Information for Meeting Africa's Agricultural Transformation and Food Security Goals (IMAAFS)

Conference Proceedings

Editors: H. Josserand and F. Rembold

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Abstract

This report contains the detailed Conference proceedings and 50 abstracts of presentations. The organizers of the international Conference on Information for Meeting Africa's Agricultural Transformation and Food Security Goals (IMAAFS) included the African Union, the UN Economic Commission for Africa, and the European Commission (through the Joint Research Center). The Conference took place at the UN Conference Centre in Addis Ababa from 1 to 3 October 2014, to widen the availability and use of evidence-based information for agricultural growth and improved food and nutrition security. With over 180 international participants, the event brought together scientists and policy makers from a wide range of institutions and research organizations from Africa, Europe and the United States, as well as major UN agencies. The Conference included nine presentation and discussion sessions (each with a chairperson and a rapporteur), executive morning briefs, break-out working groups, and a final decision-grid exercise to summarize the expert opinion of participants regarding the most promising strategies for improved agriculture and food security information.

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List of Acronyms

ACMAD	African Center of Meteorological Applications for Development
AEZ	Agro-Ecological Zones
AfDB	African Development Bank
AGIR	Global Alliance for Resilience
AMIS	Agriculture Market Information System (FAO)
ARC	Africa Risk Capacity
ASIS	Agricultural Stress Index System
AU	African Union
CAADP	Comprehensive Africa Agriculture Development Programme
CCD	Cold Cloud Duration
CH	Cadre Harmonisé
CHIRPS	Climate Hazards Group Infrared Precipitation with Stations
CILSS	Comité Inter-Etats de Lutte contre la Sécheresse au Sahel
CRAM	Crop and Rangeland Monitoring (Conferences)
CSE	Centre de Suivi Ecologique
EC	European Commission
ECCAS	Economic Community of Central African States
ECOWAS	Economic Community of West African States
EU	European Union

FAO	Food and Agriculture Organization of the UN
FAOSTAT	FAO Agriculture Statistics Database
FEWSNet	Famine Early Warning System Network
FPMA	Food Price Monitoring and Analysis system (FAO)
FSIN	Food Security Information Network
FSNAU	Food Security and Nutrition Analysis Unit
GEO	Group on Earth Observation
GIEWS	Global Information and Early Warning System (FAO)
GIS	Geographic Information System
GMES	Global Monitoring for Environment and Security
GPS	Global Positioning System
IBLI	Index-Based Livestock Insurance
IFPRI	International Food Policy Research Institute
IGAD	Intergovernmental Authority on Development
ILRI	International Livestock Research Institute
IMAAFS	Information for meeting Africa's Agricultural Transformation and Food Security Goals
IPC	Integrated Phase Classification
IRI	International Research Institute for Climate and Society
JRC	Joint Research Center of the European Commission
MESA	Monitoring Environment and Security in Africa
MIS	Market Information System(s)
NASA	National Aeronautic and Space Agency (US)
NDVI	Normalized Difference Vegetation Index
NGO	Non Governmental Organization
NPP	Net Primary Production
OSS	Observatoire du Sahara-Sahel
RCMRD	Regional Center for Mapping Resources for Development
REC	Regional Coordinator (CAADP)
RFE	Rainfall Estimates
RIMA	Resilience Index Measurement and Analysis
SADC	Southern Africa Development Community
SIGMA	Stimulating Innovation for Global Monitoring and Agriculture
SMOS	Soil Moisture Ocean Salinity
SPIRITS	Software for Processing and Interpreting Remote Sensing Image Time Series
STARS	Spurring a Transformation for Agriculture through Remote Sensing
TAMSAT	Tropical Applications of Meteorology using SATellite data and ground-based observations
UEMOA	Union Monétaire de l'Afrique de l'Ouest
UNECA	United Nations Economic Community for Africa
USDA	U.S. Department of Agriculture
USGS	United States Geological Survey
VCI	Vegetation Condition Index
VITO	Flemish Institute for Technological Research
WFP	World Food Programme of the UN
WII	Weather Indexed Insurance
WMO	World Meteorological Organization
WRSI	Water Requirement Satisfaction Index

Foreword

It gives me great pleasure, on behalf of the European Commission's Joint Research Centre, to share the content and outcomes of the IMAAFS conference. The International Conference on Information for Meeting Africa's Agricultural Transformation and Food Security Goals (IMAAFS) was held in Addis Ababa from 1-3 October 2014 under the joint auspices of the African Union and of the UN Economic Commission for Africa.

This report contains the detailed Conference proceedings and 50 abstracts of presentations. The event brought together over 150 technicians from the continent's regional and national organizations and institutions, scientists and development partners and other professionals from Africa, Europe and North America.

Building on three previous CRAM (Crop and Rangeland Monitoring) workshops held in Nairobi, which focused more specifically on remote sensing and agro-meteorology based early warning applications, the 2014 Conference was designed to bring together a broader range of scientific and policy analysis and decision-making communities. Drawing upon the diversity of presentations spanning 10 Sessions, the Conference fostered closer mutual understanding, appreciation and integration between such diverse scientific and technical disciplines as remote sensing, crop forecasting, markets and price monitoring and analysis, studies of food security determinants, and demographic, nutrition or household budget surveys.

The Conference conclusions highlight 16 priority strategies identified by participants that reflect this rich combination and interplay of scientific knowledge and decision making experience. I am therefore confident that this event will lead to enhanced cooperation for improved data collection and analysis, and to more effective agricultural, food security and nutrition policies in Africa.

Neil Hubbard,

Head, MARS Unit,

Joint Research Center, European Commission

Acknowledgements

Peer Review Process, Editing

Conference session contents were carefully reviewed by a panel of experts from the main partner organizations. While, presentation abstracts have been checked for consistency by the proceedings editors, final responsibility for the contents of Conference presentations remains with their respective authors.

Introduction

The combined effects of high population growth, rapid urbanization, climate change and powerful global economic trends have put increasing pressure on African agriculture. While the continent is well known to have the world's largest reservoir of uncultivated land, and vast hydrological and other resources, agriculture has remained beset by low input use and productivity, subject to high weather-related and other risks and constrained by limited or expensive access to markets. To respond to growing needs for basic and processed agricultural commodities, higher incomes and food security, African countries have initiated a radical transformation of agriculture; the process is still in the early stages, but is gathering strength. 2014, for instance, marked the first ten years of the Comprehensive Africa Agriculture Development Programme (CAADP). African heads of state and governments further declared that 2014 would also be the "Year of Agriculture and Food Security in Africa", and a CAADP Results Framework for the 2013-2023 period is being finalized. Regional organizations, such as ECOWAS, CILSS, IGAD and SADC have also strongly supported agricultural transformation through their specialized institutions and projects.

This transformation of Africa's agriculture will take myriad different forms, and will require very substantial investments in many areas, ranging from agricultural, trade and food security policies, adaptation to climate change and risk mitigation, improved varietal choices and cultivation practices, etc. Prospective studies indicate that the absolute number of full-time farming households will not increase much over the next generation; most of the population increase will be absorbed by urban areas (including a large number of medium-sized towns). The productivity of remaining farming households will, therefore, have to rise substantially to maintain or improve current levels of food security. This will also likely imply a change in the relative prices of food and non-food items.

A constant and common thread will, however, run through all measures taken to support the transformation of agriculture and a commensurate increase in food security: the need for better information for evidence-based decision making. This will imply better data collection and transmission, wider, faster and more open networking of information, as well as more integrated analysis. In addition, all this will have to take place in fields as diverse as seasonal and short-term weather forecasts, the epidemiology of livestock diseases, economic returns of conservation agriculture at the household level, or the relative market penetration and price competitiveness of parboiled versus imported rice.

The organizers of this international Conference on Information for Meeting Africa's Agricultural Transformation and Food Security Goals (IMAAFS) included the African Union, the UN Economic Commission for Africa, and the European Commission (through the Joint Research Center). The Conference took place at the UN Conference Centre in Addis Ababa from 1 to 3 October 2014, to widen the availability and use of evidence-based information for agricultural growth and improved food and nutrition security. With over 180 international participants, the event brought together scientists and policy makers from a wide range of institutions and research organizations from Africa, Europe and the United States, as well as major UN agencies. The Conference took place over the course of three days and included nine presentation and discussion sessions (each with a chairperson and a rapporteur), executive morning briefs, break-out working groups, and a final decision-grid exercise to summarize the expert opinion of participants regarding the most promising strategies.

Organization and Goals

The overall goal of the Conference was to motivate continent-wide production, exchange and storage of available evidence for informing Africa's agricultural transformation towards improved food and nutrition security and sustainable agriculture. The various sessions were designed to accomplish this through the fulfillment of three specific objectives:

1. Review current approaches, methods, technologies and sources of data;
2. Assess current initiatives on information, statistics and risk management systems;
3. Facilitate, the improvement of, or integration between, information systems, and review capacity building activities.

After the official opening and welcome ceremony, the eleven conference sessions (see Agenda) were organized as follows:

- **Session 1** – An overview of information needs and challenges in regional and national systems, given the current agriculture and food security context.
- **Session 2** – A review of data sources and current agriculture and food security systems, including gaps and opportunities.
- **Session 3** – Revisited the role of household and nutrition surveys for food security and nutrition assessments.
- **Session 4 –** Presented advances in market and price information systems.
- **GEO session** – A specialized event exploring means of greater coordination between agriculture monitoring systems in Africa.
- **Session 5a -** A technical review of how new satellite sensors and processing methods contribute to information on agriculture and food security.
- **Session 5b –** Assessed the usefulness of climate analysis to agriculture and food security.
- **Session 6** - Focused on information needs for various risk management systems.
- **Session 7** – Addressed the link from information to decision making in two areas: integrated analysis methods, and capacity building.
- **Session 8 –** Consisted of deliberations in three working groups corresponding to the three conference objectives listed above.
- **Session 9** – Participants took the main recommendations proposed by the three workings groups, and established priorities through a facilitated multi-voting exercise.

The relationship between the various sessions and the three Conference objectives can be illustrated as follows (various sessions contributing in various ways to each objective):
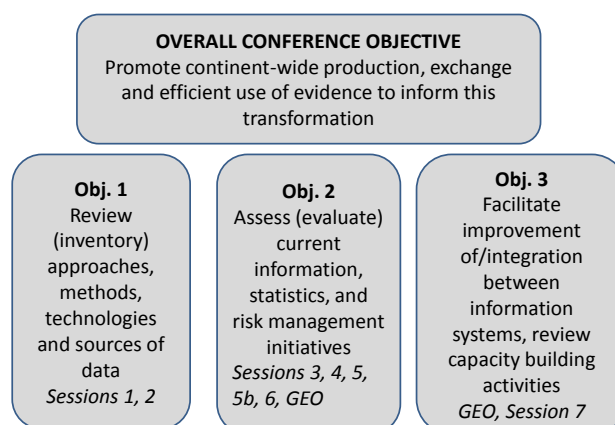
Figure 1 - Overall and Specific Conference Objectives

Official Opening and Welcome Ceremony

The Conference officially opened on October 1st with statements from the main organizing institutions (African Union, Economic Commission for Africa and European Commission) and from key partner organizations. Main themes included CAADP and agriculture transformation, the need to integrate high quality data and analysis from a variety of physical and social sciences, and the governance of information systems.

In his opening speech, **Mr. Laila Lokosang (AU)** reminded participants that 2014 marks the 10th Anniversary of CAADP; it is also the Year of Agriculture and Food Security in Africa, as declared by the AU Heads of State and Government. More specifically, the Malabo AU summit of June 2014 adopted a declaration renewing the AU's commitment to the CAADP, including a pledge to increase resilience of livelihoods and production systems to climate variability and other risks. Mr. Lokosang further pointed out that the CAADP 2013-2023 Results Framework will rely on significant investments in information systems and infrastructure, and on the use of information for improving mutual accountability and decision making.

Putting the Conference in the broader African agriculture context, **Dr. Stephen Karingi (UNECA)** emphasized the continent's complex mix of opportunities and constraints. Africa holds about 60% of the world's uncultivated land, but 4% of its currently farmed land is irrigated. Productivity remains low and, in spite of progress accomplished over the past 30 years in line with the Millennium Development Goals (MDG's), many countries are still affected by high levels of food insecurity. Reliable data must be better analyzed, and resulting information more widely disseminated in all agriculture and food security related areas.

As European Commission Ambassador to the African Union, His Excellency, **Mr. Gary Quince** reminded participants that at the 4th EU-Africa summit in April of 2014, European and African leaders identified agriculture and food security as a top priority for intensified cooperation under their partnership. At the same summit, the development of science, technology and innovation was a prominent feature of discussions, as evidenced by the recent establishment of the EU-Africa High Level Policy Dialogue on science, technology, and innovation. Mr. Quince closed by citing two relevant examples of initiatives taken under

this partnership: the Monitoring Environment and Security in Africa (MESA) activity, with satellite data receiving stations in 48 countries, and the Copernicus program whereby a $3.7 billion investment over the next few years will generate a wealth of high quality data on environment, agriculture and food security.

Speaking then on behalf of the European Commission's Development Directorate, **Mr. Quince** further noted that the EC invests significant resources in building sustainable information systems in Africa through such programs as "Improved Global Governance for Hunger Reduction" and "Information for Nutrition, Food Security and Resilience Decision Making". Looking forward to the 2014-2020 programming exercise, he pointed out that some 60 countries have chosen to focus interventions on food and nutrition security and sustainable agriculture. Mr. Quince concluded by stating that the EC stands ready to respond to clear demand in this area from national and regional organizations, backed by strong ownership and leadership of initiatives.

Speaking on behalf of the EC's Joint Research Center, **Mr. Neil Hubbard** noted that as a follow-on to the series of Crop and Rangeland Monitoring (CRAM) conferences previously organized by JRC and partner organizations, this event was designed to bring together the scientific and policy communities, with a broader scope in technical content and type of participants, and "by putting science and technology into action", bring about a closer integration of scientific and technical information systems coming from many different disciplines. These were to include remote sensing, crop forecasting, data on markets and prices, food demand and supply as well as demographics and household surveys. Like previous speakers, Mr. Hubbard emphasized that the demand from African countries and regional organisations should be clear and that this Conference would serve to find ways to work together to improve data and analysis for the prevention of food and nutrition crises, and better food and nutrition policies.

The remaining opening speakers, Messrs. **Luca Russo (FAO)**, **Gary Eilerts (FEWSNet)** and **Arif Husain (WFP)**, expanded on and added to various points previously raised:

- The necessity to support a vigorous transformation of African agriculture (a projected need to double productivity by 2050);
- The importance of keeping the agriculture, food security and nutrition community focused on evidence-based information and for this community to be accountable for what they do;
- The value of blending and integrating physical and social sciences, strengthen communities of practice, pinpoint data gaps or duplication, and identify priority investment areas;
- There are significant opportunities for closer collaboration between institutions in many areas, including crop monitoring and early warning, market and price data collection and systems, vulnerability analysis and integrated phase classification, resilience, etc.

Session 1 - Agriculture and Food Security Challenges in Africa; the Need for Evidence-Based Information

Introduction

The main objective of this first session was to gather from a panel of African experts their views on needs and challenges in agriculture-related information required to support the continued transformation of agriculture. Challenges were to be discussed at the continental, regional and country levels, and cover resource-based, technical, policy and institutional domains.

