based Minnaert topographic correction. Secondly, class accuracies of especially the coniferous and mixed forest classes were enhanced after correction. There was only a minor improvement for the other land cover classes (broadleaved forest, bare soil, grass and water). This was explained by the position of different land cover types in the landscape. Finally, coupled correction methods showed most efficient on weakly illuminated slopes. After correction, accuracies in the low illumination zone were improved more than in the moderate and high illumination zones. Considering all results, best overall classification results were achieved after combination of the transmittance function correction with pixel-based Minnaert or pixel-based C-topographic correction. Furthermore, results of this bi-temporal study indicated that the topographic component had a higher influence on classification accuracy than the atmospheric component and that it is worthwhile to invest in both atmospheric and topographic corrections in a multi-temporal study.

| 0783 | The willingness to pay for sustainable land use changes - a discrete choice experiment application to residents in Germany | Jesko Hirschfeld, Julian Sagebiel | Germany |

Although much knowledge exists on the ecological effects, land use changes imply also socioeconomic consequences which are mostly not explicitly taken into account by the scientific community and policy makers. Especially in the context of climate change mitigation and adaptation strategies, tradeoffs and synergies between carbon optimized land management and other public demands are present and need further attention. In this presentation, we focus on the provisioning, regulating and cultural ecosystem services (e.g. provision of food, preservation of biodiversity) provided by different land use scenarios and evaluate its benefits from a residents' perspective. To do so, we rely on the results of an online Discrete Choice Experiment survey, inferring preferences on land use changes from about 3000 randomly sampled German residents in Spring 2013.

In the survey, respondents were asked to choose between different land use scenarios in their immediate vicinity. These scenarios were distinguished by differing characteristics including the degree of biodiversity, the share of forest, sizes of fields and forest, rate of land consumption, share of maize fields, share of agricultural areas with high nature value, share of hedges, share of grassland and finally an associated price. For estimation we apply a latent class conditional logit model which incorporates discrete unobserved preference heterogeneity i.e. different groups of residents, which differ in their preferences for land use scenarios, are endogenously derived.

The model allows estimating individual willingness to pay values, which make tradeoffs between characteristics scalable and can be used in extended cost benefit analyses. The results reveal that preferences between individuals vary strongly, sometimes even in opposite directions. Nevertheless, we observe an overall positive willingness to pay for most characteristics summing up to several billion Euro per year for Germany.

The results are relevant for policy makers as they reflect the opinions of local residents and can help to design adequate mechanisms to publicly finance land use changes. The study addresses questions like "what is the optimal land use scenario from the point of view of residents?", and "what financial burden are residents willing to bear to implement the changes?".

| 0787 | Observations and indicators for assessing the relation between biodiversity and carbon in the context of land use change and its impact | Michael Schmidt, Pedro Díaz, Julián Equihua, Nashieli Alaniz, Melanie | Mexico |

		Kolb, Miguel Equihua, José Luis Álvarez, Christian Delfín-Alfonso, Octavio Maqueo	

Having recently proclaimed the advent of the anthropocene, we see rapid changes in the earths ecosystems. However and in spite of various international efforts to formulate binding policies to protect biodiversity or mitigate climate change, little is known about the interactions and linkages within ecosystems, for instance biodiversity and ecosystem services.

Recognizing this need the European Commission agreed to finance a 4 year research project with the objective to conduct integrated research on feedbacks between biodiversity and carbon-related ecosystem services under climate and land-use change scenarios.

The project collects and analyses information present in the region (Mexico to Bolivia), which has up-to-date not been analyzed in an consistent fashion and additionally integrates observations both in situ and by remote sensing to establish the relation between biodiversity and ecosystem services and to evaluate the feedbacks between climate change mitigation and other services.

Specifically for the project region covering Mexico, a lot of efforts have been pooled into creating and integrating a data base consisting of various government and academic data pools.

The paper presents the first findings of these analyses with emphasize on the linkage between different aspects of biodiversity (structural, functional and composition) with carbon storage and up-take.

Landsat and MODIS data in combination with national forest inventory data were analyzed to build continuous maps of indicators to assess land use and cover change impact on landscape diversity, biodiversity and carbon storage potential. Indicators were aggregated into indices of structural diversity to represent naturalness and into indices of functional diversity to represent health of ecosystems. Both indices were incorporated into a single measure of ecological integrity.

0791	Land use and land cover change in Inner Mongolia - understanding the effects of China's re-vegetation programs	He Yin, Dirk Pflugmacher, Zhengguo Li, Patrick Hostert	Germany

Debates are ongoing over the effectiveness of China's re-vegetation programs in arid, semi-arid and sub-humid environments. Large-scale afforestation efforts are critisized due to potential negative impacts on soils and vegetation cover in drylands. However, it has also been argued that afforestation projects contributed to environmental improvements in drylands and socioeconomic effects are mostly positive nationwide (Liu et al. 2008; Yang et al. 2010). The objective of this study was to monitor land use and land cover change across broad scales under China's current ecological policies. We focused on mapping land cover conversions and modifications using MODIS time series. We selected Inner Mongolia as our study region because it is one of the most severely degraded regions in China and a global hot-spot of land degradation. We employed MODIS-Terra Vegetation Index (VI) products (MOD13Q1, Collection 5) from 2000 to 2011 for land cover classification and trend analysis. We used annual spectral statistics, an extensive collection of ground references from Google Earth^{TM} and a Random Forest classifier to produce annual land cover maps differentiating forests, cropland, grassland, water and non-vegetated areas. To monitor more subtle land cover modifications, such as double cropping due to irrigation, we combined MODIS NDVI, Tropical Rainfall Measuring Mission-based precipitation time series and ground-based inventories to analyze land use intensification. We found that: i) Forest cover overall increased in mountainous areas, while forests in the Greater Khingan Mountains at the same time exhibited higher disturbance rates due to fire in remote regions ii) cropland expansion in previous grasslands and agricultural intensification is still ongoing. Our results suggest that

afforestation and forest protection policies that were implemented in the past decade play a positive role for forest regrowth and recovery in general. However, cropland expansion and intensification negatively affects water resources and increases the risk of land degradation. Overall, time series analysis based on remote sensing data allowed a consistent characterization of land change dynamics over large areas, which is crucial in gaining a better understanding of environmental changes in the light of new environmental policies and governance regimes.

0795	Collective resilience: urban environmental stewardship as a form of hybrid governance within New York City's waterfront communities	Erika Svendsen	USA

Urban environmental stewardship involves work to conserve, manage, monitor, restore, advocate for, and educate the public about a wide range of issues related to sustaining the local environment (Fisher et al., 2007). These groups serve as managers of small parks and gardens, street trees, waterfronts, wetlands, and other urban space. Overtime, stewardship groups have advanced decision-making and practice by networking their activities with other civic groups and government agencies. Many urban environmental groups have grown less content to participate in planning through traditional means of public participation, preferring the 'hands-on' role of a manager. While stewardship still includes neighborhood clean-ups and plantings, in a growing number of instances, it has grown to include formal rule making, technical expertise, fiscal management, and mediation over urban space. Svendsen will present findings from recent studies that reveal local stewardship groups to be highly adaptive and tactically operating along a spectrum of hybrid governance. In order to strengthen mechanisms of collective resilience, Svendsen argues for understanding stewardship as a key driver and innovator within an urban social-ecological system. This work contributes to the conference theme and session as it suggests that stewardship actions at the local level play a higher-order role in the formation of distinct social ecologies and represent patterns and processes at work in the transformation of global lands.

0798	Optimised cropland cover for maximising simulated crop yield or minimising its interannual variance based on simulations using LPJ-GUESS	Per Bodin, Stefan Olin, Thomas Pugh, Almut Arneth	Sweden

With a growing global population, an increase in average per capita food consumption and an increased use of agricultural land for other forms of land use (e.g. biofuels) there is an increased pressure to both expand the area used for food production as well as producing more food on existing agricultural land (by closing the yield gap). Closing the yield gap can be done in a number of ways: by improved management (including fertilizer use and irrigation) as well as by the selection of crops or crop varieties. In addition to increasing mean annual yield, in regions with a strong dependence on local food production (e.g. Sub Saharan Africa), it is also important with stable yields (low inter annual variability) in order to provide food security. Modern Portfolio Theory (MPT) is a theory for identifying an optimum portfolio of stocks aimed at minimizing risk whilst maximizing return. Here we apply MPT in order to optimize the cropland cover fractions for seven crops common across the African continent by maximising simulated mean crop yield (total number of calories produced per m^2 cropland) whilst keeping variance constant. Conversely we also optimize cropland cover fractions to minimize modeled variance whilst keeping crop yield constant. Crop yield is modeled using the LPJ-GUESS model forced with downscaled climate data from five different General Circulation Models, driven by four emission scenarios (RCPs). The model is run at a 0.5^0 spatial resolution for the entire African continent, simulating all seven crops at all gridcells currently containing cropland normalizing simulated yield against observed data. Results show the potential to increase food production or to decrease its variance by optimizing the fraction of crops grown within a region. The difference in these fractions between climate scenarios also highlights the uncertainties in these optimum fractions in relation to future

climate. Further, based on these simulations optimum future cropland fractions could be produced which then could serve as cropland cover scenarios for maximizing yield or minimizing variance.

0799	Socio-ecological niches of soil and water conservation to foster agricultural land transformation in western Africa	Diana Sietz, Han van Dijk, Kathleen Neumann, Marcel Kok, Henk Hilderink	The Netherlands

In view of widespread food insecurity, the conservation of soil and water resources is an important entry point to improve agricultural production in smallholder systems of western Africa. The implementation of soil and water conservation (SWC) measures remains however limited and the decision-making for SWC adoption poorly understood. This study investigates the determinants of SWC adoption in the drylands of western Africa by means of meta-analysis of local adoption cases (n=51). It identified six broad categories of underlying conditions pertaining to external support, household and farm properties, characteristics of SWC measures, the governance of SWC initiatives, the farmers' individual behaviour and local resource scarcity. As a methodological advancement, additional information of the context in which SWC takes place was used to differentiate these broad adoption conditions. Taken together, the context information and the broad underlying conditions serve to reveal socio-ecological niches of adoption. For example, one socio-ecological niche depicts arid to semi-arid regions with very low population density where SWC adoption depends most frequently on household and farm properties as well as on external support. In contrast, the characteristics of SWC measures and external support are the main determinants in more humid areas with higher population density. The socio-ecological niches identified in this study provide impetus to a better understanding of smallholders' land management, thus to rethink land use transitions and to debate how transformation pathways may be facilitated. In particular, the niches identified are suitable to support local and regional decision-makers in their efforts to adapt smallholder agriculture in western Africa to climate variability and other perturbations. Finally, the socio-ecological niches for SWC adoption enable stronger linkages with research on typical vulnerability patterns in global drylands to adjust adaptation strategies to local conditions.

0801	Spatial patterning and interactions of land use in complex, high-agrobiodiversity smallholder landscapes	Karl Zimmerer	USA

Smallholder landscapes are receiving increased attention due to accelerated global environmental and socioeconomic changes. Issues of intensive land use, food security, social equality, and sustainability offer important challenges and opportunity in these landscapes. Agrobiodiversity (biodiversity of agricultural systems) concentrated in certain smallholder landscapes worldwide is an issue increasingly recognized, yet still poorly understood with regard to basic functioning and structure in the context of complex smallholder landscapes. The general focus of this study is to examine spatial outcomes and social interactions regarding cropping-system choice in high-agrobiodiversity smallholder landscapes. My research on this theme constructs a model of areal dynamics and socio-spatial interactions involving the cropping systems of: (i) high-agrobiodiversity land use; and (2) monoculture cropping. This model builds on the concepts of spatial externalities and global environmental and socioeconomic changes combining long-distance telecoupled interactions as well as local- and region-scale processes. It is used to create predictions regarding socio-spatial interactions and field-type clustering. My specific goal is to apply this model to a case-study of high-agrobiodiversity maize in a complex smallholder landscape of 8,000+ fields located in central Bolivia (Zimmerer 2013). Specific questions in this research include the processes and patterns leading to the phenomena of field-type spatial clustering and dispersion (or the absences thereof). Estimates are created of the sub-area, scale-related, and temporal-change (2006-2012) properties of these spatial properties. These findings are linked via conceptual and empirical models to

the processes of land-use and land-cover transitions involving global-change, in particular the connections of complex smallholder landscapes to migration activities. The presentation concludes by discussing management insights, policy recommendations and analysis of future options.

| 0802 | Agromes – a global assessment of agricultural land use intensity | Verena Seufert, Navin Ramankutty | Canada |

Humans are a driving force that is shaping the Earth's land surface - about 75% of the Earth's ice-free land today is influenced by human land use. Traditionally the terrestrial land surface is, however, described in terms of Biomes, which are natural systems that would have been there without human interference. To account for the persistent presence and influence of humans, Ellis & Ramankutty (2008, Front Ecol Eviron 6(8): 439-447) have instead coined the term Anthropogenic Biomes (Anthromes) to describe the human-influenced terrestrial land surface.

The majority of this human land use (i.e. ca. 45%) is taking place through agriculture for the production of food and fuel. Agriculture today is a global force that is influencing the Earth system and altering the environment but that is also key to human livelihoods. Agriculture can take many different forms – from low-input and diverse agroforestry homegardens in Kerala, India, to large-scale high-input corn-soybean systems in Iowa, United States. Such different types of farming systems can have very different environmental, social and economic outcomes. For analytical and policy purposes it is therefore important to know about the spatial patterns and characteristics of different farming systems across the world. Here we aim to refine the Anthromes concept by adding detail about agricultural land use and land use intensity to describe the Agricultural Biomes (Agromes) that cover the Earth's land surface.

To be able to describe such spatial patterns we need detailed and high-resolution information about farming systems characteristics and management practices. Data about global agricultural land use and especially about agricultural management is, however, scarce and difficult to obtain. FAOSTAT provides valuable information on many management variables, often at high temporal resolution but it is limited to national level data and thus limited in its spatial detail. We therefore developed new high-resolution global datasets about agricultural management practices derived from a combination of sub-national agricultural census statistics, FAOSTAT and remote sensing data. These newly developed datasets include data about machinery use, pesticide use, farm size and agricultural labour. We then use these and other already existing global high-resolution and spatially-explicit datasets (e.g. pasture and cropland extent and fertilizer use) to describe dominant agricultural land use patterns and develop a global farming systems typology. The Agricultural Biomes developed through this approach can provide a useful descriptive and analytical framework for the discussion about agriculture and its economic, social and environmental role at the global scale.

| 0807 | Sustainable land use in mountain regions under global change: insights from the Mountland project | Robert Huber, Rigling Andreas | Switzerland |

Mountain regions provide essential ecosystem goods and services (EGS). Global change however endangers the capacity of mountain ecosystems to provide key services. The ‹Mountland› project focused on three case study regions in the Swiss Alps and aimed at proposing land-use practices and alternative policy solutions to ensure the provision of EGS under climate and land-use changes. The project provides: (i) new basic scientific findings regarding the impacts of climate and land-use changes on ecosystem processes in three sensitive mountain regions of Switzerland, (ii) an assessment of the feedback effects arising from changing socio-economic and political conditions, land-use and adaptation to climate change, using modeling techniques and transdisciplinary stakeholder interactions, and (iii) suggestions for alternative policy solutions to ensure sustainable land-use in mountain regions. We combined methods from economics and the political and natural sciences including process-based models to analyze ecosystem functioning and management in mountain regions. The added value of this

approach was that (i) data and models were based on biophysical realism; (ii) local trade-offs could be considered; and iii) a comprehensive but critical involvement of stakeholders within the studies was achieved. Linking to our coupled human and natural systems approach, we found the following key characteristics of such systems to be central to our case study areas in mountain regions: non-linearities and thresholds; heterogeneity; trade-offs, as well as feedbacks. We found relevant examples of these characteristics in all three case study regions. Our results suggest that an institutional framework focusing on three aspects is essential for maintaining and strengthening important EGS in mountain regions. Firstly, integrative approaches ('policy integration') to strengthen cross-sectoral coordination should be supported. These approaches would allow for a more effective provision of mountain EGS in the presence of heterogeneity and thresholds. Secondly, network management and steering ('network governance') to strengthen multi-level governance would permit an adequate integration of (local) stakeholders in policy formulation and implementation processes. Spatial planning instruments and methods addressing heterogeneity, trade-offs and feedbacks provide important policy alternatives in this context. Thirdly, the integration of stakeholders would permit a focus on capacity building. This is important to reduce vulnerability to changing climate conditions, socio-economic developments and related risks that we identified in ‹Mountland›.

0812	Social networks and ecosocial feedback in the governance of multifunctional agriculture	Steven Manson, Kristen Nelson, Nicolas Jordan	USA

Rotational grazing is a form of multifunctional agriculture in animal systems that has attracted much attention for its potential to produce goods and services for a range of stakeholders in agricultural landscapes and their communities. Given that multifunctional agriculture adoption has been uneven at local to global scales, conceptual models of increasingly posit the importance of social networks in driving bottom-up interactions among social and environmental systems and mediating top-down governance effects. We investigated dairy agriculture in the United States to better delineate how social networks matter to the adoption of rotational grazing in the dairy farming system. We found that social networks are important to this form of dairy but their impact is contingent on social and spatial factors, including the nature of social ties and spatiotemporal features of network formation. This research addresses the role of social networks in land governance in general and specifically examines how power and politics resident in social institutions affect the landscape.

0814	Institutional acceptance of urban soil sealing management - from raising awareness to better implementation	Martina Artmann	Austria

Urban soil sealing threatens the provision of ecosystem services as impervious surfaces such as asphalt, concrete or buildings increase surface water run-off, contribute to the urban heat island, threaten the supply of recreational areas and fragment habitats for flora and fauna. Nevertheless, a continuous increase of sealing can be observed in Europe. The European Soil Sealing Guidelines however show the raised political awareness on these crucial trends (EC 2012). Land take targets are presented as one best practice example how urban soil sealing can be steered. Such a target has also been implemented in Germany, one of the most sealed countries within Europe, to reduce daily land take for settlement and transport areas. However, the guidelines do not discuss that this target lacks of local acceptance, will and commitment of implementation and seems according to current land use statistics not realistic to achieve.

This presentation will discuss soil sealing management instruments and strategies in more detail. Therefore, the approach "Response-Efficiency-Assessment" has been developed to assess the efficiency of soil sealing management instruments. Besides evaluating the contribution of responses towards an ecological sustainable development, economical-fiscal functionality, living quality and raised awareness

this presentation will focus on the institutional acceptance of soil sealing management instruments. The institutional acceptance by urban policy seems crucial as local authorities are the main authorities and management addressees to implement laws, informal plans or spatial monitoring systems. Subjective and objective indicators such as degree of targeting precision, control of success, will and acceptance of implementation are used to assess the institutional acceptance of legal-planning, economical-fiscal, informational and co-operative instruments. The evaluation is done by a content assessment and an online survey with local decision makers in Leipzig and Munich (Germany).

The results will provide insights which instruments can be efficient to steer urban soil sealing and urban green areas, as the antagonist of urban grey, in a quantitative (reducing land take, decreasing sealing around the building, protection of urban green spaces) and qualitative (spatial targeting of new sealing, protection of valuable green areas and soils) manner and which instruments support de-sealing of underused areas or greening roofs. The presentation therefore will inform land use policies by the science based tool "Response-Efficiency-Assessment" which set of instruments are ready for implementation and which need further adaption for land governance not to threaten the quality of live by further loss of urban green.

| 0815 | Regime shifts in African smallholder agriculture: from continuous to hysteretic models of livelihood dynamics in agroecosystems | Pablo Tittonell | The Netherlands |

Agroecosystems dynamics result from the aggregation of diverse livelihood strategies in response to changes in their context, are shaped by local institutions, and their trajectories describe non-linearity, irreversibility, convergence/divergence and hysteresis. In a recent study (Tittonell, 2013) I examined a number of case studies from Africa to verify three hypotheses around the diversity of rural livelihood strategies: (1) diversity as alternative system regimes; (2) diversity as the result of transformability; (3) diversity determined by changing agricultural contexts. Here, I examine some key underlying ecological properties of complex agroecosystems dynamics and their relation with the biophysical mechanisms that govern resilience and transformability in African smallholder agriculture. Thresholds in specific driving variables that may point to the existence of possible tipping points are rather elusive and largely site specific, requiring systematic categorization of agricultural contexts. Such contexts, defined by agro-ecological potential, demography and market connectivity are also dynamic and their trajectory can be described as shifts across stability domains. The aim is to propose models to describe dynamics and understand **drivers** of land use change in order to inform new management strategies, while providing examples of **regime shifts** in smallholder agriculture. In particular, I analyze field evidence to reveal (i) hysteresis in regime shifts (or the lack of them) underpinned by soil degradation – rehabilitation cycles; (ii) the role of livestock in propending to upward shifts in smallholder agriculture; and (iii) the opportunities offered by increasing biodiversity as a means to restore resilience in smallholder landscapes. Conceptualizing change through hysteretic rather than continuous, reversible trajectories challenges the hegemonic model of agricultural development based on presumed thresholds in asset holdings. Next to technical options or new resources, policy and market developments are needed to deal with cross scale impacts, such as hierarchical confinement (poverty taps) or with interactions that may be panarchical in certain cases.

| 0817 | Drought and deforestation: how the role of land use in the Amazon changes under varied precipitation regimes | Justin Bagley, Ankur Desai, Keith Harding, Peter Snyder, Jonathan Foley | USA |

In the last decade the Amazon Basin has experienced two "once in a century" level droughts. Coupled

with impacts from expanding deforestation the droughts of 2005 and 2010 altered local ecosystem services. In this study, the biogeophysical impacts of land cover change within the Amazon Basin were examined under drought, normal, and pluvial conditions to investigate how the coupled influences of land cover change and drought may have enhanced or diminished recent precipitation extremes by altering patterns and intensity. Using the Weather Research and Forecasting (WRF) Model coupled to the Noah land surface model, a series of April-September simulations representing drought, normal, and pluvial years were completed to assess how land cover change impacts precipitation, and how these impacts change under varied rainfall regimes. Evaporative sources of water vapor that precipitate across the region were developed with a quasi-isentropic backtrajectory algorithm to delineate the extent and variability that terrestrial evaporation contributes to regional precipitation, and identify where evapotranspired moisture from the Amazon falls as precipitation during the region's dry season. A decrease in dry season latent heat flux and other impacts of deforestation on surface conditions were increased by drought conditions. Coupled with increases in dry season moisture recycling over the Amazon basin by ~7% during drought years, we found land cover change is capable of reducing precipitation and increasing the amplitude of droughts in the region. By connecting the impacts of land use and climate variability through the hydrological cycle, the concepts and results developed in this study are directly relatable to the conference theme of land use impacts and responses. Additionally, we use backtrajectory analysis in this study to estimate the impacts of Amazonian deforestation on downwind moisture providing a potentially valuable contribution to the conference session "Moisture recycling – downwind impacts of land use change."

| 0820 | Pathways to achieve global sustainability goals by 2050 | Elke Stehfest, Detlef van Vuuren, Anne Gerdien Prins | The Netherlands |

In 1992, in Rio de Janeiro, governments worldwide agreed to work towards a more sustainable development that would eradicate poverty, halt climate change and conserve ecosystems. Although progress has been made in some areas, actions have not been able to bend the trend in other, critical areas of sustainable development – areas such as those providing access to sufficient food and modern forms of energy, preventing dangerous climate change, conserving biodiversity and controlling air pollution. Without additional effort, these sustainability objectives also will not be achieved by 2050. Here we present a study with the integrated assessment model IMAGE, showing how a set of sustainable development goals derived from existing international agreements (e.g. the Millennium Development Goals, UNFCCC and UNCBD) could be met. Using a back-casting methodology, we analyze three alternative pathways towards these sustainability goals, and assess the effort levels and measures required. In order to preserve biodiversity and to ensure food security, all pathways require a substantial increase in agricultural productivity up to 1.3 % per year, and other options including improved land-use policies, dietary changes, and reducing food losses. To achieve long-term goals, four fundamental short-term policy priorities can be defined: 1) create conditions to accelerate sustainable agricultural intensification, 2) ensure a more robust food system to reduce hunger, 3) mainstream biodiversity considerations in land-use planning and management, and 4) promote changes in consumption patterns. Clearly, these priorities are likely to differ across countries, depending on income levels.

| 0826 | The future scenarios of land use change in agro-pastoral transition zone of China from households' willingness survey | Huimin Yan, He-Qing Huang, Lin Zhen | China |

Land system sustainability in dryland areas is threatened by a complex and interrelated range of social, economic and environmental changes that present significant challenges to researchers, policy makers, and rural land users. Agro–pastoral transition zone in China was the major source of newly cultivated cropland during the past decades; meanwhile, it also has been the largest source of abandoned cropland

not only from passive abandonment because of ecological protection policy but also from initiative abandonment due to farmer's economic benefits. Multiple policies on payments for ecosystem services aiming to harmonize human development goals with environmental objectives have been implemented in this area. Land abandonment and reclamation is a complex multi-dimensional process with interlinked economic, environmental and social aspects, as well as strongly associated with landowner characteristics. Within this process, peasants' willingness should be potentially play key roles in determining whether or not land is utilized for agriculture. Therefore, understanding the nature of the households' intention and the relationship within human behaviors and social or physical environment is therefore an important prerequisite for developing future sustainable adaptive agricultural policies. In this study, 161 households live in agro-pastoral transition zone in Inner Mongolia were interviewed. Based on the data of farmers characteristics and their responds to job opportunity, climate change, market access and availability, and subsidy for food or ecology, the possibilities of agricultural land is abandoned and the recovered natural vegetation is reconverted into cultivated land are discovered. Farmers' willingness of utilizing cropland or not is changed with drought frequency, crops yield, allowance or subsidy level, but its sensitivity is different by the physical conditions of land. The age structure and the motivation of children as farmer in future tell us a truth: after 40 years, there would be almost no original farmers live in such area. Therefore, whether or not utilize the land as agriculture, and who will and how to utilize the land in the future is in a significant crossroad now. This research aims to provide potential measures for enhancing livelihood sustainability and sustainable land use change transition.

0827	Land use effects on the diversity of vascular plants - a meta-analysis	Katharina Gerstner, Carsten F. Dormann, Anke Stein, Ameur Manceur, Ralf Seppelt	Germany

Plant diversity is essential for ecosystem functioning, resilience, and ultimately, ecosystem services. However, plant diversity is threatened by human-driven ecosystem degradation and land-use. To date, numerous studies have examined various kinds of land-use and its effects on plant diversity, mostly conducted at local scales (min-max of scale of inference 1 m² to 1 km²). In order to evaluate the generality and variation of these studies', findings, meta-analysis of effect sizes is a commonly used tool. Meta-analyses are able to detect the direction and magnitude of effects as well as the variability of effects among studies, e.g. for determining environmental conditions or covariates which might influence effect sizes.

Our study specifically aimed at investigating the direction and magnitude of effects of a large set of land-use options on plant species richness using a consistent method. Due to the global coverage and the various predictors we took into account we were able to verify whether these effects depend on the conditions under which management takes place, e.g. biotic or abiotic conditions, governmental belonging, or study design (experimental or observational).

To date, we calculated 500 effect sizes from 300 studies relating to 11 classes of management. Overall, we found that the effect of land management on plant diversity is strong compared to other tested effects. For example, silviculture can lead to increased plant species richness whereas abandonment of management mostly leads to reduced plant species richness. Furthermore, we found that management effects are moderated by continent. However, the power of this analysis is limited by the uneven distribution of studies which are mostly concentrated in Europe and North America. Overall, the preliminary findings show that effects are mainly in accordance with existing theory about patterns of diversity and mechanisms that lead to the maintenance and loss of plant species, as well as with previous

synthesis studies.

This study provides a summary of possible land-use effects on plant diversity and examines biophysical and socio-economic drivers. Moreover, it contributes to GLUES within the Sustainable Land Management Programme which provides approaches for synthesis and global framework scenarios for regional projects. The study also suggests that data collection outside of Europe and North America should be prioritized.

0828	Interdisciplinary cross regards on urban green infrastructure and climate change adaptation : the stakes of a governance reconfiguration (Paris case-study)	Nathalie Blanc, Sandrine Glatron, Thomas Lamarche, Aleksandar Rankovic, Anne Sourdril	France

Greening of the cities - such as favoring trees plantation, building of parks, greenways, green roofs or community gardens – are increasingly presented by city managers and in biodiversity or climate plans as an efficient and low cost measure to adapt urban areas to climate changes, bringing potential climatic services along with other ecosystem services. This has consequences on the way vegetation is perceived and should be managed at the city scale nowadays and in the future. We would like to see in this communication if and how a potential governance of those vegetation and climate links is possible, taken the example of Paris, France as a case study. We would like to question more broadly the ability for such a local governance to take into account global incentives but also local uses and policies. Through our CCTV2 - Climate Change and Greenways funded by the French GIS Climat - interdisciplinary program bringing together social scientists, ecosystem ecologists and climatologists, we seek to understand how the relationship between vegetation and climate in an urban socio-ecological system should function from an ecosystem point of view; and how it is seen, managed and governed by a diversity of stakeholders at different scales: neighborhood, city and region. Our researches show that the vegetation potential effects in the adaptation of cities to climate changes are more and more taken into account by scientists at the regional or city scale and finds responses in the inhabitants discourses. However, the division of public policies into separate sectors makes it difficult to combine climatic and vegetation official policies and plans at those same scales. Attempts exist and tend to arise but remain at a cobbling-together level. At the neighborhood scale, inhabitants do not immediately link vegetation and climate but by questioning them more broadly on the expected local benefits provided by the vegetation, links appears in terms of cooling and air quality improvements by plants and vegetation. Through our CCTV2 program we try to understand the consequences this context of climate changes will have on the existing and future vegetation governances to conform to the new climatic standards and the way scientists, officials and inhabitants could/should build constructive consultation arenas.

0829	A multi-component characterization of the active Okavango Catchment and Delta based on various MODIS products	Marion Stellmes, David Frantz, Achim Röder, Torsten Weber, Joachim Hill	Germany

The Okavango River is one of the large lifelines of Southern Africa. It has its source in the rainy highlands of Angola, forms part of the north-eastern border of Namibia and terminates in the Okavango Delta, the world's largest inland delta and the largest freshwater swamp south of the equator. Accelerating climate change, population growth, and anthropogenic over-utilization of natural resources turn the Okavango Basin with its variety of savannah woodlands and wetland ecosystems into a global hotspot of biodiversity loss and potential land use conflicts.

It is of major importance to support the development of trans-national sustainable land use management

strategies. One essential element for optimizing land use management is the assessment of ecosystem performance and resources including their spatial distribution, variability and long-term behaviour.

To contribute to this objective a multi-component earth observation product was established at a regional scale employing moderate resolution MODIS products covering the time period from 2000 to 2013. One elementary component is the derivation of major land use systems and functional vegetation types along with their changes over time. For this purpose phenology indicators were derived from the MODIS Enhanced Vegetation Index (EVI) product employing a polynomial spline model approach. Based on this information major land use systems were delineated and, by linear regression analysis, land-use/cover conversions and modifications were identified. Another constituent is the climatically unbiased assessment of ecosystem productivity and the dependency of EVI on rainfall variability. This was followed by assessing rain use efficiency by linking MODIS EVI, serving as a proxy of net primary productivity, and gridded rainfall and temperature data. The response of EVI to rainfall variability was estimated by using distributed lag models.

Even though the aforementioned analyses are of major importance to characterise the study area, a comprehensive understanding is in need of additional information. One further significant factor is the fire regime, its spatial pattern and frequency, which can be evaluated based on the MODIS fire products. Furthermore, the highly variable water availability affects the extent and duration of inundation and is especially crucial for ecosystem performance in the Delta region. For this purpose, MODIS EVI and reflectance data were utilized to derive a temporally explicit product indicating inundated areas.

The integration of all these products depicts a comprehensive picture of the status of the Okavango Catchment and Delta and supports the understanding of the ecological dynamics in the whole Okavango system.

| 0830 | Effectiveness and synergies of private and public actions for land use governance in tropical regions | Eric Lambin, Ximena Rueda, Rachael Garrett, Patrick Meyfroidt | Belgium |

A large and growing fraction of land conversion is associated with commodities produced for global markets; but globalized markets can also have positive impacts, as when consumers ask for better environmental practices for the products they buy. Civil society and corporations have designed market-based policy instruments to influence land use – e.g., eco-certification, geographical indications, multi-stakeholder supply chain initiatives (commodity roundtables and moratoria), and payments for environmental services. These new predominantly private regulatory mechanisms are interacting with traditional public forms of land use regulation – i.e., command-and-control interventions such as land use zoning and protected areas. This presentation will offer a synthesis of those instruments, assess the effectiveness of public and private interventions in promoting sustainable land use, and highlight successful interactions between private and public instruments. It will also propose a theoretical framework, based on supply, demand and structural factors in the value chain, for understanding why companies choose a particular instrument.

Overall, there is a lack of rigorous studies on the effectiveness of demand-led instruments, but available evidence suggests positive direct and indirect impacts. Private regulation systems serve optimally as a complement and supplement within policy mixes. Interactions between public and private instruments take multiple forms – e.g., governments endorsing certifications or using certification to support their own policies; governments creating enabling conditions for private instruments to develop, and be more widely adopted; and market-based instruments reinforcing public regulations or substituting for missing or weak governance. In some cases, governments, NGOs and corporations compete and may hinder each other's actions. Through case studies, we argue that corporate sustainability behavior is influenced by information on the mode of production, brand identity, and the level of vertical integration in the

supply chain, which all influence the feasibility and attractiveness of a particular sustainability instrument. The case of soy production in South America shows that the rejection of GM crops by European consumers has led to strong trade linkages with Brazil which in turn have facilitated the creation of regional soybean supply chains that have empowered European consumers to transfer their norms of environmentally sustainable production to Brazilian producers through certification programs and price premiums. We conclude by addressing the question of how public and private interventions can interact effectively.

0833	Characterization of forest disturbance using data-blending techniques applied to MODIS and Landsat time series in an Australian Savanna	David Frantz, Achim Röder, Thomas Udelhoven, Michael Schmidt	Germany

Spatio-temporal information on forest loss is essential for a wide range of applications, among them international agreements like the Kyoto Protocol or REDD, or the enforcement of land regulation jurisdiction. Despite remote sensing being the only feasible means of monitoring forest change at regional or greater scales, there is currently no remote sensor that meets the demand of monitoring forest change at landscape level with guaranteed high temporal frequency.

An alternative to relying on a single inadequate dataset is to exploit the complementary attributes of two datasets by using data fusion techniques. The Spatial and Temporal Adaptive Reflectance Fusion Model (STARFM) was specifically designed for blending Landsat and MODIS surface reflectance for applications that have demands for high resolution in both space and time.

To test the feasibility of fused data for disturbance detection, we chose a test site in an Australian savanna where anthropogenic clearing is commonplace. It was investigated whether the generated dataset could supplement information regarding forest clearing, i.e. an improvement in timing.

An operational scheme for deriving Nadir BRDF adjusted reflectance (NBAR) was utilized to radiometrically standardize all available Landsat TM data for a three year period (2007-2009). Landsat NBAR data and equivalently standardized 16-day MODIS NBAR data were used to generate a dense synthetic time series using STARFM. The quality of the derived images was assessed by comparing them with independent Landsat observations from the nearest date. Overall prediction quality was found to be good ($0.84 < R^2 < 0.97$), while indicating that there might be some problems in detecting forest loss at sub-MODIS scale.

Forest loss of the woody part of the study area was detected by applying a time series based disturbance detection approach employing the Disturbance Index. Both the original Landsat time series and the synthetic time series, as well as a combined hybrid approach were used to identify timing and extent of disturbances. The identified clearings were validated by a well established reference dataset that is regularly produced by Queensland's Statewide Landcover and Trees Study (SLATS).

A comparison of the results derived by the original and synthetic time series generally showed a high degree of agreement in spatial terms (i.e. disturbance extent) and was less pronounced with small clearings. The results of the hybrid detection indeed indicated a temporal improvement in disturbance timing relative to the discrete Landsat data.

0838	Uncertainty in the context of modeling land use change	Jan Goepel, Jan Schuengel	Germany

Land use change in the Brazilian Amazon represents one of the major drivers of global environmental changes. The extreme land-use dynamics in the last decade in the Amazon region have led to a large loss of natural ecosystems and a serious deterioration of the prevailing social structures. The adaptation of the LandSHIFT integrated land use change model to this region aim to support that local decision-makers are able to make decisions that defuse the current social situation and enable a sustainable

development of the region through the application of sustainable land management strategies.

Despite the efforts of adaption of these integrated land use change models to the social and environmental drivers associated with the particular study region, the predictive ability of the models is still surrounded by uncertainties. None of the model projections available in the literature could plausibly capture the overall trajectory of the land use and cover changes that have been observed in the Amazon over the last decade and the decoupling of deforestation and agricultural development, by mean of agricultural intensification, which has been observed in this context.

These uncertainties originate from different sources.

The first source of uncertainty is the inaccuracy which stems from different methods of land cover classification regarding different land cover products (maps) like GlobCover, MODIS or GLC2000.

The second source of uncertainty is the identification and implementation of sets of drivers for a particular study region with regard to different agricultural area and quantity statistics like the FAO or IPEA databases against the background of a tendency of decoupling of agricultural development and deforestation which has been observed for this region over the last years of this decade.

All of the previously named sources of uncertainty also influence the quantification of the accuracy of any land use change model in terms of model validation basis and refinement of modeling results.

In this study we employ the LandSHIFT model to investigate the effects of the beforehand mentioned sources of uncertainty on land use change and resulting carbon losses due to deforestation and agricultural development. Based on this analysis the authors will discuss different approaches to systematically quantify and visualize these uncertainties in order to inform decision makers.

0840	Reconciling development trajectories and deforestation reduction targets in Brazil	Aline Soterroni, Fernando Ramos, Adriana Gomes, Alexandre de Carvalho, Gilberto Câmara, Giovana Espindola, Pedro Andrade, Ricardo Souza, Victor Maus	Brazil

Implementation of REDD+ potentially requires a wide range of policies and activities, which have the potential to deliver multiple benefits, including ecosystem services and social benefits, but also carry some social and environmental risks. Thus, understanding how different policies could influence land use and its effects is essential to support informed decision-making, especially in a developing country like Brazil. The REDD-PAC project will provide a global forum for sharing and improving global data on forests and deforestation drivers and developing best practices for national REDD+ and land- use planning [1]. Within the scope of the REDD-PAC project, the GLOBIOM − a partial equilibrium, spatially explicit global land-use model for the agricultural, forestry and bioenergy sectors, developed by IIASA − is being adapted and refined to the Brazilian present economic and environmental conditions and future development scenarios. To this end, a new land cover map for Brazil for years 2000 and 2010, based on a best combination of existing sources has been produced, and important issues related to land policy, such as protected areas, transportation costs, land use intensification and deforestation restriction, have been taken into account. Here we report the first results obtained with GLOBIOM-Brazil in assessing the economic and biodiversity impacts in Brazil of different REDD+ policies. In particular, we investigate the compatibility of Brazil's agriculture, grazing and bioenergy (and related infrastructure) development trajectories for the next decades and the country commitments on deforestation reduction, as agreed at the 15th session of the Conference of Parties (COP 15) in Copenhagen.

0841	Untangling the policy effect of protected areas, land title, and economic incentives on forest cover change in the Ecuadorian Amazon	Kelly Wendland, Margaret Holland, Lisa Naughton, Free de Koning, Manuel Morales, Luis Suárez	USA

A number of conservation policies have been implemented in the tropics to curb deforestation. Most recently, reliance on strict command and control approaches has shifted to include decentralized governance of conservation areas, through land titling campaigns or devolution of management authority, and the use of direct economic incentives, through payments for ecosystem services programs. There is often spatial and temporal overlap in these conservation approaches, making it difficult to tease out the impact of a particular policy on land use transitions. In this research, we create a unique parcel-level dataset that tracks forest-cover change across four time periods between 1990 and 2013 in and around the Cuyabeño Faunal Reserve in the northern Ecuadorian Amazon. Over these four time periods, campesino cooperatives and indigenous communities living within the park were granted land title and about 20% of parcels were enrolled in the country's national payments for ecosystem services program. We use a combination of impact evaluation methods – including matching and difference in difference – to measure the effect of land titling and economic incentives on deforestation and reforestation within the park. For land titling, we examine whether titles per se changed forest cover and explore whether length of residency on the parcel interacts with the effect of land titles. For economic incentives, we test whether there is any additional benefit to receiving this payment on forest conservation versus titled parcels that do not receive the payment. The results of this analysis provide critical information on whether or not these alternative governance approaches have enhanced forest protection.

This presentation contributes directly to the conference theme "Land governance" by exploring how alternative governance approaches, including public protected areas, private property rights, and payments for ecosystem services, impact forest management. It presents a novel dataset of spatial and temporal variation in conservation policies and land use change and uses state-of-the-art program evaluation approaches to tease out the impact of these policies. The presentation focuses on a critical area for tropical conservation and an area that has seen rapid changes in land cover over the past few decades.

0843	Extreme climate stress on human-environment systems in the Mongolian Plateau drylands	Troy Sternberg	UK

Climate hazards disrupt human well-being and environmental systems across the Mongolian Plateau of northern China and southern Mongolia. The region encompasses much of the Gobi Desert and is vulnerable to one of the most challenging sets of natural hazards. Primary among them are those driven by climate: scarce and unpredictable precipitation, extreme cold weather, drought, dust and storms. Trans-border climate and hazard dynamics reflect the key roles society and governance play in both definition and impact of disasters. Several inter-related factors reflect hazard complexity in the region - whilst climate stress is a physical phenomena events have severe implications for societies. Research explores the interaction of the environment, livelihoods and policy across Mongolian Plateau drylands and how concepts of agro-pastoralism, ecological resettlement, desertification and economic development frame hazard engagement. In the shared landscape exposure, resilience and response differ in the two nations yet future climate vulnerability and adaptation depends on preparation, mitigation and policy in Mongolia and China.

0846	Promoting Baltimore's sustainability through stewardship governance networks: from inventory to collaborative management	Michele Romolini	USA

Sustainability policies are being formulated and implemented in cities throughout the globe. These policies often require organizations from the public, private, and non-profit sectors to collaborate and coordinate through networks. Indeed, the flexibility of a network approach may allow for greater adaptability in governance systems, allowing them to support and promote sustainability and resilience. However, these governance networks are still poorly understood, especially at larger scales and in relation to the geographic space in which they operate. A heightened understanding of governance network structures, functions, locations, and outcomes could contribute to the likelihood of their success. This research project examined the environmental stewardship governance network in the city of Baltimore, MD, USA through the Baltimore Stewardship Mapping & Assessment Project (Stew-MAP). The intent of Baltimore Stew-MAP was to first, characterize the overall composition and structure of the network of organizations that work on environmental stewardship in the city. This was accomplished through an inventory of organizations and a combination of descriptive statistics, social network and spatial analyses. Next, researchers sought to better understand how the data and findings could be most effectively used by the network participants to achieve their sustainability goals. A series of focus groups was conducted to elicit feedback that could prompt additional analyses and drive future research questions. In this paper, we describe the project, our initial findings, and the implications for urban governance research and practice.

0847	The wind, the peat, and the capital flow: land sharing and land sparing in Terras do Miño Biosphere Reserve	Liviu Mantescu	Germany

Serra do Xistral in Spanish Galicia bares the oldest active peat in Europe. Under the never-ending Atlantic winds, animal and vegetal remains have been conserved in the shallow cold waters of these moorlands for more than 10.000 years. This specific climate and geomorphology contributed to the formation of peculiar forms of land use amongst the villages from the area. Crop-rotation, free-grazing herding and low-density forests intermingle in a multifunctional agro-sylvo-pastoral system managed as a common property regime by the local villages.

In 2001, Serra do Xistral became part of the Natura 2000 Network within the category *Site of Community Importance* (SCI). The next year, due to its unique biodiversity and the peculiar mixture of human economic activities with the local biotops over centuries, or what in the UNESCO terminology is called 'cultural landscapes', Xistral became the core of the newly established *Terras do Miño Biosphere Reserve*.

Concomitant with the implementation of EU directives in Serra do Xistral and to its designation as the core of the biosphere reserve, three multinational companies for wind energy installed wind-power generators on the highs of Xistral. About 1000 windmills were installed in the 23000 ha of the active peat reserve, regrouped in several dozens of windmill parks from 2001 until 2008. Each windmill is planted in deep holes full of concrete. The interconnection of the power-generators through asphalted roads and ditches for electric cables drains the superficial flow of water and as a result the oldest active peat reserve in Europe is drying-up.

The ongoing ecological degradation in Xistral is coupled with increasing socio-economic conflicts at the local level. The local agricultural activities are seen as economically unprofitable and the traditional land use has no institutional support from the part of the local authorities. In turn, wind energy is considered a strategic development project by the local and national governments.

The story of Xistral is a case when both land sharing and land sparing coexist in the same space, but the two concepts are discriminatorily implemented. Following more than nine months of ethnographic fieldwork in Xistal, the paper will detail how it is possible that heavy ecological degradation take place under the world's top-most nature conservation regimes.

The paper will contribute to the conference theme by addressing the conceptual dualism *land sharing vs.*

	land sparing through a critical case study from which valuable theoretical insights can be further developed.	

0848	Ecosystems and human well-being in the French Alps: a holistic view to adapting lanscape systems to global change	Sandra Luque, Clement Parmentier, Vincent Thierion, Thomas Cordonnier	France

The concept of ecosystem services (ES) provides a powerful way of examining the interaction between ecosystems and human well-being. Despite improved understanding of the potential of landscapes and their land use systems to provide human well-being and socio-economic benefits, further conceptual and empirical work is needed to translate the concepts into operational frameworks for integrating ES into management and decision-making. The basic Ecosystem Service/Natural Capital frameworks (TEEB, 2011) link the ecological system (biophysical structure and function) to the social system (benefits and values) and help exploring the multidimensional role that the geographical location can have in operationalising the concepts. The geographical location not only matters regarding the (quantitative) biophysical characteristics underpinning the ecosystem functions, but also provides the venue to identify the (qualitative) stakeholders' values, and in this way determines the operational potential of the concept of ES.

We focus on an integrated approach that provides a holistic view to adapting landscape systems to global change. At the same time, we tried to move forwards on scenario development that has direct application to improve forest management, conservation and adaptation measures. We used *Dinamica*, a spatially explicit simulation model of landscape dynamics that presents multi-scale vicinity-based transitional functions to develop plausible scenarios of future land-cover change trajectories that are relevant to both global change science and the decision-making process. We based the analysis on changes from 1950's to the present in a complex mountain landscape mosaic. Hence, we worked through a spatially explicit simulation model that is responsive to policy intervention scenarios based not only on biophysical changes but also on scenarios developed within a participatory process with stakeholders in the French Alps region. We present a series of recommendation on how to further develop scenario assessments within a generic methodological framework that encompasses stakeholder's views and perceptions into decision planning.

0849	International aid as response and driver of land use/cover change	Marco Millones, Stuart Hamilton, Mark Buntaine	USA

International aid (IA) is a key policy tool for addressing the effects of land use/cover change (LUCC) in developing countries, where conflicting goals of sustainability and economic growth are often common and exacerbated. On one hand, IA is used to create conservation areas, promote environmental management, and establish payments for ecosystem services schemes. On the other hand, IA also funds large investments in sectors that directly and indirectly affect LUCC like transportation, energy, production infrastructure, health and education.

IA is distinct from domestic policy in various ways: donors can be countries, multilaterals, banks, or non-profit organizations, whose goals do not necessarily align with domestic policy, and are often accountable to governance structures other than national governments. In addition, the funds from aid programs often outlast governmental terms, and can be implemented through various channels (e.g., within public investment systems, through local non-profits, contractors, or directly by donors). Finally, IA interventions can work in synergy with or in opposition to those of other actors (private, government or other IA projects) and thus often result in unexpected outcomes that differ from the stated intervention goals.

In summary, IA can be understood a multi-scalar tool for environmental governance and at the same time, a type of 'tele-connection' (like trade, migration or foreign direct investment flows). It links global private and public funds, technology, information and views of the world (through 'experts', 'education') to concrete local realities and has impact on land use practices and land cover patterns, especially in poor countries with weak governments. Despite these unique features, IA has rarely been singled out as distinct driver by the LUCC research community.

Our research proposes to begin to fill this gap by presenting early results from three case studies that explore the links between IA and LUCC: (a) impact of internationally funded shrimp farming on mangrove deforestation in Ecuador; (b) land property rights and forest management interventions under the USAID-PSUR program in southern Ecuador; and (c) (mis)matching geographies of aid and LUCC in Malawi. All three cases analyze IA geocoded project activity data at a subnational level (aiddata.org) together with multi-temporal LUCC maps and a suite of contextual information to establish quantifiable relationships that give light to the direct and indirect effects on LUCC and clarify the conditions under which stated goals of interventions are met or not in these concrete places.

| 0850 | Conservation-induced resettlement as a driver of land use change in India: an object-oriented image analysis | Rutherford Platt, Monica Ogra | USA |

Located in the foothills of the Indian Himalaya, Rajaji National Park was established largely to protect and enhance the habitat of the Asian elephant and tiger. Subsequently, many Gujjar communities have been moved from inside the park to nearby forested areas. Field surveys have shown that wildlife in the park, including elephants, have expanded their range and that vegetation fodder has increased post-resettlement (Joshi and Singh 2009). In this study we evaluated the "shifting of pressure" on forest and grassland resources from inside to outside the park. We acquired high resolution multispectral imagery from GeoEye from 2002 (pre-resettlement) and 2011 (8 years post- resettlement). We then identified areas of stability and change using an object-oriented image analysis (OBIA). In an OBIA study, imagery is first segmented into homogeneous objects (polygons) and then classified based on spectral response but also geometry and contextual factors such as the relationship with neighboring objects, sub-objects, or super-objects. Many studies have found that OBIA yields higher classification accuracy than pixel-based methods for land cover classification and change detection. Using OBIA, we quantified the fine-scale changes in forest canopy (historically dominated by sub-tropical moist deciduous trees such as Shorea robusta), clearing for agriculture and infrastructure, and increased erosion surrounding the tributaries (*raos*) of the Ganges River. In the formerly-inhabited areas within the park, we detected an increase in the amount of grassland in and adjacent to the *raos* and a small increase in tree biomass. In the newly settled area of Gaindikhata we detected extensive clearing of eucalyptus plantations and an expansion of grazing. In terms of areal coverage of the change, the loss of forest and degradation of grassland outside of the park dwarfed the regeneration within the park. However, the ecological 'gain' to the park may be greater than the 'loss' to the area of re-settlement, which was already degraded and dominated by plantation forest. Field verification in January 2013 suggests that the classifications are highly accurate. The object-oriented change detection strategy that we developed successfully identified changes in land cover, many quite subtle, and can be applied to other locations.

| 0851 | Ecology's terra incognita: global geographical and taxonomic biases of studies of land use effects on biodiversity | Edwin Pynegar, Katharina Gerstner, Laura Kehoe, Tobias Kuemmerle | UK |

Land-use and land-cover change is one of the leading causes of global biodiversity loss. With both expansion and intensification likely to increase greatly over the coming decades due to rising global demand for food, fiber and bioenergy, knowledge of the biodiversity impacts of these changes is of

urgent importance. We hypothesized that current knowledge of these effects is highly geographically and taxonomically biased. We thus aimed to determine which areas of the world, taxa, and land-use changes need to be studied further in order to provide a more comprehensive understanding of the likely impacts on biodiversity of future land-use and land-use intensity change.

We based our study on over 1500 papers taken from 34 meta-analyses examining impacts of land-use change on biodiversity. We categorized these papers into 17 classes of land-use change and determined locations of each study and taxa studied in each paper. We examined the relationships between the locations of studies and biodiversity hotspots, maps of species and endemism richness, and various measures of land use intensity. We also produced correlations of type of land-use change with taxon, as well as conducting spatial analysis and producing cartograms of the data.

We found large parts of the world to be very poorly studied, particularly in areas where land use pressure is high and that are rich in biodiversity such as large areas of Asia and Africa. We also found that mammals, birds and arthropods were much more thoroughly studied than other taxa such as reptiles, amphibians and fungi. Our work provides guidance as to the geographical and taxonomic direction of future land-use change and biodiversity studies, which is important for more comprehensive analysis of alternative strategies to balance resource use and conservation goals such as land sparing vs. land sharing. Previous studies have been highly geographically and taxonomically restricted in that they have drawn sweeping conclusions based upon few, possibly unrepresentative, datasets. Further analysis of the dilemma should be based on more taxa and more types of land-use change, and our work shows where this data exists and also where it remains lacking.

0852	A bio-economic model of the impacts of global climate change on rainforest communities, based on a time series and spatial panel data	James Kahn, Carlos Freitas, Larry Hurd, ALexandre RIvas, Miguel Petrere	USA

This paper develops a bio-economic model, statistically implementable to understand the effect of global climate change and to guide policy decisions related to sustainable development of remote areas of the Amazon rainforest. Our research area is the municipio (county) of Barcelos, with 122,000 km2, only 30,000 inhabitants and 99 percent of the forest in a highly intact state. The people in these rainforest communities have not shared in the economic miracle of Brazil, and have limited income potential. Extractive products, sport fishing and ecotourism seem to be the best options for sustainable development, but there is little knowledge upon which to base the socio-economic or environmental impact of policy decisions. The model we propose contains four linked behavioral models and two exogenous drivers. The behavioral models include a model of community well-being, a model that allocates the time of community members across different activities, a predator prey model of important fish species, where predation is a function of the allocation of time, and an ecosystem model that is determined by land use choices and extraction levels. The two exogenous drivers and global climate change, which is having profound effects on the system, and a policy model. The model consists of four interacting components. These consist of an external shock module, which inputs shocks such as climate change into the bioeconomic model. The model (choice modeling) of community well-being relates rainforest community well-being to environmental, social and economic variables. The time allocation model (household production function) relates the measure of welfare derived in the choice-modeling approach to choice of time allocations (made by households), environmental variables, land use decisions and economic variables such as the price of non-timber forest products. This model will predict how time allocations change as a result of changes in abundance of fish from climate change or from other factors. The time allocations will have an effect on land-use and the harvest of fish and non-timber products. The impact of these changes will be modeled in the final component, the ecosystem model which will show the impact on broader environmental variables, such as biodiversity and forest

biomass. The paper will set-up the model, explain modeling and variable choices, and statistical issues. Most importantly, it shows how a panel of time series and cross sectional models is necessary to observe the variation necessary to implement the models. In the final section of the paper, we illustrate how shocks from exacerbated ENSO cycles can be evaluated, as well as policies to mitigate these impacts and policies to promote sustainable development in general.

0854	Deforestation/forest degradation hot-spots analysis in Mexico using time-series MODIS Vegetation Continuous Fields (VCF) data	Yan Gao, Jean-François Mas, Jaime Paneque-Gálvez, Margaret Skutsch, Jose Antonio Navarrete-Pacheco, Adrian Ghilardi, Gabriela Cuevas, Beth Bee	Mexico

This presentation analyzes deforestation/forest degradation hotspots in Mexico using MODIS Vegetation Continuous Fields (VCF) data, which contains four science data sets (sds). The first sds is percent tree cover (PTC) which gives an estimate of the percentage of crown cover (0 – 100) in each pixel; the remaining sds can be used to assess the reliability of the PTC values. The VCF data were produced with a regression tree algorithm based on16-day surface reflectance composite including MODIS bands 1-7 and the brightness temperature band, with training data from high spatial resolution satellite images. For this study, VCF data from 2000 to 2010, as presented in seventy-seven tiles, were downloaded; for each year, seven tiles of images were mosaic-ed to cover the entire Mexican territory. We first obtained 401 deforestation patches, above 500ha, from the two national land cover maps (2003 and 2007) produced by visual interpretation of Landsat images at the scale of 1:250,000. We then compared this with VCF data to obtain the annual trend of forest cover change from 2000 to 2010 at those deforestation patches. Trends in PTC show that forest cover has been decreasing during the study period, although there are evident fluctuations in most of the areas analyzed. We then reclassified the time series VCF data into dense forest (PTC > 60), medium density forest (30<PTC<60), and low density forest (10<PTC <30), and non-forest (PTC < 10). By comparing the time-series forest density maps, we obtained obtain the hotspots of forest degradation (change from dense to medium forest, and from medium to low density forest) and deforestation (change from dense, medium, sparse forest to non-forest). This study showed that MODIS VCF data can be used to evaluate deforestation and forest degradation in Mexico from 2000 to 2010. This presentation will contribute to the conference theme: Rethinking land change transitions since it focuses on the analysis of deforestation hotspots with remote sensing data.

0856	Assessing regional greenhouse gas fluxes across a complex mosaic of land surface types	Walter Oechel	USA

Estimating greenhouse gas emissions across complex regions of varying topography, vegetation land use and/or land management is challenging. However, accurate assessment of the impacts of climate, vegetation, land use, and land management on greenhouse gas fluxes and feedbacks is critical to understanding biosphere-atmosphere interactions and the impact of land use/land management decisions on climate and climate change.

Current empirical studies often lack the spatial measurement density and resolution to calculate, with confidence, the regional GHG fluxes under conditions of interest or to test the accuracy of current land surface models that frequently have resolutions of 0.25 to 1.0° of latitude. The current mismatch of scale between empirical studies and land surface models makes reliable estimation of the impact and validation of differing land use and management practices on GHG fluxes and carbon sequestration

challenging.

Here we present an approach using nested measurement systems including chamber, tower, aircraft flux measurements with remote sensing and modeling with the goal of more accurately predicting and assessing the impact of land use and management on GHG fluxes and carbon sequestration. We also propose a system of validation the total GHG impact and carbon sequestration of management, including vegetation restoration and re-vegetation.

0857	Spatiotemporal patterns of urban development from cropland and its impacts on potential agricultural productivity in China	Hongyan Cai, Xiaohuan Yang	China

Rapid urbanization and population growth in China have raised great concerns on food security caused by the occupation of limit cultivated land. In this present study, we used remotely sensed data and a light-temperature factorial model to quantify the impact urban land development on food production in China over the last two decades, taking potential agricultural productivity as an indicator. Our results showed that the area of urban use transformed from cultivated land have significantly increased over the last two decades. During 1990 to 2000, about 1.5 Mha cultivated land was developed to urban use, whereas nearly twice conversion (about 2.68 Mha) was investigated from 2000 to 2010. The conversion spatially concentrated in the East China, with its centroid southeastward moving 167 km during the past two decades. Urban land transformation in China has reduced the amount of light-temperature potential agricultural productivity (LTPAP) by 24.33 Tg from 1990 to 2000 and 47.11 Tg from 2000 to 2010. At provincial scales, the largest reduction percentage of LTPAP concentrated in the central and southeast provinces and municipalities, such as Shanghai, Tianjin, Jiangsu and Beijing, where hold highest construction land use efficiency and yet scarcity of reserved cultivated land resources. This result indicated that for these development-optimized areas, supplement of cultivated land from other provinces may be a feasible way to help sustainable land use and support the balance system of cultivated land occupation and supplement in China.

The theme we selected is "*Impacts and responses: land systems changes to mitigate global environmental change impacts and adapt to increasing demands for food, fuel and ecosystem services*". The conflict between the land needs of rapid urbanization and limit cultivated land is an inevitable issue in developing countries. How to urbanize without hurting state food security is particularly important. This study quantitatively investigated spatiotemporal patterns of the transformation of urban use from cultivated land in China, and further revealed the impacts of urban development on the amount of cultivated land and agricultural productivity. We expect the result will provide useful information for the government in the aspect of land use policy.

0858	Is there a taco connection: disjointed geographies of livestock production, meat consumption and pastures in the Mexican Yucatan?	Birgit Schmook, Marco Millones, Laura Masur	Mexico

This study explores the multi-scalar 'tele-connections' and discontinuities between three processes occurring in Quintana Roo, Mexico over the last decade: the expansion of pasture lands, the growing importance of local smallholder cattle ranching, and the rise in red meat consumption in urban centers.

Livestock production and cattle ranching have long been identified as proximate causes for land use/land cover change in tropical and subtropical regions. The driver behind cattle ranching has been attributed to a growing meat demand from local and distant, often urban, markets, and to livelihood diversification strategies, land colonization and speculation, and the display of social status.

Forestry and agriculture have historically been predominant land uses in Quintana Roo. However over the last decade, despite environmental constraints like irregular rainfall, farmers have increasingly embraced cattle ranching as an economic alternative to traditional shifting cultivation systems. The

growing importance of livestock has been associated with the expansion of pasture lands in lieu of agricultural fields, secondary vegetation, and forests. Additionally, rising meat consumption in Quintana Roo over the past ten years has been attributed to the rapid growth of coastal tourist towns, to growing incomes and shifting consumer preferences.

Since the Mexican meat production system operates at various scales, locations and timelines, it is not clear whether and to which degree the increase in pasture lands and importance of cattle ranching, and the rise in meat consumption in coastal urban center in Quintana Roo are: 1) directly affected to each other within the state 2) largely independent, or 3) mediated by the multiple scales of the Mexican meat production system.

We use governmental statistics on the number of cattle and areas under pasture to document land use changes over the last decade. We employ monthly livestock and meat product flows from Quintana Roo to and from other locations in Mexico to determine: 1) the origin of the demand for livestock from pasture areas, 2) the origin and destination of packaged meat products from outside the state. We supplement our interpretations with interviews with smallholder cattle ranchers.

Results show that young cattle are increasingly produced in Quintana Roo and are shipped to northern Mexico and sometimes to the state of Yucatan, where they are fattened, slaughtered, packaged, and returned to supply the increasing urban (especially tourist) demand for meat. Despite an increase in cattle ranching over the last decade, the expansion of pasture lands appears to not be linked.

| 0859 | Spatial land-use optimisation for sustaining natural resources and ecosystem services in New Zealand | Alex Herzig, Anne-Gaelle Ausseil, John Dymond | New Zealand |

The provisioning of ecosystem services by New Zealand's landscapes depends on the combination of environment (i.e. location), land use, and associated management practices. However, in New Zealand, land management has traditionally focused more on on-site measures, such as planting trees on erosion-prone land, or changing farm management practices on land prone to nutrient leaching. The question arises, whether those measures are sufficient to sustain natural resources and ecosystem services in the light of agricultural intensification and climate change. To maximise ecosystem services and land-use performance, spatial optimisation tools have been successfully used to optimise the spatial land-use configuration. In this paper, we present the results of an explorative case study we conducted together with Hawke's Bay Regional Council in New Zealand, looking at the application of spatial land-use optimisation tools to support regional spatial planning and policy development. Specifically, we used the Land Use Management Support System (LUMASS) (Herzig et al., in press) to investigate environmental and economic limits of the landscape, identify trade-offs between environmental and economic objectives, and explore landscape development potentials.

Furthermore, we investigated the sensitivity of optimal land-use pattern to uncertainties associated with optimisation constraints and performance scores. This is of particular relevance for spatial planners to assess the robustness of the generated optimal land-use pattern and to gauge the available flexibility in implementing spatial plans.

| 0861 | Land management and cover in urban residential parcels and neighborhoods: a multi-city comparison from the USA | Rinku Roy Chowdhury, Morgan Grove, Colin Polsky, Laura Ogden, Kristen Nelson, Kelli Larson, Peter Groffman, Jarlath O'Neill Dunne, Jim | USA |

| | | Heffernan, Sarah Hobbie, Jeanine Cavender-Bares, Sharon Hall, Chris Neill, Dianne Pataki, Meredith Steele | |

Urban residential expansion is an important component of global changes in land use and vegetative cover. At regional and local scales, residential land use and management are driven by diverse socio-ecological factors, yet may result in similar outcomes in otherwise distinct eco-climatic regions. We present initial results of collaborative research across six US cities (Miami, Baltimore, Boston, Minneapolis, Phoenix, Los Angeles), examining whether urban land use change leads to homogenization of land/forest cover. Residential land cover is quantified with high-resolution remotely sensed data and spatial analyses, and linked to social characteristics at neighborhood and broader geographic scales. Understanding the nature and extent of urban homogenization of vegetative/forest and other ecological structure is critical to developing a conceptual basis and database for estimating the impacts of these processes at the local-scale to regional scales, and for developing strategies to improve the sustainability of this increasingly common land use/land cover type.

| 0864 | Power and politics in global carbon forests: conflicts and governance implications of carbon-and-conservation agreements | Conny Davidsen | Canada |

The global scramble for effective strategies against climate change, forest degradation and biodiversity loss has led to carbon-and-conservation agreements which mark a structural change far beyond the economic realms of carbon trade and affect the overall fabric of global environmental governance. The presentation focuses on Ecuador's carbon-and-conservation policies to illustrate interfaces of conflict between oil exploitation, forest land cover, global carbon markets and multinational conservation politics in Latin America. It examines possible global implications of recent carbon-and-conservation proposals with a focus on the example of the Yasuní-ITT initiative in the Ecuadorian Amazon, which proposes to leave vast oil reserves under the rainforest underground for an international compensation worth half the unexploited revenue. This model suggests far-reaching consequences as it introduces new global scales for the sharing and management of environmental costs within a framework of neoliberal cost internalization. Based on the concept of the "ecological state" (Duit 2008) as a theoretical point of departure, the model suggests trans-scalar implications on global governance structures, which can be examined as a development toward a "global eco-state" (Davidsen & Kiff 2013). Based on this framework, the research discusses the changing relationships of power and politics between the global and multinational linkages, the state, and local realities through such carbon- and market-based initiatives. With the focus of the conference and this particular session in mind, the paper presents case-based as well as conceptual aspects to a discussion and critique of global carbon-oriented approaches to conservation, and emerging notions of global carbon forests.

| 0865 | Predicting geographic distribution and habitat suitability due to climate change of selected threatened forest tree species in the Philippines | Kristine Garcia, Rodel Lasco, Amor Ines, Bradfield Lyon, Florencia Pulhin | The Philippines |

Climate change is projected to alter the geographic distribution of forest ecosystems. This study aimed to evaluate the consequences of climate change on geographical distributions and habitat suitability of 14 threatened forest tree species in the Philippines. Based on the principle of maximum entropy, it

utilized a machine algorithm called Maxent to estimate a target probability distribution and habitat suitability of the selected species. Threatened forest tree species occurrence records and sets of biophysical and bioclimatic variables were inputted to Maxent program to predict current and future distribution of the species. The Maxent models of the threatened species were evaluated using Receiver Operating Characteristics Area Under Curve (ROC AUC) and True Skill Statistics (TSS) tests which revealed that the models generated were better than random. The Maxent models ROC AUC values of the 14 species range from 0.70 to 0.972 which is higher than 0.5 of a null model. Based on TSS criteria, Maxent models performed good in two species, very good in ten species, and excellent in two species. Seven species (*Afzelia rhomboidea*; *Koordersiodendron pinnatum*; *Mangifera altissima*; *Shorea contorta*; *Shorea palosapis*; *Shorea polysperma*; *Vitex parviflora*) were found to likely benefit from future climate due to the potential increase in their suitable habitat while the other seven species (*Agathis philippinensis*; *Celtis luzonica*; *Dipterocarpus grandiflorus*; *Shorea guiso*; *Shorea negrosensis*; *Toona calantas*; *Vatica mangachapoi*) will likely experience decline in their suitable habitat. This study provided an initial understanding on how the distribution of threatened forest trees will be affected by climate change in the Philippines. The generated species distribution models and habitat suitability maps could be used as basis in formulating appropriate science-based adaptation policies, strategies and measures that could enhance the resilience of those threatened forest tree species and their natural ecosystems to current and future climate.

| 0866 | Land use change implications from substituting imported protein feed with locally produced alternatives in European livestock production | Yaw Sasu-Boakye, Hugo Valin, Petr Havlik, Fredrik Hedenus, Stefan Wirsenius | Sweden |

International trade and consumption are important drivers of deforestation and the greenhouse gas emissions associated with deforestation. In the tropical regions of South America, soybean and beef production expand into previously forested areas to meet increasing global demands. Europe accounts for about 40% of global soybean imports, 80% of which ends up as livestock feed. Several studies have assessed the possibility of reducing Europe's soybean imports through increased utilization of alternative European-grown feedstuff, such as rapeseed and peas, in livestock feed. The motivation for such studies include to reduce greenhouse gas emissions from deforestation attributed to Europe's livestock production, and to decrease vulnerability of the livestock production to disturbances on the soybean market. However, external effects of such local actions on global trade patterns, land use transformations and global environmental change have not been considered in previous studies.

The objective of our study is to assess how local changes in European livestock diets can reduce their environmental burden, and if so assess the global impacts of such local actions. We use a comprehensive dynamic economic model, GLOBIOM, to analyze the land use changes and agricultural dimensions of international trade when livestock feeding systems in Europe shift from being soybean-reliant to systems that depend mainly on a mix of locally grown feedstuff. GLOBIOM is an economic partial equilibrium model, which integrates the agricultural, bioenergy and forestry sectors of the world economy with a bottom-up detailed representation of agricultural, and forestry management practices (Havlík et al., 2013). We develop a set of scenarios that depict future pathways of livestock diet changes in Europe and analyze local and global impacts, using GLOBIOM to optimize land use, and associated commodity prices subject to resource, technological and policy constraints.

Our study shows the greenhouse gas emissions from global land use changes when European livestock diets use more locally grown feedstuff. The study also highlights the implications of such a change on agricultural trade as well as the differences in local and global commodity price responses. The outcome of the study provides additional insight on tradeoffs between local shifts in livestock feed systems and

the resulting global challenges from land use transformation.

0868	Climate hazards and adaptive land and water management in rapid socio-economic developmental areas of China	He Qing Huang, Dan Yan, Lihu Pan, Zhijia Liu	China

Floods are one of common and widespread climate hazards and often bring about disastrous effects to societies where they are not properly managed. Land use change has been happening very fast in China over the last several decades and a lot of wetland have been converted into urban areas or cultivated land, leaving less and less space for floods. Floods provide also very useful water resources for both human being and ecosystem conservation. To mitigate the damage of floods and use the resources effectively, an adaptive approach for land and water management is more appropriate than an engineering-based approach.

An adaptive approach for land and water management needs to take into account driving mechanisms underlying land use change, ecological and environmental consequences (sensitivity, vulnerability) of land use change, uncertainties inherent in climate change and societal or human acceptance and capabilities for adaptation to changes in both human demands and climate. Because of the complexity of this approach, agent-based modeling with a generative bottom-up methodology has gained wide applications in recent years. Taking the largest fresh-water lake of China, Poyang Lake, as a typical case, this study examines factors influencing land use change in the region and identifies the behaviors of farmers on land use and land abandonment. An agent-based model is consequently developed to simulate and understand the dynamics of land use change. Finally, an in-depth analysis of the potential effects of land use change and climate variation on floods is presented and strategies for adaptively using the regional land and water resources so as to effectively mitigate the damage of floods are consequently proposed.

0870	Ecosystem service tradeoffs associated with land sparing versus sharing	Navin Ramankutty	Canada

Feeding the world while minimizing the environmental footprint of agriculture is a major challenge for the 21st century. There is now an intense debate regarding the best way to manage agricultural lands, with some scholars arguing that we should focus intensive production on the best agriculture lands, take agriculture away from the margins, and thereby "spare land" for nature. Others argue for "land sharing" with low intensity production co-existing with nature but using a larger area of land. However, this land sparing versus sharing debate has focussed solely on biodiversity, forgetting that it is only one of several major global environmental concerns. In this talk, I will review the literature to evaluate the sparing/sharing model for other major environmental concerns. My review finds that sparing or sharing is favored by different environmental problems, which are of significance in different regions of the world. Moreover, the food security challenge is also different in different regions of the world. In conclusion, I argue that that there is no global solution – land sparing or sharing or some combination of both is highly context dependent, and should consider a suite of ecological, economic, socio-cultural, and historical conditions.

0872	Targets for sustainable land use: building the bridge between planetary boundaries and national consumption levels for forestry	Meghan O'Brien	Germany

Increasing global demand for timber, a growing gap between timber consumption and timber production, and growing competition for land (for food, fuel, and fiber) are making it increasingly difficult to find a balance between an intact forest resource, a sustainable level of forest use, and a sustainable level of timber consumption. Current market and regulatory instruments focus overwhelmingly on improving production practices, but cannot prevent overexploitation of the forest resource or halt land use changes induced by rising demand. While individual countries may practice

sustainable management of their domestic forests, import of timber products may cause that country to use more of the forest resource than domestically available, or globally fair. A bridge between global sustainable supply capacities and national consumption levels is missing. This presentation will describe an approach for building this bridge. It will argue that reference values for sustainable supply are needed to prevent problem shifting—for example policies that unintentionally lead to perverse incentives to overuse land abroad—and that targets for global land use should be based on the concept of a safe operating space. Targets are needed to provide an overarching framework for the market, to improve integration across existing and new institutions, and to provide a common cause for all actors to work towards. This presentation will be broken down into three parts. First, it will describe why land use targets are needed for forestry, arguing that the interaction of three trends—the shift to a green economy, globalization and global deforestation—call for new approaches to governance. Second, an example of how land use targets for cropland have been derived, based on the work of the International Resource Panel (Bringezu et al. forthcoming), will be presented. Finally, the focus will be on how targets for timber consumption, related to forest area, can be derived. Targets will be shown in comparison to timber consumption levels of the EU-27, derived with the Global Land Use Accounting approach. This presentation fits into the session on "Globalization of land use" as it presents an approach to better control the distant drivers of land use change, namely those related to the level of consumption. There are also a number of synergies with theme 4 (Land governance) as it presents an approach to move beyond policies addressing the direct drivers of land use change and towards governance that aims to create the framework for a sustainable system.

0873	Detection of plant species distribution in the Yellow River Delta	Gaohuan Liu, Yuan Liu	China

The natural plant species distribution in east cost of China, especially in the Yellow River Delta is influenced by local environmental factors such as elevation, soil salinity, ground water table, and etc. This article describes a multidisciplinary approach to assessing the distribution of vegetation types. The relation between vegetation distribution as derived from field survey and habitat characteristics in the Yellow River Delta (YRD) was analyzed using detrended canonical correspondence analysis (DCCA). The three-dimensional groundwater numerical simulation model MODFLOW yielded an accurate distribution of the shallow groundwater table within the study area. The result shows the most significant factors influencing the plant development are soil salinity, ground water table and elevation. The groundwater table and soil salinity appeared to have the largest influence on the distribution patterns of specific indicator species. The quantitative relationships between species presence and environmental factors were further explored using logistic regression, allowing for the prediction of potential species distribution in relation to fluctuations in groundwater depth and soil salinity. Based on this mathodology, potential distribution maps for specific plant species and their communities were generated. The potential vegetation map was compared to the actual vegetation map (interpreted from remote sensing imagery), which leads to a discussion of the main factors responsible for fragmentation and degradation of the local vegetation system.

0874	Post-civil war assessment of the ecosystem services crop and tree growth with remote sensing data in southern Angola	Anne Schneibel, Marion Stellmes, Achim Röder, Manfred Finckh, Rasmus Revermann, Joachim Hill	Germany

After the termination of the civil war in 2001, Angola was subject to large socio-economic changes. In the southern part of the country an increase in population (e.g. by repopulation of abandoned areas) was

observed during the last decade, which has major impact on ecosystems and their goods and services. Our study area is situated in the upper Okavango catchment, where open to dense Brachystegia forests (so called "Miombo") naturally occur, combined with floodplain valleys, woodlands and grassland.

Traditionally, forests are used to collect wood for timber and firewood but are also cleared for agricultural production (slash & burn). This results nowadays in increased deforestation, bush clearing activities and the activation of pre-war agricultural areas. The rise in crop production is done at the expense of natural resources, which in turn will also be increasingly demanded for timber and wood extraction.

To evaluate this process, we assessed the trade-off between the ecosystem services food and wood/timber. It is hence important to obtain reliable information on population development, agricultural production and wood use in the headwaters of the Okavango River. Remote sensing data offers the possibility to capture actual land cover and transformations during the last decades.

Based on remotely sensed imagery we derived three information layers, which can be employed as spatially explicit proxies to evaluate the trade-off between timber and crop production during the last years. These include the mapping of the actual state of the land use systems, the overall change within the last decade and the temporal dynamics of land use, especially the agricultural system. In a first step, a recent land cover map was produced, which presents the spatial distribution of main land use classes, including fallows, active fields and different forest types. Secondly, land use changes since 2001 were analysed. For both purposes, we combined medium resolution, multi-seasonal Landsat data with higher spatial resolution Rapideye imagery to derive object-based information. Both products provide proxies that can be linked to local field surveys which include information on the expansion of infrastructure, biomass per forest type and crop type/yield. Thirdly, based on a Landsat time-series and the field data, the establishment of cultivation, its period and the eventual abandonment of fields were identified. These metrics enable the valuation of the studied ecosystem services, their trade-offs and provide a base for future scenarios, which are critical, since decisions in the headwaters will have impacts on downstream management.

0875	An optimization model for land use arrangement in a community-based on human comfort perspective	Pei-Yuan Chen, Ching-Pin Tung	Taiwan

The arrangement of different land use type can affect human comfort outdoor to a great extent, especially under the impact of global warming. This issue gets more and more attention in many rural or urban communities with growing population. The purpose of this study is to build up an optimization model combining a heuristic algorithm (Simulated Annealing Algorithm) with a microclimate model (ENVI-met). The model is expected to be an assessment tool for appropriate design of our living place in community scale. In this study, the physiological equivalent temperature (PET) is chosen as the index of human comfort, and the objective of the optimization is to adjust PET to 23℃(an ideal state) and to minimize the difference of PET within the study area. The method is applied to a case study in a rural community in north Taiwan. Three types of land use are considered, including the buildings, the paddy fields and the vegetation. Given the types of land use and their areas, the model is used to find the optimum configuration which provides the most comfortable environment. The result shows that the optimum design can decrease PET in summer effectively and improve the homogeneity of the spatial distribution of PET, compared to the current design. It indicates not only the relation between land use allocation and human comfort, but also the benefit of utilizing nature flow and shading. On the other hand, the model can present the influence of change in land use as well. Thus, it is recommended to take the result of the optimization model into consideration for future research of rural-community design.

0876	Predicting the response of Alpines under climate	Wei-Chih Lin, Yu-	Taiwan

| | change by downscaled climate data - taking Tsuga Chinensis as an example | Pin Lin, Yung-Chieh Wang, Cheng-Tao Lin, Chyi-Rong Chiou | |

Alpines are expected to shift their distribution upward in elevation in response to climate change. This study aims to confirm whether the distribution of Tsuga will significantly shift due to the temperature change in 15 different future scenarios from Intergovernmental Panel on Climate Change (IPCC). Based on the seasonal temperature, elevation range, and Tsuga occurrence data, shift in Tsuga's distribution can be predicted using the species distribution models (SDMs). However, the scale of seasonal temperature data from IPCC is too coarse to project Tsuga's distribution with finer resolution. Thus, before predicting the distribution, we have changed the scale (grain size) of the seasonal temperature data (from 25km×25km to 3km×3km grid cells) with area-to-point (ATP) cokriging approach based on the block temperature and elevation data. After the downscaling procedure, the habitat suitability over the study area can be calculated by maximum entropy method in different climatic scenarios. The plot of downscaled temperature data against the corresponding history temperature data resulted in a R^2 of 0.99 indicating a high accuracy of the downscaling procedure. In addition, the SDMs performed very well in predicting Tsuga's distribution. Specifically, the area under the ROC curve (AUC) is 0.91, validated by the history temperature, elevation range, and Tsuga occurrence data. According to the results of simulations in the 15 scenarios, we found that there are some significant differences in the suitable habitat site of Tsuga between those in 8 scenarios and in baseline. The results suggest that the mountainous ecosystems will experience a greater magnitude of climate change in certain scenarios.

| 0877 | Multiple outcomes of cultivation: a call for a multifunctional view of farmers' incentives when assessing land use changes in the Sahel | Laura Vang Rasmussen | Denmark |

A default assumption about Sub-Saharan Africa is that farmers consider food provision for the family as the primary reason for cultivation. The degree to which this 'cultivation for food' assumption has been embedded in the scientific literature on land use and land cover changes is signified by the fact that hardly any studies have questioned it. However, this presentation suggests that the notion of 'cultivation for food' tends to downplay a number of additional cultivation outcomes which must be considered when assessing land use and land cover changes in the Sahel.

By employing a conceptual framework that incorporates the concept of multifunctional agriculture (Wilson 2008), which was primarily developed for analysis of agricultural changes in the Global North, this presentation reports the results of a study that explored agricultural transitions in two villages in Burkina Faso. The analysis revealed that several household types exist, and one cannot assume that food provision is and always has been the main cultivation outcome. On the contrary, it was found that households have moved away from a sole focus on food production. Households have started to value additional cultivation outcomes like fodder production, preservation of farm identity, attachment to the village and prestige, with important differentiations between the identified household types. Hence, it is argued that researchers as well as policy-makers must face a reality of new agricultural transitional pathways in the Global South, and that the explicit attention to a multitude of cultivation outcomes is helpful in the understanding of changing cropland patterns.

| 0878 | Land use intensification produces uncertain livelihood outcomes at forest frontiers in the tropics | Ole Mertz, Nathalie van Vliet, Andreas Heinimann, Cristina Adams, Birgit Schmook, Torben Birch- | Denmark |

Thomsen, Kim Chi
Vu, James Lyimo

Livelihood outcomes of land use change in developing countries have been studied using cases from many countries and ecosystems, but there is little information available at sub-national, national and regional level. This is especially relevant in rapidly changing forest frontier areas in the tropics where shifting cultivation is or was a dominant farming system. In this paper we explore whether there is a significant difference between key livelihood indicators in areas that have different degrees of shifting cultivation. We use a landscape wide analysis employing national census data from Brazil, Mexico, Tanzania, Laos and Vietnam. Data are analysed down to district/municipal level and we correlate indicators of swidden (fallow area, specific crop area, actual area) with the main indicators of the Human Development Index (HDI). Preliminary results of our analysis suggest that the area of shifting cultivation compared to permanently cropped areas is significantly linked to HDI but the relationship follows a U-shaped curve: where the percentage of shifting cultivation land is low, HDI is high. However, in a few cases were shifting cultivation is still almost the only cultivation system observed, HDI can be as high as in areas were the demise of shifting cultivation has occurred, suggesting that areas undergoing the transition are those that are most affected in terms of their HDI. Because the transition towards permanent cropping systems implies high investment costs, the initial years' net returns of permanent cropping systems are generally lower, but the average return of these permanent cropping systems is higher in the longer-term. Permanent cultivation systems can pull people out of poverty, but technical and financial support is needed to support the transitional costs especially for the poorest communities. Our results moreover point to the need of including shifting cultivation systems more explicitly in national survey data for a better understanding on how agricultural transitions affect local development and livelihoods.

0879	Spatial assessment of biodiversity and climate mitigation related ecosystem services and land use change trajectories in Laos and Cambodia	Grace Wong, Andreas Heinimann, Cornelia Hett, Tracy Farrell	Switzerland

Laos and Cambodia are two of the smallest, but fastest growing economies in Southeast Asia and market liberalization policies have propelled both countries along parallel and frenetic development paths. Over the past decades, an influx of agriculture-based investments has transformed rural landscapes from complex mosaics of forests and mixed agriculture to large blocks of commercial mono-crop plantations. Swiddening is widely perceived as a backward land use practice that underutilizes the capacity of land and causes deforestation. Against this background, national strategies and market forces have promoted the transformation of smallholder swidden systems into settled farming systems leading to shortened fallow cycles, loss of large areas of regenerating fallow forests and increased degradation across landscapes. This has had severe consequences on the provision of ecosystem services and resilience of rural livelihood systems.

There are clear trade-offs of ecosystem services in these rapidly changing landscapes from primarily mixed smallholder and swidden systems, to those dominated by commercial mono-crop plantations. However, such information is rarely considered in land use decision-making due to the lack of accessible and comparable ecological and economic information.

This research is a spatial assessment of the ecological and socio-economic impacts in two landscapes in Laos and Cambodia. There have been recent advancements in the mapping of swidden systems using a landscape mosaic approach (Hett et al. 2012). This approach is an important contribution to putting swidden systems on the map, to inform the ongoing REDD+ debate concerning swidden systems and to understanding of the flows of ecosystem services from these systems.

With the research presented here we attempt to link selected social and economic aspects to the landscape mosaic approach to better inform decision-making. This involves: 1) Selection of a set of relevant indicators to capture socio-economic assets at both the local- (village) and landscape-levels based on the availability of spatial data; 2) economic valuation of selected ecosystem services through meta-analysis and assessment of incentives such as REDD+; and 3) assessing externalities caused by land use change and crop intensification in a spatially explicit way. Our goal is to contribute to the question of winners and losers who have a stake in and influence land use change in our case study areas and to assess which areas are most affected by the ecosystem service trade-offs within the broader landscape.

0880	Technical potentials of grain production through land expansion and yield increases in European Russia	Florian Schierhorn, Daniel Müller, Monireh Faramarzi, Friedrich Koch, Alexander V. Prishchepov, Alfons Balmann	Germany

Widespread abandoned agricultural land and high yield gaps coincide in Russia and suggest large potentials for increasing agricultural production. However, it remains elusive how much agricultural output Russia can produce because the rates and spatial patterns of agricultural abandonment as well as the size of crop yields gaps have not been systematically quantified to date. We assessed how much Russia can produce by recultivating formerly abandoned land and by increasing land productivity. We focused on European Russia exclusively, because the region produces the bulk of the Russian grain production. We developed a spatially explicit land allocation model to predict the location of abandoned agricultural land. The allocation model relies on a spatial econometric approach to estimate the suitability for agricultural production and provides yearly and wall-to-wall cropland maps and cropland abandonment maps at 1 km^2 spatial resolution. We further used the Soil and Water Assessment Tool (SWAT) to simulate grain yield potentials and yield gaps for both rainfed and irrigated agricultural systems in European Russia.

We identified large wheat yield gaps for European Russia (2.1 t/ha under rainfed conditions and 3.2 t/ha with irrigation). Under rainfed conditions, most of the provinces inside the black earth belt have relatively low grain yields because of higher input levels of nitrogen and phosphorus. Water-limited grain yield gaps were largest for the Northern provinces outside the black earth belt of European Russia. SWAT-simulation results demonstrate that irrigation would offset the strong yield declines during drought years and significantly raise average yield potentials, particularly in the Volga region where yield increases of up to 4.6 t/ha are technically possible.

Scenarios of recultivation and yield increases allowed quantifying grain production potentials. For example, the recultivation of the 8 Mha that were abandoned since 2001 and a 50% reduction of grain yield gaps under rainfed conditions, mainly by increasing N fertilizer application, would result in a 33% increase in grain production with moderate CO_2 emissions from converting successional vegetation. All scenario results show that Russia still exploits only a small fraction of its production potentials. Particularly the implementation of high-tech farming methods (such as efficient and sustainable fertilizer and water management) would be instrumental to elevate current production levels. To achieve significant increases in agricultural production, Russia needs to remove structural impediments for agricultural development such as difficult access to capital and markets, corruption, population decline in rural areas, as well as low investments in agricultural research and education.

0881	A meta-analysis of changes in European agricultural land systems	Jasper van Vliet, Henri de Groot,	The Netherlands

Piet Rietveld, Peter Verburg

About half of the territory of the European Union is covered by agricultural land, and this agricultural land has changed considerably over the last decades. However the trajectories of change vary greatly between geographical locations as well as between agricultural land systems. Moreover, the direction of change and the manifestation of these changes differ, as some locations are characterized by an increase in land use intensity, while other locations face an extensification of agricultural land use, sometimes to the point that all agricultural activities are abandoned. Drivers underlying agricultural land change have been reported in many case studies, originating from disciplines as diverse as (rural) sociology, economics, physical geography and human geography.

The aim of this study is to synthesize the main drivers underlying agricultural land changes from this wealth of case study evidence, and thus find typical trajectories of agricultural land change. To that effect we systematically searched and analyzed case studies that have been reported in peer-reviewed literature. Cases were coded for the direction of change (intensification / extensification), the manifestation of this change, drivers underlying these changes, and case study characteristics. Since many agricultural land changes are effectively the result of farmer's decision making, we explicitly coded for factors that influence this decision making, including social, cultural, and demographic factors.

Agricultural land changes manifest themselves in changes in acreage, but also increasingly more in changes in land management intensity. Changes in acreage are primarily reported for abandonment and relatively little for cultivation of new land. Changes in intensity are more evenly divided among increase and decrease, including for example on farm diversification, conversion to organic farming, and mechanization. Drivers are reported in all of the 'classical' underlying driver categories: economic, demographic, institutional, technological, and socio-cultural. However, the importance of the beliefs of farmers themselves, rather than socio-cultural developments in society, stood out as important as well, especially in cases were trajectories were report to deviate from what was expected given (economic) boundary conditions. Examples include the addition of landscape elements for environmental reasons, maintaining an intensive production system despite CAP subsidies for more extensive land management due to a productivist attitude, and even a continuation of farming activities to keep the family farm despite financial losses. These findings help explain observed trajectories in European agro-ecosystems, and facilitate scenario studies for future land use change and ex-ante assessment of land use policies.

0883	Comparing trends in supply and demand for ecosystem services for the Mediterranean region	Ilse Geijzendorffer, Simon Decock, Marianela Fader, Mattia Trabucchi, Alberte Bondeau, Wolfgang Cramer	France

Ecosystem services are determined by those goods and benefits the society demands, values and uses. This definition therefore distinguishes a demand for services by the human society at large, and a supply of services provided by a natural system. These two sides are in fact very interdependent and the feedbacks between the two sides are so complex that they cannot be considered separately, nor do services flow effortless from one side to the other. For instance, the supply of services is in most cases altered by human society through management and externalities. However this simplified image serves as a guiding principle for both researchers and policy makers.

A large research effort is allocated to determining the range of ecosystem services that are supplied by natural systems now and in the future (e.g. mapping studies, model scenarios, monitoring efforts). Additionally, efforts are made to determine which services are valued by the society (e.g. the Integrated

Valuation of Environmental Services and Tradeoff (INVEST), stakeholder consultations). But among all of these research efforts the trends in demands are rarely considered, despite clear evidence that society demands related to diets, recreation, housing, health and sustainable agriculture change over time. Aspects known to trigger changes in the demands for services by human actors at different scales include the impacts of climate change, urbanization, the economic crisis, the occurrence of risks or disasters (erosion, flooding, fire, etc.), governance programs and awareness raising schemes.

For future governance strategies and good practices management, both the changes in the potential of natural systems to offer services as well as the trends in the demands of services needs to be taken into account when we want to determine the pathways to sufficient and sustainable ecosystem service provision towards the future.

For the whole Mediterranean region, we have identified and where possible quantified expected trends in demands for ecosystem services from society to form demand scenario narratives. Next we compared the trends in demands with expected trends in potential supply of several selected services given identified scenarios for the region to determine which services are and will become most scarce. The analysis was used to identify possible trade-offs and compromises thus providing information on possible future focuses of governance and best ecosystem services management practices.

| 0884 | How much water and energy do we need for irrigation under climate change in the Mediterranean? | Marianela Fader, Alberte Bondeau, Wolfgang Cramer, Simon Decock, Ilse R. Geijzendorffer, Sinan Shi, Mattia Trabucchi | France |

Mediterranean agroecosystems provide a number of important services, including food production. Their agronomic and economic performance depends very much on water in form of rain or irrigation. However, the hydrological system of already water-limited agricultural landscapes around the Mediterranean is very likely to be under strong pressure in the near future through changes in consumer demands and diets, increasing urbanization, population growth, and new markets for agricultural exportation. On top of that, anthropogenic climate change will likely alter the need for, as well as the availability of irrigation water.

As a first step to assess the water demand of the agricultural sector, we use an ecohydrological model (the Lund-Potsdam-Jena managed land model, LPJmL) to estimate current and future irrigation water requirements of this region, considering various climate and socio-economic scenarios. LPJmL is a process-based, agricultural and water balance model, where plant growth is ecophysiologically coupled with hydrological variables. For these simulations, the model was adapted to the Mediterranean region in terms of agrosystems as well as crop parameters, and a sensitivity analysis for the irrigation system efficiency was performed.

Patterns of current irrigation water requirements differ strongly spatially within the Mediterranean region depending mainly on potential evapotranspiration, the combination of crops cultivated and the extension of irrigated areas. The simulations for the future indicate that the Mediterranean may need considerable additional amounts of irrigation water. However, the regional patterns differ strongly depending on changes in length of growing periods, changes in transpirational rate (temperature and precipitation change, CO_2-fertilization), and the consideration of potential improvements in irrigation system efficiency.

Bearing in mind that the water demand of other sectors is also likely to increase, the implementation of precision irrigation systems may be not only a useful option to save water but a necessary measure to compensate the increases in irrigation water requirements. However, these systems may also need more

energy. Therefore, a first estimation on the potentials of driving irrigation in the Mediterranean with solar energy was performed. The possibilities of using photovoltaics for driving irrigation pumps depend not only on the insolation rate, but also on the inclination used, the desired timing of irrigation and the technical properties of the panels and the pumps (different energy requirements depending on the water flow rate needed). This study shows that solar panels can drive irrigation pumps under certain conditions, showing that this coupling has the potential of being a realistic adaptation option and also a contribution to climate change mitigation.

0885	Re-conceptualise the technology-resource-development nexus: linking water, energy and people in India	Sam Wong	UK

This paper re-conceptualises the complex relationships between technology, use of resources and human development. Drawing three rural villages in Rajastan, India, as case studies, it focuses on water- and energy-related technologies and explores how water, energy, people, politics and the nature are intertwined. Our first case study of Kotdi suggests that the reverse osmosis system is more than a sustainable innovation. It helps re-engineer social relations and power structures of the community. Setting up the water committee helps democraticise the governance of water management by giving power back to women and other lower caste social groups.

The second case study of Manpura shows that the success of technological interventions lies in our understanding of people's changing livelihoods. The large rain-water harvesting system might be regarded as a solution to poverty since it stored water for irrigation or animal drinking, but it has become a 'victim' of poverty. People cutting down trees and digging up mud for survival has resulted in serious land degradation, and the rain-water harvesting system was left idle. The local government has started a re-forestation programme in the village, and the presence of forest department officers help monitor the re-growth of the forests. One officer, however, warns that, if chronic poverty persists and when the re-forestation scheme is finished and officers gone by 2013, the forests will return to a piece of barren land. Our third case study in Bamlas indicates that technological interventions are inextricably linked to energy and water policies, and they can create unanticipated outcomes which may hinder the economic growth and ecological sustainability of the communities in the long run.

Our research demonstrates that technologies are not necessarily 'pro-poor'. The uneven distribution of costs and benefits of the technological interventions can make the marginalised groups worse off. These observations are useful to develop a 'people-centred' framework for a better understanding of the complex relationships between technology and sustainable economic development. Our framework suggests that any (sustainable) technological interventions need to link the macro water- and energy-related policies and technologies and the micro process, such as users' perception of water quality. It calls for a different approach to conceptualising human motivations. Before any interventions take place, we need to acquire a deeper understanding of local power and gender dynamics (Chaurey et al. 2004). The 'technology-resource-development' nexus is proved to be complex, but this paper has shown that making sustainable socio-economic development by careful technological interventions can achieve equitable and sustainable outcomes.

0886	A policy framework for sustainable land use at different spatial and temporal scales	Hermann Lotze-Campen	Germany

Land use governance will be confronted with rising challenges over the coming decades, e.g. increasing demand for land-based products, increasing socio-economic globalization, climate change adaptation and mitigation as well as securing ecosystem services. Many of these challenges are dynamically inter-linked. Frequently it has been called for a "great transformation" around the land-energy-water nexus. However, any great transformation in the governance of human-environment systems will only come about through a well-adjusted and possibly harmonized set of policy measures. A suitable policy

framework for land-use governance should distort human activities as little as possible, but at the same time explore synergies and make use of the behavioral dynamics of human actors. Trade-offs between different policy goals have been shown in quantitative land-use modeling studies (Schmitz et al. 2012).

A large number of policy measures have already been tested in different contexts. For achieving sustainable land use, they have to be appropriately co-designed:

(1) Institutions and incentives: use rights for land and water have to be well defined; GHG emissions and other types of pollution have to be properly priced (e.g. through taxes or trading schemes); these measures have to be accompanied by international trade reform to allow for re-allocation of resource use; compensation payments for public goods (e.g. REDD) are also important. These measures combined provide dynamic incentives for

(2) Innovation and investment: public and private research and development (R&D) activities will lead to continuous and well-directed technology development and transfer. This has to be enabled by appropriate

(3) Infrastructure: meaning not only roads and other types of transportation, but also investment in education and extension services in agriculture and other land-use activities.

(4) Insurance schemes, e.g. against harvest losses or flooding, can be a supplementary element of a societal risk management strategy, especially in a more volatile climate.

(5) Information systems, including continuous land-use change monitoring and assessment, will provide the basis for individual and collective action. Finally,

(6) Integration has to be achieved between different policy areas (agriculture, energy, biodiversity conservation, spatial planning, international trade) by mutually adjusting individual measures and developing a coherent overall policy framework.

Only by combining these elements, an effective and efficient policy framework for sustainable land use at different spatial and temporal scales can be achieved. Experience from successful implementations in different world regions can be used for societal learning.

0887	Moving from case studies to cross-site research of urban ecosystems, institutions and governance	Elena Irwin, J. Morgan Grove	USA

Governance of land systems is a set of complex interactions among social institutions, households and neighborhoods, and the environment. In the United States, two key markets are zoning, which is a form of regulating and encouraging where land change may occur, and markets, where prices for land reflect the costs of regulation, household preferences, and neighborhood characteristics. Dynamics among zoning, markets, and landcover characteristics are complex. Understanding these dynamics requires detailed, multi-scale data that are hi-resolution and spatially and temporally extensive. This permits comparisons difference in governance regimes among places and over time. In this paper, we present a case study of our long-term study of zoning, markets, and hydrology in the Baltimore metropolitan region at the parcel scale and discuss our findings of unintended consequences over time and spill-over effects among governance regimes.

0889	The city is growing, but people are moving out: the case of Ouagadougou, Burkina Faso	Jonas Østergaard Nielsen	Denmark

In West Africa urbanisation is mostly a recent phenomenon. The history of urbanisation in this region remains however controversial. On the one hand, urbanisation is perceived as an explosive process mainly caused by rural in-migration. On the other hand, it has been contended that urban growth is slowing down and that rural in-migration no longer is the main driver of urban growth. Indeed, in West Africa new urbanisation trends seems to be emerging. Taking urban sprawl in Ouagadougou, Burkina Faso, as an example, some of these trends will be presented. Particular attention will be given to how local legislation entangled in global economic, political and environmental trends and changing urban-

0891	Observations of increased tropical rainfall preceeded by air passage over forests	Dominick Spracklen, Stephen Arnold, Chris Taylor	UK

Vegetation affects precipitation patterns through altering moisture, energy and trace-gas fluxes between the surface and atmosphere. Here we explore the effect of tropical vegetation and land-use change on precipitation using satellite remote sensed observations of precipitation from the tropical Rainfall Measuring Mission and other satellites combined (TRMM3B42) and leaf area index (LAI) from the Moderate Resolution Imaging Spectroradiometer (MODIS). We combine these observations with a Lagrangian atmospheric transport model which we use to describe daily variability in atmospheric transport patterns. We calculate cumulative exposure of air masses to tropical vegetation and explore relationships between this exposure and observed precipitation. We use remote sensed observations of land-use change that has occurred over recent decades to explore how exposure of air masses to vegetation has changed.

We find that for more than 60% of the tropical land surface, air that has experienced a large cumulative exposure to vegetation in the preceding few days produces at least twice as much rain as air that has little exposure to vegetation. To understand potential mechanisms behind this relationship we explore the atmospheric water budget along analysed back trajectories using specific humidity from analysed meteorological fields combined with global land-surface model output of evapotranspiration (ET). We find that ET in air masses with large exposure to vegetation maintains atmospheric moisture sufficiently to explain observed relationships with precipitation.

We estimate the impact of 2000-2010 land-use change on the exposure of air masses to vegetation. We focus on regions of rapid-land use change and explore how these changes have altered air mass exposure to vegetation. We attempt to identify locations where large enough changes may have already occurred to allow an observable impact on precipitation. Finally we use a business-as-usual scenario of Amazonian deforestation that was developed using deforestation rates for the period 1997 to 2002 to estimate reductions of 12 and 21 per cent in wet-season and dry season precipitation respectively across the Amazon basin by 2050, due to less-efficient moisture recycling.

0892	Forest management plans and the fragmentation Congo basin forests	Jodi Brandt, Christoph Nolte, Arun Agrawal	USA

More than half of remaining tropical forests are now managed for timber production. The implementation of forest management plans (FMPs) in those forests is viewed as a critical first step towards their conservation and sustainable management. The area of tropical forests harvested through an FMP increased 30% from 2005 to 2010, and now total 24% of the global permanent forest estate. Despite the growing prominence of FMPs as a tropical forest management strategy, impacts of their implementation have not been empirically evaluated. We assessed the association between FMPs, deforestation and logging road density from 2000 to 2010 in the Republic of Congo, Central Africa. We found that logging concessions operating through a government-approved FMP had higher rates of total deforestation (0.3% higher), core deforestation (0.3% higher) and edge deforestation (0.5% higher) than managed concessions. Logging road density was 5 times higher in managed concessions compared to unmanaged concession. Spatial patterns of deforestation indicate that high rates of deforestation in core forests may be attributable to logging road construction encouraged by FMPs. High rates of edge deforestation within managed concessions may be associated with population growth and agricultural expansion resulting from economic development stimulated by the logging industry. Our results suggest that FMPs may not achieve their intended goal of limiting deforestation in tropical production forests.

	Our results call for more rigorous empirical scrutiny to assess impacts of commercial logging practices in intact tropical forest ecosystems worldwide.		
0894	Assessing forest carbon stock changes using dense Landsat time series - a case study of the Nghe An Province, North Central Vietnam	Belinda Freiheit	Germany

Emissions from tropical deforestation and forest degradation play an important role in the carbon cycle, but current estimates of emissions have high uncertainties both at the regional and global scale. Remote sensing data have played a crucial role to improve estimates of tropical deforestation but mapping other forest land-uses such as selective logging and timber plantations has been more difficult. However, mapping such changes is important particularly in regions for which net forest cover has reportedly increased but changes in forest density and condition are unknown. In this study, we assess forest cover changes in North Central Viet Nam over the past 40 years (1972 – 2012) using dense Landsat time series.

To construct geometrically and radiometrically consistent time series we co-registered and normalized Landsat MSS and TM/ETM+ images. To fill data gaps and also to improve the accuracy of the change detection, we used separate image time series from the rain and dry season. Training data has been collected across the study area by considering (a) three different altitude zones, (b) forest ecoregions prevalent, and (c) protected core zones where most intact primary forests remain. In addition, previous research contributed information of historical land use/-cover (LULC) changes of the province: Deforestation prevail during the 1950s until the 1990s on account of timber demand due to economic growth as well as governmental resettlement programs. Beginning of the 1990s, forest areas recovered while open forests fluctuated, "reflecting both the impacts of forest conservation and the planting of tree plantations" (Truong, et al., 2009). In order to assess carbon emissions and removals, we classified temporal image composites using a decision rule classifier. We used year-on-year Landsat imagery to capture stages of regrowth of cleared plots or cultivated fields and hence distinguish mature forest stands from young trees. We estimated forest carbon stocks based on forest types and default biomass estimates.

The study will complement LULC change analyses conducted in complex, mountainous terrains with small-scale land use patches. The innovative character of the research is the challenge to capture forest degradation in an area dominated by swidden cultivation as well as the coverage of the whole province. Previous studies have captured LULC changes on village or district level. Regarding the session selected, the study will highlight a case study in the uplands of Vietnam where forest cover changes as well as forest density changes have been detected considering a long period.

0895	Rivers and governance, fragmentation or link? Similarities or discrepancies in territorial environmental governance	Christiane Weber	France

The Upper-Rhine Valley (URV) is a well-known region historically charged, economically productive and demographically dynamic. Along its course, the river crosses several countries being either a part of the national river set or a boundary as between France and Germany.

The questions of territorial governance along the river focus on several aspects. It seems that environmental questions or planning envisions as they are managed separately, may present discrepancies in the management of the proposed territorial decisions. For instance the Plan Local d'Urbanisme (PLU) of the Communauté Urbaine de Strasbourg (CUS) has to be presented to the German services, but it is not the case for the German planning documents.

One of the projects of the ZAEU LTER (France) here is to understand how the environmental issues are taken into account in planning documents in each country? Do they stress similar issues? How do they handle their similarities or discrepancies?

It is interesting to see that (1) the Rhine itself has an international level of decision, the Central Commission for the Navigation of the Rhine promoting an ecological inland navigation[2] or a common governance scheme between the 9 harbors concerned in the URV to concentrate the investments and the ease synergy[3]; (2) the two countries even if they are close one to each other have different way to address environmental issues.

Nevertheless, the questions on the coordination of the land system of both sides are important in this part of Europe to favor collaboration and coherent answer to environmental issues. As such do the differences into political level of decision making and planning rules and practices constrain or not the sustainability transition? In fact the Karlsruhe Traite (1996) is one of the pillars of this transboundary effort, some "Groupement local de cooperation transfrontalière" (GLCT) have been created, the "Eurodistricts". But the competences of these organizations, even if environment figures as a tipping point, seem not armed to promote an environmental and coherent transboundary politic in such matter. With some cases study we shall deepen these questions to assess if such a boundary river might be more or less constraining for long term environmental governance in a region.

0896	Responses of forest cover loss and regrowth to local and national drivers of agricultural development in the Miombo Woodlands of western Tanzania	Marc Mayes, John Mustard, Jerry Melillo	USA

Among dry tropical forest areas globally, the Miombo Woodlands of western Tanzania have experienced extensive forest cover changes in the past two decades that remain poorly understood at regional (100s km^2) spatial scales. Recent studies have associated large areas of forest loss in the Miombo with agricultural activities, such as increased tobacco cultivation in contract farming arrangements since the 1990s (Geist et al. 2009). However, the dynamics of forest regrowth, and thus net changes in forest cover, have not been well characterized. The roles of multiple driving factors for land changes, including climate and other political, economic and agricultural development policies, have not been assessed together due to a lack of data at regional scales.

This project assesses patterns of forest loss, regrowth and their relationships to climate, landscape biophysical factors, local and national agricultural policies in Tabora Province in western Tanzania, from 1990-2013. Our main objective is to evaluate whether patterns of forest loss and regrowth show spatial relationships with localized land use practices and environmental factors, or if land changes reflect influences of national to global-scale drivers. For local drivers, we examine if areas of forest loss and regrowth relate spatially to villages practicing conservation agriculture strategies advocated by the Millennium Villages Project (MVP) or major village centers of tobacco cultivation. For national drivers, we test whether forest loss or regrowth change in response to policies such as the 1999 Village Land Act, which delegated greater power to villages to make land use decisions. We develop new satellite remote sensing methods for mapping dry tropical forest and non-forest land cover in Tabora, based on differences in their phenology patterns in MODIS and Landsat imagery, and validate our algorithm with field data. Land cover maps, which achieve 80-85% overall accuracy, show that our study region had lost 31.7% of its 1990 forest area by 2008 (gross forest cover loss of 60.6 x 10^3 ha), but that 47.1 x 10^3 ha of non-forest area had also reverted to forest during that time. We leverage new local data, such as those collected in surveys by the Millennium Villages Project, market records, and national data to evaluate relationships between land changes and multiple agricultural, economic and policy drivers. Our work produces a new, detailed case study on land change processes in the Miombo Woodlands, an under-studied dry tropical forest region and one of the major frontiers of agricultural

0898	Monitoring ecosystem transitions with EnMAP: preparatory research activities	Pedro J. Leitão, Stefan Suess, Marcel Schwieder, Sebastian van der Linden, Patrick Hostert	Germany

In a time of great land transformations, either by e.g. agricultural intensification or land abandonment and degradation, one of the greatest challenges remains the description and quantification of the gradual transitions between different ecosystems and their services. High-quality spaceborne hyperspectral imagery, by continuously describing the Earth's surface in great detail, when coupled with adequate methods to deal with these data, should be capable of overcoming this challenge. The Environmental Mapping and Analysis Program (EnMAP) is a German hyperspectral satellite mission, aimed at investigating a wide range of ecosystem parameters. Our research is placed within the framework of the EnMAP Core Science Team, which leads the preparatory scientific activities of the mission. Here we present our current research on monitoring ecosystem transitions, illustrated by a case study focusing on an area with accentuated shrub encroachment in southern Portugal. The aim of this study was to develop algorithms and methodologies which allow for operational use of satellite hyperspectral imagery, such as that from the forthcoming EnMAP satellite, for monitoring ecosystem and biotic community transitions. More specifically we aimed at mapping and quantifying the gradual succession of shrub vegetation after agricultural land abandonment, with particular focus on shrub cover and biomass. This transition is followed by an ecological transition from a community of steppe birds with high value for conservation in the extensive agricultural areas to a community typical of Mediterranean shrubs in the encroached areas. We thus further aimed at mapping this ecological transition. Within this scope, airborne hyperspectral data were collected along a shrub encroachment gradient over our study area, which was later simulated into EnMAP-like data. Concurrent field studies served to collect reference spectral data as well as data on shrub vegetation cover and biomass and on the local bird populations. Algorithmic developments concentrated on machine learning approaches capable of dealing with high-dimensional and highly collinear hyperspectral data. More specifically we developed an operational method for using the Import Vector Machines algorithm for sub-pixel mapping of shrub cover. For describing the ecological community transition we coupled a supervised ordination approach (Sparse Canonical Correlation Analysis), capable of dealing with complex data, with existing methods for modelling dissimilarity, this way mapping the community turnover or transitions. With this study we demonstrate the potential of future spaceborne hyperspectral missions, such as EnMAP, for monitoring land transformations in detail, including the quantification of gradual ecosystem transitions following changes in land use or environmental conditions.

0900	Factors determining the persistence of logging roads in the Congo basin	Fritz Kleinschroth	France

Logging roads in the Congo Basin are often associated with forest degradation through fragmentation and opening for other land uses. However, especially in logging concessions under management plans, roads are usually supposed to be closed after each phase of exploitation. Little is known about the effectiveness of this prescription and the factors that shape persistence of logging roads. We analyzed the presence of roads between 1986 and 2013 in four-year steps on time-series of LANDSAT images, covering parts of Cameroon, Central African Republic and Republic of Congo. We identified two types of roads with differing spectral properties: "brown" (interpreted as bare soil resulting from logging traffic) and "green" (interpreted as plant cover due to re-vegetation processes). We carried out survival analyses for both road types, accounting for roads that "died" (underwent transition from brown to green

or disappeared from the images) during the study period or "survived" (persistence of the same color). Eighty five per cent of all observed roads in the (62 000 km²) image areas were inside forest concessions, almost all of them with a management plan implemented by the end of the study. Survival of "brown" roads was for a longer duration with shorter distance to a town and on poor soils, whereas "green" roads showed the shortest survival in Cameroon and close to towns. We found no significant differences between roads inside and outside concessions. Our results indicate that the persistence of logging roads is mainly associated with distance to population centers and site productivity. Forest recovery on roads takes longer in remote areas with old growth forests than in areas with a longer disturbance history. This effect is reinforced by poor soil conditions. We conclude that road closure after logging operations inside forest concessions is not effective in places where economic and environmental driving forces keep roads open.

So far, rainforest degradation through selective logging was usually evaluated based on expanding road networks. This study is the first to analyze network dynamics based on logging road persistence, taking into account their temporal development until disappearance. The use of survival analysis originating from clinical research is an innovative way to treat time series data. The applicability for geospatial land-use data has been shown by An & Brown (2008). The time series session at the GLP open science meeting will provide the ideal auditory to discuss these novel approaches to understand historical forest dynamics.

| 0901 | Processes, patterns and mechanisms of rapid land-use and forest-cover change: the impact of governance in land management in Kibaale District, Uganda | Bruce Rukundo | Uganda |

Land-use and forest-cover change in Kibaale District, Uganda, is an issue of governance in land management processes. Since 1986, the government of Uganda embarked on forward-looking structural changes to ensure good governance in land management processes and sustainable development. Despite initial notable successes, serious challenges have emerged complete with adverse land tenure insecurity, and near-irreversible environmental abuse via unfettered deforestation. The paper used Remote Sensing, socio-economic (household surveys, interviews etc.), and Geographical Information Systems (GIS) techniques. Quantifying spatial and temporal patterns of land-use change involved the analysis of Landsat Thematic Mapper (TM) images of 1986, 1995, 2002, and 2010.

The magnitude of forest loss is alarming. The study by NFA (2006, as cited by NEMA, 2008) found that between 1990 and 2005, Kibaale District lost about 49% of its total forest cover, and ranked Uganda' leading rural district in deforestation. Using 1986 as the base year, this study found that between 1986 and 2010, about 63% of the total forest-cover was lost. Forest-cover change patterns involved temporal variations. Between 1986 and 1995, the average annual rate of deforestation was approximately 1.8%, which reduced to about 0.9% by 2002, and increased to 2.6% by 2010. However, between 2002 and 2010 the average annual rate of forest-cover loss was found to be approximately 7.2%. This rate of forest loss implies that the amount of forest-cover available in future is not likely to support the livelihoods.

Land-use and forest-cover change transcends forestry. It lends itself to land management processes and governance – the land systems dynamics that explain individual land-users' decisions and influencing macro-factors. Assessing land-system dynamics requires attention to processes operating at different spatial and temporal scales, to interactions between different drivers and, in particular, to policy shifts that often lead to emergent properties and nonlinear outcomes (Briassoulis, n.d). Hence, individual actions at the area of access rights and macro-policy factors at higher levels are vital towards understanding how and why land-use and forest-cover change actually take place. This paper is guided by the following questions: how is governance in land management linked with rapid forest loss in

	Uganda's Kibaale District? What can be done to reverse rapid forest-cover losses?	
0902	What drives massive agricultural land abandonment and recent re-cultivation of abandoned croplands in Russia, Ukraine and Kazakhstan	Alexander V. Prishchepov, Daniel Müller, Rachel Licker, Roland Krämer, Florian Schierhorn, Matthias Baumann, Patrick Griffiths, Anika Sieber, Tobias Kuemmerle, Patrick Hostert, Volker C. Radeloff	Germany

The collapse of the USSR and transition to market economies affected agricultural production and resulted in agricultural land abandonment of more than 50 million hectares in Russia, Ukraine and Kazakhstan (RUK) (Prishchepov et al., 2013). In the view of global food security some abandoned lands can be re-cultivated again. Our goal was to analyze the trajectories and the drivers of agricultural land-use change (LUC) in RUK (both agricultural land abandonment and conversion of abandoned lands to croplands). We analyzed overall the trends of agricultural LUC in RUK using official statistics and remote sensing estimates. Using detailed case studies, one province within each country- Lviv in Ukraine, Rjazan in Russia and Kostanay, where agro-environmental conditions are favorable, abandonment is widespread and recultivation is common, we used 30 m resolution Landsat TM/ETM+ images to detect agricultural LUC for 1990 -2000 -2010. To analyze the drivers of agricultural LUC we developed spatially explicit models of agricultural LUC using detailed statistics, agro-environmental data and complemented our analysis with semi-structured interviews conducted with decision makers and farmers that were interpreted using qualitative content analysis approach. Our results indicated stabilization of agricultural land abandonment after 2006 and recent re-cultivation in RUK. Our fine-scale estimates indicated by 2010 abandonment reached 43% of 1990 cultivated agricultural lands in Rjazan, 40% in Lviv and 39% in Kostanay. All three provinces also experienced re-cultivation of abandoned lands after 2000, while the highest re-cultivation rate was in Kostanay ~ 34% from 2000 to 2010. Analysis of the drivers of agricultural LUC showed that most agro-environmentally and socially marginal agricultural areas were abandoned from 1990 to 2000 in Rjazan and Kostanay, while massive abandonment of marginal lands took place in Lviv after 2000. From 2000 to 2010 differences in structure, specialization of farms, and funds access affected decisions about exiting agricultural production and land abandonment. A lack of functioning land markets, limited a quick transfer of land resources from unsuccessful to successful farmers, thus additionally keeping lands abandoned. We also observed higher incentives for the re-cultivation of abandoned lands in the case of Kostanay and in Lviv, while in Rjazan, incentives were low, especially where economic costs of re-cultivation after 20 years of abandonment were high. These findings have important implications for land-use policies, help to re-evaluate agricultural potentials of Northern Eurasia and open opportunities for the ecosystem trade-offs.

0905	Land value taxation: a mean towards sustainability in cities	Blanca Fernandez Milan, Felix Creutzig	Germany

Humanity is urbanizing rapidly. By now every second world citizen lives in a city. Scenarios suggest that by the middle of this century, almost 70 per cent of the global population will live in cities. At the same time, cities constitute both sources but also potential solutions to climate change and other sustainability challenges. While diverse disciplines address some aspects of urbanization, there is a need

to integrate this knowledge in order to find optimal – or at least appropriate - pathways that could minimize the negative impacts as well as maximize the positive outcomes of the urbanization process.

In cities, solutions are strongly related to low-carbon infrastructure investment and innovative policy instruments enhancing synergies among multiple objectives. A linkage through well-designed urban plans exhibits considerable potential for urban sustainable development. In this context, land based taxation are an efficient mean towards achieving sustainability in cities.

We assess the performance of a set of value capture mechanisms in achieving specific policy objectives for different urban contexts. Urban sprawl, equitable burden sharing and local government´s liquidity to finance new infrastructure are some examples. First, we define indicators accounting for each objective. We then select a number of instruments based on the literature available (Ingram and Hong 2012) in value capture and urban land policies as well as already existing case studies. Combinations of instruments are also considered. A revenue neutral shift of the current property tax systems in selected European cities towards land value capture mechanisms is analysed. The study takes into account short and long term effects on the urban form. A special emphasis is given to innovative instrument designs accounting for externalities related to urban development. Our analysis also accounts for the political feasibility and popularity of the strategies identified based on previous experiences.

We discuss how joint land value capture mechanisms could constitute both a reliable source of public revenue and improve climate change mitigation in cities by the internalisation of externalities. Our work highlights the potential of policy shifts to making European cities more sustainable.

| 0906 | Challenges in managing multi-functional landscapes to sustain rainfall | Meine van Noordwijk, David Williamson | Indonesia |

Recent studies on the terrestrial versus oceanic origin of water vapour involved in rainfall over land suggest a larger role for "short cycle" hydrology than has been assumed in many climate change models. This implies that beyond roles in blue and green water hydrology and the tradeoff between them, land use in multifunctional landscapes, and especially the tree and forest components of it, also influence the "rainbow water" availability inside the relevant precipitationsheds. These findings resonate with local knowledge and public discourse on changes in water yield in response to reductions or increase in tree cover that are hard to explain when rainfall is treated as exogenous factor. However, the scale at which such interactions might occur is a challenge to existing research methods, and much of the evidence remains circumstantial. Ongoing studies in one of the water towers of Tanzania and the surrounding land cover change, support an interpretation where rainbow water plays a major role. Where tree cover management in multifunctional landscapes is now understood as a tradeoff between blue and green water (with trees, especially deep-rooted ones near riverbeds, using more water than other vegetation), the rainbow water relations suggest recycling rather than losses. Water management institutions and concepts of payments or economic incentives for environmental services are still largely focused on blue water, but the interest of downwind stakeholders may be opposite to that of downstream stakeholders, and the greater complexity needs to be understood and addressed. The presentation will focus on the need for high-calibre process-oriented research and multistakeholder action research to interact on this emerging new perspective on downwind impacts of land use change.

| 0907 | Global patters of embodied HANPP: relations to population density and income levels | Thomas Kastner, Karl-Heinz Erb, Helmut Haberl | Austria |

The fact that many rich nations and emerging economies displace large amounts of their land demand to regions outside their own territories has been gaining recognition recently. We use the concept of the human appropriation of net primary production (HANPP) to integrate land use pressures across different land use classes (most importantly, cropland, forests, grazing areas) from a consumption perspective. A

comprehensive time-series dataset on international trade of biomass products (1986 to 2007, covering bilateral trade links for over 450 products) reveals that HANPP embodied in international trade more than doubled in just two decades, with strongly increasing regional interdependencies. Using statistical measures of inequality we show that, while sparsely populated nations exert higher per capita pressures on land resources, the consumption perspective (via embodied HANPP) reveals that increasing parts of these higher HANPP levels are due to export production. We find only weak relations between income levels and per capita embodied HANPP, implying that richer nations, on average, do not cause disproportional larger shares of pressure on land resources as measured by the HANPP metric. This finding, which is very different from income relations for many other resources, can be explained by two counteracting developments: while rich nations have higher consumption levels of land intensive biomass products, above all animal products, they typically host more area efficient, industrialized agriculture. This type of farming shifts pressures to other resources, above all fossil fuels and is associated with the rise of various detrimental effects of land use (e.g., eutrophication). We conclude by discussing implications of these findings for national resource policies.

0909	Contrasting trends in land demands in a Central European region with decreasing population	Joerg Priess, Mathias Heinze, Christian Schweitzer, Eva Lang, Sandra Wochele	Germany

In Europe, population dynamics vary widely between regions. It has been shown that spatial changes for instance in terms of built up land in urban or rural areas often are not closely linked to changes in population. In our case study region in central Germany, representing regions with a shrinking population, we analysed population dynamics, changes in the corresponding settlement areas and per capita land demands of for the last two decades, and for the period until 2050, using a participatory scenario approach. The objective of the study was to analyse if regions with shrinking populations contribute to the political target of reducing the rate of land sealing in urban and rural areas.

We identified widely varying intra-regional land demands, namely between the three different states of Central Germany and between urban, semi-urban and rural areas. In all units of analysis, we found increasing per capita land demands for the period 1990 - 2006.

Using the period from 1990 to 2006 as a calibration period, we employed the model SITE to study historical and potential future land-use dynamics. The regional scenarios we used, vary widely with respect to population trends, attractivity of rural vs. urban areas and the trends of per capita land demands, but all historical per capita increases fading out in the coming decades. In all four scenarios a decreasing human population was assumed – though with quite different rates of change. We found that in several instances the decreases in population were overcompensated by per capita land demands and the relative attractiveness of the location, resulting in increasing land demands in several cities, and some slower than expected decreases in rural areas. Thus, assuming similar conditions in Central Europe, even under conditions of continuously shrinking populations, in urban, but also in rural areas a considerable amount of land conversion and land sealing can be expected in the next decades, also when assuming that current increases in per capita land demands slow down to zero or may be reversed.

0915	Spatial modeling of ecological-economic tradeoffs: renewable energy production and biodiversity conservation in the Alps	Sabine Fuss, Florian Kraxner, Sylvan Leduc, Nicklas Forsell	Germany

Renewable energy (RE) is considered as a cornerstone of the EU's climate change mitigation policy and at the same time gaining importance in response to Germany's, Switzerland's and partially also Italy's

move to distance themselves from nuclear power solutions. According to the Alpine Convention's Energy Protocol, the Alpine region will make a long-term contribution to meeting Europe's energy needs. However, other ecosystems services and most notably biodiversity often compete with RE for productive sites and there are thus important tradeoffs to be analyzed and understood in order to maintain ecosystem functions and services in scenarios of increasing RE demand and other pressures (e.g. climate change). The study presented uses a spatial optimization model to determine the cost-optimal location of bioenergy plants for the production of centralized heating/cooling, electricity, and biofuels under sustainability criteria at different scales (the Alpine space versus pilot regions such as Trentino/Italy, where higher resolution data are available). In addition, the analysis does not intend to assign a monetary value to biodiversity and other ecosystems functions, but progressively exclude areas from the optimization process according to a ranking of the ecosystem services they provide, thereby tracing out the marginal costs of protecting those areas. In this way, the ecological-economic tradeoffs can be quantified and visualized for the decision-maker without making assumptions on weights and preferences and judgments about valuation. By combining this with an analysis of the main sources of uncertainty (e.g. about policy support, which may or may not materialize or be maintained) and the corresponding scenario building, decision-makers can furthermore form strategies that offer them a certain extent of robustness across those uncertainties. The presentation will thus not only contribute to the identification of trade-offs in multifunctional landscapes, but provide quantification and decision-making aid by making use of a combination of a spatial optimization tool, scenario analysis and new concepts (see Svadlenak-Gomez et al. 2013 for all relevant references and background).

0916	Understanding land use change drivers and the consequential ecosystem services in peatland areas: implications on conservation efforts	Atiek Widayati, Hesti Tata, Gamma Galudra, Feri Johana, Putra Agung	Indonesia

Carbon emissions from drainage, logging and conversion of peat swamp forests in Indonesia have drawn global attention in the issue of anthropogenic climate change. Opening peat swamp forest triggers belowground emissions and decreases hydrological functions and biodiversity richness. We present two case studies in Sumatra, Tripa in Aceh and Tanjung Jabung Barat in Jambi, where peat forest degradation has occurred since 1980s and oil palm is an important land use development since 1990s. We synthesized outputs of assessments on drivers of changes and consequences on the ecosystem services in the two sites and ultimately took lesson learnt from the two cases for the conservation of peat forest and maintenance of local livelihoods. Major driver of changes is trade policies and needs on crude palm oil (CPO) and pulp/paper industries with trickle-down effects to the increasing large scale investments on plantations and eventually local mechanisms on land profitability, market and infrastructure. The contrasting conditions of the two sites on the ecological implications and on land tenure status led to different recommendations. Tanjabar peatswamp area represents an area which experiences carbon loss and where land tenure issue is dominated by migration influx. Tripa peatswamp, on the other hand, signifies a much complex ecological implications with the habitat loss of Orang Utan (*pongo abelii*), an endangered IUCN red-list species, and a much larger land use policy issue related to conservation designation. Community forestry is a viable approach in area where forest rehabilitation can support both carbon stock sequestration and local livelihoods, whilst in the case of peatswamp forest habitat conservation for a globally important species, a more stringent land use designation is necessary in combination with subnational or local incentive mechanism. This paper presents case studies which demonstrate interlinkages of global issues and local contexts which lead to environmental and ecological problems. Understanding the convergence and divergence of issues and options are key to providing recommendations for conservation.

0917	Migrating, shrinking, and expanding conditions for growing crops under future climate scenarios	Paul West, James Gerber, Deepak Ray, Jonathan Foley	USA

Our changing climate will affect agriculture and our ability to meet the growing demands to produce food, feed, fuel. Many studies have focused on the effects of climate change on yields and global (or regional) production of a few major crops. To complement these previous efforts, here we analyze how the spatial extent of the climate envelope for ~50 crops is likely to change (migrate, shrink, or expand) under future climate scenarios. For example, the spatial extent of wheat's current climate envelope shrinks 5-10% in a few climate change scenarios. We summarize the results for major crop groups (cereals, vegetables, fibre, etc.) as well as highlight individual crops to illustrate future risks and opportunities.

0918	Bioenergy, food production and zero net deforestation: integrated assessment of multiple goals and implications at different scales	Florian Kraxner, Sabine Fuss, Eva-Maria Nordström, Petr Havlík	Austria

A glimpse at the new IPCC scenarios shows that ambitious climate change mitigation targets maintaining warming below 2 degree C will only be possible under the realization of a major expansion in bioenergy (and likely the combination of bioenergy with carbon capture and storage (BECCS) for that matter). It is clear that this has major implications for land use change, which will further be enhanced by other land-based mitigation strategies - such as achieving zero net deforestation (i.e. including afforestation) - and increasing demands for food. In addition, these developments and their interactions will also exert pressure on other resources, most notably water and fertilizers. In a globalized world, policy impacts will be transmitted to other regions with impacts on markets (e.g. prices) and the environment (e.g. indirect Land Use Change). An integrated assessment approach is thus employed to capture these interactions and get a spatially resolved picture of the impacts of different goals (reducing deforestation, bioenergy targets, conservation of biodiversity) at the global level. In particular, the Global Biosphere Management Model (GLOBIOM) – a partial equilibrium bottom-up model of the agricultural, forestry and bioenergy sectors – combined with a number of biophysical process-based models (for crops, forests and livestock) is used for this analysis (see Kraxner et al. 2013 for all relevant references and background). However, as aggregate, large-scale models operating at global and regional level have difficulties in addressing locally specific conditions, diverging policy objectives at different scales (e.g. global 2 degree C target versus a tropical country's economic development agenda). A zoom into countries identified for their high potential to produce bioenergy and reduce deforestation helps to understand (and eventually solve) major conflicts between policy goals, but also to identify low-hanging fruits and synergies guiding stakeholders on a path towards sustainability rather than leading negotiations into continued deadlock.

0923	Land-change dynamics operating at different scales: complementarity and synthesis of multi-scale analyses in Albania	Louisa Jansen	The Netherlands

Scale is a central issue in land-change dynamics. Understanding the scale of interaction and the scale of different environmental and social processes is of paramount importance to the study of the interaction of human-environment systems. Not only do *multiple scales* exist, scales have also different *dimensions*. Three dimensions of scale are distinguished: (1) *space*, (2) *time* and (3) *organisational hierarchy* as constructed by the observer. The latter dimension of scale is often neglected in land-change studies but the classes present in data sets can also affect the type of explanation given to observed phenomena. Not only the dimensions of scale are crucial. Change dynamics manifest themselves also at *different kinds of*

scale and they have different *components of scale*.

The results of two projects in Albania in the period of transition are used: (1) a country-wide analysis of land-cover change based upon remote sensing providing an insight in conversions and modifications at national and district levels; and (2) a cadastral-parcel based land-use change analysis at commune level. The results illustrate clearly that there is an obvious need to make complementary multi-scale analyses, thus having different organisational hierarchies, in order to detect the land-change dynamics at different levels. So the emphasis is on the *complementarity* of analyses together with *synthesis*: the analysis results should not only be combined but the combination should enhance the understanding of land change.

However, complementarity does not only exist in *multi-scale analysis*: the interpretation of land-cover change is strengthened by land-use change, and vice versa. Land cover is an aid in understanding patterns, whereas land use helps understanding processes. Patterns and processes operate at different scales and they should be linked in spatially explicit land-change science. The realisation that land cover and land use represent different *dimensions*, *kinds* and *components of scale* should be extended to a more integrated approach in land-change science, especially as choices of scale not only affect what can or will be analysed, but also what can or will be done. Thus, scale is linked to governance.

0928	Tourists' preferences for ecosystem services and mitigation of environmental change impacts in the Okavango Delta, Botswana	Dimpho Malebogo Matlhola, Gagoitseope Mmopelwa, Donald L. Kgathi, Moseki R. Motsholapheko	Botswana

The crucial role which ecosystems services and functions play in underpinning economic activity and anthropocentric wellbeing is of growing concern as evidence mounts of the increasing pressures being placed upon such systems by human activity. Tourism as a land-use has fueled the high rates of population increase in wetlands such as Okavango Delta. The landscapes of Okavango wetlands are subject to change due to population growth in conjunction with efforts to increase food security, energy and ecosystem services. These changes may lead to landscape losses for locals and deterioration of scenes for sightseeing tourists. However, formative preferences of tourists for ecosystem services can inform actions on tourism product diversification and reduce pressure on the current tourism attractions i.e. protected areas. People's preferences on aesthetic quality and the place of recreational activities have been considered as a means to achieve sustainable wetlands management. This study therefore determines tourists' preferences for ecosystem services and analyses their influence as mitigating strategy for environmental change impacts in the Okavango Delta, Botswana.

Data were collected from 180 international tourists through choice experiments at the lower Okavango Delta. Preferences of tourists were determine using three attributes of ecotourism; management of tourism facilities, landscape of the Delta, wildlife and *mokoro* price as the payment vehicle. Findings indicate that most tourists prefer wildlife-viewing during the flooding season of the Delta as they partake in traditional canoe (*mokoro*) excursions. Results suggest that impaired landscape of the Okavango Delta by withdrawal of water in Angola would negatively affect the value of tourism as a land-use in the Delta. It is suggested that tourism operators and policy makers should use tourists' preferences to consider areas outside and adjacent to protected areas in order to distribute pressure in the Delta. The preferences of tourists and locals should be included in land-use planning. To deal with explicit demand for landscape services, the policy makers have to take into account the preferences of tourists and locals as they detect the demand for landscape services.

0929	Analyzing the impacts of national agricultural policy on regional land-use change	Christian Schweitzer, Joerg	Germany

In the last decades, agriculture in the forest steppe of Northern Mongolia has become a relevant factor utilizing land and water resources. Decreasing availability of suitable land is affecting the major land use activities grazing and crop farming. Along with Mongolia's change to a market economy in 1992 and associated market brake, earning possibilities for common labor were largely lacking. As a logical consequence, a vast increase in promising activities, such as livestock grazing was a comprehensible step. Livestock numbers largely increased, negatively affecting vegetation, leading to soil erosion and water quality problems due to nitrogen intake and increased sediment load. On the contrary, crop faming strongly declined, limited by the fertilizer availability, poor infrastructure, the absence of adequate machinery and due to the semi-arid climate.

In the last years, the government initiated national measures to achieve food security. This is done via subsidies and promoting agricultural intensification and land reclamation. Subsidies include e.g. loans without interest, provision of machinery, fertilizer or irrigation equipment. Implementation is progressing especially regarding irrigation infrastructure, introduction of new crop varieties, or expansion of greenhouse farming for horticulture. However, a survey conducted in summer 2011 revealed that only a minority of large farming companies benefit from subsidies facilitating land-use intensification, whereas small scale farmers without support tend to continue with low input agriculture. At the moment, promoted measures are leading towards a scarcity of land and water which increases conflicts among farmers, as well as between farmers and herders.

This study analyses different management options to reveal future possibilities for a sustainable use of soil and water resources. Today, water harvesting and soil erosion protection measures are practised by some farmers (e.g. strip cultivation, crop rotation, tillage), but approaches for long-term cultivation, especially to sustain or enhance soil fertility and to reduce erosion are not in place. We apply a process-based model to simulate management/cultivation decisions considering climate change conditions to identify potential land/water or important environmental conflicts.

The presentation could be a contribution to session no. 085. We show an integrated regional approach where the influence of certain land-use change drivers is variable and effects different spatial scales. The study could be an instructive example for the interaction of land-use decisions on different levels along with their impacts.

| 0931 | Local land users facing re-emerging infectious diseases in a context of global market trends leading to LUC, in South-western Amazonia | Manuel Cesario | Brazil |

There has been unprecedented Land Use Change (LUC) in the tri-national region known as South-western Amazonia, due to the on-going building of two hydroelectric dams, and their 2,500 miles of additional hydro-ways, together with the 1,000 miles of recently paved roads. These local/regional changes are driven by globalised markets eager to provide energy to the Brazilian flourishing economy, as well as to facilitate the export of the increasing large-scale crop's production from Centre-western Brazil to China, through Peruvian Pacific ports. The LUCs are coupled with increased human migration, new settlements, unplanned urbanization, agricultural development, intrusion into primary forest, deforestation, and the associated biodiversity-loss, favouring the vicious cycle: mega-infrastructure projects – increasing human migrations - land use/cover changes – uncontrolled urbanization. According to Cesario & Andrade-Morraye (2008), this perverse cycle leads to the disruption of the natural ecosystem-service known as 'disease regulation', by affecting vectors' abundance and behaviour, and by bringing people, vectors, and wild reservoirs into overlapping areas, resulting in conditions that increase the vulnerability of Bolivian, Brazilian and Peruvian regional populations to neglected vector-borne zoonoses, such as Leishmaniasis (both Cutaneous and Visceral) and Bartonellosis. The border-region encompassing forgotten territories of Bolivia, Brazil and Peru puts together the regional hyper-

endemicity of Cutaneous Leishmaniasis between the pressures of Bartonellosis (historically from the Andean parts of Peru, in the last decade expanding geographically towards the east) and Visceral Leishmaniasis (historically from North-eastern Brazil, now reaching western Amazonia). The health professionals available at the Bolivia-Brazil- Peru borders are still not trained to diagnose or to treat Bartonellosis and Visceral Leishmaniasis, since the tri-national region is still considered disease-free to them, despite the increasing risk of transmission due to human migration and to vectors' abundance. A better understanding of the role played by unsound regional development policies in perpetuating the above-depicted perverse circle will represent a timing response to the urgent need to advance scientifically informed decision-making. It is urgent to develop strategies to educate and involve regional health-service managers and policy-makers in order to incorporate sustainability, climate change adaptation and prevention of vector-borne infectious diseases into their planning and their routine activities.

0933	GLOBE: Online Tools for Understanding Local Land Use Globally	Erle Ellis	USA

To understand land change processes at global scale, it is necessary to understand the causes and consequences of land change at local scales, and to bring this local knowledge and expertise together at global scales. GLOBE is a new online scientific collaboration environment designed to accelerate this process of cross-scale knowledge synthesis. Developed in partnership with the Global Land Project with funding from the US National Science Foundation, GLOBE represents three years of research and development by a team of geographers, computer scientists, information systems specialists, and web developers. GLOBE couples local case studies with global data in an interactive online environment offering global and regional visualizations, basic and advanced statistical computations, social networking, data sharing, and knowledge synthesis. This presentation will highlight strategies for using GLOBE to assist both case study researchers and those engaged in cross-site synthesis research.

On joining GLOBE (free on request), users may enter, georeference, tag, and share their case studies online using the GLOBE system, which includes functions to map, tag, add data to, search for, and build collections of case studies and to share these as well. Over 500 published case studies are already entered and available. Tools for "global similarity analysis" enable the global context and most similar global extent of individual case studies to be computed and mapped in real-time relative to one or more global variables drawn from >50 global datasets, including both social (e.g. population density, accessibility, market influence, land use, urban area, protected area, etc.) and environmental variables (e.g. terrain, climate, soils, land cover, biomes, biodiversity, primary productivity). The same analysis also identifies and ranks all globally similar case studies, facilitating searches and collaborations. The "global representativeness" of case study collections for meta-studies or other synthesis efforts can also be computed relative to global datasets, enabling under- and over-sampled parts of the world to be identified and mapped, and potentially filled with additional studies in understudied areas.

Ultimately, the success of GLOBE will depend on the land change science community. Site-based researchers can collaborate more globally across sites and environments. Global gaps in local knowledge of land change processes can be assessed and addressed. GLOBE invites the land change science community to embrace these opportunities, and to further develop our culture of globally relevant knowledge creation and sharing .

0935	Building knowledge-action systems for urban sustainable governance in San Juan, Puerto Rico	Tischa Munoz-Erickson	Puerto Rico

There is currently great pressure on planning and academic institutions to develop arrangements that facilitate mutual interaction between science, policy and practice for harnessing knowledge and technology to address land use challenges and advance sustainability. Yet, designing effective arrangements in urban contexts is difficult because of the multiple institutions, scales, and sectors (e.g.,

housing vs. land use) that are involved in planning and managing cities. In this talk I discuss the challenges of building knowledge-action systems -- the networks of actors, their visions of the future, and the practices and dynamics underlying the production of knowledge to advance specific policies, decisions, and actions related to sustainability – in the contested context of land use and land cover governance for the city of San Juan. I present the knowledge-action system analysis (KASA) approach that draws on theories of science and technology studies (STS), innovation systems, and social network analysis to examine existing institutional dynamics and structures involved in the co-production of knowledge and social order for the city. I will discuss how, even though novel configurations of actor networks are emerging in San Juan that contribute diverse knowledge (e.g., local or civic knowledge) and present a potential for creativity in city governance, historically embedded power structures continue to dominate the expertise, rationale, and visions that shape land use planning, thus limiting innovative and adaptive capacity in governance. Based on these results I argue that developing adaptive capacities for urban social-ecological systems is not solely a matter of harnessing more science and technology, but about managing the politics of expertise and visions that emerge from complex governance systems. This study contributes to the conference session's goal of exploring the particular methodological challenges in advancing integrative understanding of urban ecosystems by proposing the KASA approach as a useful tool for systematic analysis of the socio-political, cognitive, and institutional dimensions of land governance and innovation for urban sustainability.

| 0939 | Where is your study? The geography of case studies and implications for global synthesis of case study research | Jared Margulies | USA |

Case studies remain at the core of land change research, but how case study locations and coverage are reported in the literature remains ad hoc and prone to misinterpretation and spatial error. The process of choosing which areas to include and exclude when defining a case study's geographic representation of an area of Earth's land surface sets the terms by which the results of a case study can be interpreted and used by others. In land change science, defining the boundaries within which the findings of a case study are valid is essential to understanding the potential global relevance of a specific case study to understanding patterns and processes across broader areas. Increasingly, land change scientists are turning to meta-studies as a method for making generalized inferences on land change pattern and process at global and regional scales using empirical data from locally-conducted case studies. Spatially explicit and accurate reporting of case study geometries is therefore especially important for meta-study research in which studies across multiple sites and geographic locations are compared and integrated. Using new online tools of the GLOBE project (http://globe.umbc.edu) for global comparison and meta-study of collections of case studies, this work presents the results of a systematic analysis of a representative set of land change science case studies and identifies common errors in how case study geometries are reported in the literature. Further, this work demonstrates how such errors lead not only to ambiguous representations of the spatial extents of case studies, but also to significant errors and other limitations when interpreting the results of meta-studies and global relationships derived even from the same set of case study observations. This research fits within the conference theme of how to address global challenges in land chance science while incorporating contextually specific local case study research.

| 0940 | Globalizing a classic study of agricultural intensification: Boserup/Turner Revisited | Lindsey Gordon, Nicholas Magliocca, Erle Ellis | USA |

Ester Boserup's theory on agricultural intensification was validated empirically and greatly strengthened by Turner, Hanham, and Portararo's 1977 classic meta-study, *Population Pressure and Agricultural*

Intensity, which stands as a cornerstone of geographic and land change science research. The meta-analysis examined 29 local case studies of tropical subsistence cultivators, demonstrating a strong, positive correlation between population density and agricultural intensity. By assessing case studies of agricultural intensity in relation to population and environmental factors using a rigorous statistical framework, classic Malthusian assumptions on the limits to agricultural productivity and human populations were overturned, to be replaced by a growing body of empirically-grounded general theory on populations and productivity.

As a core contribution to land change science, Turner et al., 1977 provides an ideal lense through which to explore how recent advances in the study of anthropogenic global change might offer new insights into the study's assumptions and findings. In particular, we assess how well the collection of local case studies used in this meta-study represent the global patterns of agricultural land use, population density, and environmental quality at both the time of the original study and today. The representativeness analysis tools of the GLOBE project (http://globe.umbc.edu) were used to accomplish this, with both the original case studies and the results of analysis shared freely online.

In revisiting this classic work, we encountered significant challenges, both in acquiring and assessing cited case studies as well as interpreting their approximate geographic representation. Because a majority of the case studies were conducted before the widespread use of digital mapping technology, geographic information on study locations was presented in fairly rough forms, including hand-drawn figures and maps that did not allow precise geographic description. Nevertheless, even with these limits, georeferencing the case studies enabled global gaps and biases in study coverage of global patterns in agriculture, population and environment to be quantified and mapped, and the existence of relevant new case studies was revealed, enabling the meta-study to be expanded and updated. As Turner's meta-analysis gains a shared online presence, further examination and improvement by the land change science community may further strengthen global understanding of land use intensification relationships across both temporal and spatial scales, bringing a classic study up to date and enabling its adaptation within a changing global context.

| 0941 | Meeting stakeholder knowledge needs for managing land to deliver multiple benefits from tropical forest landscapes | Simron Jit Singh, Consuelo Ortega, Barbara Smetschka, Irene Blanco, Marta Perez Soba, Manuel Winograd, Nelson Grima | Austria |

Tropical forest ecosystems are hotspots for biodiversity and provide one of the biggest stores of terrestrial carbon making their role in climate change mitigation programmes increasingly important (e.g. REDD, REDD+). As of now, we do not know how much biodiversity or what components of biodiversity are needed to sustain the ecosystem processes and ecosystem services needed for climate change mitigation. The recently launched 'ROBIN' (an FP7 project) aims to quantify the role of biodiversity in terrestrial ecosystems of South and Mesoamerica in mitigating climate change, as well as evaluate the socio-ecological consequences of changes in biodiversity and ecosystem services under climate change. ROBIN will engage local and regional stakeholders at various stages, from the selection of indicators and sites, to participatory scenario building, to providing decision support for management of land and local ecosystems. The paper will present experiences and outcomes so far in meeting stakeholder needs through participatory scenario building workshops in Bolivia and Mexico using Fuzzy Cognitive Mapping (FCM) and the integration of these scenarios with models for the analysis of policies. Thus, the paper will also illustrate methodological strength of involving stakeholders through the use of Societal Multi-Criteria Evaluation (SMCE), a decision support tool that allows for

participatory strategic integrated assessments and discussions of various scenarios and options. Both FCM and SMCE allow for integrating different knowledge systems (scientific, non-scientific/traditional, monetary/non-monetary, quantitative/qualitative, etc.), as well as learning for all involved in the appraisal process.

0946	Programme on Ecosystem Change and Society (PECS)	Albert Norström, Megan Meacham, My Sellberg	Sweden

The Program on Ecosystem Change and Society (PECS), a new initiative within the ICSU global change programs, aims to integrate research on the stewardship of social–ecological systems, the services they generate, and the relationships among natural capital, human wellbeing, livelihoods, inequality and poverty. In this talk we will present some of the ongoing work from the numerous social-ecological case-studies from around the world that are at the core of PECS. We will also discuss the opportunities and challenges in synthesizing and comparing knowledge and insights generated from these different case-studies, so as to understand social-ecological dynamics in the Anthropocene.

0948	Understanding and advancing collaborative Global Knowledge Creation in Land Change Science	Alyson Young, Wayne Lutters	USA

The complex nature of global environmental changes requires systems-level science. Land Change Science (LCS) generates systematic knowledge by conducting local case studies based on field observations and through regional studies that combine remote sensing observations with socio-economic and/or biogeophysical data. It is now increasingly popular to use meta-study approaches to produce global knowledge from these local and regional data, and by computational modeling to Earth-scale patterns and processes.

To better understand LCS meta-study processes, we used the tools of Information Systems Science to investigate and understand global knowledge creation in LCS by participating in two workshops with international LCS meta-study experts in May 2012 and June 2013. In the first workshop, nine experts described sample meta-studies; discussed the ideal meta-study; and explained how meta-studies could be improved. In the second workshop, 25 participants discussed the content of LCS meta-studies, focusing on similarities and differences across different meta-studies. Participants identified a number of limitations with current meta-study approaches. Foremost was a difficulty in locating case studies for their analyses that were relevant and comprehensive, that is containing a full picture of trends, drivers and impacts.

Our findings inform the design of GLOBE, a repository and analytic platform for individual case study researchers to locate similar case studies and to determine the global relevance of any study or collection of studies. We anticipate GLOBE will significantly alter the processes in which scientific knowledge is produced in Land Change Science.

0949	Beyond the rural-urban dichotomy: preliminary findings from the URBIS Amazônia Project - places, cities and networks in the multi-scale configuration of the urban setting in contemporary Amazônia	Antonio Miguel Vieira Monteiro, Ana Cláudia Duarte Cardoso, Roberto Luís de Melo Monte-Mór, Maria Isabel Sobral Escada, Silvana Amaral, Rodrigo Ferreira Simões, Edson Paulo	Brazil

Domingues, Roberto Luiz do Carmo, Ana Paula Vidal Bastos, Claudio Almeida, Alessandra Rodrigues Gomes, Ciro Biderman, Frederico Roman Ramos

Back in the 1970s, the Brazilian geographer Bertha Becker had already warned us that was necessary to take seriously the urban agenda if we wanted to be serious about environmental policies for the Amazônia region. For decades, the environmental-oriented agenda took a central role on the academic stage. A fairly share of the scientific production dealt only with the "green" Amazônia issues. In certain way, that situation have imposed a visibility regime for urban-oriented studies in the region along all these years. In the Amazônia, the intense urbanization processes in the past decades have produced a wide range of socio-spatial organization of nuclei population. Cities with large concentration of people and services together with small settlements, marked by small shops and houses in the streets of mud. Camps along the side of roads, mining areas/sites, colonization projects, timber industries, cattle-ranching and farm enterprises. Riverine communities, spread over kilometers of rivers. These are images that do not suggest, easily, a traditional view of an urban setting and exposes the complexity of Amazônia's current urbanization process. We have set the *URBISAmazônia Project*[1] in order to shed some lights on the nature of this complexity. We took the view that these socio-spatial forms work as nodes in an *urban system* with *multiple centralities*. The nodes linked through different flows establish a set of interconnected multi-scale networks which rearticulate the regional space based on the local, regional and global forces. The project aims to develop *explanatory models* to clarify the economic, social and cultural circumstances of the *urban phenomenon* at the Amazônia, as a support for decision making and for conception of public and private policies by unveiling how global dynamics, national and regional policies affect local life, where social and environmental problems take place. The Pará state was taken as a case study, once it presents the most diverse mosaic of the socio-spatial forms and their territorial arrangements, either associated to official investments on logistics or to mining or cattle raising activities, and associated to *territories of resistance* (preservation and maintenance of the traditional riverine occupation patterns) in the region. The state is an expansion frontier, and clearly exposes a vicious cycle between urba-rural poverty and environmental problems, despite the big amount of global capital circulating within its territory. The methodological approach taken seeks the possibility of systematic empirical exploration through the use of modeling, simulation and field work, building a qualitative-quantitative instrumental to help our understanding and to highlight the gaps in knowledge that we have on the processes that produce the observed socio-spatial dynamics at macro, meso and microescalas and the nature of their interactions. Over the last year and half, the *URBISAmazônia* has provided preliminary findings, that we show here, related at the Macro scale, where we can observe the *upper circuit* of the urban economy, with the results from a Computable General Equilibrium Model- **EGC-Amazônia**, developed for the Legal Amazônia and incorporating the most recent data on land use transitions (TerraClass 2008,2009) and the private and public investment plans for the region and, a review of the cities centralities model based on a spatial model that has put public services and spatial interactions on its core and have refined the 2008 IBGE REGIC urban network data; at the Meso scale, a demographic analysis observing the new intra-state mobility patterns and families behaviour has been developed; At the intra-municipality scale new urban landscape metrics have been developed and

applied in order to characterize the urban continuum linkage in order to observe the intensity of the urbanisation; while at Micro scale, social network models have been adapted to incorporate spatial aspects and have been applied to describe and analyse the localities and its dynamics using field-work data, revealing part of the connections and disconnections of *lower circuit* of the urban economy.

0953	Climate extremes and risks to global food security	Benjamin Stuch, Rüdiger Schaldach, Ellen Kynast	Germany

Climate change affects land-use pattern due to biophysical and socio-economic changes, which can occur directly or indirectly as a consequence of cascade processes. Our research emphasizes climate system dynamics and how these can risk food security and in particular food production stability. While several studies have analyzed land-use responses to mean climate change impacts, we additionally analyze changes in the frequency of extreme events. Climate impacts on food production and potential global food availability are vital aspects for assessing food security but need supplement by socio-economic dimensions that encompass food access for example due to international trade. We categorize countries in respect to food system capacities, for example whether they are food importer or food exporter. Changing climate variability in food importing regions has regional effects such as national food price volatility. While wealthy nation can compensate food production variability by increasing food imports, poor countries are more vulnerable to food shortages and hunger since access to global markets is limited. In contrary, climate variability and related food production instability in food exporting regions has global consequences on food supply and food prices. The socio-economically linked food system makes it possible that climate change impacts in food exporting regions indirectly impact other regions that are not necessarily affected by climate change directly. In addition to population growth and changes in diet preferences climate change adds another pressure to future land-use systems. In particular changes in climate variability are not yet sufficiently considered as direct or indirect driver for agricultural expansion and intensification.

In our study we utilize global climate data (IPCC-AR5) to simulate annual crop yields on a global grid for a baseline period 1971-2000 and a scenario period 2041-2070. The yield data are analyzed for three parameters that combined comprehensively describe changes in the food production system (long-term mean, year-to-year variability and risks of extreme events). The study highlights limitation by current land-use systems in achieving persistency of food supply under changing climate as well as adaptation potentials due to land-use transitions. In this respect we contribute to the main theme "impacts and responses" and would like to discuss our approach and results in the session "potential of improving food security through closing yield gaps and land use expansion".

0955	Food vs. fuel: the role of yield variability in realizing food security	Christopher Bren d'Amour, Felix Creutzig	Germany

The role of biofuels has been a much debated subject in recent years. Arguably the biggest area of concern in this context is the competition with conventional food production over available land and feedstock. The deployment of bioenergy is one of the factors that have put tremendous pressure on resources and land use.

In normal market conditions the supply of feedstock exceeds the short term demand. In that case the impact of biofuels on the inelastic demand is only marginal. However, smaller supply side effects (e.g. low yields due to extreme weather) caused by short term climatic anomalies could already lead to critical price spikes on a regional level. Demand for additional feedstock for bioenergy deployment would aggravate that effect substantially. Assuming that climate induced supply shocks will increase in the future, the role of bioenergy as an additional demand driver should be scrutinized.

While prior research partially suggests that bioenergy impacts food prices only marginally, we identify a

significant connection when accounting for statistical variability in annual yields. When conducting research on the implications of climate change, most scientific researchers and models examine changes in the mean. To assess the primary short term economic impacts of climate change on the food price however – which are most likely to threaten food security – we should shift our focus to the variability. Extreme weather events will be a more frequent phenomenon and will cause low yields. As a consequence, statistics of climate variability have to be observed closely before policies promoting biofuels are implemented.

In this paper we model the link between climatic variability and yield variability. On that basis we identify the probability of climatic events that would have a serious negative impact on agricultural yields under different bioenergy deployment scenarios. The results demonstrate that bioenergy deployment leads to only marginal food price increases in average but impacts food security significantly in years with harmful and large-scale climate events (drought, flooding, etc.). Our model indicates that adaptive and robust policies could minimize the risk for food security.

| 0956 | Indicators for describing and understanding land use changes - an integrated approach | Anne Gravsholt Busck, Hermann Lotze-Campen, Marcus Lindner | Denmark |

Land use changes are occurring at different pace and with a variety of drivers throughout the world. Changes can be identified at different temporal and spatial scales and using a variety of indicators, depending on the purpose of the investigation. Often researchers focus on one or a few methods when describing land use changes, the underlying processes and eventually possible futures – eg. detailed case studies of local land use change and decision-making processes or analysis of overall trends using large datasets at macro scale. In order to understand the complexity of land use changes and drivers it can, however, be fruitful to combine methods. In the VOLANTE project a number of methods and indicators are used to identify and understand paths of development in a European context. Drawing on these results the presentation explores how identification of processes and drivers through local and regional case studies using different temporal scales can be combined with European-wide modeling approaches and used as input when developing and understanding possible future pathways. The presentation focus on the development and use of indicators of intensity - emphasising significant synergies, which can be achieved when integrating approaches across temporal (from decades to centuries; past and future) and spatial (from local to European wide) scales, and also important challenges are identified.

| 0958 | Climate impact on land use distribution | Xiaolin Ren, Peter Lawrence, Brian O'Neill | USA |

Land use and land cover change play an important role in global climate change. For example, about 20% of the human caused CO_2 emissions in the 1990s were due to deforestation (Denman et al, 2007) and land use is also central to evaluating impacts and adaption options related to agriculture, forestry, and biodiversity. Land use and climate affect each other in both directions. Different land use scenarios have different consequences for emissions of carbon and other gases, albedo, and the hydrological cycle, all of which can affect climate outcomes. On the other hand, different climate outcomes affect vegetation and land productivities (for example for crop growth) and thus the level and spatial distribution of land use.Many studies have included the impacts of land use on climate at both regional and global scales. For example, the Representative Concentration Pathways (RCP) used for carbon-climate projections assessed in the IPCC Fifth Assessment Report include scenarios of changing land use. In contrast, the impacts of climate change on land use distribution have not yet been well studied, especially at the global level. In this study, the integrated Population-Economy-Technology-Science (iPETS) model, an integrated assessment model for projecting future energy use, land use, and

emissions, is linked with Community Earth System Model (CESM) to evaluate climate impacts on land use distribution and the food sector.

Climate affects land use through two sets of parameters in iPETS model: land productivities for different types of land use, and total arable land. Two scenarios are simulated in this study, one with climate impacts and the other without. For the scenario without climate impacts, land productivities are calibrated so the land use distribution matches the land use scenario of RCP 8.5 and total arable land is constant over time. For the scenario with climate impacts, CESM will produce an alternative climate scenario with corresponding changes in land productivity and total arable land. These parameters will be upscaled to a regional aggregation level and employed in the iPETS model to produce a new land use scenario. Given the different spatial scales of CESM and iPETS model, an important step is to iterate the model runs so the aggregate land productivities used in iPETS model are consistent with the CESM spatially explicit outputs. Then the impacts of climate on land use, one of the main drivers for land use change, are evaluated by comparing the outcomes from the two scenarios.

0960	Biofuel policy and stakeholder perspectives - Initial impacts of EU sustainability criteria on the Swedish biofuels sector and implications for land use	Sara Brogaard, David Harnesk, Philip Peck	Sweden

Global demand for transportation biofuels has increased significantly under the influence of policy interventions. These typically seek Greenhouse Gas (GHG) emission reductions, improved security of supply and rural development opportunities. However the impact of increasing biofuels production for land use and cover has become a global concern. In response, institutional arrangements known as certification schemes have been put in place to counter negative externalities. In the European Union, certification according to sustainability criteria for biofuels must be undertaken in order to qualify for government support, and for fuel consumption to count towards national renewable energy targets set in the Renewable Energy Directive (RED). Biofuels, locally produced or imported, must comply with minima criteria that avoid the use of high biodiversity and high carbon stock land for feedstock production, and set threshold levels for GHG reductions. Several Voluntary certification schemes are also available and often add social criteria such as land and resource rights, food security perspectives and labor rights.

In Sweden, one of the first countries to transpose the RED sustainability criteria into national law, a majority of the economic actors opted for the national scheme supervised and regulated by the Swedish Energy Authority. Documenting experiences a year passing after the first annual reporting of sustainability data, this study aims to analyse effects of this public-private governance initiative, with focus on the experiences and perceptions of the economic actors active in the Swedish biofuel arena. Acknowledging the importance of interlinking science and technology for sustainability with the perspectives of key actors, research design and analysis for this paper rests on three information attributes; salience, credibility and legitimacy (Cash et al 2002).

A questionnaire submitted to all economic actors required to report sustainability data in order to receive tax exemptions was used to examine aspects such as: a) views on existing and further development of sustainability criteria including stakeholder participation b) methods and costs of compliance c) the broader range of mechanisms affecting the biofuel market, and d) future investment strategies in a sustainability context. In parallel to documenting recent experiences of sustainability criteria implementation in Sweden, we discuss potential effects of suggested amendments of the EU RED that include encouraging greater market penetration of advanced biofuels, and inclusion of ILUC factors for biofuels.

The study aims to provide insights upon the important question if and how public-private policy mechanisms embedded in the EU RED really can promote sustainable biofuels and reduce negative

impacts on land use in a Swedish as well as in a global perspective.			
0961	Ecological complexity and integrity of landscape and ecosystem services	Peter Sabo, Tomáš Lepeška, Eva Uhliarová, Ingrid Turisová, Ľubomír Repiský	Slovakia

Building on the concepts of non-equilibrium thermodynamics and ecological complexity theory we provide a tool for assessment of ecological complexity of ecosystems and landscape. In our presentation we demonstrate a new methodology to calculate a vertical-functional pillar of the landscape ecological complexity (LEC), based on indexes of ecosystems and landscape capacity to dissipate solar energy (and partially also of their vascular plants diversity). From the LEC index we further derive a landscape ecological integrity (LEI) index as a sum of landscape ecosystems ecological distance to their referential native ecosystems. Consequently we combine LEI index and the default capacity of the undisturbed natural, seminatural or anthropogenic ecosystem to provide ecosystem services. In this way we obtain an assessment of the capacity of landscape to provide ecosystems services (LES) to human society and their change in time.

We attempted to calculate the LEC, LEI and LES indexes in the model area of the Piešťany spa town and its surroundings. The presentation illustrates cutouts from the actual land cover map (LCM) of the area evaluated, the map of the calculated components of the radiation balance. The longwave infrared radiation was calculated from the thermic map of the selected corridors, obtained from the airplane FLIR thermovision camera. Calculation of radiation balance allowed us to calculate the exergy dissipation capacity for each polygon in the LCM and then also for the landscape as a whole. Taking into account also plant species diversity we were able to evaluate landscape ecological integrity (LEI) index as the ecological distance of the current landscape LEC to the referential one represented by the map of natural reconstructed vegetation.

 To each ecosystem type we allocated a default capacity potential of ecosystem services it may provide, using standard approach (scope 0 – 5). By means of combining this ideal capacity of each respective ecosystem (or artificial surface) of the landscape, with their real status indicated by LEI map, we produced the map of the assessed capacity of individual ecosystems and landscape as a whole to provide ecosystem services to human society (LES). Comparing actual land cover maps with historical ones we may estimate LEC, LEI and LES changes in time.

0963	Evaluating changes in land use and food security: does the data indicate an optimal level of vegetation to be conserved in Nepal?	Steven Archambault, Alok Bohara, Keshav Bhattarai, Kristine Grimsrud	USA

The growth in population and resulting increased demands for food is a leading contributor to the conversion of forests into agricultural lands in many poorer countries. Through the combination of multiple year household food production and geospatial land use data in Nepal, this research builds a dynamic benefit cost optimal control model to analyze the trade-offs between stocks of primary vegetation and agricultural production, providing insight into the long-term balance between natural capital quality and food production. The hypothesis is that healthy stocks of vegetation provide ecosystem services including protection from flooding and erosion, maintenance of soil quality, and contributions to the overall health of watersheds that improve the output provided by farms. While there is a need to provide food for growing populations, it is necessary to maintain a stock of vegetation so the mentioned ecosystem services are not lost. Losing ecosystem services will likely result in increased costs for farmers if they must mitigate erosion, flooding, and poor soil quality. The model developed

analyzes food production and consumption decisions, taking advantage of available data on the market value of crops produced per land area and the cost of production. The household and vegetation data is analyzed in several time series panel econometric models to capture 1) factors causing vegetation changes, 2) factors impacting market value of agricultural production (including for subsistence level farming), and 3) the relationship between household production costs and vegetation quality. The econometric results are used to populate the developed optimal control model. The analysis determines optimal levels of per capita ratios of vegetation cover to agricultural land for the three geographic belts of Nepal: Terai, Hills, and Mountain regions.

In my presentation I will discuss a basic overview of the analytical model, datasets used, econometric techniques employed, and primary results. I believe this presentation fits well with the system dynamics session, as I have merged multiple data sets to analyze the effects of land use changes over time. I analyze the datasets using time series panel regression. I would find it very useful to discuss the challenges I have faced and the solutions I have utilized to analyze the data (e.g. merging socio-economic data with imagery data that are measured on different time scales).

0970	Leveraging globalization for forest conservation in the Brazilian Amazon	Holly Gibbs	USA

Brazil is a world leader in soy and beef production and exports. The portion of soy and beef exported from the Brazilian Amazon has quadrupled over the last 12 years. While this rise to agricultural superpower has undoubtedly led to increased deforestation and land grabs, we also see emerging opportunities to shift how agriculture is practiced through international market pressures.

We identify the international production and shipping hubs for soy, beef, and leather, illustrating the potential role of these demand-side levers to reduce deforestation. Specifically, we quantify and map the changing destination and portion of beef and soy production volume that is exported by specific companies at the municipality level over the last 12 years. We also identify the production hubs for export commodities and quantify the area of land influenced by specific companies and country export destinations.

Further, we analyze the potential of global market pressures to reduce deforestation in the Amazon through aggressive NGO campaigns, roundtables, certification schemes, and zero-deforestation agreements. We present a compilation of trade data, spatial analyses, and fieldwork to highlight the weaknesses and potential of these international efforts to go beyond domestic policy. We show results of property-level supply chain mapping studies evaluating the impacts of demand-side conservation efforts for soy and cattle in the Brazilian Amazon. Our results indicate that global market pressures can be powerful levers to both increase production of commodities and to reduce deforestation.

0972	Land use and land cover change scenarios for the Isiboro Sécure National Park and Indigenous Territory (TIPNIS): potential impacts of an international road construction	Graciela Tejada, Luciene Gomez, Chistianne Riquetti, Ana Gabriela Araujo	Brazil

Deforestation of the Amazon rainforest is threatening not only the ecosystems services that they provide but also the survival of indigenous cultures. Indigenous territories and protected areas play a crucial role in the Amazon forest conservation, although these areas threatened. The Isiboro Sécure National Park and Indigenous Territory (TIPNIS for its Spanish acronym) of Bolivia has been deforested in the southern part (known as polygon 7 that is the sustainable use zone), mostly by illegal coca cultivation. The main threat of the TIPNIS is the possible construction of the Villa Tunari–San Ignacio de Moxos highway that pretends to link Cochabamba and Beni Departments. This conflict had derived in two indigenous national marches (8th and 9th) leaded by local and national indigenous organizations of the Bolivian Amazon, arousing the attention of society, environmentalists and human rights defenders

worldwide. In contrast other groups (mostly Andean immigrants, part of the Coca farmers Federations) and the Bolivian Government promote the highway construction. Thus, the TIPNIS conflict had revealed internal contradictions in the self called indigenous government and tensions between conservation and development. In this context, the aim of the study is to create three land use and cover scenarios until 2050 for the TIPNIS considering the impacts of the Villa Tunari–San Ignacio de Moxos highway construction. Scenario "A", sustainability, has no road construction. Scenario "B" business as usual, considers the construction of the road in a long term and scenario "C" expansion of the agricultural frontier, reflects the immediate construction of the road. Each scenario is based in socioeconomic, policies, infrastructure, accessibility and environmental factors. For this, we apply the LuccME framework for spatially explicit land use change modeling with a spatial resolution of 5km x 5km of regular cells with a spatial regression value of R2=0.85. Determinant variables are, distance to roads, distance to communities with more than 400 habitants, connectivity index to national markets and the slope. With the highway construction (scenarios B and C) deforestation is progressive until it has completely paved connectivity, from this point, deforestation increases exponentially. Under no road construction (scenario A) the deforestation increases in the south of TIPNIS but does not exceed the polygon 7. Probably the real scenario is a mixture of all, but the spatial modeling helps decision makers, society and stakeholders to see the main trends of future deforestation and thus involved the protected areas and indigenous territories conservation.

0973	Spatial relationships between fire activity and connection to markets in Amazonia	Manoel Cardoso, Luciana Soler, Ana Aguiar, Gilvan Sampaio	Brazil

Fires are major disturbances for the ecosystems in Amazonia, linked to emissions of greenhouse gases to the atmosphere, changes in carbon and nutrient cycles, and impacts on the vegetation characteristics and distribution. Contemporary patterns of fire activity in Amazonia can be largely explained by a combination of climate and land-use dynamics. Here we present analyses that explore spatial relationships between fire activity and connection to markets, a major driver for change in Amazonia. Data on fire activity are based on remote-sensing detections from MODIS sensor between 2001 and 2010. Information on connection to markets in the period was calculated considering Euclidean distances and topological connections to important consumption markets, weighted by paved and non-paved roads network. Confronting both datasets, we found that the number of fire detections was different according to the proximity to consumption markets. In summary, low fire activity was related to either very low or very high connectivity to markets. High fire frequencies, on the other hand, were related to intermediate values of connectivity to markets. These broad-scale patterns are consistent with the observed dynamics of deforestation frontiers. For example, land-cover change in areas with low connectivity to markets is generally diffuse. Also, very high connectivity can be associated with places where fires do not figure as a tool in most cases, such as large-scale agriculture and urbanized areas. These results have thus potentially interesting implications for understanding the characteristics and implications of the land change process in Amazonia, by contributing to current descriptions of the occurrence of fires and their relationships with factors linked to human activities in the region.

0974	Changing climate, changing behavior: flood hazards, risk perceptions and land markets	Tatiana Filatova	The Netherlands

Spatial econometrics and analytical spatial economic modeling advanced significantly in the recent years. Yet, methodologically they are designed to tackle marginal changes in the underlying dynamics of spatial systems. In the world with climate change, however, abrupt sudden non-marginal changes in economic system are expected. This is especially relevant for urban development in coastal and delta areas where the probabilities of natural hazards such as catastrophic floods and hurricanes increase

dramatically with climate change. Critical transitions in spatial patterns and prices in those areas are anticipated. The issue is complicated by the fact that disaster risk is spatially correlated with rich environmental and urban amenities of those locations. They drive population clustering and growth of property values in flood-prone areas, rapidly increasing exposure and vulnerability in coastal areas. Land markets fuelled by individual preferences for locations play a crucial role in the formation of spatial patterns of activities and the economic value they receive (Filatova et.al. 2009). New information about climate-related risks and microlevel interactions among economic agents alter individual location choices and impact urban land markets dynamics potentially leading to the emergence of critical transitions from the bottom-up.

We address the methodological challenge of studying non-marginal abrupt land-use transitions by incorporating adaptive expectations about land market dynamics into a spatial agent-based model (ABM) of a coastal city. We build upon previous research on agent-based modeling of urban land markets, and make a step forward towards empirical modeling by using actual hedonic analysis and spatial data for a coastal town in North Carolina, USA. In our ABM heterogeneous household agents (buyers and sellers) exchange heterogeneous spatial goods (houses) via simulated bilateral market interactions with decentralized price determination. In contrast to other ABM markets, which model homogeneous goods exchange, spatial goods in this ABM market are quite heterogeneous differentiated by distance to CBD, coastal amenities, probability of hazard and structural housing characteristics. Adaptive expectations about property prices in the areas with increasing climate-driven hazard probabilities are formed by real estate agents, who learn the efficient price of any unique house and who often participate in transactions of such infrequently-purchased good as a house. Decentralized urban market with adaptive expectations about property prices in the areas with increasing hazard probabilities, may experience abrupt changes that shift the trends of spatial development and pricing.

| 0979 | "Expert" and "non-expert" decision making in a participatory game simulation: a farming scenario in Athienou, Cyprus | David Massey | USA |

The Greek-Cypriot farming village of Athienou, located in the UN Buffer Zone in Cyprus, lies on the front lines of a complex stalemate that continues to politically divide the island of Cyprus. Developing an understanding of how Greek-Cypriot farmers' agricultural decisions affects land use/cover change (LUCC) is crucial for the formulation models and assessment/sustainability plans for future scenarios. Drawing from the Companion Modeling (ComMod) approach (Bousquet and Trébuil 2005), this case study uses ethnographic fieldwork and grounded theory to develop knowledge about Greek-Cypriot farming practices and the drivers of agricultural LUCC in Athienou. A conceptual model of the Athienou agricultural system is built as a Role Playing Game (RPG). Two sets of participants, Greek-Cypriot farmers ("experts") and undergraduate students ("non-experts"), play the RPG which focuses on a scenario where the Turkish Occupied land to the north of the village becomes available for farming again. Their decision making strategies and outcomes are compared against each other and used to develop an Agent Based Model (ABM).

This research examines LUCC in Cyprus on a local scale using the framework of 'complexity'. Tools such as RPGs and ABMs are useful in describing, understanding, and examining complex phenomena and their feedback processes which link human and natural systems. Although the results are preliminary, describing, understanding, and explaining the multiple drivers and linkages that influence and affect the Athienou agricultural landscape is a critical step in developing management plans and future sustainability assessments.

| 0981 | Transformations in urban and peri-urban agriculture and the impacts on urban socio-ecological systems – implications for ecosystem | Camille Nolasco, Vicente Santos Pinto | Brazil |

	services: a case in Brazil		

The recent urbanization process in Brazil has acquired a characteristic of expansion that differs from the model highly concentrated in metropolitan areas, expanding in number and size, the medium-sized cities with the same patterns of urbanization than metropolitan areas (CARVALHO, 2003). And as long food production spaces are being reduced by the increase of urbanization, there is also more demand for food to urban dwellers, dependents on food market (RUAF, 2009) and vulnerable to supply and prices fluctuations.

Knowing that global changes are not equal for all, or occur in the same way throughout the globe (Hulme, 2009), impacting most the more vulnerable ones, it is necessary to better understand the connections between urbanized space, food production, environment and people within urban systems, and how these variables relate to ecosystem services.

In this sense, this work aimed to understand the ecological dimension of urban agriculture (UA) in intra and periurban areas of the main district of Juiz de Fora, Minas Gerais State, Brazil. The research found 179 areas of UA occurrence, classified as: Social Projects of Municipal Schools, Institutions (public, religious, welfare and medical units), Commercial Productive Areas and Productive Backyards (in one neighborhood - "Monte Castelo"). Semi-structured interviews and field observations were carried out in a total of 77 areas.

Empirically, it was possible to investigate the interactions between actors and environment. The results show a number of 173 cultivated plant species in the areas of UA, many of them, native from Brazil or Latin America, and also 69 species of wild animals that benefit from cultivated areas. The survey also demonstrates the importance of those areas of UA for the conservation of natural resources and biodiversity, for the maintenance of traditional knowledge and highlights that it could be considered as a valuable tool for ecosystem services provision toward cities' sustainability.

0982	Large area biomass monitoring using MODIS NDVI time series data	Nagendra Singh, Varun Chandola, Budhendra Bhaduri	USA

Global satellite imagery collected consistently and repeatedly over time provides an excellent resource for monitoring the biomass for large geographical regions in an online and timely manner. The key challenges associated with large scale biomass monitoring include: a). Developing an automated algorithm that can accurately locate the time when the biomass usage pattern changes, and b). Scaling the change detection algorithm to the global sized remote sensing imagery. We have developed a spatio-temporal change detection method that allows online monitoring of Normalized Difference Vegetation Index (NDVI) profiles collected using the MODIS instrument. The method provides change alarms at the resolution of the raw data, i.e., at 250m x 250m spatial resolution and every 16 days. The method uses a Gaussian process regression based predictive model to forecast the expected value at any given time. A spatiotemporal kernel function is used to incorporate the spatial and temporal dependencies including the fact that the NDVI data has a strong seasonal component. The forecast at a given time and spatial location is estimated by conditioning on the past history for the immediate spatial neighborhood. The forecast and true observations are then compared and the difference between the two quantities is combined over time within a statistical quality control framework called Exponential Weighted Moving Average (EWMA). The EWMA procedure emits an alarm signal whenever the underlying different statistic crosses a predetermined threshold. The EWMA change procedure output is then combined in a statistical smoothing framework to incorporate spatial context. At this stage, we obtain a binary score for each pixel at every time instance at which the MODIS data is sampled (23 times a year). The bi-weekly scores are aggregated to obtain an annual score. The annual score indicates if the corresponding pixel experienced a change in its vegetation profile (NDVI) or not for every year. We implemented this algorithm on a stack of 230 (16 day composites for 10 years) MODIS NDVI tiles for the mid-western

US to understand changes in vegetation pattern which may have occurred due to the impact of bioenergy over the past 10 years. To address the computational challenges of processing this large volume of data we developed multiple implementations of the Gaussian process method that can be deployed on different high performance computing architectures.

0984	Challenges in payments for environmental services policies: tradeoffs between energy, water and land services in Vietnam	Pamela McElwee, Hue Le, Nghi Tran, Tuyen Nghiem, Huong Vu	USA

An explosion of new market-based policies for environmental services (ES) has expanded across the globe in recent years, sharing in common a goal of using economic incentives to value provisioning services for human sustainability, such as carbon storage, water regulation, and biodiversity, in the hopes that the market provides a more efficient, less expensive policy outcome. Payments for environmental services (PES), which provides funding from users of ES to those who provide soil, water and forest conservation is one of the most well-known of these policies. However, despite the widespread expansion of PES, fundamental questions have not yet been answered regarding PES's impacts and effectiveness, particularly with regard to governance tradeoffs. For example, the difficulties of measuring some ES has led policymakers to focus on a narrow range of services for PES payments, primarily water provision, leading to increasing questions regarding the tradeoffs that will be required. For example, projects that focus on a single ES, such as soil conservation, can be detrimental to the quality of other ES, like biodiversity.

This paper will explore the problem of ES prioritization and tradeoffs in PES policies using a case study of Vietnam. Since 2011, the author and collaborators in Vietnam have been carrying out field research in several provinces that have PES pilot programs that have paid households for forest conservation. While Vietnam's PES projects are supposed to collect fees from energy, water and land users, most fees collected so far have come from hydroelectric energy suppliers. Examination of these PES projects shows that the difficulties of measuring ES provision has led policymakers to focus on a narrow range of services, primarily water provision, as it is easy to measure and price water ES, more so than for biodiversity or landscape amenity. The Vietnam case shows that while water PES may be easier to assess, there are real consequences of focusing on this sector to the exclusion of other ES. The ability of local areas to raise funds for forest conservation from PES levied on hydropower may be an incentive for increased hydro development in the future, raising serious ES tradeoffs. For example, PES-paying hydropower plants in one studied pilot have been implicated in reducing the water flow to popular waterfalls that were a major driver of tourism to the urban center of Dalat city. Our case study will look at how these tradeoffs have been managed at local and national levels, and raise questions for other similar PES policies elsewhere.

0986	Forest transition in Chile? Assessing the impact of forest sector intensification on native ecosystems	Robert Heilmayr	USA

As one of two South American countries to have reversed persistent losses in forest cover, Chile holds important lessons to guide the creation of effective mechanisms for slowing global deforestation. Rising incomes, labor diversification, and government policies are all influencing the expansion of tree cover. However, much of this expansion has come in the form of monoculture plantations. As a result of this rapid growth of plantation forests, Chile can inform our understanding of the land-use impacts of forest-sector intensification. Plantations provide nearly 95 percent of the country's timber production on 15 percent of its forested lands. Such intensive production has the potential to reduce pressures on native forests. However, plantation expansion has also been an important direct driver of native forest clearing. As a result of these competing interactions, the ecological impacts of Chile's forest transition are unclear.

Careful consideration of the Chilean experience may give forest transition theory greater nuance in describing the range of possible ecological consequences of forest expansion. In this paper, I use a combination of remote sensing and econometric modeling to assess increases in Chilean forest cover over the past 25 years both through rapid expansion of plantation forests as well as gradual regrowth of native secondary forests. By looking at the links between these two trends, I describe the causes of the Chilean forest transition as well as the ecological implications of these national-scale changes. In addition, I consider the complex role of global trade in impacting Chilean land use.

| 0987 | Tele-tenure: emerging forms of local expression of economic globalization | Ariane de Bremond | USA |

The issue of understanding global land use change in relation to processes of economic globalization has become a central concern of land change science (LCS). The notion of 'teleconnections' defined is now being used to describe causal relationships between land uses over geographic distances and provides a useful framework to understand rapid globally-coupled transformations in food and biofuel production, biodiversity and carbon conservation strategies, and their land change implications. Satellite-based remote sensing can now detect and monitor changes in land cover around the globe. Yet it is widely recognized that greater insight is needed into the ways that globalization processes tend to project specific suites of land use practices across the world within the fabric of institutions. Interdisciplinary approaches are indispensable to explain both the forms and patterns of land change as well as their implications to the varied stakeholders of coupled environmental and human systems. This presentation will demonstrate how political ecology and the integrative tools of LCS enable the 'global-to-local' linkages of social factors generating and responding to land change to be understood and made useful for decision and action [*Turner and Robbins*, 2008]. Generalized global typologies of land tenure systems can help to reveal both the potentials and constraints for economic globalization to enact regime shifts in local land systems. Applied to a small group of case studies, the roles of land tenure institutions in shaping the course of land system transitions in the face of global economic pressures provide general insights into the cross-scale global-local social interactions of "Tele-tenure". For example, smallholder cooperative tenure systems supporting biodiverse shade coffee landscapes are sustained or lost within the dynamics of global coffee markets. Lease concession systems engender commercial plantations driven by demands for biofuels, agricultural commodities and carbon mitigation. The potential for success in REDD+ programs, with frequent emphasis on communal forms of tenure security will succeed only to the extent that such forms of tenure are themselves secure and sustainable, no matter the demand for carbon forests. The presentation contributes the conference theme of 'land governance' (4) and 'local land users in a teleconnected world' (2) and responds to the session call for work that explores the social complexities of global environmental change. Rich traditions in anthropology, political economy and political ecology can support new efforts to reveal and act upon the processes through which the coupled local and global dynamics of land tenure guide the global patterns of land use transitions.

| 0989 | Using models in social innovation labs: modeling agro-economic systems in Southern Ontario to support innovation in food system policy | Kirsten Robinson, Mark Tovey, Nathan Wilson, Madigan Kim, Chaitanya Dogra, Hala Anwar, Mark Hancock | Canada |

This paper examines the use of spatially explicit models to support policy innovation within a novel facilitated process called a Social Innovation Lab. An increasing number of scientists and activists argue for the need for sustainability transitions. They argue that to address accelerating ecological, social, and

economic challenges we need new forms of problem solutions.

Social Innovation Labs are processes focused on supporting the development of social innovations. Social innovations fundamentally change systems by changing resource flows, authority flows, habits, beliefs, or routines. Social Innovation Labs draw on two distinct traditions. The first tradition comes from whole system methods like Future Search that cultivate common purpose and build a shared energy for shifting systems. The second stems from design lab processes that gather data and research alternatives and engage in creative recombination.

The challenge in combining these methods is to make a rich body of qualitative and quantitative research available to policy-makers. Models play a role in making expert knowledge about linked complex systems accessible to lab participants. We describe the development of the model, the design of an interface to make the model accessible to a diverse team of policy makers, and our experience in the first prototype implementation of a Social Innovation Lab.

We sketch the design, implementation, and validation of a spatially explicit agent-based model of the southern Ontario agricultural system using Repast Library Java, then focus on the development of an interactive web-based game interface designed to make the model useful to lab participants.

A challenge is to develop the model in in a way that expands participants' thinking but does not dominate the conversation To achieve this goal we build a social innovation game that lets participants interact with the model and test the statistical implications of implementing different combinations of social innovations.

This work takes a step towards the use of spatially explicit models within facilitated cross-scale decision-making processes. Since the focus is on developing formal tools to help catalyze sustainability transitions this research it links with the rethinking land change transitions theme. It makes the process of engaging with potential transition pathways accessible to a new group of policy-makers.

0990	Multi-scale approaches for detecting trends and breaks in time series of vegetation indices	Forrest Stevens, Caroline Staub, Jaclyn Hall, Michael Binford	USA

Time series of remotely sensed data are increasingly critical components of analyses of land cover and land use change at moderate spatial resolutions. We present applications of the BFAST algorithm as described by Verbesselt, et al. (2010) for detecting trends and breaks in vegetation indices derived from time series of MODIS satellite data. Our analyses include descriptive statistics of vegetation trends and abrupt changes in coniferous forested areas in the inland Northwest and southeastern United States. We combine our statistical analyses with land cover change information derived from ground-collected and finer-scale, remotely-sensed analyses. Our results underscore how time series analyses, while usually trading off temporal resolution for spatial, should be used in conjunction with a multi-scale approach in order to answer most questions relevant to the intersection of vegetation dynamics and land use decisions of forest management in these regions. We feel that such an approach is generally applicable to studies of how land changes are effected by land management in a broader context, and our work is of general interest to those seeking to use time series analyses in applied, land management-related scenarios.

0994	Land use transitions in Europe - how to reduce uncertainty	Bas Pedroli	The Netherlands

Future land use in Europe is principally unpredictable since we do not know how the factors that influence land use will develop. Developments in global economy, in demography, in climate change, etc., have large impacts on land use, both intended and unintended. Even if these would be predictable, local developments are difficult to predict because of local policies and societal conditions.

Such uncertainty can be approached by building on proven methods to reduce negative effects, or by

developing policies to influence the external system developments, minimising negative influences; this includes questioning the proven methods on new factors and opening a debate on cause-effect relationships.

But addressing our 21st-century challenges with such reactive mind-sets does not fundamentally reduce uncertainty. A clear boundary exists within the science policy interface: scientists tend to refer to the objectivity of their work to persuade policy makers to believe them while policy makers legitimize their decisions referring to the democratic obligation to balance interests and values. The EU VOLANTE project employs ways of foresight crossing this boundary in a collaborative effort, using the knowledge body available from an analysis of the land use processes in the past, and a range of dedicated land use modelling methods to envisage desired futures (Rounsevell *et al.*, 2012). Based on active involvement of stakeholders in the fields of policy, NGO and private sector, the evaluation of normative visions under explorative scenario conditions allows for the identification of trade-offs and robust pathways, improving considerably the span of control of the decision makers.

We will present current insights resulting from the work in progress in this foresight research work.

| 0995 | Uncertainties on land cover and land use data sets designed for global models | Adriana Affonso, Ricardo Cartaxo, Giovana Espindola, Gilberto Câmara, Rita Vieira, Joel Risso, Bernardo Rudorff, Marcos Adami, Aline Soterroni, Fernando Ramos, Pedro Andrade Neto, Alexandre Carvalho | Brazil |

The increasing demand for agricultural and forest products due to population growth and economic development leads to the challenge of producing global information about land conversion. FAO defines land cover as the observed biophysical cover on the earth's surface" and land use as the "arrangements, activities and inputs people undertake in a certain land cover type to produce, change or maintain it". The Earth Observation community has produced global data sets of land cover, such as GLC 2000, GLOBCOVER, PROVEG and MOD12. These data sets are obtained by remote sensing, where the land cover is extracted based on the temporal and spectral response of the Earth's surface. However, to understand land transitions, we need to produce global land use data sets. These data sets cannot be produced using only remote sensing data, and need additional information such as census data, and so, consistent land use and land cover datasets are crucial to assess past and future scenarios on global models. The GLOBIOM, global land-use model for the agricultural, forestry and bioenergy sectors, developed by IIASA, is being refined for Brazil, to project land use change by spatially modeling supply and demand for competing agricultural, bioenergy and forest commodities. Here we report the first results of a multi-source, multiscale approach to combine different sources of information, including time series of remote sensing data (e.g., MODIS and LANDSAT) and census data for global models. We also analyze the reliability between remote sensing maps and land use data sets derived from agriculture census data.

| 1000 | Impacts of landuse change on ecosystem services in the wetlands of Poyang Lake of China | Lin Zhen, Chuanzhun Sun, Chao Wang | China |

Human activities and global climate change have resulted in significant changes in land use patterns, this trend affects major ecosystem services provided by wetlands' ecosystem. Poyang Lake wetlands constitute Asia's largest overwintering habitat for migratory birds, the wetlands also play a key role in soil and water conservation, and food production. Over the past 10 years, the government's ecosystem restoration projects have changed land use patterns of the region, which affects directly ecosystem service and function as represented by the habitat ecology of the wetlands, soil and water conservation function, and food production. In this study we assessed the overwintering migratory bird habitat size and quality, food provisioning, as well as soil and water conservation function of Poyang Lake wetlands from 2000 to 2012 with the InVEST model. Using land use maps, survey data of overwintering birds for each year during this timeframe, and households' questionnaire survey data, we analyzed the trend in migratory species and population changes in the entire wetlands, and around the periphery of Chenlang and Yuanlong villages and found that habitat quality for migratory birds of the Poyang Lake wetlands has improved by 18.75% and 47.73%, respectively, and species and populations of migratory birds have increased. Soil and water conservation function was assessed by the model, and it was found that this function has improved over the past years. However, food production function has decreased due to effects of land conversion from cultivation to natural lake. These results demonstrate the effectiveness of implemented ecological restoration projects, and will be helpful for reviewing the land use policy and providing suggestions for policy makers.

1001	IPCC inventory methodology and estimates for changes in the global soil carbon pool	Tiffany Troxler	USA

The IPCC Task Force on National Greenhouse Gas (GHG) Inventories generates and updates methodology reports used by country's to estimate C stock changes and GHG emissions on managed land. These data are used to report to the United Nations Framework Convention on Climate Change and implemented to aid in national-level GHG mitigation strategies. Guidance and methods for estimating GHG emissions and removals for Agriculture, Forestry and Other Land Use include, for example, CO_2 emissions and removals resulting from C stock changes in biomass, dead organic matter and mineral soils for managed lands, N_2O emissions from managed soils and CH_4 emissions from rice cultivation. A recent supplement to the guidance provided in the *2006 IPCC Guidelines for National Greenhouse Gas Inventories* will cover land-use and land-use change in managed wetlands. For soil carbon, methods include C stock change, estimation of net soil C balance and determination of CH_4 emissions. Major challenges of applying these methods and developing robust estimates are available data and resources. Experts nominated by their Governments work to synthesize available information to develop global defaults, disaggregated, to the extent possible, by factors including soil type, climate zone, land-use intensity or soil nutrient status. These values are then applied to the change in land area associated with a particular land-use or other statistical data on which to base national-level emissions. National-level emission data can improve the robustness of estimates and reduces uncertainties. While scientific studies quantifying the effects of land use and land-use change over continental-scales are increasing, there is considerably uncertainty in national-level inventory estimates due to a paucity of data, especially for developing countries. What is critically needed are data on the global pattern of soil carbon on managed lands, disaggregated across gradients of climate, nutrient status, land-use type and intensity, and vegetation type among other factors. This presentation will review IPCC methodologies for calculating national-level emissions from soils, some of the available data as well as data gaps, and present estimates and uncertainties associated with different approaches.

1005	Land transformations and the recovery of ecosystem services in tropical dry forests	Sandra M Duran, Arturo Sanchez-Azofeifa, Mario M. Espirito-Santo,	Canada

Yule R.F Nunes,
Julio Calvo-
Alvarado, Ricardo
LL Berbara

Tropical dry forests are considered the most threatened tropical ecosystem; yet continue to be among the least protected worldwide. Dry forests have shown a high transformation rate, with a reduction of 48.5% of habitat at global level. Due to this transformation, current extent of dry forests is represented by a landscape of agricultural fields of secondary forests. Secondary forests are increasingly dominating tropical regions; thus estimating the contribution of ecosystem services of secondary forests, and understanding how dry forests recover from previous land uses is essential for developing conservation strategies in the tropics. Our study evaluates the contribution of secondary dry forests to ecosystem services at different scales. At global level, we quantified carbon stocks in mature and secondary dry forests to understand how secondary forests attain biomass-carbon values similar to mature forests, and identified main biotic and abiotic drivers controlling forest biomass variation. At regional level, we evaluated the effect of biodiversity loss on ecosystem services by assessing the relationship between tree-species richness, functional diversity and aboveground carbon stocks in secondary forests with different land use histories. At local level, we quantified carbon retention in forest stands of different ages by estimating growth and mortality rates of tree species, and by quantifying aboveground productivity. Carbon stocks in mature forests varied from 30 to 300 Mg/ha and is constrained mainly by water deficit. Carbon storage in secondary forests ranged from 23 to 88 Mg/ha across stand ages, and is controlled mainly by land use history and species richness. Land use history is also important to explain growth and mortality rates of tree species. Increases of carbon storage in secondary forests are maximized in higher mixed-species stands. We emphasize the need to protect initial and intermediate stages of forest regeneration to allow ecosystem recovery and functioning of dry forests.

This presentation is related to the conference theme by evaluating how land transformations on dry forests have affected the provision of ecosystem services. Secondary forests are becoming dominant in tropical regions, and future provision of ecosystem services for human wellbeing may rely on these modified ecosystems. However, current policies and regulations do not consider these ecosystems for protection or for restricted uses due to lack of information. Our study quantified ecosystem services in forests stands with different land-use histories and highlight the conservation value of secondary dry forests to provide baseline for forest management.

1006	Socioeconomic drivers of forest cover change in Guanacaste Province, Costa Rica	Julio Calvo-Alvarado, Arturo Sánchez-Azofeifa	Costa Rica

Understanding the causes of Tropical Dry Forest disturbance and their cascading effects on many components of this ecosystem are important to identifying negative effects on biophysical resources and human development, and for elaborating policies and strategies for conservation and sustainable management. Our current understanding of the impacts of land use/cover change on human dominated landscapes is strongly linked to a clear understanding of the socio-economic and biophysical forces driving land use and land cover change. These forces, acting at different scales (from the production land unit to the regional and international levels), contribute to regional environmental deterioration trends. In many cases, these trends cannot be fully understood because of a lack of spatial databases of socio-economic and biophysical landscape characteristics.

Traditionally Land Use Cover Change (LUCC) studies have focused on processes of negative land-cover change, primarily deforestation, partially because examples of positive land-cover change were not common. During the last 50 years an outstanding tropical dry forest deforestation and restoration processes had taken place in the province of Guanacaste, Costa Rica, which has given us a unique

opportunity to study the socioeconomic drivers of these processes. Hereafter the purpose of this presentation is to undertake a retrospective analysis of the socioeconomic dynamic of forest deforestation and restoration in Guanacaste from 1960 to 2010.

Our study combined analyses of socioeconomic data and satellite images of forest cover. We showed that forest regrowth observed in Guanacaste after the 1980s was the result of multiple socioeconomic factors. Our results indicate that the degree of incentive provided by conservation policies are not enough to ensure that Guanacaste's forest will be protected against the potentially negative impacts of future socioeconomic changes. The findings from our analysis can assist decision-makers and managers in other regions to understand how social, economic and political dynamics impact the effectiveness of forest conservation efforts.

1007	Trade-offs in climate change adaptation for multi-functional agriculture - a case study from Western Switzerland	Annelie Holzkämper, Tommy Klein, Jürg Fuhrer	Switzerland

Climate change is likely to have impacts on various agroecosystem functions (e.g. crop productivity, soil and groundwater protection). However, there is some scope for avoiding the impacts of climate change through changes in agricultural management. In this study, we explore how management could be adapted to projected climatic changes using a multi-objective spatial optimization approach. Considered management options include crop choice, irrigation, fertilization and soil management. Management changes in favor of one particular function can have negative effects on other functions. We investigate what trade-offs between multiple agricultural functions exist in adaptation efforts in a case study area in Western Switzerland. In this region irrigation is already common agricultural practice under current climatic conditions and limited water availability for irrigation has been a problem in extremely dry years in the past. Conflicts are identified between the production function and regulating functions (i.e. soil and water protection). With climate change these conflicts are projected to aggravate, which stresses the urgency to consider multifunctionality in agricultural adaptation planning. Selected balanced trade-off solutions are presented and discussed as possible goal scenarios for maintaining multifunctional agricultural land use under climate change.

1008	Forest disturbances, management actions, and a changing climates' impact on water supplies: a factorial modeling experiment in the central Rocky Mountains, USA	Brian Buma, Ben Livneh	USA

In the American West, water is an important ecosystem service for millions of residents. The Colorado River basin supplies water for approximately 30 million residents and the much of that supply comes from winter snowfall. Conflicts over shared water resources are common, and concerns about an adequate supply of water in the future focus around the combined effects of increased human demand and decreased supply due to climate change. The forested areas of the southern Rocky Mountains function as snow catchment areas, moderating flow and minimizing wind loss of snowcover in the winter. Disturbances such as mountain pine beetle (*Dendroctonus ponderosae*), forest fires, and windstorms temporarily reduce forest cover, and future climatic shifts are likely to make much of the region inhospitable to current forest tree species. This work explores the effect of climate change, disturbances, and potential management responses on forest-mediated hydrologic functioning in four major watersheds in the headwaters of the Colorado River. Using a factorial-based experimental modeling scheme, we utilize DHSVM (Distributed Hydrology Soil Vegetation Model) to simulate future (year 2100) hydrologic supplies under four scenarios: No future disturbance/extensive future disturbances and no management action (natural migration only)/facilitated migration of new tree species. The purpose is to investigate the utility and value of attempting to maintain forest cover in

areas where current tree species may not be viable in the future, using disturbances as opportunities for new species establishment. Facilitated migration requires considerable effort, both monetarily and politically, and therefore the results give insight into the value of direct intervention by land managers.

1009	INNOVATE - Analyzing land-use change in Northeastern Brazil in a global context	Gerald Silva, Márcia Moraes	Brazil

The region of the middle Sub-Basin of the São Francisco river in Brazil has a variety of water uses / users (consumptive and non-consumptive), which manages itself, with a series of conflicts already established. Moreover, compared with other physiographic regions, the sub-basin contributes with an inflow of approximately 4%, while its demand is 33% of the whole basin. An evaluation of availability and demand of water resources made by the United Nations, and publicized in the Ten Year Plan of the São Francisco Basin Committee, divulges all its sub-basins as critical or with an indispensable need for management.

Regarding uses / users in the middle Sub-Basin of the São Francisco, can be underlined the following, some of them have already established conflicts: Electricity Generation / Tourism and Recreation; Irrigated Perimeters; Aquaculture; Navigation.

The hydro-economic models (Harou et al, 2009) basically represent the hydrologic, engineering, environmental and economic aspects of water resources systems on a regional scale within a coherent framework. The idea of these models is to include economic concepts in water resources management models. An essential feature is the design of a tool to answer questions and provide subsidies for public managers and economic agents. However, the design of the model depends on the quality of existing data deriving from methods of solution and types of results obtained.

The development of a hydro-economic model for the region will identify an optimal economic allocation between uses and is planned to be developed within the economic sub-project of the project Innovate. Such a model should support the development of an integrated plan to support the management in order to maximize the economic benefits of all uses in a local level.

This model is capable of estimating not only direct economic impacts (such as production levels for goods and net benefits) due to different water allocation policies, but also associated environmental impacts by means of the water quality constituent values that the model itself calculates endogenously. Different restrictive levels for water quality constituents, standard classes and remnant or ecologic flow rate values, which stand for the institutional limits provided exogenously, can also be assessed by means of the model, in line with direct economic impacts.

1010	LEGATO - Ecosystem services and ecological engineering in South East Asian rice-based production systems under climate and land use change	Benjamin Burkhard, Anja Müller, Felix Müller, Josef Settele	Germany

Global scenarios on demographic development, climate change and economic trade patterns provided by the GLUES project are used to assess effects on land use schemes at regional scales in South-East Asia. The focus of the LEGATO project is on varying local as well as regional land use intensities and biodiversity, and the potential impacts of global future climate, land use and demographic change. Key issues related to demographic development include population growth leading to increasing food demands, urbanisation and lack of agricultural labour. Climate change can lead to water scarcity, a serious problem in water-intensive rice agriculture. The participating European and Asian teams have defined specific ecosystem functions (ESF) and services (ESS) in the respective social and ecological context they are working in based on results from stakeholder interviews and focus group discussions. Nutrient cycling has been selected as one focal ESF as well as biodiversity. Biocontrol and pollination have been chosen from the group of regulating ESS, from provisioning ESS crop production (i.e. rice,

the key staple food for a majority of the human population) was selected. Cultural identity, landscape aesthetics and knowledge systems represent the cultural ESS. For the analysis of the human-environmental interactions within irrigated rice cropping systems, these ESF and the services (ESS) they generate are quantified (based on comprehensive field measurements, interviews and ecological modelling) and indicated. Moreover, different aspects of human well-being such as income generation are assessed.

The LEGATO study design, including seven intensive test areas of 15x15 km² in Vietnam and on the Philippines, has been set up in order to be representative for different rice cultivation strategies with varying production intensities and under different socio-ecological conditions. Quantitative and quantitative as well as spatially explicit ESS modelling methods are applied in the test areas. The global LPJmL land dynamic vegetation and water balance model will be downscaled and coupled with further models in order to provide results useful for the LEGATO study design. The results will reveal ecosystem service providing units (SPU) and based on the Driver-Pressure-State-Impact-Response (DPSIR) model, the project consortium will be able to identify socio-ecological drivers of prevailing land use dynamics, the state of ESF, and resulting impacts on the supply of ESS. In the end, LEGATO will provide recommendations for sustainable land management based on ecological engineering principles under consideration of multiple future risks.

1012	Integrating indigenous knowledge with geospatial technologies to assess drivers of vegetation cover change in Falgore Game reserve, Kano State, Nigeria	Murtala Badamasi, AbdulRahman M.A	Nigeria

This study assessed the causes of spatio-temporal changes in the vegetal cover of Falgore Game Reserve (FGR) from 1986 to 2005 using an integrated approach. Vegetation change was extracted from Normalized Vegetation Index (NDVI) derived from four near anniversary imageries (November and December) of 1986 (Landsat TM), 1998 (Landsat TM), 2000 (Landsat ETM+) and 2005 (ASTER). Rainfall was modeled from 20 annual gridded point precipitation data for 19 years at 0.5o resolution covering the study area acquired from GPCC. Three FGDs sessions were conducted with stakeholders to elicit local peoples' perceptions on the causes of vegetation changes and were qualitatively analyzed. Post Classification Comparison (PCC) was used in investigating vegetation changes. The relationship between rainfall and NDVI was assessed using pairwise method. Multivariate statistics (DCA and CCA analysis) was employed to integrate the data from different sources for assessing the causes of vegetation change. PCC showed that vegetation cover has declined in the study area over the period studied. The relationship between mean annual rainfall and mean NDVI showed that there was an inverse relationship ($R2 = 0.14$) with rainfall slightly on the increase while NDVI was on the decrease. Multivariate statistical analysis identify human activities especially agriculture and grazing as the proximate causes of vegetation cover change. In conclusion, vegetation cover in the FGR has generally declined over the duration 1986-2005 due to anthropogenic-led factors than rainfall. The integration of different methods can give a more comprehensive understanding of vegetation changes than any single method.

1014	Land sparing vs. land sharing in the context of the 'land grab' debate: the case of residential tourism in Costa Rica	Femke van Noorloos	The Netherlands

For some years now, researchers, policymakers and the media have been writing extensively about the 'global land grab' or 'global land rush': the phenomenon of large-scale land acquisitions in developing countries. At the same time, the land sparing vs. land sharing debate has evolved into new directions and spurred much discussion. This paper will examine the connections between both debates: how can cross-fertilization offer new insights? First, it will make a critical inquiry by deconstructing elements of both

debates in the framework of sustainable development. Second, a specific case of land-based development will be presented: the proliferation of residential tourism in the northwest coastal area of Costa Rica.

The global trend for large-scale land acquisitions causes much concern. According to many studies, its implications have been mostly negative, with increased preoccupation with food security, rural people's livelihoods, the displacement, enclosure and exclusion of local populations, conflict, and pressure on resources. The myth that targeted land is 'empty', 'unused' and 'marginal' serves to displace many people from their land, particularly in the context of ambiguous and complex land tenure systems. The efficiency and productivity focus of both land sparing and land sharing, and their focus on economic and environmental rather than social values, might further legitimize such events. It is therefore necessary to bring social aspects of sustainability and power relations into the core of the land sharing vs. land sparing debate; while at the same time investigating the link between land use and land tenure systems. Furthermore, governance arrangements are key to both debates: however, the widespread belief in the counterbalancing power of good governance is increasingly challenged.

The case of residential tourism in Guanacaste, Costa Rica, in which 'normal' tourism has been complemented by important real estate and speculative aspects, and land is increasingly 'foreignized' and privatized, can give insight into both 'land grab' and 'land sparing vs. land sharing' debates, albeit from a rather unusual and original angle. The connection between tourism, real estate/ residential development, and conservation is examined : to what extent can these competing claims be reconciled by land sparing or land sharing? What is the role of governance?

1015	Linking smallholders to large-scale biofuel investments: insights from sugar cane schemes in Malawi and Tanzania	Raoul Herrmann	Germany

Biofuels have been promoted in many countries to combat climate change, achieve energy security and revitalize rural areas. However, latest since the 2007 food crisis, biofuels are heavily debated as a threat for food security and are criticized for the potential negative environmental implications. Especially, large-scale biofuel investments in Sub-Sahara African countries, where the biomass potential is enormous, have come under heavy scrutiny as regards to their implications for food security and wider rural development.

The presentation aims at contributing to the debate around large-scale biofuel investments in Sub-Saharan Africa and their welfare impacts in rural producing regions. Previously collected farm household data from sugar cane outgrower and estate investments in sugar and ethanol producing regions of Tanzania and Malawi are used. Estimation results from an analysis on the causal impact of such investments on household welfare outcomes are discussed and institutional arrangements on the investment and operational process compared.