Presentations

In his continental overview, **Mr. Mulat Demeke (FAO)**, briefly summarized the status of agriculture and food security, and highlighted some of the main constraints. There has been, for example, a marked improvement in the performance of the agricultural sector in the period since 2000, compared to the 1980s and 1990s. As a result, the food security situation in Sub-Saharan Africa has improved in recent years, with a decline in the proportion of malnourished people. However, considerable challenges remain; high rates of population growth, unsustainable land use, limited input application, natural disasters and climate change have resulted in low levels of agricultural productivity and increasing dependence on fiscally unsustainable food imports.

For the speaker, policy and institutional weaknesses are a key issue. Unfavorable factor and product prices stem from such factors as poor infrastructure, inadequate market institutions, low public investment in agriculture, limited access to financial services, and unpredictable government actions. Because of such institutional weaknesses and policy deficiencies, the region has failed to take advantage of its huge agricultural potential, including vast amount of uncultivated land and untapped water resources. Mr. Demeke concluded that African countries need to strengthen their institutional capacity and bridge information and analytical gaps as a matter of priority.

The following speaker, **Mr. Adama Ekberg (UNECA)** picked up on the subject of Pan-African institutions and policies to remind participants that, as part of their CAADP commitments to achieve goals by 2025, countries must monitor and review progress towards these goals, in terms of markets, employment and economic growth. Progress, however, must be measured against a realistic and fair baseline, with carefully selected indicators of agriculture transformation. Mr. Ekberg outlined several proposed areas in the CAADP Platform to measure such progress, including:

- An analysis of current impacts and gaps from current national and regional policies supporting agricultural transformation,
- Research in support of relevant policy formulation and implementation,
- Documentation of best practices,
- Tracking progress and impact of implementation of the CAADP Declaration, Framework, and Guidelines with respect to already agreed benchmarks and indicators,
- Further awareness raising on policies promoting the transformation of agriculture,
- Exchange of experiences, partnerships.

The next four speakers addressed agriculture challenges and information needs at the regional level from political, economic and technical points of view for IGAD, ECCAS, CILSS, and in Eastern/Southern Africa (RCMRD).

Regarding the Horn of Africa, **Mr. Abdel Moneim Elhoweris (IGAD)** illustrated current situation and information needs through the regional Drought, Disaster Resilience and Sustainability Initiative (IDDRIS), which aims to move the emphasis from a humanitarian assistance approach (the region receives a large share of humanitarian aid to the continent) to one of resilience building. While the region is subjected to recurring droughts, with conflicts exacerbating already severe food insecurity, national and regional initiatives have put the priority on resilience to weather shocks. The IGAD Nairobi Summit of 2011, for instance, called for the urgent introduction of strategies, policies and investment plans at national and regional levels with the principal objective of building resilience to future climatic and economic shocks. This led to the formation of the IGAD Drought Disaster, Resilience and Sustainability Initiative in 2012, which has secured some $440 million of funding so far.

Turning to Central Africa, **Mr. Rassembaye (ECCAS)** gave an overview of the situation in the 11 member states. His presentation highlighted the difficulty of implementing common policies at the regional level, for two main reasons. First, regional activities stopped from 1992 through 1998 due to conflicts in 7 of the 11 member states. Second, regional political and economic cohesion remain weak: 10 of the 11 member states also belong to other sub-regional organizations. In spite of this, ECCAS has designed and implements a common agricultural policy and several specialized regional programs (on food security, animal health and plant protection, and various commodities).

Regarding the West Africa/Sahel region, **Ms. Maty Ba Diao (CILSS)** also highlighted constraints to agriculture and food security, specifically underscoring the region's vulnerability to extreme weather events and its very high rate of population growth (the highest in Africa, and the world), most countries having not yet reached the demographic transition stage (see Figure 2).
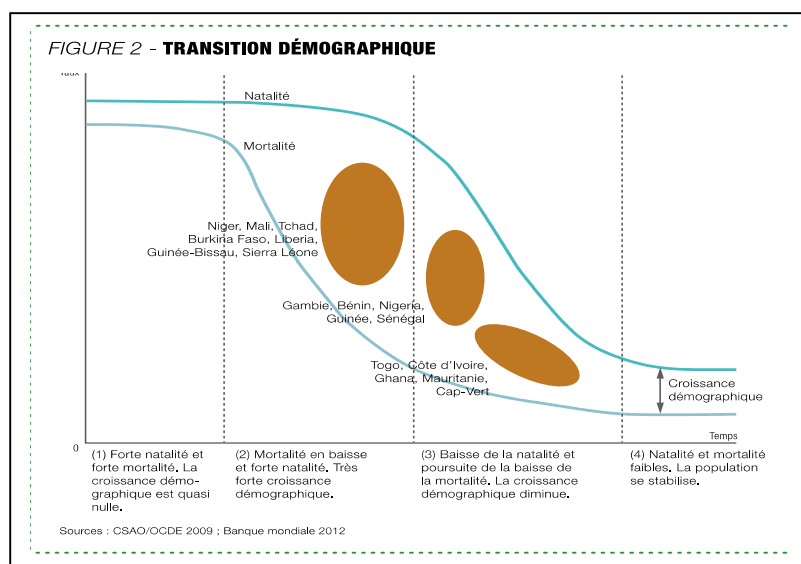
From a regional data and information point of view, the speaker noted that main constraints include the weakness of data collected by national institutions, lack of continuity in time series, the fact that much national data is not accessible to regional institutions (and other users), and that efforts to improve statistics and data analysis remain scattered and poorly coordinated.

Figure 2- Demographic Transition, CILSS Countries

Among various initiatives taken to address the regional situation and data constraints, the speaker emphasized the ECOAGRIS and AGIR regional programs. The former will collect

data and information in order to help design, assess and monitor national and regional policies under the joint ECOWAS, CILSS and CAADP framework. The second regional program will focus on: social protection and better nutrition for vulnerable households, improve agricultural productivity and incomes, and strengthen food security and nutritional governance.

With respect to Eastern and Southern Africa, **Mr. Denis Macharia (RCMRD),** presented the activities of this regional center, whose major activities include research and development, advisory services and training, project implementation, and data and information dissemination. In spite of various constraints (weak agricultural statistics, small and fragmented cultivated land parcels, mixed cropping patterns, etc.) the regional center has promoted earth observation applications and built up the

Figure 3- Evolution of Land Use in Malawi

capacity of national institutions. Several research projects undertaken with international partners will continue to provide essential information for monitoring and planning in all countries of the region. The evolution of land use in Malawi between 1990 and 2010 (showing a very large increase in cultivated areas at the expense of various forest classifications) is one of many examples included in the RCMRD presentation.

Summary and Take-Away

Significant progress has been achieved, but the transformation of African agriculture must gather further strength and scope in order to improve productivity, household incomes, and food security in a sustainable manner. There are persistent needs in terms of agricultural inputs, better rural infrastructure and improved access to financial means; these areas still pose major challenges to institutions and policy makers.

At the continental level, main findings included, on the demand side:

- Rapid growth of population, with implications on food shortages, malnutrition and hunger, and on high rates of urbanization;
- Income growth, with implications on new preferences in food consumption.

On the supply side:

- Limited input use and low productivity in agriculture;
- Unsustainable land use due to population growth;
- Limited access to finance/microfinance and to markets;
- Natural disasters and climate variability.

In terms of policy and institutional challenges:

- Inadequate policies, in input markets, consumer welfare measures, etc.

- Limited financial support, investment potential and lack of job opportunities for young and vulnerable people;
- Lack of sustainable insurance services and inadequate land related policy management;
- Significant improvements needed in science and technology for agricultural transformation;
- Monitoring and evaluation tools required to assess progress and success of agricultural transformation programme;
- The capacity of African experts in data collection must be enhanced so that reliable and comparable information may be used for decision making.

At the regional level:

- Need for reliable data in food and nutrition assessments and better linkages between projects implemented and the CAADP platform, which allows for better alignment of goals;
- Use of new technologies and information systems to help in data collection and dissemination;
- Improved governance of data collected from national level so that transparency, reliability and accessibility can be achieved
- Partnership development in food security and nutrition issues, which avoid duplication;
- Different figures between West, East and Central Africa; n West Africa, for instance, there are more projects funded by Donors due to the vulnerability of the Sahel region.

Challenges at the country level:

- High intensity in agricultural land use due to rapid growth of population
- Challenges in data collection due to fragmented plots of land and mixed crops systems
- Needs for new tools (new technology of information) to reduce costs related to traditional surveys, timely disseminate information to decision makers and build a strong agricultural information system;
- Also need to address plant diseases and food price volatility.

Several participants also emphasized the need to make more information, including climatic information or weather forecasts, to producers. Others raised the question of how to integrate large amounts of data collected by NGOs into wider data systems and the issue of retaining trained African technicians to work in national institutions or research centers. There was broad agreement on the need to rely more on advanced technologies to collect, process and disseminate data. Some of these points were also discussed at the end of Session 2.

Session 2 – Review of Sources and Status of Existing Agriculture and Food Security Statistics, Gaps and Opportunities

Introduction

This session further contributed to the first specific objective of the Conference ("Review approaches, methods, technologies and sources of data") by reviewing the main sources of statistics at national and regional scales and identifying some of the main limitations in their availability and improvement. Information needs of small scale farmers and of institutions were also discussed as well as the role of new technologies in collecting data and in making them available.

Presentations

Starting from a broad theoretical level, **Mr. Gary Eilerts (FEWSNet)** reviewed the evolution of the concept of food security over the last 40 years and whether our current understanding would serve for the next 40. New crisis drivers, for instance, contain some food security features, but it may well be that the most important contribution from the food security field is the systematic, spatial, evidence-based, and shock-outcome model and process it provides for assessing a broader concept of human well-being.

Within a shorter timeline, **Ms. Carola Fabi (FAO)** reminded participants that emerging policies issues are generating new data and information needs while the availability and quantity of agricultural statistics has been decreasing in the last decades. She emphasized the necessity to establish a minimum set of core data countries can collect to meet current and emerging demands, the need to integrate agriculture into national statistical systems, as well as improved governance and statistical capacity building. A promising approach would be to establish a direct link between CAADP-related investment plans and statistical programs at the country level.

Still on the subject of gaps and opportunities, **Mr. Justus Liku (CARE)** put the spotlight on the critical asymmetry of information between smallholders (who produce most of the food) and other actors in commodity value chains. He strongly argued that unless this is properly addressed, and unless producers are treated as viable investors, there are no prospects for gains in agricultural productivity. The issue of access to relevant information by smallholders (weather and drought-related, in this case) was also addressed by **Mr. Dennis Macharia (RCMRD),** who raised several questions:

- What is the most useful type of weather information?
- Under what format should it be presented (media news, text messages)?
- What is the best delivery mode?

Asymmetry of information, however, does not just take place within commodity value chains. The next speaker, **Mr. Felix Rembold (EC/JRC)**, reported on ongoing efforts to tap, mobilize and network the vast reservoir of local expertise in order to provide the community of interested scientists and decision makers with a better understanding of post-harvest losses. Although estimates based on this combined approach of expert knowledge and modelling may not be considered 'statistics' in the traditional sense, they provide a better assessment of the scale of postharvest losses through a "peer-reviewed" and transparent method.

Agriculture and food security statistics are often collected under difficult circumstances. An extreme case was illustrated by **Mr. Husein Gadain (FSNAU)**, who presented examples of relatively successful operational information systems in the conflict situation of Somalia.

Summary and Take-Away

Discussions based on Session 1 and 2 presentations led to a number of conclusions, which may be summarized as follows:

- The diversity of interventions underscored the fact that technical and information system-related issues relevant to agriculture and food security cover a very broad range of technical areas, ranging from soil science to satellite-based sensors, market price or commodity flow data. These are many, hard to master, and difficult to integrate.
- By the same token, a complex mix of physical and social sciences needs to be brought to bear on problems, and rigorous consistency is now expected between such diverse thematic areas as nutrition, household incomes, productivity and governance.
- On the other hand, technological advances have made some scientific methods and techniques more affordable. This has further opened to African institutions access to, use of, and contribution to agriculture and food security related information systems.
- There are now more African "centres of excellence" in areas relating to agriculture, environmental monitoring and food security.
- These institutions now host technically broader, more diverse and collaborative partnerships, including with private firms (i.e. within African institutions, a greater number of technical partners work both with African technicians, and with each other).
- Advances among African institutions have also allowed them to expand their capacity building functions.
- Ideally, African scientific institutions can now use improved information systems to quantify the cost of doing nothing with respect to a specific policy choice, or the relative economic impact on their countries of various policy options.

At the same time, Sessions 1 and 2 raised several questions and issues:

- More generally, there has been over time an overall improvement in the technical capacity of national and regional institutions working on information systems related to agriculture and food security. However, more means for capacity and institution building are necessary to enable African institutions to run those information systems autonomously. It may also be that the gap between the most and least advanced countries has become wider. This could be due to the fact that more advanced institutions have appeared more "attractive" to potential partners, and received relatively more support.
- Improved and shared technologies have established good technical levels for routine collaboration between African institutions and their partners; the question remains of how one ensures that 'pilot' activities are also taken to scale and put on a broad level of collaboration?
- Rigorous statistical methods and techniques underpinning solid information systems are rightly considered a priority, but are we taking full advantage of other worthwhile approaches (e.g. expert systems, non-parametric analysis, etc.)?
- If we are to support the transformation of agriculture through improved information techniques and systems, how do we ensure that we have an adequate

understanding of what drives transformation processes, and how they unfold, now and in the near future?

Session 3 – Food Security and Nutrition Assessment: Revisiting the Role of the Household and Nutrition Surveys

Introduction

This third Conference session provided a transition from Objective 1 to Objective 2: "Assess current information, statistics and risk management initiatives". The session started with the global Food security information network as a community to share knowledge, best practices and lessons learnt about making available timely food and nutrition security information to decision makers. It then addressed challenges and opportunities with household level assessments but also looked at policy frameworks and recent initiatives for food and nutrition security.

Presentations

The first speaker, **Mr. Arif Husain (WFP),** presented the Food Security Information Network (FSIN), a global community of practice including FAO, IFPRI, WFP, which is establishing partnerships with other international agencies and with such regional institutions as IGAD, CILSS, SICA, etc. There are some 740 members, one-third of which are among 32 countries of Africa. FSIN aims to promote synergies among people working on food security information systems, and to avoid or reduce redundancies (a joint comparative study of global market information systems managed by AMIS, FAO/GIEWS, IFPRI, FEWS NET and WFP is planned, for example). In addition, FSIN plans to develop country-led coordinated action plans for capacity development and to promote a common approach between FAO, WFP and IFPRI to support country-and regional- level capacity development efforts.

In a similar vein, the next speaker, **Mr. Akoto Osei (AU)**, observed that no single survey can possibly collect all necessary information on food and nutrition security, and that no single institution can fully measure or monitor their various components. There are, however, increasing opportunities to:

- Better coordinate efforts among sectors and institutions,
- Commonly define sets of indicators to capture all the dimensions of food security,
- Harmonize technical and methodological procedures
- Improve the monitoring of food security determinants (availability, access, utilization and stability),
- Carry out joint research to address emerging issues.