The presentation shows different approaches to integrate smallholder farmers into the supply. The analysis reveals that participation large-scale sugar cane schemes as outgrower farmer or estate worker has a significant positive welfare effect in terms of income and household asset ownership. Investments in food production improve with potentials for contributing to an improved food security effect. However, in spite of these positive effects for participating households, the qualitative analysis reveals problems in the implementation of the investment and operation set-ups of the supply chains, linked to weaknesses of project buy-in by the local population and lack of transparent and inclusive supply chain arrangements.

1016	Global multi-dimensional simulations for framing regional land use change studies	Alexander Popp, Lotze-Campen Hermann, Benjamin	Germany

		Bodirsky, Schaphoff Sybill, Beringer Tim, Hoff Holger, Bonsch Markus, Lucht Wolfgang	

Land use change has to be analyzed at different scales. Regional-scale modeling approaches have the advantage of providing detailed representations of land-use relevant boundary conditions and societal actors. However, they have to make a number of assumptions about the development of major trends outside the specific region, e.g. climate change and other global changes, population growth, economic development, trade, and policy changes elsewhere. On the other hand, global modeling approaches are being used to explicitly project the dynamics of international trade, large-scale climate impacts, and other interactions between regions across the globe. Necessarily, these models have to neglect many specific characteristics at the regional scale, which are especially relevant regarding land use and ecosystem service provision.

As part of the GLUES project, we have developed a large set of long-term model-based global scenarios, ranging from climate change and biosphere change to economic changes related to human diets, land use, international trade and prices. We provide an overview of main scenario results and illustrate the most relevant outputs for linking global-scale and regional-scale land-use change assessments. Project partners have developed a common Geodata Infrastructure (GDI), which provides access to the global scenario results for specific regional case studies. In principle, this allows for easy interaction between analyses across scales.

We discuss whether the provision of harmonized global inputs and a global framing of regional land use change projects around the world is an important element for systematic comparisons, up-scaling and syntheses of ecosystem service assessments. We also show some challenges in analyzing off-site effects and trade-offs between land use decisions in different regions. Finally, we raise the issue of how such a harmonized approach could be sustained for continuous future updates and applications.

1017	Trade-offs of increasing bio-fuel crop production in a German watershed	Sven Lautenbach, Martin Volk, Michael Strauch, Gerald Whittaker, Ralf Seppelt	Germany

Political agendas worldwide include increased production of biofuel. The existence of trade-offs between increasing biofuel crop production and several conflicting objectives is well known. The quantification of these trade-offs is an important information for land management. However, the quantification of these trade-offs is typically based on the comparison of a limited number of plausible alternatives. Since relationships between the different objectives can be expected to be complex such an analysis might not provide sufficient details to describe the functional relationship properly. We present results based on a multi-objective genetic algorithm which estimates the set of Pareto optimal solutions which describes the trade-offs between the objectives. For each solution at the Pareto frontier, no solution can be found that would increase one objective without decreasing another objective. They represent the (estimated) best options given the model and the specified control options. Our analysis was based on two alternative biogas crop production schemes: a corn based production scheme and a two-culture production scheme. The integrated river basin model SWAT was used to evaluate the effects of the different production schemes on bioenergy crop production, food and fodder crop production, water quality and low flow discharge in a medium sized German watershed (~320 sqkm). These four objectives had been identified together with local stakeholders. Our analysis studies the effect of

different crop rotation. We created a set of plausible crop rotations that are either currently used in the region or crop rotations that allow an increasing biogas production either based on corn or on the two-culture system. The optimization algorithm assigns crop rotations to the different parts of the watershed and compares the options with respect to the four objective functions. We focused on agricultural land use modifications: forest, grassland, urban areas and wetlands there not modified during the analysis. The two biogas crop rotation schemes showed significant differences in their trade-offs with water quality and low flow conditions. Expectedly, the combination of all three crop rotation sets allowed greater flexibility and outperformed therefore the solutions achievable by the focusing on one biogas crop rotation set. To assess the robustness of the solutions, we compared trade-offs under current climate conditions with trade-offs under two different regional climate scenarios. The estimated trade-offs differed significantly under the different climate condition, highlighting thereby that trade-off analysis has to consider changing boundary conditions.

1018	Carbon and species dynamics following slash and burn agriculture in the Miombo woodlands of Tanzania	Iain McNicol, Casey Ryan, Mathew Williams	UK

The Miombo woodlands, a type of woody savanna, are the dominant vegetation cover in southern, central and eastern Africa. Intense poverty and a lack of economic development mean there is a heavy reliance on the woodlands for local livelihoods. Rising populations are increasing this pressure driving extensive land use change (LUC), mostly for the small scale production of food and cash crops. Shifting cultivation is the most common form of agriculture in these areas and the constant turnover of land gives rise to complex mosaic landscapes, with mature miombo interspersed with land parcels in different stages of cultivation or abandonment.

Increasing efforts are being made to restore degraded woodland for the purpose of climate change mitigation and poverty alleviation (REDD+). Alongside carbon benefits, regeneration may also benefit other ecosystem services and biodiversity; however more data is needed in order to estimate the impact of carbon offsetting schemes that focus on the regeneration of degraded areas. Our objective was therefore to determine how slash and burn affected woody vegetation and soil carbon stocks in an area of miombo woodland in SE Tanzania, and how quickly carbon stocks, floristic composition and diversity recovered in abandoned fallows. We used the chronosequence approach, sampling areas previously cleared for agriculture (1 – 40 years abandoned), areas currently under cultivation, and nearby areas that have never been cleared with which to compare. We also assessed whether differences in soil texture (sandy vs. clay) significantly affected the response of these systems to LUC.

Aboveground woody biomass was found to recover to that of mature miombo woodland within 20 – 25 years, with recovery rates faster on sandy soils, although soil carbon showed a weak relationship with time since abandonment. Data on soil carbon stocks from clay rich soils, and changes in floristic composition and diversity are forthcoming; however we hypothesise significant differences in the rate of recovery between soil types, particularly in the soil C pool, which we expect will be less impacted by conversion to agriculture, and will significantly recover following abandonment. Data from previous studies suggests a permanent degradation of the species pool, however given the longer timeframe covered by this study (>25 years), we also predict that floristic composition will recover to that of mature woodland within the temporal window of the chronosequence.

1019	Do property rights and contract farming matter? Evidence from a large-scale investment in Ghana	Susanne Johanna Väth, Michael Kirk	Germany

With the rising demand for agricultural land it becomes incrementally important to design land deals as a win-win for investors and the local population. Accordingly, our in-depth analysis focuses on two aspects: the effect of inclusive business models and the importance of property rights for farmers

adjacent to a large-scale, land-based investment. We analyse data of an oil palm investment in the Eastern Region of Ghana where outgrower contracts were allocated in a quasi-natural experiment and compare these farmers to independent oil palm growers.

OLS estimations disclose that property rights have a significantly positive effect on interviewee's perceived future security, household's agricultural income and oil palm profit per acre. Contract farming has a significantly positive effect on the long-term measures aggregated asset and perceived future security, while its effect on the short-term measures agricultural income and plot profit per acre is significantly negative. We present a logistic regression showing that outgrowers have a 10% higher probability to engage in non-farm businesses. Thus, their poor performances with regard to agricultural income and plot profit can be explained by effort substitution to other tasks. Effects are highly significant and hold various robustness checks.

To our knowledge this is one of the first analyses providing evidence on a promising case of large-scale investment in agricultural land. Thus, it is assumed it is of high interest for the audience of the GLP Open Science Meeting.

1020	Combined effects of disturbance and landuse: new results from a DGVM	Dominique Bachelet, Ken Ferschweiler, Tim Sheehan	USA

We have run the dynamic global vegetation model (DGVM) over the conterminous US at 30arc sec to simulate the impacts of nine climate futures (3GCMs: CSIRO, MIROC and CGCM3; 3 emission scenarios: A2, A1b, B1). We first simulated potential vegetation dynamics from coast to coast assuming no human impacts. Even a moderate effect of increased atmospheric CO_2 on water use efficiency and growth enhances woody encroachment and forest growth while general warming allows forest to expand above the current tree line. However dry conditions also cause more frequent wildfires that maintain some ecotones. Simulating fire suppression starting in 1951 reduces the number and impacts of wildfires by only allowing catastrophic fires to escape. This greatly increases the expansion of forests and woodlands across the western US and ecotones disappear. However when fires do occur, their impacts (extent, biomass consumed) are very large. We also ran the DGVM with a simple protocol to evaluate the relative influence of forest harvest (as well as crop harvest and urbanization). As input we use a simplified version of the USGS landuse projections from the LandCarbon national assessment. The order of future climate scenarios based on future forest sink strength changes and the response of forests to climate futures is delayed by ~30 years as well. Clearly more work is needed to more realistically represent regional human activities than in this first effort but nonetheless the striking differences between vegetation distribution maps and the magnitude of carbon sources and sinks confirm other reports on the importance of land use on ecosystem resilience to climate change and on the sustainability of ecosystem services rendered by forests.

1023	Plausible impacts of the land reclamation on surface change changes in India: a WRF model based simulation	Sarala Khaling, Yi Qu, R.B. Singh, Qingling Shi, Chenchen Shi	China

Land use/cover change has become one of the most important factors for the global climate change. Being one of the major types of land use/cover change, reclamation of cultivated land should also have impact on regional climate change. Most of the previous studies were based on the correlation analysis and simulation analysis of the historical data of land use and climate change, with few explorations on the forecast of impacts of future land use change on regional climate, especially impact of the reclamation of cultivated land. Taking India as study area, this study used the Weather Research and Forecasting (WRF) model to analyze the impact of cultivated land reclamation on the future climate

change by forecasting the future cultivated land reclamation and its related changes of energy flux and temperature in summer and winter. The results show that under the future situation of increasing food demand, reclamation of cultivated land in India will lead to a large amount of land conversion. These types of land conversion will overall result in increases of latent heat of regional surface, as well as decrease of sensible heat flux, which will eventually lead to drop of regional average temperature. However, this impact on climate change is seasonal different, i.e. reclamation of cultivated land will lead to $0.22℃$ decrease of India's average temperature, thus has cooling effect in the summer, and in the winter, it will result in $0.11℃$ increase of the monthly average temperature. This study is of great value for the response to climate change, scientific planning and management of land use.

As an essential food production area in the world, the impact analysis of land use change in India of this study is significance for the **_Conference Session_**. The results simulated by WRF model would be helpful for the further land use scenarios research, and would provide important policy implication of land use planning especially in cultivated land reclamation in India. In addition, this research can provide methods and tools for the **_Conference Session_** to model the biogeophysical impact of land use changes on surface climate.

1024	Contextualizing large-scale land acquisitions: a spatial analysis in Sub Saharan Africa	Thomas Breu, Peter Messerli, Markus Giger, Sandra Eckert	Switzerland

What are the impacts of large-scale land acquisitions on rural development in Sub Saharan Africa and can these acquisitions contribute to sustainable development? We combine spatial information gained from an analysis of individual land acquisitions with socio-economic and bio-physical information extracted from regional and global scale. This quantitative analysis is based on the Land Matrix database, which was developed as a collaborative effort of the International Land Coalition, CDE, CIRAD, and GIGA.

Our findings show that land targeted for large-scale acquisition is distributed more or less evenly within the broad land cover categories of shrub- and grassland (35%) and croplands (34%). Only 12% of the targeted land is covered by open to closed forest areas. Moreover, an analysis of population density in these areas showed that 62% of land is acquired in contexts with population densities above 25 persons/km2. Thus, a significant part of areas targeted for large-scale acquisitions is located in places where competition for land may most likely exist of arise. Finally, an analysis of the accessibility of land acquisitions with already known exact location showed that 40% are located close to major transportation routes and are accessible within four hours or less, and 79% are accessible within six hours or less. This contradicts the hypothesis that large-scale land acquisitions will significantly help improve road access in isolated rural areas in Africa.

1025	Evaluating the relative importance of direct and indirect climate impacts on mountain forests ecosystem services in Europe	Che Elkin, Harald Bugmann	Switzerland

Climate change is projected to impact forest ecosystems, and the good and services that they provide, through directly changes in forest growth, regeneration and mortality, and indirectly through changes in disturbance regimes. The relative importance of direct climate impacts vs. modified disturbances regimes will however likely differ between regions due to the relative distance that vegetation and disturbance processes are to climate thresholds. We evaluated the projected importance of direct vs. indirect climate impacts on mountain forests in four European case study sites that under current conditions represent a range from cool and wet to warm and dry climatic conditions. Using a forest

landscape model that includes climate sensitive representations of fire and bark beetle disturbances we simulated forest dynamics in each case study region for the next century under three climate scenarios that range from moderate to severe shifts in temperature and precipitation. By running simulations with and without individual disturbances included we were able to partition out their projected impact relative to direct climate impacts, and evaluate when and where disturbances will likely be most important for the forest ecosystems and the goods and services that they provide. At sites that are currently warm and dry increased drought stress under even moderate climate change is projected to be the major driver of forest dynamics. Fire disturbances are also projected to increase at these sites, but the net impact of fire on forest state and forest ecosystem services remained smaller than the direct impacts over the course of our simulations. In contrast, at comparably cooler and wetter sites climate change is projected to substantially increase the importance of bark beetle disturbances. At these sites direct climate impacts are also projected to influence forest composition, however these impacts are not observed until the latter part of the century while the impact of bark beetle disturbances on forests is projected to occur in the near future. We discuss our findings with respect to the potential efficacy of adaptive forest management strategies and their ability to maintain forest ecosystem services under direct and indirect climate impacts at each of the case study sites.

1026	Changing the intensification paradigm by co-innovation with family farmers in Uruguay	Walter A.H. Rossing, Santiago Dogliotti	The Netherlands

Meeting the goals of sustainable growth of food production and reducing rural poverty requires assisting family farmers to develop more productive, profitable, resource efficient and environmentally friendly farms. Faced with decreasing product prices and increasing production costs during the last two decades family farmers in south Uruguay tried to maintain their income by intensifying their farms, growing larger areas of fewer crops and increasing the use of irrigation and agrochemicals. Soil degradation was aggravated by this process, limiting crop yields, undermining the farmers' aim of maintaining their income. A model-aided explorative study had shown that decreasing the area of vegetables, introducing crop rotations, cover crops and manure applications, and including beef-cattle production would be a better strategy. To test this hypothesis, a project was started at the end of 2004 and expanded in 2007, involving farmers, technical advisers and scientists in a co-innovation process that combined systemic diagnosis and redesign of the farm systems, social learning and dynamic monitoring and evaluation. The project involved 14 farms representing a large range of variation in resource endowment. Main problems found on all farms were deteriorated soil quality and low labour productivity, which resulted in low income and high work load. At the end of 2-5 years of redesign farmers had been able to implement most innovations planned. Irrespective of endowment with land, machinery, irrigation water or labour resources, re-design increased the per capita family income and the income per hour of family labour on 13 out of 14 farms, by 51 and 50%, respectively, averaged over all farms. Soil organic carbon content had increased on 11 out of 14 farms and estimated erosion rates in vegetable fields had halved. Farmers considered 'multi-year planning' the most important change introduced into their practice by the project. They concluded that the role of the extension service agents should change from mere consultants of operational–tactical, crop-centred decisions to supporters of the process of farm planning and evaluation. The project showed that even on commercial farms operating under highly competitive conditions, substantial improvements in economic and environmental indicators can be achieved when a whole farm strategic redesign is elaborated.

This paper contributes to the session topic by focusing on the interaction between human decision-making, drivers and changes in agro-ecosystems.

1031	Carbon, water and biodiversity management in peatlands in south east asia	Mitsuru Osaki	Japan

Tropical peatland preserves rich biodiversity and it stores huge amount of carbon (80-90Gt) in the world. Especially Indonesia has more than 60% of tropical peat carbon (50-60Gt). However, it has been changed to emission source by drainage of land development which causes serious oxidation of peat and wild fire. In 2005, 0.8Gt of CO_2 was emitted from peatland in Indonesia and it is estimated to grow more. One major area of concern in tropical region is rapid conversion of a vast area of tropical forest, which provide a natural carbon capture and storage function, into other land-cover types with low carbon value. During the past two decades both primary forest and total forest cover expanded in the Asian and Pacific region. In the same period, however, two thirds of countries in the region experienced an increase in the number of threatened species and South-East Asia lost nearly one seventh of its forest cover.

As there are strong links between land cover and climate, changes in land use and land cover can be important contributors to climate change and variability (Loveland *et al*. 2004). So that, the current climate change global environment issue has put the tropical region in general as a strategic element to eliminate the impact. The networking and cooperation among parties (countries, stakeholders, etc.) is the key factor to tackle the climate change issues rather than a single player.

This session demonstrates various approaches to detect the magnitude of land-use and land cover changes and predicting its implications for human system and ecosystem services. It will highlight the importance of remote sensing and GIS technology in providing good data and predictions needed for a better policy formulation. Apart from studies on terrestrial system, this session also presents a work on interaction of atmospheric carbon with ocean system, water and biodiversity. This session also will focus on current topics related to peatlands mapping, management and researches. As comprehensive carbon assessment is most important for tropical peatlands management, various researches and data management will be presented in different aspects.

1039	Annual land cover monitoring in Mexico using MODIS 250m data	Rene Colditz, Ricardo Llamas, Rainer Ressl	Mexico

Activities of land cover mapping and change detection in Mexico are embedded in international initiatives such as the North American Land Change Monitoring System (NALCMS). Although the data sets are generated by each country, common standards and guidelines such as legend, data sets, and methods facilitate the generation of continental maps. Continental monthly image composites of 250m spatial resolution for all seven spectral bands of Moderate Resolution Imaging Spectroradiometer (MODIS) images are the baseline for image classification and change detection. A continental land cover map of the year 2005 with 19 classes was generated and published in 2010. The current focus on annual land cover monitoring follows a two-step approach: (1) the detection of potential change areas and (2) updating of those areas. This process ensures map consistency for all areas that remain unchanged and guides the classification towards area of change.

This study presents the results of annual land cover mapping from 2005 to 2011 for Mexico. The data-driven approach detects for each year between 0.25 and 0.3% of the study area as potential change. Notable is the low omission error of only 12%. Map updating for change areas employs a decision tree algorithm that is trained with samples from unchanged areas. Current work focuses on different sampling strategies and feature sets. Final results are filtered to only allow logical class changes. Preliminary results of actual class change estimate a change rate between 0.08 and 0.1% per year with the majority being due to fluctuating water levels, forest change which includes loss due to forest fire or deforestation but also reforestation, and urbanization. The change rate is lower than in other studies for particular regions in Mexico due to the rather coarse spatial resolution and the limitation that the change has to be detectable by spectral or temporal differences. On the other hand, this study produces for the first time a reliable estimate using automatic wall-to-wall mapping and allows spatially-explicit

monitoring of the state of land cover for one of the most complex countries in the world.			
1041	Conservation vs. economic development: past and future trends of land transformation at Brazil's tropical dry forests	Mário Marcos Espírito Santo	Brazil

Brazilian Tropical Dry Forests (TDFs) have been historically neglected in terms of research and conservation efforts in relation to wet forests, and these ecosystems have been devastated in alarming rates in the last decades. In Brazil, TDFs are threatened by increasing logging, mining (limestone) and clearing for agriculture and cattle raising. Recently, part of the Brazilian TDFs was legally considered as part of the Atlantic Rain Forest and its deforestation was prohibited. The aim of this study was to compare deforestation rates and its drivers before and after the legal protection of Brazilian TDFs, and compare with those observed in the Cerrado, a savanna-like ecosystem. We used the north of Minas Gerais state as case study, comprising 128,000 km^2. We compared deforestation rates (using Landsat 5 TM imagery) between two decades: 1986-1996 and 1996-2006, before and after the legal protection of TDFs (1993). Our results indicate a total loss of 4,653.6 km^2 of Cerrado and (9%) and 2,227.7 km^2 of TDFs (11.6%) between 1986 e 2006. The deforestation rate was higher in 1986-1996 than 1996-2006 for both vegetation types (Cerrado: 6.84% and 2.30%; TDFs: 8.47% and 3.41%, respectively). This temporal difference is a consequence of government development policies for the north of Minas Gerais beween 1970-1990, which stimulated the economic growth through: i) plantation of eucalyptus and pinus for charcoal production; i) public irrigated areas for fruit production; iii) improving management techniques for cattle raising; and iv) planting cotton for textile industry. The reduction in deforestation rates from 1986-1996 to 1996-2006 was more pronounced for TDFs (40.3%) compared to the Cerrado (33.6%), probably as a consequence of the protection conferred by its inclusion as part of the Atlantic Rain Forest. As a whole, the counties with higher deforestation rates exhibited a strong increase in the Gini Inequality Coefficient (obtained from government census data between 1991-2000). These results indicate that the developmentalist strategy implemented in the north of Minas Gerais, based in financial support to large farming projects, had three drastic consequences: i) high rates of suppression of native vegetation; ii) increasing concentration of wealth; and iii) generation of social-environmental conflicts with traditional populations due to the creation of conservation units to compensate for TDF deforestation. This scenario is similar to other TDF and Cerrado regions in Brazil, where government policies should alternatively foster low-impact economic activities, such as family-based agriculture.

| **1043** | The spontaneous emergence of silvo-pastoral landscapes in the Ecuadorian Amazon: patterns and processes | Thomas Rudel, Laura Schneider, Amy Lerner | USA |

With the continuing decline in the global extent of tropical forests, agriculture dominated landscapes now cover approximately 50% of the tropical biome. In this context our ability to understand and influence biodiversity and carbon sequestration in the tropics depends in large part on our understanding of actively managed landscapes. Approximately two-thirds of deforested lands become pasture in the Neotropics, and therefore significant changes in their structure represent a potentially important development in terms of carbon sequestration and biodiversity, especially as ecosystem service payment schemes such as REDD+ emerge. In the case-study presented here we examine the evolution of pastures over time and the spontaneous emergence of silvo-pastoral landscapes, or pastures with trees, in the Southern Ecuadorian Amazon (the state of Morona Santiago). Analyses of interviews with the heads of small cattle ranching enterprises, soil and vegetation samples from their farms, and land-cover maps from high resolution remotely sensed data of the surrounding communities indicate quite variable densities of trees in pastures, with stem densities ranging from 30 to 400 per hectare. Spatial regressions combined with ethnographic data reveal that small scale cattle ranchers pursue an intentional management strategy of allowing trees to regrow in working pastures to an extent that is ecologically

significant. These findings confirm that even cattle ranches, albeit small in scale, can simultaneously produce food and provide important ecosystem services like carbon sequestration.

FLASH TALK ABSTRACTS

NUMBER	TITLE	AUTHORS	COUNTRY
0155	Climate variability and childhood health in sub-Saharan Africa	Titilayo Ojo, Oye Babatimehin, Sina Ayanlade	Nigeria

This study examines the relationship between climate variability and childhood health using Nigeria as a case study. The study aims at analyzing the relationship between climate variability and health of children (<5years old), with the major objective to provide a spatiotemporal analysis of the impact of climate variability on pneumonia as a risk factor for childhood mortality in Osun state. Pneumonia has been ranked the leading killer of young children under five years of age round the world claiming more than 1.6million children before their fifth birthday. Previous studies have shown that occurrence of pneumonia is more prevalent during raining season in tropics, especially in African countries. One of the biggest challenges facing the public sector in developing countries in the 21st century is the consequences of climate variability and change. It has also been established from previous findings that respiratory infection follow seasonal pattern and pneumonia which is responsible for about 18% of childhood's death worldwide is rarely mentioned in the context of climate variability. In view of the association between seasonal rainfall and childhood pneumonia in the tropics, climate variability could potentially increase the incidence of childhood pneumonia in the tropical settings both directly or indirectly. Childhood pneumonia is climate sensitive and highly significant to be ignored. Therefore this study uses both primary and secondary data. The primary data was obtained from administration of questionnaire while the secondary data include the monthly record of inpatient and outpatients (medical data) admitted or treated of pneumonia collected from the ministry of health Osun state for 10years. Climatic data on the monthly rainfall and temperature for 30 years were collected from Nigeria metrological agency (NIMET) Oshodi Lagos. Analysis of variance and correlation coefficient were used to establish the relationship between climate variability and pneumonia. Though this is an on-going research, but the results hold the benefits of better understanding of climate change implications on childhood health. If Millennium Development Goal (MDG4) which is the reduction of childhood mortality by two-third by year 2015 is to be achieved, the present study is significant for helping the health officials to create more awareness for mothers, about seasonality of pneumonia, so that there will be proper care to prevent children from been infected with the disease.

NUMBER	TITLE	AUTHORS	COUNTRY
0156	Detection of important land transitions using Intensity Analysis	Robert Gilmore Pontius Jr, Safaa Aldwaik	USA

Users of Intensity Analysis frequently ask how large a deviation between an observed intensity and the uniform intensity must be in order to be considered important. One possible response is to hypothesize whether error in the data could account for the deviation. This presentation describes a method to compute the minimum hypothetical error in the data that could account for each observed deviation from a uniform intensity. A larger hypothetical error gives stronger evidence against a hypothesis that a change is uniform. We illustrate the method with a case study concerning change during three time intervals among four land categories in northeastern Massachusetts, USA. This session resides in the conference theme concerning *rethinking land change transitions*. Software for Intensity Analysis is available for free at https://sites.google.com/site/intensityanalysis.

NUMBER	TITLE	AUTHORS	COUNTRY
0163	Developing adapted land use strategies by using participatory planning in West	Janina Kleemann, Christine Fürst	Germany

NUMBER	TITLE	AUTHORS	COUNTRY
	Africa		

Land use change is a multi-causal and cross-cutting issue. Above all, climate change is one of the emerging drivers of land use change but also population growth and land use rights influence the landscape and related services. Rural areas in West Africa are particularly vulnerable to climate change due to a low financial and physical capacity and a high dependency on agriculture. The WASCAL-initiative (West African Science Service Center on Climate Change and Adapted Land Use) aims at the improvement of the resilience of such highly sensitive socio-ecological systems. In WASCAL, we work on recommendations for adapted land use strategies. The strategies are developed in a highly participatory manner in order to achieve a better acceptance and implementation of the strategies.

Local experts will be asked in focus group discussions and semi-structured interviews for the expected demands on landscape services and their consequences for land requirements, such as the increase of irrigated areas, the increase of cash crops and fuel wood. Participatory mapping reveals the spatial extend of preferred land use types and will be taken as the basis for further discussion of different land use scenarios. On the other hand, trade-offs between important services and environmental risks (water erosion, flooding) will be analyzed.

In the presentation, we will provide an overview how to apply participatory planning in the WASCAL context. We will present a methodological framework and first results of the participatory approach. We will conclude on requirements for successful application of our approach also beyond the project context.

| 0164 | The role of local institutional diversity in adaptation to global change in the mountains of CIS | Alexey Gunya | Russia |

Local patchwork space in mountains constitutes a special world, relatively autonomous of the state, in which non-state, mainly traditional institutions predominate. For instance, the demarcation and use of mini plots of irrigated hayfields in the mountains was always a matter for customary law. Because of the specificity of natural conditions, state institutions were ineffective. State intrusion into this sphere occurred of course. However, they often were unsuccessful, and the local level constantly slipped beyond the state's grasp. Nevertheless, it would be premature to maintain that the local level was completely free of state rules and institutions. The state still determines the framework rules of the game, which is most obvious in the institution of land structure.

In the course of fieldwork carried out in the diverse mountain regions of the former USSR, it has been established that regulation of relations between people and landscapes in the mountains as well as adaptation to global change are highly dependent on: a) the specifics of self-organisation of a mountain community, b) a community's self-management, c) governance. Self-organisation denotes processes of regulation of land use as well as of social life, not anchored in formal institutions. Self-management is performed on the basis of institutions which already have formal status, but, strictly speaking, are non-state institutions. The role of self-organisation and self-management increases if the state is cannot effective regulate the land use. In some cases the institutions of self-management "usurp" some functions that would normally be carried out by the state. Finally, governance is founded on state institutions meant to complement self-organisation and self-management, but which in reality duplicate, compete with or even destroy existing forms of self-organisation and self-management.

In empirical reality the contemporary local level comprises a cocktail of state, traditional and hybrid institutions. Hybrid institutions are formed either through the formalisation and cooption of traditional institutions, or by means of the internalisation of institutions and organisations imposed on communities by the state (or by other external actors). The search for mutual benefit is at the heart of the formation of these tandems of internal and external, new and old, traditional and innovational. This is a prolonged and dynamic process which is postulated to be the only mechanisms able to adapt to global change.

NUMBER	TITLE	AUTHORS	COUNTRY
0166	An agent based model to simulate an inter-basin water market in the Segura and Tagus interconnected river basins in Spain	Christophe Viavattene, Carlos Dionisio Pérez Blanco	Spain

Hindu Kush Himalaya constitutes headwaters of some of the largest trans-boundary basins of planet that sustain one-fourth global population dependent primarily on subsistence agriculture in Pakistan, India, Nepal, Bhutan, China and Bangladesh. Climate change has stressed hydrological regimes of Hindu Kush Himalayan headwaters through higher mean annual temperatures, melting of glaciers, altered precipitation patterns and more frequent extreme weather events causing substantial decrease in discharge, availability of and access to water. This may increase proportion of water, food, livelihood and health, insecure population in South Asia which includes some of the poorest people of the world with access to less than 5% of planet's freshwater resources. This will have enormous regional implications for fundamental human endeavors ranging from poverty alleviation, food and health security, environmental sustainability, climate change adaptation and even to regional security and peace in South Asia. It is therefore imperative to evolve a multi-stakeholders regional water governance framework involving regional as well as local public, private and civil society institutions in for adaptive management of trans-boundary headwaters in Hindu Kush Himalaya (Karki and Vaidya 2010).

Study investigates reasons and rationale for missing regional cooperative inter-linkages; explores obstructions in initiating effective regional headwater governance; assesses role of institutions in trans-boundary headwater governance; and outlines geo-political feasibility for institutionalization of headwaters in Hindu Kush Himalayan countries. Comprehensive study of available literature and media reports, interpretation of people responses obtained through interviews, interaction with political leadership and government officials across Hindu Kush Himalayan countries, and a thorough appraisal of existing institutional mechanism and its existing and potential role in trans-boundary headwater governance formed the basis of this study. Study revealed that political transition and instability in some countries; threats of internal and external security, weak leadership in other riparian nations; and long standing conflictual inter-state dynamics among the major countries are important reasons for missing regional governance in trans-boundary water Governance in South Asia. Besides, increasing power of the principal economies of the region also contributed towards weakening the institutional architecture and regional cooperation initiatives among the riparian countries . However, there is increasing realization and growing demand by regional as well as national institutions particularly, NGOs, civil society organizations, public and semi-public organizations and private as well as informal institutions across the region for trans-boundary water governance which is expected to help in initiating regional cooperation for adaptive headwater governance across the Hindu Kush Himalaya in near future

NUMBER	TITLE	AUTHORS	COUNTRY
0174	Trans-boundary headwater management in Hindu Kush Himalaya: role of Institutions in water governance for climate change adaptation in South Asia	Prakash Chandra Tiwari, Bhagwati Joshi	India

Hindu Kush Himalaya constitutes headwaters of some of the largest trans-boundary basins of planet that sustain one-fourth global population dependent primarily on subsistence agriculture in Pakistan, India, Nepal, Bhutan, China and Bangladesh. Climate change has stressed hydrological regimes of Hindu Kush Himalayan headwaters through higher mean annual temperatures, melting of glaciers, altered precipitation patterns and more frequent extreme weather events causing substantial decrease in discharge, availability of and access to water. This may increase proportion of water, food, livelihood and health, insecure population in South Asia which includes some of the poorest people of the world with access to less than

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| 0175 | Patterns and dynamics of large scale land acquisitions (in Africa) - evidence from the Land Matrix | Jann Lay | Germany |

Research on Large-scale Land Acquisitions (LSLAs) suggests that this phenomenon is clearly an important trend with far-reaching implications for many developing countries, most notably for the populations living in affected areas. Yet, information on LSLAs and evidence on the impacts of this recent phenomenon are still scarce. The Land Matrix project was set up to respond to this information gap. It is a global and independent land monitoring initiative that promotes transparency and accountability in decisions over land and investment. www.landmatrix.org is the Land Matrix Global Observatory, an open tool for collecting and visualising information about large-scale land acquisitions. It records transactions that entail a transfer of rights to use, control or own land through sale, lease or concession; that cover 200 hectares or larger; and that have been concluded since the year 2000. The presentation will be based on the Land Matrix dataset and provide insights on the global patterns of LSLAs. The presentation will focus on the dynamics of land deals and the extent to which the related projects are implemented and become operational.

| 0185 | Long-term (10 years) soil responses to abrupt land-system changes: ongoing impacts of high intensity wildfires on soil organic matter quality in temperate perennial forests | Ana Cabaneiro, Irene Fernandez | Spain |

Long-term effects of forest wildfires on quantity, biochemical composition and mineralization activity of the soil organic matter were studied in *Pinus pinaster* Aiton stands from the humid-temperate climate zone. Soil samples from surface (0-5 cm) and subsurface (5-10 cm) layers were collected in untreated

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forest plots that have been burned 5 and 10 years before the sampling date; also, from the same forests, plots unaffected by the fire were established and sampled to be used as control. Lignin, holocellulose, lipids and water-soluble compounds as well as humic substances were determined by different chemical fractionation methods and total soil organic matter content was quantified by combustion; the soil C mineralization dynamics was studied using aerobic incubations and the cumulative mineralization curves fitted a double exponential kinetic model that considers two C pools decaying at different degradation rates. The results obtained from these field experiences were compared with the immediate effects of wildfires reported for the same region. The findings indicate that 5 and 10 years after the fire, the total organic matter content, particularly the unhumified components, and the parameters related to the C mineralization activity showed a notable recovery and many of the studied parameters showed similar values to those of the corresponding unburned soil. However, differences on the quality of the soil organic matter still remains visible after this prolonged period of natural evolution. The proportion of some carbon-bearing compounds and the humus composition of samples from burnt soils differed significantly from those of the corresponding unburned soils. Thus, the long-term fire effects resulted in a higher content of both the more humified organic fractions (probably generated by soil heating during wildfires) and those less humified (possibly from subsequent plant inputs incorporated into the soil). Therefore, although some signs of soil regeneration related to the size of the organic reservoir and the C mineralization activity were observed after a 10 years period of natural evolution without any human intervention, the internal composition of the soil organic pool showed a much slower recovery and the overall quality of the soil organic matter after a critical thermal event like the ones shown here seems to be highly dependent on the reestablishment of a vegetable cover of similar characteristics to those of the unburned forests.

| 0186 | Environmental governance of changing tropical mountains | Kenneth Young | USA |

Mountain ranges in tropical latitudes support the land use of millions of residents, provide water and energy to often-distant urban areas, and contain unique biodiversity and ecosystems. Global environmental change has been reducing tropical glaciers, shifting some species and ecological zones to higher elevations, and altering the locations of perhumid conditions and of agriculture. Glacier recession and an increase in woody plant coverage have been observed, while more complicated outcomes have been predicted, including altered hydrological conditions and the expansion of novel species assemblages and ecosystem types. There are inherent asymmetries to these changes, with most global changes driven by far-off economic and technological forces, but with many consequences amplified within high mountains. As a result, an important goal of environmental governance should be to facilitate the monitoring and adaptive management of dynamic montane landscapes. Existing efforts often focus on water resources, on natural hazards, on carbon stocks, or on biodiversity, but typically in an uncoordinated fashion wherein these programs may incorporate unrecognized trade-offs and contradictions. Further, they may act to increase asymmetries of cause and effect, especially in regards the relative power of local people compared to national governments. The effects of global environmental change can be exacerbated by additional market influences and as caused by the actions of multi-national mining companies. Perhaps another inherent mountain asymmetry could be used as a palliative: public land used for protected areas are predominantly located in areas of rough topography, which are considered to be of less value for settlement and agriculture, while often high elevations not controlled by the state are instead managed as common pool resource areas by local communities. Both of these situations have social dimensions and spatial footprints that may provide the flexibility needed to permit guided change along gradients of elevation, of humidity, and of land-use intensity

| 0191 | Transforming senses of nature: settlers | Carlos Del Cairo | Colombia |

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	and protected areas in Guaviare (Colombian Amazon)		

My presentation is aimed at analyzing how settlers coming from the Andean highlands deal with protected areas in the Amazon lowlands in Guaviare, a region located in the south part of Colombia, near the border with Brazil. In particular, my presentation will explore the way in which some settlers have had to change their traditional practices –usually linked to cattle ranches and intensive agriculture– because the lands they inhabited have been recently converted in protected areas. Sixty years ago, colonization was conceived as the better strategy to "civilize" the Amazon; settlers were considered the best way to populate and bring development to "isolated" lands such Guaviare. However, since the late 1980s, ideas about the sustainable management of the Amazon introduced radical changes in the way settlers were conceived. Ideas about settlers pass from agents of civilization to predators of ecosystems. In this context, this presentation will focus on how settlers transform their livelihoods to fit in the conservation rationale, what meanings they create around such a transformation, in what manner State tends to enforce those changes, and how settlers negotiate and resist green initiatives in their everyday life.

This presentation will contribute with an ethnographically-based approach to characterize how protected areas initiatives can trigger social tensions and conflicts. In particular, it expects to analyze those tensions following the point of view of settlers. Some questions guiding this endeavor are: How settlers perceive social conflict in protected areas? How they try to solve it? What conservation means for them? These questions will be answered having in account how local people (settlers in this particular case) shape their identities in a transformation context in which they are suddenly conceived as potential allies for conservation initiatives, and how they struggle with it.

| **0194** | Using multi-agent systems for modeling diversity and complexity of land-use decisions in the developing countries | Evgeny Latynskiy | Germany |

Analysis of land use changes in developing countries requires a deep understanding of household-level heterogeneity and complexity that are common for agricultural systems in these countries. There it is common to observe great differences in yields, input and labor application intensity as well as a large variety of land use decisions and choices of farming practices (Ruben & Pender 2004, Schreinemachers & Berger 2006). Such diversity is caused by significant household-level differences in resource endowments, knowledge, market and infrastructural constraints (Berger et al. 2006). Given the heterogeneity of biophysical and socio-economic constraints, one-size-fits-all type of land-use policies are unlikely to be effective. Policies are required to be precisely targeted (Ruben & Pender 2004, Berger et al. 2006). Agent-based modeling can support the design and targeting of land use policies through ex ante provision of high resolution quantitative data on the likely impacts of the respective interventions (Berger et al. 2006).

This presentation will explain using an empirical example, how the diversity and complexity of land-use decisions can be reflected in an agent-based simulation model. As a case study the author will use the country application of MP-MAS software package (Schreinemachers & Berger 2011). The application was constructed by the author for modeling of semi-subsistence agriculture in the lake-shore Uganda (Latynskiy & Berger 2012). The author will focus on several important aspects influencing land-use decisions that have to be considered in the model implementation. The first aspect is capturing the discussed heterogeneity among farming households. The second aspect is the non-separability of land-use decisions from other decisions that are taken on the farm (i.e. investment, production, consumption, marketing …). The third aspect is human-environment interaction cycles and the dynamics of the system, including interactions across levels of hierarchy (here: individual farmers and producer organizations).

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These three aspects will be communicated to the public by the three slides of the flash talk presentation containing concise flow charts of the designed simulation model (one chart per aspect).

Thus, the objectives of the presentation are: (i) discussion of factors that cause the observed diversity of land use decisions in developing countries, (ii) provision of guidelines for valid model implementation of land use decisions and (iii) discussion of incorporation of producer organizations and other collective action institutions into multi-agent system models for land-use land cover change.

NUMBER	TITLE	AUTHORS	COUNTRY
0195	Best practices to evaluate land change models	Daniel G. Brown, Lawrence E. Band, Kathleen O. Green, Elena G. Irwin, Atul Jain, Robert Gilmore Pontius Jr, Karen C. Seto, Billie Lee Turner II, Peter H. Verburg	USA

This presentation summarizes best practices concerning the evaluation of land change models organized in four broad categories: 1) uncertainty sources, 2) sensitivity analysis, 3) pattern validation, and 4) structural validation. Uncertainty can derive from questionable data quality, unclear boundary conditions, inappropriate model structure, and non-stationarity processes. Sensitivity analysis can shed light on uncertainty because sensitivity analysis examines the variation in model output due to specific amounts of variation in model input, parameter values, or structure. Sensitivity analysis offers one method to prioritize research and determine the most important parts of the model to develop. Pattern validation compares model outputs with observed outcomes. We make recommendations to improve inconsistency in the profession concerning methods and standards to compare patterns. Structural validation considers the consistency between real world processes and the processes that the model portrays. Structural validation remains a challenge because the underlying processes that give rise to observed land patterns are not fully observable.

NUMBER	TITLE	AUTHORS	COUNTRY
0204	Resilience-based perspectives to guiding high nature value farming systems through socio-economic change	Tobias Plieninger	Denmark

Global environmental challenges require land systems that integrate biodiversity conservation, food production, and livelihoods at landscape scales. In this Flash Talk Presentation, I review the approach of conserving biodiversity on "high nature value" (HNV) farming systems (covering 75 million ha in Europe) from a resilience perspective. Despite growing recognition in natural resources policies, many HNV farming systems have vanished, and the remaining ones are vulnerable to socio-economic changes. I consider the following properties and components of the social-ecological resilience framework and their integration into HNV farmland management: (1) coupling of social and ecological systems, (2) key variables, (3) adaptive cycles, (4) regime shifts, (5) cascading effects, (6) ecosystem stewardship and collaboration, (7) social capital, and (8) traditional ecological knowledge. I argue that previous conservation efforts for HNV farming systems have focused too much on static, isolated, and mono-sectoral conservation strategies and that stimulation of resilience and adaptation is essential for guiding HNV farming systems through rapid change.

NUMBER	TITLE	AUTHORS	COUNTRY
0214	Design and interpretation of intensity analysis illustrated by land change in Kalimantan, Indonesia	Robert Gilmore Pontius Jr, Yan Gao, Nicholas M Giner, Takashi Kohyama, Mitsuru Osaki, Kazuyo Hirose	Mexico

Intensity Analysis has become popular as a top-down hierarchical accounting framework to analyze differences among categories, such as changes in land categories over time. Some aspects of interpretation

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are straightforward, while other aspects require deeper thought. This presentation explains how to interpret Intensity Analysis with respect to four concepts. First, we illustrate how to analyze whether error could account for non-uniform changes. Second, we explore two types of the large dormant category phenomenon. Third, we show how results can be sensitive to the selection of the domain. Fourth, we explain how Intensity Analysis' symmetric top-down hierarchy influences interpretation with respect to temporal processes, where changes during a time interval influence of the sizes of the categories at the final time, but not at the initial time. We illustrate these concepts by applying Intensity Analysis to changes during one time interval (2000-2004) in a part of Central Kalimantan for the land categories Forest, Bare and Grass. This presentation will contribute especially to the conference theme: rethinking land change transitions, since it focuses on analysis of land change transition intensity and illustrates how to interpret Intensity Analysis in detail.

| **0236** | Agroforest's growing role in carbon losses from Jambi (Sumatra), Indonesia | Grace Villamor, Robert Gil Pontius, Jr. | Germany |

This paper examines the size and intensity of changes among five land categories during two time intervals in a region of Indonesia that is pioneering negotiations concerning reducing emissions from deforestation and forest degradation (REDD). Maps at 1973, 1993 and 2005 indicate that land change is accelerating while carbon loss is decelerating in Jambi Province, Sumatra. Land dynamics have shifted from Forest loss during 1973-1993 to Agroforest loss during 1993-2005. Forest losses account for most reductions in aboveground carbon during both time intervals, but Agroforest plays an increasingly important role in carbon reductions during the more recent interval. Oil Palm emerges as a new category during the latter time interval. These results provide motivation for future REDD policies to count carbon changes associated with all influential land categories, such as Agroforests.

| **0237** | The role of governance in adaptation to global change in mountain regions | Tim Duane | USA |

The land governance system in the United States is structured in a federal Constitutional system where the federal government plays a dominant role through both retention and control of public lands under the Property Clause and the preemption of some state and local land and resource management authority under the Supremacy Clause and the Commerce Clause. The legacy effects of historically-determined spatial patterns of public land ownership and control, together with more modern preemption of state law and authority, have played a significant role in constraining the adaptability of governance regimes in the mountainous western United States to global change. Unsurprisingly, then, the historic role of federal land and resource management agencies has been challenged as they have faced landscape-scale, ecosystem threats that transcend the jurisdictional boundaries of those federal agencies. This presentation highlights the key legal constraints on the adaptability of the existing governance regime in the United States. It also identifies changes to the governance regime that would facilitate better adaptation.

| **0283** | Advances on global land cover reference data sets and portals | Brice Mora | The Netherlands |

The main objective of this talk in this session is to develop further synergies among the global land cover reference data producers and stimulate discussions with the user communities in the context of the production of a growing number of global land cover maps.

Several global reference datasets have been released in the past years and most of them have been developed to assess accuracy of specific map products. Therefore users have access to a series of datasets of heterogeneous characteristics (e.g., sampling design, response design, legend, epoch) which make the choice of the most appropriate one difficult.

Some initiatives are aimed to guide users towards the most suitable datasets in accordance to their needs while providing data of improved quality. For instance the development of the Land Cover Classification

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System (Di Gregorio, 2005) are aimed to harmonise the interoperability of these datasets. Updated and consolidated versions of some datasets have being released also (e.g., GLC 2000, GlobCover 2005). Boston University, in coordination with the USGS and the GOFC-GOLD Land Cover Project Office (LC PO) is developing a new global land cover reference dataset based on very high spatial resolution optical satellite imagery independent from the development of any global land cover product.

In 2013 the GOFC-GOLD LC PO has released a beta version of a reference data portal (gofcgold.wur.nl/sites/gofcgold_refdataportal.php) aimed to gather the best reference datasets while providing guidance to users, promoting recommended practices for accuracy assessment of land cover maps (from CEOS Cal/Val Working Group) notably. Another initiative from the Group on Earth Observations (GEO) fosters synergies between the global land cover data producers under the Global Land Cover and Land Cover Change Task (SB-02). The Task participants have advocated the development of a GLC data portal under the GEOSS data core providing access to reference datasets and validation tools.

We wish this talk will be an opportunity to develop coordination on investigating further how global reference datasets and land cover change monitoring in general can be benefit from emerging concepts like crowd-sourcing (e.g., GEO-Wiki from IIASA).

| 0285 | Land observation strategies for improving land change modeling | Daniel G. Brown, Lawrence E. Band, Kathleen O. Green, Elena G. Irwin, Atul Jain, Robert Gilmore Pontius Jr., Karen C. Seto, Billie Lee Turner II, Peter H. Verburg | USA |

This presentation highlights some of the key findings from the NRC Committee with regard to opportunities and needs in land observation strategies to improve land change models. Land observations, be it from satellites, aircrafts or in situ sensors, have been key inputs to land change models. In recent years, there has been a significant increase in new types of data as well as ease of access to existing data archives. Moreover, advances in cloud and large scale computing and is improving access to existing data sets and analytical capability for automated processing of large data sets. These data sources and computational capabilities provide new opportunities to develop new land observations. Given the significant increase in data availability, three primary challenges with respect to land change modeling and land observations are: 1) How the deluge of new data can be incorporated into land change models; 2) How land change modelers can learn about and utilize these new data sets, and 3) How land change modelers can help inform the development of image processing algorithms that can generate land products of use in the next generation of land change models.

| 0286 | Spatial downscaling approaches for allocating agricultural land-use change | Daniel G. Brown, Lawrence E. Band, Kathleen O. Green, Elena G. Irwin, Atul K. Jain, Robert Gilmore Pontius Jr, Karen C. Seto, Billie Lee Turner II, Peter H. Verburg | USA |

Spatially explicit projections of agricultural land use are central in global scale assessments to address important questions regarding future food security, climate change, biodiversity, and climate adaptation and mitigation strategies. However, most spatially explicit land-use change models are only applicable at national or sub-national scales. Spatially explicit global scale modeling is challenging compared to smaller scale approaches, because the driving factors and their spatial characteristics of change are quite coarse. Therefore, the land use projections based on global scale models are downscaled to a suitable

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spatial, temporal, and thematic resolution. However, the value of such projections depends on the skill and accuracy of the downscaling methods. There is now a large published literature on the strengths and weaknesses of downscaling methods. This presentation will provide an overview of various spatial downscaling approaches for allocating agricultural land-use change.

0291	Conceptualizing an agent-based model for simulating regional crop pattern dynamics	Qiangyi Yu	China

Crop pattern is a key element in agricultural land systems; it not only indicates the overview of resource utilization in an agricultural region but is also closely related to food security, ecosystem services, and agricultural structure adjustment. Beyond the traditional understanding on land use and land cover change, crop pattern dynamics take place very frequently, but they are not always easily observable, making many difficulties for analysis. As the crop pattern at a regional level can be regarded as the aggregation of farmer's crop choice at the field level, an alternative approach is to conceptualize an agent-based model enabling the linkage between crop choice and crop pattern dynamics.

The model, which named as CroPaDy (an agent-based model for simulating regional crop pattern dynamics), is designed following the ODD Protocol proposed by Grimm et al. (2010). The conceptual model of CroPaDy is a closed-loop comprised by driving forces–attitude formation–decision making–consequences. We focus on the internal and external factors that influencing farmer's attitudes on decision-making instead of the macro level biophysical–socioeconomic drivers for land use and land cover change. The state variables are set to be updated automatically, incorporating feedbacks in any decision-making circle. The computational model links three sub-models named Agents Generating Module (generating agent based on survey and statistic data and geo-referencing them to real-world farm plots), Agent Classifying Module (classifying agent based on their attitude toward crop choice), and Agent Decision-making Module (using the empirical probability of crop selection of each agent type to determine individual agent's final decision) respectively. Common methods including Monte Carlo, Clustering, Artificial Neural Network, and Probabilistic Approach are used in model parameterization. An innovation is that we considered farmer's attitude before they make the decision (the importance and significance of farmer's attitude have been tested a parallel study), which is particularly helpful for agent typology analysis in the model.

The model framework will contribute to the GLP Conference session number 0108: "Human decisions in ABM for land use - how to implement and how to document". In particular, it is supposed to be helpful for small scale agricultural land system modeling.

0302	Synergies of climate change measures with nature conservation goals	Götz Uckert, Johannes Schuler, Andrea Bues	Germany

Climate change policies are mainly made on a national (e.g. the German Renewable Energy Act – EEG) up to a transnational scale (e.g. EU biomass directive). Negative trade offs on nature conservation goals have been allready reported for specific regions. In order to keep synergies with nature conservation special emphasis has to be drawn on a regional or local scale: To identify measures (cost efficient policies, …) under specific site conditions which are best to maximise greenhouse gas reduction or strenghten mitigation towards renewable energy crops without harming environment. Therefore asking which policies change what kind of land use patterns has to be flanked with an assessment of production measures with their different impact on habitats or species.

We assessed german technical measures of land use policies in their ability to contribute to climate change reduction and nature conservation goals at the same time. Analyses were done based on a literature review. Derived information of production steps like equivalent CO2 emissions, costs of implementation or land requirements were aggregated and subsumized under indicators capable to compare the measures.

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Starting from climate change measures we target on cost efficiency in carbon savings, fossil fuel substitution and a biomass production in line with nature conservation goals. We found a set of measures directed at agriculture that combine both climate change issues as well as nature conservation. Results were presented comprehensively in tables and figures. Conclusions e.g. the outstanding value of the high carbon stock in wetlands were underlined through results from a Delphi Study among German experts and a generic model based szenario anylysis.

0308	Advancing land change modeling: needs and research requirements	Daniel G. Brown, Lawrence E. Band, Kathleen O. Green, Elena G. Irwin, Atul Jain, Robert Gilmore Pontius, Karen C. Seto, Billie Lee Turner II, Peter H. Verburg	USA

This presentation provides an overview of the structure and findings of a recent report released by the National Research Council and commissioned by the USGS and NASA. The ten person committee was tasked with reviewing the present status of spatially explicit land-change modeling approaches and describing future data and research needs so that model outputs can better assist in science, policy, and decision support. Modeling approaches discussed range from those with relatively little opportunity to represent human behavioral processes, like machine learning and cellular models, to those that represent these processes with more structural detail, like economic and agent-based models. Future needs for scientific and applied uses of land-change models will require improved alignment of available approaches with goals; better coupling of land-change models to with other models and available data; broader use of the best approaches to model evaluation; and enhanced software, data, and community infrastructure.

0326	International investment and the pursuit of agricultural modernisation in Africa	Philip Woodhouse	UK

The presentation will summarise an argument that the focus of 'land grab' discussion has emphasized the role of international investors, whereas the logic of current land transactions needs to be seen from a longer-term perspective of struggles over land between different elements of African societies. From this viewpoint, recent international investment in agricultural land in Africa is a vehicle for the pursuit of long-standing goals of African governments and 'elites'. The point is exemplified with examples from Mozambique.

0329	Conflict and co-management between national parks and local communities in Colombia	Kobe De Pourcq, Evert Thomas	Belgium

Globally, there is a growing interest for a better understanding of natural resource-related conflicts (NRRCs) between indigenous and local communities (ILCs) and conservation authorities. There is also a need for innovative policy and institutional arrangements that can resolve these conflicts in a peaceful and participatory manner (Castro and Nielsen 2001). Based on fieldwork in ten Colombian national protected areas (NPAs) and more than 400 interviews, this presentation provides a better understanding of NRRCs between NPA Administration and ILCs in Colombia. We also discuss the effectiveness of co-management for conflict resolution between these parties. The presentation distinguishes between eight categories of conflict: (i) imposition of exogenous objectives; (ii) access restriction; (iii) environmental degradation; (iv) abuse of authority; (v) constrained participation; (vi) non-compliance with previous informed consent procedures and existing (co-management) agreements; (vii) limitation of socio-economic development; and (viii) disturbance of the local socio-economic environment. Furthermore, five categories of underlying dimensions for these conflicts are being identified: (i) the historical legacy of Colombian

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environmental politics; (ii) a weak state governance system; (iii) influence of global conservation partners; (iv) the neoliberalisation of nature; and (v) processes of territorial control and power. Last but not least, the presentation identifies twenty conditions that are considered to be necessary for co-management to lead to conflict resolution processes. The presentation contains five main conclusions: (i) NPAs in Colombia do hurt local people; (ii) the reasons for this should be traced back to the political ecology and economy of NPA Administration and Management; (iii) the necessary conditions for co-management to contribute to the resolution of NRRCs are rarely fulfilled in the cases we studied; (iv) the recent tendency to form co-management agreements between NPA Administration and ILCs in Colombiadoes not allow for power sharing; they rather strengthen the state's control over resource policy, management and allocation; and (v) this in turn has lead to new conflicts or has caused old conflicts to escalate.

This session is intended to contribute to the Open Science Meeting in relation to the main theme 4: Land Governance. More specifically, the presentation may contribute to Session 0130: Conserved lands and people in conflict: clashes between ideal policies and real livelihoods.

0330	Decentralization of Kyrgyz pasture governance in highly dynamic environment	Jyldyz Shigaeva	Kyrgyzstan

Kyrgyzstan is a predominantly mountainous country (94% of total land area) with semi-arid continental climate. Economic opportunities in rural mountain areas are focused on livestock and small-scale mixed subsistence-market farming, and are characterized by high costs and comparatively low outputs.

Kyrgyzstan, like other Central Asian countries, has transitioned from a centrally planned, Soviet mode of land use and management to a more dejure and defacto decentralized, market-oriented system. A rapid privatization program in the early 1990's dissolved the collective and state farms and distributed (often in a non-transparent and unequal way) land, livestock and other assets. Reforms in 1999 and 2002 resulted in a complex and rigid lease arrangement antithetical to the flexibility necessary for transhumant pastoral practices (Kerven et al. 2011).

In 2009, the Kyrgyz Parliament passed a new law on pastures that abandoned the lease system and transferred all administrative authority to village (*ayil okmotu*) level pasture committees which are elected by village pasture users unions. The committees are responsible for the planning of pasture use, monitoring the state of the pastures, selling pasture tickets for pasture use, and maintaining pasture infrastructure. The law was expected to be an important step in fostering decentralization and more sustainable use of land resources. Opinions are mixed regarding the implementation and enforcement of this legislation. Some have criticized pasture committees as very formal due to low capacity of pasture committee to implement obligatory tasks. Thus original goal of community-based governance structure has been distorted.

Despite social, economic, and political integration into global structures since the Soviet collapse and the increasing influence of climate change, very little research on Kyrgyzstan has focused on the influence of global change factors on social and ecological systems (Shigaeva et al. forthcoming). It is likely, however, that these newly created village-level pasture committees will need significant capacity development to deal with global change factors.

0340	Human decisions in ABM for land use - how to implement and how to document	Birgit Müller, Jürgen Groeneveld, Nina Schwarz	Germany

The round-table organizers identified two major obstacles for using ABMs to study the role of human decision in land use systems:

First gap: Despite a wide range of different implementations of human decision making in ABMs for this context have been applied, these human decision models are often not sufficiently theoretically based or

empirically supported but rather ad-hoc assumed. Additionally, systematic overviews of these implementations are rare in the literature. Consequently modeling novices have little orientation how an appropriate implementation of human decision in their model with respect to their specific research question and context should look like.

Second gap: Communication of the model and its results to different audiences such as peers or model end-users is hampered to a large extent since model descriptions in general but also in particular of the human-decision part are often incomplete and non-transparent.

Based on a discussion of the state of the art, we therefore intend to tackle the two open challenges:

(1) Is it possible to create a guideline in the future, which shall support a modeler in incorporating and formulating human decision making in the ABM with respect to his specific research question and context?

(2) What are prerequisites to facilitate communication of the model and its results? Can standardized protocols for model descriptions, in particular for the human-decision part, be helpful? If yes, how should these protocols be structured?

Furthermore the round-table organizers will report about experiences and results of a stimulating interdisciplinary working group that has been working over the last two years on "standardized and transparent model descriptions for agent-based models – current status and ways ahead".

0342	Institutional redundancy, system stability, and adaptation: insights from the European Alps	Jörg Balsiger	Switzerland

Governance in the European Alps is best described as a heterarchic system in which local, regional, national, and international actors engage in and with a multitude of institutions. The three main protagonists – intergovernmental Alpine Convention, the European Union's Alpine Space Programme, and the transnational Network of Alpine Regions – each performs strategic and operational functions, sometimes in concertation but often independently. Moreover, Alpine territories are subject to sectoral regulatory domains associated with global and regional treaties (eg, biodiversity, wildlife, trade), EU Directives (eg, water, habitats), and national and subnational legislation.

While such institutional copiousness is typically deplored because overlap and duplication are considered wasteful, ecologists and engineers have long recognized the value of redundancy for system stability and change. As a so-called macro-regional strategy for the Alps is taking shape, the Convention, Programme, and Network are forced to better align their roles and consolidate overall goals. In turn, researchers must now ask (again) how this reduction in redundancy will influence system stability and adaptation, and whether Alpine governance will be improved.

Against this background, the flash talk has one principle aim: to argue that redundancy deserves more nuanced considerations in governance discourse. In support of this argument, the three slides will (i) provide a typology of redundancy, (ii) draw out the typology's implications for governance, and (iii) illustrate the implications for the European Alps. The presentation contributes to the conference theme because governance processes play a key role in articulating the global challenges and local realities concerning land transformations. It contributes to the session on adaptation because the impact of institutional redundancy on adaptation is a largely unstudied issue.

0363	Uniting the unlike-minded? How perspectives matter in land use planning	Merel van der Wal	The Netherlands

Have you ever tried to work with someone, be it in a policy process, research team or on an otherwise land use or climate-related topic, and felt like you were talking in a completely different language? In this short 20x20 presentation you will learn that even though we know what we are talking about, sometimes it

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feels like you just don't reach your conversational partner. Why can it be difficult to convey the message, and why is the conversation sometimes uncomfortable?

With an uncertain future ahead, many local residents are starting to realize that the changing climate conditions are unsure of their future. Under these uncertain conditions, the best chance to successfully make and implement robust , well-supported land use policy is to include all involved stakeholders. Unfortunately, this participatory policy-making is often seen as a nuisance, a delay in the process. Nonetheless, the relevance and necessity of involving all stakeholders is crucial in land use planning. Stakeholder participation will be addressed from a 'social learning' perspective. From constructivism, we can learn that information is only absorbed if it lies within a limited distance from one's own knowledge or beliefs. Social learning theory, particularly in climate-related context, explains that new information from other stakeholders with different opinions is necessary to broaden our joint understanding of the concepts we are talking about , but also help understand and define the 'problem' that is discussed. Finally, coming from Cultural Theory, stakeholders interacting from all their different perspectives, together can reach an all-round, all-inclusive view on the problem, solutions and how to get from the problem to the solution.

Illustrated by examples from a real-life land-use planning process and a serious game, this short presentation will hopefully give some insight in the struggles, but also how you can contribute to a smooth, constructive relation with your colleagues. Whether you are a scientist, a policy maker or a local resident confronted with land use changes.

| 0387 | Shared social values in land change processes | Katja Schmidt, Ariane Walz | Germany |

The Scottish Land Use Strategy from 2011 takes an ecosystem service based approach and encourages public involvement in land use and management decisions. To date, the theoretical foundation of much government decision making in Scotland is mainly built on economic approaches. Yet, the exploration of so-called shared values is on the rise. Shared values capture the priorities of citizens not only from their individual, but from a wider societal perspective. These values can be elicited in deliberative processes on social and monetary valuation, as well as on the basis of quantitative surveys.

In this contribution, we quantitatively explore societal preferences and needs in ecosystem services along an exemplary urban-rural gradient in Scotland to better understand how social valuation can complement economic approaches. We will present and put up for discussion first results based on a questionnaire that links revealed and stated social preferences directly to monetary valuation, enabling us to assess the robustness of social and economic valuation techniques. Going beyond the mere consideration of market-based and non-market economic values, we will illustrate a hybrid approach to capture the fullest possible range of ecosystem service values to inform inclusive land use decision-making. Moreover, we will give an indication about advantages and risks of the approach and an outlook on future investigations.

| 0410 | The multi-scale hydrologic impacts of deforestation and forest degradation in the Amazon | Michael Coe | USA |

Deforestation in the Amazon causes important changes in the energy and water balance by changing how incoming precipitation and radiation are partitioned among sensible and latent heat fluxes. Pasturelands and croplands (e.g. soybeans and corn) generally have a higher albedo and decreased water demand, evapotranspiration, and atmospheric turbulence compared to the forests they replace. These differences in the water and energy balance work at a variety of time and space scales and the combined influences on regional hydrology are complex. Observations from micro (<1 km^2) to meso (100s km^2) and large (10,000 km^2) spatial scales in the Amazon clearly show that deforestation decreases evapotranspiration and increases soil moisture and stream flow. These changes result from the reduced leaf area index, altered

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phenology, decreased root density and depth, and total water demand of the pasture and crops compared to the native vegetation. Global and meso-scale climate model studies indicate that once deforestation occurs on a very large scale (> several 100,000s km^2), atmospheric feedbacks may reduce regional precipitation. Replacing forest with higher albedo, less water-demanding crops and pastures leads to decreases in the net surface radiation, moisture convergence over the basin, water recycling, and precipitation. The south-southeastern Amazon region has been most affected by these changes because of the combination of large-scale historical deforestation and its geographic position in a climatological and ecological transition zone. Given the current distribution of protected lands in south-southeastern Amazon, mitigation of future ecological impacts of externally and regionally driven climate changes will depend heavily on leveraging existing policy mechanisms to strengthen the protection of forests on private lands.

This presentation contributes to a greater understanding of the ways in which land cover and land use changes alter the energy and water balances of tropical regions at local and regional scales.

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0413	Investing in biologically-based agricultural systems to meet world food needs	Claire Kremen	USA

Today's intensive, industrialized agri-food systems rely on chemical pesticides and fertilizers and sophisticated supply chains to produce and distribute large quantities of food, fiber and biofuels. However, this system also leads to negative environmental effects including losses of biodiversity, soil fertility and nutrients, while increasing greenhouse gas emissions, eutrophication and salinization. It contributes to negative social consequences for human health such as pesticide poisoning, malnutrition and obesity, and to food riots, poverty traps, rural outmigration and land grabs. Alternatives to the chemically-intensive, industrialized model, such as organic, agroecological systems, may counter many of these negative environmental and social consequences by promoting biologically-based, regenerative agroecosystems that minimize both external inputs and waste outputs, and that encourage rural development by stimulating employment, women's empowerment and food sovereignity. However, biologically-based farming systems may produce less food than chemically-based systems; for example, recent comparisons between organic and conventional agriculture range from 15-25% yield gap. Yet, comparatively little investment of research and development has occurred in biologically-based versus chemically-based agriculture. Given the many environmental and social benefits of biologically-based farming systems, significant effort should be expended in closing this yield gap and promoting biologically-based agricultural systems world wide (1).

This presentation fits into the theme of the Roundtable Discussion which is assessing how different types of agriculture will contribute to food production and human livelihoods. It fits into the conference theme 3 (and systems changes to mitigate global environmental change impacts and adapt to increasing demands for food, fuel and ecosystem services.)

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0437	Climate change adaptation and the changing context for resource management and governance in the Great Basin	Eric Lindquist	USA

The availability and use of climate science for decision making involves a complex dynamic between science provider and potential user. Significant research has been conducted on the use of science in decision making, in general, and more recently on the use of such tools as vulnerability assessments (VAs), integrated assessments, and ecological and ecosystems assessments, for decision making. Significant barriers and constraints are in place, however, for the integration of climate science into institutional methods of decision making within traditional governance structures. The work presented

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here will focus on the Great Basin region of the Western United States and how resource managers within diverse and often conflicting or overlapping governance structures perceive and use climate science in this geographically dynamic region. The Great Basin is comprised of the series of successive north-south mountains and valleys covering most of Nevada, parts of California, Idaho, Oregon and Utah and is bounded by the Wasatch Mountains, on the east and the Sierra Nevada and Cascade Mountain to the west. Governance for public land and the contentious issue of the use of public lands in the Great Basin is currently attracting attention from the general public and media and is on the policy agenda for decision makers and resource managers in the region. While integrated assessments of ecological vulnerabilities have been is use for decades, it has been only recently that VA development has integrated political and human dimensions. Contributing factors include an increased awareness of resilience, vulnerability and climate change impacts, and from a greater emphasis on effective and efficient decision making in government in an era of reduced and limited resources for decision making. From an institutional perspective, adding to this dynamic is a limited capacity for climate change impact assessment and unfamiliarity with the application of VAs and their subsequent integration into climate change adaptation planning efforts. This Flash Talk Presentation/Poster will illustrate this situation, empirically, through a description of the institutions, their rules and interactions, with attention to the normative implications from this situation in regard to the changing role governance in the region. In particular, the evolving Wildland-Urban Interface and increased stress on land resources will be articulated as to its impact on changing governance needs and structures. This presentation will contribute to this session and the broader Conference theme through its attention to the empirical and normative dimensions of governance in a changing natural and political environment.

| **0443** | Applying the concept of spatial resilience to socio-ecological systems at the interface of urban-wetlands | Yangfan Li | China |

A resilient social-ecological system (SES) has a greater capacity to avoid negative environmental change without a regime shift. In this paper we introduce the concept of spatial resilience and apply its potential contributions to the assessment, planning and ecosystem-based management of urban-wetland interface coastal case studies of China. Spatial resilience in this case focuses on the importance of ecological sensitivity, water quality and vegetation coverage, from the idea that spatial indicators in patterns and processes impact the SES resilience. Therein we have two main criterions: Protection and Recovery and we have further sub-divided these two criterions into general and key types for four resilience scenarios viz key protection, general protection, general recovery and key recovery areas. The paper assesses the spatial resilience by indicator-based system, multi-criteria evaluation method and GIS-based spatial visualization for creating zones. Theses spatial zonings are assessed in the context of different degrees of spatial resilience. The results are integrated with indicators of population density, GDP per unit area and ecological sensitivity in the study area, in addition to the assessment of water quality monitoring and vegetation coverage with an anticipation of addressing the practical application of spatial resilience. The zoning maps showing water quality and vegetation coverage and plans are generated based on spatial resilience assessment, social indicators and administrative region, which would be helpful for the authorities to identify different purposes and implementations of protection or restoration of the ecological services for the wetlands.

| **0445** | Sensitivity of land change intensity cbservations to spatial scale | Michaela Buenemann | USA |

Information on rates and patterns of land changes is critical for assessments of human and environmental drivers and impacts of these changes. However, the observed rates and patterns of land changes often vary with spatial scale, complicating such assessments. This has been documented in numerous studies for

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patterns, but not for rates. The main goal of this study was to help fill this research gap. To do so, land cover maps were generated using aerial photography and satellite imagery for an area centered on Las Cruces, New Mexico, USA (32° 18' 39 "N, 106° 46' 54" W) for six points in time (1985, 1990, 1995, 2001, 2005, 2009). The land cover maps were then modified in two ways to examine the effects of spatial scale on observed rates of land change. First, the multi-temporal land cover data were aggregated to seven spatial resolutions (15×15, 30×30, 60×60, 120×120, 250×250, 500×500, and 1000×1000 meters). Second, the multi-temporal and multi-spatial-resolution land cover maps were subset to six spatial extents (6×6, 12×12, 18×18, 24×24, 30×30, and 36×36 kilometers). To measure rates of land change, Intensity Analysis (Aldwaik and Pontius 2012; Session "Intensity Analysis to Characterize Land Change") was subsequently applied using transition matrices generated for each time period (1985-1990, 1990-1995, 1995-2001, 2001-2005, and 2005-2009), spatial resolution, and spatial extent. Finally, scalograms were constructed to assess the sensitivity of observed land change rates (i.e., time, category, and transition intensities) to differences in spatial resolution and spatial extent. The results of this study indicate that observations of land change rates vary with changes in spatial scale and thus have important implications for "Rethinking Land Change Transitions" (Main Conference Theme No. 1) and modeling land change "Impacts and Responses" (Main Conference Theme No. 3).

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0474	Land use consolidation, soil erosion and social differentiation: a comparative case study from Rwanda	Cioffo Giuseppe Davide	Belgium

This presentation draws on a comparative case study from Rwanda to contribute to the debate on large-scale vs. small scale farming. While such debate has largely focused on the different potential for productivity of the two systems, we focus on their different effects in terms of social differentiation within the rural population, in a context of high land/population ratio – what some have called 'a Malthusian trap'. In this context, large-scale vs. small-scale agriculture are taken as holistic definitions, concerning not only plot size but also different strategies of input allocation, investments in land and labour productivity as well as broader differences in ecological arrangements. Rwanda represents the ideal case study to contribute to the debate. In fact, while it has recently embarked on an ambitious rural modernization process that promotes mono-cropping and market-oriented, large-scale agriculture, Rwanda also faces a set of structural challenges – namely: high population density, a population mostly made up of small-holders and high rates of soil erosions that threaten land productivity*. In this presentation we compare results from in-depth mixed quantitative-qualitative investigations in two settings on the Northen Rwandan highlands. In the first setting, small-scale family farming dominates agricultural production, and (radical as well as conventional) terracing are the main soil conservation methods adopted by farmers to improve land productivity. In the second setting, land use consolidation – which radically transforms land use, through the agglomeration of small plots and the homogenisation of production but leaves formal property arrangements untouched- is dominant and chemical fertilisers, subsidized by the Rwandan government through the Crop Intensification Program, are widely used by local farmers to enhance soil productivity. By comparing results in the two settings, the presentation links patterns of agricultural productivity and different kinds of soil conservation investments with the aim of building a socio-ecological narrative of ongoing processes of social differentiation under different systems of agricultural production.

The presentation will contribute to the panel debate by bringing in large-scale investments from the state in the form of land use consolidation - a category often neglected in favour of the analysis of private-driven investments. It will also bring environmental consideration into the debate, in order to strengthen and complete the socio-economic assessment of changes from small to large scale forms of production.

NUMBER	TITLE	AUTHORS	COUNTRY
*	Musahara, H. and C. Huggins (2005), 'Land Reform, Land scarcity and Post-conflict Reconstruction: a case Study of Rwanda', in Huggins, C. ans J. Clover (eds), *From the Ground Up: Land Rights, Conflict and Peace in Sub-Saharan Africa.* Institute of Security Studies.		
0478	Why GEOSHARE?	Navin Ramankutty, Thomas Hertel	Canada

Several global and regional data sets of land cover and use are now available. These data are seeing widespread use in climate and carbon cycle science, assessments of biodiversity, water resource and food security, and economic models of land change, among other important applications. However, most of these are un-coordinated efforts of individual research teams, often the outcome of one-off projects, with no interoperability between them, or promise of continued development. The GEOSHARE network aims to support co-ordination between the various global and region efforts and to seek some base level of funding to operationalize these efforts into the future. This flash talk will present the initial vision for GEOSHARE and outline the purpose of the roundtable.

| 0499 | Supply chain sustainability: the SAN cattle certification program in Brazil | Helena Nery, Peter Newton | USA |

Livestock is a primary driver of environmental change in Brazilian Amazonia, associated with high deforestation and greenhouse gas emissions. In response, government, private sector, and civil society organizations have collectively initiated a number of governance interventions that aim to lessen the environmental impact of the cattle industry. In 2010-12, the Sustainable Agriculture Network (SAN) developed a global standard for sustainable cattle production. The certification program includes principles of environmental and social responsibility, and aims to increase the sustainability of the commodity supply chains for cattle products. It has been implemented in a small number of farms in Brazil and Central America, with more farms in the process of becoming certified. Using a conceptual framework for analyzing supply chain interventions (Newton et al. 2013), this case-study research analyzes the institutional arrangements associated with the SAN cattle certification program. First, it characterizes the certification program with respect to a) the combination of institutions, incentives, and information by which the program aims to achieve enhanced sustainability and b) the suite of actors involved in implementing it. Second, it evaluates the key opportunities and challenges to the implementation and expansion of the intervention within Brazil. It does so both by examining the motivations and incentives to individual actors, and by considering the wider economic, political and particularly institutional context within which the program is being developed, with attention to other interventions that either complement or constrain it. Finally, the research draws attention to some generalizable lessons that could be of significance to other commodities or countries. As a recently-developed intervention, the impacts of the SAN cattle certification program are difficult to quantify, but by understanding the institutional arrangements and context, this research identifies some of the program's significant potential and limitations.

This presentation embraces the session theme of 'local decisions with global consequences'. The SAN cattle certification program provides an institutional framework for adopting more sustainable practices. But it is the decisions of individual farmers, about whether the incentives to participate exceed the challenges, and whether to engage with the program or not, that will determine the aggregate impact of the program. Deforestation in Brazilian Amazonia has global implications, and understanding the relationships between certification program structure, participation and outcomes could contribute to the design of better interventions for improved environmental outcomes.

| 0502 | Assessing the suitability and effectiveness of governance structures across scales: a problem-oriented | Carolina Adler | Switzerland |

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	approach		

This presentation focuses on the utility of problem-orientation as a means to assess the suitability and effectiveness of governance structures intended to support multiple valued policy outcomes, such as climate change adaptation, conservation, disaster risk reduction and poverty alleviation. To date, much research conducted in mountain regions is directed towards the scientific characterisation of physical and/or socio-economic aspects of impacts from global change processes. While useful and necessary, critical and empirically-based analyses of governance issues, where global challenges indeed meet local realities, have been less apparent. Drawing on insights from a number of case studies conducted in mountain regions in Nepal and Australia, the presentation highlights key barriers and opportunities towards the realisation of valued policy outcomes. Important to note are the intricate and complex interactions between governance structures across scales, including cross-border jurisdictions and the often divergent politics, values, interests and mandates of key governance stakeholders in a given spatial setting. However, detailed characterisations of problems and conflicts are not in themselves sufficient nor conducive towards the improvement of governance structures to support the implementation of policies. Finding common ground is imperative and can be empirically based through problem-orientation. It can assist by not only structuring and clarifying on local realities that underpin governance, but also facilitates the normally difficult science-policy dialogue on which action depends.

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0521	An overview of graphical models for describing human decision making in ABM	Zhanli Sun	Germany

Agent based modeling (ABM) of land use change is a promising tool to help understand the complex process of land systems evolution, and then to support sensible policy-makings aiming at a sustainable future landscape. However, the lack of transparency of ABM—which has oftentimes been regarded as grey or black box largely due to the diversity and complexity of decision-making and behavior rules of agents—hinders understanding models and communicating with peers and stakeholders. Thus far, text based standard protocol, notably, ODD protocol (objective, design and details), has been recommended and in general positively received from modeler's society. Yet, the resulting effects are mixed due to the fact that ODD protocol is essentially a documentation template—no or little mandatory rules, besides the structure, are enforced. By using ODD, therefore, how transparent is and easily to understand the model still largely depends on the level of details and clarity of the ODD. To further boost the discussion in this regard, we advocate the usage of graphic models and tools in stages of design, implementation and documentation. Some potential graphic models and tools (e.g., flow charts, Unified Modeling Language (UML), Bayesian Networks, causal loop diagrams and system dynamics, cognitive maps, etc.) are to be reviewed and assessed. The goal of this talk is to stir the discussion on how graphic tools can be used to streamline the design process, define decision rules, model social networks, and, most importantly, describe and document agent-based models.

This contribution, as a five-minute flash talk, is conscientiously aligned with the topic of session, "Human decisions in ABM for land use - how to implement and how to document", by discussing the application of graphic tools in design, implementation, and documentation of ABM. It also contributes the conference theme on the aspect of modeling land use change.

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0523	Where's the beef? Implications of ignoring beef production in analyzing land use, food security and climate change	Doug Boucher	USA

Analyses and models of global land use often simplify or completely ignore beef production, even though it accounts for the majority of agricultural land use, the majority of methane emissions and an appreciable

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fraction of grain consumption. Some researchers look only at crop production, even though pastures account for more than twice as much land; others subsume different kinds of animal products under the concept "meat", ignoring the large differences between beef and poultry, pork, and dairy. These approaches may be adopted to simplify analysis and modeling but may also be based on the cultural conflation of the categories "beef" and "meat", or on the incorrect assumption that most pasture land cannot be used efficiently to grow crops

Failing to consider beef tends to exclude important possible changes and policy alternatives from the discussion. These include diet shifts among kinds of meat, applying carbon prices to agriculture, and removal of implicit subsidies for extensive land use. Considering it only from the supply side – encouraging more efficient beef production, but ignoring the determinants of how much is produced – similarly tends to narrow discussion and exclude alternatives that can be important for future land use, food security and climate.

0524	Linking land markets and landscape carbon in exurban development	Daniel G Brown, Shipeng Sun, William C Currie, Joan I Nassauer, Scott E Page, Dawn C Parker, Rick L Riolo, Derek T Robinson, Sarah E Kiger	USA

This talk describes a project that seeks to understand the linkages between processes of low-density development and changes in carbon storage in exurban landscapes in the Detroit metropolitan area, USA. Our multidisciplinary project makes use of agent-based modeling as an integrating framework, and to link processes of market exchanges in land between rural land owners, developers, and home buyers with changes in vegetation, vegetation management, and carbon storage. I will describe the overall structure of the integrated models and some of the challenges associated with collecting the empirical – social and ecological – data needed to inform those models.

0532	Vector infection disease regulation under scenarios of climate and land use change using bayesian networks: linking ecosystems and people	Melanie Kolb, Octavio Maqueo, Sergio Ibáñez-Bernal, Miguel Equihua, Eduardo Rebollar-Téllez, Christian Delfín-Alfonso	Mexico

Climate change could have major impacts on ecosystems and their regulation capacity of vector-borne diseases, especially in combination with other human impacts that alter ecological integrity. Leishmaniases are zoonotic diseases with about 2 million new cases each year worldwide. In the Americas they are present from southern USA to Argentina. *Leishmania* is a genus of parasites of different mammals and phlebotomine sandflies. Transmission among mammalian hosts is predominantly by the bite of infected insects, with 23 *Leishmania* species known to infect humans. A greater presence of anthropophilous vectors with positive parasitic frequency increases the risk of human infection. The hypothesis of "*dilution effect*" is that the load decreases as a function of the preservation of ecosystem integrity. We are exploring this hypothesis with a Bayesian network approach in the context of a broader international research project financed by the European Commission that investigates the Role of Biodiversity in Climate Change Mitigation (ROBIN). One of the components is the modeling of the ecosystem service of disease regulation for a case study in Veracruz state, Mexico on *Leishmania mexicana* that usually causes localized skin lesions (ulcers) that sometimes disseminates over the body, the most common type of infection in Mexico. This case study is developing a methodology to evaluate the change of ecosystem services under climate change and land use change scenarios that both influence the infection system. The models are developed in the ARIES framework (Villa et al. 2009), and integrate a variety of social and natural aspects that determine the incidence of infections. The modeling aims at linking, among other features, a measure of ecological integrity based on structural, functional and

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compositional indicators of biodiversity, and measures of human impact. The model is complemented with explicit data on the exposure of local human population. The result is a model of the change in behavior of vector species (search for food outside of the original habitat related to the loss of wild host species) and the availability of wild mammal hosts. If the dilution hypothesis holds, preservation of ecological integrity is a benefit provided by natural ecosystems to the social system.

0556	Indigenous landscapes: land use decisions and identity in two ejidos in La Selva Lacandona, Chiapas	Susan Aragón	Brazil

In the Neotropics, a considerable part of tropical forests are under management of local and indigenous communities. A complex set of socio-economic and political factors affect the way that these rural landscapes are managed. Understanding the effect of identity on land use decision may help to have a better picture of the challenges and future trajectories of these forests.

I present the case study of two ejido communities in La Selva Lacandona, Chiapas. Through semi-structured interviews and ecological surveys this work examines the relations between identity and land use management, and the confrontation of identity-based discourses and practices by the State and the communities in the design, implementation and management of sustainable projects designed to lessen the pressure on the forest natural resources.

The State institutions and state-sponsored NGOs exhibit different and contradictory visions of what constitutes an indigenous identity and what is or must-be their relationships with the land. The insensitivity to identity issues sometimes precludes the gaining of trust and commitment from the participant communities, hampering project success.

People in the communities resist rigid and simplistic classifications and live their multiple ethnic, religious and national identities and at the same time assert their claim to land and autonomy by making land use decisions that combine different visions about their relations with land. The effect of identity on the farmers' decision making process was not uniform between or within communities; other factors such as bio-physical characteristics of the landscape or socio-economic factors such as economic opportunities, global commodity markets, and rural-urban and transnational migration trumped or modified its influence. This work contributes to the conference and session theme as it highlights the effect of local factors to the land change dynamic and the multi-scalar linkages of local decisions to national and transnational processes.

0559	Consequences of south-east Asian land use fires for human health	Ruth DeFries, Miriam Marlier	USA

Fires for land clearing and agricultural management in South East Asia emit particulate matter and trace gases that alter air quality. Atmospheric circulation can transport these emissions to population centers and affect large numbers of people (Marlier et al 2013). Fire emissions increase non-linearly during dry conditions associated with El Nino. Land use plays a large role in emissions as well, for example fire is often used to clear debris for oil palm plantations. Understanding the combined impacts of land use and climate on fire emissions can help avoid major air pollution events such as the one that occurred in June 2013.

0562	Impact of climate change on water resources and crop production in a semi-arid region of Iran	Ammar Rafiei Emam, Martin Kappas, Seyed.Z. Hosseini	Germany

The availability of water resources in the semi arid area of Iran are decreasing due to over extraction of water, surface and groundwater, especially for irrigation of farmlands. More than 90 % of water are using in the agriculture section. The water use efficiency in these areas are not more than 35 % which show high amount of water are wasting because of mismanagement of agriculture. At the other hand, the productions

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in rainfed lands alter from year to year depending on precipitation and soil moisture. According to FAO, crop productions should increase 97 % by 2050 in developing countries, therefore simulation of agricultural productions is useful for planning and management. To better understanding the water resources and land potential, we investigated the impact of climate change of water resources components and wheat yield in Razan-Ghahavand area located in a central drainage basin of Iran. For this aim we used soil and water assessment tools, SWAT, to simulate the hydrological condition and crop growth of site study at the monthly time step in the subbaisn level. The model was calibrated and validated based on river discharge and wheat yield. Three IPCC emission scenarios from Community Climate System Model, CCSM3, for period 2046-2065 were fed into the calibrated SWAT model. The results show the water components, especially precipitation and soil moisture, in temporal and spatial distribution. Winter wheat yields both for rainfed and irrigated agriculture also was simulated. Generally, the results can be used for future planning and management in the regions with the same conditions.

| 0563 | Stable isotopes in tropical tree rings as indictors of climate change and hydrological cycle | Aster Gebrekirstos, Achim Bräuning, Meine van Noordwijk | Kenya |

Tree rings are important proxies for paleo-climate studies because they contain continuous historical records of inter-annual and intra-annual time resolutions, which range over hundreds of years. The oxygen and carbon isotopic composition of tree rings as archives to explore variations of long-term precipitation patterns, seasonality of precipitation, river flow, tree responses to variations in atmospheric water demand, soil water availability, and intra-annual patterns of transpiration rates, will be discussed. A gradual increase in delta $d^{18}O$ levels in the tree rings may indicate an increased evaporation leading to more precipitation. An increase or decrease of $d^{13}C$ indicates an increase or decrease of water use efficiency. The potential of stable isotopes as climate proxy can be used to establish large-scale correlation patterns between tree rings and sea-surface temperatures, and to better understand regional hydrological cycles and recycling of source water.

| 0574 | Pricing rainbow, green, blue and grey water: tree cover and geopolitics of climatic teleconnections | Meine van Noordwijk | Indonesia |

Tree cover influences rainfall. Around the world local knowledge is certain about that, and formal science is gradually coming round to this view, recognizing the complexity of cause-and-effect chains involved. Anyone walking through a landscape on a hot day knows that trees influence temperature, humidity and wind-speed. However, no current climate maps include these effects. When we worry about crop yield affects of a warmer climate, managing tree cover in landscapes can be part of the answer. With the focus on reducing emissions from deforestation and forest degradation (REDD), carbon accounting, emissions and global climate change, little attention is being paid to the more direct and tangible influences that trees and forests have on the temperature, humidity and wind-speed in which humans, crops and livestock live (the 'micro-climate') and on the landscape and regional patterns of rainfall ('meso-climate').

Atmospheric moisture ("rainbow water") is the source of all green, blue and grey water flows. Current water-related legislation and policies have moved beyond blue (water allocation) and grey (waste water treatment) water concerns to incorporate the green water concept of additional water use by fast-growing trees; it may require further change to incorporate rainbow water relations as evident in recent literature on short-cycle rainfall derived from evapotranspiration over land. Specific teleconnections relate rainfall dynamics at any specific site to landuse and sea conditions at others. Government-mandated water use charges for payments for ecosystem services (PES) exist in some African countries but their use in enhancing actual water related ecosystem services covering the full hydrological cycle is still evolving as rainbow water science is new.

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0575	The vector, the landscape, the ecosystem: a geographical lens on tick-borne diseases	Sophie Vanwambeke	Belgium

Vector-borne diseases and zoonotic diseases are well known for the complexity of their transmission systems. These systems are influenced by a broad spectrum of environmental factors. However, these environmental factors influence the spatial distribution of the disease at various scales. Climate, for example, essentially homogeneous at a broad scale, affects the distribution essentially at the regional scale. Locally, a number of global change-relevant factors are also significant. Land cover is an important determinant of habitat suitability for vectors and hosts. This will determine the suitability of an area for the pathogen transmission cycle to take place, therefore translating into the hazard. Land use *in fine* determines areas of contact between vectors and humans, by favouring or limiting access to areas with high densities of infected vectors or host. Indeed, people have specific preferences, which could bring them into closer exposure to the hazard. Data sources pertaining to land cover and use, combined with other environmental data sets or data related to land tenure and infrastructure can help describing in a quantitative way hazard- and exposure-relevant factors. Challenges related to working with vector or disease case data will also be presented. Land cover and land use can be highly spatially heterogeneous at a fine resolution. Using illustrations drawn from our studies of tick-borne diseases in Europe mostly, the use of a landscape-focused approach that attempts at disentangling hazard and exposure, with the help of the tools of geography, will be presented. Original case studies will include Latvia, Sweden and Belgium. This presentation will contribute to address the issue of health in relation to land issues in the conference, and will bring material specific to the session with original work on tick-borne diseases throughout Europe, with additional examples from other regions of the world.

| **0576** | Which policies do really matter? an expert panel approach to assess policies as drivers of land cover change in Portugal | Isabel Loupa Ramos, Beatriz Condessa, Rui Reis | Portugal |

Landscapes reflect the evolutionary pattern of societies. As societal demands change also policy options change. Policies are recognized to be one of the main drivers of land cover change (LCC). Getting a better understanding on how past policy did influence change is relevant to inform future policies options on its potential impact. Nevertheless, pinpointing direct relations between policies and land use/cover change is still not a straightforward task, despite ongoing research in this field. The main difficulties are related to varying timescales, the interactions between policies, as well as the increased distance between divers of change and the actual landscape. Expert panels are known to be helpful in proving insights into situation of high complexity and uncertainly and thereby contribute to disclosure underlying relationships between policies and the landscape. This paper aims to report on a research aiming to identify policy divers for past land cover changes in Portugal. Here, as elsewhere in Europe, landscapes underwent rapid changes during the last decades and there is wide range of policies at different levels of governance with potential to inform those changes. This study decided to target environment, agriculture and spatial planning policies in place for the last three decades in Portugal. Methodologically land cover changes were identified based photo interpretation of on historical aereal pictures since the seventies by using Eurostat's LUCAS sampling network. Land cover classes were surveyed at a 1:25000 using a CLC-based classification as used in the most recent land cover map in Portugal (COS 2007). The data collected at nation-wide scale, captured land cover changes and provided information on the main trends in each decade. With the purpose in mind to identify the most relevant policies driving these chances, results where confronted with an expert panel. This panel was carefully chosen by bringing together with political responsibilities in the three policy domains considered in each of the three decades under scrutiny. Thus the panel interviewed

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	included past ministers, secretaries of state, and director-generals. This procedure made possible firstly to formulated a comprehensive list of the most relevant policies and also to pinpoint some key-policies more likely to be responsible to define pathways of land cover changes.		
0594	Causes of technology adoption in Brazilian cattle systems: a synthetic discussion	Avery Cohn, Leah VanWey	USA
	This flash talk will be a response to a provocative background paper on one of the three sub-themes of the panel--Technology Adoption in Brazilian Cattle Systems. The paper will describe work on technology adoption in cattle systems as part of a collaborative effort between the UN Food and Agriculture Organization and the Global Trade Analysis Project. The paper also references the wider landscape of research on theme. The paper addresses questions such as: What are the determinants of technology adoption in Brazilian cattle systems? What interventions have been modeled or examined to induce technology adoption? What do these interventions specifically aim to accomplish? How do we monitor/model the interventions and their effects? What research methods are employed to design and evaluate the interventions? Are the research methods appropriate? Are the interventions effective? What further evidence/research/modeling could help the implementation of the interventions and/or the monitoring? This Flash Talk response will contribute to the authorship of a synthesis paper with the other members of the panel. The theme is on the development of the evidence base for making and monitoring interventions in Brazilian cattle systems.		
0602	Land conservation and land restitution in Colombia: the mechanisms and tensions of allocating conserved land to restituted victims	Sarah Tadlaoui	Colombia
	This communication seeks to analyze the models and mechanisms created to manage the tensions between the land restitution policy and the conservation objects in Colombia, through a specific case study. In 2011, Colombia adopted a Victims and Land Restitution Bill, which seeks to restitute land to the hundreds of thousands of victims that were dispossessed from their land because of the armed conflict. This reparation policy sets the principle of retributive justice as a convenient alternative to deal with the land issue in the country beyond the traditional debate between equitable distribution and economic efficiency. In the implementation of the land restitution policy, conflicts have emerged over the land claimed by the victims, which mostly lacked formal property titles, and that are part of prioritized conservation objects. The institutions in charge of the restitution process have set forth innovative solutions to the emerging tensions between the victims' reparation and the conservation objectives. The proposed solutions include accepting to allocate "protected areas" which were formally out of the land allocation spectrum and creating a set of limitations and mitigation mechanisms to reconcile the environmental conservation obligations and the victims' economic and social practices related to income generation activities. This discussion seeks to discuss the tension between the competitive guiding principles of land allocation and land use and to question their underlying assumptions. It aims at analyzing the institutional and political processes that led to the emergence of this new conservation model altered by the transitional justice policy. Finally, it intends to analyze the potential effects of the new conservation model in the victims' communities through a specific case study.		
0603	Gender differences in land-use decision making and its implication to ecosystems services: a case in Indonesia	Grace Villamor	Germany
	Decision-making processes of land managers are crucial in understanding the land-use change and its		

impact to ecosystems services. However, we often ignore that the land managers (i.e., farm households) are also gender-sensitive. Gender specificity in response to land-use options and agents that offer new investment opportunities has so far received little attention. To give light on this matter, a combination of (participatory) qualitative and quantitative methods was carried-out to explore the spatial perception of men and women on rubber-dominated landscapes in Indonesia. Then, to explore the possible implication of this gender differences in decision making to ecosystem services in the landscape, we will employ an agent-based model.

| **0605** | Climate variability shapes the expansion and intensification of mechanized agriculture in Mato Grosso, Brazil | Avery Cohn, Leah VanWey | USA |

Through production of soy, maize, poultry, and beef, Mato Grosso, a 903,000 km^2 state at the Southern fringe of the Amazon Basin has helped shift global food production to the tropics. The expansion and intensification of Mato Grosso agriculture has important ramifications for the Brazilian economy, world food security, and climate change mitigation. As in other regions, a debate has emerged on how the climate system might impact agricultural development in Mato Grosso. In this paper we estimate the effects of climate variability on the expansion and development of cropping systems in Mato Grosso. We use these estimates to model the development of Mato Grosso agriculture under alternative scenarios of climate and food markets. We employ spatially explicit rainfall and temperature data and data on market prices and access, merged together with a new, richly detailed panel dataset on whether agriculture is single cropped or double cropped and the land use legacy of each cropped area. These detailed data enable us to split mechanized agriculture into eight management categories to identify differences in outputs and inputs to the system. Each production type has distinct inputs and outputs and therefore differential sensitivities to climate variability are observed. We use these observations to parameterize a model to explore how alternative climate and economy futures can speed or slow expansion of each management type. Whether we control for year fixed effects, spatial fixed effects, and agricultural prices we simulate a similar impact of climate variability on agricultural expansion and intensification in MT. Patterns of rainfall are limiting agricultural intensification by favoring conversion to single cropping over investment towards double cropping. By contrast, very different factors determine increases in double cropping on pasture land and the persistence of double cropping on lands that had been double cropping in the previous year. Therefore, spatially explicit monitoring of agriculture to identify pixel-level land transitions provides important insight on the sensitivity of agricultural development to climate variability. Climate variability already has an important influence on agricultural development in Brazil. Climate change could exacerbate this effect.

| **0610** | Response to: governance of cattle supply chains | Peter Newton | USA |

This Flash Talk will be a response to a provocative background paper on one of the three sub-themes of the panel: governance of cattle supply chains. The paper will describe work on different governance mechanisms in Brazil, including public prosecutor interventions, the SAN certification program, the Cadastro Ambiental Rural, and deforestation monitoring. The paper will address questions such as: What are the interventions in cattle supply chains? What do they aim to accomplish? How do we monitor the interventions? What research methods are employed to design and evaluate the interventions? Are the research methods appropriate? Are the interventions effective? What further evidence/research could help the implementation of the interventions and/or the monitoring? This Flash Talk response will contribute to the authorship of a synthesis paper with the other members of the panel, and closely adheres to the theme of the session: "Land Change Effects of Interventions in Agricultural Systems: Cattle Ranching in

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Northern Brazil".			
0623	Linking observed landscape patterns to government planning, location of gold deposits, and local land-user decisions in the rapidly expanding gold mining frontier of Madre de Dios, Peru	Jason Scullion	USA

Land-cover changes for the period 2001-2011 were mapped in Peru's SE Amazonian province of Madre de Dios. These changes are linked to local land-user decisions using a combination of high-resolution geospatial analyses and field interviews with local farmers and miners. The land-cover change analysis shows that during the study period, a strong transitional shift occurred with agricultural expansion dominating forest loss from 2001-2006, followed by agricultural decline and the widespread expansion of gold mining for the period 2006-2011. This transitional shift in the dominant driver of land-cover change is linked to several factors, including the rise in international gold prices, the presence of newly discovered gold deposits, and the combination of land-user decisions to begin mining over other means of employment and governmental decisions to authorize new mining concessions inside lands previously designated for conservation and other land uses. Taken together, this tightly linked combination of local, regional, and international driving factors resulted in the expansion of mining by 230% (+23,000 ha) and the loss of primary forests by -1.5% (-20,000 ha). Field interviews with local farmers suggests that an average of 40% of their lands remain under forest cover, and that depending on the proposed conservation programs, most farmers are interested in conserving their remaining forests. Field interviews with local miners suggest that miners are a mix of local people and recent migrants, most of who intend to remain in mining for only another year or two and are open to alternative employment opportunities. Despite miners' general interest in eventually leaving local gold mining as their job, the majority of interviewed miners stated they plan to remain in the region and continue working the land to make money. Together these analyses demonstrate how local land-user decisions are influenced by the synergistic interaction of local, regional and international driving forces. Ensuring long-term forest conservation in rapidly expanding forest frontiers like Madre de Dios thus requires place-based conservation programs that are targeted to local needs and conditions. Actions should also include adjustments in frontier governance regimes to account for the dynamic and rapid changes that can result from sudden shifts in the incentives for forest conservation or conversion.

| **0630** | Protected areas: local scenarios for global interests? A case-study in Santurbán, a Colombian páramo | Paola Ungar-Ronderos, Alejandra Osejo-Varona, Laura Roldán-Gómez, Susana Peláez | Colombia |

Through the illustration of a case study in Northeastern Colombia, we illustrate the following argument: although it is pertinent and necessary to understand conservation conflicts in terms of a "clash between local peoples and the scientifically-based ideas on biodiversity conservation supporting policies", as the call to this session suggests, such an understanding is deficient if the global level of analysis and the private stakeholders' agency are not taken into account.

Páramos are tropical ecosystems above the continuous timberline, located exclusively in the Northwestern corner of South America, mainly in the Colombian Andes. They are scientifically valued as biodiversity hotspots and they also suppliers of water for most of the country's urban population. In many *páramos*, there are important mineral deposits, which have been exploited since pre-Columbian times and are now object of both multinational mining interests and national development initiatives. *Páramos* are also home of an estimate of around 120.000 people belonging to indigenous and peasant communities, with diverse livelihoods and immersed in complex institutional networks. Mainly with the interest of guaranteeing the provision of ecosystem services in the face of mining pressures, the present Colombian

law dictates that all productive activities are to be prohibited in *páramos*. The application of this regulation implies multiple social conflicts.

The Humboldt Institute carries out social-ecological studies, in order to inform environmental authorities on policy and decision-making. We developed an analysis of the stakeholders involved in the Santurbán *páramo*, located in the Northeastern part of Colombia and scenario of many of the activities mentioned above. The first part of our presentation focuses on those stakeholders' relationships that illustrate the tensions between a national excluding norm and a complex local social reality. We then show a wider analysis including international level actors.

Our main results suggest, on the one hand, that "the State" is an ambiguous stakeholder that both restricts and promotes productive activities in *páramos*. In both of these lines of action, national initiatives are informed and supported by private interests of the global level. On the other hand, the analysis shows that "local people" are highly diverse and can hardly be grouped into one category. These local stakeholders' activities and value-systems are also closely tied to what Arturo Escobar called "the globalocentric perspective" (Escobar 1998).

We conclude by suggesting that the global level of analysis needs to be accounted for in any innovative approach intended to sustain alternative conservation models.

| **0649** | A progressive sense of place: cities as hierarchies in a teleconnected world | Darla Munroe | USA |

The world is now officially more urban than rural. Moreover, there is nowhere on earth untouched by the influence of urban systems, either by direct flows of food, fiber, fuel, labor, capital, energy and waste; and/or through indirect flows, e.g., climate change. The leaders of this session have set out a great challenge: how to move beyond case studies in a multidimensional, teleconnected world. One critical challenge is to change what we think of as "case study", and, correspondingly, what constitutes generalizable knowledge. Urban systems as a whole bear the imprint of a small number of highly influential actors; e.g., Chase Manhattan, American Electric Power or Richard Branson. We must study the behavior of key individuals or individual institutions, and the land-change science community to date has been largely silent on the behavior of corporate actors in particular. In addition, cities themselves comprise complicated semi-hierarchical network structures with history, and thus cannot justifiably be understood as individual cases. Therefore, we need to understand and model the functional interconnectedness of cities and those implications for both social structures and ecosystems. I plan to elaborate on key research priorities and provide a few concrete steps forward.

| **0653** | Notes on environmental governance and the Brazilian Law: public power decisions, protection of biodiversity and the Iguaçu Nation Park | Ana Paula Myszczuk, Clarissa Wandscheer | Brazil |

This paper aims to discuss legal and social environmental issues aroused from Brazilian Public Power decisions on protected areas, more specifically, on the Iguaçu National Park (PARNA). This park was created 1939, by the 1035 Law Act Decree; it is the second nation park created in Brazil and corresponds to the south region largest area remaining from the Brazilian Atlantic forest. Iguaçu PARNA has been recognized in 1986 as a UNESCO Natural World Heritage Site. Around this park fourteen municipalities are located, concentrating their economical activities on agriculture and on the Itaipu hydroelectric royalties transfer. It is possible to highlight two conflicting situations involving this PARNA: one refers to the reopening of the Colono Road, which connects two cities (Serranópolis do Iguaçu and Capanema), by a 17 kilometers road through the Iguaçu Park. This road has been closed from more than ten years and the nature has demonstrated her regeneration power, taking up the spaces projected to the vehicles passage. However, the Brazilian Congress still discuss a Law Act project on the legality of this reopening, which,

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according to specialists, will cause immensurable damages to the environmental, once that it is necessary to cut trees to reestablish the road passage and that the menace of illegal animal traffic and hunting will increase. The second issue refers to the release of transgenic soybean planting around the Iguaçu PARNA. The 9985/2000 Law Act created the Brazilian National System of Conservation Units, who's the national parks are part. This Law Act forbids the insertion of non autochthones species into PARNA. To guarantee a minimum protection to conservations units, in respect to the release of GMOs the 57-A article was established in the 9985/2000 Law Act. This article allows the Government to set up limits to GMOs growing areas that surround conservations units, until a buffer zone is not fixed and approved in the respective GMO management plan. In view of this legal permission, the 5959/2006 Decree has been edited and institutes the possibility of changing the buffer zone measures, according to decision of the Brazilian National Technical Commission on Biosafety (CTNBio). New measure settled by the CTNBio has already been demonstrated as insufficient and several lawsuits have questioned this changes that causes serious damages to the Iguaçu PARNA biodiversity.