A number of presentations then addressed the role of various food and nutrition surveys at the national and regional levels in greater detail. Describing agricultural statistics and food security monitoring in Rwanda, **Mr. Habyarimana (Ministry of Agriculture)** made the case for more integrated food security analysis and collaborative research among national institutions, and argued that joint research between government and non-government institutions requires flexible ways to discuss and validate information while facilitating and promoting data sharing and an efficient flow of information. Addressing the link between market forces and household level food security, **Mr. Nigussie Tefera (JRC)** reported on a

study assessing the impact of higher food prices on rural households in Ethiopia. The results indicate that high food prices improve the welfare of rural households at the aggregate level, but that this welfare gain is not evenly distributed among rural households: net sellers tend to gain, while some of the net buyers were adversely affected. The study also pointed out the importance of food price stability as a factor in agricultural expansion. Two presenters, Messrs. **Elliot Vhurumuku (WFP)**, and **Isaack Manyama (UNICEF)**, focused on the link between food security and nutrition surveys and on emergency nutrition assessments. The former noted that despite the potential causal relationship between food security status and nutritional outcomes among children below 5 years of age and women in child-bearing years, the two are rarely assessed together. Citing pilot studies in three very different environments of Uganda, Burundi and Djibouti, the speaker concluded that food security and nutrition assessments can easily be linked, thereby providing better information for program design than when such assessments are conducted separately (see Figure 4 below).
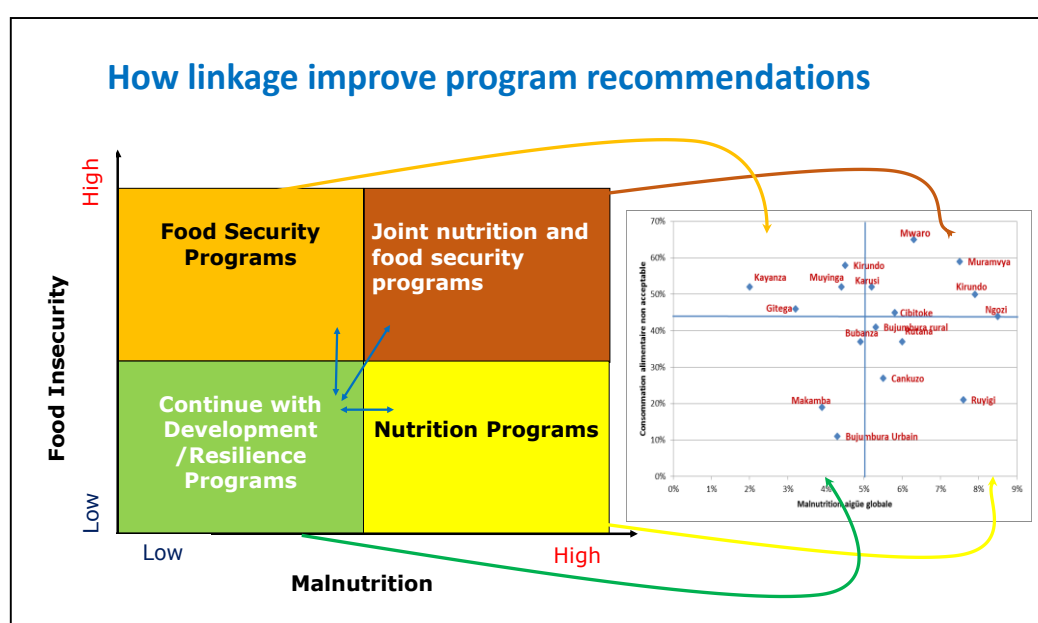
Figure 4 - Food Security/Nutrition Survey Linkages

The second presenter argued that emergency nutrition assessment methods can be used in hotspot classification (see example), facilitate resource mobilization and funding, and help set priorities for resource allocation.

Finally, **Mr. Thom Achterbosch (Wageningen University)** emphasized the need to monitor long-term drivers of food insecurity and patterns in comparable countries, and drew attention to the relationship between food prices and media attention. He advocated prospective analysis with possible scenarios based on trends in demographics, economic indicators, yields and cropland use as a result of climate change.
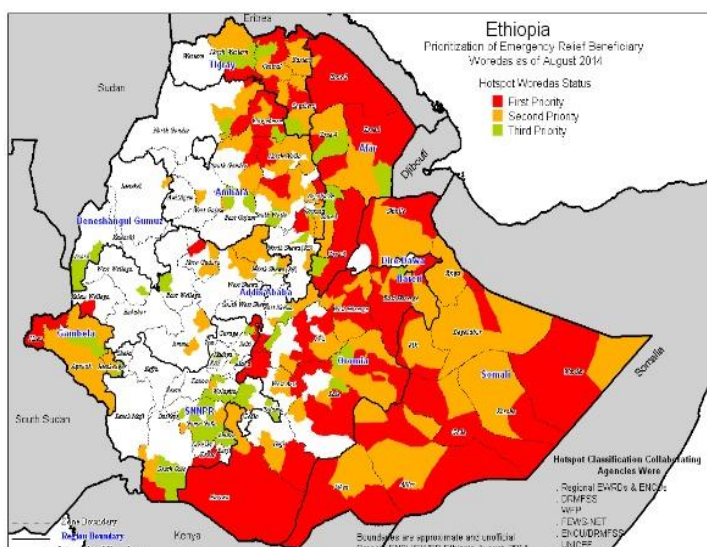
Figure 5- Food Insecurity Mapping, Ethiopia

Summary and Take-Away

The session addressed three main areas: survey challenges, cooperation/data openness, and moving from surveys to analysis.

Doing surveys is a challenge:

- Conflicts have a negative impact on agricultural statistics/surveys (e.g. 1994 Rwanda)
- Certain domains of agriculture (e.g. livestock, fish) are particularly difficult to survey
- Many and diverse indicators are needed to capture food security and nutrition status, and surveys are aimed at households as well as individuals
- Obesity is a new global megatrend, also in Africa
- Emergency nutrition surveys can be a good complementary data source for regular surveys.

Cooperation and open data facilitate dissemination:

- Guidelines are available and national institutions offer in many cases easy access to data (e.g. Institute of Statistics in Rwanda);
- These data are a public good. Whether data openness is successful depends of people using it.
- A comparative study of globally-managed price and market information systems will provide opportunities for further coordination.

Moving from surveys to analysis:

- In the context of future market developments and agriculture transformation in Africa, the question if higher prices are good for (smallholder) farmers is key. A clear answer cannot be given, although in general higher prices should stimulate production, leading to lower prices in the long term.
- One must not forget long-term developments and related uncertainty in Africa and beyond.

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Session 4 - Advances in Market and Price Information Systems

Introduction

This session included two related sub-sections: (i) Price Collection and Tools, and (ii) Market Monitoring and Analysis. It focused on the level of collaboration among international and national agencies for market price data collection, and on the limits of current initiatives in terms of quality, limited capacity at national level and consistency over space and time. The role of new technologies, such as mobile phones for market price data collection, was also to be addressed.

Presentations

The first three speakers presented current global (FAO) and Africa-wide (AfDB) basic food price collection systems. Speaking on the FAO/GIEWS Food Price Monitoring and Analysis system (FPMA), **Mr. Felix Baquedano (FAO/GIEWS)** emphasized the price anomaly and seasonality analysis capacity of FPMA. He also pointed out that this widely used global tool is now also being implemented in national systems of India, Azerbaijan, Kyrgyzstan and Tajikistan.

The African Development Bank system, which covers 332 food products, as presented by **Mr. Abdoullaye Adam, AfDB** is designed to produce reliable and relevant Purchasing Power Parities (PPP). National annual average prices of comparable and representative items with the same quality and matching on the features that affect prices are computed after collecting the data using surveys with the same spatial and temporal coverage in all countries participating in this International Price Comparison programme.

As a transition between the first part (price collection, tools) and the second part (market analysis) of Session 4, **Ms. Molly Brown (University of Maryland)** presented an assessment of the impact of weather and international price shocks on local food prices. This was based on the analysis of the short-run impact of both weather anomalies and of international price changes on monthly food prices across 554 local commodity markets in 51 countries between

	Local weather shocks have **no effect**	Local weather shocks **influence prices**
Global price shocks have **no effect**	• Low cereal stock-use ratio • Food deficit areas/connected to food deficit areas • Weather shocks in distant food surplus areas affect local prices • Low income countries	• Isolated/landlocked country • Poor, rural, poor infrastructure • Food surplus area that trades with larger food surplus area • Low income countries
Global price shocks **influence prices**	• Food deficit area or food importing country • Connected location/non-landlocked • Food deficit region in more advanced developing country • Urban/capital location	• Food surplus area in food exporting country • Urban area in exporting country that has weather similar to surplus agricultural area

2008 and 2012. As the table below shows, it is possible to establish a typology of price behavior based on exogenous and endogenous factors.

The study found that that almost 20% of local market prices were affected by domestic weather anomalies in the short run, 9% by international price changes and 4% by both domestic weather anomalies and international price changes.

The second part of Session 4, focusing on Market Monitoring and Analysis included a detailed presentation of regional cross-border flows for 10 commodities. **Mr. Moussa Cisse (CILSS)**, presented their work on monitoring markets and trans-border flows of agricultural products; this multi-annual regional program covered 17 countries, collecting prices in 550 markets (based on national MIS), and estimating cross-border flows as well as the costs of road harassment. This program was designed to allow national authorities, private operators, regional organizations (UEMOA, ECOWAS) and civil society to have a good understanding of the dynamics of regional trade in agricultural products and livestock (see the map of flows of livestock, cereals, roots and tubers, Figure 6).
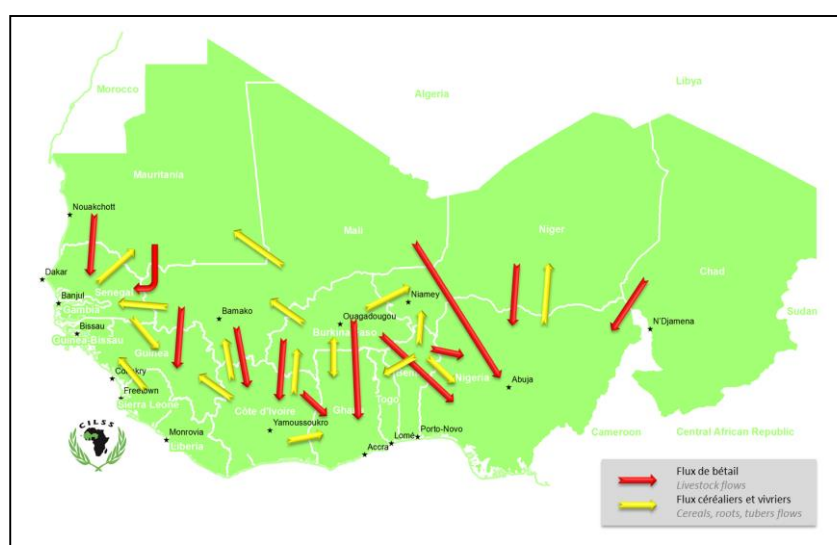
Figure 6 - Mapping of Main West African Commodity Trade Flows

Regarding data collection on both intra-regional trade and road harassment, CILSS is the process of implementing a smartphone-based system to collect data from the field, (including GPS coordinates) and have this information in real time.

The remainder of Session 4 focused on the analysis of market information, policy analysis and modeling of future regional trends. In her paper on assessing the effectiveness of regional integration, **Ms. Stephanie Brunelin** highlighted the role played both by distance and borders in explaining price deviations between markets. Within a regional organization, distance seems to lead to larger price differentials between markets than the existence of borders. However, the border effect can be quite large between countries that are not members of the same customs union or economic organization. To promote regional market integration, the emphasis should, therefore be, depending on the case, either on transport infrastructure, or economic integration.

Policy analysis and modeling by **Mr. Ferdi Meyer (University of Pretoria)** and colleagues also underpinned a 10-year partial equilibrium model for maize in Eastern and Southern Africa. The model used several megatrends shaping the African agricultural landscape:

- Food and Energy Prices,
- Income growth and distribution,
- Population demographics and urbanization,

- Changing farm structures and population distribution,
- Soil degradation and climate variability.

The model generated both maize price projections in seven countries (below), and some sector employment predictions. Main findings from the modeling exercise included an overall reduction in regional maize surplus over the next ten years, and the fact that the level of transmission of global to domestic prices varies much between countries of the region.
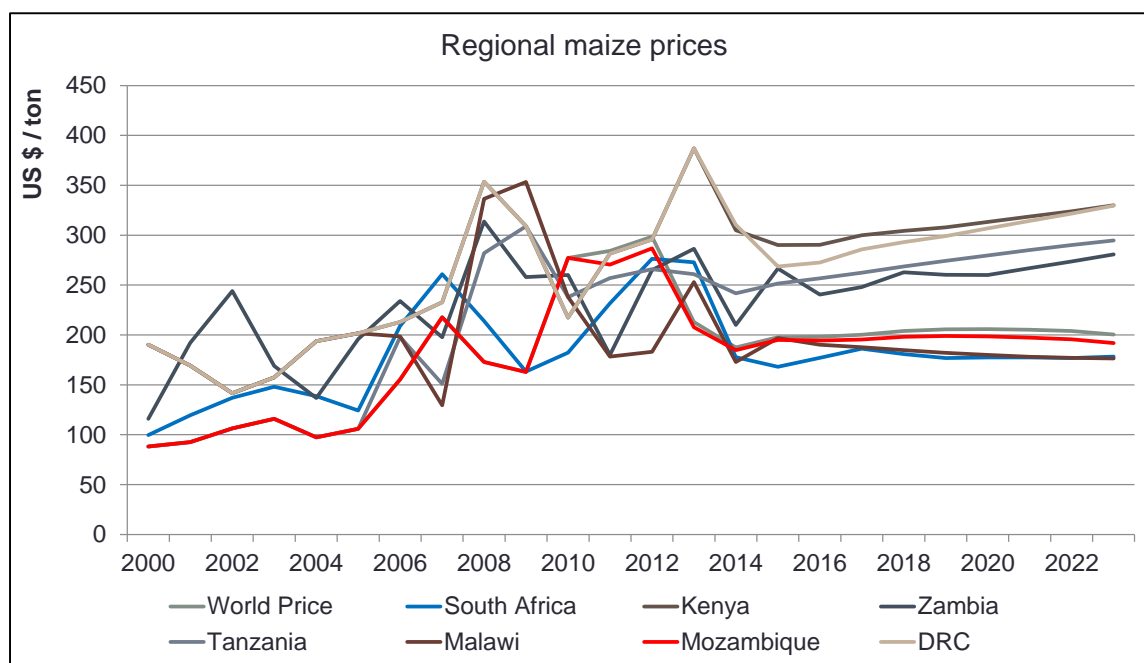
Figure 7 - Regional Maize Price Projections, Selected Countries

Regarding the impact of regional integration and trade policies on trade, **Mr. Mulat Demeke (FAO)** summarized the results of a policy analysis initiative designed to monitor and assess policies and their effects on producers and other value chain agents in selected developing countries (mainly in Africa). The results from this analysis for ten African countries show that existing policy and market environments have created trade disincentives, especially for producers. The second phase of this work will focus on ex-ante analysis of policy options, as well as advisory and advocacy activities for policy reform.

Summary and Take-Away

Much progress has been made in in markets and price monitoring and analysis, incidentally showing the weakness of official trade statistics. Various agencies (FAO, WFP and national market information systems) collaborate to collect, and disseminate price data. However, some projects do not fully take into account existing price data collection systems.

National capacity to collect and disseminate policy-related data remains weak; most of the time, data are disseminated by international partners, but more data is now collected and analyzed at the national level, through the production of bulletins for instance. New technologies are helping with more efficient data collection, and market price data is increasingly being used for a widening range of analyses: market and trade studies, early warning, vulnerability assessment, etc. There are also more interactive tools enabling everyone to have access to information that has been analyzed.

The impacts on prices of key determinants, including extreme weather events and global commodity trends, are also better known. However, the level of support for regional integration by national and regional trade policies still inadequate. Uncertainty in trade and other policies as well as high transaction costs thus continue to prevent economic actors in the region to derive full benefits from its various comparative advantages.

Session 5a – Improved Information from New Satellite Sensors and Methods

Introduction

As was the case for the GEO and Improved Climate Information (5b) sessions, this session focused on new methods and remotely sensed data, directly in the line of previous CRAM workshops. It included 15 presentations divided into two categories: improved sensors and methods (covering both global and regional initiatives), and user-oriented applications.

Presentations

Presenting the *Copernicus* initiative, **Michel Massart** (EC GROW) emphasized the fact that this Earth Observation Flagship of the European Union is now fully operational and provides services in the land, marine, atmosphere, emergency, climate change and security areas.

The Global Land component delivers in near real time 11 mid-resolution (1 km) bio-geophysical variables at worldwide level. It provides information for the agriculture sector with the production of biophysical variables relevant for crop monitoring and for crop production forecast and 5b) supports environmental policies in Africa in the domains of biodiversity, desertification, drought and water monitoring, and the setup of early warning systems. Medium resolution data will be available at different resolutions from 1 km to 300 m (max. 100m) thanks to the already existing PROBA V satellite and the upcoming Sentinel 3 satellites. Global high resolution coverage (10 m) will be available every 5 days thanks to Sentinel 2.

Presenting the Agricultural Stress Index System (ASIS), a collaborative effort between FAO, MARS/JRC and VITO, **Oscar Rojas (FAO)** showed this global system based on the VHI (vegetation health index), a combination of NDVI and temperature cumulated by using a phenological model and specific for agricultural areas. The ASIS database currently contains 30 years of agricultural hot spots data and information, starting from 1984. The system was able to identify the most significant hotspot of the first crop season 2014/15 as being in Zambia, Malawi, Mozambique, Zimbabwe and Madagascar. ASIS is also designed to be used as a standalone version at the country level, once customized with specific parameters, coefficients and land use masks for the country or region.

Still at the global level, **Curt Reynolds (USDA)** presented recent work on the use of passive microwave soil moisture ocean salinity (SMOS)-corrected model to generate a global soil moisture product. This global SMOS-corrected soil moisture product helps monitor soil moisture in regions where global precipitation products perform poorly. The current passive microwave imagery of 45-kilometers square spatial resolution is expected to be replaced by NASA's upcoming SMAP (Soil Moisture Active and Passive) imagery which will combine both active and passive microwave imagery with 10-kilometers square spatial resolution.

A number of presentations focused on improved sensors and methods at the regional level. Speaking of the Monitoring for Environment and Security in Africa (MESA) program, **Farai Marumbwa (MESA)** described the MESA application to the SADC region and its four geo-information services: Agriculture, Drought, Wildfire and Flood.

The Agricultural Service, based on the AMESD/MESA station installed at ministries of agriculture across the SADC region, provides products and tools to assist agricultural remote sensing analysts to describe factors affecting crops and rangelands during the season. Outputs help analysts and decision-makers to answer the following questions:

- What crops grow where?
- What is the crop or rangeland condition?
- What is the crop stage?
- What is the likely yield?

Users of the service are trained in the MESA tools (Estation) and in data analysis using open source GIS software like ILWIS, SPIRITS and QGIS. Relevant information can be presented to decision makers in the form of a report or bulletin every 10 days or on a monthly basis.

Mr. Seydou Traore (CILSS) presented the overall structure of the AGRHYMET system and the main components of agricultural campaign monitoring, which include:

- Timing of start-of-season by crop and by zone,
- Water requirement satisfaction indices,
- Vegetation indices derived from EO satellites,
- Status of crop pests and diseases
- Prediction of potential crop yields using crop models,
- Publication of Monthly and Special alert bulletins.
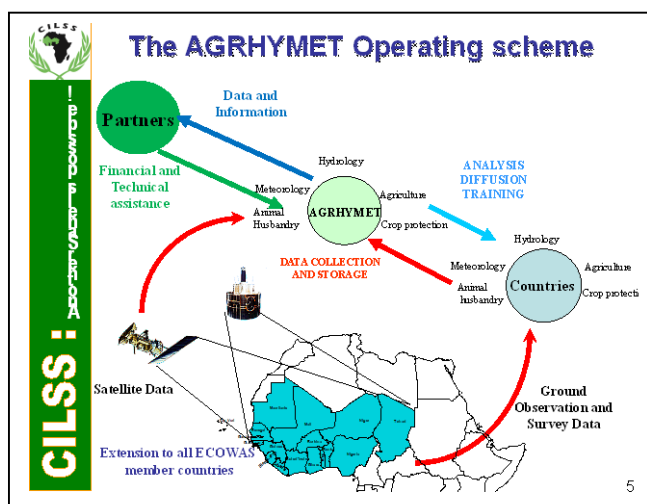
Figure 8 - AGRHYMET Operating Scheme

The next presentation, by **Michele Meroni, et al. (JRC)**, showed current work on remotely sensed phenology through which the timing of onset, duration, and intensity of vegetation growth can be retrieved from space observations and used for food security monitoring. This methodology was used to estimate i) the impact of the drought in the Horn of Africa, *ii)* crop yield in Tunisia and, *iii)* rangeland biomass production in Niger.

These case studies support the use of space-derived phenology for food security monitoring, both for an end-of-season analysis to map crop yield and biomass production anomalies and a within-season analysis to provide early warning information. Advantages include: focus the analysis on the actual growing season year by year and pixel by pixel, take the progress of the season into account so that the information provided to analyst can be automatically "weighted" for its reliability.

Next steps include: a probabilistic approach for the automated early drought hot-spot detection at the JRC (and FAO within the ASIS system), use of other satellite sensors to

increase spatial resolution (MODIS 250–500 m, Proba-V 100-300 m, Sentinel 2), and the development of a simplified vegetation growth model assimilating remote sensing data.

Presentations by **Messrs**. **Akim Abdi, Herve Kerdiles, Clement Atzberger, Gabriel Senay** and **Kees de Bie** also dealt with various methodologies applied at the regional level in Africa.

Net primary production (NPP) is the main source of energy for ecosystems and human populations that depend on them. **A. Abdi (Lund University)** presented an analysis of the supply and demand of NPP in the Sahel using NPP estimates from the MODIS sensor and agri-environmental data from FAOSTAT. While NPP demand increased between 2000 and 2010 due to a 31% increase in the human population, the NPP supply was near-constant. Keeping track of the supply-demand balance of NPP will be an important tool from the standpoint of sustainable development, and as an indicator of stresses on the environment.

While ground survey data is needed to derive unbiased crop area estimates from high resolution remote sensing data, **Herve Kerdiles (JRC)** noted that the area frame sample is the system with the highest synergy with remote sensing imagery. Classification has been problematic due to such factors as cloud cover, small parcels, mixed cropping and large variability in sowing dates. However, the availability of large swath open data sensors such as Landsat 8 since 2013 and Sentinel 2 in 2015 should ease the use of high resolution remote sensing for crop area estimation at country level. Additional tests of area frame sampling combined with remote sensing are needed, in particular in countries eager to improve their crop statistics. **Clement Atzberger (BOKU)**, for his part, presented a number of NDVI filtering techniques to obtain more reliable global data time series and information for near real time drought monitoring. A Kenya study case was shown to illustrate the high potential of the cleaned data sets.

Speaking on the integration of remotely sensed data and hydrologic modeling to monitor crop and rangeland systems in the Sahel and the horn of Africa, **Gabriel Senay (USGS)** reported that the analysis of seasonal ET Anomalies, updated every 8 days, allow for monitoring of the water use response of the landscape as a result of rainfall and/or irrigation for every 1 km^2. This remotely-sensed ET anomaly appears to yield a reliable and near-real time diagnosis of the negative impact of drought or excessive moisture. For example, the seasonal (May- August) ET anomaly for 2014 accurately depicted the unusual drought in the Arsi region of Ethiopia which killed thousands of livestock. In addition, the system's online water point monitoring tool, based on ground data, covers over 200 small farm ponds in agro-pastoral regions of Africa and provides a daily qualitative indicator of the relative fullness of each pond.

From a very different viewpoints, **Kees de Bie (Twente University)**, argued for a greater hyper-temporal integration between NDVI data and long-term census-based land use information to refine the classification of "cropped areas". The presenter argued that we must know what crop is grown where, when and how. Only then can proper "monitoring", "yield estimation", "planning", etc. become possible. By classifying 15 years of hyper-temporal SPOT imagery for Ethiopia, it was possible to define 60 crop production system zones based on the vegetation's response to climate, weather, soil, terrain, elevation, etc.

The next two presentations, by **Messrs. Rogerio Bonifaccio (WFP)** and **George Chirima (ARC)** focused on user needs, both at the institutional and smallholder levels. In his set of slides on humanitarian applications of remote sensing and climate data the first speaker reported on the growing importance for WFP of climate and remote sensing datasets. These

both serve the technical needs of climate-related initiatives, the information requirements of early warning and emergency preparedness work, and the planning of WFP interventions.

The newly launched Seasonal Monitor, a service that assimilates and processes RFE and NDVI data to produce tailored information to Country Offices and Regional Bureaus, was cited as an example.

Describing satellite data modeling as a tool to mitigate climate change risks in semi-arid Africa, **Mr. George Chirima** pointed out that modelling approaches based on remotely sensed data can provide smallholders with weather forecasts, yield predictions, early warnings of disease and pest outbreaks. These allow smallholders to better understand climate-related risks and develop strategies to mitigate them.

Summary and Take-Away

Conclusions to the wide-ranging set of discussions in Session 5a can be organized into positive and negative factors, and priority actions to be taken. Positive Factors include:

- Past and current sensor series (Landsat, SPOT) continue to provide useful information, and valuable new ones (Sentinel, SMOS, SMAP) are coming online,
- Sufficient length of time series, coupled with free data policies, have encouraged investment in new applications products for drought monitoring (ASIS, CHIRPS, Eta, water points),
- Institutions have established and maintain important programs for sustained and routine use of these applications products for decision support (e.g. MESA, COPERNICUS, etc.).

Negative factors, on the other hand, include:

- Sensor characteristics (spatial and spectral resolutions, frequency of observation) are still inadequate to map the crop areas and crop types of the complex African agricultural landscape without significant ground data support,
- Products are still most relevant to national and international decision makers, but do not reach enough individual farmers,
- Some promising applications have not yet transitioned from research to regular use.
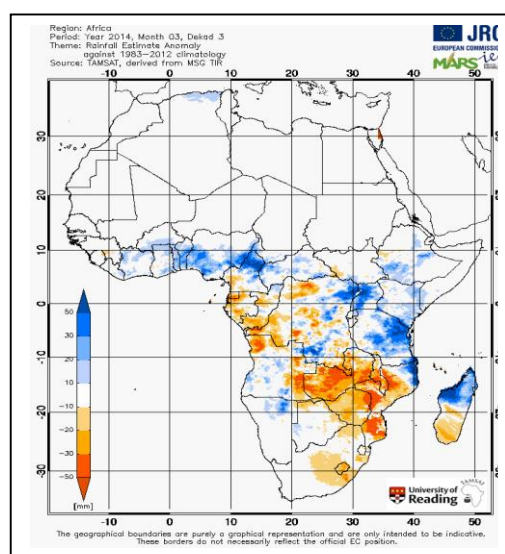
Figure 9- TAMSAT Rainfall Anomaly Mapping

Priority Actions, therefore, were thought to include:

- Advance probabilistic applications for risk assessment and management and within-season agro-climatological monitoring,
- Develop continent-wide, complete and authoritative sub-national crop zone maps. This will better support seasonal monitoring, as well as assimilation of remote sensing observations into crop modeling,
- Advance uptake of new applications and products (soil moisture, evapotranspiration, water points) in addition to traditional satellite rainfall and vegetation index imagery.

Session 5b – Improved Climate Information

Introduction

This session, focusing on improved climate information to support agriculture transformation, included six presentations, four of which dealt with improved datasets and methodologies, and two with the importance of disseminating weather-related information to various social groups.

Presentations

Mr. Ross Maidment (TAMSAT) first reported on the development of rainfall climate data based on Meteosat thermal-infra archive (1983 to the present) and the TAMSAT rainfall estimation algorithm. The 30-year TAMSAT African Rainfall Climatology and Time-series (TARCAT) dataset was created by applying climatological gauge-derived calibration parameters to the Meteosat archive. Unlike other satellite-gauge based datasets, year to year variations in TARCAT are driven purely by the Meteosat satellite observations. Comparisons between TARCAT and other long-term rainfall datasets have shown that TARCAT is able to replicate spatial and seasonal rainfall patterns well. An illustration of rainfall anomalies is included here.

Mr. Chris Funk (USGS) next reported on quasi-global precipitation estimates for drought monitoring through the Climate Hazards Group Infra-red Precipitation with Stations (CHIRPS) dataset. This method was inspired by pioneering cold cloud duration (CCD) estimation approaches developed for Africa and combines them with interpolated station data. It provides quasi-global (50°S-50°N, 180°E-180° W), gridded precipitation estimates at 0.05^{o} resolution. It is based on very large data sets including 198,000 weather stations, 500 million daily rainfall data since 1981, another 500 million back to 1832 and 600 million daily temperature data since 1833. Publicly available data are online two days after each pentad, with a final product available after the middle of the following month.

The presentation by **Shraddhanand Shukla, et al. (FEWSNet)** covered an experimental approach to the forecasting of seasonal agricultural droughts in East Africa using satellite based observations, land surface models and dynamical weather/climate forecasts. This hybrid approach combining statistical methods and dynamic climate forecasts was felt to show promise, resulting in improved March-May precipitation forecast skill in the region. Soil moisture forecasts initialized at the beginning of the season turned out skillful across the domain at 1-month lead and for some parts over 3-month lead. It is also believed that the contribution from the antecedent soil moisture state to soil moisture forecast skill during the remainder of the season could be most useful when the forecast is initialized in the middle of the season.