0658	Land use change in Mato Grosso - Brazil: the role of integrated systems in the context of livestock intensification	Juliana Gil	Germany

Integrated crop-livestock-forestry systems (IS) are an interesting strategy to promote land use optimization and agricultural intensification in Brazil, particularly in areas where large-scale agriculture is already in place.

Within this context, Mato Grosso deserves to be highlighted as the state where IS represent both a need for environmental protection and an opportunity for the development of a sustainable agriculture. The reasons behind it include the state's size (i.e. 906.806 km², or 10.61% of Brazil's total area), agricultural potential (it is the main cattle and soya producer in the country), environmental importance (it concentrates three biomes of high biodiversity within its territory, i.e. Pantanal, Cerrado and the Amazon rainforest) and strategic location (it lies adjacent to the most dense portion of the Amazon forest, on the so-called "Arc of Deforestation"). Besides, IS could help rehabilitate degraded pasturelands (which account for approximately 11 million hectares in Mato Grosso) and mitigate GHG emissions from the livestock sector.

However, little is known about the extension of these systems, where they are located, how farmers perceive them and what kind of challenges and barriers they face once they decide to implement IS.

With that in mind, the proposed flash talk will contribute to the selected session by sharing results of a comprehensive study conducted in Mato Grosso on the dynamics of land use change and determinant factors for the adoption of IS. The idea is to draw on evidence from the survey research as well as the wider literature to address the drivers that lead to the conversion of cattle pastures to mechanized agriculture and/or IS, and factors that might accelerate or slow down such shifts.

By combining qualitative and quantitative research methods that reveal farmers' characteristics and perceptions of IS, this study shows that cultural aspects play a major role in their decision and contradicts authorities' expectations about the relevance of credit provision within this context.

0664	Simulating the effects of land policy liberalization on land use and farm structures in Sichuan, China	Kristin Leimer, Zhanli Sun, Daniel Müller	Germany

Chinas rapid economic development in the last few decades was accompanied by massive waves of domestic migration from rural to urban areas. At the same time, population control policies kept birth rates low. Combined, this caused a rapid decline and aging of the rural population and a sharp decrease of the agricultural labour force. While this may have caused a decline in the number of farms and the abandonment of agricultural land in free-market conditions, structural change in Chinese agriculture was

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impeded by insecure land use rights legal constraints on land market transactions. The Chinese government therefore experiments with land rights reforms with potentially profound impacts on agricultural development. We take a unique land reform experiment in Sichuan province and to investigate the consequences of land market liberalization on household-level land use decisions and aggregate land use changes.

To analyse the determinants of land-use decision making of farmers, we collected household survey data in three distinct region of Sichuan province. The household data serves to calibrate decision trees that quantify the determinants of local land-use change. We include the decision-making behaviour of all individual households in an agent-based modeling (ABM) framework. In the ABM, farmers interact on land and labour markets and their aggregate behaviour will provide insights into the conditions and policies that facilitate land consolidation and agricultural growth. We use the modelling environment to simulate the impacts of different scenarios of future demographic development and of changes in land market policies on land use structures and agricultural production.

The insights from understanding concurrent farm decision making and the simulations of likely future farm behaviour will lead to a better understanding of potential effects of land market liberalizations and their impact on land systems in the three study sites. The comparisons across sites will permit drawing inferences about the effects of land market dynamics for regions with different endowments of natural, political, and socioeconomic assets. This will contribute spatially disaggregated insights on the likely dynamics of land use structures in rural China.

0670	Integration of power in Agent based models of land changes	Derek van Berkel, Darla Munroe	USA

Within the last decade the utilization of agent-based models (ABMs) in land-change science has dramatically increased. Land-change scientists have been attracted to the power of ABMs to represent complex socioecological interactions and integrate representations of land-user heterogeneity. For example, ABMs are able to characterize different management types and investigate how this variation contributes to land change outcomes. One of the challenges faced by agent-based modelers is formulating appropriate influence of power in human decision-making models across a region. Political dynamics take many forms, including formal government, informal collective institutions of governance, and power dynamics both within and beyond government and governance, in which some agents are more able to initiate and/or benefit from land use changes. There is also ample literature suggesting that agent behavior is influenced by *opposition* to actions and individual goals that run counter to official regulation. Research into techniques on how to integrate power in models of land changes is needed to uncover the underlying relationship between the land and people. In this session we present the agent based model PROFESS a model that attempts to simulate the, "Politics and Recovery of Forests Emerging in Socio-Space". Power is a key component in modeled decisions, simulating competing visions and goals that can lead to different land changes, spillover effects and social and environmental trade-offs. The integration of power in land change models is important step towards understanding the processes that influence land patterns.

0672	Agricultural censuses and land-use change: more than meets the eye	Lisa Ribaudo	Canada

To date, nearly all of the world's countries have conducted, or plan to conduct before 2015, one or more censuses of agriculture, with 80% having already conducted one or more census since 1976 (FAO). What can this wealth of data tell us about global agricultural land-use change and what challenges need to be overcome in order to use this data effectively? This talk will draw from our experiences compiling sub-national statistics on agricultural land use change to present some of our most surprising observations culled from data that could only have been collected by on the ground enumeration. We will also compare some of the findings from our database of global agricultural land use change to regional, remote-sensing

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based observations and reflect on how the discrepancies between these sources can elucidate both the limitations and strengths of each of these methods for evaluating changes in the extent and characteristics of lands under cultivation.

In comparing the results from our work on measuring global agricultural land use change with assessments from other sources, we hope to stimulate discussion on the strengths and weaknesses of various methods of monitoring agricultural land use change. We also hope to inform conference participants on how agricultural census statistics on land use can best be used, both on their own and as a complement to other methods of evaluating land use change.

0682	Simulating fundamental social processes in Agent Based Systems of SES	Arend Ligtenberg, Arnold Bregt, Marta Bakker	The Netherlands

To develop simulations of Spatial Ecological Systems (SES) Complex Adaptive System thinking offers a challenging paradigm for the development of Agent Based Models (ABM) of SES which structurally couples social processes which environmental ones. However to accomplish such structural coupling it is necessary to develop representations for fundamental social processes which can be implemented in ABM. Examples of such fundamental social processes are opinion dynamics, conflict resolution, development of trust, diffusion of innovation etc.

Such representations are barely available in the context of SES. Although myriad approaches exist in the social sciences, almost none are formalized nor operationalized in computer simulations. Scholars active in the field of "social physics" developed models of for example opinion dynamics, or the diffusion of knowledge and innovation, but often they lack a proper grounding in theory or, even more interesting, they do not take into account the specific spatial-temporal characteristics of many SES. Especially the influence of the location, size, scale and time on the social dynamics are absent in most, in not all ABM. For example, in most current opinion dynamics model change of opinion is purely determined by the social distance between two agents i.e. how much do they differ in their opinion. However for SES this social distance might vary depending on spatial characteristics of the environment. Also the geographic distance to other agents and objects in the environment play a role in the dynamics of opinion. One good example of such coupling between environment and social process is the NIMBY "syndrome" which describes the phenomena where people oppose strongly against a proposed change in their environment while similar change, when proposed at a more remote distance is accepted.

To bring further the development of simulations for SES we believe it is essential to include well founded representation en implementations of fundamental social processes in agent based models. Including these representations in models of SES will help to better understand the behavior of complex adaptive systems such as path-dependency, resilience en regime shifts. This requires a better integration with social sciences disciplines. Currently this integration only is very limited.

During the presentation we would like to discuss the necessity and priorities in bringing forward the integration of social processes in simulations of SES.

0695	Assessing the resilience of agricultural landscapes in the context of climate dynamics	Chinwe Ifejika Speranza, Bettina Wolfgramm, Urs Wiesmann	Switzerland

This paper conceptualizes the resilience of agricultural landscapes and discusses the methodological challenges in identifying metrics for agricultural landscapes and the workarounds adopted. The increasing climate variability, the various manifestations of climate change, and the uncertainties in climate change projections make answering the questions of "adaptation to what" increasingly difficult. Consequently, to sustain development and functioning in a changing climate context, building and maintaining resilience is critical. This paper departs from the understanding that the resilience of an agricultural landscape lies in

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its ability to continue providing supporting services such as soil nutrients and biomass production that enable meeting the human needs of food, fibre, fuel, and other raw materials despite exposure to climate-related disturbances and climate change. Departing from this understanding, we identify the functions of agricultural landscapes and the associated landscape variables, how climatic risks affect them and the indicators to assess their conditions. The developed framework offers a set of methodological steps to follow for field data collection and analysis of resilience to climate-related disturbances at landscape level. By elaborating on how resilience can be operationalized for agricultural landscapes, this paper contributes to discussions on the conceptualisations of resilience as well as related scale issues in the session "Resilience of land systems: state of conceptualization and operationalization".

| 0700 | The use of standard description protocols of agent decisions for project design, planning, and stakeholder communication | Dawn Parker, Xiongbing Jin, Umberto Gostolli, Jeffrey Casello, Kevin Yeung, Calvin Pritchard | Canada |

This presentation discusses the use of two standard protocols (the ODD and MR POTATOHEAD (MP) frameworks) for project planning for two large, interdisciplinary coupled natural-human systems modeling projects. First, the MP framework was used as a tool to discuss the choice environment faced by residential land managers in Southeastern Michigan, USA (SLUCE2). This discussion contributed to the development of two project elements: land manager surveys, and an agent-based land management decision module. Second for the development of a parallel project that models feedbacks between residential locations, transportation choices, and yard management, we used both MP and ODD for model development. MP was used to describe and document the code from the SLUCE2, and to then describe proposed modifications to this model. MP and ODD were both used to describe the new proposed transportation modeling component, both within the development team and to communicate with other team members. The successes and limitations of these tools, especially with respect to their ability to represent decision making, will be briefly reviewed in my remarks.

| 0706 | Comparing residential land management practices between two regions in the North American Great Lakes: can institutional incentives and constraints create path-dependent change in social norms? | Dawn Parker, Emma DeFields, Roger Suffling, Joan Nassauer, Derek Robinson | Canada |

Ecosystem services in urban environments are shaped in large part by the land management decisions of residential landowners, especially in North American cities where single detached houses with private yard space are the dominant form. Research has shown that these decisions are shaped by individual preferences, institutional incentives and constraints, and social norms. This presentation discusses results of a 2012 residential land manager survey conducted in Waterloo Region, Ontario, Canada by E. DeFields, R. Suffling and D. C. Parker, the third in a temporal series of surveys for the region. The survey was also designed to parallel in part a similar survey for the SLUCE2 project at the University of Michigan (lead by J. Nassauer), allowing for a spatial and temporal cross-site comparison of landscaping practices and norms between two regions sharing fairly similar biophysical, socioeconomic, and demographic environments, but different institutional environments. In both locations, some evidence of strong neighborhood and imitation effects is seen. In Waterloo Region, however, particular policies, institutional constraints, and incentives, including efforts to encourage naturalized front lawns, a residential pesticide ban, a green bin composting program, and storm water fees and mitigation incentives seem to have influenced a path-dependent shift in residential landscaping. This presentation briefly highlights some result from each case study, offers some comparisons, and discusses outstanding

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	challenges to such comparative work.		
0712	Employment in rubber commdity chains in Liberia	Steffen Fischer	UK

The emergence of the concept of 'land grabs' and debates surrounding them have given relatively scant attention to the historical trajectories of major land acquisitions especially in sub-Saharan Africa that predate the 'land grab' terminology. This paper aims to contribute to the growing historically informed debates on the subject. It aims to do this by focusing on natural rubber production in Liberia. It can be argued that Liberia's integration into the world economy since Firestone established its plantation there in 1926 was largely determined through the rubber commodity chain. To this day rubber plantations and small holder farms are the largest employers in Liberia. However the way in which the rubber commodity chains in Liberia are structured have fluctuated between production based on large scale plantations and smaller farms over time. The aim of this paper is twofold. First, historical changes between the prevalence of plantations and smaller farms will be identified with a focus on the last 10 years. Second, the aim is to explore how these changes are shaped by and impact on those employed within the commodity chains both on plantations and on smaller farms.

| **0719** | Scale and power in adaptive governance of mountains to global change | Julio Postigo | USA |

Ideally, governance regulates the interactions between resources and users through resource-use institutions. The goal of institutional governance is sustainable social ecological systems (SES). In long-term humanized landscapes, like the Andes, governance has been at the same time both an agent of adaptation and a product of it. Governance agency regulated the interactions between social units and mountain conditions making possible the adaptive process of the high Andean social ecological systems over millennia. Despite the long history of interactions between governance and the environment, currently, the scale, intensity and complexity of current global change challenge Andean institutional governance and therefore limit its capacity for adapting to such change. Moreover, effects of some changes may hinder the adaptive capacity of governance in the face of other changes.

The topic that I want to present in this round-table discussion focuses on the interplay among various aspects of global change and adaptive governance. Specifically, some challenges to adaptive governance that are posed by mining in the Andes and water demand from agribusiness in the lowlands are presented. Increasing mining operations and water demand are both driven by rising prices of minerals and commodities in global markets. These features of global change question adaptive governance in some aspects: 1. Scale: The teleconnection nature of the locally supplied globally demanded product argues for cross-scale governance, 2. Power: The dependence of national economies on revenues from exported goods from local SES challenges understanding of access and control of resources as well as the allocation of benefits and externalities, 3. Human capacity: The seasonal or permanent migration for working in mining or agribusiness undermine human resources to carry out the activities that adaptive governance entail.

The increasing involvement of Andean SES in aspects of global change prevents the return to isolated local governance. Similarly, the pace and intensity of global change may overwhelm local adaptive governance. Thus, pathways toward adaptive governance for global change in mountains may entail two-way distinct local-global cross-scale interactions with participation of empowered local populations. Governance is politics and power because it is about control of and access to resources, and decision making on resource use. Thus, some issues to be addressed in cross-scale governance interactions are the pervasive effects of some aspects of global change for adaptation to other effects, the role of mountain resources in national economies, and how the latter choose to participate in the global economy.

NUMBER	TITLE	AUTHORS	COUNTRY
0725	Sustainable manure management: what can we learn from intensive poultry production in the Chesapeake Bay Watershed?	Rebecca Ryals, Jianwu Tang, Meredith Hastings, James Galloway, Allison Leach	USA

Intensification of animal agriculture has profound impacts on the global and local biogeochemistry of nitrogen, resulting in consequences to environmental and human health. In the Chesapeake Bay watershed, a 64,000 mi^2 region encompassing portions of six U.S. states, intensive agriculture is the primary contributor to nitrogen pollution, with animal manure comprising more than half of nitrogen from agriculture. Manure is a valuable resource that can increase soil carbon stocks, boost crop production, reduce soil greenhouse gas emissions, and decrease chemical fertilizer dependency. However, highly concentrated poultry production in the region has led to an excess of manure that requires management to prevent and mitigate nitrogen pollution. As animal agriculture intensifies worldwide to satisfy growing populations and shifting diets, there is a critical need to understand the effects manure management practices at the regional and global scales.

The objectives of our research are to (1) test management strategies that may maximize benefits of poultry manure as an agricultural resource while minimizing it as a source of reactive nitrogen to the atmosphere and water, (2) quantify the nitrogen footprints of intensive and pasture-raised poultry, and (3) compare the consequences of livestock manure management in intensified agricultural systems in temperate climates and intensifying agricultural systems in tropical regions.

We address objectives (1) and (2) using controlled field experiments replicated throughout the watershed. In intensively managed systems, we compared the effects of raw, composted, and biocharred manure and inorganic fertilizer on irrigated and non-irrigated cornfields within the Chesapeake Bay watershed (Georgetown, Delaware and State College, Pennsylvania). The fate of the treatment-nitrogen was followed throughout the growing season. Global greenhouse gases emitted from soil (nitrous oxide [N_2O] and carbon dioxide [CO_2]) and regional air pollutants (nitrogen oxides [NO_x] and ammonia [NH_3]) were measured, as well as soil pools of nitrate and ammonium. Plant nitrogen uptake and grain production were also quantified to determine rates of nitrogen-use efficiency versus loss. A whole-farm nitrogen footprint model was developed to compare patterns of poultry manure nitrogen cycling from these conventional intensively managed agricultural systems with a free-range poultry pasture system (Charlottesville, Virginia). We address objective (3) by coupling these field experiments to a literature review from temperate and tropical regions. We further make recommendations for and raise key uncertainties regarding sustainable poultry manure management across a range of biophysical and socioeconomic conditions.

| **0732** | Unraveling the endogeneity of land use governance and land use/land cover change | Abigail York, Kevin Kane, Lauren Gentile, Christopher Boone, Joseph Tuccillo | USA |

Within the USA, the most common land use policies affect individual parcels through zoning and building codes crafted by local government. In turn, local maps of land use institutions illustrate the central role individual landowners' play in shaping policy through requests for rezonings, variances, and exceptions on individual parcels. Does policy drive land use? Or do changes in land use drive policy? In this speed talk, we briefly introduce and examine the dynamics of land use policymaking at the parcel-level. The flexibility of parcel-level, bottom-up land use policymaking can be both a blessing and a curse, depending on the observer and the goals. We believe that understanding the endogenity of land use policymaking and land use/land cover change is critical to land governance throughout the world, but particularly within rapidly urbanizing contexts.

| **0733** | Flash talk response to background | Maria Bowman | USA |

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	paper on the role of cattle ranching in land-use transitions in Brazil		

This Flash Talk will be a response to a background paper on one of the sub-themes of the panel that will specifically address the role of cattle ranching in land-use transitions (i.e. pasture to crop, forest to pasture, and avoided deforestation/REDD). This background paper will address such questions as: What causes the conversion of forested lands to pastures, cattle pastures to mechanized agriculture, or the integration of crop and livestock systems? What interventions may alter these transition processes, and what do such interventions aim to accomplish? How do scholars or policy makers monitor and model interventions, and using what methods will they design or evaluate them? Are such interventions effective, and how might they become more so? This Flash Talk response will contribute to the authorship of a synthesis paper with the other members of the panel that will discuss the development of the evidence base for making and monitoring interventions in Brazilian cattle systems.

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0767	Farmers' perception of erosion risk and its implication on the adoption of soil and water conservation practices	Daniel Nadhomi	Uganda

Farmers' perception of the erosion risk relates with their decision to adopt its mitigation measures. Little has been done to escalate this idea as a basis for effective watershed management. This paper assesses farmers' perception of erosion risk; and examines the underlying factors guiding the decision for the choice of SWC practices. Interviews were conducted on 390 farmers in Nabajuzi watershed of the Lake Victoria Basin of Uganda. Data analysis was performed using a *Probit* regression model. The hypotheses tested were: (a) farmers' perception of the erosion risk does not correspond with their decision to adopt SWC practices; (b) the adoption level of soil and water conservation (SWC) practices is a reflection of both their technical performance and the degree of acceptability by local farmers. The perceived risk ranged sequentially from high to very high on geomorphic units of back slope, shoulder and summit; contradicting the USLE output whose range was moderate to very high. Farmers believed that management of these slopes should combine agronomic and structural measures. On the toe and valley, sheet wash was perceived to be a weak indicator of erosion risk; and if this form occurred, mulching was sufficient to contain it. The significant ($P < 0.05$) factors in this watershed influencing farmers' adoption decision for SWC practices were: age, formal education level, on-farm income, family size, distance of farm from homestead, and access to agricultural extension service and training. It was concluded that though inconsistent with USLE, farmers' perception of the erosion risk was pivotal in adoption and implementation of SWC measures.

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0769	Endogenous determinants of land grabbing and farming approaches transformation in rural areas: a challenge to food security in Cote d'Ivoire	Kabran Aristide Djane	Cote D"Ivoire

Access to food is a constant challenge in Ivory Coast; and when problems of land grabbing and cultivation processing approaches get involved for this purpose, the problem becomes more worrisome. Based on a comprehensive approach, this research helps to understand the longitudinal and causal relationship that exists between land grabbing, cultural approaches and food security. Engaging the methods of "triangulation", "interaction", "review" processes, the use of "interlocutors" and life stories, this research seeks to examine the Ivorian pioneer foreheads (Soubré, Alépé , Aboisso).
This research presents the longitudinal nature of land grabbing in Ivory Coast. Thus, it is assumed that land grabbing can be explained by the political and cultural arrangements historically built by indigenous themselves, promoting these grabs' practices in modern day Ivory Coast. Against this background, land

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grabbing in the Ivorian context clings towards socioconstructivism.

Essentially, the proposed presentation will contribute a socioanthropologic approach of land grabbing to various sessions at the forthcoming conference.

| 0772 | The new Brazilian Forest Code and the implications for the management and land use in the Amazon | Rafael Guimaraes | Brazil |

The work deals with the evolution of the Brazilian environmental legislation, more specifically on the Brazilian Forest Code. Brazil is one of the few capitalist countries that has legislation which is required to preserve percentage of native vegetation, yet it is in the midst of private property. This is due mainly to the fact that the Brazilian territory is under significant portion of the Amazon rainforest, where there are 20% of the species of flora and fauna of the world, in addition to housing the basin of the Amazon River which is also the largest in the planet. Since 1934, when it was created the first Brazilian forest code, this legislation has undergone successive modifications, such as in 1965, 1998, 2001 and most recently in 2012. The objective of presentation is to highlight what were these changes, and the context in which they occurred, i.e. which economic and political forces that operate in this scenario dispute, besides the special role of the Brazilian scientific community within these debates. I intend to contribute to the theme and the session selected through explanation about the extent to which the changes made in the Brazilian Forest Code were linked to political and economic forces operating in the region called 'agricultural frontier'. The Brazilian Forest Code is an important legal instrument used by the state to preserve native vegetation, and in the case of the Amazon becomes important because it is one of the major biomes in regard to harboring species of fauna and flora. During the process of changing the code, different interest groups could be identified, for example, agricultural producers, the scientific community, environmentalists, indigenous population, but not all of them have the same space within the political debates surrounding the changes mentioned.

| 0776 | Land use and land cover change in the island of Santa Catarina, Brazil | Jasiel Neves, Norberto Olmiro Horn Filho | Brazil |

This case study is part of a PhD thesis about land use and land cover in the Island of *Santa Catarina* (ISC). The ISC is located in southern Brazil and is the insular part of the city of Florianópolis, situated in the coordinates 27° 22' 49.65 " and 27° 50' 36.65" south latitude and 48° 25' 01.37" and 48° 33' 36.64" west longitude, covering an area of 421.41 km^2.The municipality of Florianópolis is divided into 12 districts and 130 units of spatial planning (UEPs) adopted in 1980 by the Urban Planning Institute of Florianópolis (IPUF) for the administration plane. The ISC is separated from the mainland by two large bays, called North and South, which are divided by a narrow channel where the bridges *Colombo Machado Salles, Pedro Ivo Campos and Hercílio Luz* connect the mainland to the island. Areas of forests, lagoons, and diverse ecosystems such as mangroves, salt marshes, beaches, and dune fields, chains of hills formed by the crystalline basement formations, Quaternary coastal deposits and urban areas stand out in the study. The urban areas are located on this physical-ecological substrate of the island and populated by 421.240 people according to the Brazilian Institute of Geography and Statistics (IBGE). There are some rangeland and agricultural lands being reduced because of urban growth. The temporal mapping and spatial analysis of land transformations in this research are derived from five series of aerial photographs obtained between the years 1938, 1957, 1977, 1994 e 2007 (1:30,000, 1:25,000, 1:25,000, 1:10,000 and *1:10,000 scale, respectively*) by the government database of *Santa Catarina* State. Using methods available with GIS (PETERSON, 2009), basic information about the size and surface of polygons defined in the classification of land use and land cover, based in ten categories: forest; littoral vegetation; mangrove; reforestation; wetlands; dune fields; water; rangeland; agricultural land and urban land are being gathered. In this first stage of the project, we analyzed methods and the possibilities of GIS tools to

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detect spatial configurations and evolution of land use and cover in the study area. These configurations will be intersected with the geologic and geomorphologic characteristics present in the ISC and with the urban planning of the city, making a relationship between these elements. This presentation is intended to contribute to the conference theme and selected session by demonstrating characteristics of the land and transformations in coastal zone of southern Brazil.

| **0779** | Analysis of science-policy interfaces in land use dynamics and sustainability in the Amazon Region | Ima Célia G Vieira, Peter Toledo, Roberto Araujo | Brazil |

Growing awareness of the importance of science-policy interfaces as key elements of environmental governance has triggered a range of reflections and debate regarding the design of more effective science-policy interfaces including in land use and ecosystem services governance. The search in Brazilian Amazon for alternatives to the developmental model of the 1970s gave rise to a number of public policy and land management laws best suited to maintaining ecosystem services. Different sectors of activity, such as large livestock, must now adapt to the new institutional framework. However, the importance of agribusiness and mining in the Brazilian economy, as well as major infrastructure projects needed to develop these activities continue to generate conflict with traditional populations and the small family farms. The lack of support for agroforestry systems, necessary for the consolidation of protected areas, has threatened many achievements of environmental policies, including with regard to participatory management of resource use that takes into account the aspirations of local populations. In this work, we present the main aspects of these socio-environmental dynamics and the challenges they pose to the new institutional framework.

| **0785** | Alternative farming systems, environmental impacts and food security: an economic perspective | Thomas Hertel | USA |

The next four decades represent a critical period for global agriculture. With population continuing to increase, per capita incomes in the poorest countries projected to rise rapidly, and biofuel production assuming a larger role in the global economy, the potential pressures on agricultural land use and the rural environment are significant. Meeting these increased demands in the face of climate change may prove challenging from a supply perspective, as yield growth in many key regions of the world appears to be slowing. This interplay of supply and demand is also critical from an environmental point of view. At the local scale, agriculture is a significant source of water quality problems – particularly due to pesticide and nutrient runoff. At the global scale, greenhouse gas emissions from agriculture and land use change account for a significant portion of global emissions and recent studies suggest that land-based emissions could up to fifty percent of efficient abatement at modest carbon prices. However, such land-based abatement puts added pressure on agricultural land use and raises food prices, thereby threatening nutritional attainment for many low-income, nonfarm households. Within this environment, there is need for new agricultural

technologies which will enable increased crop output, even as GHG emissions are reduced and local environmental problems are abated. In this speed-talk, I will explore the trade-offs between increasing agricultural production, improving local and global environmental quality, and maintaining favorable nutritional outcomes for the overall population. Particular attention will be paid to the role of investments in research and development in reconciling these conflicting forces.

| **0808** | Land use and conservation in dry forest ecosystems Colombia | Hernando Vergara | Colombia |

Dry forest, in the American tropic is considered one of the most threatened ecosystems. In Colombia, due to the characteristics of its soils have been object of big transformations to the agriculture and animal

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husbandry development. In this way, from the original cover, this has decreased at the beginning as a result of the occupation of large size of lands by pastures because of animal husbandry expansion and after as a consequence of the great farming development, currently subtracting the 1.5% of the original cover.

The purpose of the presentation is to make known the relationship between land use and conservation of these ecosystems, represented by the structure and the composition of species in the dry region of the Rio Patía valley. These areas are part of the cross, inter-Andean Colombian valleys located in Cauca and Nariño regions in southwestern Colombia. They are more or less flat areas, of moderate altitude and cover by grass of anthropic origin or secondary stubbles. The original vegetation has been destroyed to be replaced by crops and pastures for animal husbandry. Burnings were an important element in the transformation of these ecosystems, therefore, the possibility of finding native vegetation is low, only a few forest patches are located near the banks of streams and others occupying small parts on flat areas or hilly reliefs.

Since many years ago all towns of these areas were associated with the breeding of livestock and small plots of agricultural production for self-sufficiency, a feature that has not changed until today.

The use of the land has been identified as the main cause of change of these ecosystems, considered very unbalanced and very little preserved and on the other hand many of its characteristics and dynamics are necessary to know for carrying out a conservation policy.

It is inherent to this type of areas the development of a conservation strategy and management of dry forest ecosystems that takes into account the different types of land use, aspect that contributes to the identification of new points of view to the conservation, as the formulated questions point out for this session.

| 0809 | The value of improved geospatial information in decision making: the case of global land cover | Michael Obersteiner | Austria |

Land cover maps provide critical input data for global land use models. Pressing issues related to global land scarcities exist ranging from sustaining food security to biodiversity conservation. Such questions can be answered only with reliable maps of land cover. Today global land cover datasets currently differ substantially in terms of their spatial extent. In this study, we evaluate differences in implementation costs of policies conditional on different land cover information. By examining these cost differences, we are able to quantify the value of information (VoI) of improved land cover information. Taking the specific example of choosing between two climate mitigation technologies namely REDD as a land use policy and carbon capture and storage as a reference technology, we have developed a methodology on how the marginal value derived from reducing uncertainty can be assessed. By implementing a portfolio optimization model to find the optimal mix of mitigation options under different sets of land cover information. We illustrate the methodology by comparing portfolio outputs of the different mitigation options modeled within the GLOBIOM economic land use model using cropland data from different databases. We find a continuous inverse-U shaped value of information schedule dependent on belief sets of little or abundant land availability. The maximum VoI of improved global land cover information was valued to be in the range of two digit billions dollars. We conclude that investments into scientific observation infrastructures of global land management can formally be assessed using the general framework of the proposed VoI methodology.

| 0811 | Transformations of the concepts of environmental conservation in Amacayacu National Park, Amazonas, Colombia | Sofia Cordero | Colombia |

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The conservation areas in the Colombian Amazon are diverse. In addition to this variety, many challenges related to the conservation areas have emerged in light of new appreciations and thoughts associated with how do we grasp the concepts of nature, politics and the effects of environmental action. Thus, the way by which nature is understood has a deep political meaning that can be evidenced when conceptual frameworks change, therefore, modifying the conservation aims of the shielded areas (Adams & Hutton 2007). The conceptual changes have demonstrated how conservation has attempted to include policies, programs and strategies in which the people´s interests, wildlife, and ecosystems are linked and joined as a fusion of interest for its management and comprehension. Nowadays, this paradigm leads the conservation purposes in colombian amazonic protected areas, and most of the efforts have been pointed toward to what might be called ´´social promotion and community participation in conservation´´. However, it is important to say that these intentions have been progressive and have taken a lot of time to happen. Hence, they haven't been a spontaneous result of its implementation, but a consequence of conceptual changes that have taken place over time, showing significant interactions between local assessments of conservation and conservation practices. This paper explores the conceptual transformations of conservation, particularly since the establishment of the National Park Amacayacú in 1975. The following work analyze ideas and conceptual changes that have determined the conservation performance in this park until 2012. This particular case illustrates the importance and value of contemporary debates that discuss the placement of people in land portions selected and intended for nature conservancy. Also, it highlights the relevance of including social and ethnic conditions of the areas between safeguards and national parks, as a special focus, suggesting a needed variation in the ways by which conservation and its practices are contemplated. Along this lines, it is evidenced a new political and social conceptual framework that should be considered with a higher mastery when planning and applying conservancy programs in this region.

| 0816 | Environmental management planning in a developing country setting (Angono, Philippines): drawing lessons from constraints, local level governance, and the environmental management planning process | Mike Medina | Oman |

Environmental management planning in the Philippines can either be integrated in the Comprehensive Development Plan (CDP) as part of the development sector, or it can be a separate plan presented in a more detailed manner addressing the management of the environment.

To support Angono's (a municipality in Rizal Province, Philippines) emerging role of becoming a mixed industrial and residential zone within the region, and being dubbed as the Art Capital of the Philippines, an environmental management plan was developed and formulated. The development of the Angono Municipality Environmental Management Plan established its environmental vision, goals, targets and actions for the next ten years and beyond. It addressed the themes of energy and emissions, water, waste, plants and animals. Prioritized actions have been developed to improve the health and function of the environment, and reduce environmental impacts of development and increasing population. Actions will be delivered through demonstration, advocacy and partnerships to position the municipality as a model of cleanliness and best practice in environmental protection.

Valuable insights from the perspective of a developing country can be drawn from this planning exercise and categorized into three groups. Firstly, constraints (i.e. logistics, priority areas, data validation) were initially identified and eventually experienced throughout the planning process. Secondly, local level governance may have the commitment but can still be limited by politics, existing programs, resources (i.e. financial, infrastructure) and institutional gaps. Thirdly, the environmental management planning

process provided opportunities and constraints in identifying issues to be considered in the final plan. These lessons can provide a feedback mechanism for streamlining and encouraging future environmental management planning activities in the Philippines and other developing countries.

| 0821 | Understanding and forcast the agricultural land abandonment in mountain China | Ying Zhang, Xiubin Li | China |

Many developed countries experienced 'forest transition' with the expansion of forest and the contraction of agricultural land during the process of urbanization and economic transition. This is a 'win-win' solution for economic development and ecological conservation since human pressure on remote mountainous has been reduced as well as the economic booming. Nowadays, China is experiencing a rapid urbanization process which is characterized with industries supported by 'floating' labor forces remaining in rural areas rather than city due to a special land and household registration system in China. So is there any differences in the rural land changes in mountain China under such a special urbanization process? Will it experience or had been experenced the land abandonment process? If so, what factors work on it and how? To answer these questions, spatial remote data and household data of wulong county of Chongqing(in the southwest of China) were collected. The spatial data was used to detect the changes happened to the agricultural land, and the household data was used to analyze what factors and how makes the change? The results show that about 8% of the land has been abandoned in the southern mountain area of China. The farmhousehold survey show farm labor loss largely contributed to the land abandonment. The remaining farm labor is significantly related to the management land, so a HLM (Hierarchical linear model) model has been used used to explain the management land, while the residual land will be abandoned. The abandonment in the future can be predicted by using this model.

| 0834 | Lessons from the HarvestChoice Project | Stanley Wood | USA |

HarvestChoice generates knowledge products that inform strategic investment decisions aimed at improving the well-being of poor people in sub-Saharan Africa through more productive and profitable farming. To do this, a novel spatially-explicit evaluation framework was developed in order to deliver a range of customized, data-rich content to development practitioners. Most decisions that HarvestChoice targets have implications that cut across country boundaries. The core questions addressed are: (a) Where are the poor and what is their welfare status? (b) On what farming systems do the poor most depend? (c) What are the constraints affecting the productivity and market integration of those farming systems? (d) What present or prospective investments in technologies and practices might best address those constraints? And (e) What are the potential productivity and livelihood benefits of such investments, and how are those benefits distributed? The purpose of this presentation will be to draw some lessons and insights from the HarvestChoice project which will be of use for other open data efforts such as GEOSHARE.

| 0853 | Private-public partnership for developing improved open Ag Data through GEOSHARE | Paul Hendley, Dave Gustafson | UK |

GEOSHARE's primary mission is to develop and maintain a freely available, global, spatially explicit database on agriculture, resources, and the environment accompanied by analysis tools and training programs for new scientists, decision makers, and development practitioners. This talk will discuss what has been learned from a tripartite (public-private-university) pilot project aimed at contributing to GEOSHARE. This particular project is supported by the ILSI Research Foundation's Center for Integrated Modeling of Sustainable Agriculture and Nutrition Security (CIMSANS) Open Ag Data Working Group. It explores how GEOSHARE can work with a range of public, private and governmental

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stakeholders to generate the necessary infra-structure and levels of user participation and interest for collecting and curating public and private data while ensuring data quality and enhancing inter-operability. The program focuses on agricultural production in Ghana and India as test environments of differing scale. Particular technical areas to be explored involve developing cloud-based technology for simplifying workflows to refine spatial tools developed by IFPRI for intelligently re-allocating data reported using one spatial framework (e.g. administrative boundaries) into other spatial frameworks (e.g. 10km grid) by combining the information with a wide range of disparate additional spatial data. A crop model will be incorporated to help understand how GEOSHARE can most effectively link data into more complex workflows to help standardize access/processes. A longer term goal is to develop tools which will make GEOSHARE a "go-to" harmonized data portal for a wide range of gridded crop production and economic models in order to permit interoperability across platforms. Both public and private sector organizations will be contributing data, know-how and support to generate these open source tools and data sets. This form of public-private partnership offers unique benefits that will be highlighted in the presentation. The talk will also emphasize the importance of generating unified high quality spatial datasets that are a readily accessible to and accepted as best-available science by all potential stakeholders involved in the production and forecasting of a secure, sustainable and nutritious global food supply.

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0888	Methods for characterizing urban ecosystems, institutions and governance	Morgan Grove	USA

Characterizing urban ecosystems, institutions, and governance requires data that correspond to social, economic, and ecological scales. These scales are hierarchical, spatial, and temporal, and have both resolution and extent. To understand the dynamics of urban ecosystems, institutions and governance, data need to be chosen carefully to examine differences among similar but different social-ecological regimes. In this flash talk, we describe the data and methods we have developed in the Baltimore Ecosystem Study.

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0904	Shaping land rights through agricultural policy: the role of formal institutions on land and water transactions in Mozambique	Amilcar Pereira	Germany

Large scale land transactions in Mozambique are frequently associated with mining and gas explorations that dictate massive resettlement of communities and lead to controversies regarding community participation and compensation from the transfer of their lands to new investors. Land transactions for agricultural development are not an exception in Mozambique, they tend to increase. Indeed, they are part of a contentious process highlighting transformations of land governance in parallel with new perspectives on agricultural development and policies.

This study investigated the role of institutions governing transactions of large-scale land acquisitions in Mozambique. It also presents a case study of the Wanbao Company that is in the process of acquiring land for rice production. The investor states that it will boost Mozambique's rice production and contribute to self-sustainability by supplying internal and external markets. The investor also plans to integrate local smallholders into a contract farming schemes.

The case evidence emphasises the need to foster the rule of law and its proper enforcement, as a way to ensure that smallholders can secure their rights to land and claim adequate benefits in cases where the state would prefer to claim land in the name of promoting superior development interests for the nation. Currently, rent-seeking behaviour by the state bypasses legal barriers by way of conveniently interpreting and exploring the gaps of land laws that are used and enforced. Strong political and economic state—investor relations, make possible the reorientation of agricultural policy in conciliation with investor interest over farmer rights. Apart from neglecting very essential rights of the people, co-optation and

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favouritism in selection of the beneficiaries to contracting farming schemes severely weaken the rest of marginalised small farmers. Despite the increase participation of civil society organisations in promoting land rights for small farmers, backed by a highly regarded progressive land law, current land governance in Mozambique and new orientations in agricultural policies are threating the possibilities of many smallholders to develop their agriculture. Lacking support from the state and without any other means to prove their capacity to farm, smallholders are faced with having to give their land to companies.

| 0908 | Mainstreaming the ecosystem approach into public policy tools for sustainable intensification of land | Alister Scott | UK |

This paper addresses the challenge of embedding the Ecosystem Approach within tools that support decision-making and policy processes. Forming part of the UK National Ecosystem Assessment Follow on project 2012-2014, we present a conceptual framework within which we operationalise the ecosystem approach and its attendant ecosystem services, mindful of the differential gaps in awareness, understanding and enthusiasm across the built and natural environment professions and wider publics. Set within co-production principles, our transdisciplinary project team has worked with selected case studies, across a range of different settings and scales, to develop a meaningful typology within which key tools are prioritised and 'ecosystem-serviced' in order to have maximum impact upon policy and decision making. The resultant toolkit provides a linked suite of tools, with associated guidance, across the principal stages of decision-making that can help users understand the benefits and additionality of using this approach. Using a series of narratives from our case studies we show the advantage of following this more holistic approach to address the opportunities for sustainable intensification of land. We conclude by outlining key policy and institutional opportunities that need to be seized in order to maximise the potential of this work in theory and practice.

| 0913 | Essential Climate Variables (ECVs) supporting climate change mitigation: the case for land cover | Martin Herold, Anthony Janetos, Jessica Holterhof, Carolin Richter, Brice Mora, Pierre Defourny, Frank-Martin Seifert, Olivier Arino | The Netherlands |

Mitigation is one of the two central approaches in the international climate change process, along with adaptation. It involves human interventions to reduce greenhouse gas emissions, and to enhance their removal from the atmosphere, including the forest and agricultural sector, and these issue are of increasing importance to the UN climate convention discussions and national implementation (such as REDD+). In addition, the Global Climate Observing System (GCOS) is leading efforts to observe Essential Climate Variables (ECVs) to support climate science and reduce uncertainties in observing the global climate system. There are major investments in improving the monitoring of ECVs, i.e. as part of ESA's climate change initiative.

Land cover monitoring and the role of land dynamics have a double role in being key for assessing global environmental change, and in its role of land endowments in providing economic services and in energy and climate policy and response. Thus, both the Earth System and the Integrated Assessment modeling communities recognize the importance of an accurate representation of land use and land cover change to understand and quantify the interactions and feedbacks with the climate and socio-economic systems, respectively. Targeted research is starting to better understand (1) the interaction of land use and land cover with the climate system (e.g. carbon cycle feedbacks), (2) the provision of goods and ecosystem services by terrestrial (natural and anthropogenic) land cover types (e.g. food production), (3) land use and management decisions; and (4) opportunities and limitations for managing climate change (for both mitigation and adaptation strategies).

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Improving land cover observations can be a catalyst to foster different science and mitigation communities and bring their efforts and integration. In this context, GCOS and GOFC-GOLD have started to work on how the efforts for monitoring of ECVs could be expanded and amended to meet the requirements of the national and global actors interested in mitigation. The presentation will update the participants on the current status and outcomes that have been focused on:

1. Assessing the general adequacy of observations to support climate change mitigation and identification of further work on the assessment of adequacy that may be undertaken in preparation of the third GCOS adequacy report in 2014/2015 or in support of other programmes represented at the workshop;
2. Identification of the requirements for observations and their use in monitoring to support climate services addressing mitigation needs,
3. Identification of the requirements for observations to support research into mitigation (such as those related to REDD+)
4. Strategic guidance on what steps the GCOS Programme should take in the coming years and how this should influence dedicated ECV monitoring programs such as ESA'climate change initiative

| **0919** | Modeling the spatial distribution of irrigated agricultural area and its impacts on global water resources | Jan Schüngel, Ellen Kynast, Rüdiger Schaldach, Stephanie Eisner | Germany |

World population will grow in the coming decades and thereby also the demand for food. To fulfill this growing demand, food production must increase and irrigation will play an important role to ensure food supply. Today 20% of the global cropland is managed as irrigated, and it is expected that the share of irrigated land will rise continuously. Natural areas that were previously unusable for agricultural could be cultivated and already used areas could be intensified by irrigation. But this will also increase water consumption and pressure on natural water resources.

This study will address the share and location of irrigated area in agricultural production and irrigation water requirements on global scale. In order to analyze these effects, **a** spatially explicit land-use model (LandSHIFT) is soft-coupled with a water-use model (WaterGAP3). LandSHIFT uses socio-economic factors to calculate temporal alterations in location and extent of land-use activities such as crop cultivation and livestock grazing at 5 arc minutes resolution. WaterGAP simulates water availability for irrigation and the impact on natural water resources.

Beside a technical overview that illustrates how allocation of irrigated area is handled, how initial irrigation distribution is calculated and how irrigation scenario simulations are performed (in LandSHIFT), the impacts and influences of irrigated agriculture intensification on global water resources are highlighted and regions with high risk for water scarcity are identified**.** In addition, with the help of water-availability data (from WaterGAP) and water restrictions in regions at risk possibilities to analyse options for a sustainable water management are shown.

| **0932** | Deforestation, climate change and neglected tropical diseases in Amazonia | Manuel Cesario | Brazil |

In Amazonia, deforestation is both a cause and consequence of Climate Change: forest burning converts forested areas into pastures or plantations, emitting Green-House Gases, contributing to a regional decrease in humidity and increase in temperature - climatic conditions that foster forest fires, further increasing GHGs' emittions, closing the perverse circle. Land Use Changes and the associated biodiversity-loss favour the disruption of natural cycles that impinge on vectors' abundance, jeopardizing the ability of ecosystems to act as buffer zones between zoonoses and human populations - an Ecosystem Service known as Infectious Diseases Regulation. The on-going building of two hydroelectric dams, their

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additional 2,500 miles of hydro-ways and the recent paving of 1,000 miles of roads are impacting on the epidemiology of Bartonellosis (Carrion Disease) and American Cutaneous Leishmaniasis (ACL), in South-western Amazonia (Cesario et al, 2011). A four-year research project aimed at developing Early Warning Systems is being developed since 2011 to enable health professionals to anticipate and face the negative impacts of climate change on the spreading of diseases. Its methods encompass secondary data analysis, eco-epidemiological field enquiries, risk mapping, vectors' and parasites' collection and identification, multivariate statistics, and Information Technology tools for data collection and sharing, as well as for health education. The number of cases of Bartonellosis in Peru increased tenfold from 1997 to 2005, while its geographical distribution expanded from few locations in the Andes region to numerous areas from the Pacific coast, Cuzco top touristic destination, and the Amazon borders with Bolivia and Brazil, countries lacking expertise to its diagnostic and treatment. The Detection Coefficient of ACL in all sides of the Bolivia-Brazil-Peru borders is above the level of very high infection-risk, and the Brazilian municipality of Assis Brasil (Acre State) reaches 20 times that level. A strong Pearson Correlation ($p=0,0030$; $r=0,8298$) between ACL's Detection Coefficient rates and the deforestation rates in Acre State, between 2001 and 2010, suggests linkages between Climate Change and ACL's hyper-endemicity. This paper concludes that the Ecosystem Approach sets the best framework for scientists from various disciplines, health-service managers and policy-makers to better understand the role played by unsound regional development policies in fostering the re-emergence of neglected zoonoses, allowing for a timing response to the urgent need to advance scientifically informed decision-making in respect to climate change socio-economic impacts, health vulnerability and adaptation measures - concerns of the Global Climate Change Human Dimensions' community.

NUMBER	TITLE	AUTHORS	COUNTRY
0943	Evaluating supply and demand of landscape functions for future rural land use: a case study from the Dongting Lake area, China	Huirong Yu, Liming Liu, Peter Verburg	China

There is broad agreement that ecosystem services play an important role in policy making and land-use decisions. The future land-use decision-making mainly depends on the ecosystem services (supply of landscape functions) and the choices of local residents (demand of landscape functions). Therefore, the objective of the study is to provide the rural decision-maker with an effective and sustainable pathway for future land use decisions. It focuses on identifying and quantifying on the interactions between the supply and demands of local landscape functions. A transect along Zi River in the Dongting Lake area is selected for case study, which contains one city and three counties of gradient developmental levels. Landscape indicators of the last 30 years are used to quantify changes of the ecosystem services, simulate and map future supply of landscape functions in 2020, while questionnaires and GIS are applied to identify the spatial characteristics of land use visions (functions demand and preferences) by local governments and people for the future (2020). The future supply map and demand map of landscape functions are subsequently overlapped and aggregated to the identify supply/demand ratios of different services. Based on the supply/demand ratios, implications and suggestions of future land use are put forward for policy makers. The study presents a new spatially explicit methodology to forecast future land use, and the outcomes of the case study will contribute to well-informed management of rural land use. It also fit to theme of 0128: VOLANTE visions of land use transitions.

NUMBER	TITLE	AUTHORS	COUNTRY
0968	Monitoring of land degradation due to teleconnections in Africa within the MESA project	Ingrid Hartmann	Niger

The contribution will highlight the first findings of the MESA project in regard to land transformations due to teleconnections.

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The MESA project is a collaboration programme between the European Union and the African commission for the purpose of environmental monitoring through improved access to Earth Observation data over the African continent, also to fill current gaps of information and to enhance resolution and accuracy of data.

The contribution will present satellite-based approaches and first results of relating ENSO-related teleconnections with enhanced land degradation phenomena over West and East Africa.

| 0971 | Influence of zero-deforestation agreements on Brazilian cattle ranchers and meatpackers | Holly Gibbs | USA |

Cattle expansion is associated with roughly three-quarters of deforestation in the Brazilian Amazon. Over the last four years, a range of national, state, civil society and industry-led actions have reduced the rates of deforestation in Brazil and increased the transparency of the cattle sector. State-level efforts to enforce environmental laws combined with influential NGO reports highlighting environmental and social problems associated with cattle ranching have been particularly powerful levers. In response, the major Brazilian meatpackers signed zero-deforestation agreements with NGOs and state prosecutors. The agreements restrict meatpacker purchases to direct suppliers or fattening ranches that have registered their property, have no illegal deforestation, no slave labor, and are not on the IBAMA list of embargoed properties.

We evaluate these zero-deforestation agreements by quantifying and mapping changing patterns of international trade, stakeholder interviews along supply chains, and spatial analyses to quantify response. Here we will present a property-level analysis of rancher and slaughterhouse response to the zero-deforestation cattle agreement. To accomplish this, we developed novel methods to map individual cattle suppliers at the property level and trace the slaughterhouse supply chains before and after the agreements. Our results indicate that the direct suppliers and slaughterhouses impacted by the agreements have made remarkable changes following the 2009 agreements, but that critical weaknesses remain. For example, our ranch-level analysis illustrates that direct suppliers are more than twice as likely as any other type of rancher to register their property, and that slaughterhouses have reduced deforestation in their direct supply chains by roughly a third. We show that the number of transactions with embargoed properties decreased in the direct suppliers while simultaneously increasing in all other parts of the supply chain. Substantial leakage has occurred into the clandestine market and indirect portions of the supply chain that are not directly influenced by the agreements. Our spatial analysis and field surveys also indicate that fraud is widespread and masks non-compliance in some cases.

| 0977 | The colombian Peaseant Reserve: emancipation or territorial contention spaces? | Lina María Hurtado Gómez | Brazil |

The aim of this article is to discuss the double meaning of the Colombian peasant reserves areas (PRA) figure for the government and the social movements. Even if the PRA's emerge from the fights of the peasant movements for the land distribution and the recognition of their territories, in the last years, it has been spotted by the government, not as an emancipation figure of the peasant communities, but as a possibility to stop the expansion fronts over the protected areas. At the same time, other state institutions, such as the Agriculture and Defense Ministries, keep stigmatizing the figure, as territories of bandits' concentration. Meanwhile, the peasant movements have move on with their mobilization process to the figure positioning as an expression of their territorialities and have developed meeting and discussion mechanisms to show the figure to the Colombian society. This figures, the PRA, proposed and created in the base of social movements fight, as an expression of the peasant community, have today other sense for the government, which seems them as instruments to consolidate the hegemonic vision over the territory

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(Zibechi; 2007), useful for the population control (Foucault: 2002), as territorial contention spaces and of mobility control (Haesbaert:2009); in this case, that of the peasants.

| **0996** | The social-ecological systems meta-analysis database (SESMAD) project: a case study-base tool for discovery, theory building and diagnosis | Sergio Villamayor-Tomas | Germany |

This presentation will introduce the work of the Social-Ecological Systems Meta-Analysis Database (SESMAD) project. Begun by a group of Resilience Alliance Young Scholars in 2011, the project is focused on synthesizing research on medium- to large-scale social-ecological systems across countries, continents, and sectors. The project builds on previous meta-analytic methodologies that have been developed by prominent researchers in the field of common-pool resource management. This previous work has focused primarily on small-scale systems, and to date comparatively less synthetic work has been done on larger systems, such as the Great Barrier Reef Marine Protected Area or the International Commission on the Conservation of Atlantic Tuna. The SESMAD project is designed to fill this gap in comparative knowledge across larger social-ecological systems, with an initial focus on examining the applicability of common-pool resource theory to large systems. The SESMAD methodology is primarily a meta-analysis, which involves the consistent coding of data from multiple cases into a relational database to enable cross-case comparisons. Without such a process making these comparisons would be very difficult, due to distinct data collection and research protocols of the initial work done on each system. Comparability of the data coded for each case is ensured by a rigorous training process and a coding manual to assist team members and maintain high inter-coder reliability. The project has advanced to the stage where some basic comparative analyses can be accomplished. Next steps include the collection of data from more cases and the development of new comparative studies resource within sectors and regions.

| **1002** | Communicating the role of ecosystem services to public decision makers in urban planning processes: critical issues and successful case studies | Daniele La Rosa | Italy |

The Communication the role of Ecosystem Services is of high importance in planning process. This might also be more crucial when financial resources for choices on land-use are scarce or limited, and their optimization is always seen as the most important priority for public decision makers. For scientists and planners it is therefore fundamental to choose the most appropriate way and technical tools to efficiently communicate the relation between choices of sustainable land-use planning and Ecosystem Services. This calls for a first definition of shared common values and services provided by Ecosystem Services.

This contribute aims at reviewing recent experiences of land-use planning at different scales in Italy (urban, provincial, regional planning), highlighting how the concept of Ecosystem Services has been communicated to public decision makers and how it has been incorporated in planning tools (land-use plans). Critic issues, successful case studies and propositions for improvement of Ecosystem Services communication will be presented and discussed.

| **1003** | Satellite remote sensing of fires and recent scientific developments | Chris Justice, Louis Giglio, Krishna Vadrevu, Ivan Csiszar, Luigi Boschetti, David Roy | USA |

Earth observation satellites have immense potential for fire detection, mapping and monitoring. In this presentation, latest updates on satellite remote sensing of fires will be highlighted. Since the 1980s, remotely-sensed data acquired by sensors on several satellites, such as NOAA/AVHRR, LANDSAT/TM/ETM+, Terra/Aqua/MODIS, ENVISAT/AATSR, etc., have been utilized for detecting

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active fires and burned areas in several regions of the world. Parallel to improved sensor technologies and development, algorithms for active fire detection and burnt area mapping have improved significantly leading to development of operational fire products of known accuracy. For example, MODIS active fire, burnt area and fire radiative power products are routinely being generated using a combination of optical and thermal bands. The launch of Suomi-National Polar-orbiting Partnership (NPP) VIIRS during October 2011, further enhanced the fire monitoring capabilities due to its improved spatial resolution (than MODIS), and data aggregation scheme. Similarly, the successful launch of LANDSAT-8 during February 2013 has opened avenues for improved active fire detection and burnt area mapping at a higher resolution than MODIS or VIIRS. Providing observations at high temporal frequency, geostationary fire detection systems also continue to be improved as the next-generation satellites are designed and launched. In summary, the recently launched satellites show significant promise in terms of data continuity and indicate substantial possibilities for mapping fire extent and frequency useful for fire management and mitigation purposes. In the presentation, the potential and limitations of the above sensors for fire mapping and monitoring will be discussed. Sample case studies on fire mapping will be showcased. In addition, an overview of the international GOFC- GOLD Fire mapping and monitoring program will be presented. The GOFC-GOLD fire program aims to refine and articulate international observation requirements and encourage the use of satellite-derived fire products and information from existing and planned systems for global change research, fire management, and policy decision-making.

| 1004 | The 'land rush' and classic agrarian questions of capital and labour: a systematic scoping review centred on the socio-economic impacts of 'land grabs' in Africa | Carlos Oya | UK |

This paper has two main objectives. First is to address the problematic of socio-economic impact of land deals in Sub-Saharan Africa by looking at what we know from the available literature so far, i.e. what has been claimed and how much research has been done on the issue, as well as why we do not know very much despite the quantity of material published. This task is undertaken with the use of a systematic scoping review, which aims to avoid some of the biases inherent in conventional literature reviews and tries to provide evidence on some basic features of the emerging research on 'land grabs' in Africa, with specific reference to their contribution to the understanding of livelihood impacts. Second, the article links empirical questions about impact and implications of 'land grabs with a discussion of alternative (neglected) research questions, notably the implications of the current phenomenon of 'land rush' for the classic agrarian questions of capital and labour, as understood in agrarian political economy. In other words, the paper proposes a re-engagement with debates on the classic agrarian question in a Marxist political economy tradition in light of the recent experience of large-scale land deals, in order to move the 'land grab' research agenda towards conceptually and empirically challenging research questions.

| 1027 | The Future Earth approach and its importance for understanding land use change in Africa | Melissa Leach | France |

Global environmental changes have regional and local impacts, simultaneously undermining natural resources and ecosystem services, and endangering human well-being and security. The cross-scale interactions between human activities, large scale changes in the Earth system, and local impacts have important implications for human development and create many of the sustainability challenges facing society. Achieving global sustainability requires bridging the gap in awareness between local actions and global effects.

'Future Earth – research for global sustainability' is an ambitious international research programme

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bringing together IGBP, IHDP, Diversitas and WCRP, with a vision to provide the knowledge societies need to secure a sustainable future. Launched in June 2012 in the context of the Rio+20 conference, Future Earth will pioneer new approaches to international research bringing together many knowledge fields around common research challenges. It will provide an international platform for engagement and communications with policy, business and society around global sustainability challenges.

As GLP is considering its transition to Future Earth, the event provides an opportunity to discuss the benefits of working across natural, social and engineering sciences and engaging stakeholder groups in defining research priorities and delivering research that can inform action. The speakers will discuss the potential of interdisciplinary and transdisciplinary work to strengthen the outcomes for sustainability through an example related to the drivers of land use change in Africa.

| **1028** | Engaging research centers in Africa on land use issues in support of Future Earth | Cheikh Mbow | Kenya |

Challenges related to land use in Africa are increasingly attracting concerns at all level of development. Sustainable land use is a must have development model to address the uncertain future with increasing extremes events, long term climate change, increase in population, urbanization, etc. To address the challenges, African research centers may need to develop knowledge that are relevant for potential safety nets (safe space) and trade-offs to cope with land use drivers and trajectories. This short presentation will address both the issue of information availability (sharing) and the expectations for Knowledge translation to various stakeholders to meet the action needs for sustainable development. "Linking content to people" requires that African research centers investigate more options to acquire data that are fully understood and match the specific sustainable development needs (refer to SDGs). Some challenges we will address are related to the shortfall of research 'in' development such as the access to information, relation between data and scale, bundle evidences and scale up innovations, managing exclusion and vulnerable groups including gender synergies and addressing the polycentric governance needs.

| **1029** | Consulting land system development under climate change in West-Africa | Christine Fürst | Germany |

Climate change poses one of the major challenges for a sustainable development of land systems worldwide. Especially already arid regions such as in the Sahel or Sub-Sahel zone in Africa suffer increasingly from reduced or temporally shifting precipitation. The carrying capacity of the current land uses is expected not to correspond any longer to population growth and resulting increasing demand on food and water provision. Therefore, the large-scale BMBF research-focused program WASCAL (West African Science Service Center for Climate Change and Adapted Land Use) has the aim to enhance the resilience of human and environmental systems to climate change by developing and consulting strategies for adapted land use. Taking a set of case studies from the WASCAL context as an example, this talk demonstrates how integrated land use planning processes can be initialized, supported and bundled to transferable recommendations for how to best involve management practices and land use pattern as basis for evolving especially rural land systems in West-Africa.

| **1030** | Exploring land system transformations in the Sahel: the value of complementary perspectives | Anette Reenberg | Denmark |

The talk addresses the challenge of conceptualizing and analyzing complex change processes and causal explanations in human-environment systems. To illustrate this challenge empirically, it takes point of departure in the apparent paradox that the agricultural practices in the desert fringe zone of the Sahel seem to remain remarkably unchanged despite huge and accelerating changes in major driving forces such as climate variations, population pressure, policies, and market access. Such partly unexpected trends

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suggest that novel insight is needed into the human environment interactions that shape the use of land for cultivating purposes in this region.

The presentation suggests employing a portfolio of complementary conceptual lenses to human-environment interaction in the Sahel. This will help understanding local land transformations and their implications for local livelihoods and regional to global sustainability.

| **1032** | African governance models that differ in adaptability to global change | Willem Ferguson | South Africa |

A large proportion of mountain areas in South Africa is home to indigenous rural communities that lead subsistence livelihoods. The governance of these areas is complex. Firstly, there are three tiers of government: national, provincial and district. Policy with respect to the development of mountain areas are mostly set by the national government, with powers of execution and enforcement being delegated at smaller spatial scales corresponding to the lower tiers of authority. The translation of national policy to the execution at lower levels is not perfect because of differing political priorities. In addition, a fourth level of governance, the tribal council, has a largely independent authority. Despite the fact that there is a dedicated ministry dealing with tribal councils, the tribal and government authorities are largely competitive or in opposition. I compare two mountain areas in South Africa, the Lubombo (where the tribal authorities have strong influence) and the Mpumalanga Drakensberg (where the government authorities have a stronger influence). Practical management of the mountain landscape is much more efficient in the area with strong tribal authority, while mountain resource management is caught up in between-departmental conflict in the area with strong government input. Promoting informed local decision making skills allows for quicker adaptation to the needs of sustainable management of mountains and promotes adaptation to a changing environment.

| **1033** | Necessity of considering high-ordered adaptive decisions in modeling long-term land use transformation | Quang Bao Le | Switzerland |

Understanding how human actors perceive and adapt to social-ecological changes is crucial to sustainable land-use transformations. In long term, adaptive decisions on land use are not only perceiving environmental changes and acting based on pre-existing cognitive schemas (models), but also modifying the pre-existing schemas to deal better with new situations. The later adaptive process has largely been absent in many current agent-based models for land-use change. Thus, these models are weak to explain and support sustainable land-use transformations. My flash talk presentation highlights this gap and suggests key points for discussions toward filling the gap.

| **1034** | Disaster risk reduction, climate change adaptation and governance in a climate-vulnerable Himalayan region | Reinmar Seidler, Sarala Kahling, Kamal Bawa | USA |

At the moment of this writing (June 2013), a weather-related catastrophe is evolving tragically in the high mountains of Uttarakhand (India) and western Nepal. Flash floods of a volume not seen in 80 years seem to have taken authorities to some extent by surprise, and large numbers of people are stranded in exposed positions. The entire Himalayan range suffers from inherent meteorological and geological instabilities, but the effects on people and landscapes have been heightened by political conflict, institutional weaknesses and poor governance in many places. Since we must expect increasing near-term distortions in climate and local weather patterns, better planning for how people use these landscapes is an absolute priority. In a country like India, lack of technical or financial capital is no longer a barrier. The barriers are institutional and governance-related.

Unfortunately, it is also true that given the weaknesses of current institutional arrangements in many developing countries and regions, comprehensive landscape development planning will not occur from

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one day to the next. The challenge therefore is to stimulate and promote a rapid 'sustainability transition' that incorporates improved institutional frameworks. We suggest that for institutional capacity-building in climate-vulnerable montane regions such as the Himalaya, disaster preparedness and disaster risk reduction (DRR) represent the 'thin end of the governance wedge'. In and of itself, disaster preparedness is crucial and something that virtually everyone can get behind. Consensus, at least in principle, can often be generated relatively easily. A number of significant *positive secondary outcomes* at the institutional level can be expected from the process of strengthening disaster planning. We describe these outcomes and illustrate them with the case of one high-risk region, the Darjeeling and Sikkim Himalaya. Our research-action programmes there integrate DRR with climate change adaptation, ecosystem services-based livelihoods and institutional reforms.

Governance forms in this area range from traditional 'indigenous' local institutions (e.g., *Dzumsa* in N. Sikkim) to relatively progressive 'modern' state arrangements (Gangtok, Sikkim) and to distant state powers (Kolkata, W. Bengal). Several grassroots 'hill culture' groups are actively agitating for various degrees of regional independence from the state authorities perceived as plains-oriented ('Gorkhaland' movements in Darjeeling District). We observe spontaneous climate adaptations, both in agriculture and animal husbandry, among higher-altitude communities at individual household and village levels. However, the integration of DRR with climate change adaptation (CCA) at the institutional level remains at a preliminary stage.

| 1035 | Land management institutions and agricultural commercialization in Central Mozambique | Helena Pérez Niño | UK |

This paper looks at the impact of increasing agricultural commercialization on the evolution of land management institutions in Mozambique to show how the local non-statutory forms of authority over land adapt to new demands and patterns of land transfer and utilization. On the basis of the case study presented we will critically interrogate the literature on land tenure security on the grounds of what is the subject of protection and what is the nature of the threats to tenure security.

Mozambique has been the subject of much speculation about the socio-economic impact of 'land grabs' or 'large-scale land deals', but as elsewhere, there is still insufficient evidence of land grabbing becoming the predominant mode of organizing agricultural production. Departing from that research agenda, the research informing this paper was interested in actually existing processes of transformation in the institutions regulating access and transfer of land.

For our case study two research sites were selected in the Northwestern province of Tete in an tobacco growing district, all tobacco growers take part in a contract farming scheme. Site A is a recent settlement, with lower population density and larger land-holdings in an agricultural frontier. Site B is an established settlement with smaller holdings and no remaining forest to allocate. The paper traces the way in which local authorities moderate and intervene land transfers in this two different settings. All transfers are between Mozambican farmers, there are no foreign agricultural investors acquiring land in the area.

We trace the genealogy of the rules and mechanisms that regulate the use and transfer of land and how they may have responded to an array of exogenous shocks: war-time displacement and return; adoption of a high-value export agricultural commodity; expansion of contract farming schemes and changes in the national legislation on land. Such a reconstruction aims at identifying the drivers of land commodification and the role of non-statutory authorities in the process. Our findings speak to a debate between those who claim that land commodification disintegrates customary institutions and endangers livelihood strategies and those who claim that customary institutions are not incompatible with the emergence of vernacular land markets and that social differentiation is an inevitable process in agrarian systems that increasingly depend on markets for their reproduction.

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1036	Key findings from the GESOSHARE pilot project	Thomas Hertel	USA

The lack of time series, interoperable, geospatial data at global scale has greatly inhibited the ability of scientists, practitioners and policy makers to address the socio-economic and environmental impacts of contemporary policy issues related to the long run environmental sustainability of the world food system. GEOSHARE aims to help fill this gap. With funding from the UK and US governments, it is currently in its pilot phase, focusing on a handful countries in Sub Saharan Africa and South Asia. This pilot effort will be completed in the first half of 2014. This 'flash talk' will summarize accomplishments, challenges and lessons learned from this pilot effort, in addition to making some suggestions about the appropriate way forward.

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1040	The influence of roundtable certification on land cover in Indonesian oil palm plantations	Kimberly Carlson, Lisa Curran, Dessy Ratnasari	USA

Oil palm (*Elaeis guineensis*) plantations are rapidly developing throughout the humid tropics, especially Indonesia. In 2012, ~16% of Indonesia's palm oil production was certified by the Roundtable on Sustainable Palm Oil (RSPO), a private governance organization aiming to promote "the growth and use of sustainable oil palm products through credible global standards." Companies wishing to produce RSPO-certified products must conform to a set of nationally interpreted principles and criteria. These include requirements to avoid clearing forested lands, and to set aside high conservation value forests, watercourses, and wetlands. Independent empirical assessments are required to determine whether RSPO certification confers forest and riparian protection that exceeds that of conventional plantations.

Here, we contrast forest cover within conventional and RSPO-certified oil palm plantations in Indonesia. We assemble a spatial database of conventional and RSPO-certified plantation boundaries and longitudinal land cover data. With these data, we map the fraction of forested lands converted to oil palm, as well as extent and location of forested land occurrence and maintenance within plantation boundaries. Results inform how roundtable commodity certification alters agricultural land use practices.

This research contributes to the conference theme by assessing how commodity roundtables, which can be considered alterative approaches to governance, influence local patterns of land use. In addition, our work is a good fit for this session because it examines how property-level decisions of oil palm plantation companies affect forest fragmentation and extent.

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1042	Feedbacks between land system change and the climate system	Almut Arneth, Peter Verburg	The Netherlands

Interactions between land use and climate are often represented in climate models by incorporating the changes in land cover. Changes in land management and in the land use mosaic, both with potentially important climate impacts, are not accounted for. Similarly, land use models account for climate change in terms of changed crop productivity, but ignore the multiple ways in which humans adapt land use decisions in anticipation of climate change and perception of associated risks. This flash talk will outline the main challenges for improving the representation of such feedbacks and illustrate this with a comparison of alternative representations of land use and empirical evidence of adaptive behavior in response to climate change. These examples are intended to initiate discussion on the ways in which the land change and climate communities can increasingly collaborate to better understand the feedback loops between both components of the earth system.

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1044	Action research for bringing the land-water nexus to life	Holger Hoff	Germany

IWRM has promoted the coordinated management of water and land for more than a decade. The term "green water" has drawn attention to the role of land management in the hydrological cycle for an equally

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long time. More than half a decade ago the Comprehensive Assessment of Water Use in Agriculture has explained in detail how "every land use decision is a water use decision", and later the planetary boundaries concept has identified global limits of water and land (and other) resource uses and how these are interrelated. However, these principles are hardly put into practice, mainly due to a lack of i) spatially explicit quantitative information at the appropriate scale and ii) tools and mechanisms for translating that information into decision and policy making.

This flash talk highlights the following key steps in action research for bringing the land-water nexus to life:

1) quantification of land and water availability – also relative to demand - and their respective productivities in different uses;
2) definition of context-specific boundaries of sustainable land and water use, for avoiding further loss of natural capital and resilience, e.g. based on environmental flow requirements (water boundary) or net primary productivity (land boundary);
3) cost-benefits analysis of sectoral vs. integrated management of land and water, including e.g. water-related costs of land degradation and land-related costs of water degradation;
4) identification of opportunities for co-management and simultaneous productivity improvement of land and water, e.g. through multi-functional systems, cascading resource use and recycling;
5) guiding investments in support of sustainable intensification of land and water use;
6) capacity building for bridging institutions across the land and water sectors.

| 1045 | Joint and integrated management of land and water resources | Claudia Ringler | Germany |

Water, land and energy resources are all crucial contributors to food security. As a result of growing natural resource scarcity, the inter-connectedness of these sectors has become more apparent, as evidenced by growing tradeoffs and the incipient search for cross-sector efficiencies. In particular, water and land productivities are closely interlinked. Investment in advanced irrigation systems or in increased energy use on land can increase agricultural and land productivity; while degradation of water or land reduce productivity. This talk will examine these interlinkages based on farm production data in Ethiopia and Pakistan.

| 1046 | Integrating water and land resources management and ecosystem services by combining scenario analysis and optimization on different scales | Martin Volk | Germany |

Integrated Water Resources Management emphasizes on linkages between land-use and hydrological systems, ecosystems and human health, and between political and scientific aspects of water management. One of the most important water security threats is the challenge of balancing human and environmental water needs while safeguarding essential ecosystem services and biodiversity. To date, most of research on water security is relatively poorly integrated with the needs of policy-makers and practitioners. While trade-offs between, for instance, water use and water protection are in part addressed by the concept of ecosystem services, this is to a large still missing in water resources management. There is an urgent need for improved methods to identify trade-offs at all scales as scenario analysis frequently results in a discrete set of options. The use of optimization algorithms including Pareto-frontiers combined with scenario analysis could provide efficient options for sustainable land and water use from global to sub-global scales. The presentation will show how the combination of model-based scenario analysis and optimization can contribute to quantify trade-offs between land and water use and ecosystem functions and services (and the services themself), such as bioenergy production, food production, water quality, water quantity and biodiversity aspects. Such procedures can be used to improve the link between water

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	and land resources management and the ecosystem services concept.		
1047	Land degradation: ecological system resilience interacting with social system adaptability	Uriel Safriel	Israel

Land degradation is a direct issue of the food producing livelihood and indirectly to the whole global population, since each of the current 7 millions requires food (produced by the 2 billion land users), daily. If productive land is being degraded, the security of food for the current population plus the added two billion expected by 2050, is at risk.

The farming and pastoral livelihoods are based on cultivation and grazing, respectively. They use natural ecosystems, woodland and grassland, which have been transformed to croplands and rangelands, human-managed ecosystems, respectively. These livelihoods utilize the provisioning ecosystem services of their lands, which depend on supporting services and regulating services, many of which provided by the remaining natural ecosystems. These ecosystem services depend on the land's natural capital, soil and biodiversity. The natural rate of flow of the provisioning services is sustained as long as the natural capital is used sustainably, i.e. allow rate of flow of services to be matched with rate of renewability of the natural capital.

This maintains the land, i.e., the ecological system in a stable sustainable state. But the ways land users use their land and the drivers that make them do what they do, move the ecological system from its stable sustainable state, through a process of land degradation (reducing the flow of services), to a stable state of desertification, i.e. generating productivity which is persistently lower that that of the land's capacity. Whether the social system will drive this transition or not, depends on the ecological system's resilience, whose components are latitude, resistance, precariousness and panarchy. However, due to its adaptability, the social system is able to manage the ecological system's resilience such that it does not desertify the land, and/or restores a desertified land back to its sustainable state. A diagrammatic scheme will be provided to illustrate the effects of adaptability on resilience, and the two actions (not degrading and restoring) for achieving a land degradation neutral world.

NUMBER	TITLE	AUTHORS	COUNTRY
1048	Variability of moisture recycling using a precipitationshed framework	Patrick Keys	Sweden

Moisture recycling, whereby evaporation from Earth's surface flows through the atmosphere and falls out as precipitation on land downwind, is increasingly being acknowledged as an important feature of the global Earth system. There is still substantial uncertainty of how large-scale, spatial patterns of moisture recycling vary under historical climate conditions. Understanding this historical, spatial variability of moisture recycling is critical for quantifying and determining the relative importance of other drivers such as land-use change or increasing greenhouse gases. This research explores this topic by quantifying the variability of moisture recycling for several key regions globally, using the precipitationshed as the unit of analysis. We employ the Water Accounting Model (WAM 2.0), a numerical water transport model, to track how moisture flows through the atmosphere. Using two global climate datasets, spanning the period 1979-2012, variations in moisture recycling relationships are identified. The results suggest that spatial variability is relatively low during the thirty years of analysis. Given this, we explore how the physical dynamics between the sources and sinks of moisture within these precipitationsheds may lead to upwind and downwind social dynamics similar to those in surface watersheds.

NUMBER	TITLE	AUTHORS	COUNTRY
1049	Economics of Land Degradation	Alisher Mirzabaev	Germany

Healthy soils are essential for sustaining economies and human livelihoods. In spite of this, the key ecosystem services provided by soils have usually been taken for granted and their true value – beyond market value – is being underrated. This pattern of undervaluation of soils is about to change in view of rapidly raising land prices, which is the result of increased shortage of land and raising output prices that

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drive implicit prices of land upward. Moreover, the value of soil related ecosystems services is being better understood and increasingly valued. It is estimated that about a quarter of global land area is degraded, affecting about 1.5 billion people in all agro-ecologies around the world. Land degradation has its highest toll on the livelihoods and well-being of the poorest households in the rural areas of developing countries. Vicious circles of poverty and land degradation, as well as transmission effects from rural poverty and food insecurity to national economies, critically hamper their development process. The findings from the ongoing research on Economics of Land Degradation (ELD) suggest that the costs of inaction against land degradation are much higher than the costs of action.

| 1050 | Quantifying climate services provided by tropical forests with dynamic global vegetation models | Kirsten Thonicke | Germany |

The presentation shares the perspective from global vegetation models on the topic of tropical forests, climates and tele-connections.

| 1051 | Ecosystem services for connecting actors | Paul Opdam | The Netherlands |

Community-based landscape planning is a way of planning in which not the state but the local stakeholders negotiate about preferred future landscapes and decide about spatial adaptations which make such a landscape future-proof. The concept of landscape services (ecosystem services within the context of local landscape planning) allows to distinguish two roles within the stakeholder group: those who benefit from using the service (demanders) and those who can supply the services by caring for the land. To ensure sustainable use of the services, collaboration is of prime importance for two reasons. Firstly, collaboration between stakeholders that demand for landscape services to develop a common ground to coordinate their diverse interests. Secondly, collaboration between placeholders, who own or manage part of the landscape. Because many landscape services require landscape level ecological networks, placeholders need to cooperate if they want to raise the level of service provision. Planning methods and tools need to enhance such collaboration.

| 1053 | Are ES a reliable decision making base in a West-African context? | Christine Fürst | Germany |

WASCAL (West-African Science Services Center for Climate Change and Adapted Land-use) is a German-African initiative to build competence, bundle and develop land system research with a focus on consulting adaptation strategies under climate change. We started research on how the concept of ecosystem services can be already used or should be adapted to assess the impact of such strategies and to communicate them for land use planning and policies consulting. Problems that we currently face are related among others to acceptance and applicability of ES as these are so far unknown and not practiced for impact assessment and consulting in West-Africa. The importance of economic considerations and the pure pressure to ensure daily needs (food and water) are considered to be much more relevant for decision making compared to supporting, regulating and cultural services. Finally, extremely small scaled, scattered and mixed land-use types and great temporal variability in the potential provision of ecosystem services (drought / rainy season) provoke difficulties in delineating appropriate impact assessment units. In this input talk, we provide some first results on a potentially appropriate set of services, its acceptance and how to make use of it in the WASCAL context. We will suggest some ideas how to adapt the ES concept to Africa and will provide some questions on how to further evolve the concept in an international context.

| 1054 | Cultural ecosystem services and their benefits as complementary information in landscape planning - innovations and | Christian Albert, Christina von Haaren | |

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	added-value in the German context		

For more than three decades, German Landscape Planning has assessed 'landscape functions', understood as the capacities of a landscape to sustainably fulfill socially legitimized human demands and thus similar to a normative interpretation of ecosystem functions of the ecosystem services cascade (Potschin and Haines-Young). However, landscape planning has not yet explicitly delivered information on the actual use of services, the benefits that these services provide, and the degree to which human demands are actually met.

The objective of this paper is to explore the effects of including information on ecosystem services and benefits in landscape planning and decision-making practice. It focuses on cultural ecosystem services (CES) and uses the case study region of Hannover, Germany. The research design consists of four steps: (i) assessing exemplary CES, (ii) illustrating their benefits to human well-being, (iii) estimating the beneficiaries, and (iv) a focus group with relevant planners, decision-makers and civil society representatives to discuss the added value of the CES assessment results for decision making.The results include a method for assessing CES and their benefits on the basis of existing information, exemplary assessment results for the region of Hannover, and empirical insights from the focus group concerning the added value of applying the ecosystem services concept within the established planning system. Finally, we discuss the transferability of both the proposed method and the identified benefits to other case studies and planning system contexts.

| **1055** | ES in an urban context | Adrienne Grêt-Regamey | Switzerland |

This talk will contribute to the session with some thoughts how to consider better the characteristics of urban systems in ES assessment and modeling and will demonstrate some tools that can be used for introducing the concept in urban planning.

| **1057** | ES policies and stakeholder perception | Dawn Parker | Canada |

As mentioned in the session abstract, the concept of ecosystems services is rarely employed in the planning sector. Further, it is not yet a part of the general vocabulary and consciousness of stakeholder groups. In my remarks, I discuss my experience and perceptions of how individual ecosystem services are represented by planning and environmental management authorities, how policies related to these services are explained and marketed towards public stakeholders, and how stakeholder perceive relative costs and benefits.

| **1058** | Governance and the assessment of ecosystem services and human wellbeing | Luis Lebel | China |

Assessments of ecosystem services are one way of incorporating concerns with environmental change and ecosystem conditions into landscape and development planning. How assessments are governed and the political context in which they are introduced influences how ecosystem service concepts and their assessment are used in policy and planning. This paper explores case studies in Thailand in which central and local government agencies and research organizations partnered to engage local stakeholders in assessments of ecosystems and well-being in three provinces. The analysis here focuses on the governance and influence of the ecosystem service assessments. In each case the broad aim of the assessments was to improve understanding of the services provided by ecosystems to people and how they are or might be affected by development. More specific aims related to the particular development policy problems and environmental concerns in each province. A key element of the broader political context for all assessments was a transition in national policy towards area-based planning and broader political reforms to expand public participation and encourage more evidence-based decision-making. Through comparison of lessons learnt in three provinces we found evidence that assessments built capacities for governance actors and institutions to explore scientific and research-based evidence, consult scientific experts, and

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then evaluate existing policies and plans using this newly acquired information. At the same time, scientific experts also learnt to explore public policy issues, to consult planners and decision-makers in government, and based on this knowledge evaluate scientific evidence and revise the scope and goals of their research and analytical activities to better meet policy needs and demands. We also found evidence, however, of significant cultural and institutional constraints to designing and making better use of ecosystem service assessments.

| **1059** | Interlinked resource stocks and cycles: why water and land cannot be separated | Janos Bogardi | Germany |

The recognition of the limits of Earth resources is a key to understanding the capacity of our planet to support a large and expanding human population with aspirations for improvements in well-being. The degree of human appropriation of abiotic planetary and biotic ecosystem-based resources offers a useful framework to define sustainability, once societal aspirations and technology are taken into account as shown in Fig. 1. Because these linkages can be influenced by decisions this approach is suited to support policymaking for sustainability. The utility of this approach will be demonstrated on the human appropriation of water in the food production, one of the key forms of land use. A significant intensification of human appropriation of water will be necessary to support anticipated basic services and wealth generation over the coming decades. Furthermore, a major expansion of degraded water systems will be needed unless conscious preventive investments or costly remediation of impaired water quality are implemented in due course.
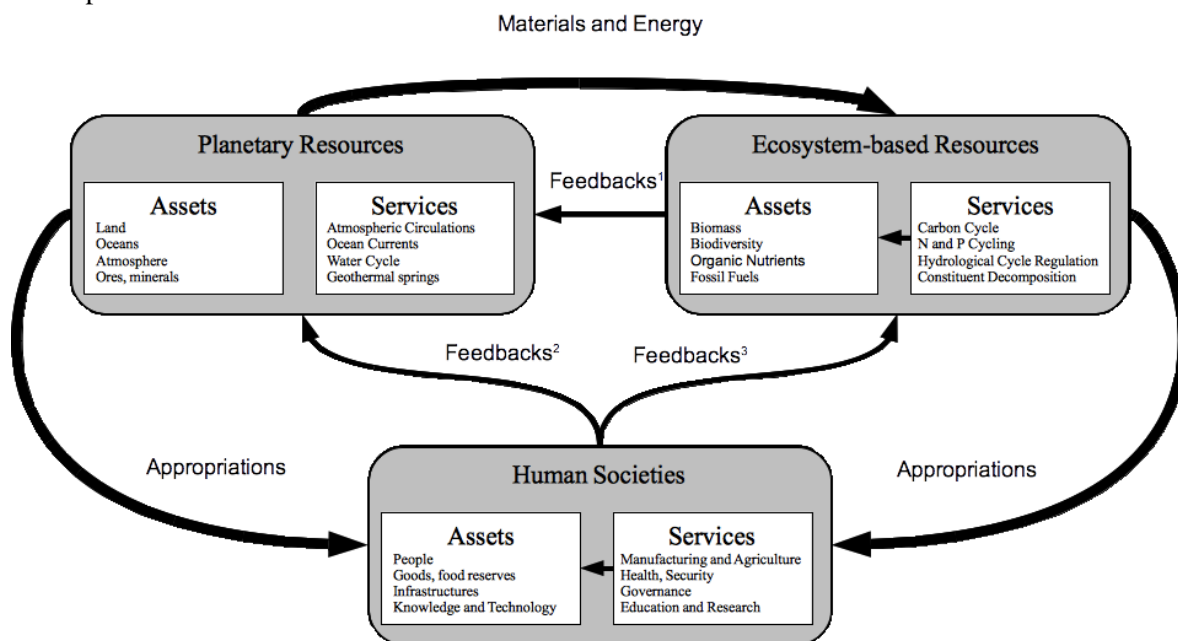
[1] Earth system abiotic component interactions with the Biosphere
[2] Depletion of non-renewables, use of renewable energy and mass, degradation
[3] Overuse of ecosystem assets and services, depletion of biodiversity, pollution

Figure 1. Balanced Triangle of planetary and ecosystem-based resources and human societies. Modern human society emerged as a dominating force in appropriating both planetary and ecosystem

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	services and putting feedback pressures on these domains. Achieving sustainable human development will require a balance between the three services: provisioning planetary to ecosystem, planetary to human societies and ecosystems to human societies) and their impacts. (Assets and services listed are illustrative examples without the claim of completeness).		

POSTER PRESENTATION ABSTRACTS

NUMBER	TITLE	AUTHORS	COUNTRY
0141	Application of remote sensing and GIS in modeling land use changes impacts on local climate of the Niger Delta, Nigeria	Ayansina Ayanlade	Nigeria
Tropical ecology has been experiencing environmental degradation over the years. Environmental change not only affects bio-physical components but also socio-economic activities. Earlier studies have reported that pressure from agricultural activities, increasing population; industrial and other social-economic activities engaged by human have impacts on forest reserves in Africa (Lambin *et al.* 2003). Therefore the present study aims at modelling climatic and societal implication of vegetation degradation in Okomu forest reserve of Nigeria. Both remote sensing and non-remote sensing data and methodologies were used. It is apparent from the results of this study that deforestation resulting from farmland encroachment has been increased in Okomu forest reserve. In 1984, about 17% of the reserve was deforested and this increased to 37% in 2011. This value reveals a massive deforestation. Though the study could not reveal direct significant impacts of vegetation degradation on local climate rather indirect impacts result from climate events. It is obvious from social survey that unrestrained felling of forest in the region has also rendered the soil vulnerable to invariable erosion and flooding since forest tend to reduce the impact of erosion and floods. Understanding of environmental change therefore provides better knowledge of environmental management in the delta.		
0143	Vulnerability and adaptation of community in expanding industrial land	Ngoc Pham Thi Bich	Thailand

Industrial development has been defined as the key development paradigm in Vietnam since the Innovation Policy (*Doi Moi*) was promulgated in 1986. This approach has introduced a variety of issues into the country, one transitioning from a planned economy to a socialist-oriented market economy. The Hoa Khanh Industrial Zone (HKIZ) represents one of the first and most important applications of this approach, taking place as it is in Danang City where so-called environmental city in 2007. Although economic growth has been introduced to the city since the HKIZ was set up, local communities around the HKIZ, such as Hong Phuoc village - the study sites have become more vulnerable due to the industrialization process. The research was using a qualitative research approach and both qualitative and quantitative data. Observations, in-depth interviews and focus group discussions were used to collect primary data from 50 community members. Two levels – the individual and community levels were used as the unit of analysis. The study found that the communities are poor and lack access to local resources for living, such as agricultural land, drinking and agricultural water, fresh air and local bio-resources. The HKIZ has made them poorer because they have lost their jobs and suffered a decline in income levels. They now lack access to local resources due to the priority given to marketization policies and changes in property rights – changes which have led to the conversion of common property to individual property under a central state controlled framework. Therefore, the development of industrial activities has given little priority to the maintenance of local livelihoods

| **0149** | Effects of land-use change on woody cover and carbon stock trends in a savanna basin of the Orinoco lowlands | Dirk Thielen, Jose San Jose, Ruben Montes, Nathaly Matute | Venezuela |

Changes in woody cover and carbon stock were assessed in a savanna basin from aerial photographs

(1938, 1961, 1978 and 1997) taken in the Orinoco lowlands. The savanna basin is characterized by a northern ablation area with hills, high plateaus and a southern accumulation area with foothills, valleys and plains. The climatic trend featured wet (1938-1963) and dry (1963-1997) periods as defined by the Palmer Drought Severity Index. In the wet period, the woody cover of the northern area increased 1.68% and the rate of change was 0.07% year-1. In the drought period, the values decreased -1.90% and -0.05% year-1 over a 37-year period. Over these two periods, the woody cover decreased -0.29% and the rate of change was null. The analysis of net ecosystem production, ecosystem respiration and gross ecosystem production based on eddy covariance measurements indicated that flux response to drought was certain. However, the changes in the carbon stock were in balance over the 60-year period. In the southern area, stream diversion was practiced from 1930 to 1940 and the magnitude and direction of the water flow was modified by supplying water year-round. In the wet and dry periods, the woody cover increased 8.31 and 11.04%, respectively at the rate of 0.36 and 0.30 % year-1, respectively. The carbon stock increased from 1.96 Gt in 1938 to 12.7 Gt in 1997. That is a 6.6-fold increase. Over the whole savanna basin, the carbon density in the savannas and gallery forests increased 1.91 and 6.43 g C m-2 yr-1 over a 60 year period. These results indicate that a woody cover and carbon stock response-based approach offers good opportunities for gaining insight into the carbon dynamic behind savanna basin response to relief, soil climate and disturbance.

Contribution to the conference theme and session selected: The present work gives information regarding land cover and use change impacts on a savanna ecosystem, as well as climate-land use interactions. Results are from a multiscalar approach study that integrates the information from field with those from Remote Sensing. The studied savanna is a Neotropical savanna representative for those present in the Orinoco Lowlands, from both, Colombian and from Venezuela.

0150	Response of terrestrial-aquatic palm ecotone (morichal) to land-use in the Orinoco lowlands	Dirk Thielen, Jose San Jose, Ruben Montes, Miguel Mazorra, Carmen Buendia	Venezuela

The study tested the assumption that the effect of land-use changes on hydrological dynamics and edaphic features of an aquatic-terrestrial ecotone have led to vegetational patchiness and decrease primary productivity (NPP). On the basis of the depletion of a groundwater-fed stream, three study sites corresponding to interrupted, intermittent and permanent streams were selected throughout the ecotone in the Sunsunes catchment (Orinoco basin, Venezuela). To describe the human impact on land cover, patchiness, biodiversity, hydrological and edaphic features, NPP and nutrient availability, we use structural and functional approaches. Hydrological (i.e., duration of inundation and maximum inundation height), soil chemical (e.g., Ca concentration, available phosphorous, soil organic matter) and physical (i.e., water-filled pore spaces) features were the best predictors of anthropogenic disturbance. In the ecotone, the tree species invasion from well-drained savannas increased woody cover as described by a stretched exponential model. Groundwater drawdown in the interrupted and intermittent streams increased with 74 and 34 colonizer species from well-drained savannas. The NPP of the ecotonal vegetation along the interrupted stream (909 g C/m2/yr) was a higher sink as compared to the intermittent and permanent streams (580 g C/m2/yr). Anthropogenic stress along with natural disturbance resulted in a decline in the system´s functioning. In contrast to hydrology, the effect of the nutrient addition (i.e., liming and phosphorous) on the carbon accumulation by species was not significant. Therefore, the functional response of the system was more sensitive to hydrology regime. The results indicate impact on the ecotones occurred in short term, and that vulnerability to climate is crucial of groundwater-dependent vegetation.

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Contribution to the conference theme and session selected: The present work gives information regarding land-water interactions, at ecotone level, from a Palm Swamp formation (Morichal), characteristic for Neotropical savannas, from both, Colombia and Venezuela. This system has not been sufficiently studied. Results from this study refer to ecotone functioning and land change impacts on ecosystem services and biodiversity and climate-land use interactions.

| 0151 | Estimating agricultural land use change, a case for Karamoja Uganda | Catherine Nakalembe | USA |

Land use information is useful for deriving biophysical variables for effective planning and management of natural resources. Land use information is also needed to understand negative environmental impacts of land use while maintaining economic and social benefits. Recent maps of land cover and land use have been generated for Africa at the continental scale from coarse resolution data (e.g. MODIS, Spot Vegetation, MERIS, and Landsat). In these map products, croplands and rangelands are generally poorly represented, particularly in semi-arid regions like Karamoja. Products derived from coarse resolution data also fail at mapping subsistence croplands and are limited in their use for extraction of land-cover specific temporal profiles for agricultural monitoring in the study area (Fritz, See, & Rembold, 2010). Given the subsistence nature of agriculture, most fields in Karamoja are very small that care not discernible from other land uses in coarse resolution data and data products such as FAO Africover2000. product derived from 30m Landsat data is one such product. There is a high level of disagreement and large errors of omission and omission due to the coarse resolution of the data used to derive the product. In addition population growth and policy changes in the region have resulted in a shift to agro-pastoralism and systematic expansion of cropland area since 2000. This research will produce an updated agricultural land use map for Karamoja. The land cover map will be used for estimate agricultural land use change in the region and as a filter to extract agricultural land use specific temporal profiles specific to agriculture to compare to crop statistics.

| 0152 | Economics of colonial and contemporary land acquisition in Cameroon: contextual impacts of agrarian capitalism on labour supply and livelihoods | Ernest Molua, Assoua Joe | Cameroon |

Cameroon is characterized by large amounts of arable land and potentially suitable land. The rapidly increasing population and growing industrial base has implied increasing need for fertile arable land to meet food and raw material needs. However, inaccessibility to productive land and threats from competition by large multinationals on fertile land has compounded the agricultural production challenge in the country. The German colonization of Cameroon (1884 – 1918) and subsequently as a British and French protectorate (1919 – 1960) Cameroon witnessed the seizure of prime agricultural land for the establishment of capitalist plantations for the production of export crops (Banana, Rubber and Oil palm) in its Southwestern region. In line with the colonial land grabs, there has been a recent surge on land acquisition. This paper examines large-scale land investments in Cameroon and how it affects economic growth and development. The paper evaluates the socioeconomics of plantation agriculture established in South-western Kamerun in 1900 as a German colony, and later managed by the British from 1918 to 1950s, and since 1960 when these plantations became a single government-owned enterprise - the Cameroon Development Corporation. The trends, threats and opportunities are reviewed using historic data on the colonial acquisitions and contrasted with preliminary data on recent large-scale land acquisitions in the country collated from diverse published sources. While the colonial estates pulled labour from other regions of the country and improved the livelihoods of locals and migrant labourers, there have been rancorous debates whether this were meaningful opportunities in the country's economic history. The paper proffers solutions of best practices on international land acquisitions that may lead to

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sustainable development. The current analysis draws lessons on the risks and opportunities associated with contemporary large-scale land acquisitions, with a number of practical considerations to take into account to accommodate recent land acquisitions.

| **0154** | Sustainable development goals with a focus on land and soil: Guatemala as a case study | Ivonne Lobos Alva | Germany |

Soil and land resources will likely form part of the final set of Rio+20 Sustainable Development Goals (SDGs), as an individual SDG or as a target under a goal for food security and sustainable agriculture, which has created momentum to initiate discussions on the need to develop clear indicators; on necessary implementation mechanisms; on supporting governance instruments; and on the role of public participation. Guatemala makes for an interesting case study in this regard as it was one of the first two countries to support the proposal by Colombia to create the SDGs and at the same time faces some of the biggest challenges in the region in terms of food security, inequality of land distribution, poverty and overcoming the effects of a 36-year long civil war. The lessons learned from implementing the Millennium Development Goals (MDGs), a similar process to set and implement global goals reaching their target date in 2015, have provided a framework which can help guide the process of design and implementation of SDGs in terms of soil and land resources. These lessons include the need for tailored indicators that respond to the different meanings attached to soil and land resources, a domestication of targets and indicators into national policies and programs, the inclusion of relevant stakeholders to jumpstart changes in behaviors, and the introduction of an open dialogue with all concerned groups that can lead to common strategies and solutions.

This presentation will provide an overview of the effectiveness of international development and sustainability goals and national policies in Guatemala with regards to land and soil resources. The focus is on the priorities expressed by national stakeholders from government, NGOs, universities, farmers and rural community members on what aspects and uses of soil resources should be considered and how this priorities clash with existing international goals and national policies.

| **0161** | Crop enhanced index for soy monitoring in the crop/year 2011/2012 in the context with soy moratorium | André Luz, Joel Risso, Marcos Adami, Bernardo Rudorff | Brazil |

Brazil is a major producer and exporter of soybeans on the world stage. This paper presents a methodology based on vegetation index (CEI - Crop Enhancement Index) derived from multitemporal data EVI2 (Enhanced Vegetation Index) MODIS sensor, in order to identify quickly the soybean acreage under the Soy Moratorium on the crop/year 2011/2012. The proposal is to use the CEI images, derived from pictures of MaxEVI and MinEVI. Although the proposed methodology is to be used in soybean crops, can also be considered of high importance to detect and map other major crops, since their agricultural calendars are well defined and known.

| **0167** | Cultivated land loss and its impacts on national food security from 1990 to 2010 | Wenfeng Chi, Wenhui Kuang | China |

Since 2011, over half of the population lives in urban areas in China, for the first time that urban population exceeds rural population. The rapid migration from rural to urban areas accelerated the land transform from rural to urban landscape at the expense of fine-quality agricultural fields surrounding the urban regions. The improvement of quality of life also requires more supply of foods. It is a challenge for China to support the huge population with agriculture lands per capita that is less than one third of the world's average level.

This study employed time series national land cover datasets between 1990 and 2010, which were developed from Landsat images with the computer-aided interpretation, for examining spatiotemporal

patterns of cultivated land loss and its impacts on food security at national and regional scales. Timely and precise monitoring of China's urban development is significant on decision-making using Remote Sensing methods. The study found China has accelerated urban sprawl in the 21st century compared with that in 1990s. China's urban expansion increased by 2.26×10^4 km^2 from 1990 to 2010, of which 73.61% were converted from croplands. Average urban expansion rate in the period of 2000-2008 was doubled than that in the 1990s due to implementation of the national macro-land development policies since the year 2000. The coastal region showed mainly the concentrated urban expansion with an average annual rate of 780.47 km^2 comparing with central, western, and northeast regions with average annual rates of 233.95 km^2, 191.41 km^2, and 51.36 km^2 respectively. Western region had experienced higher urbanization rate in the early 21st century than in the 1990s due to the implementation of China's "Western Development Strategy". The 21st century witnesses a faster and more dispersed urban expansion mode than in the 1990s. New urban sprawl patterns have emerged from megacities to its surrounding medium and small cities. The rapid land transformation from rural to urban poses new challenges to national food security.

China's cultivated land loss obviously has regional differences. The advantages of geo-location and low-cost shipping made the east coastal regions higher urban expansion rates than any other regions, in the meantime resulted in a large loss of agricultural land. The over-expansion in such megacities as Beijing and Shanghai accelerated the conflicts between resources, environment and transportation, resulting in rapid urbanization of the medium and small cities surrounding the megacities. However, the urban land use has poor efficiency and unsuitable inner structure due to the driving of economic benefits which lead to unordered sprawl. The policies on protection of agricultural lands in China played an important role in prohibiting disordered urban sprawl and in protecting fine-quality agricultural lands. It is urgent to solve the conflicts of benefits between central government and local governments in decision-making of urbanization and regional development, in order to improve the urban land use efficiency by intensive management and improvement of inner urban land use structure for urban sustainability.

| 0169 | Interrelations of agricultural policy and ecosystem services | Klaus Wagner | Austria |

In some national and international projects the Federal Institute of Agricultural Economics in Vienna examined the effects of agricultural management on the landscape and ecosystem services on the background of the development of agricultural policies. The presentation shows which ecosystem services are influenced by agricultural land use and management and what are the positive or negative aspects for the society on the one hand and for farmers on the other. One example shows that agricultural land use can contribute to water retention to avoid floods - of course only for a certain amount - by implementing environmental measures which are partly already offered to farmers in rural development programs.

Another example shows that negative climate change prospects of water scarcity can be lessened by specific agricultural land uses. Various potential steps of interventions are summarized - depending on the workability of climate change prognosis. In addition the economic effects of adaptation measures for farm enterprises have been assessed (Wagner, K.; Neuwirth, J.; Janetschek, H. (2012). Lower profits and higher management costs have to be taken into consideration and are compared to situations with or without negative weather incidents. In other examples the pattern of functions of agricultural areas like production, resource protection, recreation, diversity or spatial structuring have been estimated on the background of different agricultural policy periods. An overall view of these project-results can raise the awareness of the influence of agriculture and agricultural policy on the landscape and its functions or ecosystem services.

| 0171 | Land use changes and their Impacts on ecosystem services in peri-urban zones in Himalaya | Prakash Tiwari, Chandra Bhagwati | India |

NUMBER	TITLE	AUTHORS	COUNTRY
		Joshi	

Himalaya represents tectonically alive, economically underdeveloped, and the most densely populated mountains. Forest based subsistence agriculture constitutes main source of livelihood even though the availability of arable land is severely limited and productivity is poor. During recent years, Himalaya has experienced rapid urban growth mainly due to population increase, enhanced transport connectivity, development of tourism, economic globalization, improved access to market, and due to lack of effective land use policy. As a result, urbanization has emerged as one of the major drivers of environmental change in Himalaya. Besides emergence and growth of a large number of new urban centers, existing towns are rapidly increasing both in size and area transforming peri urban landscape through conversion of forests, rangelands, traditional grazing areas and community land into urban land use. These land use changes are impairing critical ecosystem services in peri urban areas, particularly supply of freshwater, biodiversity, grazing, soil formation, wilderness and recreation and increasing vulnerability of peri urban population to a variety of natural and socio-economic risks (Poudel 2008).

Paper attempts to analyze peri-urban land use dynamics, interpret their drivers and to assess their impacts on peri urban ecosystem services with a case illustration of Kumaon Himalaya, India. Study used high resolution satellite data and field-based techniques for monitoring peri urban land use changes, social survey techniques for interpretation of drivers of peri urban land use changes followed by qualitative and quantitative empirical methods for appraisal and mapping of ecosystem services. Results indicated that speedy urban growth has brought about rapid land use changes in peri-urban zone decreasing forest (7%), wetlands (5%), community pastures (11%) and cultivated land (25%), and transformed traditional agricultural land use and increased built up area (57%) during 1981–2011. These changes have disrupted hydrological regimes and decreased the discharge and availability of water for drinking (25%) as well as for food production (37%), eroded biodiversity (11%), and depleted wilderness and beauty of natural landscape in peri urban zones. Besides, the continued loss of wetlands and forests has reduced capacity of peri urban ecosystems to buffer from extreme weather events, and consequently increased the frequency and severity of extreme weather events, particularly flash floods and landslides by 15%. Since, peri urban areas constitute source of essential ecosystem services both for urban as well as peri urban areas, effective land use policies need to be evolved, and implemented through multi-stakeholder governance process.