Addressing next a modeling framework to develop scenarios for major agricultural production systems, **Messrs. Renato Cumani** and **John Latham (FAO)** presented work on climate change predictions in Sub-Saharan Africa, including estimated impacts and adaptation measures. In this case, land evaluation and agro-ecological zoning were used to develop scenarios of major production systems, based on dynamic land use, climate, and CO-2 fertilization effects, considering sliding 30 year long-term averages and 40 parameters derived from the agro-climatic assessments and climatic models outputs. The model then uses changes in the suitability analysis for 12 major crops, combining the FAO ECOCROP database with agro-climatic parameters as well as shifts in Agro-Ecological Zones (AEZ) due to climate change and variability. Resulting spatial datasets, tabular information, metadata

and technical reports are available from the FAO online. A sample of output results is shown below.
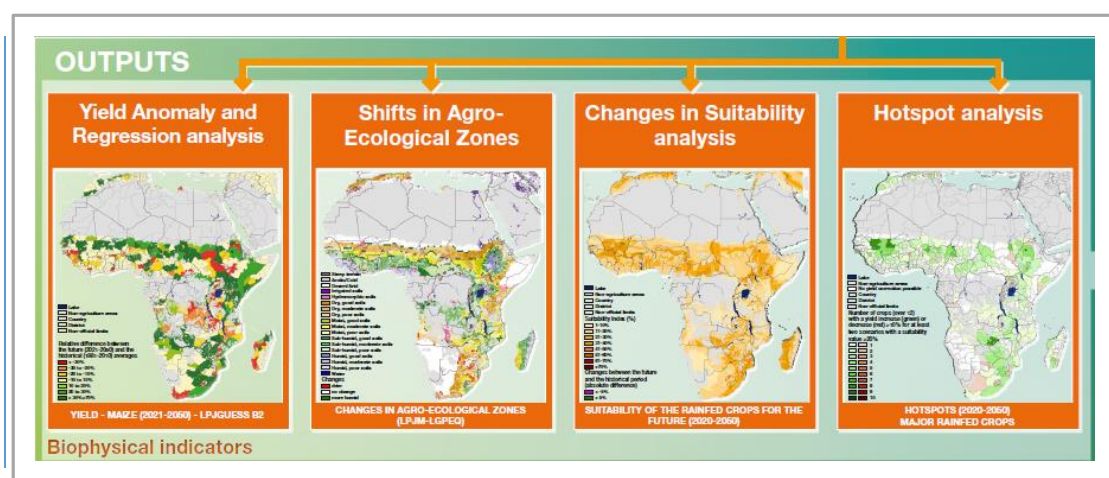
Figure 10 - FAO Model Scenarios, Biophysical Indicators

The last two presentations focused mostly on the wider dissemination of weather-related information and forecasts to various social groups, especially rural smallholders, who have been shown to use it effectively to reduce risk and increase the viability of small farms.

Robert Stefanski and Jose Camacho (WMO) first provided an overview of WMO-GFCS actions in support of the provision of climate and weather information for smallholders in several regions of sub-Saharan Africa. From 2008 to 2013, more than 300 seminars were conducted in West Africa and close to 15000 farmers were trained on the use of weather and climate information, enabling them to build their capacity to improve production systems, better understand weather and climate-related hazards, and apply best practices and solutions.

The Severe Weather Forecasts Demonstration project in Southern and Eastern Africa, has
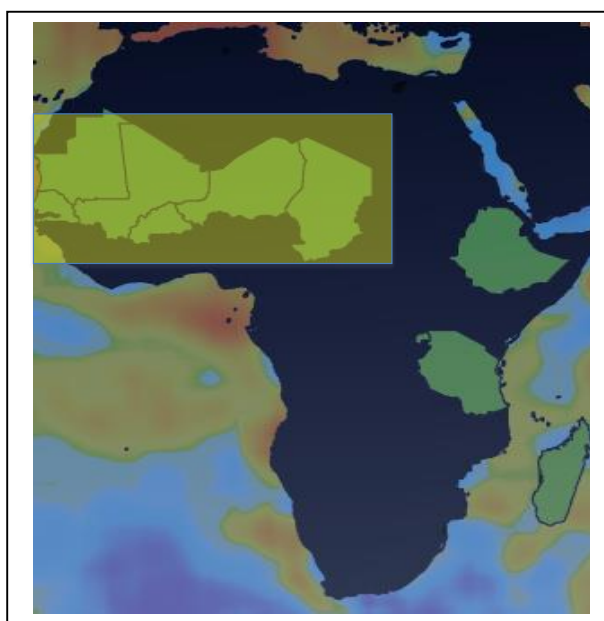
built up a structure to enable NMHS access to regional numerical weather prediction models outputs that can be used to derive warning and alerts on wind gusts, thunderstorms, cold and heat waves, coastal sea conditions and heavy rains. A pilot project coupling those new products and mobile phone tools was also developed for users at the Uganda shores of Lake Victoria, contributing to secure fishery and transport activities through the delivery of a four color warning scheme to the fishermen. A similar project was conducted in Kasese Region (Western Uganda) providing warnings and advice to farmers in relation with climate and weather hazards.

In addition, the Ethiopian National

Meteorological Agency (NMAE) conducted a four-year project on training of trainers in cooperation with the Ministry of Agriculture, in order to extend services at the Woreda level.

Finally, **Tufa Dinku (IRI) et al.** reported on enhancements to national climate services to agriculture. IRI, in collaboration with national meteorological agencies and regional climate centers has worked to improve the availability, access and use of climate information at the national level. Data availability is first improved by blending national observations with satellite and other proxies, data access and use is then improved by providing online tools for data visualization and download and training users. This initiative includes five main components:

- Building technical capacity at the national meteorology agency,
- Generating rainfall and temperature time series for every 4 km grid across each country,
- Customizing and installing the IRI data library in national agencies,

Figure 11 - IRI Collaboration with National Meteo Agencies

- Developing an online mapping service providing user-friendly tools for the analysis, visualization, and download of climate information products, and
- Engaging stakeholders on the use of new products and services, training them on available tools, as well as incorporating their feedbacks and requirements into further product development.

This work has so far been implemented in Ethiopia, Madagascar, Tanzania, Rwanda, and the Gambia at national levels, and at the regional level for the CILSS countries. It is expected to be implemented soon in Ghana, Mali and Burkina Faso (see Figure 11 above).

Summary and Take-Away

Long time series of rainfall estimates have recently become available based on satellite data (TAMSAT) or on blending satellite and rain gauge data (CHIRPS). The key message is that multiple data sets should be considered for inferences of long-term rainfall variability and trends – there is no single optimal data set and all users of climate data should take this into consideration.

Other activities include research for a better understanding of the current dynamics of major food production systems; simulations indicate considerable uncertainty surrounding future predictions. At the same time, there are many actions supporting the provision of climate and weather information to smallholder producers, as well as substantial enhancements to the national climate services to agriculture through national agencies.

GEO Session – Towards more Coordinated Contributions to GEO's Global Agriculture Monitoring across Africa

Introduction

Many partners involved in the organization of the Conference are also part of the GEO-GEOGLAM community of practice and the conference was an opportunity for this group to convene in a dedicated session and to share their results and news with the larger audience. The GEO session was divided into three parts: i) setting the scene, ii) contribution from EU-Africa partnerships to research and development, and iii) national level applications and perspectives. The session included examples of remote sensing applications from the GEO community in Africa, focussing on new data, tools, and on capacity building initiatives.

Presentations

1. Setting the Scene

Mr. Michel Deshayes, from the Group on Earth Observation (GEO), introduced the structure and governance system for the GEOGLAM initiative, designed to improve global-level information on agriculture monitoring to assess food supply and prospects.

The presenter also discussed the interactive collaboration with the FAO's agricultural market information system, AMIS (see Figure 12 below).
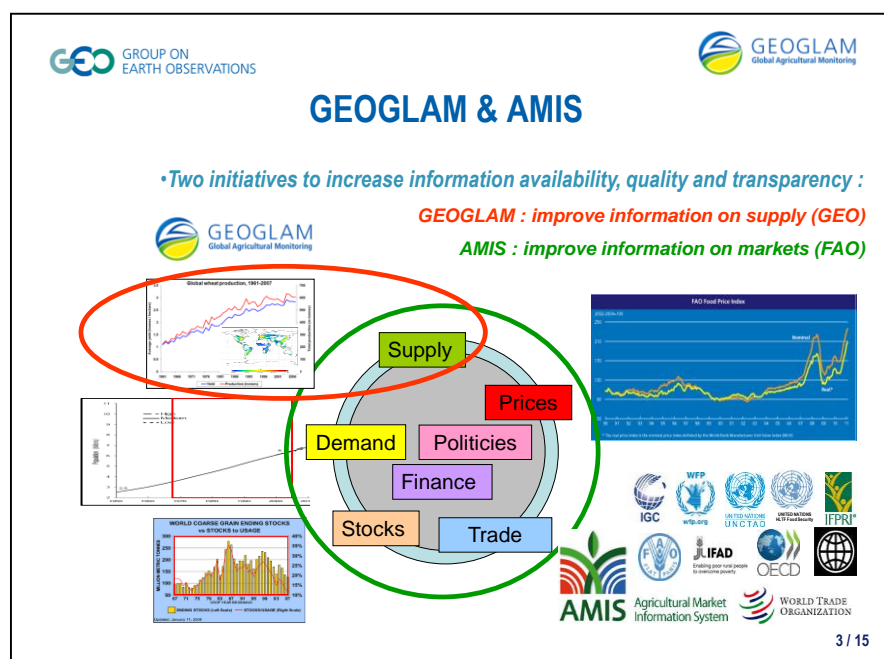
Figure 12 - GEOGLAM and AMIS Initiatives

Addressing challenges for EO-based agricultural monitoring in Africa, the speaker emphasized the need to adapt to regional agro-systems, and gave examples of agroforestry systems in Tanzania, with small fields, mixed crops, variable presence of natural vegetation and cropping systems evolving over time.

Regarding the quality of available cropland maps, this presentation illustrated an approach used in southern Mali, based on the hypothesis that a cropping system can be properly characterized by:

- spectral signature (*linked to level of vegetation biomass*),
- spatial and textural signatures *with landscape components*,
- temporal signature (*seasonal variations*).

Using a combination of field-level statistics and remotely sensed data, the mapping of the cropping system involved a four-step process: i) classification in three crop types by expert analysis, ii) elaboration of a village-level mapping unit, iii) extraction of spectral, textural, spatial and temporal indicators from MODIS images, and modeling village classes with a random forest classifier. This approach allowed for the mapping of three crop production system types with 62% accuracy, the construction of qualitative indices on farmers' practices, the generation of maps usable as inputs for crop modeling and yield forecasting.

Another speaker from the GEO Secretariat, **Mr. Andiswa Mlisa**, summarized the AfriGEOSS, an initiative to implement GEOSS in Africa, a coordinated and comprehensive system of earth observing systems (see illustration). After reminding participants that GEO includes 24 African member states and several participating organizations (e.g. ACMAD, RCMRD, UNECA) the presentation outlined

Figure 13 - AFRIGEOSS Initiative

AfriGEOSS' mission statement: "to enhance Africa's capacity for producing, managing and using earth observations data and information, by developing a continental coordination framework regrouping national, sub-regional and continental stakeholders". To do so, the consortium has assigned itself five main objectives:

- Coordinate and bring together relevant stakeholders, institutions and agencies across Africa,
- Provide a platform for countries to participate in GEO and to contribute to GEOSS,
- Assist in knowledge sharing and global collaborations,
- Identify challenges, gaps and opportunities for African contributions to GEO and GEOSS, and
- Leverage existing capacities and planned assets and resources.

Mr. Mahama Ouedraogo, (AUC) for his part, concluded this introductory segment by presenting the current status of the GMES Africa Program identification study. Africa GMES' purpose is stated as "*Allowing Africa to make full use of the potential of space systems for sustainable development and reinforcing Africa's capacity and ownership in using and contributing to remote sensing science".* In addition to the African Union Commission, main actors in Africa include AfriGEOSS members, regional organizations, the African Development Bank, etc.

Main cross-cutting areas between GMES and its Africa component are:

- Financial - the new program is expected to be financially supported by the Pan African Programme,
- Infrastructural - acquisition of satellite information from African national space missions and from Sentinel data,
- Capacity building - identify cross-cutting needs for capacity building,
- Governance – Overall implementation scheme of the programme.

The main objectives of the identification study include:

- Analyze and assess the current sector context in Africa and Europe (i.e. COPERNICUS),
- Ensure continuity with MESA,
- Assess the options to incorporate North-African countries in the future project,
- Organize two consultative meetings with the stakeholders of the programme, in cooperation with the Technical Assistance Team of the JAES.

2. Contributions from EU-Africa Partnerships to R&D Projects

Sven Gilliams (VITO) introduced this topic with a presentation on the Stimulating Innovation for Global Monitoring and Agriculture initiative (SIGMA), which regroups 22 partners in 17 countries throughout the world. SIGMA's goal is to "improve remote sensing based methods and indicators to monitor and assess progress towards sustainable agriculture". It started as a result of the very strong positive response to the question of whether there would be an interest in 100 m resolution frequent imagery.

This is to be done through:

- An inventory of crop land distribution and its changes over time,
- A characterization of changes in agricultural production levels,
- An assessment of the environmental impact of agriculture over time.

Main areas of focus include: land cover and cropland assessment, agricultural productivity, environmental impact assessment of land use change, and capacity building.

The next presentation, by **Mr. Tomaso Ceccarelli (Alterra),** reported on activities carried out in the EU-FP7 project AGRICAB (see Figure 14). Main concepts underlying the project are: stimulating the uptake of EO techniques, developing predictive models and use cases, and a sustained provision of EO data and tools. The speaker focused mainly on agro-meteorological modelling, carried out in Senegal, Kenya, and Mozambique, the rationale being
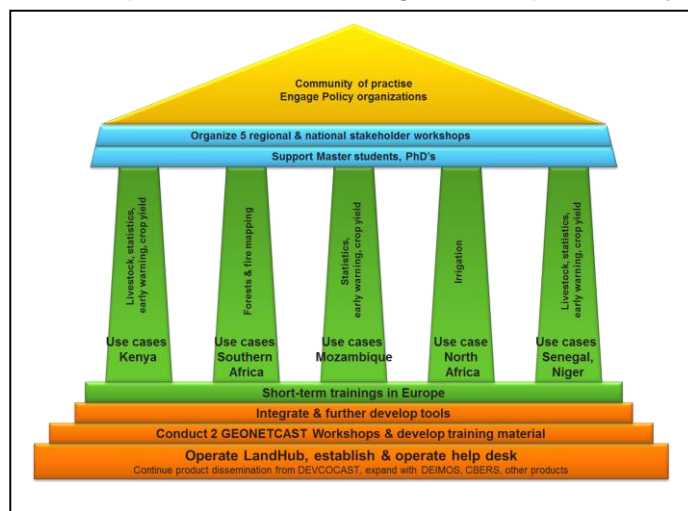
Figure 14 - EU-FP7 AGRICAB Project

that current Early Warning systems for rainfed agriculture mainly use global data on weather, EO-based vegetation indices such as NDVI, and simple water balances. On the other hand,

crop simulation models like WOFOST, by analyzing the very processes behind crop growth can:

- Help evaluate the integrated effect of weather, soil, crop management
- Deliver useful indicators for monitoring (crop specific, direct response, indication of phenological stages),
- Provide advanced indicators for statistical crop yield forecasting,
- Allow for studies on land and water management scenarios, adaptation to climate change, yield gaps, etc.

This approach was implemented as operational services in the three countries mentioned above, strengthening capacity in ministries of Agriculture and other relevant organizations, and creating a 'Community of Practice' in the relevant domains.

3. National-Level Applications and Perspectives

This last part of the GEO session covered applications and prospects in Senegal, three countries of North Africa, Mozambique and South Africa. In addition, the STARS initiative operates in Tanzania, Uganda, Mali, Nigeria and Bangladesh.

Speaking on the integration of early warning products in the decision-making in Senegal, **Mr. Bamba DIOP (CSE)** presented work done by the *Centre de Suivi Ecologique* (CSE) and other national actors to improve the use and dissemination of satellite data through the various monitoring agro-pastoral bulletins. With the African Risk Capacity initiative of the African Union for agricultural insurance, CSE could demonstrate, through a multi-year comparison of Vegetation Condition Index (VCI) and the Water Requirements Satisfaction Index (WRSI) used by the ARC (Africa Risk Capacity) project, that the various satellite data were consistent even if from different sources. Field surveys confirmed that satellite data are a good tool for monitoring, decision making and planning, such as nation-wide drought insurance and crisis management.