0172	Land use changes in Himalayan headwaters and their impacts on water resources: opportunity of integrating multiple actors for sustainable land governance	Prakash Chandra Tiwari, Bhagwati Joshi	India

Himalaya represents tectonically alive, economically underdeveloped, and the most densely populated mountains. Ecosystem services flowing down from Himalaya not only support livelihood of up-streams communities but also sustain subsistence agricultural economy in down-streams. During recent years, variety of changes have emerged in traditional resource use structure in response population growth and resultant increased demand natural resources; economic globalization, growth of tourism, construction of roads and rapid urban development. These changes are leading to land use intensification through rapid changes in land cover in Himalayan headwaters. As a result, natural forests, wetlands and rangelands have deteriorated and degraded steadily and significantly leading to their conversion into degraded and non-productive lands. These changes are disrupting hydrological system of headwaters through reduced groundwater recharge, drying of natural springs and decreased stream flow, and consequently, increasing vulnerability of large population dependent on subsistence agriculture to water, food, livelihood and health insecurity, both in up-streams and down-streams (FAO 2005). Since, ecosystem services provided by mountains headwaters are critical for all actors -- urban population, rural communities, tourism organizations, global market agents and private sectors -- of landscape change, this provides opportunity

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of integrating all stakeholders in sustainable land governance in Himalaya.

Paper attempts to analyze land use dynamics, interpret their driving actors, and to assess their impacts on water resources with a case illustration of Kumaon Himalaya. Study used high resolution satellite data and field-based techniques for monitoring land use changes, socio-economic survey techniques for identification and interpretation of different actors of land transformation, followed by qualitative and quantitative empirical appraisal of water resources. Urbanization, tourism, resource exploitation and road construction emerged as major actors of land transformation decreasing forest (7%), wetlands (5%) and community pastures (11%), and increasing built up area and roads (57%) during 1981–2011. These changes have disrupted hydrological regimes of headwaters and decreased discharge and availability of water for drinking (25%) as well as for food production (37%). Besides, continued loss of wetlands and forests has reduced capacity of headwater ecosystems to buffer from extreme weather events, and consequently increased frequency and severity of extreme weather events, particularly flash floods and landslides by 15%. In view of this, a multi-stakeholder land governance framework has been evolved interlinking all actors involved in land use change processes, and it is expected the proposed action plan will go long way in sustainable development of land resources and restoration of ecosystem services in Himalaya.

| 0173 | Forest cover changes and their impact on freshwater ecosystem in Himalayan headwaters | Prakash Chandra Tiwari, Bhagwati Joshi | India |

Himalaya is one of the few mountain ecosystems of the world still richly endowed with large areas of natural forests. Natural forests consisting of wetlands constitute headwaters of freshwater ecosystems particularly in densely populated rain-fed middle and outer Himalayan ranges. Water flowing down from forested slopes in forms of springs and streams not only sustain life and economy through providing water for drinking and food production in adjoining lowlands but also augment water discharge of snow-fed rivers. During recent past, a variety of changes have emerged in traditional resource use structure in response population growth and resultant increased demand natural resources; economic globalization and rapid urban growth leading to land use intensification and rapid changes in forest cover in headwater ecosystems. As a result, natural forests in Himalaya have deteriorated and degraded steadily and significantly leading to their conversion into degraded and non-productive lands and depleting wetland ecosystem. These changes are disrupting hydrological regimes of Himalayan headwaters through reduced groundwater recharge, drying of natural springs and decreased stream flow, and consequently, increasing vulnerability of large population dependent on subsistence agriculture to water, food, livelihood and health insecurity, both in up-streams and down-streams (IPCC 2007).

Study aimed at monitoring changes in forest cover, interpreting their natural as well as socio-economic drivers, and analyzing impacts of forest cover changes on freshwater ecosystem with a case illustration of Ganges Hradwater in Uttarakhand Himalaya, India. Methodology included monitoring forest cover change by digital interpretation of multi-date satellite data, and interpretation of drivers of forest cover change through comprehensive socio-economic surveys supported by qualitative and quantitative empirical methods, and long-term hydrological monitoring and mapping of streams and springs. Results indicated forest cover decreased 7.36% due to extension of agriculture into forests (4%), and depletion of forests for fuel-wood, fodder and grazing and its conversion into degraded and wastelands (3.35%). Nearly 33% natural springs and 27 km stream-length dried, and stream discharge declined 15% during last 30 years. Consequently, 65% villages are facing severe water crisis, and the headwater has lost 18% irrigation potential due to diminishing of water resources. These changes are expected to have enormous regional implications for fundamental human endeavours ranging from food security, poverty alleviation to climate change adaptation. It is therefore, imperative to analyze all crucial issues related with

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	conservation of forests in an integrated manner by considering forest management as one of the essential components of overall land use policy.		
0190	Uncertainty and the impact of forecast information on agricultural welfare, food security and environmental externalities in India	Roger Cremades, Uwe A. Schneider	Germany

Indian agriculture is strongly affected by variations in the South Asian monsoon, and a seasonal meteorological prediction makes a difference on farming decisions. India has a strong policy towards food security. The current lack of adaptability to climate change of the agriculture in developing countries raises the importance of adaptation policies. Improving yields, seasonal climate forecasting appears as an innovative means to help agriculture adapt to the variability of the monsoon and the extreme events linked to climate change in this region. The information contained in the forecast has several implications. Initially, it has an added value to the welfare of the agricultural sector. Then, better forecast information allows farmers to choose more suitable crops and land use patterns, thereby the same yields can be obtained with less land, thus there is land that can be allocated to other uses, such as food production or biodiversity conservation. Moreover, the influence of forecast information on planting and land use patterns produce different levels of environmental externalities, such as pollution, erosion and variations in soil quality (Shakhramanyan, Schneider et al. 2013). These implications raise the three main questions addressed in this paper. First, what is the whole economic value of the forecast information? Second, how much food can be produced with the land made available? And third, how climate forecasting influences agricultural externalities? Additionally, international trade is considered in different scenarios, which involve the availability of forecasting information for different international actors. An integrated assessment model written in General Algebraic Modeling System with inputs from a coupled biophysical model (EPIC) has been used to answer these questions.

The main contribution of this research relies on the incorporation of uncertainty. By incorporating uncertainty, the results show that as climate variations increase, the agricultural welfare decreases. Besides, the model will show that lower uncertainty makes more land available for other uses, like food production, but the environmental externalities vary in different biophysical contexts. More importantly, the more accurate the forecast, the lower the differences on welfare amongst the climate variation scenarios, demonstrating the importance of the contribution of accurate forecasting to adaptation to climate change. The findings of this study have crucial implications for policy makers, they provide useful insights concerning investment in climate forecasting.

0198	Land management and land use changes in mountain area in transition period of economics	Hukmatullo Ahmadov	Tajikistan

Tajikistan is a mountainous agrarian country and any change in land use management leads to both negative and positive consequences. After Tajikistan has got its independence and civil war (1992) has been accomplished the country faced economic and agriculture problems.

Stabilization of economic has been started since 1997 and it influenced population level of life. The whole land use history can be divided into three periods: before 1925 (before soviet period), from 1925 till 1992 (soviet) and after 1992 (independence period) and every period has its own features.

The dynamics of land use change and its impact on environmental situation and development of country economic were investigated. It was identified that significant negative changes in land use have taken place in irrigated and as well as rainfed areas. Destruction of irrigated and drainage systems has led to increasing of underground water table and secondary salinization process.

Different methods of rational and irrational land management were collected and described. Government politics directed into increasing of land resources productivity and reduction of rural population poverty. Now reorganization of kolkhozes and sovkhozes is being conducted and on their basis peasant farms of

NUMBER	TITLE	AUTHORS	COUNTRY
	different types are organized.		
0206	Vegetation change in relation to species richness and productivity under nomadic use in Mongolian pasture	Noboru Fujita, Reiichiro Ishii, Norio Yamamura	Japan

In Mongolia where pastoral nomadism is the main industry for livestock production, livestock grazing is the main land use and affects vegetation change in relation to species diversity and productivity. Mongolian vegetation changes from taiga forest to dry steppe via steppe along moisture gradient from north to south. Water dynamics based on precipitation and evapo-transpiration also affects vegetation change. To assess effects of livestock grazing and precipitation, we conducted a field study including experimental mowing to measure annual production in Mongolian pasturelands.

Species diversity and productivity of pasture decreases generally with decreasing in precipitation from north to south, however, at the same site, moderate (intermediate) grazing pressure by livestock maximizes both species diversity and annual production of pasture. No pasture use by preventing livestock grazing and too much use of the pasture by overgrazing lower the species diversity and production of the pasture. Especially overgrazing that is too intensive and continuous initially increases above-ground annual production due to compensated translocation from underground storage, but after several years, production decreases due to excessive consumption of the underground storage, and species composition of the pasture changes from palatable to unpalatable species. The overgrazing does degrade the pasture vegetation.

The total precipitation during the 15 days prior to the mowing for the measurement of pasture production correlated positively with the mowed biomass of pasture plants at a 3-cm height measured in 15-day intervals, though 10 mm was the threshold for effective growth. Precipitation fluctuates spatially and temporally. Therefore, It is difficult for livestock to graze constantly at one site without migration. In the steppe and dry steppe zones where the climate is dry, precipitation as well as livestock grazing affects pasture vegetation.

Pastoral nomadism is characterized by migration of herders and their livestock. The migration can avoid the overgrazing at the same pasture, and be adaptable to precipitation fluctuation. Mongolian pastures have been not degraded relatively compared with the Eurasian steppe zone of other regions. However, recently, a rapid increase in livestock and lowering of migration under market economy and privatization cause a crisis of the pasture for degradation by overgrazing.

Our results can suggest the future land change of steppe vegetation under livestock grazing by human activity.

0211	Soil moisture management and its implication on plant growth	Antje Fiebig, Ian Dodd, John Quinton	UK

Currently, 80 % of the world's available water resource is used for irrigated agriculture. Improper irrigation practices can lead to waterlogging, which can result in soil oxygen deficiency (hypoxia) and leaching of nutrients. The line between adequate and excessive irrigation is not well defined. Growers try to ensure profitable crop production rather than thinking of possible environmental impacts. This can lead to misjudgement of the plant's actual needs and result in under- or over-irrigation. Through soil moisture monitoring, irrigation scheduling and choosing a suitable type of irrigation, the applied amount of water and its timing can be determined and managed. By automatically scheduling irrigation according to soil moisture thresholds (Delta-T SM200 soil moisture sensors connected to a GP1 datalogger) this work tries to understand the effects of different soil moistures on changes in the soil and plant growth as well as to improve irrigation management to enhance crop quality (uniformity, yield) and decrease costs. Tomatoes (*Solanum lycopersicum* Mill. cv. Ailsa Craig) were grown in a peat-based substrate, and exposed to different irrigation treatments by varying the number of drippers in the pot (1 water deficit, 2 control, 3

overirrigated). Furthermore, soil moisture sensors were deployed in a representative "commercial nursery". Hand-watering resulted in significant variation in soil water content that may compromise crop uniformity and quality. In contrast, feedback regulation of irrigation via soil moisture monitoring provides a useful tool to water plants according to their actual water needs. Overirrigating containerised pot plants grown in a peat-based substrate significantly reduced crop fresh weight, height and leaf area more severely than water deficit. Furthermore, overirrigation led to a higher soil pH and NO_3^- concentration, but lowered Ca^{2+} in the soil. In contrast, water deficit lowered soil pH and NO_3^-, but increased Ca^{2+}. These finding suggest that both overirrigation and water deficit induce severe changes in the soil environment and reduce crop productivity.

0213	Direct and displacement effects of the nagorno-karabakh conflict on land-use	Matthias Baumann, Volker C. Radeloff, Mutlu Ozdogan, Vahagn Avedian, Tobias Kuemmerle	USA

Human suffering from warfare and armed conflicts are severe and receive much attention, but the impact of warfare on land-use change is far less studied. The war between Armenia and Azerbaijan between 1992 and 1994 over the autonomous region Nagorno-Karabakh was one of the bloodiest conflicts in recent history with more than 20,000 fatalities and 1 million displaced people. Here, we analyzed the direct and the displacement effects of the Nagorno-Karabakh conflict on land-use, using satellite data and statistical modeling approaches over the time period 1990-2000-2010. Our results suggested that the conflict had both, direct and displacement effects. For the period 1990-2000 we found widespread farmland abandonment (up to 25%) and settlement destruction in the immediate areas of the major clashes, and new cultivated areas and new settlements afar from the combat zone, primarily on Azerian territory. During the post-war period (2000-2010), previously abandoned farmland was re-cultivated and new settlements were created in the former combat zone. The main drivers were immediate fighting actions, forced migrations of Azerians from the Nagorno-Karabakh region to Azerbaijan, and Armenians controlling the disputed area. All of these were much more important drivers than biophysical constraints for agriculture or forestry. Our study shows that warfare can have multiple effects on land-use not only in the immediate area of the combats but also afar from the actual warfare zone, making these systems hard to predict.
The interplay of warfare and land-use change has not received much attention in the past. Our case study shows how unpredictable land-use transitions can be when the underlying political and socio-economic conditions change rapidly and drastically. It therefore contributes directly to the conference theme I Rethinking land change transitions, specifically to the topic of non-linear system shifts that trigger agricultural abandonment.

0216	Land-cover change and biodiversity in Africa: Do we know what we lose?	Juliana Stropp, Julien Gaffuri, William Temperley, Dario Simonetti, Andrea Lupi, Philippe Mayaux, Andreas Brink	Italy

Agriculture, forestry, and urbanization drive land-cover change and loss of biodiversity in Africa. Monitoring the direct biodiversity loss over long time periods and large areas is often unfeasible. Recently, however, primary biodiversity data from natural collections in natural history museums and herbaria are becoming increasingly available through the Internet. These data allow deriving valuable information on biodiversity loss across Africa. Although collection data offer great potential, they are

subject to limitations. Biases in spatial and temporal coverage and the lack of recent material, may make it difficult to interpret collection data in reference to ongoing land-cover change. To date, it is largely unknown to which extent the biodiversity stored in natural collections can still be found in nature. Here, we provide a timely integrated overview of the historical coverage of herbaria records of flowering plants and of the loss of natural vegetation in Sub-Saharan Africa. We aim at contributing to the debate on "Impact and Responses" addressed by the GLP 2014.

We retrieved from the Global Biodiversity Information Facility (GBIF) in October, 2012 3,258,622 herbaria records representing 95,043 taxa names. After applying standard procedures of data cleaning (e.g., excluding records with geo-referencing errors), we obtained a final dataset with 820,137 records representing 34,647 species names, which were collected between the years 1709 and 2012. For analyzing land-cover change, we used two land cover datasets comprised of samples of Landsat scenes in Sub-Saharan Africa. The first dataset is composed of 57 Landsat scenes, from which nine 20 by 20 km samples per scene were extracted for the years 1975 and 2000. The second dataset comprises samples of 10 by 10 km extracted from 2,045 Landsat scenes for the years 1990, 2000, and 2010 (Mayaux et al. 2013). The two datasets were classified according to five classes of land cover. For every sample in each year, we obtained the number of records, number of species, and year of collection. We then estimated the spatial coverage and number of records occurring in areas that have been subject to loss of natural vegetation. Our results indicate that flowering plants are poorly represented in herbaria over vast areas of Africa. Gaps in botanical collections overlap with land-cover change, for instance, in the coastal Zambezian region in Mozambique. We suggest that areas, which are poorly represented in the herbaria but are subject to intensive land-cover change, should be the focus of biodiversity research and conservation interventions.

| 0238 | Optimal conservation planning of multiple ecosystem services under land use and climate changes in Teshio river watershed, northernmost of Japan | Min Fan, Hideaki Shibata | Japan |

Most impacts on providing ecosystem services (ESs) are related to land use and climate changes that may cause loss of ecosystem functions. Effective information regarding ES responses to land use and climate changes provides useful support for decision making in ecosystem services planning, management and policies. This study integrated the approach of spatial explicit ESs (water yield, inorganic and organic nitrogen (N) and sediment retention) by using hydrology and material flow model (Soil and Water Assessment Tools, SWAT model) into system conservation of multiple ESs according to land use and climate changes in Teshio watershed located in the north of Hokkaido, Japan. We investigated the spatial patterns and the hotspots of ES changes to determine the spatial pattern of changes in system conservation optimal area of ES protection (sub-watershed level) in terms of ES protection targets.

Our results indicated that various land use and climate changes scenarios had different levels of impact on ES and system conservation in the watershed. The forest land use change significantly affected on the water yield, sediment and N retention. The decrease of forest cover increased the water yield, but decreased the retentions of sediment and organic N. The increase of crop land use increased the inorganic N load from soil due to the increased fertilizer N input larger than crop N uptake and soil N retention. Climate changes (i.e. precipitation and temperature changes) were predicted to provide much impact to increase the water yield, sediment load and total N load compared to the impact by land use change. We applied the system conservation model to optimize the area for management of multiple ESs satisfied the protection targets in each ecosystem service. The model indicated that the area of spatial optimal ES protection for multiple ESs were totally different from those for single ES. The area of each ES protection to satisfy the ES protection target increased with the decrease of total ES under land use and climate

changes.

The proposed approach provided useful information to assess the responses of ESs and system conservation optimal planning units under the land use and climate changes. The system conservation optimal area of ES protection for multiple ESs provided an effective trade-off tool between environmental protection and economic development.

0240	Modeling the impact of land use and cover changes on evapo-transpiration	Liu Zhengjia	China

The variation of surface energy balance is an essential reason to global climate change, and plays an important role in the study on climatic change. Land use changes altered land cover to further change surface energy balance. To some extent, the change of surface energy balance is caused by land cover changes arousing albedo changes. For this reason, this study attempted to model the impact of land use and cover changes on evapo-transpiration (ET), basing on Penmon-Monteith equation (PMe). In PMe, net radiation (Rn) played an important role and it decided by net longwave radiation (Rnl) and net solar radiation (Rns). Rns is the fraction of the solar radiation (Rs) that is not reflected from the surface, and its value is (1-a)·Rs, where a is albedo. The albedo is highly variable for different surfaces (or land cover types). In this study, we used meteorological data from China Meteorological Data Sharing Serving System (including daily data of mean temperature, maximum temperature, minimum temperature, wind speed, relative humidity and sunshine hour) and MODIS imagine from United States Geological Survey (including LAI and albedo, the spatial resolution of 1km and the temporal resolution of 8 days) during 2001 to 2010 to explore the impact of land use and cover changes on ET. The 2000 and 2005 of land cover data were got from Data Center for Resources and Environmental Sciences. Firstly, Meteorological data were interpolated to the spatial resolution of 1km grid using ANUSPLIN4.3 software and DEM data. Secondly, the mean annual albedos of different land cover types were counted respectively using the albedo imagine which is the spatial resolution of 1km and the temporal resolution of 8 days, and further established look-up table to correspond to various land cover types. Thirdly, we used a C program to model ET in China, based on PMe and the above data. And ET in different land use and cover changes was counted and analyzed. **(319 words)**

0246	Cultivated land dynamics and its influence on the productivity in recent 20 years in a typical region of the Loess Plateau, China	Wenchao Liu, Changzhen Yan	China

The use pattern of land resources in China change rapidly since the 1980s. Urbanization and ecological restoration impacted on the spatial distribution pattern of cultivated land and that also affected the farmland productivity. Analysis on regional land use changes and its influence on farm productivity are of great significance for the assessment of regional farmland and food security and the planning of regional land use scientifically.

In this study, the typical region of the Loess Plateau, Northern Shaanxi Province, located in the central part for Grain for Green Program of National Ecological Protection and Construction Plan, is taken as the research area. Spatial and temporal series of land use change data, from medium and high resolution remote sensing images (Landsat TM/ETM), in recent 20 years (from the end of 1980s to 2010) was generated by image interpretation. Furthermore, by using GLO-PEM model, AGRO-VPM model and combined with medium resolution and long time series of remote sensing data (AVHRR/MODIS), Net Primary Productivity (NPP) and its changes on cultivated land was accounted. Finally, the response of the cultivated land change on productivity was analyzed.

The result shows that during the first decade of research period, the cultivated area and its productivity in Northern Shaanxi experienced a small fillip, while in the later 10 years both area and NPP were significantly reduced. With a method that reclaimed a large area of grassland and unused land to meet the

food demands of the local population as well as to compensate for the occupation of urban constructions, the area of cultivated land net increased 272.94 km^2 in the first decade. However, for reasons of implementation of the Grain for Green Program, which generated a significantly conversion of a large unsuitable area for cultivation, the area of cultivated land net decreased 12274.22 km^2 rapidly in the later decade. Overall, in the past 20 years, the total area of cultivated land in Northern Shaanxi decreased by 42.56%, and the cultivated land Net Primary Productivity (NPP) dropped 41.90% over the same period.

0251	Understanding the drivers of land use change: the case of the different oil palm cropping systems in Sumatra (Indonesia)	Margot Moulin	France

Agricultural landscapes are primarily designed by farming practices. Farmers choose their farming practices in a balance between strengths and constraints, from local and wider scale as well as from biophysical and human context, following different land use strategies. These different strategies shape the landscapes and drive land use changes with consequent impacts onto the environment (e.g., on biodiversity conservation, soil erosion, water quality). In the last decades, land cover and land use changes have occurred in tropical areas: many tropical landscapes have shifted from forest to agriculture. Large areas are now used for agriculture. This is the case for oil palm plantations that have been increasingly developed to answer the global fat demand. In Indonesia, oil palm plantations are conducted through different farming practices eventually resulting into a wide range of environmental impacts. Understanding and modeling the drivers of the diversity of oil palm farming practices and their associated spatial location within the landscape is then crucial to assess oil palm environmental future impacts and to find possible ways to foster its sustainable development (Verburg et al., 2004). The aim of this communication is then to present a conceptual model of the oil palm growers' decision regarding their oil palm farming practices as a first step to propose oil palm possible futures. The case study is in Sumatera, Indonesia.

While combining interviews of the different oil palm growers (industrial growers as well as independent small scale growers) and available biophysical maps (e.g., of land use, soil type, topography), we intend to understand and identify the main drivers of the diversity of the different oil palm farming practices and to propose maps of them at the grain of the plot.

This presentation will contribute to the wider understanding of land use managers' decision making processes as a way to better assess possible land use futures. This case study will also provide a methodological example that combine stakeholders' in-depth interviews and biophysical maps to model the processes involved in agricultural land uses allocation and their possible changes, which can then help fostering transitions towards more sustainable production.

0252	Monitoring spatiotemporal dynamics of urban expansion in China by integrating nighttime light data, NDVI and LST	Chunyang He, Zhifeng Liu	China

The sustainability of China's on-going urbanization is concerned due to its intensive pressure on resource and significant effect on environment. Monitoring the spatiotemporal dynamics of urban expansion timely and accurately will provide the sound foundation to understand the sustainability of urbanization in China. Although the Defense Meteorological Satellite Program's Operational Linescan System (DMSP/OLS) nighttime light data provide an effective way to monitor spatiotemporal dynamics of urban expansion in China at the national scale, the accuracy was always argued due to its limitation of overglow and saturation. The paper developed one new approach to monitor the spatiotemporal dynamics of urban expansion in China in last two decades at the national scale by integrating three time series dataset of the nighttime light data from DMSP/OLS, the normalized difference vegetation index (NDVI) data from SPOT VEGETATION (SPOT/VGT) and the land surface temperature (LST) data from the Moderate

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Resolution Imaging Spectrometer (MODIS). The results indicated that the proposed approach implemented well to obtain the spatiotemporal urban dynamics in China in last two decades. The integration of the nighttime light data, NDVI and LST could reduce the effect of overglow and saturation of nighttime light data and facilitate the improvement of the monitoring accuracy due to its effective reflection of the physical and social attributes of urban land. The average quantity disagreement and the average allocation disagreement of the extracted urban land were 0.71, 91.00%, 4.19% and 4.81%, respectively. It also revealed that the urban expansion in China in last two decades were tremendous with clear regional discrepancy. The urban land in three coastal economic regions of Eastern Coastal China, Southern Coastal China and Northern Coastal China expanded more faster than other regions of China. How to make urbanization sustainable is becoming one big challenge of China's development at present.

NUMBER	TITLE	AUTHORS	COUNTRY
0257	Payments for environmental services as source of development funding for small-scale farmers in northern Namibia: preliminary results	Nikolaus J. Kuhn, Simon Angombe, Lena Bloemertz, Marianne Böller, Simon Käche	Switzerland

Studies in Africa suggest that improving Soil Organic Carbon (SOC) on cropland soils increases yields, but also offers the opportunity of earning carbon credits. Further potential for earning carbon credits and generating Payments for Environmental Services (PES) lies in an integrated approach to landscape carbon management, including shrubland and pasture used for grazing and timber supply. These studies indicate that funds raised from PES could be used to foster both the development of small-scale farming as well as reducing soil and land degradation in northern Namibia. However, the limited information on soil quality and the rationale for particular soil management and land use practices applied by small-scale farmers in Namibia so far prohibited a conclusive assessment of the potential of Payment for PES as a source of income or fund- ing opportunity for development initiatives in the northern central regions of Namibia. Therefore, the aim of this study is the identification of potential intervention mechanisms to improve the livelihood of small scale-farmers and reducing land degradation with the support of PES in the communal regions of northern Namibia. The work in Namibia aimed at identifying existing soil management and land use practices as well as soil quality, including carbon stocks, on land used by small-scale farmers in the densely populated northern central region. The main objective was to develop an overview of farming practices and soil quality. Four settlements were selected for the field work based on their distance to the urbanized corridor between the regional center of Oshakati and the Angolan border as well as the economic and social background of indivdual farmers. Initial results confirm the potential to enhance C sequestration and to increase productivity on land used by small-scale farmers. The key element for such a development lies in the management landscape carbon stocks, i.e. an intensification farming on cropland while managing grazing pressure and limiting bushland clearance. However, limits to earning PES might be the lack of a market for the crops produced by the farmers, and thus an incentive to shift from subsistence to commercial farming.

NUMBER	TITLE	AUTHORS	COUNTRY
0261	Long-term land cover transitions in a peri-urban area of Nw Argentina	Jorgelina Gutiérrez Angonese, Ricardo Grau	Spain

The intensity and pace of land use and land cover changes have been accelerating in the last decades. Detailed long-term land cover studies allow us to have a complete knowledge of the local and regional processes influencing land cover dynamics. In particular, peri-urban systems are important to understand the interaction between humans-environment because they include components of both natural and highly transformed systems. The peri-urban area of Sierra de San Javier (SSJ)- Great San Miguel de Tucumán (GSMT), in NW Argentina, is considered a dynamic region, including interactions between different types

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of natural and human-dominated land cover units, responding to changes in economy and demographic dynamics. The SSJ-GSMT area is composed by subtropical montane forest and natural grasslands in the mountain area, dry forest in low slopes areas mixed with agricultural uses, areas with extensive agriculture on foothills (sugar cane and citrus plantations) and very fast-growing urban areas. Our objective was to analyze the temporal and spatial patterns of land-cover change in the last four decades, related to urbanization and forest dynamics, as consequence of current socio-economics and demographic trends.

A detailed analysis of land-cover changes allowed us to identify systematics transitions occurred in the study area and characterize the relationships between patterns of change and environmental and socio-economic variables. Expanding urban areas in the piedmont was the most evident change of land cover in the period 1972-2010, occupying agricultural areas. Agricultural uses were relocated in areas suitable for modern mechanized agriculture on flat lands closer to roads, resulting in deforestation of dry forest. Subtropical montane forest area increased in humid mountainous areas and steep slopes. Numerous swaps between categories were observed, representing changes in location of one category and implying a modification of composition and structure of original ecosystems (e.g. secondary forests replacing mature forests) while the total area does not change.

In summary, the SSJ-GSMT system exemplify a process of economic development promoting expansion of cities and agricultural intensification to increase food yields, concentrating activities in more productive lands and allowing forest recovery in marginal agricultural areas, which in turns favors watershed protection and biodiversity conservation in mountain areas.

This work emphasizes the importance of carrying out long-term studies of land cover changes in peri-urban areas to characterize the temporal and spatial patterns of land cover transitions and identifying the socio-economic and environmental processes that influence them. Also, highlights the importance of consider swaps and persistence when evaluates land cover changes, because both have several implications on ecosystems structure and functioning.

| 0265 | A MODIS-based disturbance index model for monitoring desertification dynamics in an arid environment: a case study of Sinai Peninsula, Egypt | Nasem Badreldin, Rudi Goossens | Belgium |

Desertification is one the hazards that face arid environments, which is the process whereby the productivity of land was reduced. Improving a new satellite-based model for monitoring desertification in arid environment will provide useful information for agro-ecosystem conservation. Evaluating the relationship between the land surface temperature and land cover is important for understanding the desertification dynamics. A multi-temporal remote sensing data of MODerate resolution Imaging Spectroradiometer (MODIS) was used for estimating the Soil-Adjusted Vegetation Index (SAVI) and Land Surface Temperature (LST), for the monthly data in the years 2002, 2005, 2008 and 2011. The soil salinity was considered as the major land degradation hazard in Sinai and associated with MODIS-based disturbance index (MBDI), 44 soil samples were collected for assessing MBDI model, strong relationship ($r = 0.79$; $p < 0.001$) was found between the measured data (soil samples) and the estimated values of disturbance (MBDI). The results shown that the mean-maximum SAVI and mean-maximum LST over the case were strongly correlated ($r = -0.88$; $P < 0.001$). The desertification dynamics in the case study were decreased in many sites as a result of agriculture development and land remediation. MBDI is a useful tool to distinguish the difference between the natural variability and instantaneous/non-instantaneous desertification indicators, through monitoring the long-term variation in the ratio of annual maximum composite LST and SAVI on a pixel-by-pixel basis. >

| 0266 | The reconstruction of cropland spatial distribution in Late Qing Dynasty of Songnen Plain | Lijuan Zhang, Lanqi Jiang, Xuezhen | China |

NUMBER	TITLE	AUTHORS	COUNTRY
		Zhang, Xiaodong Yan, Shuang Wu	

Songnen Plain become the fastest development region of human activities in the past century, and has also become the most typical area for the impact of human activities on the land cover change. Therefore, recovering the spatial distribution of agricultural land in Songnen Plain becomes essential for the study of human-environment change.In this study, the spatial distribution map of agricultural land in late Qing Dynasty, Songnen Plain was estimated with the spatial resolution of 1 km using reclamation tendency model and spatial analysis techniques. In particular, the aggregated area of agricultural land at county level in Songnen Plain was estimated using multi-sources historical correction data, correlation model, and the projected human population. The reclamation tendency model was constructed by excluding forest, water body, mountains, and other unsuitable areas of the development of agricultural land. It is designated by factual spacial distribution of agriculture land. With the help of the recovery results, the century dynamic change study of the spatial distribution of agricultural land has also been conducted. And comparison with cropland spatial distribution of 2010 is made. The research results as follow: (1) The total areas of agricultural land of Songnen Plain in late Qing Dynasty is 44077 km2 and the reclamation rate is 20.503%, and it is mainly distributed in the eastern part of Songnen Plain; (2) The areas of agricultural land in Songnen Plain has increased 86686 km2 from late Qing Dynasty to the year of 2010, which is 2.97 times larger than that of late Qing Dynasty. Hundreds of years later, agricultural land is pervasive in Songnen Plain and the reclamation rate is 60.825%. The increased area of agricultural land is located in the whole area of Songnen Plain, but the spatial distribution is diverse: the agricultural land in northwestern part increases greatly and densely, while the middle part, to different degrees, is increased by part. The results provide the most basic historical data for the study of essence and harmonious development between people and environment in Songnen Plain.

0268	Biophysical parameters modification under different LUCC situations in eastern China	Meiting Hou, Xiaodong Yan	China

Green vegetation fraction (GVF) and surface albedo are important biophysical parameters for validating climate and land surface models that largely influenced by environmental gradients and human activities. In this study, GVF and albedo derived from Landsat TM/ETM+ images and MODIS products at different spatial resolutions were investigated in different land use and cover change (LUCC) situations. The Greater Guangzhou and the Baiyang Lake region located in eastern China were selected. The two studied areas respectively represent rapid urbanization area and agricultural production area. The results show that LUCC and the associated fragmentation/ homogenization processes had obviously changed vegetation cover and surface albedo in the two areas during the period 1990-2006. There was a GVF threshold of approximately 0.21 associated with the change in the relationship between albedo and GVF in the Greater Guangzhou from 1990-2000. The pattern of surface albedo decline from urban center to natural land was detected in the Greater Guangzhou. However, the GVF and albedo show complex changes due to the decrease of cultivated land and the level of landscape fragmentation in the Baiyang Lake region. It is indicated that surface energy balance influenced by albedo could result in different climate responses to LUCC.

0271	Trends and patterns of N wet deposition in NE Spain for the last 3 decades	Rebeca Izquierdo, Laura Aguillaume, Marta Alarcón, Anna Avila	Spain

Human activities have strongly perturbed the N cycle over the last century by increasing the emission, transport and deposition of reduced and oxidized nitrogen (N), mostly in the northern hemisphere. Upon

recognition of the effects of N deposition on eutrophication and acidification of terrestrial and aquatic ecosystems, protocols were launched under the Convention on Long-Range Trans-boundary Air Pollution of the UNE-ECE to revert this situation (Bull et al. 2001). The implementation of these protocols resulted in decreased N emissions and deposition in several countries in Europe in the last 20 years. However, Spain followed an increasing trend for NH3 and NOx emissions (24-21% respectively from 1990 to 2006) and only very recently it seems that emissions start to stabilize. While the need to monitor these trends is widely acknowledged, very few studies have up to now been undertaken in Spain to study the origin of the air masses carrying and depositing N and the time trends in N deposition.

To fill this gap here we characterize the synoptic climatology and long-range transport of N pollutants at a rural site in Catalonia (NE Spain) for a 3 decade span (1983-2012). The objectives of the work are: 1) to determine the source emission areas that influence this site, 2) distinguish between local and long-range transport, and 3) analyze time trends, either for annual totals or differentiated by provenances. The latter allows for an evaluation of the results of the abatement measures in the various regions affecting the study site.

These objectives have been tackled: 1) by cluster analysis and the application of a source receptor model to weekly wet precipitation data collected at La Castanya (Montseny, 41º 46'N,2º 21'E, 700 m asl) for the spatial analysis and 2) the analysis of Kendall tau time series for the temporal analysis.

This presentation contributes to the session on "Cascading interaction of global and long-term nitrogen cycles in coupled human and ecological system" by providing an evaluation of spatial connections between source emission and receptor sites. It also evaluates the role of current control measures in abating N deposition.

0276	Carbon stock and tree diversity of dry-zone homegardens in Southern Sri Lanka	Eskil Mattsson, Madelene Ostwald, S.P. Nissanka	Sweden

Traditional land-use systems such as tropical homegardens hold a large potential for climate change mitigation and adaptation due to their multi-functional role in providing income and ecosystem services while decreasing pressure on natural forests. Although, the importance and recognition of homegardens has been highlighted for their large potential in carbon sequestration, tree diversity and functioning there is still lack of quantitative data on homegardens and their contribution to climate change mitigation.

In this study, tree diversity and above-ground biomass carbon of woody species was estimated on a local level around the village of Beralihela in the dry south-eastern part of Sri Lanka. A total of 45 homegardens were sampled on size, floristic composition of trees, girth at breast height (GBH) and height of trees. In total, 4278 trees were sampled and 82 different tree species were recorded. The Shannon Wiener index used to evaluate biodiversity ranged from 0.76–3.01 with a mean value of 2.05. Using allometric models, we find a mean above ground biomass carbon stock of 13 Mg C ha^{-1} with a large range among homegardens (1–56 Mg C ha^{-1}, n=45) due to a variation of tree diversity, species and composition between individual homegardens. Per unit area basis, above ground carbon stock was higher in small homegardens (26 Mg C ha^{-1}) than medium (9 Mg C ha^{-1}) and large (7 Mg C ha^{-1}) homegardens due to a higher tree density. The results of this study contribute to closing the knowledge gap of the less studied dry-zone homegarden agroforestry systems and their function in storing carbon and provide multi-functional benefits to its users. The results are also useful for the national process of whether homegardens should directly or indirectly be considered to be included as an activity within Sri Lanka's newly commenced UN-REDD National Programme.

This study shows the potential of using tropical homegardens for future land-use planning and multiple benefits including carbon sequestration potential, particularly in terms of land scarcity and climate mitigation options. The concept of homegardens in Sri Lanka also provides interesting aspects to the

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	debate and future research in terms of forest definitions and general sustainability. Therefore, this study is most relevant under session 0052: "Tree cover transitions in tropical landscapes: hypotheses and cross-continent synthesis"		
0278	Tree management in cocoa agro forest of South West Cameroon: implication for livelihood and carbon stock	Sonwa Denis J., Ewane Nonga Nathalie Sariette, Nkongmeneck Bernard-Aloys, Gockowski Jim	Cameroon

Cocoa agroforests are reservoirs of trees species diversity, vital for livelihoods and constituting an integral part of rural economies. The farming practices of cocoa agroforests involved the conservation or the integration of trees either simultaneously or sequentially with cocoa. However the increasing demand for fuelwood, non timber forest product and timber has greatly affected the practice of leaving trees on farms resulting in deforestation. Trees in cocoa agroforest provide carbon stock and have a potential of mitigating climate change.

The objective of the presentation is to present the tree diversity and carbon stock in cocoa agro forests of south west Cameroon. The study has been carried out in 120 plots of 25m x 25m from 30 cocoa agro forests. Results obtained showed that local trees species or indigenous species store 68.4% of carbon for 31.6% carbon stock from exotics trees species (introduced in Cameroon). Local plants (indigenous trees) are used for the needs of farmers and at the same time contribute to carbon storage.

This presentation contributes by giving out some of the solution to mitigate climate change. Thus cocoa agro forests of the south western Cameroon stored 126.9 Ct/ha; *Ceiba pentendra* stored 25.3 Ct/ha (13.5 %) of the total carbon. *Albizia, Irvingia, Terminalia* and *Pycnanthus angolensis* are the common indigenous trees found in the south western cocoa agro forest in Cameroon. This quantity of carbon can be used to mitigate climate change and will enable smallholders to participate at the PES (Payment for Environmental Services). Knowing the theme**,** impacts and responses will present land systems changes to mitigate global environmental change impacts and adapt to increasing demands for food, fuel and ecosystem services, this presentation also shows how the Smallholders tried to take into account their context in maintaining indigenous species in the cocoa agro forest that satisfies their needs in terms of health, nutrition, income etc ... This enables the completion of ecological functions such as conservation of biodiversity, but also carbon sequestration and income diversification.

Therefore is a valuable opportunity that will allow to: (i) Share my experience to-date in agro forestry with the participating research and research members, (ii) share what is already known in carbon stock in my country, and (iii) Learn how to share lessons from participatory activities on climate change with the national and international community.

| 0280 | Global deforestation of tropical forests and role of forest communities' economic activity in forest monitoring and preservation | Elena Mechik | Germany |

Objective of this presentation is to show the role of forest communities in protection of tropical forests against illegal logging. Tropical forests represent natural capital of national and international importance. Despite their importance and efforts of national governments and international community to protect them against illegal deforestation, forests continue being destroyed. A large fraction of forests in developing countries is located in poor areas, where household livelihoods depend on extractive forest uses or wholesale conversion (Sunderland and Ndoye 2004). Challenge of tropical forest preservation coexists with the challenge of poverty inside of tropical forest communities. In this presentation I want to show

how drastic changes in land cover in tropical forest regions can be hindered and managed by tropical forest communities' inhabitants.

Economic activities in forest communities of Brazil, India, and Thailand were analysed based on the concept of sustainable development. Work of forest communities' inhabitants with Non Timber Forest Products (NTFP) is regarded as a possibility to create sustainable sources of income, to protect the forests from deforestation, and to increase wellbeing in forest regions. As result of the analysis, it can be concluded that self-regulated sustainable development in forest communities cannot be achieved by communities' inhabitants without external support. It can be assumed that with help of targeted investments, and legal, organizational and technical assistance it is possible to organize monitoring and preservation of tropical forests and to increase living standards of local inhabitants.

Based on definition of sustainable development and this research, sustainable development for tropical forest community can be formulated as: Creating conditions for maximal welfare for forest communities' inhabitants from small scale forest enterprises with social responsibility and obligatory monitoring and preservation of the forest and its biodiversity. For achieving sustainable development in tropical forest communities, a mathematical model may serve as a basis for motivated and reasoned calculation of minimum required initial investments and as scientific justification for policy decisions on allocation of corresponding investments into development of tropical forest communities' economic activities. Analysis of economic activities of tropical forest communities reflects the general trend of economic organization which allows achieving sustainable development of society.

NUMBER	TITLE	AUTHORS	COUNTRY
0282	Spatial and temporal distribution of ground cover and its relationship with SOC distribution and soil loss in two olive grove catchments with contrasting soils	Encarnación V. Taguas, Karl Vanderlinden, M. Gema Guzmán, Aura Pedrera-Parrila, María Burguet, Tom Vanwalleghem, José A. Gómez	Spain

The role of ground cover in soil protection as well as improvement of soil properties is well-known. However, establishment of efficient ground cover systems in Mediterranean agricultural systems, such as olive groves, where the climatological features and the impact of management operations limit its development, is still a challenging matter for farmers and soil conservationists. The described benefits of cover crops in olive groves are mostly based on small scale studies where full ground cover by the cover crop is relatively easy to obtain, whereas preliminary observations suggest that ground cover by cover crops might be extremely variable in orchards at landscape scale.

This study presents a preliminary analysis of the spatial and temporal distribution of the spontaneous ground cover, consisting mainly of grasses, observed during 2011-2013 in two catchments of 6 and 8 ha, with contrasting soils (Vertisol and Cambisol), dedicated to olive farming. In addition, relationships with meteorological attributes, soil organic carbon (SOC) and soil loss are evaluated. The olive yield in both farms differed notably (7000 kg ha^{-1} versus 1000 kg ha^{-1}), although both used similar deficit irrigation systems. The soil management in "La Conchuela" farm was based on the use of herbicide in the lanes with a selective herbicide to promote the growth of grasses, with sporadic chisel tillage in compacted spots when necessary. The grass is mechanically killed in June. In the other farm, "Arroyo Blanco", the management operations are almost inexistent and the spontaneous grass cover is allowed until mid-spring, when it is also mechanically killed by several tractor passes.

Ground cover degree was evaluated by field surveys (4 per year) with an approximate density of 4

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samples/ha by photos of an area of 0.25 m^2. In addition, rainfall, runoff and sediment yield have been measured since 2005. Finally, measurements of SOC following a regular grid, parallel to tree rows with 5-8 samples/ha, were carried out in the catchments during the years 2011 ("La Conchuela") and 2012 ("Arroyo Blanco")

In this work, the main limitations to develop an efficient ground cover, its influence on the SOC distribution and its role on soil erosion control will be described. The influence of ground cover patterns on SOC and soil losses might constitute key tools as indicators of soil quality and of carbon sequestration potential. This is especially significant for olive orchards in Mediterranean environments in Southern Spain.

| 0290 | Linking farmer's decisions with land system change: a survey approach | Qiangyi Yu | China |

Agricultural systems are the complex, human-managed land use systems intended to provide goods and services for human development. Understanding the complexity of agricultural systems requires both a systems perspective towards land use and insight into the human-environment interactions (e.g. farmers' agricultural decisions) underlying the system dynamics. However, few existing studies have considered both aspects in an integrative manner. In this case study, we used a survey approach to acquire farmer's agricultural decisions in a typical agricultural region of Northeast China focused on land tenure, crop choice and intensification. We analyzed farmer's decisions and further used them to present the possible patterns and processes of land system change in the study area. It shows that land transfer was fairly common across the study area: farmland acreage per household almost doubled from an average of 1.3 ha by early 1980s to 2.6 ha by early 2010s especially due to urban migration of farmers. The survey also indicates an increase in land transfers over time with a sharp decrease of the average period of land transfer contracts. Crop choice displays a trend of decreasing diversity as several cereal crops such as wheat, sorghum, and millet are no longer grown in the study region and the vast majority of the beans area has been replaced by maize and tobacco since the early 1980s. Land transfers can explain part of these changes, but not necessarily the full change to a dominance of a smaller number of crops at the region level. Irrigation intensity is related to the locations of rivers while agricultural inputs, along with land transfer and crop allocation, show a spatial pattern which is related to the spatial variation in road accessibility and economic conditions.

Our study will contribute to the GLP Conference thematic 2: "Local land users in a tele-connected world: the role of human decision making on land use as both a driver and response to global environmental change" by addressing how to make the best use of survey approach that involves the scientists, decision makers and local land users to work towards agricultural land system change assessments.

| 0296 | Spatially explicit assessment and its' effect on the stakeholders' decisions for rural landscape planning - a case study in Japan | Kikuko Shoyama, Yoshiki Yamagata | Japan |

Over landuse had most influenced biodiversity in the past few decades in Japan, on the other hand underuse of natural resources is a current concern for environmental degradation with biodiversity loss. Depopulation and aging in rural areas have led to reductions in land management and increased abandonment of land, both of which have consequently caused degradation of Ecosystem Services (ES). Because the rural landscape can be considered a key source of food production, cultural, social, and environmental services that benefit society, the government has strengthened measures to maintain multiple ES across rural landscapes. However, it is not clear whether ES trade-offs are being recognized comprehensively in terms of ecosystem management. Decision-makers need to know the social benefits of ES and trade-offs if they are to incorporate public value into land-use management. However, trade-off analyses can be unrealistic in regard to how actual choices are made, and the process of decision-making

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concerning ES trade-offs is a case in point. This study aims to realistically evaluate stakeholder's decisions and to explore how spatially explicit assessment based on biophysical information influence their preferences. The study was conducted in the test site, Kushiro watershed in Northern Japan, as follows:

(1) To identify ES trade-offs arising from land change, we determined land change patterns across the watershed under land use scenarios as well as past changes. The change in ES supply was quantified and mapped based on collected biophysical information including time-series sensing and observation data.

(2) We conducted social survey and field experiment with spatially explicit assessment to assess the perceived values of multiple ES in the area. The social value index was calculated from the respondence to the survey. The index was compared among survey subgroups as distinguished by socio-economic and individual characteristics of the respondents to explore the effect of social contexts and then mapped to define the spatial gaps with biophysical indices.

The presentation contributes to the session theme by suggesting effectiveness of trade-off analysis to communicate with stakeholders.

0301	Effects of land use changes on the evapotranspiration of grassland ecosystems in Northern China	Liangxia Zhang, Jiangwen Fan, Zhongmin Hu	China

Evapotranspiration (ET) is one major component of terrestrial water cycle. Investigating the influences of land use changes on regional terrestrial ET is one key topic in the field of global change research. The grassland in China mainly distributed in northern temperate regions and the Qinghai-Tibet plateau, where are very sensitive to the global climate changes. Thus, it is imperative to understand the spatiotemporal variations of the ET in China's grassland ecosystem and the responses to land use changes. Based on long-term meteorological observations, remotely sensed data, and land use information, we simulated the grassland ET (and its components) in Northern China by using an improved Shuttleworth-Wallace model. The inter-annual variations of ET during 1981-2012, and the spatial patterns together with the underlying mechanisms were investigated. In addition, we examined the effects of land use changes on the ET fluctuations in past 30 years. Since ET is one important component of surface energy balance, the changes of which can impact surface climate at different spatial scales, this work is closely related to the theme of "Modeling biogeophysical impact of land use changes on surface climate" session which we would like to present in "2014 Global Land Project Open Science Meeting".

0303	Mauritius beyond the flows: the metabolic challenge of survival for mono-cultures	Cristina Madrid Lopez, Tarik Serrano Tovar, Juan Cadillo Benalcazar, Zora Kovacic, François Diaz-Maurin, Jesus Ramos-Martin, Richard Aspinall, Mario Giampietro	Spain

The Republic of Mauritius is a small island socio-ecosystem where 80% of arable land is devoted to sugar cane production for export, using 90% of total water consumption. The country relies on international trade for food and energy provision. Sugar cane exports account only for a small fraction of GDP (2.5%). The financial and real estate sectors (22% of GDP) provide the economic surplus necessary for the imports of food and energy sources needed to sustain the population. As such it makes an interesting case

study for the integrated analysis of the connection between the environmental impact and the social use of the nexus elements as well as between the local and the global levels.

For this connection to be made, we assess those nexus elements which are used or produced by societies (water, land, energy, food, money, etc) and which are considered a flow. We also related these with those other elements of ecosystems (water bodies and land cover) and societies (human activity) which are structural, and considered funds. This relation expresses a metabolic pattern that is unique for each level of analysis. This case study illustrates how the Multi-Scale Integrated Assessment of Societal and Ecosystem Metabolism (MuSIASEM) approach can be applied to the analysis of the nexus between food requirements, water and energy use and land systems.

Typically, countries whose food safety relies on imports present a lower level of impact over environmental funds. We show not only how this is not the case for Mauritius, but also test two possible scenarios in order to assess possible responses to the constraints and limits posed by the current development path. Firstly, sugar cane is used for ethanol production for internal consumption in order to reduce dependence on energy imports, which an unsatisfactory decrease of only 30% of imports of fuel. Secondly, sugar cane is substituted by food self production, which would decrease the water use but be unviable due to human activity constraints. Both scenarios highlight the complexity of coupled human-environment systems as metabolic systems. The first one being too

The paper is aligned with the GLP Open Meeting focus on land systems, and particularly Theme 3 on Impacts and Responses. We present a new interdisciplinary approach to the integrated assessment of different dimensions of land systems and human-environment interactions, the multi-scale assessment and organization of the work connecting local land use to global impacts and responses.

0304	Forest harvested areas detection and analysis of the biophysical variables that affect forest harvesting	Kamal Idir	France

Forest biomass is considered as one of the main renewable energy resources able to replace fossil fuels and mitigate climate change by reducing greenhouse gas emissions. The availability of forest biomass resources depends on biophysical characteristics of forest stand level. Reliable methods to assess forest biomass availability are needed to improve the forest harvesting durability at regional level (Gómez et al., 2012). Remote sensing and GIS offer valuable data and methods to assess biomass availability and to help to understand the locations of forest harvested areas (land cover change). We put forward that mapping harvested areas can provide information on the complex interactions between biophysical variables and harvesting decisions.

The aims of this study is to (i) better understand the relationships between geographical localization of harvested areas and biophysical variables that characterize them, (ii) compare and explain differences between private forest harvesting and public forest harvesting and (iii) identify generic constraints and levers for forest harvesting. The study area (5229 km²), Ardennes, located in northeast of France, is characterized by a large number of forest owners (public and privates) using different management practices and harvesting.

The study was organized in three steps. Firstly, harvested areas were detected using photo interpretation analysis and comparison between two time series of aerial photographs (2005, 2010) provided by the French National Geographical Institute (IGN). Secondly, detected forest harvested areas were characterized using geographical information data (e.g. slope, accessibility, stand characteristics, proximity to agricultural area). Thirdly, data mining models based on classification and regression trees were used to understand the relations between harvested areas and biophysical variables that characterize them. By using these models, we have identified generic constraints and levers for forest harvesting.

The preliminary results showed that forest stand characteristics, accessibility, and slopes are the most

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important biophysical variables that determine the location of harvested areas. In addition, the results of regression trees analysis provided a list of explanatory factors of forest biomass harvesting intensity. These factors can be used by landowners and users to evaluate forested area that can be harvested, and to identify constraints and levers for additional harvested areas.

| 0305 | Plant phenological versus meteorological controls on land-atmosphere energy balance and temperature: a case study in Northeast China | Fengshan Liu, Fulu Tao | China |

Land use/cover change significantly affects the climate through biosphere-atmosphere interactions, and their relative importance vis-à-vis meteorological forcing within general circulation models (GCMs) is highly concerned. Using an off-line SiB2 model and method illustrated in reference 1, we evaluated leaf area index (LAI) and meteorological controls (temperature and precipitation) on energy balance components (net radiation, latent heat, and sensible heat), and surface temperature from 2001 to 2010, at one Northeast China site containing three vegetation types (farmland, grassland, and broadleaf and needleleaf forest). Our results demonstrated that variations of LAI had significant correlations with energy balance components and temperature. With the increase of LAI, net radiation and temperature were increased at forest, but decreased at farmland and grassland; latent heat (sensible heat) was increased (decreased) in three vegetation types. Among various meteorological forcing, precipitation had positive correlation with latent heat for all the vegetation.

The differences of LAI among the three ecosystems and their differences of energy balance components were further compared in pairs. Considering the same atmospheric forcing they used, these worse relations demonstrate the influences on energy balance of vegetation physiological factors and height. We found that radiation incident, as source of energy balance components, had dominant control on energy balance components and temperature, compared to LAI; LAI had relatively higher importance than temperature and precipitation in regulating energy partitioning.

Our findings are relevant to land-atmosphere coupling in GCMs, especially considering that LAI variations are a crucial element in land use/land cover change simulations. For the Main Conference Theme: Impacts and responses, it provides an innovative and quantitative tool to recognize the key changes caused by Land use/cover change and energy balance responses to this change are also reasonable due to scientific method.

| 0306 | Quantifying drivers of land system change: remittances, food security and water overexploitation in Punjab | Zora Kovacic, Cristina Madrid Lopez, Juan Cadillo Benalcazar, François Diaz-Maurin, Tarik Serrano Tovar, Jesus Ramos-Martin, Richard Aspinall, Mario Giampietro | Spain |

Punjab is an agricultural state specializing in intensive grain production. The metabolism of Punjab's human-environment system is characterized by overexploitation of water and land and by high outputs of grain production most of which is destined to feed India's large population. Approximately 33% of Punjab's labor force is employed in agriculture, notwithstanding the low value added per hour of work in the sector.

The grain procurement policy causes a lock-in of the system in its role as the "granary of India", preventing Punjab from diversifying not only its economic activities (outside agriculture) but also the

crops cultivated. This situation is tolerated because a relatively high per capita income is achieved in Punjab (compared to other Indian states) thanks to subsidies for irrigation and remittances complementing the direct return of agricultural activities, which is largely determined by the Minimum Support Price established by the central government for procurement grains. These monetary flows entering Punjab from India and abroad are essential for maintaining the economic viability of the region but at the same time aggravate environmental degradation. Overexploitation of groundwater resources and intensive agriculture are leading to a rapid degradation in soil fertility and groundwater quality. This process makes agricultural production in Punjab environmentally unsustainable in the long term.

The link established between bio-physical and socio-economic variables in our multi-scale integrated assessment sheds light on the complex challenges posed by the precarious equilibrium of Punjab. On one hand, grain production is secured at the cost of environmental degradation and of eroding the resilience of the socio-ecological system. On the other hand, a significant decrease in subsidies and/or remittances is likely to have devastating effects on the viability of the metabolic pattern of Punjab, and, as a consequence, also on the food security of India. The multi-scale approach allows us to identify the constraints of the system and the drivers of change and productivity of the current land use system at the regional, national and international level.

The paper is aligned with the GLP Open Meeting focus on land systems, and particularly Theme 3 on Impacts and Responses. The authors present a new interdisciplinary approach to the integrated assessment of different dimensions of land systems and human-environment interactions, the multi-scale assessment and organization of the work connecting local land use to global impacts and responses.

| **0309** | A backcasting framework for inferring ecological and socio-economic thresholds of mountain ecosystems | Sibyl Brunner | Switzerland |

Continuous degradation of ecosystems from the global to the local scale has fostered the development of the concept of ecosystem services reframing environmental resource use by bridging human welfare and the natural environment. But, anchoring ecosystem services in sustainable land-use planning needs operational methods combining dynamic ecosystem modeling and participatory approaches. Given the severity and intensity of ongoing ecosystem changes and related long-term consequences that are hard to predict such methods should identify thresholds of sustainable land-use development while exploring the freedom of planning options with respect to these boundaries. Backcasting has been advocated as an approach for assessing strategies and pathways leading to future visions of sustainable development and for allowing stakeholders to actively examine trade-offs associated with different management strategies. However, despite a long tradition in strategic sustainability planning, quantitative backcasting applications supporting land-use planning processes are scarce.

In this contribution we present results from an assessment of ecological and socio-economic thresholds of land-use development in a mountainous case study based on a backcasting framework. The framework has been developed for a spatially explicit land-use model (Briner et al. 2012) simulating land-use change by linking ecological models, a socio-economic land-allocation model and ecosystem services modules, thus, allowing for exploring combined influences of climate-driven environmental changes and regional socio-economic conditions on ecosystem services. In a first step, observed patterns characterizing the dynamics of land use development in Swiss mountainous ecosystems at different spatial scales are used as guidelines for simplifying the complex model regarding running time while maintaining its ability to predict system behavior. The model is then iteratively and systematically run for testing diverse and multiple trajectories of potential land-use development. In a second step, tolerable future states regarding key ecosystem services levels elicited from stakeholders in a prior choice experiment in the case study area are used to delimit the possible space of solutions and thereby identify thresholds of the socio-

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ecological system in space and time. Results from such an analysis will allow for inferring desirable management strategies for sustaining the long-term provision of mountain ecosystem services.

The presentation contributes to the session by illustrating the application of a quantitative backcasting approach for a mountainous case study region using a complex land-use model involving ecological, economic and social processes. The study can furthermore support the discussion on the potential and limits of quantitative backcasting approaches for sustainable land-use development.

| **0315** | Nineteenth century transformations: commercial flows and changing patterns of land use | Ulf Jonsson | Sweden |

Ulf Jonsson, Stockholm University. Nineteenth century transformations. Commercial flows and changing patterns of land use 1800-2000.

The agro-food world of 1800 and the first decades of the nineteenth century constitute the final phase of the first wave of the European expansion that started in sixteen century. To put it somewhat differently it was the end of the proto-globalization period. Long distance trade in agro-food products was to a large extent confined to high value rather than bulk products. In the early nineteenth century we are still very far from the huge flows of temperate goods, wheat, frozen and chilled meat both beef and mutton not to speak of dairy products like cheese and butter that characterized an increasingly global food system a hundred years later.

The paper discusses to what extent this expansion of cash crop production either in form of large scale plantations or small holder cultivation changed the landscape and reduced biological diversity in a thorough way. To understand the dynamic of these processes and whether the consequences are harmful or not the analysis have to include a focus on power relations, market conditions and the wider institutional framework under which these systems operate.

Local as well as global power relations are in the final count decisive. As long as the global demand for a specific good is expanding, the power of the local population involved weak and lots of land available, the cycle that started with the sugar boom in the sixteenth century is likely to reappear, certainly in different forms.

| **0317** | Simulated regulations of agricultural development on local climate change in Eastern China from 1980 to 2000 | Xuezhen Zhang | China |

Besides emitting greenhouse gas, such as CO_2, CH_4, to produce warming climate, human also regulate the regional climate change through modifying land cover and relevant surface albedo, roughness, emissivity, and so on. To obtain enough food and well welfare, large areas of natural vegetation were converted into cropland in North China in last two decades of 20th century (Liu et al., 2005). Meanwhile, as the response to global climate warming since the early 1980s, local climate warming occurred. However, we know little about the role of agricultural development on local climate change. As the local ground-based measurement contained the signal of global warming and local forcing including land cover changes, the modeling would be an effective way to pick out the regulation of local land cover changes on local climate changes. To reach this aim, we carried out two 20-year simulations with the latest Weather Research and Forecast (WRF) model. One simulation, as the control simulation used the dynamical land surface properties; the other simulation used static land surface properties as in the 1980. Except for the land surface data, both of two simulations used exactly same settings. Thus, the differences in the two simulations represent the regulations of local land cover changes on local climate changes. The results show agricultural development in North China might produce a cooling effect through increasing evaportranspiration. The increased evaportranspiration implicate increase in surface latent heat flux and decrease in surface sensible heat flux. As a result, the cooling effect occurred. This result demonstrates that, as the byproduct of agriculture development, the local response to global climate warming was

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depressed. In other words, in the absence of agricultural development, local climate warming would be more intense than ground-based measurement.

| 0331 | The impact of land use and land cover on climate warming in China | Wu Dan, Quanqin Shao | China |

The global average surface temperature has increased by 0.76 ± 0.19 °C over the last 100 years especially since about 1950. The most important anthropogenic influences on climate are the emission of greenhouse gases and changes in land use (IPCC, 2007). Many scientists now reason that land use practices such as deforestation, intensive grazing, and agriculture may affect regional climate. The temperature in China has increased by 1.2 °C since 1960 supported by continuous measurements from meteorological stations. The objective of this research is to find out the relationship between land use/land cover and climate warming in different climatic zones of China since 1970.

The land use/land cover dataset (1980, 2000 and 2005) was provided by the Data Center for Resources and Environmental Sciences, Chinese Academy of Sciences. It was constructed with classification into six primary categories (Farmland, Woodland, Grassland, Settlement, Water body and Unused land). The temperature data during 1970-2010 of more than 700 meteorological stations over China was downloaded from China Metrological Data Sharing Service System.

Made a 3km buffer of each metrological station and clipped the land use/land cover vector dataset of 1980, 2000 and 2005, and then statistic the proportion of every land use/land cover type in each buffer. The type whose area ratio was more than 60% was chosen to represent the underlying surface type of these metrological stations. The changing tendency of temperature of each type from 1970 was calculated according to the climatic zones.

The temperature gradient of Tropical and subtropical humid zone, Warm temperate humid zone, Middle temperate humid zone, Middle temperate sub-arid zone, Middle temperate arid zone, Qinghai-Tibet plateau zone was 0.28, 0.33, 0.36, 0.45, 0.42 and 0.38 °C/10a. All the zones had an increasing temperature tendency from 1970 to 2010. And the warming trend in the north was greater than in the south. The increasing trend of settlement was the highest, while the trend of woodland was lower than other types in each climatic zone except that in the warm temperate humid zone. These were evidence that land use/land cover had impacts on climate warming in China.

| 0334 | Land use zoning of western Oasis in China - a case study in Ili Prefecture | Zhiyou Liu, Chunling Pu | China |

As China is in the transition of economic development, regional economic development affects the change of land use structure profoundly.The purpose of this paper is to study the land use zoning of western oasis in China, which is conducive not only to the use of advantage of regional land resources, but also to the sustainable development of society, economy and ecology in oasis.

The paper takes the ili Prefecture as the research area. System clustering analysis method is employed. The paper establishes the quantitative analysis model of land use zoning and does the empirical study by the data of land change,socio-economic and ecological statistics in ili prefecture over the period of 2002 to2009.The result reveals that the prefecture can be classified as center town industrial development zone, modern agriculture comprehensive economic zone, ecological tourism comprehensive economic development zone.The different function zones should have different directions of land use which guide the sustainable utilization of land resources efficiently..

The paper takes society, economy and ecology into account,which is beneficial to the reasonable zoning of land use and the realization of the sustainable utilization of land resources.

| 0339 | Impact of cropland expansion on regional climate in China | Xiong Zhe | China |

By using Regional Integrated Environmental Model System (RIEMS 2.0), continuous 22-year simulation

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in China for the period of 1 January 1979 to 31 December 2000 was conducted with ERA-INTERIM reanalysis data as the driving field with two kinds of landuse dataset in 2000,1980 to discuss impact of cropland expansion on climate in China. Change of Surface temperature, precipitation and large-scale circulation was analyzed. The analysis results showed the following: crop expansion in China result in that summer Asia Monsoon and winter Asia Monsoon decreases, and changes of surface energy balance and meteorological elements. In winter surface air temperature decrease with the range of 0.4-0.6℃ in especially, most obvious areas is Northeast China in winter; Precipitation in Hebei province and Sandong Province and parts areas of South China decrease with the range of 10%-20% with expansion of cropland in China; In summer, surface air temperature decrease, with the range of 0.4-0.6℃ in North China ; precipitation decrease in South China with 10%-20% and increase in Center China with 15%-20%; winter precipitation decrease. In general, cropland expansion result in that annual surface temperature decrease in parts of Northwest China and South China, annual precipitation increase in North China and decrease in South China.

| 0346 | The non-linear farm size growth in the United States | Yang Chen, Martha Bakker, Arnold Bregt, Arend Ligtenberg | The Netherlands |

Farms in the United States have grown tremendously over the 20th century. The agricultural sector initially consisted of a large number of small and diversified farms while 100 years later a much smaller number of large and specialized farms remained. Farm size increased from around 40 hectares on average to around 180 hectares per farm. The USDA attributed the growth to factors that on the one hand suppress margins, such as market integration and consumer influence, and on the other hand facilitate farm enlargement (technological development) (Dimitri, Effland, & Conklin, 2005). An interesting observation, however, is that the changes in farm size are non-linear. Farm sizes first underwent small and gradual change, followed by an accelerated growth, after which the speed of change slowed down again (S-shaped curve). Classic economic theory and the drivers identified by the USDA explain the growth of farm size and the consequent decrease in farm number, but they do not explain the S-shaped curve.

The S-shaped curve shows similarities with system changes observed in ecosystems such as 'clear-water to turbid-water lakes' and 'coral-dominated to algae-dominated reefs'. Here, the non-linear system response is attributed to complex system dynamics, which is characterized as being the result of components that interact and which exhibits self-organizing processes because of feedbacks from higher levels. We hypothesize that the non-linear response of farm size reflects the property of a complex adaptive system, and that it comes from the interactions of the system components (farmers) and feedback from higher levels (e.g. land markets). These interactions and feedbacks give rise to a self-organizing process, which may lead to tipping points and regime shifts.

We present an agent-based modelling approach to uncover the internal interactions between farmers and explain the S-shaped growth in farm size. Farmers' behaviours are captured by a set of rules and goals and they interact through links and feedbacks from the system. Mechanisms derived from neighbours' competition theory, relative deprivation theory, and local interactions are explored to explain the empirical observations. The exploration of farm size change is part of a wider research programme on tipping points and regime shifts in land-use systems. Our research provides a spatially explicit example on non-linearity of complex systems and contributes to the knowledge on farmers' behaviour and decision making, regime shifts in social-ecological systems, the drivers and mechanism of historical land-use change, and how they lead to tipping points and regime shifts.

| 0351 | Changes in Oak woodlands and impacts on ecosystem services during the last 50 years in | Teodoro Marañón, María Anaya- | Spain |

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	South Spain	Romero, Carmen Padilla-Díaz, Miriam Muñoz-Rojas, Beatriz Ibáñez, Ignacio Pérez-Ramos	

Oak woodlands and forests occupy about 1,200,000 ha in the Andalusian region, southern Spain. During the last 50 years there has been little variation in the total forested surface (including shrublands) of southern Spain (about 40% of total) but the relative composition has varied strikingly, mainly by the extensive plantations of pines and eucalyptus. Differences in patterns of land cover changes are associated to peculiar environmental and socio-economic dynamics.

Among the main ecosystem services provided by the Andalusian oak forests we can remark the provisioning services such as the production of cork from the *Quercus suber* (about 40,000 metric tons/year), and the production of high quality meat from free-range animals raised in the oak-savannas, called "dehesas".

As regulating services associated to the oak forests we remark their capacity to sequester carbon and therefore to mitigate climatic change. Other important services are the capacities to regulate water and air quality, and to protect soil from erosion.

Cultural services provided by oak woodlands have increased with the increasing demand from urban populations using them for recreation and ecotourism. At the same time, the abandonment of rural areas is provoking a loss of cultural services associated to local knowledge and cultural identity, as well as a deterioration of cultural diversity in sylvo-pastoral landscapes.

In this work we present 1) an analysis of the changes in forested lands in South Spain during the last 50 years, in particular of oak forests and woodlands; 2) an analysis of the changes in abundance of the five *Quercus* species (*Q. ilex*, *Q. suber*, *Q. pyrenaica*, *Q. faginea* and *Q. canariensis*) using data from the Second and Third National Forest Inventories; 3) an overview of the main ecosystem services provided by the Andalusian oak woodlands and forests, their trends and drivers; 4) the main conclusions about the impacts of woodland changes on ecosystem services.

This presentation will contribute to the session 3. Impacts and Responses, in particular to how land change impacts on ecosystem services, with examples of Mediterranean environments in South Spain. Specifically, the session 0177 will be devoted to "Changing land use and ecosystem functioning in the Mediterranean: past, present and future".

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0360	CRAFTY-Sweden: an agent-based model of Swedish land-use dynamics	Victor Blanco Gonzalez, Calum Brown, Mark Rounsevell	UK

Our planet's land surface is today under intense pressure, subject to the demands of a growing human population and to changing patterns of consumption. These demands drive competition for a limited land resource between food producers, resource extractors, nature conservationists or urban developers amongst others. In Sweden, forests are among the country's most valuable natural resources, covering 60% of the country and providing for one of Sweden's largest industries, the forestry sector. This sector is expected to be significantly affected by climate change, in terms of increased forest growth, increased forest damage and biodiversity loss, and ecological responses and adaptation. Additionally, demand is anticipated to vastly exceed the potential supply of woody biomass in Europe up to 2030, putting a very high pressure on Swedish forest resources and likely forcing difficult trade-offs between forestry policy goals. Under such uncertain prospects for forest socio-ecological systems there is an obvious need for

further in-depth studies of potential future forestry-related land use transitions in Sweden, in order to better understand the possible changes in forest service provision. Given the importance of incorporating human behaviour and decision-making processes to the study of such complex socio-ecological systems we resolved to create an agent-based model (ABM) to explore Swedish land-use dynamics.

The focus of this poster will be to present the CRAFTY-Sweden (Competition for Resources of Agent Functional Types - Sweden) model, a new agent-based model of Swedish land-use dynamics, and discuss the empirical applications of this model. The CRAFTY-Sweden model is based on demand and supply of particular services, including ecosystem services. Demand, generated by an assumed non-spatial population, is given exogenously while supply is a function of agent productivities and behaviours, and location characteristics (i.e. capitals). Each cell may be managed by one or several land use agents, which use the capitals available on the cell to provide services according to their associated production functions. At the same time, institutional agents (e.g. governments, forest advisors), which are associated with larger geographic spaces corresponding to their area of influence, can affect capital levels and competitiveness of land use agents in the supply of services, and can limit the types of land-use and hence manager types allowed in particular areas.

This poster shall contribute to theme no. 2 by showing the importance of human decision-making in land-use dynamics. Furthermore, the incorporation of climate change to the model and its important effects on high latitude and altitude ecosystems, such as those happening in Sweden, make this poster relevant to session 0058.

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0365	Greening the cities by integrated governance approaches: local policies to adapt and mitigate climate change effects in urban areas	Torsten Lipp, Tina Gäbler	Germany

The building sector is one of the main contributors to the global greenhouse gas emissions (GHG). The European Commission's 2011 Energy Efficiency Plan considers that the greatest energy saving potential lies in buildings, due to the fact that almost 40% of the final energy consumption takes place in buildings. Responsible for buildings and urban development are local and regional authorities; their policies and decisions lead to greener cities.

The conceptual framework developed within the RE-GREEN Project highlight the many complementary and cross-sector relationships that a wider notion of green building can have on resource efficiency. This utilises a planning-based recognition that once a building is constructed it is inseparable from its greater context of the existing built environment and associated infrastructure - particularly mobility systems.

The project aim is to add to the discussion how multi-level policy can approach green building in new ways to help Europe achieve its unparalleled potential for resource savings. The conceptual framework outlines the three integrated dimensions that account for the diversity of factors that need to be acknowledged: the green buildings dimension, the green urban systems dimension and the green governance dimension. The framework also introduces a series of key factors, many of which relate to more than one dimension. Each of these factors helps to account for the comprehensive perspectives that are part of the overarching notion of green building.

This framework is approved by regional and local partners from seven European countries, which developed individual implementation plans based on comprehensive self-assessment reports. The success of these local and regional implementation plans can be measured by an indicator system which also was developed within the project. This indicator system focuses on the strategies and policies which were set up to foster the greening of cities and regions. Furthermore, good practice examples were identified and described in a way, that the partners can easily take over good ideas and adapt them to their situation. Major findings so far are that the individual conditions of cities and regions have to be considered regarding not only site conditions but also political, social and economic circumstances. Public

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participation and awareness raising are further issues which are as important as comprehensive funding schemes.

The poster will show the integrated and approved governance approach to make the cities greener by implementing locally adapted action plans and an indicator system, which helps to measure the effects of policy instruments.

0370	Explaining interactive exchange in socio-ecological systems using land cover mapping and monitoring	Nidhi Nagabhatla	India

The heightening rate and degree of alternations in natural and managed landscapes calls for a holistic understanding of socio-ecological systems. Understanding multi-level and varied socio-ecological interactive exchanges require a body of knowledge and a mix toolbox (data, models and techniques) to assess and address the drastic land change transitions. An (transdisciplinary) approach that traverses beyond a disciplinary bias by linking impacts and responses in an integrative manner is critical for achieving sustainable land governance. Presented is multi-level land cover mapping and monitoring methodology that focuses on developing transdisciplinary science. In an effort to elaborate on this focus, the paper derives reference from the experience of 'BioDIVA' research project that had an overarching aim to generate transformation knowledge and enable local land users and decision makers to assess the current land cove change situation for devising future land resource strategies. Amid other points of interest in this transdisciplinary implementation, the role of geospatial data, tool and techniques to explain paradox of spatial scales in land cover mapping and monitoring, visualization of spatial patterns of human-landscape interactions and simulation of tradeoffs and tipping points of socio-ecological systems are explicated.

Empirical experience with projects and partnerships offers prospective opportunity to explore intersections in theoretical arguments and practical approaches of sustainable resource management. Projects research understanding was built by spatial assessment of land use change for a tropical agro-ecosystem in South India. Centered on hypothesis that land use cover change is a key structural aspect deeming consolidative explanation, the article draws a schematic layout relating landscape transformation and interactive exchange with a socio-ecological sphere. The highlight is the attempt to integrate perspectives, data and knowledge on land use change of disciplinary experts. Besides, the policy and institutional aspect of land change transition was given due reference for explaining drivers and variability of change and the impact, consequences, responses for human and ecological sustainability.

On one hand, technical advantage of earth observation data :30 m Landsat, 15m Aster data and 0.5m GeoEye was harnessed to derive land use pattern at provincial, sub-provincial and village level and spatio-temporal dynamics evaluated using land change modeler function. On the other, explanation on current status and past trends was shaped based on collaboration and exchange between experts, institutions and stakeholders, through formal or informal discussions and multi-stakeholder workshops. In principle, collaborative transdisciplinary approach can feed in managing socio-ecological systems across manifold disciplinary presumptions of programs aiming actionable research.

0372	Stakeholders' frames: analysis and understanding of environmental conflicts in protected areas: case study of Wadi El Gemal Protected Area/Egypt	Aziza Moneer	Germany

In Egypt there is now a sharp rise in the relative power of protectionist groups and their ability to exert pressures on the government, which is occurring simultaneously with the increasing trend towards democracy and pluralism. This has coincided with a major change in environmental policy since the ratification of Law 102/1983, which provided a legal framework enabling the Egyptian Environmental Affairs Agency (EEAA) to establish, declare and manage protected areas in Egypt. The EEAA has

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declared to date 30 protected areas, and the government plans to increase the number of protected areas to 40 by the year 2017.

However, the establishment and management of protected areas in Egypt have given rise to environmental conflicts which contribute to the cloudiness of the ecosystem management paradigm of the protected areas and impede nature protection efforts in Egypt. In this context, in Wadi El Gemal Protected Area (WGPA) – with its diverse ecosystem services and its management plans, extending across different organizations and encompassing cross sectoral institutional arrangements, there are different types of conflicts among resource users.

The resolution of environmental conflict is difficult in the absence of a clear understanding of stakeholders' interests, values, and relations, and the current/potential tools that organize and shape these relations. Accordingly, it is important to understand how the different stakeholders of WGPA perceive and "frame" environmental conflicts, and to understand how they perceive the structure of WGPA management perspectives. The study uses a prospective frame elicitation based upon interviewing the actors of WGPA to ascertain their perceptions and interpretation of the conflict dynamics and then feed back the frame analysis to parties as a means of helping them forge an agreement or build a consensus about how to mitigate the conflict. With the session's aim to discuss field based experiences that explain the social conflicts triggered by the clash between local peoples and the nature conservation initiatives, I believe my case study provides an interesting example of gaining a deeper insight into the conflict dynamics and reasons. Particularly conflicts are far beyond the single paradigm of conflicting interests among stakeholders and arise from deeper cognitive level and related to power relations and values that are deep rooted in the socio cultural system in any society.

0381	Assessing the role of land use and land management regarding regime shift in drylands	Matteo Jucker Riva, Gudrun Schwilch, Hanspeter Liniger	Switzerland

Regime shifts have been acknowledged as a fundamental aspect of the dynamic of socio-ecological systems. However, its integration in land management planning remains marginal and limited to specific processes in particular environment. Current research approaches, based on mathematical modeling and statistical analysis of spatio-temporal data for specific environmental processes or features do not fulfill the needs of land managers, who are confronted with the challenge of identifying integrated and holistic management strategies to address multiple processes in a specifc area.

The EU-FP7 CASCADE project is looking at regime shifts of dryland ecosystems in Southern Europe and specifically focuses on rangeland and forest systems which are prone to various land degradation threats. One of the aims is to develop a simple, qualitative-quantitative tool to provide land managers with information about the positive and negative impacts of various management options on the ecosystem processes.

Feedback loops, defined as the chains of processes linked by causal relationship that reinforce (positive feedback loop) or mitigate (negative feedback loop) the degradation drivers can be considered as the core mechanism that can "push" the system over a threshold causing a regime shift.

At the local scale an assessment tool is being designed, building upon the WOCAT (World Overview of Conservation Approaches and Technologies) evaluation method, to assess the role of management actions regarding three main questions: How are management actions affecting the feedback loops of the specific land use system? How is the land management affected by changes in the natural and human environment? How is the regulatory framework affecting land use and land management?

Causal loop diagrams are used to quantify and visualize the feedback loops of the land use system and the influence of human presence (in particular past and present land use practices). Threshold values for each process involved in the degradation of the ecosystem can be determined, creating a simple model of the

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dynamic of the land use system and of the role of land management within it.

The model serves as a base to design a specific Geographic Information System to monitor changes in the environment, including possible early warning signals for approximating regime shifts, facilitating the design of adaptive management strategies.

The implementation of the model on 6 study areas in Mediterranean Europe can give new insights about the interplay between land use, land management and regime shifts in these areas.

| 0384 | Impacts of vegetation change on the regional surface climate: a scenario-based analysis of afforestation in Jiangxi Province, China | Enjun Ma, Anping Liu, Yingzhi Lin, Jinyan Zhan, Xing Li | China |

The land use/cover change (LUCC) and greenhouse gas emission are known as the two primary factors that contribute to the global climate change, while the afforestation is one of the most noticeable human activities that affect the climate by influencing not only the carbon sink but also the thermal properties of the land surface. This research accessed the potential effects of artificial vegetation change on the regional climate in Jiangxi Province, China. It is showed that there are more than 40% of the pixels (concretely, 2717 pixels) in Jiangxi province covered by forest. About 30% of the forest area is covered by broadleaf forest and the needleleaf forest covers more than 52% of the total forest area. A comparative analysis was carried out on the future temperature and precipitation of four hypothetical vegetation cover scenarios, under which the forests are deciduous broadleaf, deciduous needleleaf, evergreen broadleaf and evergreen needleleaf on the basis of the simulation with the Weather Research and Forecasting (WRF) model. The results indicate that there are significant effects of the vegetation change on the regional climate. The deciduous forest plays a positive role in decreasing the annual average temperature, while the evergreen forests promote the annual average temperature rise. Besides, the expansion of deciduous forests may result in severe drought in the summer in Jiangxi Province. The effect of afforestation, especially deciduous forest expansion, on average monthly precipitation is significant, while there is slight average monthly temperature change deduced by afforestation. In addition, the deciduous forest expansion may result in severe drought locally in summer in Jiangxi Province. These conclusions are of important policy implication to the future afforestation in Jiangxi Province, China and other regions of the world.

These conclusions are of important policy implication for future afforestation for Jiangxi Province and warning significance for other regions of the world. Generally, changing in natural vegetation cover affects the climate through biogeophysical processes that influence the surface energy, moisture budget and atmospheric composition. The research an important research component for this *Conference Session*, for this research can enrich case study of biogeophysical impact of land use changes on surface climate on regional scale. In addition, the WRF Model a next-generation, limited-area, non-hydrostatic, mesoscale modeling system with a terrain-following eta coordinate is used for our simulation. This can provide methods and tools for the *Conference Session* to study biogeophysical impact of land use changes on surface climate.

| 0390 | Simulating impacts of land use/cover change on regional climate by multi-model ensembles in China | Xianliang Zhang, Xiaodong Yan, Zhe Xiong, Xuezhen Zhang, Ying Shi | China |

With the development in China, land use/cover suffered from great changes in past 21 years from 1981 to 2001. More serious land use/cover changes (LUCC) occurred in southern (reforestation around the Yangtze River), eastern (forest changed to cropland) and central (grassland changed to cropland) China. The changes in land use/cover caused regional climate change which can be simulated by the regional climate models. Different from simulating the climate effect of LUCC by one climate model in many

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other studies, three regional climate models (RIEMS, REG3 and WRF) were used to simulate the climate effects of LUCC in this study. The changes in temperature and precipitation were well simulated by three regional models. However, the simulated climate effects of LUCC were different for three models. In order to reduce the bias of individual model, ensembles of three regional models were calculated. The simulations of three models were ensemble averaged by equal-weight ensembles and Bayesian model averaging. Ensemble modeling showed that the multi-model ensembles obtained better results than any individual model. The simulated results could be improved by equal-weight ensemble means when the individual model had not well performance in some month. The equal-weight ensembles had better performance than individual model almost in every month. Moreover, Bayesian model averaging which give higher weights to the models given their performances in the past obtained much better results than the equal-weight ensemble means in every month. When comparing Bayesian model averaging ensembles to equal-weight ensemble means, the correlation coefficients increased with the decrement in bias and RMSE suggested that the Bayesian model averaging is an effective method used to reduce bias in simulating the climate effect of LUCC. In conclusion, the simulations of climate effects of LUCC could be improved by multi-model ensembles..

| 0393 | Determinant of land management practices: empirical evidence from Ethiopia | Tesfamicheal Wossen | Germany |

Many developing countries grapple with high rates of farmland degradation and low agricultural productivity amidst increasing climate variability. Considerable efforts have been exerted to promote the diffusion of improved farmland management to address these challenges. Despite these efforts, adoption rates especially of soil conservation and water harvesting technologies are still low, which has been the subject of investigation in several studies in Ethiopia and elsewhere (Di Falco & Bulte, 2012; Kassie *et al.*, 2012). Most studies on the adoption of these technologies, however, tend to focus on economic incentives only, paying little attention to social capital and its role in disseminating information, coordinating collective action, and sharing risks. The objective of this presentation is therefore to shed more light on the role of social capital and empirically evaluate the determinants of adoption of improved farmland management. Specifically the presentation explores the mechanisms through which social capital may facilitates coordination among individual adopters when dealing with the spatial externalities of land degradation as well as help individual adopters to overcome their resource constraints, which in turn may be critical for the adoption of improved farmland management.

| 0407 | Management of the climate change in the Carpathian region: impacts on ecosystems and the organisational background | Harald Egerer, Giacomo Luciani, Sandor Szalai | Hungary |

The Carpathian mountains are the second longest mountain chain in Europe and are located in Central/Eastern-Europe. In order to further promote the sustainable development of the Carpathian Region, the Framework Convention on the Protection and Sustainable Development of the Carpathians (Carpathian Convention) was adopted and signed by the seven countries in May 2003, and entered into force in January 2006. It is the only multi-level governance mechanism covering the whole Carpathian area and represents and important institutional framework and platform of cooperation and projects development fro all the stakeholders in the Region. Two Protocols to the Convention are into force (Biodiversity and Sustainable Tourism Protocols) and one has been adopted (Sustainable Forest Management Protocol). Several Working Groups are active in the frame of the Conventions, including the WG on Adaptation to Climate Change (Climate Change). The WGs prepare strategic documents (Protocols, Strategic Action Plans etc…) dealing with the respective areas of expertise. The WGs, as the Climate Change WG, work in cooperation with different projects, in particular EU projects, as CARPATCLIM, CARPIVIA and CarpathCC. The main outcome of the CARPATCLIM project is a high

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resolution, gridded and harmonized climatological (observational) database. This freely available database can serve as a starting point of all future investigations in the Region. CARPIVIA project aims to assess the vulnerability of the Carpathian Region to climate change in combination with other anthropogenic pressures. Based on this vulnerability assessment the project creates an inventory of potential and already implemented adaptation measures. The recognized gaps in these researches are filled by the CarpathCC Climate Change Framework Project project. The CarpathCC aims to provide an in-depth assessment of the vulnerability of the Carpathian Region to climate change and establishes a diversified portfolio of sustainable adaptation measures. This policy decision support study will be produced in close cooperation with the most important stakeholder groups of the Carpathian Convention. Vulnerability of water, soil, forests, ecosystems and related production systems are assessed in order to propose concrete ecosystem-based adaptation measures, including their costs and benefits.

Ongoing work is the development of adaptation measures, which efficiency and impacts on the ecosystems and their services will be investigated in the future.

| 0411 | North American Landsat Albedo Project | Crystal Schaaf, Zhuosen Wang, Yanmin Shuai, Jeffrey Masek, Feng Gao, Christopher Williams | USA |

With the successful launch of Landsat8 in 2013, a new era of Landsat derived products are becoming available that will take advantage of both the enhancements present in the new sensor and the long record of data available from past missions. An albedo product for North America is under development, which will couple 30m resolution near-nadir Landsat surface reflectances with concurrent coarser resolution (500m) MODIS surface Bidirectional Reflectance Distribution Functions (BRDF) products to fully capture the surface anisotropy and produce higher resolution surface albedo than from MODIS alone (Shuai et al., 2011). Albedo, the proportion of solar energy that is reflected by the Earth's surface, is an essential climate variable, and is required for accurate climate, biogeochemical, and surface energy budget modeling studies. This data set will encompass the years from 2001 to present and will utilize atmospherically corrected, cloud cleared Landsat5 and Landsat7 data. While daily MODIS data from Terra and Aqua will serve as the primary source of the BRDF data, Suomi-NPP VIIRS data will also be considered in the later part of the record. Of particular interest will be areas of disturbance, coastal regions, and areas experiencing seasonal snow where the increased spatial resolution of Landsat will allow a better representation of the surface albedo throughout the year. Although the TM and ETM+ data saturates over bright snow, the increased radiometric capabilities of the Landsat8 OLI are also expected to improve cryospheric research in the future. The radiometric fidelity, along with the presence of an additional channel, is also expected to improve coastal studies where tidal effects and complex mixtures of water, sand, and vegetation confound the remote sensing signal. Early results from the project will be presented.

| 0415 | Large-scale land acquisition and food security in sub-Saharan Africa | Chizoba Chinweze | Nigeria |

The growing large-scale investment in land and agriculture in sub-Saharan Africa streams from a combination of factors; ranging majorly from national policies requiring mandatory blending of biofuels in the transport sector- as in the EU and USA, to governments seeking to secure their nations' food security in the face of volatile prices.

The various bioenergy mandates promoted industrial plantations in sub-Saharan Africa for biofuel production. The continual export of biofuel crops will contribute to serious food challenges as most of

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these crops are used as staple food and the effect shall harm the poor households most.

Most nations in the global north in addition to China, India and Arab countries are investing in land and agriculture in the sub-Saharan Africa with the notion of increasing food production; but in real terms these countries are faced with domestic resources constraints, in particular land and water* and hence they look for opportunities internationally to meet their ever increasing demands.

While these approaches of investment will likely improve agricultural production in sub-Saharan Africa, it does not improve food availability or security especially for the poorest in the region as the food produced are ultimately exported to the investing national. The best way to address food insecurity for the poor is emphasising access and not production.

Again these investments are with the expectation of higher long-term returns as the financial powerful nations gets the most quality land, while the natives are either displaced, dispossessed, incorporated into the emerging agribusiness to their detriment or pushed further to non-fertile land, forests or woodland; a threat to biodiversity.

Large-scale investment on farmland according to Olivier De Schutter the UN Special Rapporteur implies huge opportunity costs, with a farming type that will have much less poverty-reducing impact, than if access to land and water were improved for local farming communities**. William Moseley in his post to G8 2012, argued that foreign drive to end hunger in Africa through large-scale agribusiness is deceptive, that helping poor households in rural Africa feed themselves in an affordable manner should means introducing low-cost, sustainable enhancement to farming.

This paper reviews the trends of large-scale land investments in the Sub-Saharan Africa, the consequences on rural livelihoods, agricultural production, food security and developmental challenges.

* SOLAW (State of the World's Land and Water Resources for Food and Agriculture). 2011. State of Land and Water. Rome, Italy. FAO.
** De Schtter, O. 2011. How not to think of land-grabbing: three critiques of large-scale investment in farmland. Journal of Peasant Studies. Vol 38;2:249-279. March 2011.

| **0420** | How the global market for seafood is driving deforestation in the coastal zone of Ecuador and the implications of this transition on blue carbon holdings. | Stuart Hamilton | USA |

This research utilizes established remote sensing techniques, land cover data from 1966 to present, and ethnographic research within a coupled human-environmental systems approach to quantify and explain the LCLU transition occurring in Ecuador's estuaries over the last half century. The analysis attempts to explain the driving forces of the estuarine land cover / land use change (LCLUC) at the global scale, while incorporating local realities and adaptation strategies at the estuarine level that then in-turn feedback into wider global issues.

The land cover / land use (LCLU) within Ecuador's estuarine environments has undergone a significant and rapid transition during the last 40-years. The estuarine land cover has transitioned from one dominated by mangrove forests, swamplands, and estuarine waters to a land cover dominated by growout ponds that are systematic of commercial shrimp aquaculture land use. Across the major estuaries of Ecuador, mangrove deforestation has reached levels unseen in other nations, and approximately 93% of this deforestation is the direct result of shrimp aquaculture growout ponds directly displacing mangrove forest (Hamilton, 2013). Indeed, many of Ecuador's estuaries now contain more aquaculture based land cover than mangrove forests, swamplands, salt-pans, mud-flats, surface water, and all other estuarine land cover combined (Hamilton & Stankwitz, 2012). This LCLUC appears almost entirely driven by the developed and developing world's appetite for farmed shrimp of which Ecuador is the 6th largest global

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supplier (FAO 2011).

The aforementioned estuarine LCLUC has led local communities, traditionally reliant on the mangrove economy for their livelihoods (and food security), to find alternate forms of income and to either resist or integrate with the new export-based aquaculture land use (Hamilton 2013b). Beyond the local implications of this transition, this globally driven LCLUC process likely results in substantial increases in atmospheric carbon and the loss of substantial future carbon sequestration potential. By examining the commodity driven LCLUC occurring in coastal Ecuador further insight is gained into the often complex, and always controversial LCLU transitions occurring within the wider forests of Latin America. The mangrove-shrimp-livelihoods-carbon relationship is an example of how external global demand can result in substantial and rapid LCLUC at the local level. This LCLUC then in-turn results in local responses and mitigation strategies which themselves feedback into wider global issues as diverse as climate change and migration. This global to local LCLUC analysis fits well with the conference theme of land cover transformation as viewed across differing geographic scales in addition to expanding on our knowledge of externally driven LCLUC that is occurring across Latin America and much of the developing world.

| **0425** | Land use change in the Eastern Black Sea Mountains, Turkey | Mehmet Somuncu | Turkey |

The aim of present study is to evaluate changes in land use and function in the yaylas (Yayla: a temporary settlement in mountain pastures; plural: yaylas) of the Eastern Black Sea Mountains, Turkey. For this purpose, four different types of sample have been taken based on a research in 30 yaylas from three provinces of the Eastern Black Sea Region. Both quantitative and qualitative research techniques has used in the study for collection of data. The change in number of homes in the yaylas during years of 1973-2004 has been determined with help of aerial photographs and geographic information system. Primary data have been collected by a household survey during summer of 2010 in which 900 households have participated from 30 yaylas of three provinces. The qualitative data have been collected through personal observations and in-depth interviews with 45 key representatives of local communities. As a result of the analysis it has been determined that pastoralists live in 357 houses and 543 houses are second homes in 30 yaylas located in the Eastern Black Sea Region. The number of second homes in the yaylas has increased respectively during years of 1980-2010. The other change in the yaylas is functional change. The yaylas once primarily used by local people as mountain pastures in summer for grazing activities until the 1980s have been currently used for recreation purposes by amenity migrants and turned into holiday resorts. These changes in land use and function of yaylas have environmental, economic and social effects.

| **0426** | Land use related interventions on the nitrogen cycle | Andrea Schröck, Wilfried Winiwarter | Austria |

Agricultural practices and the use of nitrogen (N) are intrinsically connected. Agricultural intensification always has been an important factor leading to land use change and is also closely linked to the N cycle. With N not only being indispensable for agricultural production, but also responsible for negative environmental impacts, both on the global as on the local scale, exploring options to mitigate N related impacts becomes decisive. Such interventions thus are necessarily connected to land use.

In this paper, we apply a biophysical soil model (landscape-DNDC) to describe N stocks and calculate biosphere-atmosphere-hydrosphere fluxes of N under different conditions of land use. Interventions in terms of smart intensification and extensification in animal husbandry, aimed at optimizing nitrogen use efficiency and closing nutrient cycles, will be tested in terms of their effects on the N flows, and land use related consequences will be identified.

Modelling uses, on the one hand, physical input parameters. Considering relevant soil properties as well as drivers such as climate, the transfer of reactive N compounds between individual environmental pools can be assessed. On the other hand, information on human influence on the land is needed, as parameters

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like animal stocking, N fertilizer input and vegetation are decisively depending on human choice. The understanding on decision making will be taken from a socioeconomic assessment, modeled in a parallel activity over a 200-year time period (Remesch et al., this session).

Application area is the Upper Austrian Enns valley, a rural region featuring a highly diverse landscape. The region mostly covers mountainous area but extends to the Danube valley. Management practice (and –choice) ranges from grazed pasture to harvested grassland and forests while the less mountainous area can also find use as farmland.

In the paper the impacts of human decisions, reflected in the socioeconomic model, on land use and N related consequences (N use efficiency, N application) will be demonstrated. Based on an analysis of past and present agricultural practices, future scenarios will be developed describing the transition of ecosystems as a consequence of land use change (e.g. change from forest to arable land, grassland conversion, reforestation or cultivation of woody bioenergy crop on former arable land). A changing motivation in agricultural management and the resulting effects are depicted in form of land use change and emission mapping. As a result, land use related interventions on the N cycle will be proposed.

| 0427 | Estimating land cover change with remote-sensing products: techniques to reduce error | J. Meghan Salmon, Holly Gibbs, Tyler Lark | USA |

Estimates of land-cover change that are based on differences between classified satellite images are now widely used. These post-classification change analyses have gained popularity, due largely to the increased generation and distribution of national-to-global scale land cover maps, repeated at annual-to-decadal intervals. Unfortunately, post-classification change analyses are prone to magnifying errors and uncertainties in land cover maps and the results may dramatically misestimate change.

True change detection involving simultaneous analysis of satellite images from multiple time periods is the ideal approach to estimate land cover change. However, this full change analysis approach requires significant time, resources, and expertise unavailable to many scientists. Because remote sensing expertise is rare and land cover classifications are commonly available, error-prone estimates of land-cover change based on post-classification analysis will continue to proliferate in the literature until simple techniques for reducing errors are developed and applied.

To address this issue, we review appropriate methods and procedures that can reduce the errors in estimating land cover change using available data products. We include four topics for analysts to consider while performing post-classification change analyses, and include specific recommendations with each topic. First, we clarify the two types of classification time series: independent series (e.g. The MODIS Land Cover Type Product) and change-based series (e.g. Corrine). We recommend specific practices unique to each type of classification time series. Second, we discuss issues of mapping accuracy, class persistence, and rates of change, explaining how each affects post-classification change analysis. Third, we discuss common changes in mapping methods during classification time series, such as spatial and thematic resolution. Fourth, we recommend specific procedures that exploit the spatial and temporal information in classified images to reduce errors when mapping change. These filters and rules are simple to implement in any GIS, and thus have potential to improve the accuracy of numerous land cover change studies. Overall, our recommendations form a guide to assist users of land cover classifications in reducing errors in their post-classification change analyses.

| 0428 | Hotspots of recent agricultural expansion: insights from a global assessment | J. Meghan Salmon, Holly Gibbs | USA |

During the 2000's, market shifts and new policies have changed the pathways of agricultural expansion in some regions leading to reductions in tropical deforestation in some cases. However, the specific nature of these changes is geographically varied and not yet documented. In this work, we harness twelve years of

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global, moderate-resolution satellite-based data sets, in concert with a variety of local studies, to characterize recent pathways of agricultural expansion. The project consists of three components: first, we present a new database of agricultural expansion, 2002-2011, based on global land cover maps; second, we identify the types of land (e.g., forests, grasslands/pastures, and shrublands) converted to cropland; third, we incorporate local-scale studies and ancillary datasets to provide the contexts of recent changes, including the drivers of recent conversion pathways. Throughout, we highlight specific examples, or "hotspots" of rapid agricultural expansion such as the Brazilian Amazon, Indonesia, and XXX

The global database of agricultural expansion, 2002-2011, is based on the MODIS Land Cover Type Product. To account for uncertainty in the generation of these global land cover maps, we employ two strategies: (1) temporal aggregation to remove classifier noise and (2) thresholds based on the probability of cropland presence to remove false change. The resulting maps of land cover change during the 2000's are then spatially aggregated to represent the net agricultural expansion at 5 arc-minute resolution among four temporal segments of the study period.

Moderate-resolution land cover maps, such as the MODIS Land Cover Type Product, are helpful for monitoring large-scale changes in the land surface but miss the detail needed to understand the likely drivers and impacts of the changes. We incorporate higher-resolution information to fill in the gaps. Specifically, we compile local-scale studies of land use policy and land cover change in the vicinities of the selected "hotspots". We also utilize inventory statistics at national and sub-national scales to describe the agricultural and economic contexts of recent changes. In areas experiencing rapid agricultural expansion, these additional data sources provide key information regarding expansion pathways, such as the crop types grown on newly converted lands. Finally, through this synthesis, we compare the apparent effectiveness of modes of reducing agriculture-driven deforestation, providing key knowledge for future policies.

| 0429 | Assessing the state of sustainable land management research in Kyrgyzstan and Tajikistan | Jyldyz Shigaeva, Bettina Wolfgramm, Chad Dear | Kyrgyzstan |

This paper synthesizes findings from a review of the state of research on sustainable land management in Kyrgyzstan and Tajikistan and an analysis of the interface between research and action. Using the Global Land Project (GLP 2005) analytical framework, we analyzed the distribution of 131 selected publications (including local and international academic and grey literature) across the components and links in a socio-ecological system. There is a strong emphasis in the literature on the impact of changes in land use and management on ecosystems, however, there is little research on the implications for ecosystem services. This is the opposite finding of a similar analysis focused on publications at the global scale (Björnsen Gurung et al 2012). Another key gap was the lack of research on Kyrgyzstan and Tajikistan regarding the influence of global factors on social and ecological systems, despite social, economic, and political integration into global structures since the Soviet collapse and the increasing influence of climate change. Our analysis disaggregated academic literature published in the region and international academic literature and revealed stark differences. These differences are partly attributed to the legacy of the late Soviet-era principle of "rational use of land resources," which fit the planned economy, but lacks approaches for decentralized resource governance. Finally, the emphasis of research on system knowledge, the lack of transdisciplinary research, and the critical feedback of stakeholders at a regional sustainable land management forum suggest that actionable sustainable land management research on Kyrgyzstan and Tajikistan is rare. Recommendations are made for targeted, application-focused, multi-stakeholder research and knowledge sharing, including local and international researchers as well as practitioners, policymakers and land users.

| 0433 | Analysising of Beijing urban land expanding and | Jing Wang, | China |

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	impervious surface growing based on the linear spectral mixing decomposition model	Gencheng Su, Wenhui Kuang	

The impervious surface is one of the most basic components of the city, its coverage condition with the change of urban development plays a decisive role in urban local climate, urban hydrology, surface energy flux. Linear spectral mixing decomposition model is a simple and effective method to solve the problem of mixed pixels that exist in urban moderate spatial resolution remote sensing images (such as Landsat). Taking Beijing city as the research area, using the data of Landsat TM 5, extraction of impervious surface in Beijing, combined with the urban land expansion, analyse the relationship between them ,meanwhile, analyse the relationship between the impervious surface and green space. The result indicates that after 2000, Beijing urban land was expanding rapidly . The impervious surface accounted for larger proportion in the expansion land. However, in recent years, The proportion of impervious surface is gradually declining but the greenbelt area instead is increasing.

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0436	Greenhouse gas emission inventory, methodology IPCC 1996, case: state of Mexico, Mexico.	Claudia Alanis, Luis Bautista, Susana Libien, Bibiana Valdes, Pablo Escamilla	Mexico

Mexico is one of the countries non-attached I of the United Nations Framework Convention on Climate Change (UNFCCC or FCCC) which is an international environmental treaty negotiated at the United Nations Conference on Environment and Development (UNCED), promises to elaborate, to update from time to time, to publish and facilitate the inventory of GHG emissions, to the Conference of the Parts, in conformity with the established in the articles 4 and 12. The calculations of emission of Greenhouse gases (GHG) were of Guidelines for National Greenhouse Gas Inventories (IPCC, 1996).

In 2009, the State of Mexico had an initiative of climate change which identify the most vulnerable zones, and establish measures of mitigation for the subsectors of major emission, also implement lines of action before that current phenomenon. The present study had sectors which following the methodology IPCC, 1996 and as year base 2010, they are: agriculture, waste, energy, industrial processes, land use, land use change, and forestry (LULUCF).

The preliminary results observed that the sector that major it issue is the energetic, with 43.81 %, waste 24.21%, industrial process 20.92%, LULUCF 5.64% and agriculture with 5.42 %, which help to take measurements of mitigation and adaptation. On having done the comparison with the information brought by the National Inventory (INEGEI) for 2010, observe that the State of Mexico contributes with 6.6 % of the total emission. The reduction of GHG's emission is a common aim raised by the protocol of Kioto and Montreal, for which, opportunities of mitigation are identified by means of the implementation of projects placed in the clean mechanisms development (CMD), with the emission will reduce in the energetic sector in order to expire with the awkward goals.