Speaking on the issue of using remote sensing to support information needs in irrigation agriculture in North Africa, **Mr. Mustapha Mimouni (OSS)** presented work done at the 22-nation *Observatoire du Sahara-Sahel* (OSS), described activities undertaken under the AGRICAB project. These include water withdrawal estimation using remote sensing techniques, land use / land Cover mapping (SPOT Vegetation), GEONETCast (combining EUMETCast Europe and CMACast China) and capacity building (regional workshops).

Figure 15 - Rates of Water Withdrawal and Recharge (OSS)

One of the main issues highlighted was the sharp expansion of irrigated agriculture in three north African countries (Algeria, Tunisia, Libya), leading to a significant excess of water withdrawal over the rate of annual recharge for the North Western Sahara Aquifer System (NWSAS) region

since 1985 (see Figure 15).

The next presentation, on the contribution of the AGRICAB project in Mozambique, by **Mr. Hiten Jantilal (Ministry of Agriculture)**, started with a diagnostic of agriculture in the country (most of the population rural, involved in agriculture with low productivity) and highlighted some trends in crop choices (more drought tolerant millet and sorghum being replaced by maize, especially in low rainfall areas, resulting in increased risk exposure).

This is particularly worrisome since drought is the major risk to the agriculture sector, followed by --more geographically concentrated-- floods (see Figure 16 below). The presentation concluded with recommendations to strengthen Mozambique's agriculture monitoring and early warning systems (e.g. capacity building, more detailed drought monitoring and management, etc.).
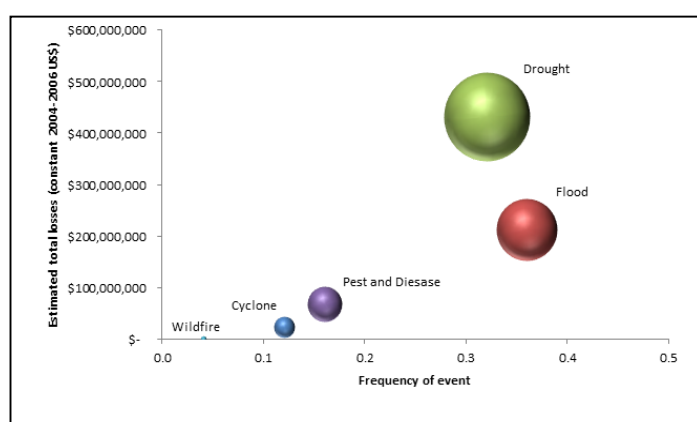
Figure 16 - Relative Ranking of Risks to the Agriculture Sector, Mozambique

Turning to the issue of an increasingly integrated monitoring of agricultural production in South Africa, **Mr. George Chirima** reported on the work of a local consortium charged with such large-scale monitoring. The derived geo-information is integrated into a Geographical Information System, combined with data from aerial and telephone surveys, and data on grain deliveries to silos. The techniques provide data, statistics and information to markets and government, which can guide policies and investments. Earth Observation is also used to reveal problematic areas and develop specific hot-spot maps to help farmers and government plan mitigating actions.

Finally, **Mr. Jan Dempewolf (U. of Maryland)**, presented Spurring a Transformation for Agriculture through Remote Sensing (STARS), an initiative designed to monitor and raise the productivity of crop-based smallholder production systems in sub-Saharan Africa and South Asia. STARS aims to test the hypothesis that one can monitor crop growth at the scale of the farm management unit using remote sensing technologies in combination with other data sources.

STARS has the following four main objectives:

1) identify smallholder farm production constraints that can be better addressed using remote sensing and evaluate corresponding remote sensing technologies,
2) compile a repository of multi-temporal and multi-spectral remote sensing data and processing algorithms together with co-located ground data of crop condition and cropping system information,
3) determine existing and required institutional and human capacity to take advantage of remote sensing technologies to benefit smallholder farmers and local, private agro-businesses,
4) investigate to what extent one can identify cropland, cropping system types, monitor crop production systems and optimize surface water irrigation using remote sensing.

Figure 17 - STARS Regional Experiments
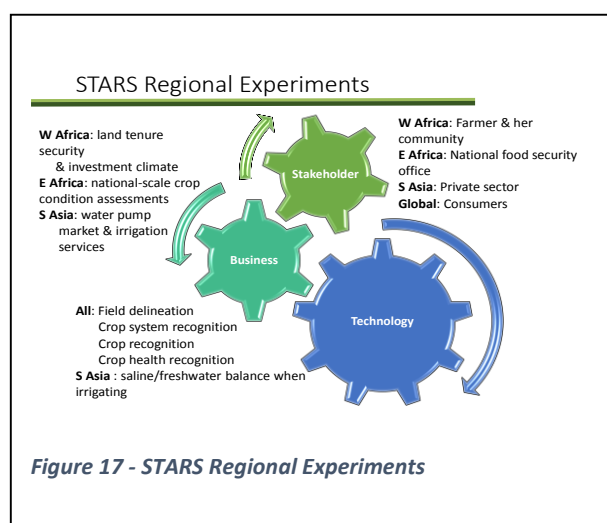
There are three regional experimental use case studies in East Africa (Tanzania and Uganda), West Africa (Mali and Nigeria) and South Asia (Bangladesh). A technical and institutional landscaping study of remote sensing investment opportunities will also identify where remote sensing is most likely to transform agricultural development.

Summary and Take-Away

This rich GEO session underlined the fact that the fast growing number of EO platforms, sensors, methods and techniques creates a slightly overwhelming variety of initiatives. At the same time, there are increasingly successful efforts to coordinate and integrate these initiatives, and to turn them into practical, development-oriented applications. Integration is never easy, but this session showed that it now takes place across space and aid agencies, centers of teaching and research, African organizations and national institutions.

The growing sum of scientific evidence from earth observation not only makes it easier to make better, evidence-based decisions; it also makes it politically much harder to ignore such evidence in the pursuit of less socially desirable choices.

Session 6 – Linking information to Decision-Making: Risk Management

Introduction

This session provided conference participants with a broad sample of risk management approaches falling into two main categories: risk management through contributions to Early Warning/Early Response systems, and risk transfer through weather-indexed insurance schemes.

Contributions to Early Warning and Response systems ranged from automatic remotely sensed indicators to drought risk profiling, from rainfall products for risk assessment to access to information and included the use of price signals to mitigate crises. Presentations dealing with risk transfer addressed the benefits of quick disbursement mechanisms, assessments of weather indexed macro- and micro-insurance programs for agriculture and livestock.

Presentations

1. Contributions to Early Warning and Response

This first category included 6 presentations. Dealing first with the fundamental issue of basic rainfall data, **Dr. Elena Tarnavsky (TAMSAT)** commented on recent efforts to provide agricultural weather index based insurance), and the need for information on continent-wide historical rainfall occurrence available in near-real time, with information on uncertainty and skill scores. To do so, TAMSAT extended their coverage to the entire continent, providing an internally consistent dataset spanning 30+ years. Data are disseminated to users in near-real time through their website and EUMETSAT's data broadcasting service.

TAMSAT also works with data users and decision-makers through capacity development and training activities to develop tailored applications, including weather-related risk assessment.

The potential usefulness of remotely sensed data for weather-indexed insurance was also discussed by **Mr. Sven Gilliams (VITO**), who reported on a pilot study carried out in 2013 in Senegal to assess the usefulness of seven remote sensing services (from EARS, FEWSNet, GeoVille, IRI, ITC, Sarmap, and VITO) to weather-indexed insurance. The different techniques being tested ranged from vegetation indices, to remote sensing-based estimations of rainfall, soil moisture, and evapotranspiration. First results are still mixed; for one thing, 2013 was a good year in Senegal, and the various sampling areas showed that the reliability of the various methodologies are crop and area-dependent[1].

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[1] Editor's note: In 2014 Senegal subscribed to the African Risk Capacity nationwide insurance program for drought and, after a poor season, received a $16.5 million indemnity payment in early 2015.

Messrs. **Gregory Husak** and **Hari Jayanthi**, both affiliated with (**FEWSNet**) dealt with *ex-ante* risk mitigation (Figure 18).

The former presented a Decision Support Interface (DSI) designed to help non-specialists better appreciate a set of analytical tools based on a combination of rainfall and vegetation-related products and classified drought monitoring tools. This web-based application gives users without advanced skills in statistics a chance to assess dry conditions and compare them to previous seasons. The DSI will next include evapotranspiration data and the Water Requirement Satisfaction Index (WRSI) values in the assessment of crop conditions over Africa.
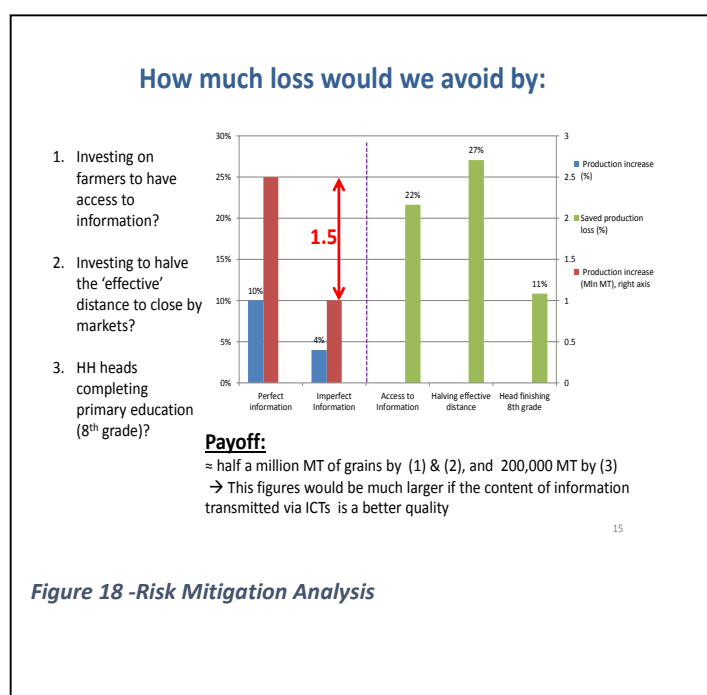
Figure 18 -Risk Mitigation Analysis

The second speaker introduced a pilot study of evidence based drought risk profiling for Kenya, Malawi and Niger. Based on a combined use of historical crop and yield data, water requirement satisfaction indices and other indicators, the authors generated drought vulnerability functions for maize in Kenya and Malawi, and millet in Niger. This agricultural risk profile highlights the likely crop losses for a set of hazards ranging in probable severity –with respect to past experience-- from 1/100 to 1/5. Risk profiles can be useful in assessing the appropriateness of various risk management instruments, ranging from planning, prevention and mitigation, to risk transfer through insurance, or residual action at the national level when crises are mild (see Figure 19).
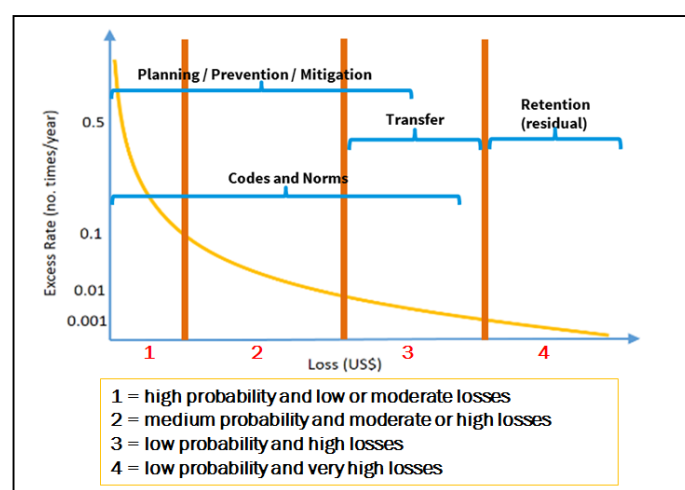
Figure 19 - Risk Profiling and Risk Management Options

With respect to *ex-ante* risk mitigation, **Mr. Mekbib Haile (Bonn University)**, presented the results of a study on access to information and price expectation by smallholder farmers in Ethiopia. This work suggest that farmers who invest more in acquiring better price information and who reside closer to grain markets are more likely to have smaller price forecasting errors. The risk-management value of this information, however, decreases as distance to grain markets rises, emphasizing again the need to provide both market information and good infrastructure. The study estimated the potential economic gains of improving both access to information and transport infrastructure.

Following up on this discussion of market information systems, Ms. **C. Araujo-Bonjean (University of Clermont-Ferrand)** presented a study on the use of Market Information Systems for food policy design with reference to millet in Burkina Faso, Mali, and Niger. Millet is a regionally traded good whose price is determined by local conditions of supply and demand, with a strong seasonal pattern. Leading markets are markets whose current prices help to predict future prices in distant markets; this is the case in Maradi, for instance. Warning indicators are, therefore, based on the spread between the current price at lead markets and its trend value. The study findings further support the idea of a regional approach to food insecurity based on a regional early warning system.

Finally, at the juncture between early warning and risk transfer, Mr. **Luigi Luminari (NDMA),** presented a drought phase classification system used in Kenya for the quick disbursement of drought contingency funds; this reduces considerably losses of assets by households during drought crises and contributes to their resilience.

The disbursement of these funds is based on a model identifying five drought-warning stages, these stages being triggered by a set of indicators including both biophysical indicators derived from remote sensing like the VCI for measuring the severity of drought and socio-economic indicators showing its expected impact. This methodology contributes to transparency and accountability in the use of contingency funds, and discourages politically motivated false alarms.

2. Risk Transfer through Insurance Schemes

This part of Session 6 included four presentations addressing directly the issue of weather-indexed insurance; two case studies and two assessments.

The first case study, by **Mr. Andrew Mude (ILRI)**, presented evidence and insights from index-based livestock insurance (IBLI) programs in northern Kenya and southern Ethiopia. To evaluate the impact of the insurance scheme, ILRI carried out a baseline survey of over 900 Marsabit households in October 2009 which was then repeated annually to track the dynamics and drivers of change. A similar survey was launched in Borana, Ethiopia, in March 2012 covering 515 households. Annual repeat surveys produced data regarding IBLI impacts on a range of key livelihood indicators. According to these survey results, IBLI was shown to have positive impacts ranging from improved livestock productivity and income, to enhanced livelihood resilience and better nutrition (see below).

> - **36% reduction in likelihood of distress livestock sales**, especially (64%) among modestly better-off HHs (>8.4 TLU)
> - **25% reduction in likelihood of reducing meals** as a coping strategy, especially (43%) among those with small or no herds
> - **Increases investments in maintaining livestock** through vet expenditures
> - Increases total and per animal income from milk, positive effect on subjective well-being, even after premium payment and w/o any indemnity payment.
>
> IBLI appears to provide a flexible safety net, reducing reliance on the most adverse behaviors undertaken by different groups, improves economic outcomes as well as overall life satisfaction.

The second case study, by **Mr. Federico Doehnert, (ARC),** presented the African Risk Capacity, an extreme weather insurance mechanism designed to help African Union Member States resist and recover from severe drought and other natural hazards. ARC is an African approach to transferring the burden of climate risk away from governments – and the farmers and pastoralists whom they protect. This AU-led financial entity uses *Africa RiskView*, a satellite-based weather surveillance software to estimate and trigger indemnity payments to countries hit by severe drought. The *Africa RiskView* system combines four well-established disciplines: crop monitoring and early warning, vulnerability assessment and mapping, operational response, and financial planning and risk management. It allows participating countries to monitor the cropping season in near real-time, and to estimate the potential impact of a drought on vulnerable populations. Indemnity payments are made within 2-4 weeks of the end of the rainfall season, thereby allowing participating countries to begin early intervention programs before vulnerable populations have to take negative coping measures.

Four countries formed the 2014 ARC Risk Pool (Kenya, which is insuring two seasons, Mauritania, Niger and Senegal). Due to the poor performance of the 2014 rainy season in West Africa, Mauritania, Niger and Senegal have received in January 2015 payouts totaling more than US$ 25 million, ahead of the 2015 humanitarian appeal for the Sahel.

The following two presentations, by **Mssrs. Agrotosh Mookerjee (Microensure)** and **Alexandros Sarris (University of Athens)** presented assessments of experience to date in weather-indexed insurance for smallholders in Africa.

Both presenters agreed that weather-indexed insurance (WII) is much less expensive than conventional insurance, but that basis risk –in spite of significant advances in earth observation-- and the relative cost of premiums compared to expected (and discounted) benefits remains very high. They also emphasized that uptake is much easier when insurance is combined with access to credit and inputs, which makes potential demand very much a function of the current level of intensification in farm enterprises. For this reason, most WII programs remain subsidized, and both presenters concluded that they should be considered part of a broader risk management strategy, rather than as a single tactic. One of the conclusions from Dr. Sarris' work was in fact that "the greatest payoff in future WII work is in designing flexible finance-cum-insurance packages to allow transfers to households in times of income shocks, by combining WII with savings".

Main findings and recommendations from these two presentations emphasized the need to:

- Continue innovation and research in satellite- and ground-based index validation,
- Organize weather information and insurance education campaigns,
- Consider macro-level disaster management programs (e.g. ARC),
- Promote links with weather forecasts, extension services and improved access to inputs.

Overall, the main conclusions from this Session on risk management systems can be summarized as follows:

- Weather-indexed insurance (WII) as an option should generally be assessed as part of an overall risk management strategic portfolio. WII insurance schemes require a dense web of ground rainfall stations and very few areas in Africa meet such requirements. In addition, results from the recent study on weather-indexed risk

management in Senegal are inconclusive: much depends on local conditions and the exact assessment of the basis risk remains challenging;

- The size of the pool for most weather-indexed insurance pilots – whether for crops, livestock or inputs - is too small to make them financially sustainable (especially when dealing with smallholders rather than large, commercial agriculture). Most current programs receive substantial public or donor subsidies to compensate for low uptake by smallholders (high relative cost);
- Remotely sensed data are playing an increasing role in both weather indexed insurances (IBLI and Microensure examples) and in national level risk management systems such as the one presented by NDMA (National Drought Management Authority) in Kenya and the ARC (African Risk Capacity);
- The best approach to agricultural risk management is a holistic one; all mechanisms, including WII, should be assessed and combined most efficiently, and be based on a better knowledge and use of community-based risk management strategies.

Session 7 - Linking Information to Decision Making

Introduction

This session was designed to present a number of integrated approaches used to measure food and nutrition security. Various initiatives for resilience measurement were also discussed. The discussion focused on which data are collected and used for food and nutrition security analysis, and on their availability and quality. The session was divided into two parts considered relevant to the link between information and decision making: i) integrated analysis methods, and ii) capacity building.

Presentations

1. Integrated Analysis Methods

This first part of the session included six presentations discussing state of the art integrated analysis methods (IPC, *Cadre Harmonisé*, various studies of resilience).

The first two speakers, **Ms. Cindy Holleman**, and **Ms. Maty Ba Diao (CILSS)** presented two integrated analysis methods that have converged to a large extent, the Integrated Phase Classification (IPC), and the *Cadre Harmonisé*. The IPC is a multi-partner initiative to inform food security policy and programming; it consists of standardized protocols for classifying both acute and chronic food insecurity, thus improving the rigor, transparency, and comparability of food security analyses for decision makers. An IPC analysis provides key information on: the severity of the situation (How bad), most affected areas (Where), the magnitude of the problem (How many), the duration and timeframe (When), the population most in need (Who), and the driving factors (Why).

IPC and the partner initiative *Cadre Harmonisé* (CH), led by CILSS, have the potential to provide continent-wide, comparable food security information for decision making. Both methodologies analyze data from existing national information systems, by applying internationally recognized standards, developed in the African context.

Although the CH analysis started out with nation-wide cereal balances, the identification of vulnerable populations was integrated in the late 1990s on the basis of agro-climatic and socio-economic information collected at village level. This data was then used to calculate vulnerability indices related to biophysical risks and ability to cope. Convergence evolved up to the point that in 2012, the CH integrated the IPC analytical framework (see illustration from the *Cadre Harmonisé, Figure 20,* below).

Figure 20 - CILSS Cadre Harmonise Illustration

IPC and the CH have been shown to encourage a broader understanding of food security, particularly among high-level policy makers and government stakeholders. IPC has also had a strong influence on resource allocation in crisis-prone countries, where IPC products are effectively used in regular humanitarian appeal processes, such as Somalia, South Sudan, Democratic Republic of the Congo, and the Central African Republic. Moreover, IPC acute and chronic analyses help governments, UN agencies, NGOs and donors design short- medium- and long-term strategic plans, based on reliable assessment and analysis. In this context, IPC protocols are also useful for monitoring and evaluation of food security programs.

With respect to the *Cadre Harmonisé*, there are plans for additional capacity building at the national level. A wider application of the CH methodology is also anticipated, include an extension to all 17 countries participating in the Regional Food Reserve Project (EU).

Regarding the use of integrated food security analysis by decision makers, **Mr. Tharcisse Nzunkimana (EC/JRC)**, the speaker first emphasized the weak link between situation analysis and response planning/implementation. He went on to suggest the option of providing better estimates of the likelihood that some households will transition from one

food insecurity phase classification to another. This will require further advances in estimates of populations in need (either at risk, or already vulnerable), accurate targeting and better communication of findings to potential beneficiaries.

The next three presentations addressed various aspects of resilience to weather-related and other shocks. As an introduction, we draw on the presentation by Luca Russo (below) to re-state some basic definitions: first, Vulnerability is a function of a household's risk exposure and its resilience to such risks. Secondly, Resilience itself can be defined as the capacity to bounce back after a shock, the capacity to adapt to a changing environment, or as the transformative capacity of an enabling institutional environment. Resilience analysis should therefore be seen as a complement, not an alternative, to vulnerability analysis.

Mr. **Luca Russo (FAO**), introduced the Resilience Index Measurement and Analysis (RIMA) model which uses the household as unit of analysis and through a two-stage factorial analysis identifies resilience dimensions and related contributing factors. The speaker then outlined case studies from Niger, Kenya, Somalia, and Burkina Faso, illustrating different use of the RIMA model for decision making: targeting, Program and policy and investment design, and impact assessment (see illustration on the Kenya study below, showing the main vulnerability factor and most likely successful interventions). He also illustrated an example of a mixed-method approach employed in Somalia, by FAO, UNICEF and WFP, where RIMA has been integrated with more qualitative approaches.

Kenya – 2006: Policy implications

Most vulnerable: rural poor who depend on agriculture and livestock – limited Access to Basic Services

Pastoralists

- Distance to work
- Access to credit

Agropastoralists and smallholder farmers

- Distance to water sources

Livestock interventions

- Destocking
- Supplementary feedings
- Transport subsidies to support destocking
- Restocking

Water access interventions

- Creating/rehabilitating wells and boreholes
- Establishing strategic water reserves
- Subsidized provision of fuels and pumps

Mr. Nigussie Tefera (JRC), followed up the discussion of household resilience by presenting empirical evidence from rural households in Ethiopia. He first emphasized that resilience is a multidimensional concept consisting of three interconnected capacities: absorptive, adaptive and transformative capacities.

This study, using 2004 Ethiopia Rural Households Survey data, showed that resilience (a latent variable) significantly influences the absorptive and transformative capacities of households (latent variables by themselves). Further analysis revealed that the absorptive capacity of households positively and significantly influenced household per capita income (crop, livestock, on-farm and off- farm wage income), total livestock owned, cultivated land,

and involvement in social networks, as well as borrowing and lending among community members. Finally, transformative capacity was found to be positively and significantly linked to the use of inputs such as fertilizer, irrigation and access to basic information or extension services.

To carry this work further, the speaker concluded that:

- Model specification must be improved, and it may be adapted for panel data analysis,
- Additional and more recent datasets are needed, for ex-post analysis of resilience interventions and to disaggregate the analysis (by gender, for instance).

To conclude the series of presentations on resilience, **Dr. Mark Constas (Cornell University)**, discussed information architecture with respect to Indicators for resilience analysis. Information architecture is a foundation discipline describing the theory, principles, guidelines, standards conventions and factors for managing information as a resource. Its purpose is to provide guidance for using existing data sets, identity opportunities and gaps, and help establish a minimum core data set for resilience. The presentation used illustrations from the Horn of Africa, raising such questions as: What data are collected or selected to model resilience? What characteristics of data are associated with resilience? What information is needed to inform investment decisions for ending drought emergencies investment framework?

2. Capacity Building

This second part of Session 7 included five presentations and was chaired by **Mr. Adama Ekberg (UNECA)**.

The first speaker introduced to Conference participants the Global Strategy for Improving Agricultural and Rural Statistics, an initiative of the United Nations Statistical Commission, in partnership between International Agencies, developed and developing countries. **Mr. Joseph Ilboudo (UNECA)**, added that the strategy has three components, one of which is Training in Agricultural Statistics, entrusted to UNECA.

This training component will help strengthen statistical training centers in Africa with infrastructure support by supplying state of the art technological aids and software. At the same time, the component also provides technical support for agricultural statistics agencies in the continent to identify and prioritize their training needs as well as efficiently manage their agricultural statistics human capital. The component does this by enhancing the capacity of human resource managers in these agencies through tailored frameworks and policy guidelines for agricultural statistics human capital development.

On the supply side, this Global Strategy component will focus on expanding the availability of training in agricultural statistics through the development and adoption of research outputs and strategies into training curriculum, modules and syllabi, developing training courses in new adopted methods in agricultural statistics. On the demand side, the component will implement short and long term scholarship programs for those experts working in agricultural statistics agencies to study towards postgraduate diploma and masters in Agricultural statistics.

The following two presentations, by **FEWSNet**'s **Tamuka Magadzire** and **Gideon Galu**, discussed an analytical software tool used for gridding and analyzing precipitation and temperature data through the calculation of statistical parameters such as median,

coefficient of variation, and percentiles, for both rainfall and temperature (see illustration below). The GeoCLIM software also facilitates the calculation of climate trends over long periods of time, usually 30 years or more. The software also supports the use of a variety of gridded rainfall and temperature datasets, one of which is the Climate Hazards Group Infrared Precipitation with Stations (CHIRPS) dataset (discussed in an earlier presentation), a freely available, quasi-global, 30+ year pentadal rainfall dataset that incorporates satellite imagery with in-situ rain gauge data. In the absence of nationally maintained, higher density rain gauge station data, CHIRPS allows users to work with the GeoCLIM to analyze historical climate trends.

For example, using the CHIRPS data, GeoCLIM analysis suggests that December to March seasonal rainfall totals have increased on average between 1981-82 and 2012-13 in central parts of the southern Africa region, and decreased in the northern parts of the region. Where locally maintained in-situ station data are available, the GeoCLIM provides a module to blend the station data with background gridded datasets such as CHIRPS

Figure 21 - GEOCLIM Analysis of Selected Variables

and other gridded climate data, thereby helping to fill in observational gaps in often-sparse in-situ data networks. Extraction of polygon-aggregated statistics facilitates building of time series for inter- and intra-seasonal analysis, and scripting utilities enable the automation of repetitive analytical processes. A comprehensive set of training resources are also available for GeoCLIM, including a detailed manual, video tutorials, and training files. Future plans include improved inter-operability with related capacity building and development initiatives.

The next presentation, by **Mr. Felix Rembold (JRC)**, showed two examples of training materials produced over the years by the JRC FOODSEC group, which summarizes the monitoring of agricultural production in food insecure areas via crop monitoring bulletins.

First, an E-learning module jointly produced with FAO (Remotely sensed information for crop monitoring and food security), which has two main target audiences:

- Food security analysts with different who are commonly confronted with spatial data including remote sensing derived information when it comes to the analysis of early warning products and crop monitoring bulletins in food insecure countries;
- Crop monitoring experts who want to deepen their understanding of remote sensing products in a food security context.

Secondly, a free Software for Processing and Interpreting Remote Sensing Image Time Series (SPIRITS). This is a stand-alone toolbox developed for environmental monitoring, particularly to produce clear and evidence-based information for crop production analysts

and decision makers. It includes a number of tools to extract vegetation indicators from image time series, estimate the potential impact of anomalies on crop production, and share this information with various audiences. SPIRITS offers an integrated and flexible analysis environment with a user-friendly graphical interface. It allows for sequential tasking and a high level of automation of processing chains; extensively documented, it is distributed freely for non-commercial use.

Information on both products can be found at:

http://www.fao.org/elearning/#/elc/en/course/FRS and at   *http://spirits.jrc.ec.europa.eu/*

Concluding the capacity building part of Session 7, **Messrs. Jakobs and Gilliams (VITO)**, presented the AGRICAB project, a framework for enhancing earth observation capacity for agriculture and forest management in Africa. The project involves 17 partners located in 12 different countries: 6 in Europe, 10 in Africa and one in South America.

The project is focused on the development of national-level cases of use related to monitoring and management of agriculture (crop yield forecasting, crop mapping, statistics, early warning), livestock and rangeland and forest and fire, covering study areas in Kenya, Mozambique, Senegal, South Africa, Tunisia and Niger. Its capacity building component includes:

- Reliable data retrieval through, among others, GEONETCast satellite broadcast and online sources,
- Improvements to the data exchanges between free software tools,
- Training and enhancing freely shared training materials, and
- Networking and awareness raising, the latter being open to international partners, such as UN bodies, Africa's continental (AUC) and economic regions, and the global GEO initiative, in collaboration with AfriGEOSS.

Summary and Take-Away

Main conclusions from Session 7 may be summarized as follows. Integrated analysis tools have become more sophisticated, and convergence has taken place in some important cases. Recent years have also seen significant advances in the analysis of resilience, which is now assessed through a greater variety of practical tools. All this work, however, cannot benefit African countries in the long-run unless national institutions and local experts build up their capacity to use such tools. A wide range of new agro-climatological data and tools (CHIRPS, GeoClim, SPIRITS…) is available including capacity building (sometimes covering several tools and datasets as in the FP7 project AGRICAB); capacity building is still needed not only for technicians but also for decision makers. Both data and tools are still produced and distributed independently by different international organizations. Some questions remain whether and how specifically the proposed tools reflect the real needs of African countries, and whether there is enough coordination in their conception, production and in related capacity building activities.

Session 8 - Strategic Recommendations, Priority Ranking by Conference Participants

Following the two and-a-half days of technical presentations and discussions, it was important to provide participants with an opportunity to express their views on strategic

priorities with respect to the overall objective of promoting continent-wide production, exchange and efficient use of evidence to inform the transformation of African agriculture. Conference participants were therefore divided into three working groups, each being given the task to identify main constraints, opportunities and promising strategies for their respective specific objective areas. Working groups identified, drafted and presented in the subsequent plenary session 16 strategies to improve information systems supporting the transformation of African agriculture. Due to time limitations, working group 2 elected to focus on the risk management part of specific objective 2 ("Assess current information, statistics and risk management initiatives".