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0439	Evaluation of species diversity in Inner Mongolia, China	Lulu Liu, Quanqin Shao, Dan Wu	China

Effect of different land use types on species diversity of the typical steppe was investigated by quadrat survey method in Inner Mongolia steppe. Six treatment plots were devised, including Stipa grandis enclosures, degraded Stipa grandis area, Leymus chinensis enclosures, tame pasture, post fire recovery sample area and clipping pasture. Five quadrats were laid in every treatment plot, and the cover degree and height of every species were investigated, and another ten quadrats were laid to get the species types in them, in order to get the frequentness of every species. The Patric index(R) 、Shannon—Wiener index(H) and Pielou index(J) were chosen to show the species' richness, diversity and evenness. The

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Patric index(R) equals the number of species in every treatment plot. The Shannon—Wiener index (H) equals $-\sum P_i ln P_i$, in which P_i is the relative importance of every species, equals the average of the relative height, relative cover degree and relative frequentness. The Pielou index (J) equals H/lnS, in which S is the number of species in every treatment plot and H is the Shannon—Wiener index. The results showed that clipping pasture's species richness and diversity was highest, followed by Leymus chinensis enclosures, and the tame pasture's evenness was highest, followed by post fire recovery sample area. Stipa grandis enclosures' species richness and diversity were higher than degraded Stipa grandis area, but the evenness was lower than degraded Stipa grandis area, this was because the fact that the Stipa grandis enclosures has lasted more than 30 years, and other research results indicated that enclosures can protect species diversity in some degree, but the length of time should be dependent on the degree of degeneration and recovery state, if the enclosure period was too long, regeneration of grass would be influenced. In a whole, clipping pasture's species diversity was best, followed by Leymus chinensis enclosures and post fire recovery sample area, and the degraded Stipa grandis area was worst.

In order to learn more about land change impacts on ecosystem biodiversity and provide a scientific basis for grassland biodiversity and protection, this research indicated the impact of different land use types and anthropogenic change on species diversity in typical temperate grassland, and the comparative study between Stipa grandis enclosures and degraded Stipa grandis area indicated the effect of enclosures.

| **0441** | Surface latent heat flux change over agriculture-pasture transition zone in China due to land cover change during recent 10 years | Tian He, Quanqin Shao | China |

Land cover change is one of the most important reasons to change of surface albedo and emissivity and change regional energy balance and water balance. In this study, two regional surface evapotranspiration models were applied in simulating the surface energy flux partitioning in agriculture-pasture transition zone in China. The impact of land cover change to regional energy balance was analyzed. The first model is aerodynamic resistance-surface energy balance model (*SEBS*), which use bulk approach to calculate sensible heat flux (*H*), friction velocity (*u**) and Monin-Obukhov length (*L*) simultaneously. The second model was Penman–Monteith approach which considers the biophysics characteristic, such as surface resistance and canopy conductance and calculates latent heat flux (*LE*) directly. These two models have been successfully applied to different ecosystems in many districts. Two models were used in the study because the H and LE can be derived independently. MODIS data and local meteorological data from 2000~2010 were used as input in the study. Land use maps of the study area for the year of 2000, 2005 and 2008 were used for analyzing. The derived *LE* and *H* were calibrated by R_n. The result showed that *LE* decrease in the west and middle of area over the study period, which was likely caused by steppe degradation. But *LE* over the cropland tends to increase in the east of area, which was likely caused by improved irrigation facilities. The further research should evaluate the energy change quantitatively.

| **0442** | Evaluation and mapping of ecosystem services to find better balance between climate change prevention and biodiversity conservation | Akihiko Ito, Minaco Adachi, Nobuko Saigusa, Rikie Suzuki, Hozuma Sekine, Kikuko Shoyama, Yoshiki Yamagata | Japan |

Our project "Development of Evaluation Method of Ecosystem Services to Find Good Balance between Climate Change Prevention and Biodiversity Conservation" funded by the Ministry of Environment, Japan, aims at providing a useful tool to evaluate ecosystem services for supporting decision making in ecosystem management. Especially, to find a good balance between the climate change prevention and

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biodiversity conservation, we are trying to use an index of ecosystem services, which are derived from multiple ecosystem functions. This project is composed of five sub-themes: (1) modeling and mapping of ecosystem functions: (2) database of ecosystem functions: (3) remote sensing of ecosystem functions: (4) development of ecosystem service indices: and (5) development of GIS-based system of ecosystem service evaluation. Sub-themes 1, 2, and 3 provide information on ecosystem functions related to ecosystem services to sub-themes 4 and 5: e.g., net primary productivity related to provisional service and greenhouse gas budget related to climate regulation service. To facilitate interdisciplinary activities, we share three study sites: (a) Kushiro watershed and wetlands, Hokkaido (northern Japan): a mixture of wilderness and pastoral areas: (b) Yokohama, central Japan: a mixture of urban and green belt: and (c) Lambir Hills, Malaysia: a mixture of primary tropical rain forest and oil palm plantation. These three sites cover a wide spectrum of relationship between human society and ecosystems, allowing us to test the ecosystem service evaluation system. We have conducted field studies at these test sites, aggregated information into databases, and developed a prototype of the ecosystem service evaluation system. At the Kushiro site, sub-themes 2 and 3 gathered filed data of vegetation structure and biomass, which are closely related to ecosystem provisional services. Sub-theme 1 developed a process-based model of terrestrial carbon and nitrogen cycles, which enable us to simulate greenhouse gas budget at watershed to countrywide scales. Sub-theme 4 examined several methods to quantify ecosystem services: e.g., the hedonic approach and conjoint analysis. Sub-theme 5 developed a prototype of the GIS-based evaluation system and conducted case studies at each test site. The prototype system was based on the InVEST, a commonly-used ecosystem service evaluation software, and QGIS, an open-source GIS platform. In the context of the Global Land Project, our project may provide several case studies and make a contribution with respect to evaluation of ecosystem services to find a good balance between different environmental countermeasures.

| 0446 | Complex evaluation of land transformation of Samtskhe-Javakheti | Dali Nikolaishvili, Besik Kalandadze, Vazha Trapaidze, Maia Tskhvaradze | Georgia |

A method for the complex evaluation of land transformation was elaborated based on concept of the spatial-temporal analysis and synthesis of natural territorial complexes (NTCs). The object of the studies is Samtskhe-Javakheti - one of the most diverse region of Georgia. However, irrational use of natural resources impedes region's economic development. But the region is perspective in the different attitude: developing of tourism and recreation, trans-boundary tourism, also developing of arid zone and wetland places protected areas system, existing here pastures are large potential for developing of cattle-breeding, etc. In consideration of those prospects particular emphasis is made on working out complex evaluation scheme.

The main results of research are creation of Landscape-ecological computer model of Samtskhe-Javakheti and revealing of spatial-temporal analysis of landscape-ecological features. On the base of analysis of different parameters and detected tendencies were estimated risks toward climate change according to each landscapes. Also agri-resource potential evaluation methods for the landscapes were worked out.

The study is based on the field and statistical data. Land Inventory for the region was completed in 1:1,000,000 and 1:500,000 scales. All data was elaborated on the base of GIS-technologies. A database of land-resource potential of Samtskhe-Javakheti were done and a series of thematic maps was created.

| 0447 | Water conservation function of forest ecosystem in China from 2000-2010 | Dan Wu, Quanqin Shao | China |

Ecosystem service is the foundation of human survival and development. Water supply and conservation

is one of the important service functions of terrestrial ecosystem. It is manifestation of interaction among vegetation, water and soil. Water conservation function calculation and mapping are of great importance to water resource planning and management. The current evaluation methods include canopy intercept, soil water storage, water balance, precipitation storage and annual runoff (Zhang et al. 2009). Compared with bare land, the vegetation would obviously reduce surface runoff. The objective of this research is to evaluate the water conservation function of forest ecosystem through the amount of reducing surface runoff in China from 2000-2010.

The forest classification dataset of 2000 and 2010 in China were refined through human-computer interaction interpretation using TM/ETM images, which included evergreen coniferous forest, evergreen broad-leaf forest, deciduous coniferous forest, deciduous broad-leaf forest, mixed forest and shrubbery. The surface runoff coefficient of different forest types and bare land in different climatic zones of China were collected from runoff plot observation through numerous published literatures. The precipitation data in 2000 and 2010 were interpolated through over 700 meteorological stations over China.

The amount of water conservation (reducing surface runoff through canopy intercept, litter water storage and soil water storage) of forest ecosystem in 2000 and 2010 was $6800.90 \times 10^8 \, \text{m}^3$ and $7633.20 \times 10^8 \, \text{m}^3$ respectively, which was increased $832.30 \times 10^8 \, \text{m}^3$ over the past ten years. In the humid southeast area of China, the amount of water conservation was large. While in the arid area of northwest China, the amount was smaller due to a corresponding decrease in regional precipitation. The function of water conservation for forest ecosystem was affected by many factors, such as vegetation type, climatic change, soil properties, topographic and geomorphic conditions.

0449	The effects of extreme afforestation in modeling future climate	Ye Wang, Xiaodong Yan	China

Forests provide a wide range of economic and social benefits to humankind. These include contributions to the overall economy mainly through employment, processing and trade of forest products as well as investments in the forest sector. Forests and trees are also important carbon sinks which absorb 2.4 billion tons of carbon dioxide each year. Carbon sequestration by forests has attracted much interest as a mitigation approach, as it has been considered a relatively inexpensive means of addressing climate change immediately. This poster comprehensively assessed the effects of extreme afforestation in modeling future climate. Firstly, it introduced the extreme afforestation experiments in an earth system model of intermediate complexity and reviewed the progress in the researches on the biogeophysical process in simulating future climate. While the effects of afforestation have been modeled many times, the latitudinal response of climate to afforestation is less certain. In addition, it has been suggested that the net effect of afforestation is highly dependent on the latitude at which afforestation occurs. However, the relative importance of the biogeophysical effects in different latitudes has never been quantified. Secondly, the biogeophysical effects of extreme afforestation on climate globally and regionally were introduced. Since forest expansion affects climate through changes in the aerodynamic roughness of the landscape and the capture of precipitation on the canopy and the root extraction of soil moisture as well as land surface albedo, it is the key to the successful simulation with earth system model to accurately and precisely obtain the response of temperature, surface albedo and precipitation to latitudinal afforestation. In addition, the role of the oceanic heat transport in shaping the climate response to afforestation was explored.

The net effect of afforestation is highly dependent on the latitude. Where does the afforestation play a more important role in global and regional climate change? The impacts of afforestation on the climate are the synthetic effects of changes in land surface albedo and precipitation. But which of the two kinds of processes makes a greater contribution to the climate change at the global and regional scale, or which one plays a dominant role? How does the oceanic heat transport affect the climate in response to future

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	afforestation. By answering these questions, this work can help to compare afforestation effects and find areas where afforestation mitigates climate change most effectively.		
0453	Impact of farmers' decisions on the land use transformations of peri-urban agriculture: an agent-based approach	Zhaoxu Liu, Liming Liu	China

In recent years, China's rural regions are undergoing a period of transformations, which is a result of multiple interactions between socio-economic and biophysical processes. These interactions differ largely between rural regions as processes within the region are different and they also respond differently to the pressures and stimulations the region is facing from outside. In particular, the diversity of farmers' decision-making in rural regions may have an important influence on how the region responds to endogenous and exogenous processes. This response can affect the use and the structure of the landscape. The aim of this paper is to explore how the farmers' decision-making to endogenous and exogenous processes can affect the regional agricultural land use transformation. This is achieved by implementing different future scenarios in an agent-based modelling approach for a peri-urban region in the China. Basing on the theory of man-land relationship territorial system, using RS and GIS technologies and the methods of sampling investigation and Agent-based model (ABM), a comprehensive database combined agricultural land use type and households' information are established by collecting the remote sensing and land use type data, and household survey and interview information. By analyzing the characteristics of households, the agricultural land use pattern and the households' spatial distribution, we define the different typical households' agents and allocate them to suitable location based on the conditional probability and stochastic simulation methods. The land use decision-making and the mechanism responding to national policy of typical households will be investigated, and based on the multi-objective utility function theory, we will build the typical-households-based agent model, which is of a Bottom-up processing determining the agricultural land type driven by typical households decision-making. This paper focuses on the study of the process and dynamic pattern of land use transformation under the pressures and stimulations outside. The characteristics of this paper are embodied on the systematic research on the type diagnosis, dynamic monitoring and forecast, and scientific regulation of agricultural land use transformation, which can be used to provide scientific basis for government's decision-making on effectively promoting urban-rural integration development.

| **0454** | Modelling land use change in the Brazilian Amazon using structured additive regression | Mirjam Rehr, Edzer Pebesma, Gilberto Câmara | Germany |

Land use transitions in the Amazon region, especially when implying deforestation, are of great concern to science as well as to politicians and the public. Deforestation measures are not only of interest as such but also serve as covariates in models that aim to estimate associated CO_2 release and biodiversity loss.
Even though a broad amount of research on modelling deforestation processes in the Brazilian Amazon already exists, over-simplifying distributional or structural assumptions have been imposed in most statistical approaches. Advanced regression techniques have rarely been applied, and have mostly been ignoring spatial or temporal information and/or dependencies.
Spatio-temporal modelling of land use (and land use change) in dependence on various drivers, and by means of advanced regression techniques is the objective of our study. The rationale for using elaborate methods from statistical theory is their capability for flexibly representing e.g. nonlinear, time-varying, space-varying, random and interaction effects by means of semiparametric additive predictors. Moreover, statistical models allow for the quantification of uncertainties as well as model comparison and selection.
We rely on a rich data set spanning the last decade of land use in the Brazilian Legal Amazon region, and comprising market related economic covariates as well as environmental and socio-demographic ones.

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Dependence due to unobserved variables will be accounted for by spatial, temporal and random effect terms.

We present preliminary results which we hope will lead to more insight into the dependence structure of land use and land use change in the Brazilian Amazon on the considered covariates. Critical combinations of drivers leading to increased probabilities for land use change can be inferred from these models, while spatio-temporal heterogeneities hint on unobserved covariates that might prove significant in determining land use.

| 0455 | How validating future LUCC based on scenario-based modeling approach? | Thomas Houet | France |

Validation of LUCC model outcomes is crucial in LUCC modeling (Pontius 2008). It becomes even more fundamental when exploring the future using the combination of scenarios and LUCC models. The proposed model assessment approach aims at improving the plausibility of future LUCC for scenario planning (Amer et al. 2013). Indeed, scenario validation is based on five criteria commonly accepted: plausibility, consistency, creativity, relevance and transparency (Durance and Godet 2010; Alcamo and Henrichs 2009). Thus, when LUCC models are used under prospective perspectives (Houet et al. 2010a) or scenario land use planning (Xiang and Clarke 2003), model validation contributes to improve the transparency and plausibility criteria by answering the two following questions 'How does the model work?' and 'How does the model perform for simulating the LUCC dynamics and processes defined by the scenario?'. Because prospective scenarios define realistic LUCC, aiming at being plausible, the model's capacity to simulate realistic LUCC improves scenarios' plausibility (Houet and Gaucherel 2007). Inversely, if the model's assessment cannot prove its ability to accurately simulate realistic LUCC defined by future scenarios, the corresponding simulated LUCC maps could remain implausible. Indeed, if the land demand is attained, it does not necessarily mean that LUCC dynamics are realistic or that path dependence, as defined by Brown et al. (2005), is accurate.

The proposed overall assessment of realistic LUCC simulations consists in combining several (existing) approaches and indices (sensitivity tests on LUCC processes and input parameters, comparison of simulated vs. observed landscape over a past period, model ability to simulate contrasted LUCC, etc.) answering the two following questions: (i) Does the model accurately simulate various LUCC we expect it to perform (i.e. at each time step; over the whole simulation; at multiple spatial scales)? (ii) Does the initial landscape influence the model capacity to simulate scenario-based LUCC?

When using LUCC models for scenario-based studies, we suggest using a combined approach for assessing the model performance because, in most cases, the use of a single index assesses the predictive power of the model (ROC, LUCC budgets, Kappa, etc.). Single indices assessing model outcome plausibility are not common. Most importantly, we assume that such a combined approach helps in the understanding of how the model functions and improves the transparency of scenario results, and thus is particularly suitable to improve scenario plausibility.

This contribution aims at contributing to the "relative merits of different modeling approaches" and the "limits of predictability in land systems" discussion topics.

| 0456 | Effects of possible forest management scenarios in the Romanian Carpathians | Žiga Malek, Dagmar Schröter, Thomas Glade, Luc Boerboom | Austria |

Buzau Carpathians in Romania are part of one of the main European mountain ranges, the Carpathians - one of the major biodiversity hotspots, as well as one of the biggest continuous forest ecosystems in Europe. Since 1990 they have witnessed substantial socio-economic changes and resulting changes to the forest cover mostly in form of forest expansion on the account of land abandonment but also

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deforestation. These have been a consequence of a complex interplay of poor economic conditions, land ownership reforms, and institutional difficulties. The spatial extent of forest disturbances in this area has not reached alarming levels of similar areas in Romanian Carpathians, however most recent trends suggest that future forest management might result in more extreme land cover changes. These trends can be described by various attempts to loosen forest-harvesting regulations, particularly in connection with clear cutting and minimum age of harvested trees to enable easier exploitation of Romanian forests. Maximization of wood provision could result in altering other forest ecosystem services: changes to habitats, and regulation of natural hazards. Possible changes to the occurrence, pattern and consequences of hydro-meteorological hazards are particularly significant, as two thirds of the area is subject to landslides. In order to understand potential consequences of possible changes to forest management, we integrated remote sensing, GIS and land use/cover modeling to explore future forest management scenarios in this part of Romanian Carpathians. By involving stakeholders we constructed three scenarios, labeled as: 1: continuation of current trends with institutional difficulties; 2: changing the forest policy to withdraw the clear-cutting limits; and 3: a sustainable future with enforced forest control and protection. These future pathways were identified through interviews with local and regional decision makers in the field of forestry, environment and hydro-meteorological risk, researchers and foreign investors in the forestry and wood processing sector. Scenarios were spatially allocated by using the Dinamica EGO modeling environment (Soares-Filho et al. 2002), as it enables the emphasis on particular planning decisions, in this case forest harvesting. Through this research, we were able to explore the effects of alternative futures as consequences of today's decisions, and provide a comparison between different forest management pathways.

| 0457 | Simulating backcasting futures of urban growth: the SLEUTH* model | Thomas Houet, Doukari Omar, Aguejdad Rahim, Clarke Keith | France |

The use of models for exploring the future of land use and cover changes (LUCC) can be distinguished into 'model-driven' vs. 'scenario-driven' approaches. Dedicated models for the latter approach are not so common and face the challenge of validation. This poster has a double objective: (1) to present a 'scenario-driven' version of the SLEUTH urban growth model which has been modified in order to incorporate an additional spatially explicit factor and to be used in a full control mode for spatially allocating future urban changes accordingly to contrasting scenarios; (2) to present a methodological approach for assessing the plausibility of future LUCC projections.

Assuming that a predefined prospective scenario exhibiting contrasting LUCC over time is plausible, the corresponding landscapes are supposed plausible if the model is able to simulate realistic LUCC in terms of landscape composition, configuration and dynamics. Plausibility inherits from the confidence the LUCC modelers and users have in their model to accurately simulate contrasting LUCC which is assessed by combining three types of tests: (1) sensitivity tests, (2) a simulation of urban growth over a past period, (3) a simulation of contrasted future urban changes. Results show that SLEUTH* conveniently simulates urban changes.

SLEUTH* is able to explore contrasted urban changes and land planning strategies whose plausibility depends on the scenarios. Based on six backcasting scenarios, defining desired/undesired futures of Toulouse urban area for 2100, the demonstration is made that this model is adapted to simulate contrasting futures.

The SLEUTH* model is a freeware downloadable online.

This poster aims at completing the literature on the use of LUCC models for exploring future LUCC. The model validation approach is helpful for increasing the confidence users can have in the simulated results.

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0459	Combining process-based and optimization approaches for simulating fine scale agricultural LUCC	Thomas Houet, Gaucherel Cédric, Castets Mathieu, Schaller Noémie	France

Fine scale and subtle LUCC are often underestimated in terms of environmental consequences (Houet et al. 2010a). Their analysis is therefore relevant (Lambin and Geist 2006), but remains a challenge, due to the granularity of such analyses: the finer the scales considered the more realistic the modelled LUCC must be.

Identified as a key issue (Verburg et al. 2004), combining top-down and bottom-up approaches have been explored, leading to many fruitful studies. However, when considering that the top-down approach depends on finer organization levels (e.g. farm) with specific land demand objectives, the combination with a bottom-up approach is becoming more difficult as landscape units and dynamics have to be refined. Indeed, a commonly used pixel-based approach can exhibit some limitations in the representation of a real agricultural landscape where agricultural fields and islets are the key landscape units influencing LUCC (Thenail et al. 2009). Agricultural landscapes are probably those where LUCC are the most difficult to simulate due to the diversity of LUCC processes of farming practices (Benoît et al. 2007). As summarized by Castellazzi et al. (2008), land use and land cover transitions within crop rotations could show various characteristics: fixed or flexible transitions, and fixed or variable transitions length. Geographic (soil types, slopes, exposure, etc.) and agronomic (duration between identical or different types of crops, preceding-following crop pairs, etc.) constraints have also to be considered. Farm level is the key organization level: considering that crops are chosen and allocated accordingly to farming system characteristics and production objectives (Rounsevell et al. 2003), the challenge to understand these dynamics consists in modelling the appropriate proportions of crops at the farm and landscape scales, respecting all constraints and all transitions rules.

Based on a detailed review of LUCC models, we developed a model implemented with the DYPAL modeling platform (Gaucherel et al 2012) that is able to deal with LUCC processes to simulate crops successions according to various constraints that respect a user-defined amount of crops at the farm and/or landscape scale(s). Used within a scenario-based approach, this model shows promising results for assessing the influence of (for example) a CAP reform (expecting an increase of wheat) on crops allocation and occurrence that may affect environmental issues such as biodiversity or water resources.

| **0460** | Climate change effects of different urban sprawling patterns of urban agglomeration: a case study of Wuhan City agglomeration, China | Xinli Ke, Feng Wu | China |

Urbanization is one of the most important anthropogenic influences on climate. China has reached the "urban tipping point", with about 52.57% percent of its population now living in cities. By 2030, the number of people who live in cities will likely be on bilion. Nowadays, urban agglomeration has become the main feature of China's urbanization. A large body of literatures studied the effect of city size on economic effeciency while few researches pay attention to figure out climate change effects of different urbanization patterns, especially spatial patterns of urban sprawling. Wuhan City Agglomeration is one of the most important urban agglomeration in China, which is is on the way of rapid urbanization. In this research, climate change effects of different spatial sprawling patterns of urbanization are examed for suitable urbanization pattern choosing from the aspect of climate change.

In our research, 3 urban sprawling pattern scenarios are laid out: baseline scenario, centralized sprawling scenario and distributed sprawling scenario. In baseline scenario, urban sprawling rule just like historic urban expansion. In centralized sprawling scenario, cenral cities in Wuhan City Agglomeration has priority in urban sprawling. In distributed sprawling scenario, small cities have the priorities. In this

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research, Partitioned & Asynchronous Cellular Automata model(PACA) is employed to simulated spatial patterns of different urban sprawling pattern scenarios. In PACA, we can adjust transfer speed to simulate different sprawling scenarios: higher transfer speed in central cities in centralized sprawling scenario, lower transfer speed in central cities in distributed sprawling scenario. Then the simulation results of urban sprawling in 3 sprawling pattern scenarios are taken into Weather Research and Forecasting Model(WRF) to examine climate change effects of different sprawling patterns. By analyzing result of WRF, we can find what kind of sprawling pattern has less impact on surface climate. This research will be helpful for choosing better urban sprawling patterns in city agglomeration at the aspect of climate change.

| 0461 | The transition to integrated systems in Mato Grosso - Brazil | Juliana Gil | Germany |

Brazilian agriculture is expected to satisfy a significant share of the global food demand in the coming decades, while also ensuring that agricultural expansion will not threaten the integrity of its forestry resources.

With that in mind, the federal government is trying to optimize land use in already deforested areas and promote sustainable agricultural intensification. To achieve this, the so-called *ABC Plan for Low-Carbon Agriculture* was implemented. A part of this plan is offering special credit lines to farmers adopting low-carbon agricultural practices, such as the adoption of integrated crop-livestock-forestry systems (IS).

IS's potential benefits include a significant increase of the fertility and organic matter content in the soil, higher biomass production, as well as carbon sequestration. This allows for higher stocking densities in pasturelands, which in turn helps avoid further deforestation and contributes to climate change mitigation. The use of these systems is particularly interesting in Mato Grosso, a Brazilian state in Southern Amazonia, lying on the so-called 'Arc of Deforestation', where large-scale agriculture is already in place and livestock production systems are generally inefficient (i.e. low stocking density).

However, despite all incentives and benefits associated to IS, these systems still represent a very small share of the state's agricultural area. This highlights the need to investigate the drivers and barriers of such transitions, assess the scenarios under which they might occur, and the factors influencing farmers' decisions to adopt IS.

Considering the state's relevance in the agricultural sector and its strategic location (where the agricultural frontier is quickly expanding and putting pressure on the rainforest), this study provides new insights into the possible implementation of low-carbon agriculture in Southern Amazonia. Preliminary results will be shared on i) the typology of the main agricultural production systems in Brazil; ii) the land-use modeling framework generated for the region; iii) the land-use responses to various policy scenarios (including credit, logistics improvements and variations in commodities' prices); and iv) the effect such transitions will have on land change and overall GHG emissions.

| 0463 | Projecting 2100 urban growth to assess urban climate changes on Toulouse urban area (France): combining forecasting/backcasting scenarios and land change models | Thomas Houet, Masson Valéry, Bonhomme Marion, Moine Marie-Pierre, Marchadier Colette, Bretagne Geneviève, Aguejdad Rahim, Doukari Omar, Viguie Vincent, Avner Paolo, Hidalgo Julia, | France |

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		Pigeon Grégoire	

To assess the influence of urban growth on future urban climate, a scenario-based approach is required. Exploring long term desired/undesired futures may help land planners to better mitigate and adapt their strategies. This is even more obvious when considering that climate change scenarios can only be differentiated after 2050. Moreover, urban growth (> 75% of inhabitants are expected to live in cities in 2050) and climate change (increase of mean air temperature and heat waves) show consistent trends that may strongly affect humans. Indeed, Urban Heat Island (UHI) phenomena induce strong impacts on human health, urban environment and energy consumptions with feedbacks on urban climate.

One of the challenges consisted in projecting long term urban growth at a fine thematic and spatial resolution in order to be combined with physical models. Our four-step methodology consists firstly of defining interdisciplinary scenarios; secondly of simulating long term city evolution combining socio-economic, land-use and architectural models; thirdly of calculating impacts with climate models, and finally of calculating the indicators that would help defining the adaptation strategies.

This presentation intends to presents the overall methodology and more specifically the way scenarios and models were combined to project backcasting futures of Toulouse urban growth (South-West of France, 4th biggest town). It will then focus on models coupling. Six contrasted scenarios were spatially explicitly simulated (Figure 1) accordingly to international and regional economies trends and assumptions, contrasted land planning strategies and technological advances.

Some examples of outputs are given in figure 2 and main results obtained by comparing all scenarios show:

- A strong increase of urban surfaces, from +20400 ha (+21%) to +68600 ha (+48%) compared to 2010;
- A decrease of energy consumption, from -40% to -50% compared to 2010, except for one scenario, mainly due to building insulation and renovation;
- A decrease of the urban heat island effect (from -0.5°C to -1°C in winter and in summer) for all scenarios.

Whatever the urban planning strategies and climate change scenarios are, these results how energy and technological issues (building insulation, renovation, energy consumption behaviors, etc.) are the key-triggers to reduce future urban climate changes. Another finding is that the UHI is important to accurately reproduce the energy consumption in cities (Masson et al, submitted).

Finally, this presentation intends to give insights of coupling scenarios and models for long term projections. It also illustrates how exploratory economic and/or demographic scenarios and backcasting land planning scenarios can be combined within a modeling platform.

0464	Mapping the vegetation aerodynamic roughness of China's land-surface using MODIS data	Deyong Hu, Lei Deng, Wenji Zhao	China

Aerodynamic roughness is an important parameter in land-surface-atmospheric models. It affects the exchange of momentum and energy between the land surface and the atmosphere and is a parameter influencing calculations of momentum flux, sensible heat flux, and latent heat flux. Accurate quantification of aerodynamic roughness length can improve the precision of land-surface-atmospheric models.

The objective of this study was to find an approach to map the vegetation aerodynamic roughness length of China's land-surface. Our research applies Raupach's formulation of momentum aerodynamic roughness to the remote sensing data. The roughness variables are to be estimated using the leaf area index (LAI) data product generated from data captured by the Moderate Resolution Imaging Spectroradiometer (MODIS) instrument orbiting aboard the Terra platform.

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We present the results of mapping the aerodynamic roughness length of China's land surface vegetation using data from the Geoscience Laser Altimeter System (GLAS) and the Moderate-resolution Imaging Spectroradiometer (MODIS). Our results demonstrate two conclusions: (1) Different vegetation types have different changes in roughness by season, with lower roughness values during the growing season and higher values in the non-growing season. When the canopy area index is high, roughness tends to be low. The evergreen broadleaf forest and evergreen broadleaf forest roughness have a narrowest change range, along with the closed shrubland and open shrubland roughness. (2) The aerodynamic roughness z_0 of evergreen needleleaf forests is the highest of seven vegetation cover types, ranging $1.43 - 1.53$, and the deciduous needleleaf forest is lowest, ranging $0.51 - 0.77$, followed by the open shrubland, which ranges from 0.86 to 0.89.

These results demonstrate how to model aerodynamic roughness impact of land use changes to meet surface climate research requirements.

| 0468 | Assessing agricultural vulnerability to improve adptative capacity of rainfed farmers in India | Kausalya Ramachandran | India |

Rainfall variability and increasing occurrence of extreme weather events during last three decades have negatively impacted Indian agriculture although agricultural production has risen in post-green revolution period. Increasing internal demand and growing export market require steady increase in production but changes in monsoon and occurrence of drought and floods often simultaneously in various parts of the country, cause economic and human hardships to millions. As these events necessitated proactive measures, the Government of India assigned the task to Indian Council of Agricultural Research to assess agricultural vulnerability of India. A national program titled National Initiative for Climate Resilient Agriculture was launched in February 2011 to identify vulnerable zones and develop appropriate strategies to help mitigate hardships and improving adaptative capacity among farmers across India.

To study impact of extreme weather events like drought, heat-wave, flood, frost, cold-wave and cyclones, satellite time-series data were obtained and changes in landuse - land cover and vegetation index were studied as remote sensing provides a unique platform for undertaking temporal and regional studies of bio-physical aspects on earth surface to understand role of drivers in such extreme events. NDVI was used to understand these processes while precipitation and temperature data were used to corroborate the findings.

Temporal analysis of satellite data and NDVI data products from NOAA-AVHRR (15-day 8km) and TERRA-MODIS (16-day 250m) revealed that in 2006, 163.73 million ha of agricultural land was vulnerable. Of these over 51.55 million ha were moderately to severely vulnerable in western and central parts of India. MODIS data (2001-2011) with finer ground resolution, indicated that 207 million ha were vulnerable in 564 districts of which 161 districts encompassing 55 million ha were moderately to severely vulnerable. These statistics are now being employed to develop appropriate strategies for management of stress and for improving adaptative capacities of farmers.

Identification of vulnerable areas has helped in analyzing the underlying factors that contribute towards it viz., poor soil fertility, low available water-holding capacity in soils, excessive ground water exploitation, small farm-holding sizes, slope, delay in onset of monsoon or mid-season breaks, etc. Application of GIS techniques have helped to identify appropriate technology or strategies to address each of these issues on an regional basis. For instance watershed projects have been implemented in suitable locations while protective irrigation sources have been developed in other areas. Even policy decisions like providing subsidy to farmers could be addressed using tools of geomatics.

| 0471 | Validating and improving the algorithm for land surface radiation with Landsat TM in China's mega- city | Yinyin Dou, Wenhui Kuang | China |

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The surface heat radiation of the mega cities was affected by the high-intensity land use and atmospheric pollution, the quantitative retrieval of remote sensing parameters has high complexity. But the international typical algorithms of the surface radiation for estimating the urban surface radiation have some limitations. This paper carried out the eddy covariance experimental observations of the eight representatively urban underlying surfaces, verified the instantaneous value of remote sensing inversion based on Landsat TM by used the observations of the albedo, shortwave radiation and net radiation. Meanwhile, a new model parameterization schemes was developed. The results show that atmospheric pollution of the mega city resulting in loss of about 0.3% of the surface radiation has a great significance for the atmospheric transmittance. The albedo of remote sensing inversion underestimated approximately 0.10 causing by the shadows of the high building in the mega-city. The inversion of surface radiation and observed values have preferably coherence, the RMSE of downward and upward shortwave radiation were approximately $20W/m^2$ and 14.92 W/m^2, the downward and upward long wave radiation were about $12.08W/m^2$ and 13.77 W/m^2,and the RMSE of the net radiation was approximately 20.72 W/m^2.

| **0476** | The effect of deforestation in Northeast China on the regional surface temperature | Lingxue Yu, Shuwen Zhang, Kun Bu, Fengqin Yan, Jiuchun Yang | China |

Land cover change, an important driving force to climate change has become the focus of the global change research and GLP (global land plan). A large number of studies have pay more attention to the global influence of LUCC and proved that land use change occurred at different temperature conditions may produce different climate effects, for example, forest degradation in tropical areas can lead to higher temperatures as the reduction of roughness and the decreasing of drag coefficient, while in boreal areas similarly forest degradation can cause lower temperature as the increasing of albedo particularly in the snow covered winter. However, the understanding of if the forest degradation at different humidity conditions have a similar impact on climate is not deeply. From this perspective, this article uses WRF model to simulate the surface temperature impacts of forest degradation of Northeast of China. In this study we designed two scenarios: one is the situation without intervention by human and the other is the current forest situation. In order to express more clearly of the humidity effects on surface temperature, we chose three typical areas in humid, sub-humid and semi-arid regions to do sample analysis. According to the analysis, the maximum variation of surface temperature appeared in humid areas, reducing by an average 1.14 ℃, while the change in semi-arid and sub-humid areas is relatively small.

| **0477** | Spatio-temporal patterns and drivers of cultivated land with Ulanqab agro-pasture ecotone during 1990-2010 | Gencheng Su, Meng Kong, Wenfeng Chi | China |

Cultivated land changes are monitored at 5-years interval from 1990 to 2010 using Landsat TM. Spatio-temporal Patterns and drivers of cultivated land change with Ulanqab Agro-pasture Ecotone are analyzed based on GIS spatial analysis. Cultivated land dynamics with Agro-pasture Ecotone indicated the great temporal and spatial variations. We found that the cultivated land increased during 1990-2000 and then decreased since the first 10 years of 21st. Conversion between cultivated land with grassland was the dominant type of cultivated land dynamic. The study indicated that economy development and urban development are the dominant drivers with cultivated land increase. " Grain for Green " and ecological protection policies caused importantly the cultivated land decrease. The cultivated land dynamic with Agro-pasture Ecotone had induced the local ecological vulnerability.

| **0479** | Impacts of land use/cover change on mean surface air temperature simulation in different seasons over China using RIEMS2.0 | Dong Siyan, Yan Xiaodong, Xiong Zhe | China |

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Although many researchers have studied the impacts of LUCC, data related to these impacts on Chinese climate simulation remain sparse because of the diversity of Chinese regional changes in land use, especially related to impacts on climate simulation by using new accuracy land cover data sets in Region climate model. In this study, impacts of land use/cover change (LUCC) on mean temperature were investigated through different seasons climate simulations using two types of land cover maps in Regional Environment Integrated Modeling System 2.0(RIEMS2.0), and the results had significance test. One type was an USGS land cover map, and the other type was a LUC90 land cover map derived from satellite data which have more accuracy of land use/cover information, and we also focused on heat flux changes at LUC90 vs. USGS. The results showed that: 1) At USGS experiment, systematic biases were found in the (RIEMS2.0) through the 10-year China simulations. In the simulations, negative surface temperature biases of 2-5℃ occurred systematically over northeast at Spring and Winter. At LUC90 experiment, annual cold biases and winter cold biases in China are decreased, passing the test of significance (P<0.05), and mean temperature biases in different seasons were reduced at northeastern region, passing the significance test (P<0.05). At LUC90 experiment, the inter-annual variability of temperature simulation in the winter have greatly improved, which is better than the other seasons, and inter-annual variability in China North improved better than the other regions. 2) LUCC had an impact on surface flux distribution, and it has an influence on mean temperature through changes in the latent heat flux and the net absorption the radiation flux. At model grids where forests were converted to cropland, the net radiation absorbed has less influence on surface air temperature at lower vs. higher latitudes. Further, latent heat flux has a stronger influence on surface air temperature at lower latitudes. At the grids where cropland converted to short grass, evapotranspiration decrease, the latent heat flux decrease, the temperature increase in the summer.

| 0486 | Urban expansion forecasts and changing human population distribution in Africa | Catherine Linard, Marius Gilbert, Andrea E. Gaughan, Forrest R. Stevens, Andrew J. Tatem | Belgium |

The human population of Africa is predicted to double over the next 40 years, driving exceptionally high urban expansion rates. Some scenarios predict that the urban land cover area of sub-Saharan Africa will increase more than 12-fold between 2000 and 2050, due to projected urban population growth rates combined with an overall decrease in average urban population density. In the context of globalization and looming global land scarcity, such an increase in urban land use may significantly decrease potentially available croplands and make biodiversity rich areas such as African savannas at risk of being converted to agriculture, generating important environmental and social costs. Spatially-detailed urban expansion forecasts are increasingly required by global change modellers in order to evaluate the magnitude and spatial extent of urban land demand.

Besides models that predict the quantity of change, it is essential to predict the location of change given the geographic variations in ecological attributes and land quality. However, predicting the spatial patterns of urban land-use change is challenging in Africa, given data requirements for model calibration and validation. Here we introduce a simulation method that generates spatially-detailed urban expansion forecasts for 2020 and 2025 for Africa. Our main objective was to develop an intermediate approach between high-resolution city-scale studies and low-resolution worldwide-level studies in order to identify factors that commonly drive spatial patterns of urban expansion at the continental level. By using spatial statistic modelling and remotely-sensed data, we evaluate the predictability of urban spatial patterns only using a parsimonious set of generalizable factors.

The urban expansion of every large African city will be simulated for 2020 and 2025 and will be used to

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	produce projected population distribution datasets under a range of growth scenarios following AfriPop methods (Linard et al., 2012). These upcoming datasets will be more spatially detailed and likely more accurate than existing large area urban expansion datasets in terms of spatial resolution (100 m vs. 5 or 10 km) and input data, as the datasets will be based on detailed Landsat-derived settlement extent data from AfriPop (Linard et al., 2012). Despite the significant uncertainties in urban pattern predictions, the urban expansion datasets presented here can be seen as realistic scenarios for the future, and the most detailed Africa-wide urban expansion predictions ever undertaken. Such spatial datasets are increasingly in demand by global change modellers, but are currently lacking.		
0487	Modeling the climatic effects of the land use change in eastern China	Mingna Wang	China
	The effects of farmland expansion in Northeast China, grassland degradation in Northwest China, deforestation in South China were simulated by using the WRF model coupled with a single urban canopy model, as well as the latest actual land cover datasets. The simulated results show that, when forest converted to farmland, the air temperature decrease due to the increase of surface albedo in the northeast of China. The climatic effects of grassland degradation on the Loess Plateau is not obvious. The temperature decreased only near the Taihang Mountain because of the high albedo induced by the deciduous broad-leaved forest converted to farmland. On the whole, deforestation in south China caused the decrease of temperature and increase of precipitation. The temperature decrease caused by the increased albedo counteract the effects of evapotranspiration decreased which make the temperature increase, so the summer temperature change is not obvious in south China. The LUCC in eastern China (not including the effects of urbanization in the North China Plain) renders the cooling trend as a whole. The region which temperature changed in summer is less than that in winter, which is mainly due to the reduced evapotranspiration in summer offset partly by the albedo increased.		
0488	Modeling studies of the impacts of boreal deforestation on the near-surface temperature in European Russia	Zhihui Li, Qingling Shi, Xinli Ke, Yingcheng Liu, Xiangzheng Deng	China

Russia has a large area of boreal forest, and the European part with high boreal forest coverage percentage, which has gone through intensive anthropological activities, be chosen as typical case study area to detect the biogeophysical climate impacts of human land use/cover change-boreal deforestation on climate in boreal forest region. In this paper, firstly tested and validated the simulation results of near-surface temperature in the study area simulated by Weather Research and Forecasting (WRF) model. Then scenario-based land cover dataset of USGS classification with 24 categories in different years (2000 as baseline year, 2010 and 2100) were used in WRF in each simulation to explore the impacts of boreal deforestation on the near-surface temperature. The results indicated that the WRF model has the ability to simulate the temperature change in the study area of European Russia, and the land use/cover change in the boreal forest region of European Russia, which was characterized by the conversion from boreal forest land to cropland (boreal deforestation) in future 100 years will lead to significant changes in the near-surface temperature, with the regional near-surface temperature decreased by 0.058℃/year on average, and with drastically average decrease of 1.81℃during wintertime. Generally, these simulation results indicate that boreal deforestation trend in the future 100years can cause cooling effect to some extent, and make the near-surface temperature decrease except for springtime.

The study can be an important research component for Modeling biogeophysical impact of land use changes on surface climate, since it can enrich case study of biogeophysical impact of land use/cover changes on surface temperature on regional scale with the WRF model, which is a next-generation, state-of-the-art atmospheric simulation system based on the Fifth-Generation Penn State/NCAR Mesoscale Model (MM5). Thus, this study can also provide case study of the application of the WRF model to

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	explore biogeophysical impact of land use changes on surface climate.		
0490	Dynamics of land system model and its contribution for parameterizing the land cover patterns embedded for the climate models: a case study in North China plain	Yongwei Yuan, Zhaohua Li, Xinsheng Wang, Rui Yu, Xiangzheng Deng	China

Land use / land cover change (LUCC) is an important component of global environmental change. The impact mechanism of LUCC on climate change has profound significance, is the core problem of current global environmental change research. In this research, North China Plain as the research area, adapt to climate change (mainly CO_2 emissions) as the purpose, research under the driver of the social and economic development to assess the possible land use change trends in the future. Use of AGLU module of global change assessment model (GCAM model, Global Change Assessment Model) assess corresponding land use structural changes in driven by socio-economic, then use land use change to obtain the CO_2 emissions of each scenario. By setting three different socio-economic development scenarios to simulate land use trends, and obtain the best scenario of reducing CO_2 emissions, which can provides a theoretical basis of land use planning to control climate change. In addition, The Dynamics of Land Systems (DLS) model is capable of integrating multiple data sources to simulate the dynamics of a land system and has been applied to project near future land-use trajectories of North China Plain. There are three main modules in DLS: a spatial regression module to identify the relationships between land uses and their influencing factors; a scenario analysis module of land use changes as required by the demands of land uses at the regional level and a spatial disaggregation module to allocate land use changes from a regional level to the disaggregated grid cells.

For the **Conference Session** of "Modeling Biogeophysical Impact of Land-Use Changes on Surface Climate", this research can help to parameterize the land use and land cover patterns embedded for the climate models by understanding the land system dynamics and projecting near future land-use trajectories of a region. In addition, as the session mentioned, projecting future climate changes due to future land surface biogeophysical condition is still poorly reported, so as a linkage for climate modeling, this research can enlighten future climate research by high quality and high resolution LUCC dataset.

0496	Impact of climate change on grassland and herdsman's income: a case of Three-river Headwaters Region in Qinghai Province	Chunhong Zhao, Fang Yin, Yanfei Li, Yingcheng Liu, Xinli Ke	China

The "Three-River Headwaters" region of China has great effects on the climate change at national, continental and even global scale due to its unique geographical environment and climatic conditions. Aiming to provide scientific and technological support for the formulation of sustainable development policies and land use planning of the "Three-River Headwaters" region, this research focused the effects of the climate change on the animal husbandry production. The database used in this study was first established by collecting the ecological data and social economic data of "Three-River Headwaters" region through remote sensing, field surveys and statistics on the basis of the data fusion. Then, key climate factors which influence the animal husbandry production and the social-economic system were selected and used to assess the tendency of the economic situation in the past 30 years. Besides, regression relationship between the climatic factors and NDVI (an index of the grassland ecosystem) were used to analyze the spatial and temporal pattern of the change of NDVI under the impacts of the climate change. Thereafter, multi-level modeling (MLM) was used to determine the response mechanism of the net primary productivity (NPP) of grasslands and herdsmen's income to the climate change and build the simultaneous equations to explore the mechanism and principle of ecosystem services' supply change so

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as to access impacts of the climate change. The results indicate the climate change in the study area showed a "wet and warm" trend during the past thirty years. There was strong correlation between the climate change and NDVI, showing a lagged relationship with temperature and a quadratic interdependency with precipitation. In addition, the socio-economic factors accounts for 48% of the impacts on NPP.

As one important research components in land use-climate interactions and the potential impacts of land use, this research has three levels of contribution. Firstly, this research will be helpful for the scientific and reasonable land use planning and adaptation measures for the dual objectives of improving the ecosystem services and mitigation of climate change. Secondly, the models and methods can serve as the climate sub-models in the simulation to analyze the land impact and responses. Thirdly, it provides an innovative and quantitative tool to recognize climate impacts caused by land use change.

0500	Differences in time and space in vegetation patterning of the Pyrenean Mountains: the impact of past land-use change on floristic biodiversity	Florence Mazier, Didier Galop, Thomas Houet	France

Since the mid 20th century, the Pyrenean Mountains have undergone a process of population decline, an abandonment of land by farmers, and a significant decrease in grazing pressure. The national conservation strategies in mountainous areas have promoted the maintenance of traditional agro-pastoral activities, such as extensive grazing activities, to restore open lands that are favourable to biodiversity. Those results are mainly based on present day ecological studies with datasets spanning only a few decades. The potential of paleoecology is highly acknowledged to address specific conservation issues by providing long-term records of the degree and rate of land-use change, regime shifts (from deforestation to reforestation and vice versa) and their impact on the biodiversity. The Vicdessos Valley (Eastern Pyrenees) is representative of a common scenario in the Pyrenean massif where agro-pastoral activities have reached an extremely low level (Galop et al, 2011). In consequence the reforestation at different altitudes has been observed. This poster focus on the forest history of this mountainous area and examines the local variability of land-use history and the spatial patterning of vegetation over the last 60 years based on remote sensing data available at 10-year intervals since 1942 and over the last 200 years based on pollen records from eight lakes and bogs sediments. Temporal changes in the percentage cover of plant taxa (trees and herbs) in a 2-km radius around the sites were quantified using a novel pollen-based approach: the Landscape Reconstruction Algorithm (LRA). The LRA-based estimates of land-use cover (grassland, heathland, coniferous and deciduous forest…) were first evaluated to corresponding estimates derived from remote sensing-data around each target site. The LRA approach was then used to reconstruct the 200-year history of local land-use dynamics at 10 to 20-year intervals at clearly defined spatial scale around the eight sites. A land use and cover change model was used to reconstruct plausible past landscape scenarios by allocating the pollen-inferred cover of land-use within the defined area. The land-use changes were also compared with pollen-inferred floristic richness to evaluate the footprint of land-use change and regime shifts between open and forest land on plant biodiversity. The comparison of the floristic richness with documentary sources (demographic data and book records of number of cattle in the valley) provides valuable insights on the role of human-induced disturbances such as grazing activities on floristic and landscape diversity.

0501	Pollen-inferred vegetation dynamics in the South Swedish Uplands during the past 1000 years: effects of local land-use change on floristic diversity	Florence Mazier, Daniel Fredh, Anna Broström, Petra Bragée, Shinya Sugita, Dan Hammarlund	France

NUMBER	TITLE	AUTHORS	COUNTRY

Long-term records of environmental history at decadal to millennial time-scales enable ecosystem variability and responses to past anthropogenic disturbances to be assessed, and are fundamental for the development of environmental management strategies. This study examines the local variability of land-use history in the South Swedish Uplands over the last 1000 years based on pollen records from the sediment successions of two small lakes. Temporal changes in the percentage cover of plant taxa were quantified using a novel pollen-based approach: the Landscape Reconstruction Algorithm (LRA). The LRA-based estimates of the extent of four land-use categories (cropland, grassland, wetland, and woodland) were first compared to corresponding estimates based on historical maps and aerial photographs in AD 1769-1823, AD 1837-1895, AD 1946 and AD 2005. The reconstructed vegetation composition is generally in good agreement with estimates based on the historical records. Subsequently, the LRA approach was used to reconstruct the 1000-year history of local land-use dynamics at 20-year intervals around the two lakes. The land-use changes were also compared with pollen-inferred floristic richness to evaluate the footprint of land-use change on plant biodiversity. The LRA results show significant differences in the land-use history between the sites and reveal a dynamic land-use pattern, with agricultural expansion during the 13th century, a partly abandoned landscape around AD 1400, re-establishment during the 15-16th century and a transition from traditional to modern land-use during the 20th century. The inferred response time of c. 20 years of floristic richness during rapid agricultural expansion indicates how fast plants can spread across areas that have been cleared. Succession from open land to a more tree-covered landscape may favour floristic richness during a period of about 40 years. Quantifications of past vegetation dynamics provide information on the size (amplitude), frequency and duration of past land-use changes and their effects on terrestrial and aquatic ecosystems, and should be taken into account when nature conservation strategies are developed. The variability of the past agricultural landscape provides information about the land-use types, their transition and regime-shifts, which promote floristic diversity.

| 0504 | Land use change resilience and vulnerability analysis of indigenous community in Western Himalaya | Bindhy Wasini Pandey | India |

Present research is an attempt to investigate the impact of land use change on agro horticultural crops, water supply and vulnerability of livelihood security among the local community in Upper Beas Basin of Western Himalaya. Study is based on both the Primary as well as Secondary Sources of data. To collect the primary data, twenty two hamlets of the Valley between the elevations of 2000-3000 meters were surveyed on the basis of Stratified Random Sampling. Two hundred questionnaires were fulfilled along with the physical investigations of quality and quantity of water and land use changes between 1956 to 2005. Attempt has been made to assess the changes in food availability, quality and quantity measurement and analysis of changes in method and mode of food supply. At the end, effort has been made to analyse future vulnerability and changes in the nature of occupations and household economy.

The research findings highlight that the number of livestock has been increased in the valley, while the areas under grazing land has reduced. This is because of the privatization of the land and closing the forest area. Consequently more pressure has been exerted on agricultural land. The numbers of household of the nomadic herders have been considerably reduced, as the new generation is migrating towards plain for job in metropolitan areas like Delhi and Mumbai. There were less than 10 hotels in Manali in 1975, which has increased to more than 1000 in 2008. The growth of Tourism based urbanization has taken place on agrarian region is economically lucrative today, but can pose a risk of food crisis tomorrow as non agricultural uses of the land is increasing in the interest of the outside population on the cost of the local community. A planned land use from the Government is of dire need to save the livelihood security, vulnerability of food supply and biophysical capacity of the Western Himalaya.

NUMBER	TITLE	AUTHORS	COUNTRY
0506	Radiative forcing and surface heating change over China due to construction land increase	Zhai Jun, Liu Jiyuan, Liu Ronggao	China

Human induced land use change could impact the regional and global climate by change the surface biophysical parameters, such as surface albedo, emissivity latent heat and so on. Construction land increase, like urbanization, is one main human activities which could impact the surface climate system. Accurate assessment of the climatic effects of Construction land increase is critical for future land use decisions. Many studies have shown that the city's temperature will be significantly higher than the surrounding natural vegetation's temperature because of the urban heat island effect. The main reason for this is the anthropogenic heat emissions and greenhouse gases increase. However, the reason of urbanization induced climatic effects could not be revealed accurately from the mechanism level if the surface biophysical process was neglected. In this study, construction land change information were calculated from the 1:100000 land use data in 2000 and 2010, which was generated from Landsat TM data by visual interpretation. The surface albedo, emissivity, land surface temperature from MODIS products and the downstream radiation data from reanalysis products were used to calculate the parameters change, radiative forcing in national nine climatic zones. Also the surface heating change caused by construction land increase was calculated by using the latent heat data which is also from MODIS product. The result show that, the construction land area have been increased by $3.76*10^4 km^2$ during 2000-2010. Surface albedo in the construction land in the middle temperate humid zone, middle temperate semi-arid zone, middle temperate arid zone and the northern Loess Plateau were decrease, the maximum reducing value is 0.029 which located in middle semi-arid zone. Surface emissivity in the construction land in all of the zones decreased. The northern Loess Plateau had the maximum reducing value of 0.00538. The radiative forcing in the Tibet Plateau zone, northern Loess Plateau, middle subtropical humid zone, middle temperate arid zone, southern subtropical humid zone and the middle temperate semi-arid zone showed negative radiative forcing. The maximum negative forcing value is $-23.86 w/m^2$ in the Tibet Plateau. The warm humid zone showed positive radiative forcing of $3.52 w/m^2$. The surface heating showed spatial difference. The southern subtropical humid zone had the maximum increase value of $50.45 w/m^2$ because of the large latent heat change, and the middle temperate arid zone had the minimum value of $1.26 w/m^2$ because of the little latent heat.

| **0510** | Impacts of land transformation from crops farm to Shrimp Pond of Southwest Coastal region of Bangladesh | Md. Hafiz Iqbal | Bangladesh |

Shrimp farming plays an important but controversial role in the economic development of many countries in Asia because of high economic returns and often catastrophic environmental impacts of production in coastal region (Anh et al., 2010). Bangladesh is one of the shrimp producing countries in the world. Bangladesh enjoys advantages of natural setting for shrimp culture (Sohel and Hadayetullah, 2012). 90% of crop land has been converted from agricultural uses into shrimp ponds in the southwest coastal region of Bangladesh (Swapan and Gavin, 2011). The shrimp production requires saline water as an input to a shrimp pond. Prolonged saline water logging in shrimp ponds accelerates leaching of base minerals, and increase salinity and acidity of soil. Salinity and acidity of soil are responsible for creating the adverse effect on the coastal environment, damage to the traditional agriculture system and rapidly change the socio-economic scenarios in this region. This study carried out through questionnaire survey in the shrimp pond abundant areas of southwest coastal region of Bangladesh and attempts to assess the impact of land transformation from crops farm to shrimp pond. Depends upon the collected household micro cross-section data, electrical conductivity data, Cobb-Douglas function, and GPS information, this study quantify the various impacts of land transformation and making the map of study area. The major findings identified as human health, and crop ecology are badly hampered by land transformation from crops farm

NUMBER	TITLE	AUTHORS	COUNTRY

to shrimp pond, and increase social conflict between shrimp farmers and crop farmers. The findings of this study provide robust basis for policy makers, researcher, government, stakeholder to give clue for further research and make more specified policies in this field and improve regional agrarian economy of the southwest coastal region of Bangladesh.

0511	Community governance of extreme events on the south west coast of Jamaica	Tracy-Ann Hyman	Jamaica

The Bluefields community (population size ~5000) is located on the southwest coast of Jamaica. Major economic activities of its residents include fishing, farming and tourism. The community is prone to storms, hurricanes and rainfall extremes which have led to flooding, landslides, beach erosion and drought, and which have impacted infrastructure and livelihoods. The projected effects of climate change in Jamaica include warmer days and nights and temperature increases of 1.1°C to 3.5°C by the end of the century, as well as decreased total rainfall and more intense hurricanes. Climate Change will further exacerbate existing hazards in Bluefields due to its bio-geophysical characteristics and dependence on climate sensitive sectors.

Though the Bluefields Peoples Community Association has established a sustainable development programme, they acknowledge that hazard mitigation is a missing component. Research shows that community based approaches to disaster risk management, as opposed to 'top down' efforts of national agencies, are integral in mitigating against devastating events. In this study the community's preparedness and response strategies to hydro-meteorological hazards will be analysed; response scenarios of fishermen and farmers to hurricane warnings, communication systems, transportation routes, timing of warning broadcasts, and impact reduction techniques, will be inputted into an Agent Based Model (ABM).

The aim of this (ABM's) is to assist the community with emergency planning and management interventions, with the use of a modeling tool. ABM's are computer simulations that can capture the decisions of stakeholders and their interactions with the environment or other stakeholders. It is expected that the information gathered will influence the National Disaster Management Structure in Jamaica. This work is being undertaken as part of a Fulbright Nexus programme.

0515	The impact of changes in land use and agricultural practices on water-related agroecosystem services in peri-urban watersheds in central Mexico	Leendert van Wolfswinkel, Diego Valbuena, Jeroen Groot, Santiago Lopez-Ridaura, Pablo Tittonell	The Netherlands

The use of more appropriate agricultural practices may contribute to the provision of ecosystem services from agriculture (agroecosystem services, AES), such as flood and erosion control and water quality, while at the same time achieving farmers' own objectives. In peri-urban areas, water management is particularly challenging, and agriculture is intricately intertwined with urban activities. The presented research aims to understand and quantify how land use/cover changes affect water-related AES, focusing on agricultural land use. This is examined in an ongoing case study in peri-urban central Mexico, considering such changes over the last 30 years. Multiple water-related AES are taken into consideration, based on a structured assessment of stakeholders preferences for these services. Selected AES include: (i) providing sufficient, good quality surface and groundwater; (ii) regulating water discharge peaks, i.e. flood prevention; (iii) supporting a stable soil that is resistant to water erosion. It is hypothesized that urbanization, as the most important driver of land use change in this case study, has led to a significant deterioration in the provision of all water-related AES. Three main methods to test this hypothesis are triangulated: stakeholder perceptions of change (oral histories, key informant interviews), statistical analysis of historical data (remote sensing imagery, secondary data on the above-mentioned AES), and

NUMBER	TITLE	AUTHORS	COUNTRY

simulations using the USDA's Soil and Water Assessment Tool (SWAT). This case study contributes to understanding the value of multifunctional agriculture for water management in (peri-)urban watersheds.

This presentation contributes to theme 3 of the conference (Impacts and Responses), as it assesses the impacts on water management of a major driver of global land use change (i.e., urbanization) and urbanization-related changes in agricultural practices. As a case study in a peri-urban area, it fits well with session 0009 "Land use change and ecosystem services in peri-urban area".

0516	Monitoring drivers for REDD+: status and options	Veronique De Sy, Martin Herold	The Netherlands

Under the United Nations Framework Convention on Climate Change (UNFCCC), negotiations are in progress to develop a mechanism to reduce emissions from deforestation and forest degradation, and enhancing forest carbon stocks in (sub)tropical non-annex I countries (REDD+). A national measurement, reporting and verification (MRV) system is required which follows the international Good Practice Guidelines of the Intergovernmental Panel on Climate Change (IPCC). Accurate and robust methodologies to estimate emissions from deforestation and forest degradation are crucial for the effectiveness of REDD+. Remote sensing, in combination with ground measurements, is commonly considered an objective, practical and cost-effective solution for developing and maintaining REDD+ MRV systems. The need for data on drivers and activities causing forest carbon change has been highlighted as a central component in REDD+ readiness efforts.

Monitoring drivers (e.g. deforestation by agricultural expansion, fuel wood extraction etc.) for REDD+ puts an emphasis on monitoring and tracking human activities. Remote sensing can help to provide information on follow-up land use, type and intensity of land changes, and shape and pattern of deforestation and degradation; which can generate understanding about proximate causes and drivers of deforestation and forest degradation. The 2010 global remote sensing survey of the FAO Forest Resource Assessment will be used to quantify and assess regionally specific deforestation and degradation drivers, by the interpretation of forest change patches and follow-up land use in deforestation areas (FAO & JRC, 2012). These improved estimates generates novel opportunities for analyzing relationships among specific drivers of deforestation and national circumstances, and for identifying underlying causes of deforestation. Assessing drivers is important for designing and implementing REDD+ policies and adjusting reference (emission) levels to national circumstances. The types of drivers will have great influence on the choice of data sources and monitoring approaches, as well as the need for engagement with other (non-forest) sectors and broader development objectives such as national mitigation actions or low carbon development strategies.

The objective of this research presentation is to give an overview of regionally specific drivers of deforestation based on a pan-tropical remote sensing assessment, the role of drivers of deforestation and forest degradation and the implications for forest monitoring and the measurement, reporting and verification of REDD+ activities. We anticipate that this presentation will contribute to the understanding of forest carbon change impacts related to deforestation and forest degradation and the options to measure and monitor these impacts.

0518	An agent-based model to simulate encroachment dynamics in Pyrean agro-pastoral ecosystems	Laure Vacquie, Thomas Houet, David Sheeren	France

European mountain landscapes have experienced massive land-use change for the past sixty years and continue to experience extremely high rates of natural reforestation, encroachment and changes in agricultural land-use. The strong decrease of production activities and agro-pastoralism pressure due to rural depopulation of the French Pyrenees raise major environmental and societal issues. Uplands are particularly sensitive to those dynamics since their natural state is entirely dependent of agro-pastoral

activities. A multi-agent model was developed to simulate uplands land cover evolution in regard of grazing activities. By providing a detailed assessment of both natural dynamics and human governance, such model offers a clear overview of local drivers and their repercussions through specific agro-pastoral systems. To simulate human-natural interactions at fine scales, knowledge from local experts and landscape ecology/agricultural sciences have been combined. In a first step, local knowledge from the Pastoral Federation of Ariege provided specific grazing patterns and pastoral rules to simulate cattle behavior. The "natural" evolution trends were derived from assessments of land-use land-cover change (LULC) since the 1940s, providing with specific knowledge of transitions types and rates occurring in mountain areas. By integrating local agricultural specificities and LULC knowledge, this model is expected to be generic and easily reproducible on any landscape considered relevant by any local actor. Once the model adapted to the current agro-pastoral dynamics, scenarios were used to assess the impact of specific grazing management strategies on land cover evolution and more specifically on encroachment and natural afforestation of grasslands and pastures. To simulate alternative short and long-term management strategies of pastorals lands, several variables were developed at different space scales such as a rising of temperatures allowing for an extended use of pastoral lands (global scale), an increase of cattle number (regional scale) or local strategies increasing agro-pastoral pressure on specific uplands to limit encroachment dynamics (local scale). By assessing current landscape dynamics, this model allows for local actors to take further actions in order to preserve specific pastoral lands from spontaneous reforestation.

As part of the "Coupled human-natural system models for the assessment of the dynamics and resilience of mountain socio-ecological systems" session, this poster intends to underline the necessity for coupled model to take into account knowledge from various spatial and temporal scales to better evaluate upland sensitivity to human activities and better simulate future land cover evolution.

Number	Title	Authors	Country
0525	Spatial modelling of livestock grazing impacts on the amount of vegetation in Mongolia	Izuru Saizen, Narumasa Tsutsumida, Reiichiro Ishii, Masayuki Matsuoka, Eiichi Kusano, Norio Yaamura	Japan

In arid and semiarid regions, dry ecosystems are highly controlled by climatic events and patterns, especially related to rainfall. Forage and grassland productivity is mostly affected by rainfall and relatively unaffected by biological factors such as grazing by livestock and herbivores. In recent times, climate change has, however, made the dry steppe ecosystems more vulnerable to grazing and shifts in temporal biomass patterns have posed potentially significant implications in grazing management. In Mongolia, some previous studies also pointed out that increase in the density of livestock could become or be one of the reasons for grassland degradation.

A significant problem in assessing grazing effects is the difficulty of conducting large-scale experiments. Previous experiments have been conducted mainly in chambers or sample plots to examine the interactive effects of rainfall and livestock grazing by domestic animals. Grazing has a significant impact on vegetation processes, accordingly it is important to include grazing in studies of ecosystem responses to climatic events at a large scale. The objective of this study is to explore and determine the impacts of grazing on vegetation indices in Mongolia using spatial modelling technique.

The study area covers Ulaanbaatar and 10 aimags, provinces of Mongolia, namely, Arkhangai, Bulgan, Darkhan-uul, Dundgovi, Govisumber, Khentii, Orkhon, Ovorkhangai, Selenge, and Tov. An NDVI index

was generated using a 5-day composite NDVI dataset based on daily MODIS observations, whereas rainfall data was acquired from APHRODITE water resources. The statistical data of livestock population by administrative boundaries called sum provided by the National Statistical Office of Mongolia was utilized for the analysis.

GWR (Geographically Weighted Regression) was applied and the presence of strong relationships between NDVI and rainfall was confirmed, which were consistent with recent works highlighting the effects of rainfall on NDVI in arid regions. Although these relationships were inevitable obstacles to explore the effects of grazing on grasslands in some parts of the study area, the effects of livestock distribution on grasslands were also able to be detected clearly and spatially by GWR in many areas. The results indicate the necessity for managing the number of grazing animals in such areas. It would be also important to develop techniques that can detect even slight relationship between NDVI and grazing effects, and overcome the strong effect of rainfall. Such studies would not only contribute to grassland management but also help realize sustainable nomadic herding of Mongolia for the future.

NUMBER	TITLE	AUTHORS	COUNTRY
0536	Empowering masses for land use land cover changes through arts and media: a case study of an Indian artist	Sushma Yadav	India

Environmental education refers to organized efforts to teach about how natural environments function and, particularly, how human beings can manage their behaviour and ecosystems in order to live sustainably. Environmental education is a learning process that increases people's knowledge and awareness about the environment and associated with land use land cover changes challenges, develops the necessary skills and expertise to address the challenges, and fosters attitudes, motivations, and commitments to make informed decisions and take responsible action. Environmental education includes:

- Awareness and sensitivity about the environment and environmental challenges in changing world.
- Knowledge and understanding about the land use land cover changes and challenges.
- Skills to mitigate the environmental problems raised through land use land cover changes.

The roots of environmental education can be traced back as early as the 18th century when Jean-Jacques Rousseau stressed the importance of an education that focuses on the environment in Emile: or, On Education. Several decades later, Louis Agassiz, a Swiss-born naturalist, echoed Rousseau's philosophy as he encouraged students to "Study nature, not books." These two influential scholars helped lay the foundation for a concrete environmental education program, known as Nature study, which took place in the late 19th century and early 20th century.

Planning must be applied to human settlements and urbanization with a view to avoiding adverse effects on the environment and obtaining maximum social, economic and environmental benefits for all. In this respect projects which are designed for colonialist and racist domination must be abandoned. To achieve this environmental goal will demand the acceptance of responsibility by citizens and communities and by enterprises and institutions at every level, all sharing equitably in common efforts.

Above objectives are being achieved through the participation of the students community and the viewers among the general public of the society. In India. It is a popular method to promote Environmental Education and Empowerment of the Rural Communities at Various regions of India. Presentation of my paper is based on the theme of the Arts, Media and community participation to save the Critical Environment and Ecosystem.

NUMBER	TITLE	AUTHORS	COUNTRY
0540	Evaluation of the lands use and environmental degradation in Brazilian savannah ecosystem, Distrito Federal, Brazil	Marilusa Pinto Coelho Lacerda, Helena Maria Ramos Alves,	Brazil

| | | Tatiana Grossi Chquiloff Vieira, Margarete Marin Lordelo Volpato, Vanessa Cristina Oliveira de Souza | |

The great economic and population growth in Brazil increases the demand for food and consequently the increase of agricultural activity, sometimes with uncontrolled exploitation of natural resources, contributing to the environmental degradation of regional ecosystems. The Brazilian Savannah Ecosytem is in this scenario, with increasing of agricultural activities, with intense replacement of various Savannah phytophysiognomies by agricultural activities. For the implementation of sustainable agriculture, with rational and sustainable use of lands, in Brazil is used in agricultural planning, the Evaluation System of Lands' Aptitude for Agriculture (Brazilian Land Suitability Classification System) The Distrito Federal (DF), inserted in the Savannah Ecosystem, already presents environmental problems due to indiscriminate lands use and occupation. The objective of this study was to evaluate the appropriateness of the lands use and occupation in representative areas of the agricultural occupation of the Distrito Federal (DF), to verify the sustainability of farming, using the techniques of Remote Sensing and Geographic Information Systems (GIS). Were selected two representative areas of agriculture in DF, consisting of the area called Brazlândia, representative of horticulture and area named Rio Preto, representative of grain production. Were generated lands use maps in these areas from supervised classification using maximum likelihood algorithm in satellite images Landsat TM5, SPOT 5 and ALOS AVNIR, through the ENVI software. The maps generated for lands use and occupation were correlated with soil maps and lands agricultural suitability for the two studied areas, generating the corresponding lands suitability use maps through the software ArcGIS 10. It was found that in both areas the soil most frequent is the dystrophic Rhodustox, with predominant use in agriculture, respecting the soils agricultural potential. Both Brazlândia as the Rio Preto, the lands proper use class is predominant, however were observed, improper use, in contradiction to the lands agricultural potential causing degradation of natural resources in both areas studied. The great development of urbanized areas was also observed in the two study areas, sometimes cluttered, causing considerable environmental degradation. Upon checking and validation of the products generated in the fieldworks, it was found that the major problems of environmental degradation are related to the disregard of environmental conservation standards and the settlements of small farmers without adequate agricultural planning, causing risks to the sustainability of lands in Distrito Federal, Brazil. The Remote Sensing and GIS are important tools for studies of changes in land cover and lands management.

| **0545** | Impact of grassland degradation and restoration on sand-fixation service function in Xilin Gol League | Guoli Gong, Quanqin Shao | China |

With climate warming and drying and irrational human activities, the problems of degradation and desertification of grassland ecosystem in arid and semiarid zones of northern China are very serious. Not only that, northern grassland is a major area for sand, the degradation of grassland exacerbated serious soil erosion hazards.After the year 2000, the heavily investment has been made in the development of ecological restoration and implement a number of major projects in ecological protection and construction, such as the treatment project of sandstorm sources of beijing and tianjin, the continuing degradation of ecosystems in some regions has been curbed.

Wind-blown mass transport related to the spatial variation of the wind erosion controlling parameters, e.g. vegetation cover, Soil moisture,snow coverage,soil crust and so on.In order to fully grasp the grassland ecosystem changes situation and achievements have been made in the ecological function-fixation sand at

NUMBER	TITLE	AUTHORS	COUNTRY

the beginning of the second phase of the treatment project of sandstorm sources of beijing and tianjin.This article intends to grasp the changes of the grassland ecosystem in Xilin Gol League, before and after the implementation of ecological engineering; reveal the impact factor and driving mechanism of the sand-fixing service function of the grassland ecosystem, analyze the impact of the change of grass coverage on the sand-fixing service function, establish the wind erosion modulus in Xilin Gol League.This poster is intend to identification the impact of grassland degradation and restoration on sand-fixation service function.

0547	A scaling-up methods for high-resolution land cover data in climate modeling	Yunfeng Hu, Jiyuan Liu, Xiaodong Yan	China

Since the 1990s, a series of global or regional land cover / land use datasets have been produced, such as GLC2000, NLCD, CLCD, et al. Such land datasets were usually interpreted from high-resolution remote sensing images, and the map scales can achieve 1:100,000 or an even better. The dataset quality is good in the aspects of spatial resolution and the classification accuracy.

While, in the usual climate modeling simulations, the models can tolerate a variety of data with a resolution between 30 km to 2°*2°. Due to the immense integral operations, the time- and hardware-consumption will increase exponentially when the grid of input data decreases, while the results wouldn't be obviously better due to the lack of instinct and reasonable mechanism expression in the fine scale. The underlying surface input data are usually potential, theoretic and static features.

So, if we can take full advantage of the long-term land datasets with high spatial and temporal resolution, and develop one suitable scaling-up algorithm to convert them to meet the requirements of climate models, it will definitely bring great benefits to the simulations.

There already existed some regular scaling-up methods, such as converting the grid center, converting the single feature with the largest area within a grid, converting the features with the largest combined area within a grid, getting a specific within a sliding window, et al. Researchers also tried to invent some complicated mathematical methods including geo-statistics and wavelet method. However, these methods do not always perform well in the aspects of output accuracies or time / hardware consumptions.

Here, the authors proposed a new scaling-up method based on regional area conservation principle. Such method involves 3 main steps: spatial statistics, type configuration, and grid allocation. Comparative analysis shows that: the output datasets can keep the physical geographic laws and spatial distribution patterns, while ensuring significant objects can also be represented. The authors offered a series of case studies in different regions and scales to prove the good features of the newly-invented scaling up method.

0548	Soil conservation function of different ecosystems in Loess Plateau of China in 2000-2010	Wei Cao, Quanqin Shao, Guobo Liu	China

Soil erosion by water is a serious global problem which will significantly threaten the global economic and environmental sustainability. By protecting soil from water erosion, terrestrial ecosystems played a very important role that supplied human beings with soil conservation service. The Chinese Loess Plateau is one of the regions in the world that suffered from severe soil erosion. The Chinese central government launched a series of projects for soil and water conservation in Loess Plateau. And the Grain-to-Green project, launched in 1999, was the most famous and massive one. In this study, the change of total and mean annual soil loss amount and soil loss rate after Grain-to-Green project from 2000 to 2010 in Loess Plateau of China will be calculated by Revised Universal Soil Loss Equation (RUSLE). The spatial distribution of soil erosion and the relationship between soil erosion and vegetation cover and slope gradient will be studied. And the soil conservation capacity, calculated as potential soil erosion (erosion without vegetation cover) minus actual soil erosion, with different ecosystems including cropland, forestland and grassland will be evaluated. And finally according to the results of the above aspects, the further solutions for soil conservation in Chinese Loess Plateau will be discussed. All the factors in

RUSLE are calculated by local dataset. To calculate the rainfall erosivity R-factor in RUSLE, the Chinese meteorological data of daily precipitation data recorded by 72 climatologically surface stations in Loess Plateau plus 61 stations around the region will be used. To get more accurate slope length and slope steepness factors (LS-factor), the ASTER GDEM V1 data with 30-meter resolution rather than SRTM3 V4.1 data with 90-meter resolution will be used due to the fragmentation of topography in Loess Plateau. For the computation of other factors (soil erodibility factor, cover and management factor) in RUSLE, the 1:1000000 National Soil Database of China and the MODIS NDVI (MOD13A2) products will be used.

0550	Characteristic scale analysis of DEM and NDVI in the Mongolian Plateau	Zhiying Xu, Yunfeng Hu	China

Scale is defined as the space or time unit for human observing, measuring, analyzing, simulating and controlling various natural processes, which is a passive choice when researchers carry out experiments and make analyses limited by certain objects, the technique of observation, the ability of models, etc. And selecting the appropriate scale and analyzing under multi scales are critical steps for further research, that arouses more and more scientists or other scholars involved in exploring and discussing the scale problems. As an emerging multi-scale analysis method, wavelet analysis was frequently applied in ecological, remote sensing and geographical researches, with its ability of dealing with and analyzing multi-scale, multi-level and multi-resolution problems.

On the other hand, partitioned by countries' boundaries and limited by the differentiations of scientific research directions, academic levels and techniques, the Mongolian Plateau is a deserved area to study that most researchers are confined to the Inner Mongolian region on Mongolian Plateau problems. This paper was aimed to study the relationship between DEM and normalized difference vegetation index (NDVI) in the Mongolian Plateau. The GTOPO30 dataset and MODIS NDVI dataset (MYD13A3) were utilized to calculate the wavelet coefficients and their variograms, examining the characteristic scale and the coupling relationship of DEM and NDVI along four latitudinal and longitudinal transects.

Based on 4 transect through the whole Mongolia Plateau, supported by wavelet transformation technique, this authors analyzed the characteristic scale of Mongolia Plateau and the coupling relationship between DEM and NDVI. The results showed: (1) The spatial variation of DEM in northern transect and western transect were stronger than that in the southern and eastern lines. And there existed one scale pattern of DEM distribution of around 20 km along latitudinal and longitudinal transects. (2) The spatial variation of NDVI in northern transect and western transect were stronger than in the southern and eastern lines. Two characteristic scales of NDVI distribution were identified, with a small scale of 2~4km and a larger scale of 20 km.(3) The variation of DEM and NDVI represent the topographic and ecological spatial pattern respectively. And the tightly coupled relationship between DEM and NDVI at 20 km scale indicates that the topography restrict the spatial pattern of ecosystem at a larger scale, whereas the desynchrony of the variances reflects that the distribution of ecosystem may be affected by the comprehensive impacts of terrain factors and other factors.

0552	Changes in the use of ecosystem services by local people: cause and consequences	Shoko Sakai	Japan

Utilization of ecosystem services by local people is rapidly decreasing and/or changing throughout the world with economic globalization, the prevalence of a monetary economy, and degradation of ecosystems. Potential causes and consequences of the decrease and changes, however, have rarely examined using quantitative sociological data. In this study, we investigate relationships between changes of the intensity of utilization of ecosystem services by local people and their environments including land covers in Sarawak, Malaysia as part of the research project of "Collapse and Restoration of Ecosystem Networks with Human Activity" (Research Institute for Humanity and Nature, Japan). In Sarawak, primary forests were exploited by indigenous people through swidden agriculture (slash-and-burn

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agriculture) and collection of wild animals and plants before the modern economic transformation, which started in the 1960s. In the last few decades, however, commercial logging and the development of oil-palm plantations have changed the land cover drastically. On the other hand, many indigenous people today have migrated to urban areas, or even outside of Sarawak. Village life has also changed in various ways, and local people depend on natural forests less and less. To investigate relationships between land cover changes and forest use, we conducted questionnaire survey in more than 90 villages. In addition, the proportion of the land covered by forests surrounding the villages was estimated based on the land cover map based on satellite images. We conducted GLMM (generalized linear mixed model) analyses with various forest uses as response variables and forest cover, remoteness, richness of households, and social relationships as explanatory variables. They suggested that decrease of forest cover at least partly explained decrease of use of forest products and swidden agriculture, while other factors also significantly responsible for the decrease. Activities such as hunting and swidden agriculture have played an important role to enhance accumulation of social capital in the area. It is possible that deforestation affects social capital of local villages through decrease of shifting agriculture and other forest uses. By multidisciplinary approach of collaboration of sociologists and ecologists, this study demonstrates extensive repercussions of land cover changes on lives of local people. Therefore, the study could contribute the conference theme of "Rethinking land change transitions". Since our research site is in Malaysia, the presentation may best fit the session "Progress of land change sciences in Asia".

NUMBER	TITLE	AUTHORS	COUNTRY
0555	Understanding the process of urban expansion in Ulaanbaatar, Mongolia	Narumasa Tsutsumida, Izuru Saizen, Masayuki Matsuoka, Reiichiro Ishii	Japan

Ulaanbaatar, the capital of Mongolia, has grown over the last decade. Owing to the dramatic transition from a planned economy to a free-market economy because of the collapse of the Soviet-backed regime in 1992, Mongolians are free from restrictions on internal migration and job selection. Consequently, many Mongolians in rural areas have migrated into urban areas, especially into Ulaanbaatar, to seek job opportunities and a better income, education and living environment. Many of residential plots have been rapidly developed in the peripheral area, called "ger-area". Unrestricted developments of ger-areas progress because of the clash of two different frames for dealing with lands between the current master plan and the land reform policy. The aim of this study is to detect land cover change by urban expansion and to find its driving force. We employ two spatio-temporal analyses. One is a Breaks For Additive Seasonal and Trend (BFAST) method which enables us to detect the location and the time of land cover change using Normalised Difference Vegetation Index (NDVI) calculated from MODIS time series during the period 2000–2010. This method detects land cover changes, which are distributed spatially in accordance with the extent of ger-areas, the internal development of ger-areas, and the land degradations by anthropogenic activities like the development of the earthen roads in Ulaanbaatar. BFAST also detects that the time of land cover changes basically tends to be later with the increasing distance from the city center. The other analysis is an autologistic regression model using high-resolution satellite images of IKONOS for 2000 and Quickbird for 2008. To focus specifically on the urban expansion phenomenon, we chose a study area in a fringe of Ulaanbaatar where the ger-area has been expanding during the last decade. High-resolution satellite images confirm that the actual distribution of residential plots is expanding since 2000. The autologistic regression model suggests that the driving forces of the new development of residential plots are the proximity to roads and water-kiosks which provide water for life in ger-areas, not the proximity to main roads, slope, and elevation. This study helps understand the

dramatic change of land cover and its driving force of the urban expansion in Ulaanbaatar. The results will contribute to the implementation of appropriate planning for dealing with urban expansion.

NUMBER	TITLE	AUTHORS	COUNTRY
0561	Modeling past and future land cover changes in the Pyrenean Mountains: a multi-scale / multidisciplinary approach	Thomas Houet, Mazier Florence, Sheeren David, Dejoux Jean-François, Vacquie Laure, Ducrot Danielle, Hagolle Olivier, Galop Didier	France

Fine scale and subtle LUCC are often underestimated as well as their environmental consequences (Houet et al. 2010a). Their analysis is therefore relevant (Lambin and Geist 2006), but remains a challenge, due to the granularity of such analyses. We assume their modeling must consider longer (historical) and larger (regional) trends for (1) better understanding past human-nature interactions and their consequences on LUCC, (2) identifying LUCC processes and dynamics (rate, direction, patterns, etc) and (3) exhibiting LUCC trends that would be considered implausible without this look backward. Based on these knowledge, assumption is made that future LUCC scenarios to potentially be more robust, plausible and original accordingly to the prospective 'scenario's method' (Godet 1986).

The MODE-RESPYR project (Modeling Past and future land cover changes in the Pyrenees - http://w3.moderespyr.univ-tlse2.fr/index.php) aims to identify ancient and contemporary past land cover changes and project future possible changes at various spatial and temporal scales applied on the Pyrenees. Pyrenees Mountains are an attractive experimental site and show high environmental stakes: they are concerned by sensible landscape changes (natural reforestation) and expect strong impacts of climate changes compared to others European mountains (IPCC 2007).

The methodology is based on retrospective and prospective modeling phases.

The retrospective modeling combines various spatial and temporal methods to identify land cover changes and their explanatory factors at three spatial and temporal scales: (1) at the regional scale over the last seven thousand years using palaeo-environmental data; (2) at the local scale, on three study sites (fig 1), over the last 60-200 years combining aerial photographs, historical maps, palaeo-environmental data; (3) at the regional scale over the last 15 years using high resolution satellite imageries. The use of models is necessary when using palaeo data to reconstruct land cover changes.

1. Davantaygue (76 km²)
— In the Peripheral area of the Pyrenees National Park
— 6 municipalities

2. Haut-Vicdessos (244 km²)
— In the Regional Natural Park of Ariège
— 7 municipalities

3. Garrotxes (85 km²)
— In the Regional Natural Park of the Catalan Pyrenees
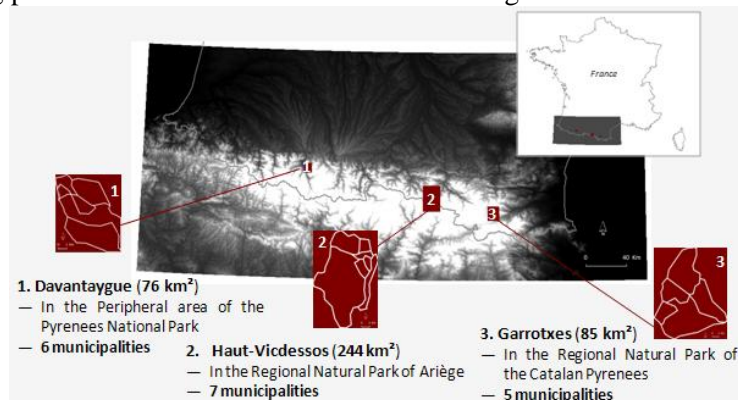— 5 municipalities

Figure 1: Location of the three study site of the Pyrenean Mountains

The prospective modeling, based on previous results, aims at building spatially explicit local / regional

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scenarios. To approaches are conducted: at the regional scale using the FORE-SCE model to consider climate change scenarios; at the local scale by combining two ABM models.

Results from the retrospective modeling show great complementarities between palaeo and land cover classification datas. It helps to improve the knowledge of contemporary LUCC and understanding main driving forces (fig 2.). Comparison of the three study sites illustrates the sub-regional LUCC differences (from West to East). This is completed using 2002 and 2009 regional land use/cover classifications made using multi-temporal Landsat synthesis.

This poster intends to give an overview of a multi-scale / multi-disciplinary approach combining various methods to better understand and simulate past and future forest changes in the Pyrenean Mountains.
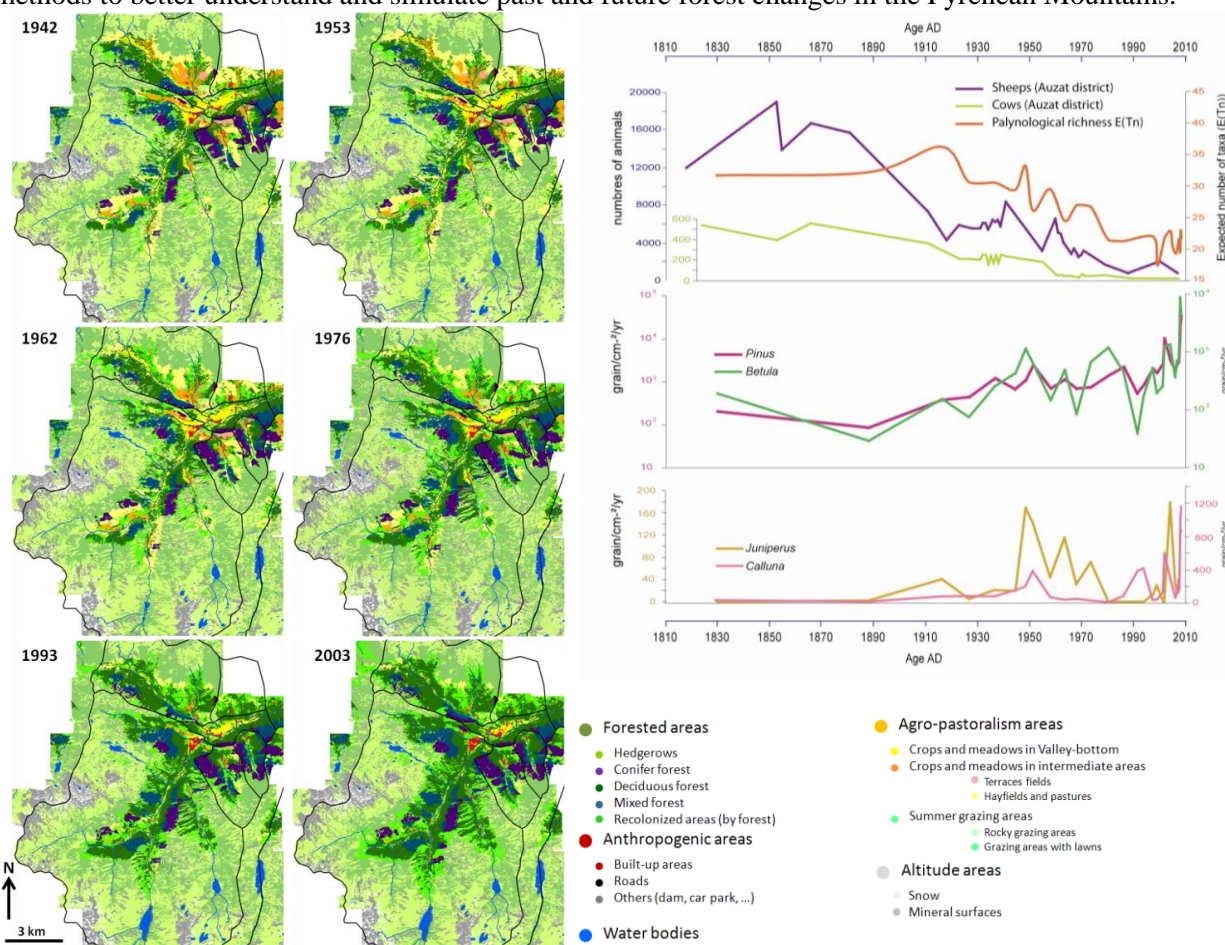
Figure 2 : Local contemporay forest changes dynamics and driving forces using palaeo and remotely sensed technics.

| 0568 | Impacts of urban expansion on local climate in Huang-Huai-Hai Plain of China during 1990-2010 | Guosong Zhao, Jiyuan Liu | China |

Since implementing the policy of reform and opening up, China's urbanization and urban economic develop quite rapidly, urban expansion is gradually becoming the dominant features of the land-use change in China. During 1990-2010, China is in a period of accelerated development of urbanization, especially in Huang-Huai-Hai plain with famous Beijing-Tianjin-Hebei metropolitan area and Yangtze

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River Delta metropolitan area included. To what extent will urban expansion in Huang-Huai-Hai plain impact local climate? And how? By answering these above questions, it can strengthen our understanding of the potential impact of urban expansion on surface climate. The regional climate model such as WRF, RegCM3, MM5 are useful tools to do climate change study. In this analysis, the weather research and forecasting model coupled with a single layer urban canopy model (WRF/UCM) is used to simulate the impact of urban expansion on regional climate, with temperature emphasized. Original land cover (LC) data are replaced by high accuracy datasets with 1km resolution produced by high resolution TM/ETM+ remote sensing datasets. Parameters of urban canopy are acquired by field observation or existing observation data. Two cases with different land cover data of 1990 and 2010 and the same climate driving data are compared to explore the climatic impacts of urban expansion. Then spatial and temporal patterns of mean surface air temperature change, diurnal temperature change are revealed. Finally, this study explained the effects of urban expansion on local climate from the degree of radiation and energy balance.

| **0571** | Land use effects on climate in East China as simulated by a regional climate model (RegCM4) | Ying Shi, Xuejie Gao | China |

A regional climate model (RegCM4) driven by NCEP2 reanalysis is used to investigate the climate effects of land use change over East China. Four sets of 20-year length simulations (1981~2000), one with real land use in 2000 (hereafter called CTL), the other three with the vegetation cover of the 1980 over the Northeast/Northwest/South (hereafter called NE/NW/SC, respectively) are conducted. Following the assessment of model performance by comparing the CTL simulation against observations, the climate impacts of land use change are evaluated from the difference between the simulations of NE, NW, SC and CTL. Results show that the current land use (modified by anthropogenic activities) influences local climate through the reinforcement of the monsoon circulation in both the winter (DJF) and summer (JJA) seasons. In winter, land use change in NE simulation leads to decreased precipitation and increased surface air temperature in Northeast China while for NW and SC, there are mainly on little change. In summer, a temperature increase over the middle of Inner Mongolia and south of Yunnan and a mixed change pattern of precipitation increase and decrease over the northern part of East China are simulated by NE. A decrease of temperature and an increase of precipitation can be found over the areas of land use changed in NW simulation. For SC, the change of temperature is the same as that in NW simulation while the precipitation change is similar to that simulated by NE. In general, the current land use in East China leads to more significant changes in summer compared to winter, especially the temperature change over the northern part of the domain. In addition, both daily maximum and minimum temperatures are also affected by land use.

| **0577** | Impacts of reclamation on the surface radiation forcing in China North in the early 21st century | Jia Ning, Jiyuan Liu, Jun Zhai, Lin Huang, Quanqin Shao, Jiangwen Fan | China |

Global climate change is the current hot issue, the root cause of which is the break of Earth's energy balance. The study of land cover change on surface biophysical parameters, especially radiation forcing impacts, is an indispensable part of comprehensive understanding of climatic effects caused by human activities, and also the base of further analysis of surface energy distribution (such as latent heat and sensible heat change). In the early 21st century, a large area of reclamation appears in China North, whose impacts on energy balance can't be ignored. Reclamation mainly distributes in Sanjiang Plain, Northeast China Plain and the Tianshan Mountains, and mainly transformed from grassland and forest. In our study, we quantitatively calculated the radiation forcing of reclamation by changing the surface albedo and emissivity in China North form 1980s to 2010, and analysis the impacts of the reclamation on surface radiation balance from the point of view of the energy balance. Surface albedo is influenced largely by

snow cover, and there is a large proportion of snow cover in the Northeast region and northern Xinjiang, about 0.30-0.35. So, combined with snow albedo and no snow albedo calculation, we find reclamation led albedo both increase and decrease, depending on the land types changed into farmland, that is, forest reclamation will increase significantly albedo, while grassland reclamation will decrease albedo. Emissivity is less affected by snow, and reclamation leads to increased emissivity. There is a negative correlation between changes of the key parameters of surface albedo and emissivity with the shortwave and longwave radiation forcing budget. The correlation between total radiation forcing and surface albedo is much larger than the surface emissivity. The direction of radiation forcing changes has less relevant with the area of reclamation, but is closely related to the reclamation types. In the Northeast region, reclamation in Sanjiang Plain caused a negative radiation forcing, while it shows a positive radiation forcing in the central and southern of Da Hinggan Mountains, mainly because the different types of reclamation lead to different albedo. In addition to surface albedo and emissivity, reclamation significantly alters other surface biophysical parameters, such as surface roughness and, thus, changes radiation forcing.

0579	Towards a sustainable use of soil in peri-urban areas - an inverse approach	Jonas Schwaab, Maarten van Strien, Adrienne Grêt-Regamey	Switzerland

The pace and scale of the demand for land is increasing worldwide, as population becomes urban, lifestyles change, and industrial agricultural practices are intensifying. Although, there is a large amount of policy instruments available for spatial planners, none of these instruments has proven to be effective in the preservation of the resource soil at the fringes of urban areas. A great variety of land-use models have been designed to simulate the expansion of urban area. Most of these models use traditional forecasting approaches, which are based on dominant trends and are therefore unlikely to generate novel solutions. Articulating desired futures first and using them as a guide for designing and implementing measures, as inverse modeling techniques suggest, can facilitate generating innovative transitions towards a sustainable land use. Planning from a future vision, inverse modelling techniques can be used to find trade-offs between ecological and socio-economic variables.

We follow the approach of using inverse modelling techniques and implement them together with a cellular automata in a Swiss peri-urban area. This novel approach combines the strengths of the well-established concept of cellular automata, which is used as a robust forecasting instrument, and the inverse modelling methods which are addressed to steer land-use change towards a future desired by stakeholders. We will present the conceptual model, and some preliminary results of the model inversion showing the necessary trade-offs between ecological variables including ecosystem services and socio-economic variables for reaching desired urban development. Furthermore, we will highlight the strengths of the concept of inverse modelling and possibilities to link this approach to well established concepts of forward modelling. These first research steps are embedded in a large Swiss National Research Program "Sustainable Use of Soil as a Resource" and will serve as a basis for formulating innovative policy solutions for sustainable soil use that respect the country's fundamental diversity.

0581	Implementing landcover modeling as a spatial planning tool to assess scenarios of landslide exposure - a case study in Lower Austria	Catrin Promper, Thomas Glade	Austria

Widespread landslides are dependent on many predisposing, triggering and controlling factors. Hereby, in particular land cover change is influencing the spatiotemporal patterns of landslides as well as elements at risk and the consequent exposure. These patterns are influenced by climate and anthropogenic changes. Hypothesizing that the anthropogenic influence has a larger influence on land cover change in the study

area than climate change, spatial planning tools will be incorporated in the land use modeling. The objective of this analysis is to develop a concept on how a land cover scenario based on the spatial development plan might modify possible future landslide susceptibility as well as exposure of elements at risk to landslides.

This concept is tested in the case study Waidhofen/Ybbs, a district located in the south east of Lower Austria in the alpine foreland. It is characterized by smooth slopes with scattered settlements in the north and the city of Waidhofen in the center along the river Ybbs. The South is characterized by steep slopes with a limited building area. The prevailing land cover types are forest and grassland.

The future land cover modeling is conducted with the model Dyna-CLUE (Verburg and Overmars, 2009). The demand is based on specific spatial development scenarios developed for Austria up to 2030. The spatial development plan will be incorporated according to e.g. specific restrictions or location factors like accessibility.

The expected results will then be compared to spatial development scenarios prepared without spatial planning regulations based mainly on demands for the study area. This comparison may highlight locations where further analysis is needed to enable improved sustainable planning and adaptation to future global change . Thus it might be a first step towards a strategic tool in spatial planning.

0583	Analysis of land-cover transitions based on historical topographic maps — Take western Jilin province for example	Yuanyuan Yang, Shuwen Zhang, Yan Lv, Shuying Bai, Jiuchun Yang	China

Historical cartographic materials are useful for retrospective analysis of land cover patterns and their change over time (e.g., Kienast,1993; Petit and Lambin,2002). Historical topographic maps, containing land-cover information as a time-layer, serve as a basis for the reconstruction of the past land use and land cover, especially when they are used in a geographic information system (GIS). The objective of this study is to reconstruct past land use and land cover of western Jilin province in the 1930s and 1950s based on historical topographic maps (1954 maps on the scale of 1:100,000; 1935 maps on the scale of 1:50,000 and 1:100,000), and then we analyzed the land-cover transitions. This could provide an important research idea for studying historical land use transitions before the advent of the earliest satellite, launched in 1972 and lay a solid foundation to make intelligent choice for the future and utilize land resources sustainably as decadal to centennial land-cover change have been consistently singled out as a key element and an important driver of global environmental change (Turner Ⅱ,2007; Foster *et al*.2003; Gragson and Bolstad, 2006).

Historical land-cover data, described as areal features, can be extracted from historical topographic maps, while linear feature and point feature could offer supplementary information for areal feature as indicative symbols. For example, well is a sign of habitation while it could indicate the place is far away from the saline. Generally, we extract the land-use and land-cover information based on the following principles: (1) The land-cover with certain boundary, such as river, lake and wetland, *etc*, could be digitized and extracted directly from the historical topographic maps in strict accordance with their boundaries; (2) Neighborhoods and areal water in accordance with the scale of the map should be digitized in strict accordance with the map's standard; (3) Contours should also be considered in the process of digitalizing wetland and sand, *etc,* as these land covers' distributions are closely related with topography. For example, wetland often distribute in the relatively low location while the location of sand is generally higher than that of wetland and lower than that of arable land; (4) Shrubs locate in the hillside and the terrain is generally lower than that of the sparse woodland, so we could digitize them combined with terrain. As for the mixture distribution of shrubs and sparse woodland, the land-cover type could be

identified according to the density of various land-cover symbols; (5) Most grass distribute mixedly with wetland, shrubs and cultivated land, *etc*, which could be lastly extracted from the historical topographic maps. (6) Extracting cultivated land should consider settlement place, road network and contour.

To improve the interpretation accuracy of the topographic maps, there are five methods that could achieve it. (1) Different land-use types should take the different interpretation methods (Referencing to the above extracting principles). (2)The topographic maps at different scales, in the same period, should be combined. The maps with large scale reflect the surface features comprehensively and accurately. (3)The topographic maps with different draw purposes should be combined. The topographic map at the scale of 1:50,000 in 1935 was made by Japan for military purposes and only some land covers that need to be emphasized have the boundaries, such as arable land, while the topographic map at the scale of 1:100,000 focused on the description of natural landscape and the arable land do not have certain boundaries. (4)The topographic maps should be combined with other thematic maps, such as geological map, geomorphologic map, soil map, vegetation map, *etc*, as these maps reflect the region's natural background conditions from different angles. (5)The topographic maps in different periods should be combined and then we can use their complementary relationship. (6)We could interpret the land cover from the topographic maps combining other multi-source data.

Taken together, it has been published that the best way how to make these data more accessible, is to scan original topographic maps at high resolution (this is necessary due to the high requirements for interpretation purposes and the quality of the old maps), rectify them, choose control points, resample(e.g., using polynominal equations) in a raster-based GIS to get the best fit, georeference and digitize them in vector format, extract land-cover information based on the above principles and publish them within the frame of web map services. If the result proved to be unsatisfactory, new control points were chosen or uncertain control points were omitted, and the transformation was repeated. The use of maps with GIS methods has been considerably broadened by digitization, and by the general availability of these maps in electronic form. The quality of the research depends on the accuracy of the historical maps and their potential to be integrated in a GIS.

| 0584 | Land use change and ecosystem services associated with oil palm landscapes in Sumatra, Indonesia | Ando Fahda Aulia, Andrew C. Millington, Harpinder Sandhu | Australia |

Palm oil is amongst the leading vegetable oils in terms of global production and consumption due to the growing demand by food and non-food industries. Indonesia is the world's largest palm oil producer and has been the most dominant palm oil exporter since 2008. The oil palm industry contributes 4.5% to the national GDP in Indonesia. Yet, the industry is highly vulnerable to accusations that it is not ecologically sustainable even if it appears to be economically sustainable. Moreover, the oil palm farming often has to deal with critical environmental risks such as land cover change, loss of biodiversity, changing carbon dynamics, and impacts on soil and water quality. An analysis of ecosystem goods and services (as benefits) and impacts (as disservices) of oil palm farming can provide information to understand the role of oil palm industry in maintaining and improving socio-economic and environmental sustainability.

This study identify, assess and value ecosystem services (and disservices) associated with the oil palm plantations in Riau, Sumatra, Indonesia. First we identified ecosystem services (and disservices) associated with oil palm landscapes and classified them into four categories; provisioning, regulating, cultural and supporting services. Second, we surveyed 75 households (hh) cultivating oil palm in four different landscapes; foothills in Ujung Batu (14 hh), plains in Petapahan (20 hh), lower foothills in Bukit Harapan, Kerinci Kanan (15 hh) and peat swamps in Bunga Raya (26 hh). Surveys revealed households' sources of livelihood and income generated from oil palm and other sources. Across all the four

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landscapes, majority of the households are dependent on oil palm to meet 80% of their income. The major drivers for taking up oil palm farming identified in this study are transmigration policies, land suitability, land tenure and management practices. The information from household surveys is used to assess and value ecosystem services associated with oil farming. It concludes with discussion on the impacts of land use change by oil palm plantations on ecosystem services and socio-economic sustainability of rural households. This poster will contribute to the conference theme 3 (impacts and responses) by providing information on the impacts of current and ongoing land use change by oil palm plantations and their linkages with socio-economic outcomes for rural households in Indonesia. It will also contribute to the proposed session by providing information on multiple benefits in terms of ecosystem services associated with oil palm plantations.

NUMBER	TITLE	AUTHORS	COUNTRY
0586	Prehistoric land use in southern Loess Plateau reconstructed from archeological data by a new developed model	Yanyan Yu, Zhengtang Guo, Haibin Wu	China

Estimation of land use during the Holocene is crucial to understand impacts of human activity on climate change in preindustrial period. Until now it is still a key issue to reconstruct amount and spatial distribution of prehistoric land use due to lack of data. Most reconstructions are simply extrapolations of population, cleared land amount per person and land suitability for agriculture.

In this study, a new quantitative prehistoric land use model (PLUM) is developed based on semi-quantitative predictive models of archeological sites. The PLUM is driven by environmental and social parameters of archeological sites, which are objective evidences of prehistoric human activity, and produces realistic patterns of land use.

After successful validations of the model with modern observed data, the PLUM was applied to reconstruct land use from 8 to 4 ka B.P. in Yiluo and Wei valleys, southern Loess Plateau. Both of them are the most important agriculture origin centers in northern China. Results reveal that about 9% of land areas in both valleys have been used by human activity from 8 to 4 ka B.P., expanding from gentle slopes along the river to hinterlands of the valleys. The land cover was affected by increasing agricultural land use during the middle Holocene.

The extensive spreads of land use since 7 ka B.P. in both valleys were driven by the combined impacts of population increase and agriculture development, which was further favored by wet and warm climate conditions during middle Holocene; while the decreasing rates of land use expansions after 5 ka B.P. were mainly induced by improved agriculture technology.

With the scaling up of PLUM to larger regional or global levels by a greater use of archeological data, the impact of human land use on global change can be studied more accurately.

This session 084 assembles a number of long term case studies and highlights trajectories in individual countries as well as cross-country variation through time, our land use reconstruction at long timescale shows both the improvement in methodology and a case study in China.

NUMBER	TITLE	AUTHORS	COUNTRY
0595	Study on evaluating and zoning of intensive utilization of the cultivated land in Heilongjiang Province	Du Guoming, Liu Yansui	China

The farmland natural subsystem and social economic subsystem combine with each other within a certain geographical region, constitute the regional cultivated land use system. It has specific internal structure and exhibits specific ecological function, economic function and social function, is a concentrated reflection of the regional man-land relationship. Level of intensive use of the cultivated land resources directly affects the effectiveness of the regional agricultural production, food production farmers' income and ecological environment quality. Objective analysis of regional differences and influential factors as well as proposition of mode and distribution of intensive utilization of the cultivated land would provide a

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basis for regional agricultural development. Heilongjiang province is vast. The province's total cultivated land area occupies more than 1/10 of the whole country. The average cultivated land area is 3 times of the national average level. In 2011, total grain output and commodity grain output were the first in the country. Taking the county as evaluation unit, this article will give evaluation on the issue of intensive utilization of the cultivated land of Heilongjiang Province based on entropy method and evaluation model of "PSR" frame construction. The main conclusions are as follows: first, in the process of cultivated land system use, "PSR" model can well characterize the man-land relationship in the intensive utilization of cultivated land. "Pressure" is a variety of investment in using the cultivated land. "State" is the cultivated land use level, "Reaction" is the production condition of the cultivated land. Second. the degree of intensive utilization of the cultivated land of Heilongjiang province takes on positive skewness distribution, and the intensive utilization on the whole stays at a low level. Since the intensive utilization level among prefectural region has significant spatial correlation, aggregation and imbalance, it shows significant regional differences. The intensive degree is high in main cities and their surrounding counties, in Sanjiang Plain and the south and east of Songnen Plain and in the south of Heilongjiang province. Third, the factors of intensive utilization of the cultivated land of Heilongjiang Province –the investment intensity, utility state and efficiency differ among different regions. Fourth, the location condition, natural features and economic condition are the main reasons which caused the spatial difference. Fifth, intensive utilization of cultivated land in Heilongjiang province should be divided four regions: Sanjiang plain region, Songnen plain region, mountains and hilly region and surrounding region of large and medium-sized cities, where take scale management mode, union-service management mode, characteristic management mode and compound management mode differently.

| 0596 | Impacts to human wellbeing induced by coupled land-use & moisture recycling changes | Patrick Keys, Lan Wang | USA |

Moisture recycling studies have recently demonstrated the surprising connections between land-use changes inducing changes in precipitation downwind. Much has been speculated regarding the potential impact that moisture recycling changes could have on human well-being downwind, particularly human societies whose livelihoods are directly reliant on ecosystem services (e.g., farming, forestry, pastoralism). Nonetheless, the specific social and ecological mechanisms that connect changes in land-use upwind to changes in human well-being downwind are as yet poorly understood (Keys et al. 2012).

This study aims to bridge the fields of land-use changes and moisture recycling with human well-being research to provide a nuanced analysis of how land-use changes could potentially affect human societies dependent on moisture recycling.

In collaboration with others, this work employs the coupled Simple Terrestrial Evaporation Model (STEAM) and the Water Accounting Model (WAM) approach to provide estimates of changes to precipitation availability. Using a set of specific case study regions, we identify the quantitative consequences to changes in human well-being resulting from potential changes in precipitation availability. To do this, we employ a globally gridded, human well-being model that translates the changes in rainfall to changes in human well-being. Finally, strategies for responding to the impacts to well-being will be evaluated in a case-specific basis. Based on the results, we conclude with a discussion of management responses and implications.

This research fits into the *Impacts and Responses* theme due to its focus on (a) the impacts of land-use change on human societies, and (b) how societies can respond, if necessary, to negative impacts. This research specifically fits the agenda of the session *Moisture recycling - downwind impacts of land-use change* because of its focus on moisture recycling as the bridge between land use changes upwind and impacts to human well-being downwind.

| 0604 | Micro-satellite constellation, a future tool for | Yukihiro Takahashi | Japan |

global monitoring

Micro-satellite with a weight of 50-100 kg has various merits compared to middle or large sized satellite, that is, 1) low cost fabrication compared to middle or large sized satellite, namely, few M EUR including BUS and mission payloads. The launch cost will be 1-2 M EUR as piggyback, 2) quick fabrication: about one or two years for flight model would be sufficient, enabling application of the latest technologies, 3) on-demand operation, taking detail information at a point of interest, and 4) the low cost and quick fabrication make us possible to launch not a small number of satellites, which is called as constellation flight.

The constellation of micro-satellites realizes a frequent monitoring from the low earth orbit. If we inserted 48 satellites into proper orbits, we can watch any location in the world every 7-8 min, which could be dedicated efficiently to time-variable phenomena, such as flood, thunderstorm, forest fire and Tsunami. Another important aspect of micro-satellite is the advanced technology of payload sensors. LCTF, liquid crystal tunable filter, enables the super multi-color imaging at several hundreds of wavelengths without image distortion due to the unstable attitude of spacecraft. Bolometer array sensor technology makes it possible to take image in mid-infrared band range around 10 um without cooling system, meaning lightweight and less power consumption.

We would suggest the establishment of such "smart remote-sensing" with super micro-satellite constellation, making use of advanced sensors, under international collaboration in the near future.

NUMBER	TITLE	AUTHORS	COUNTRY
0607	The status of saline-alkali land in semi-arid Northeast Asia: expansion and relative causation	Jiuchun Yang, Shuwen Zhang, Kun Bu, Liping Chang, Junmei Tang	China

Since the saline-alkali land is known as the waste land with hardly any production at all, and unintended environmental consequences and social disbenefits would be induced to salinization (Hussain and Hanjra, 2004), it has been always the hot object to focus. Now the findings that desert saline-alkali soil could be socking away large quantities of CO_2 in an inorganic form (Luo et al., 2007), which would contribute to the well-known problem of "carbon black hole" (Richard, 2008), reinflamed the extensive interest of international academia. As one of the greatest environmental threats facing globally, especially the arid and semi-arid areas, salinization and alkalization is the concurrent result of harsh natural conditions, i.e. strong soil water evaporation, high water table and much dissoluble salt and alkali, and inappropriate human activities that destroy the salt and water movement balances (Szabolcs, 1992；Wang, 2004). Many countries paid high attention to the monitoring, prediction, amelioration and development of saline-alkali "wasteland", particularly nowadays in the context of global food crisis.

However, due to limits of spectral confusions (Metternicht and Zinck, 2003) and availability of remote sensed data, quantitative reports on saline-alkali changes at regional scale for a long period is very few, hardly to reveal the earlier characteristics with less human interferences. And the contributing factors input the prediction models are mostly site sampling measured, with spatial variability at regional scale. The researches on geo-relationship between salinization/alkalization and human interferences, landforms and hydrogeological conditions are also numbered (Jordán et al., 2004; Fang et al., 2005). The objectives of this study were: 1) to investigate the extent and distribution of saline-alkali land in the western Songnen Plain, China; 2) to analyze the spatial and temporal characteristics of saline-alkali land in a long term; and 3) to assess the contributing factors of salinization/alkalization at regional scale and provide useful information for prediction and development of saline-alkali land.

This study quantitatively and spatially investigated the spatio-temporal dynamic characteristics of saline-alkali land in the Western Songnen Plain, China during the past five decades, using RS and GIS

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techniques. The results showed an expansion trend. The area of saline-alkali land increased significantly from 401.48×10^3 ha in 1954 to 1097.45×10^3 ha by 2010. The secondary salinized land mainly emerged during the period 1954-1976. It was mainly due to grassland and farmland salinized, and saline-alkali marsh and ponds becoming evaporated or even exhausted. And once the grassland, swampland and farmland in the Western Songnen Plain salinized, they were hardly to be restored. Salinizaiton / alkalization inner and outside the irrigation districts were both significant. And the results also indicated expansion trends towards higher elevations and deeper water table. Although most of the expansion trends of saline-alkali land in Western Songnen Plain were individual, the management ways of other countries suffered salinization (e.g. Australia) provide useful references. And this study will contribute to decision-making regarding reasonable development of land and environment protection associated with global food security and sustainability.

| **0609** | Impact of decentralisation on deforestation: the case of Central Kalimantan Province, Indonesia | Aritta Suwarno | The Netherlands |

Indonesia has undergone a process of rapid and far-reaching decentralization since early 1999, just after the reformation era. This reform applied in many sectors, including forestry, and changes the mandate of forestry sector in district level by granting district more authority of their forest management. Insufficient transfer of power, fiscal authority and various interests of stakeholders in decentralised forest governance influence their interaction in defining institutions, which affects land use management.

Central Kalimantan is the province in Indonesia that has suffered the second highest rate of deforestation in recent years. In the period of 2000-2008 this province contributed approximately 0.9 million ha of the total forest lost in Indonesia (Broich et all., 2011). Deforestation in Central Kalimantan is driven by a range of economic, institutional, social, ecological, and infrastructural factors. One of the key issues in this context is the effect of the decentralisation policy implemented in Indonesia since 2000. This policy has substantially changed the authority of different levels of government over natural and forest resource management and has been pointed out as one of the underlying causes of deforestation (Casson, 2001; Colfer and Capistrano, 2005; Ribot *et al*., 2006, Béné and Neiland 2006; Larson and Soto 2008).

This study investigates how institutional factors, and in particular the recent decentralisation policy in Indonesia, have influenced land management at the district level. We apply stakeholder and institutional analysis to understand the current condition of the institutional system of decentralised forest governance and its effect on forest governance performance, using deforestation as an environmental indicator. Study was conducted in 10 sample districts and 1 sample municipality in Central Kalimantan Province, Indonesia.

The objective of this paper is to analyse the impact of the recent decentralisation in Indonesia on deforestation rate at the province level. This paper therefore investigates how institutional factors, in particular the recent decentralisation policy have influenced land management and forest conservation in Central Kalimantan.

This research applies stakeholder and institutional analysis to understand the current condition of the institutional system of decentralized forest governance and its effect on forest governance performance, using deforestation as an environmental indicator. Specifically, we study changes in deforestation rate at the district level, and examine how they relate to decentralisation and some bio-physical indicators. The scope of our study covers a sample of 10 districts and 1 municipality in Central Kalimantan.

| **0614** | Estimation of croplands in west Africa using global land cover and land use datasets: preliminary results | Pradeep Adhikari, Kirsten de Beurs | USA |

Africa is vulnerable to the effects of global climate change resulting in reduced agricultural production and worsening food security. Studies show that Africa has the lowest cereal yield compared to other

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regions of the world (Funk and Brown, 2009). The situation is particularly dire in East, Central and West Africa. Despite their low cereal yield, the population of East, Central and West Africa has doubled between 1980 and 2007. Furthermore, West Africa has a history of severe and long droughts which have occasionally caused widespread famine. To understand how global climate change and land cover change have impacted crop production (yield) it is important to estimate croplands in the region. The objective of this study is to compare ten publically available land cover and land use datasets, covering different time periods, to estimate croplands in West Africa. The land cover and land use data sets used cover the period from early 1990s to 2010. Preliminary results show a high variability in cropland estimates. For example, in Benin, the estimated cropland area varies from 2.5 to 21% of the total area, while it varies from 3 to 8% in Niger. Datasets with a finer resolution ($\leq$ 1,000 m) have consistently estimated comparable cropland areas across all countries. Several categorical verification statistics such as probability of detection (POD), false alarm ratio (FAR) and critical success index are also used to analyze the correspondence between estimated and observed cropland pixels at the scales of 1 Km and 10 Km.

This study contributes to the theme of "Assessing Land Cover Change in Sub-Saharan Africa" more specifically to the usefulness of the existing land cover and land use datasets to identify agriculture area. This study analyzes comparative merits of each datasets to estimate agriculture area.

| **0621** | Landsat applied: conservation planning and land-cover mapping on Peru's forest frontier | Jason Scullion | USA |

Landsat is an important tool for conservationists working in frontier environments by enabling the production of accurate near real time maps and geospatial data products. In this poster we show examples of how a 2001-2011 time series of Landsat satellite imagery contributed to regional conservation planning and land-cover studies on the forest frontier of Madre de Dios, Peru. For the years 2001-2006-2011, Landsat derived land-cover maps were produced with ten land-cover classes each, including mining areas and five forest-cover types. Map accuracy greater than 85% was achieved using the decision tree classification algorithm RuleGen with calibration and validation data from GPS field surveys and iterative map editing based on feedback by local experts. The results of this mapping effort shows that during the study period an important transitional shift in land-cover dynamics occurred, with the reversal of agricultural expansion and the rapid and widespread expansion of artisanal gold mining, which grew by 230%. In addition, the geospatial data products produced from the time series include important foundational components of a rigorous conservation planning study, including accurate maps of vegetation and anthropogenic land-cover, ecosystem change statistics for the study of policy effectiveness, and the spatially explicit analysis of habitat connectivity, habitat value, and ecosystem vulnerability. In summary, Landsat offers conservationists working in frontier environments with the ability to inexpensively understand local land-cover dynamics while concurrently providing the spatial datasets needed to develop geospatial data products that can inform and improve decisions related to conservation and development activities. Given its flexibility and extensive archive of imagery from around the world, the Landsat sensor series is likely to remain an integral tool used by conservationists to engage in accurate and timely conservation planning and land-cover mapping.

| **0622** | Land use and livelihoods in the Red River Delta (Vietnam) under the economic reform: which one drives the other? | Van Cu Pham, Thi Dieu Dinh, Thi Thuy Hang Nguyen, Ole Mertz, Jytte AGergaad, Ngoc Hai Pham, Thi Huyen Ai Tong, Tuan Anh Nguuen | Vietnam |

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The Red River Delta in Vietnam is one of two largest rice producing areas in the country and land use practices in the delta have been changing due to various driving forces. Our study argues that land is one of the five assets (i.e. nature) used in livelihood analysis and land use changes can be used as an indicator showing how livelihoods change. This argument is verified in the context of land use change before and after the economic reform (Doi Moi) introduced in rural Vietnam.

Using a series of Landsat and SPOT images from 1975 to 2011 we determined land use change patterns of the Red River Delta through five case studies: Ba Vi District in a mountainous-hilly area, Dong Anh District in peri-urban of Hanoi and Thai Thuy, Giao Thuy and Kim Son Districts in the coastal zone. To characterize livelihood changes we used statistical data and a questionnaire survey of about 1000 households in the five sites. Factorial analysis using land use change, and statistic and survey data allow us to show how changes in land use impacted livelihoods and vice versa. During the period between 1975 and 1990, before Doi Moi has really impacted the national economy, land use practices remained almost unchanged and conditioned homogenous livelihood in the rural sector of the delta. With the end of the U.S. trade embargo in 1994, Vietnam has become the largest rice exporter in the world and has been moving toward export-oriented commodities. This period is characterized by new land use change patterns that were driven by the diversification of livelihoods, i.e. cash crops. Since 2000, such diversification strategies continue to influence land use, esp. when rice production seems to be less profitable and non-agricultural income plays an increasing role in livelihoods of households in the delta.

0626	Cattle ranching in the Brazilian Amazon: where is the best beef consumed?	Ritaumaria Pereira, Holly Gibbs	USA

0627	Simulated impacts of different forest land cover changes on surface climate over China with BCC_AVIM model	Xueli Shi, Yanwu Zhang, Weiping Li, Tongwen Wu, Wenyan Zhou, Hongchang Ren	China

Land cover changes (LCC) of forests have significant impacts on climate via biogeophysical and biogeochemical ways, which have been proven through numerical simulations or observations at different regions around world. This study investigated the simulated effects of various forest cover changes of

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China on surface climate with the land surface and terrestrial carbon cycle model of Beijing Climate Center (BCC_AVIM1.0). Besides control simulations, four sensitive experiments were conducted by replacing the forest grids with bare soil, shrub, crop and C3 grass. The differences between sensitivity experiments and control run represented the impact of forest cover changes. The results show that changes of temperature, leaf area index (LAI) and carbon cycle of vegetation majorly constrain at regions where the forest cover changes. The temperature was consistently increased when degrading forest, especially to bare soil. The heat fluxes, soil moisture and vegetation processes also changes correspondingly. Generally, the changes were largest when replacing forest with bare soil, but relative smaller with other vegetation covers (shrub, grass and crop) instead of forest. This implied the importance of maintaining of the vegetation on surface climate and ecosystem.

Land-use changes, in particular afforestation, deforestation and agricultural intensification have the potential to significantly change land-atmosphere water vapor fluxes. Through atmospheric transport, these changes may impact precipitation in - sometimes distant - downwind regions. The mechanism behind this, termed moisture recycling, is increasingly being acknowledged as an important feature of the Earth system. Thus, characterizing the extent, magnitude, and specific nature of land-use induced impacts to moisture recycling is necessary to understand what, if anything, can be done to respond to these actions. This is particularly evident in some precipitation dependent regions in the world, where pressures on land are also quickly transforming the vapor flux landscape. Researchers in this session will present work from a range of regions where moisture recycling plays an important role, including China,West Africa, and the Amazon. Research topics will include analyses of land-use impacts on downwind crop yields, consequences to ecosystems and fresh water resources, and corresponding management responses. By shedding light on this important aspect of land-atmosphere-water dynamics, this session intends to communicate the latest science to a broader land science community and facilitate a closer integration of land and water management.

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0629	Geographical information based land use and ecosystem services approaches for assessing conservation land use polices in a watershed scale in Taiwan	Yu-Pin Lin, Horng-Yng Chen, Tao Huang, Li-Chi Chiang	Taiwan

Ecosystem provides a wide range of benefits to people; however, land use changes can affect landscape structure and ecosystem services. In order to sustain the provision of vital ecosystem services, proper and efficient land use planning strategies are necessary. When simulating and analyzing the impact of land use changes on ecosystems, spatial data of the study area are needed. In recent years, many researchers have been working on integrating different analysis models into the Geographic Information Systems (GIS) to promote the usefulness and convenience of the model. However, there is little research on integrating land use change model and ecosystem service evaluation model into GIS for assessing conservation land use policies at a watershed scale. Therefore, we integrated a land use model (CLUE-S), and an ecosystem service evaluation model (InVEST) into a novel platform in a Geographical Information System (ArcGIS). Our objective is to simulate land use changes and their impacts on ecosystem services in the Wutu watershed in Taiwan. Given different conservation and development scenarios (with and without ecosystem service protected area), future land uses and their impacts on ecosystem services in the study area were simulated in the ArcGIS platform. The results demonstrate that the developed GIS-based land use change and ecosystem services approach can efficiently assess the impacts of future land use changes on watershed land use planning and management.

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0632	Vulnerability to land degradation in the face of climate change: a case of Nkonkobe community, Eastern Cape Province, South Africa	Leocadia Zhou	South Africa

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There is serious land degradation to the Nkonkobe community in the Eastern Cape Province of South Africa. This has been a result of unsustainable land management practices. Climate changes will exacerbate the existing vulnerability to land degradation. This paper investigates the impacts, vulnerability and responses on land degradation to the rural poor. Assessing people's experiences, perceptions and responses of stakeholders to recent climate changes can support rehabilitation initiatives and developments of adaptive strategies.

| 0634 | Promoting sustainable meat consumption: results of the effectiveness of an information campaign | Sina Nitzko, Anette Cordts, Achim Spiller | Germany |

Meat and meat products are an important component of everyday meals for large segments of society especially in industrialized countries. Nevertheless, excessive meat consumption can be associated with negative effects. Apart from the potential health problems caused by high meat consumption, meat production is characterized for its negative effects on animal welfare, the environment, the climate and global food security (McMichael et al., 2008).

The production of animal-based food is associated with higher additional land needs than the production of plant-based food. Especially in developing and emerging countries, this is linked to massive changes in land use. These changes contribute in turn to climate change and are associated with negative social consequences (e.g. displacement of population).

Given the negative consequences that are linked to high levels of meat consumption, there are increasing calls for state interventions to reduce meat consumption and to promote the consumption of meat of higher quality in developed countries. However, there have as yet been no studies on the effectiveness of campaigns to reduce meat consumption, despite the fact that a reduction in consumption of meat and meat products would have a positive effect not only on individual level, but also at societal and global levels.

Our empirical study (n = 590 consumers) therefore stimulates an information campaign aimed to reducing meat consumption and tests its effectiveness. In an experimental framing design, the respondents were randomly given one of four different fictional results (on animal welfare, health, personal image or climate) of a scientific investigation reporting the negative effect of meat consumption. After the presentation of the information, respondents were asked to rate the likelihood that their eating behavior will change on the basis of the campaign.

The results show that the campaign is more effective on people who generally eat less meat than on people with medium or high meat consumption. There was no significant difference between the consumers with low, medium and high meat consumption concerning the willingness to reduce consumption for environmental, animal welfare and health-related campaign topics. Only the image-related campaign induced a greater willingness to reduce consumption among people with low meat consumption than among those with high consumption. Especially in connection with the consequences concerning environment and climate, implications for the implementation of measures to reduce meat consumption are derived from this simulated campaign.

| 0640 | Sustainable soil management in the western Siberian corn-belt | Maria Störrle, Hans-Jörg Brauckmann, Gabriele Broll | Germany |

The interdisciplinary joint project SASCHA (Sustainable land management and adaptation strategies to climate change for the Western Siberian corn-belt) is part of the German Federal Ministry of Education and Research (BMBF) - Research program "Sustainable Land Management", Module A "Interaction between Land Management, Climate Change and Ecosystem Services". SASCHA aims to provide basic knowledge, practical management tools and adaptation strategies to cope with recent and future ecological change and landscape transformation in the Tyumen region, Western Siberia. Particularly, the

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interactional effects of climate and land-use change on natural resources and ecosystem functions in the Pre-Taiga and Forest-Steppe ecotone are in the focus of investigations. Based on this information, practical implementation and monitoring tools for a wise future land use will be introduced. All research, development and implementation activities will be carried out in close cooperation with regional and local stakeholders from science, administration, and practice [1].

Currently, – like in other parts of the world – there are no concepts and strategies in Western Siberia to steer and mitigate fundamental changes in land use as triggered by climate change and new socioeconomic developments.

Objectives of the subproject 500 are to develop strategies for a sustainable agriculture including adaptation strategies to current climate change in the Oblast Tyumen. Whereas one project of subproject 500 focusses on biodiversity and carbon stocks of oldfields, another project deals with the analysis and optimization of sustainable agricultural management practices on the farm level. The project of the University of Osnabrueck analyses long-term field experiments with respect to carbon, nutrient balances, different tillage variants, decomposition rates of soil organic matter and soil structure. Topsoil characterization with field methods will be used to assess soil quality [4]. Monitoring and tracking of soil dynamic changes in topsoil will be carry out on different land use sites. A regional analysis of by-products produced by livestock and arable farming started to get information on the potential for organic fertilization. Modeling of material-flow management at regional level [5, 6] will complete the investigations and will lead to a regional material-flow management for nutrients and organic carbon in the corn-belt of the Tyumen region. Based on the results of the subproject 500, concepts for the improvement of sustainable land use practices shall be implemented [1].

| 0643 | The role of system properties in driving socio-ecological transitions: the case of Messara Valley, Crete, Greece | Vassilis Detsis | Greece |

The interplay of exogenous and endogenous forces underlies human responses in land systems (what people do the way they do it) that cause socio-ecological transitions along its evolutionary path. This study argues that human responses modify system properties that, in their turn, feedback on human decision making and affect responses to future forces. This conceptual approach was adopted in the EU-funded FP7 project LEDDRA to assess the socio-ecological resilience of land systems. It builds on the position that socio-ecological resilience is a global system property that emerges from the place- and time-specific combinations of lower level properties that shape the land system's resilience *sensu stricto* as well as the ability of social actors to manage this resilience through adaptation and transformation. Resilience *sensu stricto* is assessed in terms of the attributes of the stability landscape (Walker et al. 2004). Human responses modify these attributes and, under particular place- and time-specific combinations of biophysical and socio-economic circumstances, lead to land system transitions.

This presentation concerns a case study that illustrates the application of the LEDDRA conceptual approach for the analysis of the Messara Valley (Crete, Greece) land system that has undergone two major transitions in the post-WWII period. The LEDDRA conceptual approach, embedded in the broader pertinent literature, is briefly presented first. The Messara Valley, a cropland socio-ecological system, is described next the emphasis being on the major phases it has passed through, the exogenous factors at play over time, the interplay of system properties and human responses in each phase and the mechanisms through which the major transitions of the Messara Valley system occurred under particular combinations of exogenous and endogenous forces in specific points in time. The explanation of the post-WWII trajectory of the Messara Valley system attempts to provide support to the LEDDRA conceptual approach that the study of land system properties can meaningfully contribute to the analysis of socio-ecological transitions and support the associated policy and decision making. Future research directions conclude the

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	presentation.		
	The presentation contributes to Theme No.1, "Rethinking land change transitions", since it deals with a range of issues relating to land use and land management changes, by examining historic land use transitions and system shifts. It specifically contributes to session No. 087 "Trajectories of change in agro-ecosystems" because it negotiates both a conceptual framework of studying such trajectories and an empirical application of it centered on human responses.		
0644	Municipal analysis of Legal Reserve in southern state of Minas Gerais, Brazil	Adriana Koumrouyan, Dalton Valeriano, Luz Adriana Pineda	Brazil

Exploration of the Atlantic Forest has been happening for several centuries due to proximity to the sea and the consequent easy access by man. Today, the transition of land use in the region is slower, but continuous (FSOSMA & INPE, 2013), and we are left with the role to manage and monitor its remaining native vegetation. In this context, this paper aims to analyze the deficit of Legal Reserve (LR) in the counties included in the Verde River basin, located at the southern state of Minas Gerais, Brazil. According to the old Brazilian Forest Code (Law number 4,771/1965) for the Atlantic Forest biome, each landowner should retain at least 25% (smallholders) to 50% of LR on their properties. The latest Forest Code (Law number 12,651/2012) decreased the percentage required for 20% in this biome. The same percentages will be maintained for the analysis on the municipal level, excluding the areas of urban centers, and considering, for the oldest Forest Code, all the properties as small. These counties are within a midsize watershed which constitutes one of the main contributors to a large dam that provides water and electricity to the population at the regional level.

This study analyzed 23 municipalities of the basin. For this analysis, the Permanent Preservation Areas (PPAs) – as riparian areas, vegetation on slopes greater than $45°$, in the mountains above 1,800 m in altitude and hilltops – were defined and subtracted from the mapping based on classification of a TM/LANDSAT-5 image of 2006. The results indicate an average deficit of 5.3% (maximum 9.9% - minimum 1.5%) in 14 counties according to the old law and 2.5% (maximum 4.7% - minimum 0.5%) of LR deficit in six municipalities according to the latest law.

With the recent changes in national forest legislation – such as the possibility of LRs being computed along with the PPAs and the riparian areas range according to the property extension – remote monitoring should become more complex. Within the chosen theme of the conference, we believe that this work can show how changes in the environmental management may affect the natural resources (or vice versa, in the Brazilian case).

| 0645 | Collective land titling and the Multicultural State in Colombia | Monica Hernandez | USA |

The main aim of this paper is to demonstrate how the Colombian state responded to common processes of acquiring collective ownership for ethnic minority communities and to focus on collective land titling for Afro Colombian communities. The first titling processes in Colombia responded to the Law 70 of 1993, which included specifically communities in the Pacific Coast, and left space open for communities "with similar characteristics." More than ten years after the first title was granted to a community in the Pacific coast, communities located in the Caribbean coast are seeking to broaden the scope of the law to also grant them collective titles. Through an analysis of case records of institutional documentation, research studies and newspaper articles, the different strategies of the state to deal with this situation will be identified and show how the lack of mechanisms to rule on and manage property rights in collective territories is reshaping the relation between the state and the communities.

| 0646 | The effectiveness of marked-based instruments to | Penelope Lamarque, | Belgium |

| | promote sustainable land use: the case of Geographical Indications (GIs) in the French Alps | Eric Lambin | |

The last decade has seen the emergence of market-based instruments to promote sustainable land use. We lack empirical evidence on the effectiveness of these new forms of private regulation of land use. In European mountain, agriculture has been an essential feature of grassland ecosystems for centuries, where multiple ecosystem services are valued. These traditional extensive livestock farming systems and associated ecosystem services are threatened by the intensification of agriculture in the lowlands to respond to growing food demand. The maintenance of these multifunctional landscapes relies mainly on Common Agricultural Policy subsidies. Consumers could play a greater role in promoting sustainable land use management, by paying a higher price for quality product processed according to specifications that benefit multifunctional landscapes. Consumers show an increasing interest for local and quality food certified for their origin and/or their environmental production standards. One kind of agricultural product certification, called Geographical Indications (GIs), identifies a good as originating from a region where a given quality, reputation or other characteristic of the good is attributable to its geographical origin. The European Union has developed two types of GIs: Protection of Designation of Origin (PDO) and Protection of Geographical Indication (PGI). GIs create a price premium to protect traditional practices from being standardized and to compensate for higher production costs to compete with non-differentiated markets. Sustainable land use could be a potential indirect effect of GIs because: (1) better environmental stewardship is required to preserve natural factors (the "terroir") associated with the unique characteristics of the product, (2) some requirements or specifications relate to land management practices (e.g., forage production influenced by cattle feeding requirements). There is little empirical evidence to substantiate the claim that GIs have an impact on land use. Using data from face-to-face survey with farmers and census data at regional scale, we analyzed statistically the land use impact of PDO, PGI and non-labeled cheese produced in the Northern French Alps, controlling for socio-economic and topographic factors. We analyzed differences in land management for these three production systems in 2012 and changes in land management since the implementation of the GIs in the region in 2000. Results show that GIs only lead to minor differences in land use because: (i) their aim is to maintain traditional land use, and (ii) they are implemented in marginal regions with stringent constraints on production systems and thus with little scope for alternative land use practices.

| **0647** | Spatially varying relationships between urban land expansion and river water quality: a case study of Lianyungang, China | Wenjun Zhao, Xiaodong Zhu, Xiang Sun | China |

River water quality is significantly affected by anthropogenic factors, in terms of land use changes, especially in the rapidly-urbanizing regions. Due to differences in the catchment's characteristics and land use practices, changes in water environment in response to urban expansion are inconsistent over space. To fully understand the driving forces altering surface water quality during urbanization process, we investigated the spatially varying relationship between water quality indicators and land use changes through statistical analysis, with a case study in a fast-growing coastal city in China. Global statistics tool of ordinary least squares (OLS) and local regression technique of geographically weighted regression (GWR) are both applied to modeling relations between changes in nine water quality parameters and two land use indicators. The study presents improvements in model performance by using GWR regression method, as there are great spatial variations in the relationships between water quality changes and urban land expansion. Pollutants generated by industry developments (Oils, Hg) and nutrients (N, P) are more sensitive to urban land use changes than organic pollutants (BOD5, COD). Remarkable progress in organic pollution control is observed in highly-urbanized watersheds, while water quality in less-urbanized watersheds has strong negative relations to urban spatial growth. The results obtained by GWR

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models are further analyzed by non-parametric tests to identify the major influencing factors of the spatially varying impacts generated by urban expansion. It is found that urbanization level is significantly related to the varied responses in water quality changes, which can be explained by the differences in urbanization phases and land use compositions. Furthermore, it is also implied that environmental management policies and local development strategies have evident influences on the varied relations. This study suggests that GWR can be effectively applied in quantitative assessing the impacts of land use practices on water quality changes. An integrative perspective should be adopted in analyzing the human-environment interactions by taking land use changes, socio-economic process and environmental polices into account.

| 0655 | Assessing local attitudes towards protected areas in semi-arid regions | Chiara Bragagnolo, Richard Ladle, Ana Malhado, Paul Jepson | Brazil |

Legally mandated protected areas (PAs) are the cornerstone of global biodiversity conservation. They are also the external manifestation of one or more conservation values (e.g. aesthetic, recreational, wilderness, economic, etc.). In this context, the long-term viability of a PA depends, in part, upon alignment between the values and aims of the park and those of the local and national stakeholders. For example, if the population surrounding a park do not understand, or support, the objectives of the PA, they will be less likely to respect regulations controlling access, building, and resource use. These take on added importance when the livelihood and well-being of local communities is directly affected by PAs designation. Thus, generating knowledge about the attitudes of local communities towards PAs and conservation issues may be essential for developing strategies to increase public support and mitigating conflicts. In this contribution, we assess the attitudes of local communities living adjacent to two National Parks in the highly impacted Caatinga Biome, a unique semi-arid eco-region in northeast Brazil. We report the findings of an extensive survey with a stratified random sample of residents living adjacent to the two Parks. Results are presented, compared with the outcomes of previous research, and discussed in the context of challenges to the maintenance of the PA networks in the region.

This presentation will contribute to the conference theme, by discussing local knowledge and attitudes on conservation in the context of global PAs challenges (e.g. biodiversity conservation, social equity, etc.). It will further provide insights on several important aspects concerning land governance (Session selected), by reflecting on relationships between positive attitudes and local rights to land and natural resources, level of public agreement/disagreement on PAs' rules and zoning, etc.

| 0656 | Scrutinizing commercial agricultural expansion in Mozambique: impacts on ecosystem services and livelihoods | Janet Fisher, Genevieve Patenaude, Casey Ryan | UK |

We present research from large (£2 million) research project, recently funded by the Ecosystem Services for Poverty Alleviation consortium (www.espa.ac.uk, UK government), focused on Mozambique. Miombo and mopane woodlands in southern Africa present a unique social-ecological system characterised by relatively high population densities, rapidly growing populations, shifting cultivation, a reliance on biomass for energy, and complex ecological interactions involving multiple disturbances. There are extremely tight linkages between social and ecological components of the system: rural households derive much of their wellbeing from the woodlands and associated agricultural systems, and ecosystem services (ES) have a strong role in mitigating poverty. However, such systems are changing rapidly: Mozambique is at the centre of an influx of capital and technology from the emerging BRICS economies, coupled with new linkages to commodity chains, bringing increasing exposure to the global

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demand for land and protein. Mozambique's Poverty Reduction Action Plan promotes the expansion of commercial agriculture, and efforts to improve returns from agriculture. The potential is high and change imminent; the Ministry of Agriculture recently indicated the intention to allocate 5.8 M ha to grow soya in northern and central Mozambique under the ProSavana project. However, the environmental trade-offs in terms of altered ecosystem services availability, and sustainability of services into the future are not well understood, nor are the social tradeoffs in terms of who wins and loses from commercial agriculture. At this early stage of our research project, the rationale of our presentation will be to seek feedback on our conceptualization of the issues, which takes a novel ecosystem services lens, allowing us to, with some novelty, investigate the ecosystem services embedded in various agricultural exports, as well as the changed ecosystem services available to local people whose relationship with the land changes through commercial agricultural expansion. We also present on our methodology and data collection plans for examining these issues, through commodity chain analysis (economic and embedded ecosystem services analysis), and household surveys to understand livelihood implications. This presentation will contribute to the conference theme of 'local land users in a tele-connected world', and more specifically to the chosen session, by presenting a conceptual and methodological framework by which the contribution of large-scale investments in agriculture in Sub-Saharan Africa can be scrutinized.

0657	30 years of land cover and land use change in Kenya	Mike Griffiths, Norton-Harvey Herr, Henry Neufeldt	Kenya

There are many drivers of land cover and land use change, including population growth, pressure on natural resources, market access, weak governance and lack of eco-zoning and climate change, to name but a few. Often it is difficult to quantify the drivers of change due to the lack of sufficiently disaggregated socioeconomic and biophysical data, particularly in developing countries. While it may often be possible to identify land cover change using remote sensing, the underlying causes can often only be assessed qualitatively because spatially explicit socioeconomic information is missing.

In view of the need to quantify drivers of land use change, advantage must be taken of examples where highly disaggregated data is available. In 2012 the World Agroforestry Centre (ICRAF) and the CGIAR Research Program on Climate Change, Agriculture and Food Security (CCAFS) provided funding to resample high resolution aerial photographs taken in 1983 using high resolution Quickbird satellite images. Ca. 60,000 km^2 of western and central Kenya were analyzed to give a 30-year perspective of land cover and land use change in the context of population growth, tenure and climate change.

The most noticeable change has been a rise in land under cultivation from ca. 42% in 1983 to 63% in 2013, an increase in almost 1.3 million hectares. While management intensity of both adjudicated (freehold, leasehold) and unadjudicated (no title deed) land has increased over time, net returns to land were 2.3 times higher and trees were about 4.5 times more abundant on adjudicated land. Although natural tree cover decreased considerably during this time, the amount of trees on farms (aka agroforestry) increased over the period, resulting in only a minor decrease in total tree cover.

During the presentation, which contributes to Session 87 'trajectories of change in agro-ecosystems', the authors will present these and other drivers of change, and discuss opportunities to improve policies and support to decision-making at national and local scales.

0666	The role of soils for sustainable ecosystem services in the Mediterranean Basin	Mattia Trabucchi, Wolfgang Cramer, Alberte Bondeau, Simon Decock	France

Soils are a key element for the development and long-term sustainability of terrestrial ecosystems and the

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services they deliver. The agro-ecological systems in the Mediterranean Basin have been shaped by human activities since millennia, with highly variable levels of intensity and periods of degradation. During recent decades, agro-sylvo-pastoral system have declined and arable agriculture has intensified in the Northern part of the basin along with post war industrialization, however there is now emerging evidence, especially in nations affected by economical crises, of a return to smaller-scale agriculture as a first source of income. Throughout the basin, soils are considered the most fragile part of the system because of several factors, such as low soil organic matter content, slow rates of soil formation, thin and poorly developed profiles and pressure from unsustainable grazing. Climate appears to be changing towards less but more intense precipitation (especially in the North) and temperatures are significantly increasing. These factors, alongside others, may lead to intensification of soil degradation and subsequent erosion, one of the major historically well known threats for the basin. To put these challenges in perspective to other risks for Mediterranean land use systems, we present a first assessment of soil-related ecosystem services for each nation present in the Mediterranean basin. We have used literature and available data to create a list of key soil-derived ecosystem services for the human population of the region and identify possible synergies, trade-offs and secondary threats that could arise from different land management strategies in the area. We relate findings to known Best Management Practices (BMPs) available and applicable for the main land use systems in each nation, providing first estimates of risks and opportunities for sustainable land use in the region for the longer term.

| **0671** | Mapping recreational ecosystem services and its values Europe-wide: a combination of spatial statistical models | Volkmar Hartje, Joachim Maes, Luke Brander, Jan Philipp Schägner | Germany |

We map the recreational use and its value across non-urban ecosystems spatially explicit EU-wide. Therefore, we use two separate spatial statistical models: one to model annual recreational visitor numbers and one to model the monetary value per recreational visit. Both models are estimated by using regression analysis of large primary data sets on annual visitor numbers from recreational visitor monitoring studies and on value estimates from environmental economic valuation studies. Explanatory variables of the models are spatial biophysical and socioeconomic indicators such as land use/cover data, biodiversity, climate and accessibility, but also variables accounting for the study methodology of primary data collection. In order to optimize the models' fit, we compare linear regression with generalized, additive and mixed modelling techniques.

By connecting the final models to a GIS data set, visitor numbers, marginal recreational values and recreational values per hectare are mapped EU-wide. Thereby, the models may contribute to Green Accounting, they allow for choosing preferable locations for recreational/nature protection sites and for evaluating land use policies and scenarios. By combining the models with other spatially explicit ecosystem service value maps, trade-offs of alternative land use patterns can be displayed and optimal land use patterns can be identified. Nevertheless, as any spatially explicit ecosystem service model and value transfer exercise, accuracy and precision of the models are limited. In particular, if applied to map recreational values at low resolutions.

| **0688** | Land-use and socio-economic change in irrigated high mountain oases: the case of Ladakh, Indian Himalayas | Juliane Dame | Germany |

Modifications of the mostly subsistence-based economy and a general trend towards livelihood diversification are characteristic dynamics in high mountains. Using a case study from the arid mountain region of Ladakh (Northern India), current trends in land utilization and livelihood strategies are presented and discussed. Situated in the Himalayan rain shadow, cultivation in this region is limited by a short

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growing season and the availability of irrigation water from glaciers and snowfields.

The empirical study employed a mixed method approach. The assessment of persistence and change of land-use patterns is based on a comparative analysis of high resolution satellite images (Corona, Quickbird) and recent field research. Empirical data (household surveys, qualitative interviews, market surveys) from three case study villages and the district capital Leh are used for an actor-oriented analysis of local livelihood strategies.

Results show a high persistence of field structures that is fostered by a set of environmental, political and social factors. At the same time, the survey shows a diversification of the cropping pattern and recent trends in agricultural practices. Subsistence-oriented combined mountain agriculture is no longer fundamental to food security. Today, households secure their livelihoods through a combination of agrarian land-use practices, off-farm employment and external interventions. This trend leads to a dissolution of mountain households which have become increasingly multi-local. Further, the study shows that local strategies are significantly shaped by interventions of external actors and their development perspectives. These are negotiated in a "development arena" where actors with divergent interests and positions of varying power interact.

The poster contributes findings from an empirical study to the conference. Within the thematic session on smallholder irrigation and land transformations, it highlights how local strategies are influenced by national policies and the global economy. The case of Ladakh specifically illustrates how high mountain livelihoods are modified by a number of internal and external factors, including new agricultural practices, rural development initiatives, food subsidies and off-farm income.

It is argued that land use change can only be understood following multilevel approaches that take local agricultural practices as well as the broader environmental, socio-economic and political context into account. Integrative assessments of human-environment interactions enhance the understanding of current dynamics and development challenges, especially in the framework of globalization processes.

NUMBER	TITLE	AUTHORS	COUNTRY
0691	EU biofuel policies in practice - a carbon map for Kalimantan and Sumatra	Mareike Lange	Germany

One of the components of the European Commission´s (EC) strategy to replace fossil energy sources by non-fossil renewable sources is to expand the production of biofuels. Biofuels are especially important for reducing the dependency of the transport sector on fossil fuel and for decarbonising it. Through its biofuel sustainability regulation (EU-RED), the EC seeks to achieve a minimum target of 10% renewables in the transport sector by 2020. The EU-RED was supplemented by a regulation stipulating a mandatory reduction of 6% in the emission intensity of fuels used in transport to emphasize the aim to reduce greenhouse gas emissions (emissions). However, it is still difficult for biofuel producers to proof the contribution of their biofuels to reducing emissions because the production of biofuel feedstocks can cause land use change (LUC), which in turn causes emissions. A carbon map can serve as a basis to proof such contribution. I show how to calculate a carbon map according to the sustainability requirements for biofuel production adopted by the EU-RED for Kalimantan and Sumatra in Indonesia. For the calculation of the carbon stored in biomass in Kalimantan, I use a biomass density map generated by Sarvision that combines a vegetation structural type map derived from recent ALOS PALSAR radar satellite imagery and the ICESat-GLAS space borne LIDAR height measurements that can be directly related to above ground biomass. For Sumatra I use a national land cover map and for the carbon stored in the soil I rely on FAO and IPCC data.

Based on the carbon map and the carbon balance of the production process I derive maps showing the possible emission savings that would be generated by biofuels based on palm if an area were to be converted to produce feedstock for this biodiesel options. I evaluate these maps according to the criterion contained in the EU-RED of 35% minimum emission savings for each biofuel option compared to its

fossil alternative. In addition, to avoid indirect LUC effects of the EU-RED that might offset any contribution of biofuels to reducing emissions, I argue that all agricultural production should be subject to sustainability assessments. In this effort, my carbon map can be the basis for a sustainable land use planning that is binding for all agricultural production in the country. However, this would reduce the possibilities to increase palm oil production in Indonesia to intensification and restoration of degraded areas.

0696	Land-use change, climate change and hydrological service of Marsabit's montane forest, northern Kenya	Adano Wario Roba	Kenya

Kenya's natural forests have faced a serious threat of destruction in recent years. Policies to conserve critical forest ecosystems exist, and the ecosystems' support of the local livelihoods is well understood. Yet evidence linking forest ecosystem functions and their hydrological services are limited. This paper assesses the impacts of rainfall trend and agricultural land expansion on the watershed service of Marsabit montane forest in Northern Kenya. Household surveys and secondary data are used to assess the forest ecosystem functions. Analysis of long-term rainfall data reveals reduced precipitation and increased drought years since the 1970s. Farmers' recent growing of horticultural crops using a drip irrigation system harnessed from within the forest area is an innovative adaptive response to reduced rainfall. The removal of vegetation-cover on the mountain causes modification and fragmentation of the forest habitat, simultaneously endangering the condition of the ecosystem and dependent livelihoods as well as threatening loss of biodiversity. A model relating farmland expansion and climate change to the forest-based urban water production predicts a decreased hydrological service and increased (economic) cost water-yields for urban uses. This model captures jointly delivered public goods benefits of conservation efforts. The diminishing forest service also harms the pastoralists living in the surrounding arid rangeland who fall back on the mountain resources such as shallow wells during dry seasons. Any alterations in the forest composition as land-use changes may serve as a warning for conservation agencies and policy-makers alike. Contrary to the current policies and practices, the conservation of montane forests in ecologically sensitive areas takes priority in conservation efforts. The paper provides evidence of ecosystem functions that challenges the ongoing forest destruction in favour of an integrated conservation and management of wider ecosystems in the future. There are potential gains in reconciling conservation efforts and local community needs to achieve an equitable and wise use of forest ecosystem resources.

0698	Land use dynamics of deforestation and afforestation across the Usumacinta Valley, Chiapas, Mexico	Zachary Christman, Hamil Pearsall, Birgit Schmook, Sofia Mardero	USA

This paper investigates patterns of deforestation and afforestation from 1984-2013 across the Usumacinta Valley of Eastern Chiapas, where changing agricultural practices, expanded cattle pasture, and new strategies for diversifying land management practices have emerged by both local residents and industry.
While nestled within the "*Selva Lacandona*" between the forested landscapes of the Montes Azules National Park of Chiapas, Mexico and the Sierra Del Lacandón National Park of Petén, Guatemala, the Usumacinta River Valley is now largely deforested following a series of land use transitions that have included widespread timber harvesting in the mid-20th century and a rapid expansion of cattle pasture since. Intact forest and zones previously used for smallholder agriculture continue to transition to more extensive agricultural systems and rangeland for cattle, as available valley land becomes increasingly scarce.
Multiple studies have described the widespread deforestation of the Lacandón Rainforest in the Lowlands of Chiapas, citing both the extent of deforestation and drivers including logging, maize cultivation, and

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cattle pasture. However, these studies have not generally addressed the dynamic nature of the landscape, including a variety of land use practices that promote vegetation growth.

This paper describes the range of vegetation densities and configurations in the Lacandón Rainforest region from 1984-2013, comparing the extent and locations of deforestation and afforestation across the Usumacinta Valley and linking these trends to cultivation practices based on interviews conducted in 2012 and satellite imagery analysis.

The landscape-level diversification observed is linked to cited patterns of new land uses, including a restructured local cattle economy, expanding industrial palm oil cultivation, and new teak and rubber forest plantations. Effects of these changes are spatially variable, and residents cite numerous strategies for coping with the new economic and environmental externalities that influence their livelihoods.

This paper directly contributes to conference theme 1, "Rethinking land change transitions," through a cross-scalar exploration of new land use management strategies, environmental impacts, and local livelihoods shaping land cover patterns across the Usumacinta Valley.

Both the context and analysis of the study address the session theme of "Secondary forests and agro-diverse systems: dynamics of regrowth in the Neotropics" by characterizing and quantifying the patterns of deforestation and afforestation across the dynamic landscape, including impacts of expanded cattle grazing along the Usumacinta Valley and the varied new land use management strategies employed in this region of palm oil, teak, and rubber cultivation.

| 0699 | The effect of prices changes on land use in Brazil | Mareike Lange, Angela Kopmann | Germany |

The world population will be growing to up to 10 Billion over the next few decades. Income in the emerging markets will continue to grow at high rates implying changing nutritional habits towards a higher consumption of animal-based, and thus land intensive products. It also increases the need to provide alternative energy sources which requires, in the form of bioenergy sources, considerable additional biomass production. On the other hand, an accelerating climate change demands an increasing management of global carbon sinks and soil and water resources. These developments will put tremendous pressure on scarce land resources world-wide. This pressure will materialize through an increase in agricultural prices which will set incentives to increase agricultural production areas. By how much these price increases result in agricultural expansion can be expressed via land supply elasticities. Such elasticities can be used for example in general equilibrium models to simulate the land use effect of policy shocks such as biofuel policies for example.

We calculate local supply elasticities for Brazil which has become one of the biggest producers and exporters of agricultural products in the world. Brazil has experienced large expansion dynamics of its agricultural production area together with a local development of an industrialized agricultural sector. At the same time Brazil is one of the most biodiverse countries in the world and stores a tremendous amount of carbon in its natural biomass. Thus, in order to establish environmental protection strategies it is important to know by how much the local land use reacts to changes in agricultural prices mainly due to price changes on the world market. Till now such information is not available for the main agricultural areas of Brazil. We use a system of output-supply and input-demand equations to calculate the land-supply elasticities for the most important crops on the regional level for Brazil using data from 1980-2010 and seemingly unrelated regression estimation. We further investigate by how much the availability of unused land and the distance of actual yields to potential yields effect the size of the land supply elasticities

| 0705 | The agent-based-model of mobile pastoral systems for the quantitative prediction of ecological and economical sustainability in | Satoshi Kato, Reiichiro Ishii, Noboru Fujita, | Japan |

NUMBER	TITLE	AUTHORS	COUNTRY
	Mongolia	Ryosuke Koda, Norio Yamamura	

Mobile pastoralism is a pastoral mode widely adopted in dry grassland area. Different from sedentary pastoralism, it allows people to select pasture of larger plant biomass which fluctuates both spatially and temporally at a broad spatial scale due to the climatic fluctuations. However, recently in Mongolia, their pastoral mode is shifting from the traditional mobile style to sedentary one with increasing livestock number under changing political and economic regimes. This change is nowadays considered to induce overgrazing of the pasture and hence the land degradation in Mongolia. In order to minimize the degradation, thus, it is necessary to understand how economic and social factors affect human activities and environmental change due to change in the modes of pastoralism.

We developed an Agent-Based-Model (ABM) for mobile pastoralism in Mongolia, which simulates daily and annual interactions between the dynamics of plant biomass and the behaviors of agents (i.e., herder families) in the spatially explicit lattice. For realistic estimations, we incorporated data on climatic conditions, vegetative biomass and spatial-temporal pattern of derived from *insitu* observations concerning vegetation growth and Mongolian pastoralism (e.g., rainfall, grassland biomass, migration distance, etc...)

To depict the impacts of the modes of mobility and grazing pressure by livestock we analyzed the results of the simulation along four scenarios, that is, with/without the mobility (mobile or sedentary) and with/without the limitation of livestock number. Using these simulations under these scenarios, we quantitatively estimated and compared both for degradation of grassland and for economical sustainability of Mongolian pastoralism, which suggest clearly the importance of mobility for the grassland sustainability. These comparisons of predictions will help in the development of management strategies for sustainable pastoralism.

NUMBER	TITLE	AUTHORS	COUNTRY
0708	Land cover dynamics and factors influencing vegetation loss and regeneration in Central Chile	Jennifer Schulz, Luis Cayuela, Cristian Echeverría, José Maria Rey Benayas, Boris Schröder	Germany

Central Chile has experienced profound landscape transformations since the middle of the sixteenth century. Perennial vegetation cover such as forest and shrubland remains threatened due to high population densities, land use intensification and limited natural regeneration. Remnant forest patches are reduced to the mountain areas, but even there land use pressures have increased, as demands exceed available flat areas. To quantify land cover changes and obtain an understanding of specific pressures on vegetation cover, we classified a series of satellite images from 1975, 1985, 1999 and 2008, and linked them with a multi-temporal analysis of influencing socio-economic and biophysical factors. Classified maps were analyzed in a GIS, obtaining the spatial distribution and rates of land cover changes. We analyzed areal changes by cross-tabulation in order to quantify net changes, gains, losses and persistence, as well as inter-categorical change trajectories.

The major trend was a continuous reduction in forest and shrubland cover, as well as a strong increase of human induced land cover types. In contrast to deforestation patterns in other parts of Latin America, vegetation loss took place as a stepwise and progressive modification from forest to shrubland cover, and a highly dynamic conversion between shrubland and human-induced types of land cover, with a time lag in relation to deforestation. According to the different change trajectories identified, we analyzed socio-economic and biophysical factors influencing vegetation change using classification trees and logistic regression. Separate models explaining forest and shrubland loss as well as forest and shrubland

regeneration were estimated for four time intervals. The most significant and consistent factors affecting vegetation change over time were slope and distance to primary roads. Often, forest and shrubland loss and their regeneration pathways displayed opposite patterns in relation to the different explanatory variables.

The differentiated analysis of change trajectories over several time intervals in combination with an analysis of influencing factors provides important insights into the studied system's dynamics. In terms of spatial dynamics, it enhances the understanding of subtle phenomena such as passive revegetation that partly counterbalances vegetation loss. In terms of temporal dynamics, our analysis of land change transitions facilitates an understanding of the factors representing continuing vegetation pressures and factors enhancing vegetation regeneration over time. As the mountain areas of Central Chile host some of the last remnants of a unique formation of dry forest, these insights are a critical basis for conservation and restoration planning.

| 0709 | To avoid the catastrophic vegetation transition for sustainable pastoral land use in Mongolia under the global climate change | Reiichiro Ishii, Noboru Fujita | Japan |

Spatial distribution of vegetation reflects both physical conditions and human activities and thus, these changes are the major drivers for vegetation transitions. Previous dynamic vegetation models, however, had difficulties to incorporate both of these effects in comparative way. One of the critical barrier was the mismatch the spatial scales at which both of these drivers are quantified, that is, climate conditions are generally observed and modeled with much coarser resolutions than human activities often influenced by topography or transportation networks.

To tackle this problem, we developed a set of new models based on the observation at the topographic scale in Mongolian vegetation where discontinuous vegetation transition can be observed: (1) mathematical dynamics model for the interactions among two plant species' biomass and local soil water content (SWC) that limits plant growth and (2) hydrological model for the spatial distribution of potential SWC governed by topography of the target region incorporating a strong positive feedback in plant-SWC interaction. By integrating these models we could successfully reconstruct the observed spatial patterns from the topographically estimated potential SWC. This underscores the importance of this feedback process at the topographical scale. Further, we suggest the vegetation might exhibit regime-shift at the scale under heavy drought and/or livestock grazing pressure. Using this model, we could calculate the economical impact by increasing livestock and suggest the maximum sustainable livestock density under given climate change scenarios.

| 0713 | Global land cover data for climate change integrated assessment modeling | William Emanuel, Saurabh Channan, Allison Thomson | USA |

Recently assembled, global land cover data sets are described. These global data, assembled from standard MODIS remote sensing data products, are well-suited to use with climate change integrated assessment models and in related applications.

Climate change integrated assessment models relate human factors and activities, such as demography, energy use, technology, the economy, agriculture, forestry and land use to greenhouse gas emissions, other perturbations to the climate system, and to the resulting radiative forcing of climate change. At global and continental scales, these models incorporate geospatial land cover and land use data that, in many cases, are derived from satellite observations. Global land cover and land use data derived from Advanced Very High Resolution Radiometer (AVHRR) measurements collected in the 1992–1993 time period continue to be used to be used (e.g., *Klein Goldewijk and Ramankutty*, 2004). These data are, for example, incorporated into the Representative Concentration Pathways for the 5th assessment of the IPCC.

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To facilitate the use of satellite observations better suited to contemporary land cover estimates than are older AVHRR measurements, we assembled global mosaics of the standard MODIS land cover data product in the IGBP classification, projected in geographic coordinates of latitude and longitude. Global data sets are available for each year during the 10 year period 2001-2011. The MODIS data at 500 m pixel resolution are aggregated to two coarser resolutions in common use with integrated assessment models: (1) 0.5 degrees latitude x 0.5 degrees longitude, and (2) 5' latitude x 5' longitude. The Global Land Cover Facility distributes the data in both GeoTIFF and ESRI ASCII Grid file formats.

In addition to land cover by classes, we similarly assembled the MODIS Vegetation Continuous Fields data product into global mosaics with the same projection and resolutions. Together, these data facilitate analysis of the degree of plant canopy cover by land cover class globally.

While these global data derived from MODIS observations should provide better quality land cover representations, integrated assessment models typically combine geospatial land cover data with statistical data in order to estimate measures of land use, such as fraction of land in crops or pasture, with the same geospatial structure. The availability of annual, global land cover data over a significant contemporary period will enable use of inventory data by organizations such as the U.N. Food and Agriculture Organization contrasting year-to-year differences to reduce inconsistencies and estimate land use change.

| 0714 | Geospatial technologies for the assessment of changes in land use in coffee producing regions of Brazil | Tatiana Grossi Chquiloff Vieira, Helena Maria Ramos Alves, Margarete Marin Lordelo Volpato, Marilusa Pinto Coelho Lacerda, Vanessa Cristina Oliveira de Souza | Brazil |

Três Pontas is one of the largest and most important coffee producing regions of Brazil. Therefore it is important to know and map the distribution of the coffee lands in the regional landscape and monitor land use change to understand transitions and provide sound information for science based agricultural planning. The objective of this work was to analyze the evolution of coffee fields in time and space using remote sensing and geographic information system. Landsat images from five different dates, during a ten year study period, were used. Land use maps for the years 2000, 2003, 2005, 2007 and 2010 were produced using the GIS SPRING. The results showed an increase of 7% in the areas cultivated with coffee from the year 2000 to the year 2010. The total area with adult productive coffee trees increased by 11%, which also resulted in an increase in the region's productivity. Patterns of change in the spatial distribution of the coffee lands were not found. The data produced are important to ensure a more sustainable and competitive coffee agricultural production system.

| 0717 | Land use decisions in Loíza, Puerto Rico: have climate hazards and demographic vulnerability been considered? | Brenda Castro-Voltaggio, Luz León-López, Hernando Mattei | Puerto Rico |

Since the second half of the 20th century global warming has become an issue. The increase of sea level has been one of its consequences, a particularly concern for several islands and coasts around the world. Puerto Rico is a tropical island located in the eastern part of the Caribbean basin. Loíza is a municipality at the northeast cost of the island, and a vulnerable area based on its geospatial and demographic characteristics. The objective of this investigation was to examine, from a socio-ecological perspective,

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how demographics would increase the geospatial vulnerability of the municipality of Loíza. ArcGIS 10 program was used to visualize the information in spatial mode and analyzed the population vulnerability at different sea level rise. Data was obtained from different areas: Population data from the 2010 U.S. Census, Federal Emergency Management Agency (FEMA) data, land use from 2006. Loíza is located in a low land area and also has the biggest river delta from the island, the Río Grande of Loíza (752 km^2). The Caribbean is very susceptible to atmospheric events; such hurricanes, tsunamis, tropical storms, etc. Puerto Rico has been hit from 13 major hurricanes raging between categories 1 thru 5, since the 1900's. Loíza was affected in 1989 from Hugo, a devastating hurricane that pass through the island. Sea level change simulators indicate that this area will be totally submerged by water at 7meters. In addition, it has been classified by FEMA as a floating high risk area with a 97% chance for water flows, 75% of the area is classified as wetland. This town's demographics add up to the already existent geographic and physic vulnerability of this area. Total population is slowly decreasing however, housing units increased by 16.4%, during last decade. Loíza' population is mostly urbanized, with the majority living in the coastal areas, in some cases in less of 100meter from the coast. It has an old age structure, with 14% a population over 65 years old; 52% of population area are females, and 1 out of 3 are female headed households. The median income is about $18,897, with almost half of people living above poverty level and it has a very low educational level. This research will contribute to rethink the demographics and climate-land use interaction in Loíza. Demographics characteristics in this area pose a great risk for people satisfactorily respond to present and future climate hazards in the area.

NUMBER	TITLE	AUTHORS	COUNTRY
0718	The impacts of sucessive ocupations of human societies on the medium of the Sanga da Areia basin in southwestern Rio Grande do Sul, Brazil	Sidnei Luís Bohn Gass, Roberto Verdum	Brazil

The geomorphological province known as Peripheral Depression in Rio Grande do Sul, specially the areas belonging to the hydrographic basin of Sanga da Areia in southwest Rio Grande do Sul (Brazil), shows original countryside characteristics. They can be found in different investigation scales, both in detail regarding medium dynamics, and regarding its major countryside compartments. These differences find their expression in their lithologic, hydrologic, geomorphologic, surface and soil usage differences associated to successive occupation by human societies. In terms of history, economic usage of the region went through changes from traditional extensive cattle breeding to large scale soya beans and wheat production. These usages are associated to the potentialities of the medium, specially its native vegetation and soil fertility. The morphogenetic processes identified in the basin have been potentiated due to the medium fragility and the handling introduced into the area, an item that has in some extent made farming impossible for a part of the farmers. Recently the implementation of the eucalyptus monoculture in cleared fields to supply the cellulose industry causes new interference in the region's soil occupation and usage. In this context this paper intends to associate usage and occupation changes to the environment degradation process; specially its interference in legal Areas of Permanent Preservation (APP's) and in the dynamic of Sanga da Areia, spacing these changes along a timeline in a pilot area. Brazilian legislation defines APP's as protected areas, with or without native plant cover having the environmental function to conserve water resources, landscape, geologic stability and biodiversity, to ease genetic flow of fauna and flora, to protect soil and to assure human well-being. Insertion of this discussion into the thematic context defined for the participation in the Global Land Project called 2nd Open Science Meeting allows to insert into the global discussion agenda issues related to particularities of the Pampa biome (constrained to the southern half of the State of Rio Grande do Sul, to Uruguay and a part of Argentine) to contribute to the research of elements that take into account the historical changes of soil usage in a socio-environmental view concerned to conserve medium equilibration

NUMBER	TITLE	AUTHORS	COUNTRY
0724	Modeling the expansion of sugarcane in the state	Grasiela Rodrigues,	Brazil

NUMBER	TITLE	AUTHORS	COUNTRY
	of São Paulo (Brazil)	Angelica Giarolla, Gilvan Sampaio	

Modeling the Land Use and Cover Change is important in understanding its dynamics in space and time and is based on biophysical and socioeconomic driving forcings that affect the processes involved. Thus, in the context of sustainable agriculture, know the land use and cover changes in future periods is relevant information to the challenges related to demands for food and energy when they are considered mainly crops like sugarcane, soybeans and corn. Therefore, this work shows scenarios for the land use and cover changes to the State of São Paulo with focus to the production of sugarcane, according to their productivity over the past 30 years.

For this, we employed the use of land use and cover change modeling (LUCCME) developed by the National Institute for Space Research, a modeling framework for land use change and land cover, useful for future simulations and generation of scenario. The methodological step considered land use maps of the State of São Paulo for the years 2000, 2005, 2010 and 2013 in the calculation of the demands; biophysical information such as pedology, fertility, digital elevation model, slope, hydrological network, climate, temperature and rainfall, and socio-economic variables such as income distribution, location of shopping centers, roads, railway network and location of sugarcane mills. This information was manipulated in software TerraView and composed a database with variables distributed in cellular space of two kilometers (use of pluggin of cells, extension of the software). Was applied model CLUE-S, using the modeling of spatial dynamics of land use on a regional scale, integrating analyzes from socioeconomic and biophysical forcings.

Thus, we designed the expansion of sugarcane scenario considering the simulation for the year 2020 in the state of São Paulo, showing various information that are associated with the expansion process of culture, however climatic conditions and soil fertility are main driving forcing for the determination of potentially productive areas.

NUMBER	TITLE	AUTHORS	COUNTRY
0728	Urban seasonality and change at 4 microns: what the neglected middle infrared can reveal about the dynamics of urban areas?	Geoffrey Henebry, Cole Krehbiel, Monika Tomaszewska, Valeriy Kovalskyy	USA

The middle infrared (MIR) region (3-5μm) of the electromagnetic spectrum is the mixing zone, in roughly equal proportions, of reflected sunlight and emitted earthlight. To date the MIR has received little attention in urban remote sensing. Yet, this neglected portion of the spectrum has certain advantages, including the ability to penetrate most anthropogenic haze and smog. Here we demonstrate how urban MIR brightness dynamics are modulated by vegetation cover, percent impervious surface area, and the sensor view zenith angle (VZA). We focus on Aqua MODIS band 23 (4.02-4.08 μm) at 1 km resolution using monthly maximum value composites by VZA. The study area spans the US Great Plains. We illustrate how the seasonality of MIR can be modeled with the convex quadratic form that has been used successfully in studies of land surface phenology. We explore the limits to detecting urban change at this relatively coarse spatial resolution.

This presentation contributes to **Session 0079: Utilizing time series analyses to enhance understanding of system dynamics** through its examination of urban land cover dynamics using an unconventional part of the spectrum and its use of a convex quadratic to model middle infrared seasonality.

NUMBER	TITLE	AUTHORS	COUNTRY
0730	Changes in soil carbon stocks during forest succession	Jianwu Tang	USA

The soil carbon stock is sensitive to the changing climate and human disturbance. Depending on human management, soil carbon could either act as a sink or a source to the atmospheric CO_2 concentration.

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Forest development and succession drive the changes in soil carbon stocks. However, this process has not been widely represented in ecosystem and earth system models. We analyzed soil carbon stocks in a chronosequence of forest succession in the upper Midwest of the U.S. ranging from recent clear-cut to an old-growth forest of more than 350 years old and a long-term soil carbon record (over 20 years) in a forest in Massachusetts in the U.S.

This work will contribute to the conference theme by understanding impacts of land transformation on soil carbon and also contribute to the submitted session by improving our knowledge in soil carbon under disturbance and human impacts.

| 0734 | Building typologies of farming systems to understand agricultural landscape dynamics at regional level | Marta Debolini, Pierre Lejeail, Martine Guerif | France |

Mediterranean agricultural landscapes are expected to face deep changes in the next decades related to the decline in water resources, the urban pressure on farmlands and the soil degradation. For this reason, many recent researchers aim to analyze climate change impacts and possible adaptation strategies of agricultural Mediterranean landscapes through the assessment of farming systems spatial configuration and dynamics at regional scale. To this aim, it is necessary to develop tools that could model/explain/predict agricultural land use changes. In this perspective, a preliminary step is the analysis of current dynamics in farming systems, based on historical geodatabase. Our work aims to develop a definition of existing farming systems typologies and their dynamics in the study area. The case study is located in the Vaucluse department (Provence-Alpes-cote d'azur Region, Southern France). The area was chosen because it is potentially representative of different dynamics occurring in the last 10 years in Mediterranean agricultural landscapes and it is therefore interesting to test the proposed methodology. Moreover, many different databases are available in the area, with different spatial and temporal scale. On one hand, this allows to integrate information both from the geographical and the agronomical and socio-economic point of view. On the other hand, a homogenization and reorganization of the available information was needed in order to process it. In particular, we obtained a full and spatially explicit database at farm scale in the Vaucluse department for each year from 2001 to 2006. From the whole farm attributes a selection was carried out based on a preliminary assessment of the variable explanation of the farm typology. Then, a principal component analysis (PCA) of the whole occurrence of farms and a cluster analysis were developed. Through the K-means classification method we obtained eight groups of farms, corresponding to the main typologies of farming system in the study area. The eight farming system typologies were based on the 2001 database. In order to point out the farming system changes in the following years, we appointed the farms on 2002 to 2006 databases depending on the distance between their characteristics and the class centroids of the 2001 database. This approach allows to understand the evolution of farming system, highlight the conversion of the farms among the classes and also to point out the changes in the original classification.

| 0743 | The impact of land use change in Xinjiang region in the past 20 years | Shixin Wu, Juan Zhang | China |

Mediterranean agricultural landscapes are expected to face deep changes in the next decades related to the decline in water resources, the urban pressure on farmlands and the soil degradation. For this reason, many recent researchers aim to analyze climate change impacts and possible adaptation strategies of agricultural Mediterranean landscapes through the assessment of farming systems spatial configuration and dynamics at regional scale. To this aim, it is necessary to develop tools that could model/explain/predict agricultural land use changes. In this perspective, a preliminary step is the analysis of current dynamics in farming systems, based on historical geodatabase. Our work aims to develop a definition of existing farming systems typologies and their dynamics in the study area. The case study is

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| 0745 | Increasing forest cover intensity and cropping pattern changes for addressing adaptation requirements in a changing climate | Ajay Bhave | India |

Land cover change and optimized cropping pattern are important adaptation strategies for the sustainable management of water resources in a changing climate. While adaptive land use planning for climate change, such as India's National Action Plan on Climate Change (NAPCC) is often a top-down approach, optimum cropping patterns have to be locally appropriate and acceptable to stakeholders, especially farmers. The effectiveness of such altered land management in a changing climate needs to be evaluated to determine the proportion of potential impacts which may be managed in the future. Also with the increasing population and changing water consumption patterns, assessment of limits to adaptation through land use management is crucial. Based on this rationale, in this paper, we assess the extent to which land management options address adaptation requirements for the water sector using the Water Evaluation And Planning (WEAP) model. The study river basin is characterized by rain-fed agriculture in the upstream region, while a reservoir provides irrigation in the lower reaches. The effect on streamflow due to Increasing Forest Cover (IFC) in the reservoir catchment, as suggested by NAPCC guidelines, is analysed in conjunction with changes in water demand induced by optimized cropping pattern in the reservoir command area. Climatic projections of four high resolution (25km) Regional Climate Models (RCMs) for the SRES A1B scenario for mid-21st century (2021-2050) are used to drive the WEAP model along with projections of changing water demand in the future. We find IFC reduces peak monsoon runoff into the reservoir while sustaining dry season low flows, which is a stakeholder prioritized adaptation requirement in the basin. Cropping pattern changes reduce irrigation requirement and also provide opportunity for increased cropping intensity in the reservoir command. We conclude that locally relevant land use management strategies need to implemented in conjunction for enhancing the benefits of adaptation. Adaptive land management to adjust in a changing climate may be a defining feature in the future. Therefore it is of paramount importance to understand the implications of measures used for adaptation from the point of view of intended consequences and the extent to which desirable consequences are achieved.

| 0747 | The decreasing nature - a GIS quantification of anthropization in Southern Patagonia, Chile | Luis Inostroza | Germany |

Humans have almost completely transformed the world's land surface, with nature in its purest sense remaining in only remote parts of the planet. However they are experiencing strong setbacks in surface. Patagonia, in the southern part of the South American continent, is one of those last virgin territories. The future development of this region is being planned in absence of adequate knowledge of their highly sensitive ecosystems. Here new activities are colonizing and transforming one of the world's last bastions of pure nature, that of Chile, where spatial scope of these transformations remains unknown. In this study we will analyze the range and spatial distribution of anthropogenic changes in Southern Patagonia by using two indicators fully assembled in GIS: the anthropogenic degree (GAT) and the human influence index (IH). These have shown a net decrease of pristine nature, despite a low population and the high percentage of protected land (52%). In fact over 72% of this territory has some degree of human alteration/influence. This result is consistent with global assessments, showing that Patagonia is following similar trends to that of the world as a whole. The expansion of economic activities goes unnoticed in the vast extension of this territory, constituting a paradox: an anthropogenic driven regression of pristine nature in a highly protected area and sparsely populated. Looking towards the future opens the need to redefine the relationship between society and nature, in one of the last natural areas of the country.

0751	The study impacts of ecosystem-atmosphere interactions on Persian sturgeon (Acipenser persicus) in coastal waters of Caspian Sea	Kourosh Haddadi Moghaddam	Iran

Global climate change and effects on global annual fishery catches estimated to be about 2 million metric tones in the mid-1800s, grew exponentially and then peaked at about 80 million metric tones in the late 1980s. Catches appear to be declining at a rate of about 0.7 million tones per year since that time. These changes in global climate and in global fishery catches. In addition to some spectacular collapses of one productive and lucrative commercial fisheries have caused serious concern about the effects of large-scale fisheries on marine ecosystems. The resources of Caspian Sea are important for the local economics and thus understanding ecosystem atmosphere interaction on sturgeon and interact on fisheries removals to impact the exploitable resources of the Caspian Sea. In this study Persian Sturgeon caught under 10m depth using bottom trawl net by research vessel during winter 2006, summer and winter 2007 and spring 2008 in east, central and west of southern parts of Caspian Sea. Examination of stomach contents in the sturgeon specimens revealed that the food spectrum was composed of bony fishes (Teleosts), invertebrates, worms, crustaceans .Result showed that the worms is the primary consumed food and crustacean is the secondary one ($P>0.05$) also the major effects of water Pollution on food diversity have been observed in winter 2007,.However, given that sturgeon populations have been reduced by such as large degree, that should probably be considered functionally extinct in terms of their roles as top predators in the current food web.

0756	The vanishing of agro-forestry mosaics in the fringes between metropolitan areas and protected natural sites in the province of Barcelona (1850-2010): socio-metabolic drivers and landscape ecological impacts	Enric Tello, Joan Marull, Iago Otero, Elena Galán	Spain

We examine the evolution from mid-19th century to the present of cultural landscape in several Catalan townships located in edge environments between Mediterranean plains and mountains. They have changed from agricultural patches confronting forestry and livestock-raising areas to a border of the Barcelona Metropolitan Region confronting 'natural' protected sites, experiencing the two main landscape dynamics that characterize great parts of Europe today: intensification and abandonment. The most salient ecological outcome has been the loss of landscape mosaics. In the plains these traditional mosaics interwove cereal cropping with vineyards and olive orchards together with patches of woodland and

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pastureland into an agricultural land matrix. In the mountains, a woodland matrix of holm oaks and pines became cleared through timber, cork and firewood extraction, and the pruning of branches for charcoal making, creating a mixture of open forest articulated by grazing areas, cropland and scrub. Both sides of the edge interlinked and played a key role to maintain biodiversity. From the 1960s onwards the abandonment of an integrated management of forests, livestock breeding and cropland has led to a significant reforestation and a loss of landscape mosaics. While many studies praise this forest transition for its benefits in carbon sequestration, their effects in biodiversity remain poorly understood. By applying landscape metrics and indices, ecological connectivity maps have been drawn to assess the environmental impacts on habitats and species richness. Energy and nutrients balances of the prevailing farm systems have also been calculated to bring into light the socio-metabolic driving forces behind these land-use changes. While larger reuse flows were related with a greater complexity of agroecosystems in past times, they have been given up by current industrial farm systems mainly relying on external inflows from fossil fuels. The end of an integrated land-use management has entailed a linear simplification of agroecosystems that renders cultural landscapes less diverse. In spite of the transformation of much of these mountain areas into natural protected sites, the growth of a uniform and continuous reforested woodland canopy, directly confronted with urban sprawl, is endangering its species richness—such as Mediterranean orchids and the variety of butterflies whose habitats are disappearing. Hence the desirability of unmanaged forest transitions should be critically examined in relation to context and policy objectives. Our work emphasizes that conservation of landscapes with a long history of human use needs to take into account the role of humans in shaping ecological functioning and biodiversity.

| **0758** | Institutions, policies and control of productive activities that depend on land use in the Brazilian Amazônia | Thiago Castelo, Oriana Almeida, Sérgio Rivero | Brazil |

Productive activities in the Amazônia (agriculture and unlawful logging) are expanding over the years and has been responsible for the increase in deforestation in the Amazônico territory (MARGULIS, 2003). The advance disordered productive activities can endanger the flora and fauna existing in areas of dense forest. Documentary surveys showed that the gross income generated in the production of crops in the Amazônia was more than R$ 10 million reais in 2010 (12% of national production), which highlights the cultivation of rice, maize and soybeans. Furthermore, the increase in cattle prices along with the opening of new pastures influenced by the positive performance of the sector in recent years (BARRETO & SILVA, 2013). The high economic profitability deriving these activities is one of the factors responsible for attracting migrants and expansion of plantations in the Amazônica region. The lack of supervision, lack of integration between the institutions responsible for penalties as well as the involvement of officials of environmental agencies in corruption are obstacles to the implementation of stricter environmental laws on land use in the Amazônia (BRITO & BARRETO, 2005) . Therefore, technicians and researchers of environmental agencies in city of Belém/PA, located in the Amazônia region, were consulted about the recent changes in environmental management (new laws and issue of the New Brazil's Forest Code – Law # 12.651/2012) and influence laws in making decisions about the actions to combat deforestation and sustainable land use. The results showed that there is controversy about the effects that the new forest code can bring to the Amazônico biome. Researchers are more pessimistic about the changes in the forest code; technicians reported that corruption is a serious problem especially in the timber sector; however, most agree that it is necessary to further integration of environmental agencies in monitoring production activities in Amazônia. Therefore, actions between government, states and municipalities in the monitoring and management of forest areas can minimize the damage caused by production activities, increase the efficiency and applicability of laws, and promote the region's development with environmental sustainability, development of natural resources and wellbeing of local populations.

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0760	What have we learned about land use modeling in the Amazon over the last decade?	Eloi Lennon Dalla-Nora, Ana Paula Dutra de Aguiar, David Montenegro Lapola, Geert Woltjer	Brazil

Land cover change in the Neotropics represents one of the major drivers of global environmental changes. In this sense, several models have been proposed to explore future trajectories of land use and cover change, particularly in the Amazon. Despite the remarkable development of this tool, model results are still surrounded by uncertainties. None of the model projections available in the literature plausibly captured the overall trajectory of land use and cover change that have been observed in the Amazon over the last decade. In this context, this study aims to review and analyze the general structure of the land use models that have most recently been used to explore land use changes in the Amazon, seeking to investigate methodological factors that could explain the divergence between the observed and projected rates, paying special attention to the land demand calculations. Based on this review, the primary limitations inherent to this type of model and the extent to which these limitations can affect the consistency of the projections will also be analyzed. Finally, we propose a multi-scale approach for land demand calculation that could, particularly in the Amazon, increase the internal consistency of forthcoming land use modeling exercises.

0762	The transition toward the sustainable land use in the Norwegian cities: between the governmental initiative and individual choices	Fabio Hernandez Palacio	Norway

The transition toward the sustainable city seems a long and full of tribulations journey. Cities are complex artefacts in constant transformation, influenced by very different aspects: social, economic, technical, political, or environmental. In Norway, this transition has been addressed by the programme "Cities of the future", an on-going national initiative that aims to promote the sustainable city in the main urban areas. The slogan of the programme is "compact and good cities"; the main objective is to reduce emissions of greenhouse gases and make cities better places to live. The successful application of this national initiative requires a renovated approach toward the use of land, urban planning and design, and urban ways of living.

The Sustainable City Strategies have as main objective the rational use of land, energy and materials. Cities, being the space of most of human activities, have big impacts in energy and natural resources consumption, in the production of CO2 and other pollutants. The compact city has been widely adopted as the model of sustainable city. Regarding urban patterns, the densest have proved more efficient use of space, infrastructure and energy than those sprawled. But densification seems to lack of attractiveness to many urbanites. The social acceptability of urban highly intense environments appears as a bigger challenge in the transition toward the sustainable city. In Norwegian cities, a large number of dwellings are detached houses with gardens, constituting low density expanded urban areas. Urban intensification (high density and multifunctional arrangements) seems to be contrary to the expectations of urban quality of life.

The use of land for urban functions seems to be growing faster than the population, despite the adoption of urban intensification as the planning strategy to achieve sustainability. There are three main barriers in the achievement of compact city objectives: (1) the individual choices seem to favour low density mono-functional neighbourhoods. This social preference by detached homes and automobile dependant urban areas create a 'lock-in' that condition decision making in urban planning and design. (2) The difficulty in creating high-quality and high-intense urban areas that can attract inhabitants to inner-city locations.

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Urban renewal operations demand complex negotiations among diverse groups (inhabitants, landowners, developers, city authorities). These processes take longer periods and bigger costs than new developments in the periphery. (3) Real estate agents perceive these kinds of operations as risky, and instead they promote their projects in the low dense urban borders.

| **0764** | Land grabbing and sprawlling rural-urban migration in Nigeria: a sociological exploration of Greater Lagos | Adebusuyi Isaac Adeniran | Nigeria |

In recent Nigerian history, extraction of natural resources, large scale agricultural practice (often facilitated by foreign multinational interests) and sprawling pattern of urban growth have been primary precursors to subsisting system of land grabbing. With the promulgation of the Nigerian 'Land Use Act' of 1978 (as amended in 2003), the ownership of lands in Nigeria has been taken from individuals and communities and awarded to governments at various levels (that is, federal, state and local). By implication, the stage has been prepared for perpetual denial of individuals' (customary) right to land across the length and breadth of the country. In all of the ensuing processes however, migration (especially, rural-urban migration) has been a central and recurring issue of interest; more so, that the sources of livelihood of a considerable percentage of Nigerians (that is, 50.2 %) are directly tied to land (World Bank, 2011). Besides the destruction of extant indigenous knowledge of subsistence, ongoing land grabbing system in Nigeria has continued to worsen the incidence of unbridled relocation from rural areas to urban centers where the state of existence is already precarious. Socio-economic infrastructures, such as, housing, employment, sanitation, road and other transportation means are over-stretched, and the level of criminality has been soaring. Engaging the 'Greater Lagos' region (which is the largest area for destruction of farmlands and expansion of metropolitan life in Nigeria) as a case study, this research seeks to explain the processes and implications of ongoing forceful acquisition of land in Nigeria vis-à-vis the transmutation of hitherto rural individuals to permanent urban dwellers, even when the conditions of existence in such urban centers have not been comparatively encouraging. My proposed presentation at the conference will enrich related discussions by providing a comparative framework for understanding the evolving pattern of land acquisition and management in Africa relative to other regions of the world. It will, nevertheless, present potent responses to the proposed roundtable discussion session ('Land grabs', 'Water grabs', 'Green grabs': is research accounting for differentiation in the African context?) by means of utilizing the outcomes of my recent studies on related areas to its focus.

| **0768** | The biodiesel program and territorial reconfiguration in Eastern Amazon, Brazil | Fabio de Castro, Celia Futemma, Ana Claudia Braga | The Netherlands |

Renewable energy has become a central element in mitigation strategies for carbon emission. However, the expansion of biofuel production has triggered major criticisms regarding ecological and social impacts to marginalized rural populations. Land grabbing, food security, and land degradation are some of the impacts of biofuel in rural territories (Journal of Peasant Studies 2010). In this paper we address the reconfiguration of rural territory driven by the National Program of Production and Use of Biodiesel (PNPB), and by the Oil Palm Pole (OPP) in the Eastern Amazon implemented in 2005 and 2010, respectively. The PNPB was designed to achieve two main goals: 1) to replace imported diesel and fulfil the increased demand resulted from economic growth; and 2) to promote the participation of small

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farmers in the production chain by supplying feedstock to biodiesel plants. Five year after the launching of the PNPB, advances towards the first goal could be observed - the annual production target was achieved and the compulsory biodiesel/diesel blending scheme (B5) helped to move towards self-sufficient diesel production. On the other hand, progress towards the second goal related to social inclusion was insignificant - the feedstock processed by the biodiesel plants were mainly obtained from large-scale farming systems (soybeans) and slaughterhouses (animal fat). In order to tackle the shortcomings of the social inclusion component of the biodiesel program, a series of initiatives were launched by the national government. This paper focuses on the Oil Palm Pole program (OPP) implemented as an effort of the national government to foster social inclusion component of the PNPB. Although oil palm crop system has long been established in this region, the OPP program foresees an expansion from 80 to 210 thousand hectares by 2014, and investment of USD500 million for new biodiesel plants and credit lines to benefit mainly small and medium farmers. Based on preliminary data collected in 2011 and 2013, we analyze the transformations in territorial configuration in the municipality of Tome-Açú resulted from this initiative. The discussion will focus on two key elements of this session - power relations among farmers and the biodiesel plants, and the role of the state in the reconfiguration of rural territories in the region - by addressing internal (conditions established by the contracts between farmers and the biodiesel plants) and external (supporting policies for the expansion of oil palm crops) factors driving the oil palm expansion.

	Combining earth observation and cultural anthropology to assess the impact of urban growth and rural land use transformations on ecosystem services in Northern Namibia and Southern Angola	Achim Röder, Marion Stellmes, Michael Pröpper, Johannes Stoffels, Anne Schneibel	Germany
0784			

The Okavango catchment is a hot spot of accelerating land use change, where predictions of climate change and demographic developments are expected to increase pressure on resources and a growing utilization of ecosystem services and functions. Land use conflicts, the sustenance of precarious livelihoods, deforestation of woodland savannas, upstream-downstream water issues and human-wildlife conflicts are among characteristic of the management challenges in the region.

In the Kavango region of Namibia, a unique cross-border situation exists that allows assessing the impact of different socio-economic settings, including political history and local land management, on ecosystem services. We use a set of multi-temporal Landsat-5 TM and -7ETM+ data sets covering the period from 1989 to 2010 to assess the contrasting development of resource utilization on both sides of the Okavango River. Reflecting the high spectral variability in surface types, support vector machine classification is used to map major land use types, while further discrimination of Savanna ecosystems is achieved using Iterative Spectral Mixture Analysis. In addition, MODIS- derived seasonality descriptors provide context at a coarser scale, while Quickbird data yield explanatory details at finer resolutions.

Results show a strong gradient in land use intensity between Angola and Namibia. In Angola, residential and agricultural development has only recently started after the end of the civil war. Noteworthy is the strong and interconnected urban growth on both sides of the river. The area around Rundu has constantly been evolving to become Namibia's second largest city, also functioning as a hub of transborder commerce and development of opposing Calai. This trend is affecting adjacent settlement areas and causing widespread conversion of woodland Savannahs to agricultural land or being used for timber extraction.

Information on people's livelihoods, their individual ways of resource utilization and consumption have been collected using interviews and household surveys with 1800 individuals to collect information on demography, household composition, households' consumption, households living situation, farming

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activities, strategies and preferences, income, expenditure and subsistence. Linking this information to remotely sensed information allowed to spatially characterize people's perception of resources, where a strong overlap between physical, (potentially) monetary and cultural uses was noted.

We therefore argue that while many conclusions on ecosystem services may be drawn from geospatial data, the often overlooked cultural services are equally important in land use decisions and should therefore be an equal component of approaches to model ecosystem services.

| 0786 | Quantifying and assessing land use/land cover dynamics in a global breadbasket using MODIS EVI time series | Stephanie Spera, John Mustard, Dan Mahr, Joel Risso, Marcos Adami, Bernardo Rudorff, Leah VanWey, Avery Cohn | USA |

Between 2001 and 2011, the agricultural frontier of Mato Grosso State (900,000 km2), Brazil became a global breadbasket. Characterizing both the extent and nature of the land use/land-cover changes associated with this increase in agricultural productivity is essential when addressing both the drivers and consequences of these transformations and issues of food security, climate change, and environmental conservation. Using 16-day 250 m MODIS Enhanced Vegetation Index (EVI) and Day of Year (DOY) data and a new decision-tree algorithm tuned to phenological events characteristic of Mato Grosso's major natural vegetation cover and crop rotations, we mapped land-cover across the entire state over 11 growing seasons (2001-2011). Our time series analysis allowed us to not only discriminate between forest, pasture/cerrado, and mechanized agriculture, but also the specific crop rotations of mechanized agriculture—a soy- or cotton-single commercial crop rotation, or a soy-corn or soy-cotton double commercial crop rotation. Between August 2000 and July 2011, the amount of land in a soy-cotton double-cropping rotation increased over 11-fold from 2.2×10^4 ha to 2.4×10^5 thousand ha and that in a soy-corn rotation increased over 6-fold from 0.46×10^6 ha to 2.9×10^6 ha. Our results, validated with over 2900 points and a web tool created at the National Institute for Space Research (INPE) in Brazil, exhibited an accuracy of 92% with a k_{hat} of 0.90. The temporal frequency (16-day composites) of the MODIS EVI data product was central to the success of this analysis, however, data at higher spatial or temporal resolutions would strengthen these and future results. Simple Markov transition matrices indicate that while extensification and the trend to single-crop dominated the first half of the decade, intensification and double-cropping has taken hold in the latter. Moreover, the resolution of our new dataset allows us to analyze the drivers and consequences of aggregate changes in land-cover type, and the drivers and consequences of pixel-specific land-cover transitions. Analysis of the complex local and global dynamics at play within a landscape like Mato Grosso will assist in making more informed environmental, economic and political decisions at the farm, regional and global level.

| 0788 | From the biodiversity conservation to the struggle for ethnical recognition: studies cases in Brazilian Amazon | Ana Mendes | Brazil |

I propose to discuss the relationship between some recent cases of identities emergencies as ethnical groups in Brazil and some policies promoted by the State, specifically those intending to preserve and respect the cultural diversity and those aiming to promote the conservation of biodiversity. By an analysis of the national legislation, I noticed that the lack of administrative possibilities for conciliating the conservation of these two patrimonies - the brazilian sociodiversity and the brazilian biodiversity - reflects a specific interpretation of it.

As we could observe after some field research in Amazonia (Reserva de Desenvolvimento Sustentável

Mamirauá e Parque Nacional do Jaú) and as a consequence of this scenario, in the last decade the demands made by social groups that live in areas designated for biodiversity conservation have enormously increased. These demands are made in order to achieve the recognition of some local groups as indigenous and quilombolas communities (those that descend from slaves) and represents strategies to guarantee land permanence and access, and also to maintain specifics ways of life.

All these political struggles and negotiations generate discussions about multiculturalism, identities constructions and the role of the State in those processes, especially when we recognize how flexible the ethnical frontiers in those study cases.

| 0789 | Interaction between construction land change and GDP growth based on modified decoupling model in China | Xiaofan Zhao | China |

Decouple theory has been introduced to the study fields about resource and environment since 1990's. As an important method to depict decoupling relation between resource consumption and economic development, elastic analysis was frequently used. However, discrepant judgment criteria in elastic analysis resulted in uncertainty of evaluation results. Therefore, we redefine the criterion in the study, and with the help of which, temporal and spatial pattern of the interactive relationship between construction land-use change and GDP growth in China was explored based on GIS and statistical data during the period of 2003-2008. Results indicated, (1) from national scale, the interaction between construction land-use change and GDP growth varied from weak decoupling to weak coupling, and the ratio of provinces with weak coupling in China amounted to 100% in 2007; (2) from provincial scale, decoupling degrees had little difference in each province in China, which showed continuous coupling distribution in space, and a few provinces had showed strong decoupling once in a while; (3) Although a few provinces had been in strong decoupling during 2003-2008 years, it could not continue to remain and back to weak coupling. We can conclude that it was difficult to realize decoupling between construction land-use expansion and GDP growth in urbanization of China, and decoupling process may be transformed in opposite direction.

| 0792 | Large-scale mining and land use: the footprint of the iron ore mining industry. | Diego Murguia | Germany |

The presentation addresses the question of large-scale metal mining and its footprint as a general indicator of environmental pressures on ecosystems. Advances of research within the framework of a PhD thesis will be presented with a focus on iron ore mining at a global level and its land use changes. Surface disturbances caused by mining during mines´ life cycles are monitored and calculated via time series analysis of Landsat satellite images combining pixel and object-based methods (eCognition software). The presentation contributes directly to the issue of the Landsat archive since the research is based on multi-temporal scenes profiting from the opened archive. Moreover, this research matches the Conference´s topic since mining provokes serious effects at the local level, but at the global level its impacts on land cover changes are not as significant as agricultural or forest land uses. Then, the question of how to upscale local results to global levels becomes of paramount importance in methodological terms.

| 0793 | Exploring trends in land use change in Baakse Beek, the Netherlands | Shah Jamal Alam, Martha Bakker, Eleni Karali, Jerry van Dijk, Mark Rounsevell | UK |

We present a spatially-explicit agent-based simulation model of rural land exchange RULEX (RUral Land EXchange) for the Baakse Beek region in the Netherlands [1]. The model development process is part of

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an on-going research program* aiming at understanding the effects of climate change and socioeconomic drivers on agriculture land use and nature conservation. The RULEX model is being developed to study trends in increase of farms size under different climate change and socioeconomic scenarios. RULEX incorporates a market-based land exchange mechanism through which agents representing the nature managers and farmers in the region compete for the available land parcels they are interested in. This allows a cross-sectorial competition analysis for land resources between two actor types, viz. farmers and nature managers that take into account different factors when determining the desirability of a land parcel that is on sale. Both qualitative and quantitative data inform the processes in our model. This includes ownership maps, agriculture census, semi- and structured interviews and regular feedback from the stakeholders. Our modeling approach has been to find a neutral solution of not optimizing either from the ecological or economic perspectives but to mimic the observed behavior to engage the farmers in the Baakse Beek region and other stakeholders in exploring trajectories of land use change in the region. We report results based on two scenarios: 'global economy' and 'regional communities' with a +1C and +2C temperature increases respectively by 2050.

NUMBER	TITLE	AUTHORS	COUNTRY
0794	Urban growth in the fragmented landscape: estimating the relationship between landscape pattern and urban land use change in Germany, 2000-2006	Rose Keller	Germany

The expansion of urban land into natural landscapes has resulted in loss of ecosystem services throughout Europe. Understanding why the share of urban land has increased will be important for managing urban growth and maintaining ecosystem services. Building on regional science and economic geography research, I develop a model of landscape change that integrates geospatial and socioeconomic data in a spatial autoregressive model to explain the variance in urban growth observed in Germany, 2000-2006. The results show that despite the vast spatial heterogeneity in land cover and land use in Germany, urban growth occurs when fragmented land and/or environmental amenities are prevalent. Three key landscape mechanisms were found to drive urban land-use change: (1) the level of fragmentation; (2) the share of protected areas; and (3) the share of prime soil. Given that international comparative studies are vital for understanding urbanization, the methodology employed here is exportable to land use research in other areas.

NUMBER	TITLE	AUTHORS	COUNTRY
0797	Analysis of the protected areas effectiveness for deforestation containment in the Brazilian Amazon based on time series	Denise Zanatta Martini, Eloi Lennon Dalla-Nora, Mauricio Alves Moreira	Brazil

Monitoring land use and cover changes in protected areas (PA) is a fundamental issue for biodiversity conservation. Amazonian protected areas of strict protection in particular, aim to maintain local ecosystems free from any changes caused by human interference. Therefore, this work studied the dynamics of land use and cover change in the PA of strict protection of Monte Alegre State Park (PEMA) in the state of Pará, Brazil for the purpose of deforestation containment. We also analyzed its buffer zone to evaluate the effectiveness of its creation as an initiative to preserve the surrounding biodiversity. 20 years of remote sensing time series were used to analyze the land use and cover change dynamics in both areas (i) PEMA and its (ii) buffer zone. The results revealed that the creation of the protected area was important as 10 years after its creation deforestation rate decreased 58%. However, this result is not satisfactory, since factors that threaten the local biological integrity like population and urban areas growth were still observed after its creation. In these sense, more appropriate protection measures still remains as conservation measure to be taken in order to achieve the original goal of PEMA`s creation.

NUMBER	TITLE	AUTHORS	COUNTRY
0805	Spatial response patterns of subtropical forests to a heavy ice storm: a case study in Poyang Lake Basin, southern China	Leilei Shi	China

Between 11 January and 5 February 2008, an unexpected ice and snow storm (major freezing rain events) hit southern China, severely affected the subtropical forest ecosystems, especially in the Poyang Lake region. Although ice and snow storms are common within mountain forests in southern China, the magnitude and extent of the 2008 storm far exceeded damage caused by typical ice and snow storms in the recent past. The objective of this study is to investigate the spatial pattern of the 2008 ice and snow storm on subtropical forests and to analyze the effect of topography features (elevation, aspect and slope inclination) on the damage with remote sensing data in the Poyang Lake region. The Enhanced Vegetation Index (EVI) was employed to assess forest vigor and canopy density in atmospherically corrected Moderate Resolution Imaging Spectroradiometer (MODIS) satellite imagery of study area. Digital change analysis of the baseline forest condition (2004 EVI data), and the condition encountered in a post-storm image (2008 EVI data) was conducted. The results display a northeast-to-southwest gradient and a gradient from the center to boundary of Poyang basin and Jitai basin in damage that apparently corresponds to a gradient in the depth of ice and snow that accumulated during the storms. Damage also varied topographically, particularly by elevation and slope in the Poyang Lake region. Topography affected patterns of ice and snow damages in study area with the greatest EVI losses occurring on north-, northeast- and east-facing (windward) slopes; and at middle elevations; and on slopes of moderate steepness. Unlike previous studies in North America that found damage was most extensive at middle elevations, EVI decrease associated with the 2008 storm was greater not only at the middle elevations (0.09), but also at the higher elevations (0.07) in the Poyang Lake region. This result suggests that subtropical forests are more vulnerable to ice and snow disturbance.

| **0806** | Effects of slash and burn agriculture at tropical savanna-forest boundaries on subsequent fallow vegetation and implications for land use change in Central Cameroon | Lindsey Norgrove | Switzerland |

Central Cameroon has been characterized as having a high deforestation rate and only 4% of remaining land covered by primary forest. Yet, reports from local people contradict the idea of recent large-scale deforestation, with farmers claiming that forest cover was actually less during their youth and that a process of afforestation has been occurring. They report a process of forest invasion of adjacent savanna and that this has been accelerated by: previous cultivation along the forest grassland boundaries; the appearance in the 1960s of *Chromolaena odorata*, an exotic shrubby weed which is now one of the dominant fallow types and weed species in central and west Africa; and, planting useful trees around homesteads.

An experiment was designed to test the farmers' view that cultivation of savanna along forest boundaries promotes a succession to tree fallow. The experiment had a factorial block design, with six replicates, where the effects of cultivation versus an uncultivated control, dry season burning versus fire exclusion and distance of the plots to the forest edge were assessed on the species composition and density of the following fallow vegetation. Cultivation had a significant impact on the following fallow vegetation compared with the uncultivated control with higher dicotyledon densities and lower grass densities in the previously cultivated plots. The implications of these results on land use change are discussed.

| **0810** | Land cover effects of shale gas drilling in Carroll County, Ohio, USA, 2010 - 2012 | Shanon Donnelly | USA |

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Technologies such as directional drilling and hydraulic fracturing promise the production of "clean energy" in the form of natural gas from previously unreachable sources in several places in the world. One such area in the Utica and Marcellus shales in the eastern United States has seen a significant increase in drilling in rural but populated areas. Because surface and mineral rights are separated, and individual land holdings are often smaller than minimums needed for drilling, institutions for competition and cooperation among land managers is emerging. The incentive of large sums of money for land managers in this economically depressed landscape has so far outweighed the potential environmental and health impacts of this new and evolving technology.

To answer the research questions of how much land cover change is occurring, what types of change are occurring, and what particular features are causing changes, this research quantifies the type and amounts of land cover change that have been caused by shale gas drilling in one county in the state of Ohio, USA. Land cover was interpreted from aerial photography and satellite imagery in 2010 and 2012. Land cover changes were categorized as direct if they are caused by clearing for features that are part of the accessing and acquisition of shale gas such as drilling pads, access roads, water retention ponds, etc. Land cover changes are categorized as indirect if they are associated with downstream transport or processing of the gas such as pipelines and processing plants. The findings include the predominance of land cover transitions due to indirect causes, particularly pipeline right-of-ways.

In terms of land cover change, this research identifies significant transitions over a short time period. As more infrastructure, particularly pipelines, come online in this area, the development will continue for several years to decades. While this research fits several of the conference themes, it most directly relates to Rethinking Land Change Transitions in that the global demand for energy is influencing local land managers and their relations to one another in a new way in this agricultural landscape.

| **0813** | Application of the pressure-state-response framework to assess land use changes in the Carrados of central Brazil | Rosana Grecchi, Q. Hugh Gwyn, Antônio Formaggio, Fernando Fahl | Brazil |

The main purpose of the research to be presented at the 2nd GLP Open Science Meeting was to understand the rates and patterns of land-use and land-cover (LULC) changes in an intensively managed landscape of the Brazilian Cerrado (savannas) and how these changes have affected the environment at a landscape scale. The Cerrado is the second most extensive Brazilian biome, after the Amazonian, and has been intensively converted into agricultural lands in the past decades with the consequences still poorly assessed.

The methodology encompassed three main parts. The first consisted in extracting historical LULC information from a temporal remote sensing dataset. In the second, LULC changes were linked to land vulnerabilities, focusing mainly on erosion risks (via Universal Soil Loss Equation - USLE), and impacts on fragile lands (e.g. wetlands). The finally part focused on identifying key environmental indicators from the preceding steps, and assessing them within the Pressure-State-Response (PSR) framework of the Organisation for Economic Co-operation and Development (OECD).

The indicators identified captured key information about land-use and environmental changes in the study area, helping to synthesize the information obtained using a remote sensing/GIS approach and to highlight cause-effect relationships. They showed that expansion of agricultural lands (predominantly annual crops) have been the principal human activity exerting pressure on the environment at a landscape scale, with a pattern of change, which included high rates of crop expansion and the use of fragile environments (wetlands and highly erodable sandy soils) for cropping. Consequently, the Cerrado vegetation was intensively converted and has become increasingly fragmented during the period studied. Concomitantly, a significant increase in erosion risk was detected, mainly related to the increase of crop areas and the use

of fragile lands. Some societal responses were identified; however, when we assess them against the results of the present research we verify that they have not been adequate to prevent depletion of certain natural resources.

Our research contributes to Category 0018 (The state of tropical savannas: responses to direct and indirect anthropogenic change) by presenting a detailed study of the rates and patterns of Cerrado conversion into agricultural lands that can be considered representative of many other agricultural landscapes in the Brazilian Cerrados. In addition, our study contributes to the assessment of how changes affect erosion risks and invasion of wetlands, and the role of certain societal responses to prevent environmental degradation.

0818	Environmental risk assment of mining to Argentine high Andean wetlands	Andrea Izquierdo, Ricardo Grau, Javier Foguet	Argentina

The assessment of the threats of human activities to natural ecosystems is one of the more important components of an effective conservation planning process. Consequently, understanding the spatial relationship between these risk elements and ecological health within focal conservation sites provides valuable insight into conservation management. We mapped and quantified human impact by mining to High Andean wetlands from Argentine Puna and High Andean ecoregions, a study area of 14.231.505 ha, located above 3500 m elevation in NW Argentina

High Andean wetlands (lakes and peatbogs) represent the highest biodiversity and productivity of high elevation Andean ecosystems, and provide essential ecosystems services to local inhabitants. They contribute a significant proportion of primary productivity, maintain vertebrate populations, and regulate hydrological resources, which have high incidence in urban and agricultural areas downstream. While historically the region has been affected by grazing; presently the combination of global markets and domestic policies suggest mining will expand rapidly in the region, with potentially vast impacts on water cycles.

We developed a map of wetlands and an Environmental Risk Surface (ERS) to High Andean wetlands by mining. The map of wetlands was based in Maximum likelihood classification of Landsat (30x30 m resolution). The ERS was developed by assigning different intensity values and influence distances to indirect threats (i.e roads) and direct threats considering visual impact and a characterization of each mining project and prospect (i.e. exploited material, type of work, state, production); and summarizing an overall contribution of mining impact in a final risk spatial raster model. Finally, we analyzed the overlay of the wetlands with this ERS, and calculated a risk rating for each wetland.

The total surface of wetlands is 113.143 has (0,79% of study area), which 34.560 ha are petbogs (0,23% of study area) and 80.474 has are lakes (0,56% of study area). Only 11.400 ha of petbogs (35% of total area) occurred in area with some level of risk (5267 ha in level 1, 5938 ha in level 2 and 194 in level 3). While, 22498 ha (28% of total area of lakes) of lakes are in areas with some level of risk (7538 ha in level 1, 7901 ha in level 2, and 7058 ha in level 3). These risk assessments vary according to different geographic categories (e.g. elevation, size, shape, temporal variability); that need to be considered as basis of land use planning and environmental impact assessments in the region.

0819	Modeling the impacts of bioenergy: influence of climate and biogeophysical feedbacks	Justin Bagley	USA

Currently human management, primarily in the form of pasture or cropland, directly influences 30-40% of the global ice-free land, and the remaining untapped arable land largely resides in ecologically rich and climatologically significant regions. This biogeophysical limit of arable land combined with the effects of growing global energy and dietary demands under scenarios of changing climate necessitate a careful assessment of how to optimize the services that agro-ecosystems provide. Recently, the fraction of arable

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land being utilized for bioenergy production has increased. However, the impacts of adopting bioenergy agro-ecosystems on overall ecosystem services are still unclear in many regions. A central component of these services is the regulation of climate across a spectrum of spatial scales. Here we present an extension of the Agro-IBIS model that has been developed to test the carbon, energy, and moisture impacts resulting from the potential adoption of 2nd-generation bioenergy crops across North America. This model combines multilayer vegetation with state-of-the-art physiology and microenvironment physics, as well as a diagnostic bulk boundary layer model to test land use impacts on local climate. Using novel observations from the University of Illinois Energy Farm to validate the model, estimates of marginal land, and downscaled climate data we present realistic estimates of future extent and yield, and biogeophysical feedbacks of this potential land use change on climate regulating ecosystem services. With the interplay of food, energy, and climate being inextricably entangled in studies of bioenergy agro-ecosystems this work is intended to contribute to the conference session "Food, energy, climate – modeling and understanding land use change drivers across scales" by presenting the unique bioenergy perspective as well as a new modeling approach.

| **0822** | Land cover change and downstream habitat modification: Valley Oak (Quercus lobata) dynamics in the Santa Monica Mountains, California, USA | James Hayes | USA |

Land use and land cover change negatively impact species, ecosystems, and ecosystem services around the world primarily through habitat loss and ecosystem modification. Habitat loss and fragmentation due to land cover change has contributed to population decline and isolation in valley oak (*Quercus lobata*) and land use may be related to regeneration failure. Valley oak is a keystone species and endemic to California. Little work has examined the indirect effects of land use and land cover change on valley oak habitat, regeneration, or recruitment. This project examines how watershed-scale land change affects vegetation dynamics at the site-scale in adjacent nature reserves. Spatial and temporal patterns of stem establishment are examined at two sites using dendroecology and GPS mapping. To examine relationships with land use and cover change, temporal patterns in land development from historical records and remote sensing are compared with temporal changes in vegetation. Results suggest that one site experienced a recruitment failure in the past, but that new recruitment is beginning; however, new recruitment is limited to a narrow habitat type within the site, potentially establishing a very different spatial pattern of trees on the landscape. Analysis of a second site suggests that regeneration and recruitment has been occurring at a roughly constant rate for some time with little difference in location of new recruitment compared to older stems. Tree-ring analysis indicates that recruitment of stems at the first site is non-random, occurring in unusually wet yet years. At the second site recruitment appears to be stochastic. Examination of historical records, aerial photography of both sites, and housing development records for the watershed indicates a sudden increase in riparian vegetation associated with post-WWII land development and increased water availability through implementation of a state water project. Landsat data for the watershed reveals that development patterns upstream of the two sites are very different in density, land use diversity, and age. These differences in land use and cover may contribute to runoff patterns affecting stream flow and ground water availability, which in turn affect microclimate and topographic habitat differentiation. The findings of this work are especially significant in light of recent research indicating that climate change may limit valley oak to isolated climate refugia. The results presented here indicate that the amount and spatial distribution of suitable valley oak habitat can be altered by interacting local factors including topography, water use, and land modification interacting with climate.

| **0823** | Green grabbing: appropriation of land in Sub-Sahara Africa | Oyebola Adebola Elemide | Nigeria |

The term 'grabbing' focuses on appropriation, which has long been the subject of analysis in political economy, In many parts of the world, a new political economy of land and livelihoods is emerging, driven by 'green' market economics, and global discourses of the use and repair of ecosystems. New valuations of nature are legitimizing and incentivizing new appropriations, and multiplying them, as ecosystems become compartmentalized and commodified in an ever greater variety of ways. This appropriation of nature for green ends – 'green grabbing' – adds a new dimension to the wider discussion of 'land grabbing' and the study of agrarian change in diverse rural locations across the world. There are new actors, political-economic processes and forms of resistance, constructed through new discursive framings. While there are many echoes of past interventions in the name of the environment, green grabbing operates often virtually through novel legal and market mechanisms, suggesting new methodological and analytical challenges, as well new dilemmas for action.

This paper declears that there is a clear role for engaged researchers and activists, NGOs and even aid donors in changing the terms of debate, the biases of policy and so the dynamics of investment. Agrarian struggles, focused on land and resources, must be seen in a new light, and must engage with virtual markets, fictitious commodities and the speculative character of 'green' commodity trading. This is new territory for many, and will require alliances of communities, activists and scientists in counteracting the negative effects of green grabbing and seeking out and shaping alternative solutions, even in highly constrained settings.

The paper recommended that the emerging phenomenon of 'green grabbing' presents a fundamental and new challenge to 'peasant studies', and indeed all those concerned with the both the analysis and transformational change of rural politics and economies.

Environmental green agendas are the core drivers and goals of grabs – whether linked to biodiversity conservation, biocarbon sequestration, biofuels, ecosystem services, ecotourism

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0824	Land change and groundwater management in Yucatan, Mexico: some implications for the environment and society	Yolanda López	Germany

Groundwater resources involve complex human-environment (HES) interactions. Due to the lack of collaboration between agents, one of the challenges has been the uncertain future on freshwater resources supplies, particularly in areas where water is scarce. In the dry region of Yucatan, Mexico, for example, where water is readily available only at specific sites because of the absence of surface streams, groundwater reservoirs has been since decades a major source of water for human consumption. However, the volume of stored water is being polluted in an increasing rate: drainage from septic tanks, broken sewers, privies, and barnyards contaminates the resource. The calcareous nature gives to its soil characteristics of high porosity and permeability causing rainwater evaporation. Thus, the water situation in Yucatan can quickly reach critical conditions: pollution and salt intrusion from the sea towards the interior of the basin; overexploitation of the aquifers and other water sources; deterioration of wetlands and contamination derived from a bad solid disposal and climate change. Therefore, this research aims to understand the dynamics of social-ecological systems and to provide a framework for estimating the extent of human impacts on groundwater resources and the amount of perturbations. Yucatan will be taken as a case study, specifically an area with excellent data about Mayan population and biodiversity: the Cenote* Ring. The area is surrounded by groundwater reservoirs resulting in many interactions between environmental processes. However, it is difficult to have a single management program and local inhabitants do not often stop to think that groundwater is a non-renewable resource. We include the analysis on groundwater uses in order to develop and improve techniques for modeling and mapping ecosystem services to better understand the impacts of land change on supply of services. Because HES

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	data related to water resources are generally scarce in Yucatan, we consider here the groundwater management as an object for a human ecology approach. Our framework combines the social system (indigenous attitudes towards groundwater use changes, traditional knowledge and local governance) with the ecological system (functioning of groundwater dynamics). With this we contribute to the understanding of HES [1] and to improve our comprehension that the systematic use of this resource requires cooperation between stakeholders, connecting local land use decisions to global responses. Directly addressing the conference theme No. 3, our research provides an example of how management at inappropriate scales has created both, biological and social problems in the area.		
0825	Remote sensing of ground cover for better land management: some insights from Australia	Juan Guerschman, Peter Scarth, Gary Bastin, Kenneth Clark, Robert Karfs, John Leys, Tim Malthus, Alexis McIntyre, Tim McVicar, Gregory Okin, Stuart Phinn, Matthew Purss, Lucy Randall, Jasmine Rickards, Alison Specht, Jane Stewart, Phil Tickle, Rebecca Trevithick	Australia

Ground cover, defined as the proportion of the soil surface covered by vegetation and litter is a key variable associated with landscape processes like water infiltration and runoff, soil erosion and carbon sequestration. Land management practices have a strong influence on ground cover and together with natural climate variability are the main drivers of the spatio-temporal dynamics of ground cover. This paper presents an overview of techniques for ground cover estimation using remotely sensed information integrated with field data and how this ground cover information is being used by land managers in Australia. Several methods exist for estimating ground cover using the Landsat and the MODIS sensors. These approaches use the spectral properties of green vegetation, dry vegetation/ litter and soils via spectral indices and/or linear spectral unmixing for estimating fractional cover of each component. The performance of these methods vary but in general they can estimate these fractions with mean errors of 10-18% cover in Australian environments. In recent years the availability of consistent and reliable field measurements of ground cover has increased dramatically thanks to state and federally-funded data collection and national infrastructure projects. Access to more field site data allows better calibration and validation of remotely sensed fractional cover across Australia. Moreover, the national database allows different fractional cover algorithms to be compared and revised.

State and federal governments have begun using remotely sensed fractional cover to inform a range of policies and programs. Fractional cover data is being used to inform monitoring of soil erosion, atmospheric dust, and grazing and cropping practices across large areas, in several states.

Despite the progress achieved, some challenges remain and are the focus of current and future research: (1) delivery of ground cover information to users via web-based or mobile/tablet applications; (2) separation of the effects of natural climate variability and land management practices on land cover over time; (3) improved access by land managers to information on biomass, lateral cover and ground cover under trees in savannah and forested areas. The aim is to continue to deliver this research in a nationally

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	coordinated way.		
0831	Land and power: evidences of clientelism in Ukraine	Olha Zadorozhna	Poland

This paper investigates the relationship between the political corruption and the development of the land* market in Ukraine. As indicated by Keefer (2007), younger democracies are more prone to clientelism, political violence, and targeted transfers to narrow groups of voters. In Ukraine some politicians tend to buy votes of the electorate by exchanging favours for the votes. Such favours can take a form of lower rental rates for agricultural land for companies who encourage their employees to vote for a specific party during the elections. Due to the lack of bargaining power and low security of property rights for land, landowners almost never (re)negotiate their land leasing contracts. The paper aims at answering the question whether indeed political parties tend to allocate more assets and resources to the communities that would give them the strongest electoral support. Three rounds of Parliamentary elections in Ukraine are analyzed. An evidence of systematically lower rental rates for land in districts that exhibit greater electoral support for parties that form the Parliamentary Majority after the elections is found. Also, with the implementation of the land reform that granted more secure property rights for land, political popularity of the centrist parties increased significantly, while the share of votes given to the right or left-wing parties decreased.

The paper explores issues of political corruption and clientelism in the context of land market, hence, the discussion of its results during the conference session selected could contribute significantly to the understanding of implications of regime shifts for the land market relationships. Also, the discussion of how political power can affect the development of the land market in the transition country could be an interesting insight into the topic.

* In this paper *land* refers exclusively to agricultural land.

| **0836** | Decoupling cultivated land loss by construction occupation from economy and population growth in Beijing, China | Wei Song | China |

China has undergone large-scale expansion of construction land (i.e. urban settlement, rural settlement, road, railway, etc.) and rapid loss of cultivated land for more than three decades especially in metropolis. In this paper, we examined the construction land expansion and its occupation on cultivated land in Beijing. The effects of economy and population growth on cultivated land losses were also assessed using decoupling approach. It was found that expansion of construction land in Beijing occupied 845.17 km^2, 304.48 km^2 and 868.95 km^2 of cultivated land during periods of 1986-1995, 1995-2000 and 2000-2005 respectively. During 1986-1995, cultivated land was mainly occupied by expansion of urban settlement; during 1995-2000, the cultivated land loss in construction occupation was mainly attributed to the expansion of rural settlement while expansion of other construction land (i.e. road, railway, independent industrial land) takes main responsibility for cultivated land losses in construction occupation during 1995- 2000. The economy and population growth in Beijing were well decoupled from cultivated land losses during 1999-2000 while they are coupled again in the following period of 2000-2005.

| **0837** | LULC and LULC processes of change as driving forces - implications on water quality | Zara Teixeira, Heliana Teixeira, João C. Marques | Portugal |

Land use and land cover are driving forces potentially exerting pressures on water bodies, which are most commonly quantified by aggregated data simple to obtain. However, this is insufficient to detect the drivers that arise from the landscape change itself. To achieve this goal it is necessary to distinguish between random and systematic transitions and to identify those transitions that show strong signals of

change, since these will allow identifying those transitions that have evolved due to population growth, industrial expansion and/or changes in land management policies. The goal is therefore to characterize driving forces that arise both from LULC and dominant LULC changes, recognizing that the presence of certain LULC classes, as well as the processes of transition to other uses, are both sources of stress with potential effects on the condition of water bodies. This paper first quantifies driving forces from LULC and also from LULC processes of change for three nested regions within the Mondego river basin in 1990, 2000 and 2006. Subsequently, it discusses the implications on water quality and on environmental management policies. The fingerprint left on the landscape by some of the dominant changes found, as for instance urbanization and industrial expansion, is expectedly low due to their proportion in the geographic regions under study. However, their magnitude of change and consistency represent strong signals of change regarding the pressures acting in the system. Assessing dominant LULC changes is vital for a comprehensive study of driving forces with potential impacts on water condition.

Our study focuses on the interlinkage of landscape changes and the condition of water bodies, characterizing driving forces which in turn may potentially affect ecosystem services provided by river and estuarine systems, such as water quality. Driving forces characterization, as well as the characterization of subsequent potential pressures and impacts, is required for any economic analysis on water uses and services. We have selected session number 0116 – Landscape change and ecosystem service trade-offs: examples of spatial explicit assessments at different geographical scales – as this session aims at providing spatial explicit studies focusing on the interlinkage between ecosystem services and landscape changes.

| **0844** | Regime shifts and land-use adaptations to climate change and variability on Mt. Kenya: a spatial and temporal cross-scale analysis | Camille Washington-Ottombre, Bryan C. Pijanowski | USA |

In a context of climate change coupled with limited public investments, it is crucial that policy makers in rural Sub-Saharan Africa precisely identify the geographic areas where help is most needed to maintain sustainable land-use systems. However, land-use modeling often tends to downplay small-scale specificities and the social processes that explain landscapes' disparities beyond physical attributes. In order to address those issues, this work proposes to study landscapes' dynamics and regime shifts applying a spatial and temporal cross-scale modeling approach to the study of the slopes of Mt. Kenya (Kenya).

This case study on an elevation gradient combines life-stories interviews, archival work, and aerial photography to retrospectively model the adaptation of land-use practices and land-use responses to climate variability from 1920 to 1990. In an effort to develop scenario-based approaches for 2030 that fully incorporate social dynamics in a context of climate change, we develop a neural net model integrating a climate and crop model, interviews of local leaders, a survey of 350 farmers along the slope of Mt Kenya, role-play simulations, as well as a social network analysis.

Our model projects a transition from homogeneous and clearly defined land-use zones over the elevation gradient to a heterogeneous land-use and crop diversification supported by local rural institutions and social networks in response to climate change and variability in 2030. To achieve this, our model takes into account both local social and land-use dynamics and scales-up those adaptations to the regional level.

In addition to projecting future land-uses in a context of climate changes and variability, this multi-method cross-scale analysis results in identifying landscape's dynamics. Furthermore, it allows us to define the slow and fast variables as well as the functions and feedbacks of this social-ecological system. We also shed light on critical tipping points and the diffusion of regime shifts from the local to the regional scales between 1920 and 2030.

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By modeling processes of land-use adaptations to climate change, this work can support planning and development on Mt. Kenya. More precisely, we highlight local specificities and dynamics that help disaggregate our understanding of this landscape and identify more precise targets for support in their efforts to adapt to climate change. Finally, our research on landscapes' dynamics and regime shifts yields surprises that redefine the geographic location of the supposed losers and winners of climate change across the landscape and may completely overturn assumptions about policy needs in the region.

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0860	Forest- and agroclimatic potential changes in the Altai-Sayan ecoregion under climate change during the XXI century	Elena Parfenova, Nadezhda Tchebakova	Russia

The Altai Sayan ecoregion (ASE), central Asia, is located in Russia, Mongolia, China and Kazakhstan, within the window 80-102° E and 42-57° N. The ASE is a territory with a great variety of landscapes observed at a short distance: from nival and tundra landscapes at highlands, to taiga (dark-needled and light-needled) and subtaiga at middle elevations, to steppes at lower elevations. This southern part of Siberia is known as having a high agroclimatic potential due to favorable climatic and soil resources. Crops of food, forage, and biofuels primarily reside in steppe and forest-steppe zones and are resistant to frequent droughts and the cold climate. Regional studies over the Altai-Sayan ecoregion have already registered a change in climate at the end of the 20th century: January temperatures increased 1-2°C and July temperatures increased 0.7-1.5°C over the last 50 years in the northern portion of ASE; in the southern, more continental portion of ASE, both January and July temperature increased two times greater, 2-4°C and 1.4-3.2°C,0 respectively.

Our goal was to model how mountain vegetation in ASE may be altered in a changing climate through the century to the year 2080 and if the agroclimatic potential in the lowlands of ASE may benefit from climate change. We used our montane bioclimatic vegetation model (MontBioCliM) to predict the future vegetation distribution, coupling MontBioCliM with the HadCM3 A2 and B1 climate change scenarios for 2020, 2050, and 2080. MontBioCliM is an envelope-type model that predicts a vegetation type from three climatic indices: growing degree days, base 5C; negative degree days below 0°C; and annual moisture index.

Our model runs indicated that by 2080, forest habitats would decrease from 52% to 48% according to the moderate scenario B1 and from 52% to 38% according the harsh A2 scenario. At the expense of forests, more potential agricultural lands were modeled to appear in new forest-steppe and steppe habitats in foothills and lowlands in ASE. These lands might become suitable for growing traditional crops and introducing new crops. Bioclimatic models determining crop range and regression models determining crop yields were constructed and applied to the above climate change scenarios. Crops were predicted to extend in size and to 2-fold increase. However, due to shortage of water in the future dry climate crops would necessitate irrigation..

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0863	Global estimation of fertilizer use in croplands in the 20th and 21st centuries	Motoko Inatomi, Tsuguki Kinoshita	Japan

Fertilizer input is one of the determinant factors of cropland productivity and then important for food security and human sustainability. On the other hand, overuse of chemical fertilizer results in environmental pollution and greenhouse gas emission. Therefore, appropriate scenarios of fertilizer input are required for evaluation of future food production, land use and management, and climate change.

In this study, we developed fertilizer scenarios using a cropland model, SWAT. We simulated actual and potential yields of eight representative crops at the global scale, at a spatial resolution of 0.5-deg, and estimated fertilizer input to fill the yield difference. It was found that there remain substantial rooms to improve the present crop yields in developing countries. Then, we estimated future fertilizer input using four atmospheric greenhouse-gas concentration scenarios (i.e., RCPs) and five climate-model scenarios in

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2011–2099 provided by the ISI-MIP protocol. We found that the future fertilizer requirement to sustain food production would be dependent on emission and climate scenarios and different among countries.

We are using the fertilizer scenarios to drive land-use and biogeochemical models, by which future cropland areas and greenhouse gas emission (e.g., N_2O) would be re-evaluated. These results may contribute to "Re-thinking land change transitions" by providing original data on agricultural intensifications, to "Impacts and responses" by providing an analysis on the dependence of fertilizer input on climate scenarios, and to "land governance" by presenting a desirable option of fertilizer use in terms of both food production and environmental sustainability.

| **0867** | Rethinking the role of drivers influencing forest cover changes - lessons learnt by the adoption of forestation approach | Zsófia Benedek, Imre Fertö | Hungary |

While understanding of deforestation drivers is becoming more and more solid, knowledge on forestation at the global scale is remarkably underdeveloped, despite the fact that forest cover has been increasing on the 40% of the world forested areas. The existing literature focuses mostly on case studies; scholar attention seems to slowly move towards broad-scale patterns and drivers. Addressing drivers of forestation may also improve the overall understanding of underlying causes of global land use changes by regarding the other side of the forest cover coin. Our study focuses mostly on countries where the forest cover increased between 1990 and 2010, with the aim of analysing the possible effects of certain socio-economic processes.

We conduct our analysis in two steps. 1) First we introduce a biodiversity corrected Forestation Index in order to distinguish between different forest types (primary or naturally regenerated forests or the ones that are planted by the use of native or exotic species). Empirical evidence shows that overall biodiversity is clearly affected by management type. Thus, we introduce Biodiversity Factors by modelling the potential biodiversity level of forest types by the application of the species-area relationship function well-known from the fields of island-biogeography and conservation biology. Biodiversity Factors are used to modify forest cover data. 2) The relationship of our Forestation Index and several variables is analysed in the second step which employ ordinary least squares and quantile regressions. Forest cover data are derived from FAO Global Forest Resources Assessment. Data on factors that may act as underlying drivers are from institutions such as The World Bank, FAO, IUCN and others. Our results present some evidence to support the existence of an environmental Kuznets curve (EKC) regarding forest use. Direct conservation investments appear to have negative effect on forestation which implies substitution of measures. Several traditional factors, which are important in deforestation (such as economic freedom) seems to have no impact from forestation perspective or their effect is less clear than it is suggested by deforestation literature.

Our presentation addresses theme 1 "*Rethinking land change transitions*" and it fits perfectly in session 0128 "*VOLANTE visions on of land use transitions*". This session focuses on interdisciplinary research topics to discuss socio-economic factors that may shape land use transitions. Our outcomes may be used in future international land use policy development which is the ultimate goal of the VOLANTE project as well.

| **0869** | Renewable energy policy implementation in Spain from a territorial perspective | Patricia Martínez Alonso, Richard Hewitt, Jara Vicente Guillén, Lara Román, Verónica Hernández Jiménez, Jaime D.Pacheco | Spain |

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Actions aimed to mitigate climate change, specifically those related to the implementation of renewable energy installations, can generate effects that may be harmful in other areas, despite their benefits in terms of reduced greenhouse gas emissions at the point of production. In terms of land use, for example, food production and the renewable energy generation may find themeselves in competition for the same land areas. This may give rise to social conflicts or rejection of policies aiming to promote the development of renewable energies. Many actors are involved in the complex decision making process that surrounds the implementation of renewable energies for a low carbon future.

In Work Package 3 of the COMPLEX FP7 project, we explore a wide range of factors and elements and the complex interactions between them from the point of view of land use and landscape, together with the adaptive processes that are emerging which may determine success or failure in the widespread implementation of these clean energy technologies.

Two different approaches were used: a) an LUC analysis to measure the importance of LUC change associated with RE implementation and the establishment of what we have termed Renewable Energy related Landscape Features (RELF; and b) initiation of a participatory process using techniques based on those employed in Participatory Action Research (following Pretty 1995).

In relation to RE potential implementation problems, two main groups of conflicts can be discerned: a) those related to ecosystem modification and landscape impacts due to RE installations and b) those related to the distribution of economic benefits of RE implementation.

Although it seems to be generally agreed that solar energy has been implemented mainly in agricultural areas and wind energy in natural areas, this may be an over-simplification. There are some exceptions, for example in the case of Aragon, where wind energy has generally been developed on non-irrigated arable land perhaps because of the low agricultural yields in these areas. At this point, there is a general agreement between the stakeholders interviewed about productive combinations of land uses (e.g energy production plus agricultural production), which seems to be possible in the case of wind energy but not solar power.

NUMBER	TITLE	AUTHORS	COUNTRY
0871	Adaptive land use and water governance in drought contexts: cooperation and institutional robustness in the Riegos del Alto Aragon irrigation project (Spain)	Sergio Villamayor-Tomas	Germany

The presentation the ability of more than 10,000 farmers in a large irrigation project to cooperate and adjust their cropping patterns to cope with droughts. Causal inferences are formulated with the aid of common pool resource (CPR) theory as well as qualitative and quantitative evidence. According to the analysis, a series of robust water management institutions as well as additional land use factors contribute to the collective adaptation of farmers in drought conditions. Water management institutions include a flexible common property regime, effective environmental and social monitoring mechanisms, and decentralized administrative leadership. Land use factors include the existence of a moderate heterogeneity of farmers in their dependence from irrigated agriculture, the relatively substitutability of high and low water demand crops and a strong mechanism of governmental income support subsidies. Overall the analysis illustrates the interest of understanding climate change adaptation from the perspective of CPR theory, as well as the usefulness of integrating the study of water and land use dynamics to understand sustainable governance in the irrigation sector.

NUMBER	TITLE	AUTHORS	COUNTRY
0890	Urban sprawl detection using remote sensing and spatial metrics for Hyderabad, India	Maik Netzband	Germany

India's urban population has grown tremendously in the last four decades from 79 million in 1961 to 285 million in 2001. This fast rate of increase in urban share is mainly due to large scale migration of people from rural and smaller towns to bigger cities in search of better employment opportunities and good life

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style. The rapid population pressure has resulted in unplanned growth in the urban areas to accommodate these migrant people which in turn lead to urban sprawl. In this paper an attempt has been made to use Shannon's entropy model to assess the urban sprawl for one of the fastest growing city of South India (Hyderabad-Secundarabad) and its surrounding area.

This paper applies an integrated approach by using remotely sensed Landsat TM (1989), ETM+ (2000) and IRS P-6 (2005), survey of India topographical sheet (1971) data. The results clearly show that a remarkable urban sprawl took place in and around twin city between 1971 and 2005. The total city area has increased 174% compared to population (124%) in the last three decade. This leads to increase in the impervious surface and reduction in the ground water recharge and overall changing the whole urban ecosystem. With urban sprawl there is complete loss of water bodies in terms of numbers i.e. 423 in 1971 to 48 in 2005. There were 59 sq. km area under water in 1971 but it reduced to just 12.17 sq. km. by 2005. So with the increase of impervious surfaces and continued illegal/informal construction in dangerous areas may lead to high vulnerability of social groups especially the poor living in slums and squatter settlements in the event of flooding.

Furthermore, from continuing study change maps of the urban agglomeration of Hyderabad between 2001 and 2009 using temporal transects of ASTER data and applying up-to-date change detection techniques at different spatial and temporal scales are presented. This is also used for quantifying urban and peri-urban processes (land use / land cover changes of settlements, agriculture, industry, and landscape) in this urban agglomeration (growth rates, urbanization) and additionally, for predicting the development of urban fringes, rural settlements, informal settlements, urban and peri-urban agriculture. Data of macroeconomic and demographic development, instruments of urban planning, and socio-economic settings have been integrated as data were available.

| **0893** | Degraded land assessment for palm oil expansion in Pará state (amazonian region), Brazil | Carolina Carvalho | Brazil |

Palm oil production for biodiesel in Brazil, due to palm tree high productivity and favorable environmental conditions in Amazonian region (especially in Pará state), is planned to increase in the next 10-15 years, under the Sustainable Palm Oil Program main guidelines, a program launched by the Brazilian government, which are to avoid deforestation through the use of degraded land for palm crops and focus in social inclusion. This research assess palm oil expansion only in degraded land, in Pará state. First of all, the concept of degraded land inside the brazilian context was defined, based on literature and previous research and also the Sustainable Palm Oil Program, which is every land that is deforested until 2008, including areas where native forest is not completely removed yet. Afterwards, degraded land in municipalities producers of palm oil was evaluated through geoprocessing techniques and pre-existing data in around 675 plots from 1-1800 ha randomly distributed through the main producers near Belém, the capital (especially Moju and Tailândia), and all implications are discussed. Palm oil in degraded land may cause changes in the production process if only these lands should be used from now on. There is a need to develop policies for degraded land sustainable use for biodiesel, and an update of palm oil "Business As Usual" in Brazil to use these lands, instead of traditional monoculture systems. Besides, a social analysis regarding degraded land and HDI values shows that in municipalities where degraded land extension are the biggest, HDI is the lowest , suggesting that some actions could be proposed to improve life quality for rural and urban population in the Palm Oil Program. Palm oil in degraded land brings positive social and environmental impacts. It is also a challenge and an opportunity for Brazil to commit with sustainable development and land use and be a leader in environmental friendly palm oil for biodiesel. This research contributes to the conference theme because a new model of land occupation for biodiesel production in Brazilian amazonian region is growing, since planned expansion has already started. From monoculture systems and native forest conversion to palm crops to degraded land use for

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these crops is a huge change in the business as usual of palm oil production, and can bring positive and negative environmental and social impacts. Small farmers and population living nearby can be deeply affected with these model changes and research is widely necessary.

0897	Addressing equity issues in ecosystem service assessments	Davide Geneletti	Italy

A key issue in planning and policy-making is represented by the assessment of equity in the distribution of positive and negative effects of decisions. The concept of equity, and in particular its declination in inter-generational and intra-generational equity, represents also the underlying principle of sustainable development, whose most popular definition includes the objective of satisfying the needs of current generations, without hampering the possibility for future generations to meet their own needs.

I argue that the explicit analysis of equity issues in ecosystem service assessments will improve the way such assessments are used in decision-making. This requires spatially-explicit (for intra-generational equity) and time-explicit (for intergenerational equity) information on the distribution of ecosystem services, and their tradeoff, in the study region. To this purpose a theoretical framework is developed here, and applied to a case study in land use planning. The framework proposes a way to address in a comprehensive way equity issues related to the trade-offs in the distribution and appropriation of ecosystem services, at different spatial and temporal scale. The use of the framework is demonstrated through a case study, where the effects of land use decisions are simulated. The use of spatial modeling to represent future scenarios of ecosystem service production and use allowed to generate the information basis needed to feed the theoretical framework, and conclude about the effect on equity of different land use decisions.

0899	Drivers of agricultural land use change in developed countries: a farmers' perspective	Bano Mehdi, Bernhard Lehner, Ralf Ludwig	Austria

Incorporating farm-level decisions in land use models requires detailed studies of the farm as well as of the specific local conditions. In light of changes brought about by a warmer climate we were interested in how these changes may affect farmers' crop choices and farm management, and in turn how this impacts the loadings of nutrients into surface water bodies.

The research focuses on farmers in intensive agricultural areas in developed regions to: 1) ascertain whether profit maximization is the dominant driver in decision-making processes regarding crop choices for land use, and 2) investigate other, if any, decision-making factors being considered by farmers for planting crops, or for changing the types of crops grown on their farm.

Agricultural land use drivers at the farm level were established through administering a questionnaire to groups of farmers in two study areas (north of Munich, in Germany, and southeast of Montréal, in Canada). Four independent groups were questioned that represented farmers from different regions, different generations, and different farm types. In total, the questionnaire was distributed to 923 farmers; responses from 150 farmers were received and analyzed.

For each question, farmers were allowed to rank suggested factors of what influences them to make decisions regarding which crops to plant. Farmers also had the choice not to rank a factor if it was not considered by them, or to add additional decision factors and rank them. To evaluate the importance of each decision-making factor, a farmer "influencing factor" (IF) weight was calculated for every driver in each question.

Responses showed the drivers of land use (as well as land use change) in the two regions were composed of a suite of factors, of which maximizing revenue was only one of several important ones. Interestingly, some non-financial factors (i.e. access to farm equipment, the farm experience, and climate) ranked higher, or just as high, as the financial factors.

The core message was: although financial factors (e.g. revenue, markets, subsidies), are important drivers, farmers also consider factors related to the climate, available technology, information, their experience, and their farming tradition.

Agricultural land use depends on a multitude of drivers, which are often very site-specific. The extent to which these findings can be applied to other regions remains to be determined. Nevertheless, this research contributes to the human decision-making component of land use change, and can provide drivers for agricultural land use which are not explained by financial factors alone.

| 0903 | NDVI-based vegetation changes and their responses to climate change from 1982 to 2011 in the central Himalayas | Yili Zhang, Jungang Gao, Linshan Liu, Zhaofeng Wang, Mingjun Ding, Xvchao Yang | China |

Considerable researches during the past several decades have focused on monitoring changes in vegetation growth due to its important role in regulating the terrestrial carbon cycle and the climate system. In this study, we combined datasets of the satellite-derived Normalized Difference Vegetation Index (NDVI) and climatic factors to analyze spatio-temporal patterns of vegetation growth in 1982–2006 in the Koshi River Basin (KRB) in the middle Himalayas. In addition, the dataset from the global land surface satellite sensor from SPOT-4's Vegetation instrument in 1998–2011 was used to further verify the results of this study. At the regional scale, although a statistically significant increase in average growing season NDVI was observed (0.0008 yr^{-1}, P = 0.03) during the entire study period, there existed three distinct periods with opposing trends. Growing season NDVI significantly increased in 1982–1994 (0.0019 yr^{-1}, P = 0.03), and then decreased in 1994–2000 (-0.0058 yr^{-1}, P b 0.001), while increased again in 2000–2006 (0.0049 yr^{-1}, P b 0.001) and in 2000–2011 (0.0034 yr^{-1}, P b 0.001). A sudden drop in NDVI in 1994–2000 largely contributed to these fluctuations in growing season NDVI over the KRB. Spring, summer and autumn NDVI significantly decreased in 1994–2000 (-0.0077 yr^{-1}, P b 0.001; -0.0067 yr^{-1}, P b 0.001; and -0.0155 yr^{-1}, P b 0.001; respectively). Our further spatial analyses supported the existence of the sudden decrease in spring, summer and autumn NDVI in 1994–2000.

| 0910 | Exploring the potential of remote sensing as an analysis tool for land reform - the Zimbabwean showcase | Konrad Hentze | Germany |

In my presentation, I want to emphasize the needs and benefits of applying remote sensing and geospatial analysis within the research on land reform. By choosing Zimbabwe as a regional example, I am able to deliver answers to the question how remote sensing and GIS can help to understand and monitor global and local land transformations.

Zimbabwe's fast track land reform is one of the world's largest and most extensive land reform programmes of our times. After the eviction of white large scale commercial farmers and the indigenisation of production, Zimbabwe's agriculture is standing on shaking grounds. Explanations such as the recent hyperinflation, droughts, sanctions and HIV/AIDS serve to understand Zimbabwe's economical and structural problems of the last 15 years.

Considering these manifold explanations, different scientific and public opinions evolved from the assessment of the Zimbabwean land reform: While some authors see the land reform as a full success in many aspects, others emphasize the country's pathway from the 'bread basket of Africa' to the 'basket case of Africa'.

However, proven findings about the impact of Zimbabwe's 'fast track land reform programme' on national crop area and production are lacking. Most authors rely on questionable national statistics or surveys and

interviews on local scale, partly due to the absence of spatial data on land redistribution and information on changes of land cover.

I argue that geospatial applications are crucial for a thorough understanding of land reform, and demonstrate a solution of data provision for the case of Zimbabwe. A participatively created spatial dataset of farm evictions, the first of its kind in research, will serve as an important reference with a high explanatory power on questions concerning land reform.

It can be linked to a temporal classification of a MODIS-LANDSAT fusion which shows changes of crop area and crop type in Zimbabwe and can therefore answer questions on land use and land cover change occurring on redistributed farms in particular. The result will be a spatial explicit analysis of agricultural change linked to Zimbabwe's eventful land reform.

This dataset of land use change and altered crop production on redistributed and non-redistributed farms, as well as communal land, will serve as the first objective, non-political argument within the debate on success of Zimbabwe's land reform programme.

NUMBER	TITLE	AUTHORS	COUNTRY
0912	The impact of the 'fast track land reform programme'on Zimbabwe's crop area production - a countrywide satellite based analysis	Konrad Hentze	Germany

The poster presents a PhD project which assesses the impact of the Zimbabwean state led land reform on land use change in Africa. Although land reform is not an "acquisition by the state" in the pure sense, tenure disputes and ownership change are significant features of the subject.

After the implementation of the 'fast track land reform programme' in 2000, Zimbabwe's agriculture is standing on shaking grounds. Reports describing the *'failed state'* of Zimbabwe and it's pathway from the *'bread basket of Africa'* to the *'basket case of Africa'* are common and manifold. But proven findings about the impact of the land reform are lacking.

The study therefore aims to address spatial questions related to Zimbabwe's land reform with satellite products:

- Did the planting area and rotation patterns of main crops change in recent years?
- Where did these changes occur, does a spatial pattern exist?
- When did these changes occur, is there a significant relation to land tenure and redistribution?

Within the PhD project, funded by the Heinrich Böll Foundation, answers to these questions shall be achieved by the generation of a dataset on eviction of white farmers using PGIS and by correlating it with a temporal classification of a multisensor dataset. The classification analyses changes of crop type and crop area for the whole of Zimbabwe and allows therefore to estimate effects of the land reform programme by relating it to a dataset of ownership change.

The change of crop types and crop areas, as well as the dataset of evictions, will be displayed as a spatial explicit statistical dataset which serves as a non-political, objective argument within the hot debate on land reform in Zimbabwe.

NUMBER	TITLE	AUTHORS	COUNTRY
0914	Increasing concentration of crop production and implications for vulnerability of food supply	James Gerber, Deepak Ray, Paul West, Jonathan Foley	USA

Meeting future demand for crops is likely to take place through a combination of closing yield gaps (intensification) and farming more land (extensification.) However, these processes, in combination with market incentives for large-scale monocultures, can lead to spatially concentrated areas of production (breadbaskets). As these breadbaskets become critical to the regional food supply, they lead to vulnerability to weather shocks. The present research project takes advantage of recently developed data-sets of yield and area for several major crops to examine where -and how quickly- spatial concentration of

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key crops is taking place. Using historical weather datasets to assess probabilities of historically observed droughts repeating themselves, we consider implications for potential shocks to the food system.

| **0920** | How LULCC offers new potential for land sharing and land sparing in post-Soviet European Russia | Anika Sieber, Tobias Kuemmerle, Alexander Prishchepov, Patrick Hostert | Germany |

Land-use and land-cover change (LULCC) is one of the main drivers of the current biodiversity crisis and protected areas are a global key conservation strategy to protect species' habitats against impacts of land use. The Russian network of protected areas is currently covering about 12 % of the terrestrial surface across many ecoregions. Seven types of Russian protected areas permit different degrees of land-use intensity within their boundaries, thus allowing for different levels of land sparing and land sharing. Since 1978, the UNESCO Man and the Biosphere program (MAB) has been introducing biosphere reserves in Russia. The breakdown of the Soviet Union in 1991 resulted in socio-economic shocks and institutional and political upheavals, triggering widespread LULCC and raising both uncertainties about the effectiveness of Russian protected areas in times of rapid changes and hope for new opportunities in nature conservation.

We evaluated a long time series of satellite imagery regarding LULCC in Soviet and post-Soviet times in temperate European Russia. We also assessed the effectiveness of Oksky State Nature Reserve, which was established in 1935 and became one of the first Russian UNESCO biosphere reserves. Our results showed that Oksky State Nature Reserve was effective in limiting LULCC in most of its protection zones and that land use in the surroundings of Oksky State Nature Reserve was very intensive in Soviet times, with stock breeding, intensive agriculture, and high forest logging rates. In post-Soviet times, however, land-use intensity rapidly decreased due to reduced rates of forest disturbance within the buffer zone of the protected area and its surroundings, as well as widespread farmland abandonment (Sieber et al. 2013). These changes provide the unique chance of expanding wildlife habitats to unprotected areas and offer new opportunities for land sharing and land sparing within and outside of protected areas in formerly intensively used areas in European Russia. This study contributes to the conference theme not only by addressing the assessment of widespread LULCC in the largest country of the world but also by linking land-use trajectories to local impacts on protected area effectiveness and nature conservation. It particularly contributes to session 0045 by identifying the potential of a Russian biosphere reserve for accompanying the new potential for land sharing and land sparing in times of rapid LULCC. This is especially important today, when global demand for food and bioenergy is steadily increasing and the recultivation of formerly abandoned fields becomes more likely.

| **0921** | Assessment of condition, change and potential of East African wetlands for food security | Esther Amler, Michael Schmidt, Gunter Menz | Germany |

Wetlands fulfill several ecosystem services and are of high importance to communities at regional up to global scale, e.g. through regulative functions and carbon storage potential.

The large multidisciplinary project GlobE aims to develop a management scheme that can support East African policy makers to sustainably transform current semi-natural wetlands into future 'breadbaskets' and hence enhance food security. Not only climate change but also environmental and socio-economic changes urgently demand for a wise expansion of agricultural areas and productivity on a sustainable basis. Balancing conservation and land use is a major challenge for vulnerable communities living in regions that are highly influenced by wetland dynamics. The transnational initiative is funded by the German Federal Ministry of Education and Research.

NUMBER	TITLE	AUTHORS	COUNTRY
	A framework for remote sensing based wetland assessment in East Africa will be presented. Field based observations in combination with high spatial resolution imagery for super-testsites are the basis for establishing a wetland catalogue for East Africa. Time series metrics will be used to classify different wetland types and to generate frequency maps for inundation, land cover/use and vulnerability maps. The research project includes multiple datasets and techniques. Thus the presentation can show an approach to assess and categorize complex landscapes that are increasingly influenced by human use.		
0922	The supply and demand of aboveground net primary production in the Semi-Arid Sahel	Abdulhakim Abdi, Jonas Ardö	Sweden
	Net primary production (NPP) represents the rate of formation of new plant biomass and carbon uptake and is an important component in the global carbon cycle. The supply of NPP drives the most basic ecosystem processes that support human survival. Fluctuations in the demand for NPP influenced by sudden events such as droughts, or gradual phenomena such as population expansion or land degradation, directly impact human livelihood. This poster is divided into three objectives (1) identification of the present condition of per capita NPP availability in the semiarid sub-Saharan Sahel region of Africa using existing remote sensing datasets and compare them with biomass production data from the Food and Agriculture Organization of the United Nations, (2) improvement of existing MODIS GPP/NPP product in the Sahel using a data-fusion approach, and (3) projection of resultant improved data on present per capita NPP to 2050 using established climate and population models. The aim of this analysis is to identify trends in NPP supply and demand at present population and climate conditions, and how these trends are modified in the future under different conditions. This poster will elucidate the application of remote sensing in quantifying NPP in the Sahel and its ability to measure the present state of food security in the region and model future conditions.		
0924	When space beats time: spatial dependence and temporal inertia in land use and land cover patterns under abrupt 'clean slate' scenarios	Benoit Parmentier, Marco Millones	USA
	GIS based predictive models have a long tradition of using both spatial structure and temporal structure to predict better the future location and quantity of variables (Griffith 2010). Both temporal (e.g., past observations, land transitions, moving averages, seasonal parameters like phase and amplitude) and spatial (3x3 neighboring pixel filters, moving windows, lags, distance-based and fragmentation-based variables) are used together to improve predictions in various modeling exercises. But the nature of the contribution of each component is less understood. Abrupt ('clean slate') events that dramatically change the spatial configuration of an area can break the temporal correlation and inertia in landscape systems. In such case, the spatial component in models may outweigh the temporal components in land cover change models. In this study, we seek to explore and illustrate such hypothesis by using models that predict the spatial configuration and value of the Normalized Difference Vegetation Index-NDVI before and after the impact of hurricane Dean in the Yucatan peninsula (August, 2007). We use a MODIS NDVI time series to examine quantitatively and visually the contributions of the spatial and temporal structures, and to identify sequences of points in time in which space outperforms time in terms of predictive power. Early results indicate that for datasets of manageable size, a specific period of time can be defined when space beats time in land cover modeling of hurricane post disturbance transitions. Results are also scale dependent in terms the spatial resolution of the cells, the scope and extent of the area analyzed. We also discuss the implications of space-beats time scenarios for other applications such as rapid and slow urban growth.		
0926	Would lower beef consumption mitigate greenhouse gases emissions in the near future?	Luis Gustavo Barioni, Rafael de Oliveira Silva, Dominic Moran,	Brazil

NUMBER	TITLE	AUTHORS	COUNTRY
		Fernando Antonio Fernandes	

A dynamic linear programming model was developed with the objective of evaluating the effects of meat demand variation on the net greenhouse gas emissions from beef production in the Brazilian Cerrado. The model maximizes the future value of a project and includes: (a) herd dynamics: reproduction, growth, purchases and sales; (b) feed budget: pasture production, consumption and losses; (c) Cash flow: own capital, sales, purchases and bank credit, and; (d) pasture category dynamics. Pasture area is partitioned into categories of different level of productivity. The flow of area between pasture categories mimics pasture restoration and degradation. Soil carbon (SC) dynamics was modeled assigning a different level of long-term equilibrium SC to each of the pasture categories and calculating the SC stocks change as proportional to the deviations from the respective equilibrium level. Soil carbon stocks trajectories are determined, therefore, in response to the pasture productivity dynamics (degradation and restoration).The model can: (i) restore (which imply in investments to improve pasture productivity); (ii) maintain (which imply in additional costs of inputs to keep pasture annual productivity in a constant pattern), and; (iii) naturally degrade (with no intervention).

A 25 years (2006 to 2030) period with production and pasture are constrained to projected values taken from the Brazil Low-Carbon Country Case Study (Gouvello et al., 2011). Responses in emissions were produced by parametrically changing the 2030 demand in a range from -30% to +30%, with 10% interval and linearly interpolating demand changes for the years in the interval. Beef consumption was replaced by chicken meat in a carcass weight basis and associated emissions accounted for. The model assumes that changes in demand would not result in further deforestation or fallow. This assumption is consistent recent trajectories of pastureland and governmental policies. Also, when unconstraining production, the model intensifies production above that resulting from maximum level of demand tested, further corroborating with the assumption. Deforestation responses will be tested in future analysis. Counterintuitively, Global Warming Potential has changed +5%, +4%, +1%, -2%, -3% and -4% for changes in demand of -30%, -20%, -10%, +10%, +20% and +30%, respectively. Although CH_4 and N_2O emissions increase because the higher number of animals needed to meet the increasingly demand, the C sequestration potential of Cerrado pastures are able to offset these emissions. The presented study indicates that consequential rather than attributional approaches should be taken when evaluating changes in beef demand.

| 0927 | Land use changes in the urban Area of Montpellier (2010-2040): scenarios of the impact of urban sprawl on agricultural land and protection of agricultural land from urban sprawl | Jean-Pierre Chery, Eric Barbe | France |

The Montpellier urban area, south of France, has an important population growth for several decades. Urban sprawl is an important phenomenon which is a set of challenges for public land policy, development of economic activities and natural heritage management. These complex issues make difficulties to have an easily and shared vision of the future of this area. Urban sprawl simulations in the area, from research productions, give cartographic representations, by the year 2040, according to different scenarios limiting or amplifying the phenomenon.

This urban sprawl is a general context in France. It is synonymous with artificialization of farmland and natural areas, the latter being better protected by urban planning laws. The French law of modernization of agriculture and fisheries, adopted in July 2010, includes a section that defines the goal of halving the loss of farmland in 2020. To do this, a "National Observatory of Agricultural Land Consumption" was established in June 2011. The observatory is expected in particular to develop relevant tools to measure changes of agricultural land use with indicators. The observation of the phenomenon of loss of

agricultural land aims for providing awareness to urban planning's decision-makers. Some reflections intended to define principles of agricultural productive assets protection, which can be integrated into urban planning procedures. Lands with high production potential (especially due to the soil nature) would be priority excluded areas to be urbanized. An initial study in Languedoc-Roussillon Region tested the representations and spatial analysis terms of artificialization crossed with agricultural land potential for a long-term use.

The poster presents an application of a land use change modeling using the "Spacelle" software (Cellular Automata), on the large urban area of Montpellier, by considering different scenarios. A baseline scenario provides a BAU vision of the urban sprawl and consumption of agricultural land. Alternative scenarios illustrate the inclusion of (i) agronomic potential for crops, and (ii) for viticulture for the years 2010-2040. Scenario results are compared to identify issue's areas. This can help to define indicators for agricultural land protection and to locate areas to protect in priority.

The poster is intended to contribute to the conference theme and the selected session particularly on the issues of land values and land use for public interest vs individual strategies, with the effects of spatial visualizations of these issues.

NUMBER	TITLE	AUTHORS	COUNTRY
0930	Remote sensing application for prediction of agro-climatic zones and climate change in Ukraine	Oleksandr Syrotenko, Tetyana Ilienko, Tetyana Kuchma, Mykhailo Tarariko	Ukraine

Agriculture is a strategic sector of the economy in Ukraine that provides a solution to both food security and food export potential. Agricultural sector development requires the revision and improvement of the strategies and tactics to increase production, especially grain production, which is also related to climate change. The objective analysis and prediction of climate changes, including assessment of the positive and negative aspects and possible risks to grain industry are essential.

The climate of Ukraine is quite sensitive to its global change. Temperature rise in Ukraine occurs at a faster rate compared to the global. For the last 35 years a strong upward tendency of the mean annual temperature have been seen, in particular from 9.3° C (1973-1980) to 11,3 ° C (2006-2010), ie by 2° C. Changes in mean annual rainfall does not have a clear pattern of change over time, but there is a trend of increasing precipitation with storm character and strengthening of the wind regime, which increase the risk of soil erosion and deflation. These risks are amplified by a predicted significant increase of the tilled crops area, and its expansion to the North into Polissya zone, where soils have a low erosion resistance. Thus, it is important to evaluate the different scenarios of agro-ecosystems adaptation to new environmental conditions.

The purpose of research was to use the satellite data to assess climate change in Ukraine and its impact on grain yield and prospective prediction of gross harvest of grain.

Based on calculated logarithmic trend, according to NOAA temperature of the earth's surface (SMT) and vegetation index (NDVI) over the period of 1982-2012 the temperature and NDVI changes prediction was conducted for near future (up to 2025), mid-term (2050), and the long-term (2100) perspective for agro-climatic zones of Ukraine. In 2025 the temperature in northern regions of Ukraine will increase by about 1,2-2,0 ° C and will approach the temperature parameters of steppe zone. In turn, the temperature regime of Forest-Steppe zone will fit the Steppe zone. In 2050 the dry steppe subzone will towards much further north, and the drought phenomenas will increase. By 2100 the temperature will increase in northern regions in comparison to the historical period by 3-3,5 ° C and up to 5°C, which will correspond to the typical average annual climatic characteristics of arid steppe.

Based on the close relationship between the observed NDVI and grain productivity and experimental data

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of long-term agronomic experiments of research institutions of National Agrarian Academy of Sciences and statistic data of temporal changes of crop yields for the period of 1955-2012, observed in test polygons located in different agro-climatic zones, the prediction of climate change impact on crop productivity is developed. It was determined that climate change, including temperature rise at the current stage has a positive effect on the crop yields, as evidenced by the experimental data of long-term agronomic experiments, statistical data, and NDVI growth rate. It is expected, that with the temperature rise within certain limits and current patterns the productivity of grain crops will increase to 2025. Never the less it is important to develop an adaptation measures related to the soil protection from erosion and degradation and efficient use of available water resources.

| 0936 | Agent-based model for forest cover change and biomass simulation in west Africa: case of a protected area in Dahomey Gap, Togo | Hodabalo Pereki, Thomas Thiel-Clemen, Kperkouma Wala, Koffi Akpagana | Germany |

In the Dahomey Gap located in West Africa, lying between south-eastern of Ghana, Togo and Benin, tropical raining forests ecosystems have been highly fragmented by anthropogenic and climate disturbances (Salzmann and Hoelzmann 2005) and converted into ecological fragile land use systems. As result, the gap break up the original single moist forests of West Africa into two blocks (i.e., Lower and Upper Guinean moist forests) (Poorter et al. 2004). Despite this critical situation, Dahomey Gap is still characterized by particular endemic species and high biodiversity richness and, is included therefore in the world's 25 biodiversity hotspots (Myers et al. 2000). There is no doubt concerning its social and economic contribution in terms of biodiversity ecosystem functions and services for local communities well-being. However, Dahomey Gap forests have received little attention compared to its Lower and Upper side. Consequently, carbon credit allocated to deforestation measurements (results of land use) and carbon stock baselines that can help REDD+ scheme implementation are expected to be more complicated in definition, setting and prediction anywhere in this gap. In order to deal with this extreme complex issue, this study will apply the usefulness of Agent-Based Models (ABM) approach suitable to solve complex problems exceeding human ability (Grimm et al. 2005, Ralha et al. 2013).

Our ABM applied on Abdoulaye Wildlife Reserve (AWR) land use change consists of stakeholder agents, land agents and socio-ecological parameters. Stakeholder agents represent governmental managers, rangers, farmers, illegal loggers, who are capable of autonomous actions in the biophysical environment. We consider land agents as a set of grid cells representing land patches (dense forests, open forests, dry forests, riparian forests, savannahs parklands, fallows and fields) with their characteristics such as tree species and density, disturbance level, land cover and use. Socio-ecological parameters are a set of external influences (human well-being, management policies such as REDD+) and internal conditions (environmental variables). The biophysical environment is the whole AWR (i.e., all its vegetation types) which is heterogeneous and in continual change related to socio-ecological parameters.

Modeling AWR forest cover and biomass in the current global environmental change context is essential for at least two reasons: (i) to understand the importance of carbon stocks at local level (ii), to help decision makers in their sustainable forest resources management.

| 0937 | Dynamic of sugarcane harvested areas in São Paulo state, Brazil, over the last two decades | Bruno Schultz, Antônio Roberto Formaggio, Clement Atzberger, Alfredo José Barreto Luiz, Elizabeth Goltz, | Brazil |

NUMBER	TITLE	AUTHORS	COUNTRY
		Marcio Pupin Mello	

Sugarcane plantations in São Paulo State play an important role in the Brazilian production. Around 20% of the state area is planted with sugarcane. São Paulo State has 645 municipalities distributed over 15 mesoregions, eleven of which grow sugarcane to produce sugar and ethanol at an industrial scale. The remaining mesoregions (*Vale do Paraíba Paulista*, *Metropolitana de São Paulo*, *Litoral Sul Paulista* and *Macro Metropolitana Paulista*) do not produce significant sugarcane due to relatively unfavorable environmental conditions. Over the last two decades, this crop has had a considerable expansion in all the 11 mesoregions that cultivate sugarcane in São Paulo State. However it is important to understand the dynamic of this expansion over the mesoregions, since factors such as land prices, economic attractiveness, subsidies and tax incentives, input prices, proximity to the receiving plant and environmental liabilities influence the spatial distribution of sugarcane within the state. Thus, this paper aims at analyzing the spatial dynamics of sugarcane expansion in São Paulo State over the last two decades. To achieve this, we evaluated historical data from IBGE (Brazilian Institute of Geography and Statistics) of sugarcane harvested areas from 1990 to 2010. Historical data from 1990, 1995, 2000, 2005 and 2010 were used as input to an agro-dynamic model proposed by Garagorry and Chaib Filho (2008), which calculated for each year a center of gravity based on the sugarcane harvested area for all municipalities within each mesoregion. Eventually, the 11 mesoregions were used to calculate the center of gravity of the state for the five mentioned years. The results showed that sugarcane moved from the middle mesoregion of *Piracicaba* in 1990 to *Ribeirão Preto* in 2000 and then to *São José do Rio Preto* in 2010. In two decades the sugarcane harvested area in São Paulo doubled, with major contributions from mesoregions located in the Northwest of the state. Indeed, *Piracicaba* mesoregion, for instance, has traditionally cultivated sugarcane in São Paulo, but when sugarcane started to be economically more attractive than citrus and livestock, several other mesoregions located in the Northwest of the state (e.g., *São José do Rio Preto*, *Araçatuba* and *Presidente Prudente*) expanded their sugarcane areas. This expansion in the Northwest of the state moved the center of gravity of sugarcane harvested areas from the center to the Northwest portion of the state. In fact, the expansion of sugarcane in São Paulo occurred mainly in the mesoregions located in the Northwestern of the state, even though traditional mesoregions such as *Piracicaba* and *Araraquara* did not decrease their sugarcane cultivation.

| 0942 | Local and global threats to the water resources in the Amazon basin | Laura Borma, Roballo Suelen, Thamy Gióia, Victor Nascimento | Brazil |

A combination of factors such as high levels of annual rainfall, low population density and modest industrial park make the Amazon basin one of the few regions of the world where water scarcity is (still) not a concern. The evapotranspiration of such a dense forest, together with the evaporation of the Atlantic Ocean produces high levels of air humidity and, consequently, high levels of precipitation. However, recent and future changes in terms of land use or climatic seasonality may eventually change this pattern. The synergic action of extreme events of droughts and floods, increased growth rate of the population without adequate sanitation, and large government projects (such as dams) require a deeper analysis of the current conditions of water resources in the Amazon region, in order to better address future prospects of water availability in the region.

Despite the damage which can cause, extremes events of droughts and floods have been working as natural laboratories to anticipate the potential impacts of climate change in the Amazon basin. Due to the fact that the climate models used by the IPCC, in general, project a warmer and drier climate for the Amazon, major emphasis has been given to the impacts of extremes droughts. The impact assessment considers, in general, the effects of deforestation, droughts and fires over the biomass forest loss and

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corresponding CO2 emissions (see, for example, revision of Nobre & Borma, 2009 among many others) in terra-firme forest. However, the increasing concern about global water scarcity requires that, besides the important forest-climate point of view, the Amazon basin also be viewed through the importance of their water resources.

This paper presents the impacts on Amazon basin water resources considering synergistic action between climate extremes (e.g. droughts and floods) and local threats (e.g. discharge of sewage, water contamination and large dams). This assessment take into account: i) discharge anomalies of the main drought and flood events of the last years (i.e. 1997/98, 2005 and 2010 droughts and the 1999, 2009 and 2012 floods); ii) socio-economic and demographic growth prospects of local communities and related problems of water quality; iii) governmental plans of building dams. These analyzes will be made by watersheds, producing a map of vulnerability of water resources in these basins in relation to global and local drivers above mentioned. We believe that this presentation will contribute to the Main Conference Theme No. 2: Land users in a tele-connected world.

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0945	Differential sensitivity of vegetation and soil properties to land use and land cover change in a tropical dry forest	Bárbara Ayala-Orozco, Mayra E. Gavito, Patricia Balvanera, Ilyas Siddique, Helena Cotler, Miguel Nakamura, Francisco Mora-Ardila, Luz Piedad Romero-Duque, Víctor J. Jaramillo-Luque, Enrique Martínez-Meyer	Mexico

There has been a worldwide extensive conversion of tropical dry forests to pastures and agricultural land. Primary forest, originally the main provider of ecosystem services on the Pacific coast of Mexico, is now found mainly in protected areas. Landscape is currently dominated by a complex, dynamic mosaic of active agriculture and pasture plots, and abandoned and semi-abandoned plots under natural regeneration, whose ecosystem properties, functions and potential provision of ecosystem services are poorly understood.

We conducted a study to evaluate and compare the differential sensitivity and recovery of several vegetation and soil variables to the disturbances associated to land use and land cover change (LUCC) in the region surrounding the Chamela-Cuixmala Reserve. We 1) described the nature of change in a set of vegetation and soil properties that were coherently measured in pastures and secondary vegetation, the most common types of land cover, 2) tested for changes in magnitude and variance for each property measured using the old growth forest as a reference, and 3) assessed the relative resistance or recovery of the groups of properties measured: vegetation and soil physical, biogeochemical and microbiological.

In general, LUCC showed few significant effects on most vegetation and soil properties measured at the plot scale. We found differential sensitivity of ecosystem properties to LUCC: vegetation properties were the most sensitive, both individually and as a group of properties, whereas changes in soil properties were smaller and more inconsistent. As individual properties, there were more changes in soil biogeochemical and soil physical properties, but as groups of properties changes followed the order: soil biological > soil biogeochemical > soil physical. Most properties that were sensitive to LUCC showed recovery at the plot scale within two decades of continuous succession.

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We intend to contribute to the conference and session by showing that ecosystem properties of this, and perhaps other tropical dry forests, are in general resistant to LUCC and seem to recover rapidly when allowing natural regeneration. Also, that vegetation properties were more sensitive to LUCC than soil properties. These results may be used to

- focus future diagnosis of impact of LUCC on the sensitive properties and develop indicators of ecosystem change,
- implement adequate practices for the sustainability of areas under management with potential to recover ecosystem functions and provide ecosystem services,
- design realistic policies for conservation and sustainable management of the current land cover types and dynamic LUCC scenarios.

0947	Albedo interventions in European cities can realize local health and global mitigation benefits	Tiziana Susca, Felix Creutzig	Germany

Climate change mitigation requires globally coordinated efforts, while climate change adaptation demands mostly local action. Most of the policies for facing climate change need conspicuous technological, economic and behavioral efforts. Published literature shows the importance of increase in albedo in mitigating climate change and its beneficial effect on the local climate, reducing the urban heat island effect. In particular, the increase in rooftop and pavement´s albedo can be easily integrated in ordinary building and urban maintenance plans resulting, in this way, a cost-free intervention.

In this study a geographical investigation about the potential impact of the city-wide increase in albedo in European cities was conducted for evaluating the effects on radiative forcing and on local climate. The study looks at the incoming solar radiation, clearness index and the morphologic variables from a sample of European cities. This study relates to the session topic directly in providing an explicit model and evaluation of albedo change on global and local climate.

We found that cities in South European countries have the best potential per surface unit to mitigate climate change by increasing their albedo. Unexpectedly, the results indicate that this potential in Scandinavian cities is higher than in northern and central European ones. This is explained as follows: Even though the incoming solar radiation in Scandinavian cities is lower than in northern-central European ones, the clearness index is higher in the firsts than in the seconds. For each of the geographical areas a representing city has been chosen. Helsinki, Krakow and Porto respectively represented Scandinavian, northern-central European cities and southern European ones. Extending the study to the urban surface that can be enhanced in each of the three cities, it resulted that Helsinki has the potential best effect on global climate because of its extension.

At the local scale the analysis was conducted considering a regression model that correlates the potential increase in average urban albedo with the decrease in temperature. We found that – depending on the urban specific morphological and climatological characteristics – the increase in albedo can efficiently decrease the peak in summer temperature. In particular, in Porto the peak in summer temperature can be reduced of about 1°C. The mitigation in temperature positively influences the energy use in summer but it slightly negatively influences it in winter.

The co-benefits produced by the urban temperature reductions are: reduction of the tropospheric ozone formation, positive effects on heat related mortality or diseased.

The outcomes of this research provide useful information for policy-makers. The potential of urban albedo modification can be a valuable spur to design both municipal and European-wide climate-change strategies.

0951	Competition between the ecosystem services energy and food in different regional contexts and	Philipp Grundmann, Christian Kimmich,	Germany

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	scenarios	Rolf Meyer	

Impact assessments of expanding energy crop provision for energy markets in the future differ greatly. The interdependency of different land uses may be intensified due to energy crop cultivation. There are only preliminary findings on what circumstances trigger desired and undesired effects, how they are reinforced by energy crop cultivation and what may be done to address these effects. This paper presents an analysis of the development of energy crop production and the competition between ecosystem services in different scenarios and study areas. We compare future development options for energy crop production in three study areas in Germany using a regional "farm-type" model for scenario simulations. The regional scenarios used in this study were derived from the global scenarios of the Millenium Ecosystem Assessment (MEA, 2005).

Regionally differing resource endowments, production patterns and market conditions bring about different developments of energy crop production and related impacts in the study areas. Competitions between the provision of ecosystem services energy and food are less marked in the study areas with specialized animal and crop production, compared to the study areas with mixed agricultural production. The stronger competition in areas with mixed agricultural production is of special concern to ecological farming in these areas. Competition between energy and food production decreases in scenarios with increasing availability of arable land, rising crop yields, increasing efficiencies in production and conversion of agricultural biomass into bioenergy, and the preferred use of residues and waste materials from animal and crop production. Increased competition with regulative ecosystem services (e.g. greenhouse gas emissions, humus formation in soils) results, if these scenarios come along with ploughing up of grassland, diminishing areas for nature conservation and relaxation of regulations that ensure ecologically compatible cultivation.

The results suggest that targets for the expansion of energy crop cultivation and bioenergy production should be defined carefully and concertedly. Approaches and solutions proposed for taking regional differences into consideration include conceptualizing regionally differentiated strategies for the expansion of energy crop production, and compensatory and adaptation measures at regional level.

0952	Law and culture in the forests of Nepal	Nikoletta Kanellopoulou	Norway

Understanding culture is a tool to develop the best legal practice for forest governance. The effectiveness of natural resources management relates to the compatibility between law and the cultural narratives on the relationship between man and nature.

Traditionally, forest management has been arranged in three main ways; command and control regulation, private property or communal management. The Institutional Analysis and Development framework provides some indicators of when communal resource management might succeed. However, what needs further research is the role of culture and trust in choosing the best forest governance practice. When do we need central regulation of forests? In the cases where the law cannot develop conditions for trust and self-regulation. So, what are those conditions and in which cases do we see them evolve? My poster suggests how an analysis of the cognitive metaphors and mentality of forest users can be integrated as a tool for a legal efficiency evaluation of the various institutions.

The major indicator of institutional success is the level of trust among forest users 1) on the legitimacy of the institutions in terms of the local cultural narratives and 2) on the behaviour of the other forest users. According to findings of sociology, trust is built on common values rather than shared knowledge. Common values, in turn, can be explored with the tools of cognitive psychology. The metaphors on the relationship between man and nature shape culture as common meaning of behaviour and on this basis it is possible to explore any common values.

With this poster presentation, I would like to start a dialogue and collaboration with scholars from

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	different disciplines on the directions of natural resources governance. This kind of analysis might prove useful for taking a step back and reassessing the fundaments of the concepts of economic growth and sustainability.		
0954	Social vulnerability assessment for rain-induced flood and hazards using GIS: case of Infanta, Quezon (Philippines)	Mike Medina	Oman

A social vulnerability assessment for rain-induced floods and landslide hazards was conducted for Infanta, Quezon (Philippines), using geographic information system (GIS). The primary objectives of this research is to establish the importance of multi-hazard maps, identify and prioritize barangays based on social vulnerability, and to recommend structural and non-structural mitigating measures against these disasters. Secondary data analysis such as maps, demographic data and population density were used in this study. Results showed that the higher the population density, the higher the vulnerability of the community is to the rain-induced floods and landslides. Moreover, this study produced decision maps and priority matrices derived from the collected thematic maps. In conclusion, the GIS is an advantageous tool in the validating the suitable and non-suitable areas of development.

This study is relevant because information generated on vulnerability will be useful for enabling and providing significant inputs and recommendations to decision and policy-makers to come up with appropriate measures to minimize the social impacts of natural hazards particularly rain-induced landslides and flooding.

| 0957 | Path dependencies in urban form: history, mode choice and welfare | Steffen Lohrey, Felix Creutzig | Germany |

Cities host the majority of the world's population. Rapid urbanisation will further mold urban forms and demand increasing land consumption. At the same time, climate mitigation efforts are strongly influenced by the existing infrastructure stock and the built environment. Non-reversible infrastructure developments - known as lock-ins – will enable or aggravate mitigation efforts. Lock-ins can seriously hamper climate change mitigation but also constrain the choice of future development pathways and lifestyles.

Urban form, transport infrastructure and modal share in urban transport are interdependent and influence each other in non-linear ways. Historical circumstances and technologies can have a strong effect on the way cities are built. In a temporal domain, urban form is controlled both by exogenous factors such as technology availability and by endogenous growth dynamics. The interaction of these factors is poorly understood, and an improved understanding of urban form dynamics is key to a better management of cities. Research needs to identify both the casual dynamics in the long-term development or urban form and its associated infrastructures and possibilities for sustainable development.

In this study, we analyse and determine major driving factors of urban form evolution. Key indicators include urban density, cities' extent, mode choice and human welfare. As relevant cases, the evolution of urban form in three stylised city types in different world regions (Europe, Asia and the United States) is investigated, accounting for different starting points of city development and respective economic, cultural and technological circumstances. The variety of factors that need to be taken into account suggests treating cities with tools from complex system dynamics. Therefore, agent-based modelling is chosen to investigate temporal development of urban form: Agent based models can model time-dependent, nonlinear behaviour and can represent heterogeneities. This stands in contrast to classical methods in urban economics which largely build on equilibrium assumptions. Our results point to enabling factors of sustainable city development and indicate risk factors leading to detrimental lock-in efforts.

This study will contribute to session 0069 because it highlights relevant complex temporal dynamics in urban systems and their land consumption.

NUMBER	TITLE	AUTHORS	COUNTRY
0959	Marine protected areas in Brazil: environmental policy and social issues of artisanal fishing communities	Liandra Caldasso, Naila Takahashi	Brazil

The early 2000s is considered a period of advancement of conservation policy in Brazil, mainly due to the approval of 9885 Act which establishes the National System of Conservation Units. At the international level, the Convention on Biological Diversity established in Aichi Biodiversity Target (Nagoya, 2010) the need for expansion of protected areas, especially in coastal areas, the focus of this work. Although these important advances, which address to some extent the social demands, such as the need to protect the livelihood of the traditional population, still, to Brazil achieve the goals will require a broader environmental policy. Today, only 1.54% of marine area is protected in Brazil, being the biome with less protected area the country.

In this light, this study aims to discuss the process of creation of Marine Extractive Reserves (Resex-Mar), the obstacles posed by land use conflicts and its potential to reconcile elements such as traditional culture heritage and conservation of marine biological diversity. Resex-Mar is a category of protected area under Law 9,985 of sustainable use, i.e., which predicts the existence of traditional communities within. Today, there are 22 Resex-Mar in the coastal region of the country; their establishments has been driven by concerns about the conservation of natural resources but also and mostly by conflict over the use of coastal areas between fishing communities and other sectors.

According to the Ministry of Environment (MMA, 2007, p. 103), the environmental integrity in coastal region suffers great pressure due to the large use conflicts, making the coastal areas one of the most endangered regions on the planet. In Brazil a quarter of the population lives in coastal areas, and coastal economic activities are responsible for about 70% of the national GDP (MMA, 2007, p. 103). Therefore the conservation of the coastal resources tends to be increasingly problematic and costly, both politically and environmentally.

Alongside to political and environmental issues, there are social problems faced by fishermen in these regions arising from the use conflicts in an area where several economic activities compete. There are pressures due to external factors and broader processes: real estate speculation, tourism, port and off-shore activities, pollution due to industrial activity, increase in the cost of living alongside the urban sprawl, among others. And there are problems directly related to fishing communities, as social exclusion, low average income, lack of representation (paternalistic and assistentialist culture of the representative bodies), dependence on middlemen, among others.

| **0964** | Evolution of climate change, new climate and predictions constraints in the western Mediterranean | Mohammed-Said Karrouk | Morocco |

Since the eighties of last century, climate research has made a major scientific breakthrough in the field of prediction, the variability of the evolution of different climatic parameters were beginning to be clearer!

But today, probably due to the cumulative thermal oceanic and climatic zones shift poleward under selective forms, climatic events no longer changes depending the usual and expected patterns. These events for a further evolution and spatiotemporal distribution, which characterize the "New Climate".

In this situation, the Western Mediterranean region, suffered the effects of the "new climate". Usually, the atmospheric response to major climatic events in the region such as "El Niño" was characterized by stability and drought, because of the dominance of the zonal circulation in winter. By cons, in episode "La Niña" is the predominant meridional circulation, and precipitation became abundant.

The "new climate" creates a new atmospheric circulation in the North Atlantic area, characterized by persistent ripples in which a central ridge is pushed deep into the pole, because the permanent positive energy balance **above the ocean**. When the negative balance settles over the continents in winter, the

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	atmospheric circulation, intense and fast, is forced to wave to bypass the Atlantic anticyclone. The flow that reaches the Western Mediterranean is to north-south, parallel to the European coast and is a stream that marks the shearing energy from the warm ocean to positive and the negative balance in the cold continent. In September/March 2008/2009 (La Niña phase), and December/February 2009/2010 (El Niño phase), the planetary valley installed on the Europe and North Africa, subjected to the Western Mediterranean area moisture conditions "exceptional" accompanied by floods. These weather conditions are "New" and put the Western Mediterranean under the influence of moisture, which can minimize the effects of water stress, if it fits properly in the "New climate".		
0965	Spatio-temporal dynamics of deforestation of the Brazilian savanna in Minas Gerais state	Alan de Brito, Christianne Riquetti Corsini	Brazil
	This study used a spatial geographic data areas, focusing on the spatial distribution of the deforestation in the Minas Gerais state in the period from 2002 to 2012, based on deforestation alerts data provided by the Laboratory of Image Processing and GIS at the Federal University of Goiás, and biophysical and socioeconomic data. We are using the Grimson and Scan methods, with the aim of grouping the areas of the municipalities in regions with adjacent space and similarities. We will seek to identify possible spatial clusters and evaluate the spatial relationship of adjacency between the municipalities with the largest areas of deforestation. From the application of the methods, we hope that the results indicate areas most likely spatial agglomeration of deforestation and the emergence of new agricultural frontiers in the state. The scientific contribution of this work is on understanding the spatiotemporal dynamics of deforestation occurred in the Cerrado in Minas Gerais and in identifying new agricultural frontiers in this area. These results enable decision makers develop policies for land management for the conservation of this biome, considered one of the hotspots priority for nature conservation.		
0966	Use and occupation of land and the process of desertification in drylands northeast, estate of Bahia, Brazil	Jémison Mattos dos Santos	Brazil
	This research takes place in the municipality of Campo Formoso (CF), which is situated in the middle region Centro Norte Baiano, is 400 km from Salvador. Located north of the State of Bahia. It occupies an area of 7,259 km^2, and its territory is completely included in the drought polygon, Vale do São Francisco and has a population of 66,616 inhabitants (IBGE, 2010). Due to its geographical location, CF is inserted in the Drought Polygon, featuring a predominantly semi-arid climate particularly in the savanna zone, with rainfall concentrated in summer. The study was conducted from the definition of 03 key issues, namely the region of Campo Formoso suffers effects of climate change in semi-arid regions? How climate change affects the livelihood of the farmer? As farmers and local government adapt to climate change, and how they interact with each other? The involved case study methodology, literature review, collection and organization of primary and secondary data, thematic mapping, image processing of Landsat, field work and preparing the map of land use and occupation. Soon, motivates us to provide science-based solutions and approaches to adapting agricultural systems to climate change for the rural poor, especially the most vulnerable farmers in semi-arid regions of northeastern Brazil (Bahia State). Seeks to identify and prioritize areas of greatest risk and developing adaptation, gender equality and mitigation strategies as an integral part of agricultural development programs in these disadvantaged areas. And fundamentally understand and analyze the role of Technical Assistance (will cover innovations in agricultural institutions), the role of women, social capital and social networks. The first results will be presented: The framework for change and climate change or has directly influenced the planting of farmers and has reduced their income. Farmers who have various types of land are affected differently by climate change.		

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Rainfed agriculture has shown a low production, there is an increasing loss of income always sharpened by years of drought, consequently, it has been the impoverishment of the rural worker, and the farmer has used some interesting strategies for adaptation to drought (alternative technologies). But a significant part of farmers said they cannot do anything to change the situation of environmental constraints, socioeconomic. Women have contributed greatly to the preservation of local culture and land. Regarding local policy notes that governmental action has been little significant issues facing the vulnerability and adaptation in the region! It was evident that a major challenge is harnessing rainwater inside the coexistence with the semiarid region, as well as proper management of the land.

| 0967 | Impact of changing land use pattern on local livelihoods in Sundarban Delta Region: a study | Mohan Kumar Bera | India |

The islands in Sundarban region are highly vulnerable to saline water flood. The intensity of floods has increased due to rising sea level which has been experienced by river encroachment and rapid land erosion at river bank. The islands become smaller due to rapid erosion and the villagers close to river become highly vulnerable to chronic flood. Recent study has claimed that Indian part of Sundarban has lost 251.961 sq km landmass including two islands which had submerged by 1986. As a result, total agricultural land and production becomes less. On the other hand, villagers have converted agricultural land into brackish water inland aquaculture to avoid the loss of production due to chronic saline water flood. The changing land use pattern has affected on local ecosystem and islands become prone another disaster. As the land use pattern has changed, local food habit gets affected and nutritional level goes down. The study has been conducted in two villages in Sundarban delta region to explore the impact of changing land use pattern on local livelihood and ecosystem.

| 0969 | The use of hyperspectral imagery to assess the sensitivity of ecosystem photosynthetic parameters along two California climate gradients | Sean DuBois, Ankur Desai, Shawn Serbin, Phil Townsend, Eric Kruger, Clayton Kingdon | USA |

In order to estimate the impact of a changing climate on an ecosystem, the sensitivity of ecosystem parameters must be known. Remote sensing data is often used to determine these parameters, such as leaf area index, biomass, and vegetation stress. New technological advancements increasing the resolution of spectrometers have demonstrated that the photosynthetic parameters J_{max} and V_{cmax} can be estimated using hyperspectral data collected at the leaf level (Serbin et al. 2012). Furthermore, aircraft imaging spectrometers such as the Airborne Visible/Infrared Imaging Spectrometer (AVIRIS) and the Hyperspectral Infrared Imager (HyspIRI) offer the ability to determine the sensitivity of these parameters at the regional scale (Serbin et al. 2012). Determining ecosystem-scale photosynthetic parameters is essential in understanding the sensitivity of such forests, as these parameters can be dependent upon temperature and other climate forcings. We used hyperspectral remote sensing data in conjunction with leaf level spectroscopy, gas exchange, and flux tower data to characterize the local ecosystem photosynthetic parameters, carbon uptake, and climate forcing. Leaf level validation data, including hyperspectral and gas exchange measurements, and ecosystem parameters, such as leaf area index and species abundance and composition, were also collected along two climate gradients at two separate times throughout the year. These gradients include nine sites equipped with flux towers, four being forested sites, and two agricultural sites. The ground based measurements have been collected concurrently with NASA airborne hyperspectral data via HyspIRI aboard their ER-2 high altitude aircraft as part of HypIRI Airborne Campaign (http://hyspiri.jpl.nasa.gov/airborne) activities. This medium resolution data will provide canopy level data that will be used to scale up the leaf level measurements in order to estimate

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V_{cmax} and J_{max} on the ecosystem scale. Flux tower data and hyperspectral images are analyzed in order to determine the temporal and spatial variability in photosynthetic parameters. Differences in observed ecosystem photosynthetic parameter plasticity among ecosystems may explain the ability of certain forest types to survive under changing conditions, and the capacity to migrate to new areas along the mountain slope. There is the potential for systems to shift to new locations along the climate gradient depending on similarity of key microclimatic parameters that most influence photosynthetic resilience. Understanding the sensitivity of such ecosystems will allow for the creation of policy proposals that mitigate potential positive feedbacks to the climate system, and maintain forest ecosystem services in a changing climate.

0975	Modeling fire dynamics driven by land change in Amazonia	Manoel Cardoso, Vinicius Capistrano, Gilvan Sampaio	Brazil

Global dynamic vegetation models are needed to evaluate the synergistic effects of changes in climate and land cover in Amazonia. Coupled land-surface and climate models, for example, are being improved to evaluate the vulnerability of Amazon rainforest to more frequent and severe droughts or to deforestation, either through a direct effect on tree mortality and removal or indirectly via increased occurrence of vegetation fires. In this context, we are working on improving dynamic vegetation models to better represent land-atmosphere interactions over South American biomes, including fires. To this end, models of fire dynamics are being developed for evaluating fire occurrence and impacts considering major natural and anthropogenic factors in the region. Current fire equations are based on methods already tested in global dynamic vegetation models, and lead to reasonable representation of major spatial and temporal features of the fire occurrence. At large scale there is correct representation of time and location for most of the burned area reported in datasets based on remote sensing. However, important under- and over-estimation of model results occur at smaller scales, presumably caused by the simplicity of equations and current parameterization based on spatial and temporal averages of reference fire data. To enhance the precision of the models, we are now working on better representation of sources of ignition, mostly by developing new relations between fires and land change from human activities. These improvements will then contribute for evaluating the signal and strength of potential feedbacks between fires, land change and climate in Amazonia.

0976	People, deforestation patterns, and forest ecosystem services: a case study with Brazilian nut harvesting in the Amazon	Vagner Camilotti, Isabel Escada, Patricia Pinho	Brazil

World's tropical forests are disappearing at high rates mainly due to human settlements, agriculture intensification and predatory forest products trade. Ecosystems around the world create and maintain suitable environments for different life species maintenance, but also providing services and goods for human well-being. The Amazon basin is considered one of the most important ecological system and responsible for the provision of crucial ecosystems services and goods with economic and social values. Brazilian nut (*Bertholletia excelsa* H.&B. 1808) is responsible for about 10% of household income from extractivism in the Amazon. Land use changes have significant negative impacts on ecosystems and, consequently, on the services they provide. Until 2010 approximately 15% of the Amazon forest was deforested and figured as a major cause of nut trees loss in the region. In order to understand the relationship between land cover and Brazilian nut harvesting, a multi-set of methodologies were employed. Using GIS techniques and multiple regression models, we analyzed data of deforestation and forest cover, and deforestation patterns associated to different agents in 23 counties in the Pará, State Brazil. Deforestation data was more important to analyze nut harvesting than forest cover. The counties showed two responses for the relationship between nut harvesting and deforestation: five counties showed a positive correlation (positive group) and seven a negatively (negative group). The multiple regression

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model showed a strong and significant relationship between deforestation and nut harvesting the positive group (R^2 = 0.96; $p < 0.001$), but the same was not observed in the negative group (R^2 = 0,45; $p < 0.05$). Deforestation patterns related to the increase in nut harvesting in the positive group were those classified as less intensive and were caused by small farmers in the beginning of the land occupation and deforestation process, who are responsible for the most part of the nut harvesting in the region. Patterns related to the decrease in nut harvesting were those classified as more intensive, suggesting that the increase in the intensity of land use may configure as an important factor for the decrease in the nut harvesting due to the abandonment of harvesting activity and/or the reduction in the number of nut trees by the deforestation (even this species being protected by law). With these results we hope to provide subsidies to understand how deforestation processes can affect the use of ecosystem services and goods by households in the Amazon.

| 0978 | Land use change and protected areas in Amazon Protected areas program (ARPA) | Daniela Oliveira e Silva, José Luiz de Andrade Franco | Brazil |

The Amazon Protected Areas Program (ARPA) is described as the biggest tropical forest conservation program in the world and as an important mechanism to expand and consolidate the National Protected Areas System (SNUC) in the Amazon biome in Brazil. ARPA was presented to the international community during the Rio+10 Environmental Summit Conference which took place in South Africa, in September 2002. ARPA's general target was designed to ensure the long term protection of a representative sample of the Brazilian Amazon biodiversity in well managed protected areas, while contributing to meet the needs of the Brazilian people through a sustainable development model. The Program's framework consists of three different phases and its present global target is the consolidation of 60M ha in the Amazon. By the end of the 1st Phase (2002-2010) ARPA encompasses around 33M ha, allocated in 63 protected areas (PAs). Protected areas are the principle defense against forest loss and species extinctions. Joppa and all (2008) measured forest cover at progressively larger distances inside and outside of protected areas in the Amazon and ours result showed that PAs are generally large and retain high levels of forest cover, as do their surroundings. But, there are many different ways for evaluation the success in PAs. Timko and Satterfield (2008) proposed a set of criteria and indicators that have been effective in addressing both social equity and ecological integrity of PAs, such as landscape changes, fire regimes, and invasion of exotic species. Other set of indicators as indicators of biodiversity status (population tendencies, risk of extinction, community composition, habitat extension) and indicators of pressures on biodiversity (habitat conversion, exotic species, over-exploitation, and climate change impacts) also could be used, together or not. Barber et al. (2012) estimated the conservation success of Brazilian Amazon PAs facing varied levels of human development pressure in their surroundings. Nepstad and all (2006) studied the Inhibition of Amazon deforestation and fire by PAs. This poster exhibition has for goal sharing the results of the study on the dynamics of the use and cover of the land of PAs supported by the ARPA of the 1st Phase as a way of evaluating the success of the Program in the conservation of biodiversity and maintenance of traditional livelihoods. Understanding the dynamic nature of ecosystems and the consequences of human interventions is essential to manage areas in order to mitigate threats and maintain their integrity. References: Timko and Satterfield (2008) Natural Areas Journal; Joppa and all (2008) in Proceedings of the National Academy of Sciences of the United States of America. Conservation Biology.

| 0980 | Evaluation of the impact of climate change on net and productivity of the sugar cane culture in the city of Rio Largo, AL, Brazil | Alan de Brito, Fernanda Casagrande, Karinne Reis | Brazil |

NUMBER	TITLE	AUTHORS	COUNTRY
		Deusdará Leal	

This study aimed to evaluate the impact of two emission scenarios of greenhouse gases in net revenue and yield of sugar cane in Rio Largo, Alagoas state/Brazil. Initially we calculated the expected net income depending on the yield of cane sugar in different months of planting in accordance with current conditions of precipitation and evapotranspiration in the municipality. Subsequently, simulations were performed productivity and net income expected considering the changes in precipitation and evapotranspiration associated with high (A2) and low (B2) emissions scenarios of greenhouse gases proposed by the Intergovernmental Panel on Climate Change (IPCC). Were then considered three different simulation periods: 2011-2040, 2041-2070 and 2071-2100. The results show a reduction in net income expected over the years of simulation for IPCC scenarios compared to the current expected net income. Brazil is currently the largest producer of sugar cane and the expectations of the culture in the country are in favor of expansion. However, being a semi-perennial plant, the culture is influenced by climatic variations throughout the year, and the availability of water the main cause of yield variability from year to year. Thus, understanding the response of this culture in the face of projected climate change is indispensable for Brazilian agroindustrial planning to meet domestic and global demand.

NUMBER	TITLE	AUTHORS	COUNTRY
0983	Landscape disturbance and ecosystem services use in the Brazilian Amazon: implications for human well-being	Vagner Camilotti, Isabel Escada, Patricia Pinho	Brazil

Human settlements, agriculture intensification and predatory forest products trade are contributing to the disappearance of tropical forests worldwide. Forests around the world provide ecosystem services and goods for human well-being. The Amazon basin is considered one of the most important ecological systems and responsible for the provision of crucial ecosystems services and goods with economic and social values important to the maintenance and improving of human well-being. In this research we are investigating how human well-being is related to: (1) landscape disturbance; (2) the use of some important forest products from extractivism (timber and non-timber forest products); and (3) cultural characteristics in settlements located along a gradient of disturbance in the landscape. We are applying questionnaires about well-being perception and use of forest products in settlements along that gradient of disturbance in the Amazon. In the first field data collection in a region characterized as low disturbed, we obtained a description of the most important forest products used by those populations and the importance of them in a quantitative way, as well as the perception of well-being in the settlements and data about cultural characteristics. Forest products have great importance for inhabitants' consumption, low value for income generation and it is carried out without any forest management. Well-being indicators varies from regular to satisfactory, and the interviewees declared positive perception of security, housing, participation in the decision-making, leisure activities, festivities, solidarity and equitable division of tasks between men and women. In the next field data collection we are going to the regions characterized as medium to high level of disturbance and the data obtained from questionnaires will be analyzed together with landscape data to obtain the relationships among these dataset. This research can be improved during the GLP meeting with the dialog with other subject experts, once we will have collected all the data we need and still have performed some analysis. On the other hand, our research can contribute to the discussions about how important is to look for human well-being when thinking about land use change due to the differences in this subject that we are hoping to find.

NUMBER	TITLE	AUTHORS	COUNTRY
0985	Ancient futures: the case of Amazonian dark earths	Susan Aragón	Brazil

Neotropical rainforests are important for the maintenance of key ecosystem services such as C sequestration and biodiversity maintenance. These forests are also home to millions of people many of them smallholder farmers challenged to cultivate in nutrient-poor, highly weathered soils. A scheme that

combines the objectives of forest conservation and agricultural production in a sustainable way is urgently needed to avoid a natural and social disaster. Unexpectedly, this solution was found by the indigenous people of pre-Columbian times, by the production of Amazonian Dark Earths (ADE). ADE are highly fertile soils which exhibit high nutrient and soil organic matter content which were the product of settlement pattern, fire, waste, and sanitation management, together with biotic activity, especially soil microbial and fungal activity (Glaser 2007). These soils if recreated today may, under the right social, economic, and governance context, allow sustainable agriculture.

Using spatial predictive modeling at the landscape and regional scale this study tries to understand the land management decisions of pre-Columbian people and its implications to current efforts to recreate ADE in the Amazon.

Based on an ongoing research on ADE in Brazil, the main objective of this poster is to show the possibilities and limitations of geospatial technologies in helping understand the sustainability potential of ancient indigenous land management practices.

This poster contributes to the conference theme Land Governance and session on "Geospatial technologies, indigenous institutions and sustainable land governance in developing countries" by stressing the existence of indigenous land management practices which were successful in allowing sustainable agriculture and the potentials and limitations of geospatial technologies in helping study and understand these practices in the Neotropics.

0988	Dynamic data assimilation using particle filters for spatially explicit agent based models	Kirsten Robinson, Andrea Scott, Mark Tovey	Canada

This paper examines the application of particle filters to data assimilation in spatially explicit agent models. In the social sciences, empirical data typically is only incorporated into setting the initial values for model runs. Over time errors accumulate, often dwarfing quantities of interest. The dominant approach in weather forecasting and climate science, among other areas, is to integrate data dynamically on an ongoing basis using data-assimilation methods. These areas show that even in highly complex systems, short-term data-driven forecasts are feasible.

Although particle filters typically fail rapidly as systems become large, new methods extend them to large systems. Unlike the dominant data assimilation methods, particle filters do not require linearization or Gaussian error assumptions, making them well suited to agent-based models. They perform poorly, however, in large systems. Recent advances attempt to overcome the limitations of the particle filter for higher-dimensional problems. This paper examines how particle filters fail for large systems, the challenges and opportunities involved in their extension to spatially explicit agent models. It then reviews several approaches that are promising for application to large problems and describes the implementation of an equivalent weights filter in a spatially explicit agent model.

The ability to integrate dynamically both fast (regularly updated) data streams and slower (historical) data will play an important role in the development of next generation empirical models of linked socio-ecological systems. Dynamic updating with methods that work with highly non-linear, non-Gaussian systems makes it possible to extend these methods to bring data into large operational agent-based land models.

Developing operational methods requires significant work, however it has tremendous potential. It can help to identify the system state accurately to inform policy and manage the accumulation of error. The social sciences are transitioning from being data-poor sciences to being data-rich sciences. Such methods could play a critical role in the development of forecasting tools to help policy makers to rigorously consider alternatives. It is our belief that these methods belong in the core toolbox of social science, and especially land-policy, modelers.

NUMBER	TITLE	AUTHORS	COUNTRY
Fit with theme: Data assimilation methods have the potential to play an important role in the examination of land change transitions and to facilitate their effective governance.			
0991	Transitions on land use impacting peri-urban agriculture: using interdisciplinary approaches to contribute for the discussion of land use and food security linkages on high population density areas - a case study in Brazil	Camille Lanzarotti Nolasco, Luciana de Souza Soler, Jean Pierre Henry Balbaud Ometto, Myanna Lahsen	Brazil

In Brazil, Human Rights to Adequate Food was institutionalized in January 2010, incorporating adequate feed within the Citizens Social Rights as part of Brazilian Federal Constitution. Access to adequate food that guarantees and promotes such rights has been limited due socioeconomic issues and environmental changes. Expansion of cities in size and number, as well as population growth concentrated in urban areas might directly affect land availability for agriculture, reducing viable spaces near cities to produce fresh food in order to respond the increasing demand for food by urban consumers. Vegetables are vital for a healthy human diet, and long market chains represent a damaging step between production and consumption, resulting in great losses due to high perishability, raising prices and difficulting the access food. Thus, the identification of changes on productive areas used for vegetables' production can subsidize public policies and be part of adaptation mechanisms to achieve urban population's food security in future.

The municipality of São José dos Campos and neighborhood cities had a past strongly supported in rural activities, turning into an industrial hub in the last century. In recent years experienced a large population increase and rapidly urbanization. This resulted, besides the obvious change in the landscape, in profound changes in small farming, principally engaged in horticulture. Land use changes along changes on marketing concentration through major market groups, implied on changes in socio-ecological aspects of production, and on model of fresh vegetables' supply to urban dwellers. In this sense, this work aimed to understand the changes in the peri-urban agriculture actives, linking GIS and Social Sciences approaches.

Nolasco et al (2013) used GIS techniques to create a map of potential suitable areas for horticulture in the micro region of São José dos Campos, Brazil. The results of the four classes of areas suggested by LEGAL (GIS Spatial Algebraic Language) in their work were then verified with Satellite images to compare the results of the model and the current horticulture activities there. Interviews with stakeholders related to horticulture production and market were also taken.

The final results provide a basis to support discussion of land change and food and nutritional security linkages by showing the state of this activity, its changes along the years and the potential areas where horticulture could be developed, maybe being tackled as priority areas to improve the nutritional security for this region citizens in near future.

0993	Land use changes and consequences on maize stemborers incidence in Hawassa, Ethiopia	Yodit Kebede, Diego Valbuena, Frédéric Baudron, Felix Bianchi, Pablo Tittonell	The Netherlands

Cereal-based agro-ecosystems in Ethiopia are dynamic as reflected in changes in land cover, land use and agricultural management practices. Such changes can affect the composition and functioning of agro-ecosystems. For instance, the large-scale growing of maize monocultures in the Hawassa region has resulted in simplified, maize-dominated landscapes. Although the reason for the current high stemborers infestation levels are not known, this could be explained by the incremental increase in the area of high quality host plants for stemborers, which support the build-up of stemborer populations. Although much

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research has been conducted on stem borer control at field level, little is known about how management practices at farm level or landscape composition influence stemborer populations. While agricultural management decisions are typically taken at the field and farm level, the population dynamics of stem borer are likely to be influenced at the landscape scale because of their mobility as adults and their inability to recognize property borders. Landscapes that provide a lower proportion of host plants of stem borers and provide habitat and shelter for their natural enemies may hold potential for the sustainable suppression of this pest and improve food security.

To understand the changes of the farming systems and the consequences for stemborers population dynamics, secondary data on major spatial and temporal changes on land use and stemborers incidence will be collected in the Hawassa area, Ethiopia. In parallel, discussions with key informants among farmers, researchers, administrators were conducted to assess the drivers (socio-economics factors, institutional settings, land tenure) of the changes. Land cover changes (cropped land, grassland, hedges, forest and housing) and their relative importance were analysed and quantified after an-object-based classification of Landsat images using E-Cognition. In addition, participatory resource mapping was conducted with farmers to capture their perception of the evolution of the farming practices and resulting changes in landscape composition. The three types of results (literature review, discussion with key informants, land cover changes) document the changes in the last xx decades in the Hawassa region and allow a better understanding of the drivers of these changes and the consequences of landscape composition. This study aligns well with the objective of the session 0087 on "Trajectories of change in agro-ecosystems" by presenting a case study that highlights that studying historic trajectories of change can help to address current issues.

NUMBER	TITLE	AUTHORS	COUNTRY
0997	Assessment of the influence in the change cover/use land on runoff the basin Paraitinga-SP, Brazil	Fernanda Arguello, Diogenes Alves, Laura Borma	Brazil

In recent years, Brazil has figured among the countries with highest frequency and intensity of damages caused by extreme events of floods and droughts. Worldwide increase in disaster occurrence has been attributed both to a change in environmental conditions (increase in frequency and intensity of extreme events) as well as an increase in the overall population, especially in places considered as "risk areas". A high number of floods has been reported for the Southern and Southeastern regions of the country in recent years. The Brazilian Atlas of Natural Disasters - São Paulo volume, identified the largest number of flash flood events in the last two decades within this state, which occurred mainly during the months of December, January and February. A typical case of Sudden Flood occurred in São Luiz do Paraitinga (São Paulo state) during New Year's Eve 2009/2010, with almost complete destruction of the historic center of the city and thousands homeless. Over the centuries, the river basin Paraitinga (where this event occurred) has undergone several changes in cover/use land, with the removal of forests for planting coffee, pasture and recently reforestation with eucalyptus. The impacts of events such as floods and landslides aroused subjects for studies evaluating of the influence of the changing cover/use land in hydrologic cycle. This article presents the partial results of a research which aims to investigate the causes and the short, medium and long-term consequences of an extreme flood event which occurred in the municipality of São Luiz do Paraitinga, São Paulo, Brazil, between Dec, 31 2009 and Jan, 01 2010. The development of this research uses the SWAT hydrologic model as a methodological tool to identify the causes of the event (i.e., a meteorological or hydrological extreme event). This article presents the steps taken to assess the interaction of change cover/ use land and runoff of the basin Paraitinga. The methodology for this phase of the research will involve the construction of a map cover/ use land to be used as input in the SWAT model, which will simulate the runoff. The expected results of this step should report the possible or no correlation between the change in cover/use land and runoff in the basin Paraitinga.

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	The work evaluates the interaction of the changes in cover / use land with the hydrological cycle, contributing to the conference with discussion on making decisions in land use linking environmental changes.		
0998	A spatial computable general equilibrium model to forecast urban land cover change: lessons from San Diego	Daniel Flyte	USA

The San Diego Association of Governments (SANDAG) is the Metropolitan Planning Organization for the San Diego, California (USA) region of over three million people. San Diego is the second largest city in California, and is a highly multicultural region, sharing the busiest land border crossing in the world with Mexico. SANDAG has developed and applied a spatial computable general equilibrium (CGE) model to forecast land cover change and spatial socioeconomic character of the region as part of its 2050 growth forecast. Using the Production, Exchange, Consumption Allocation System (PECAS) (Hunt and Abraham, 2005), SANDAG has developed a small area land forecasting model to show the change in urban form, as well as address state and local legislation to alleviate congestion, reduce greenhouse gas emissions, and manage growth through greater redevelopment and densification.

The San Diego PECAS model is integrated with a tour based travel forecasting model to simulate the interaction of land use and transportation policies and demand. Built upon a spatial input-output framework, with explicit representation of households, industrial sectors, and governments, PECAS models the flow of commodities through the economy from producer to consumer. Using transport time, cost, and accessibility measures, the model predicts location choice and buying and selling preferences for producers and consumers at a spatially disaggregate scale.

As it simulates the actions of developers and property owners, PECAS predicts the change in land cover and urban form in response to modeled rents, zoning, development impact fees, and local plans and policies.

This presentation will describe the results of a series of land use and transportation policy scenarios that SANDAG has evaluated using PECAS, and their use as part of the planning process. Furthermore, it will demonstrate the opportunities and challengers for planners and policy makers in using new integrated models for policy simulation and analysis.

| **1013** | Potentials of traditional Arab Cartography for sustainable land governance in Middle East Fringes | Naeema Al Hosani | UAE |

Many of the modern geospatial technologies have their roots in Arab cartography and tools developed by Arab cartographers in the Middle East and North Africa. Urbanisation, industrialisation, and mining have changed much of the Arab world including lifestyles, livelihoods and landscapes. In spite of that, many desert fringes remain substantially rural and habitable. This paper traces the relevance and applications of cartographic tools and knowledge in understanding land characteristics. In contrast to modern cartography and geo-spatial technologies this indigenous knowledge is not restricted or closed to group of specialists who often lack knowledge of skills of traditional land resources in desert fringes. These resources include oases, desert biodiversity and passages. This paper suggests the need to integrate this type of indigenous knowledge into contemporary syllabuses for geo-information, cartography, geography sciences in schools, colleges and universities. This would help younger generation to appreciate better resource management.