The exercise results should be interpreted as a brainstorming on strategies for improving information systems in Africa, and identified strategies obviously do not cover all aspects of agriculture and food security information. Nevertheless, considering the high level of expertise of conference participants, the multiple nature of their backgrounds and experiences, and the amount and quality of the information exchanged during the preceding three days, these 16 strategies are an important statement of expert opinions on improving information for Africa's agricultural transformation. The table below shows the 16 identified strategies by specific objective.

1: Review (inventory) approaches, methods, technologies and sources of data	2: Assess (Evaluate) current information, statistics and risk management initiatives	3: Facilitate Integration between information systems, review capacity building activities
1. Common field data validation protocols/metrics	2. Make community based risk assessment linked to technological risk assessment conducted externally	3. CAADP result framework should be the entry point for all information systems and capacity development. The REC should perform the same function at the regional level. Clear entry points are also needed at the country level including clear accountability, political will and ownership (Gate Keeper Concept).
4. Reinforce infrastructure and finance collection of good quality data, continuity	5. Understand local risk management strategies before external management strategies are developed	6. All work should be demand driven supported by appropriate capacity needs assessments.
7. Creation of interagency database(s) with property rights management, to have global view and identify gaps	8. Use multiple information sources when designing risk management strategies (linking local information with external data)	9. Information systems should be grouped into few relevant cluster and clear lead institution for methodologies, standards and harmonization.
10. Establish inventory or catalogue of field data collection activities	11. Building capacity for improved risk management among decision makers	12. International agencies to support this work but clear demand should come from countries
13. Promote use of mobile phones for field data collection		14. No parallel systems should be developed. They should be anchored in current institutions to ensure sustainability and ownership. Capacity development should not be ad-hoc but responsive to clear assessed needs and what should be done and in which time frame.
15. Capacity building in data collection and processing		16. Create synergies including private sector

In order to understand the participant's perception of relative importance among these 16 strategies, a final decision-grid exercise was held in plenary session, whereby each person ranked each of the 16 proposed strategies according to four key criteria: relative level of priority, cost-effectiveness, scalability, and ease of implementation.

The overall sums of scores for priority, cost-effectiveness, scalability and ease of implementation are represented by the colored vertical segments in the figure below.

Based on these criteria, the most promising strategies were found to be:

Objective 1 - Review (inventory) approaches, methods, technologies and sources of data

- Developing and using common field data validation protocols and metrics
- Continuing to reinforce infrastructure and support sustainable collection of quality data
- Promoting the use of mobile telephones for data collection
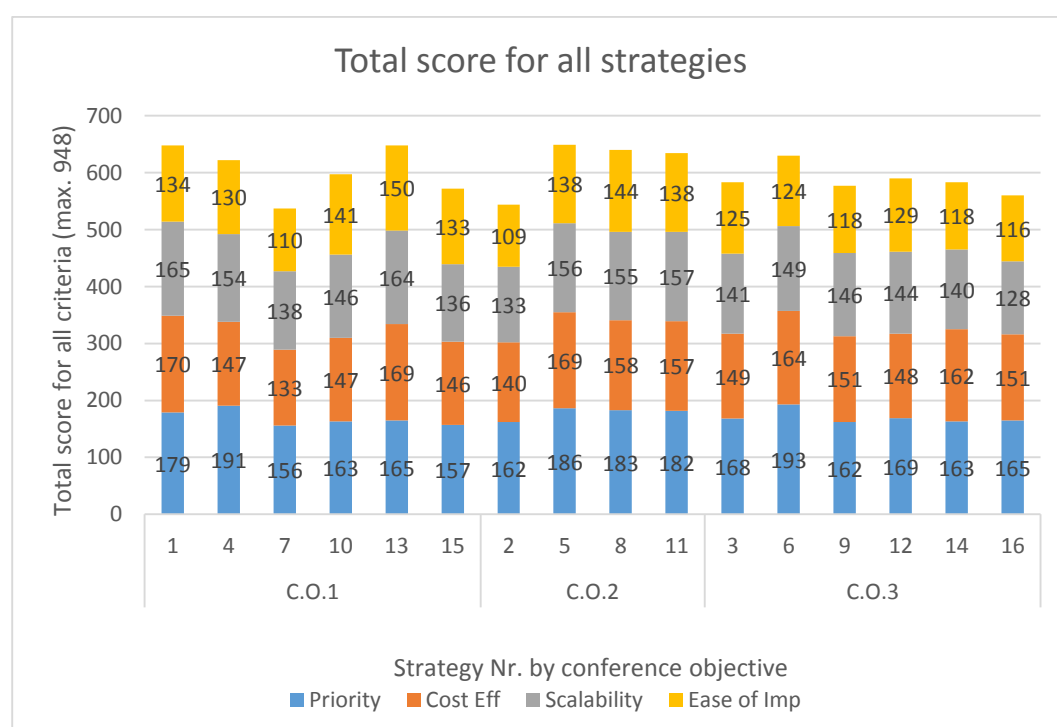
Figure 22 - Relative Scores of Recommended Strategies, by Criteria

Objective 2 - Assess (Evaluate) current information, statistics and risk management initiatives:

- Using local experience, knowledge and multiple information sources when designing risk management strategies
- Raising the capacity of decision makers to carryout risk management

Objective 3 - Facilitate Integration between information systems, review capacity building activities:

- Making sure that all work for information systems is demand-driven and follows capacity needs assessment.

Session 9 - From Strategies to Strategic Action Areas

To help review and assess the complex set of sixteen strategies ranked with respect to four distinct (and equally weighed) criteria, strategies identified by conference participants have been further organized into four strategic action areas (strategy numbers 1-16 are in brackets):

(a) Regarding **key general principles**:

- All new or expanded systems should be anchored in existing institutions to ensure sustainability and ownership (14), and be supported by adequate capacity needs assessments (6);
- There is a need for support from international agencies, but a clear demand must come from countries (12) to avoid the development of parallel systems (14);
- African institutions and development partners should use the CAADP result framework as the entry point for all information systems and capacity development.
- The REC should perform the same function at the regional and national levels, including clear accountability, political will and ownership (Gatekeeper Concept) (3);
- Capacity development should focus on data collection and processing (15).

(b) Regarding priorities in the **development of new approaches to data collection**:

- Continue to reinforce infrastructure and support sustainable collection of good quality data (4);
- Develop and use common field data validation protocols/metrics (1);
- Promote the use of mobile phones for field data collection (13);
- Establish an inventory/catalogue of field data collection activities (10).

(c) Regarding proposed strategies in **risk management**:

- Use local experience and knowledge (5) in multiple information sources when designing risk management strategies (8);
- Raise the capacity of decision makers to carry out risk management (11); and
- Link community based risk assessments and external risk assessments or strategies (2, and related to 5 and 8 above).

(d) Finally, to promote a **greater integration between information systems**:

- Develop synergies in data collection, processing and analysis, between institutions and with the private sector (16);
- Group information systems into a few thematic clusters, with a clear lead institution for methodologies, standards and harmonization (9);
- Create interagency database(s) with property rights management, to have a global view, identify gaps (7).

Conference follow-up

It was generally felt that the IMAAFS Conference was successful in bringing together a larger number of representatives of the technical community generating information related to agriculture and food security in Africa and a large number of users in the decision and policy

making domains. Information producers gained a better understanding of user needs, while the latter group was exposed to a multitude of available data sources and methods.

Main steps undertaken or planned as a follow-up to this Conference include:

- A conference main findings and conclusions report which was shared with all partners and hosts of the Conference by the end of October 2014. This report includes a detailed analysis of the results of the strategic prioritization exercise.

- More detailed proceedings, including abstracts and presentations (in digital version), to be prepared in early 2015.

- Various follow-up events to be discussed with relevant partners and hosts. Among these the most relevant for the time being is the Food Security Information Network Technical Consultation which will be hosted by the African Union in Addis Ababa from 2 to 6 November 2015. The event is entitled: "Food and Nutrition Security and Resilience Analysis- Are We Effectively Using the Right Data?"

International Conference for Meeting Africa's Agricultural Transformation and Food Security Goals (IMAAFS)

Abstracts of Presentations

1-3 October 2014

UNCC Conference Center, Addis Ababa, Ethiopia

Session 1 – Food Security and Agriculture Challenges in Africa, Need for Evidence-Based Information

An Overview of the Food Security and Agriculture Challenges in Africa

Demeke, Mulat - FAO, mulat.demeke@fao.org

Keywords: *Africa, agriculture, food security, challenges, constraints, information*

The food security situation in Sub-Saharan Africa has improved in recent years; the proportion of malnourished people having declined from 32.7% in 1990-92 to 24.8% in 2011-13. A marked improvement in the performance of the agricultural sector was also observed during the period since 2000, compared to the 1980s and 1990s. However, considerable challenges remain as the number of malnourished people is increasing, and hunger and rural poverty are rampant. High rates of population growth, unsustainable land use, limited input application, natural disasters and climate change have resulted in low levels of agricultural productivity and increasing dependence on unsustainable food imports.

At the root of the constraints to improving agricultural productivity are policy and institutional challenges. Output and input prices are unfavorable for producers mainly because of poor infrastructure, inadequate market institutions, low public investment in agriculture, limited access to financial services, and unpredictable government actions, among others. Lack of stable and remunerative market environment has discouraged investment in agricultural production and associated value chain. Inadequate land-related policy measures and distortive government interventions in support of consumers have further compounded the problem. Because of intuitional weaknesses and policy deficiencies, the region has failed to take advantage of its huge agricultural potentials, including vast amount of uncultivated land untapped water resources.

African countries need to build their institutional capacity and bridge the information and analytical gap as a matter of priority. The extensive market failures and uncertainties need to be addressed to spur investment and unlock the agricultural potential of the region. A major prerequisite in improving the business environment is building the capacity for monitoring and evaluation of the food and agriculture policies and institutions in order to identify gaps and generate evidence-based recommendations. FAO has taken several initiatives, including the Monitoring and Analyzing Food and Agriculture Policies (MAFAP) and the Food and Agriculture Policy Decision Analysis (FAPDA), to help low-income countries develop their monitoring and evaluation capacities.

A Synopsis of the IGAD Drought Disaster Resilience and Sustainability Initiative (IDDRSI)

Elhoweris, Abdel Moneim - Food Security and Nutrition Expert (IGAD), moneim.elhoweris@igad.int

In 2010/2011, the IGAD region was hit by a severe drought that affected more than 13 million people and exacerbated chronic food insecurity to famine levels in several areas. This drought crisis reflected the failure of past practices (Humanitarian Approach), highlighted the importance of focusing on sustainable development and brought to the fore front the urgent need to invest in resilience building as a means to end drought emergencies in the region (Developmental Approach). Hence, a decision to end drought emergences was taken by IGAD and East African Community (EAC) Heads of State and Government at a Summit convened in Nairobi on 9th September 2011, calling for increased commitment by affected countries and Development Partners to support investments in sustainable development especially in the Arid and Semiarid Lands (ASALs). The Nairobi Summit assigned the IGAD Secretariat the role of leading and coordinating the implementation of the decision; and urged all countries to work together as a region and all concerned to do things differently, working concertedly and holistically, combining relief and development interventions, aimed at building resilience to future shocks.

IGAD Drought Disaster Resilience and Sustainability Initiative (IDDRSI) was formed and its strategy prepared being an inclusive and participatory process that involved the staff of the IGAD Secretariat and IGAD specialized institutions as well as public and non-state actors in member states. The Strategy was further informed by consultations with other stakeholders commonly affected by drought or involved in responding to its effects, including CGIAR and UN agencies and development partners. The process of developing the Strategy was guided by the IGAD Strategy 2011 - 2015 and defined, in scope, rationale and justification, by consideration of the region's SWOT and PESTLE analyses. The Strategy defines its vision, mission and overall goal, envisioning a region with communities free from vulnerabilities to drought emergencies. The strategy proposes operational and institutional implementation arrangements and a result based monitoring and evaluation system to track the progress of projects activities in the implementation of the initiative.

The IDDRSI Strategy recognizes the need for a comprehensive and holistic approach to combating chronic food and nutrition insecurity and addresses the deep-seated poverty and environmental degradation to build the resilience of communities and households to the effects of droughts and other shocks in the region. The Strategy identifies 7 priority intervention areas, where the necessary investment and action will help build resilience through reducing the vulnerability of target communities to climatic and economic shocks. These priority intervention areas include ensuring equitable access and sustainable use of natural resources, while improving environmental management; enhancing market access, facilitating trade and availing versatile financial services; providing equitable access to livelihood support and basic social services; improving disaster risk management capabilities and preparedness for effective response; enhancing the generation and use of research, knowledge, technology and innovations in the IGAD region; promoting conflict prevention and resolution and peace building; strengthening coordination mechanisms and institutional arrangements for more organized, collaborative and synergistic action as well as improving partnerships to increase the commitment and support necessary to execute the objectives of the initiative.

The Strategy serves as a common framework for developing national and regional programmes that will be designed to enhance drought resilience through building sustainability in the IGAD region.

The strategy, by design, recognizes that while drought-prone communities face common challenges and are often interconnected through shared natural resources and regional trade and trans-boundary human and animal movements, individual IGAD member states may have their own specificities and areas of emphasis.

Session 2 – Review of Sources and Status of Existing Agriculture and Food Security Statistics, Gaps and Opportunities

The Food Security Concept at Age 40: Where to From Here?

Eilerts, Gary - USAID, geilerts@fews.net

Keywords: *food security concept, causality of food insecurity, human well-being*

Roughly 40 years ago, "food security" was delivered as an academic construct of Amartya Sen. It soon found an applied home in a new field of practice, based in science, which attempts to distinguish the different abilities of nations, communities and individuals to meet their food consumption needs.

Almost everyone in the food security community which grew out of that same period, came to accept Sen's definition. But at 40 years old, how has it grown? What new features does it present? What new unknowns is it confronting? Is it still capable of leading us through the next 40 years? The original food security pillars of availability, access and utilization have stood the test of relevance over time well. They are still considered fundamentally important dimensions of Sen's concept. Since then, the concept of stability has been added in response to realities seen in the field, where the persistence and temporal variability of food security conditions has come to be seen as an additional important pillar of the food security condition.

Nutritional security, focusing upon the individual human impacts of food insecurity has been added by many as an affiliated idea to food security, and new tools and higher resolution data have also pushed the average unit of analysis down from the national level to near community-levels, and even lower. At the same time, longer data series have provided new understandings of trend and variability in the past, and have conversely opened up our ability to predict the most likely future, by projecting forward.

Although perhaps not a new dimension of the food security concept, a more proximate determination of the "causality" of specific food insecurities appears to be emerging as a technically feasible product of the use of new food security tools, and more and better data. How much of the malnutrition problem is actually due to an enteric inflammation, rather than to a shortage of food? Despite climate change, are droughts becoming more frequent in some places, and less so in others? To what degree do food price spikes reflect global, as opposed to local drivers? The empirical basis exists now to test and begin to answer these and other causality questions.

Will the food security concept, as it is currently expressed, remain relevant for another 40 years? It is being challenged by a number of new assessment needs which, interestingly enough, are only quasi-food security threats. Rightly or wrongly, the food security community and its practices are what decision-makers are falling back upon to characterize, monitor, and address new challenges coming from the ebola virus, from a lack of water availability, from climate change and from conflict. Yes, these new drivers of crisis do contain some food security features, but could it be that the most important contribution the food security field has made to the future is the systematic, spatial, evidence-based, and shock-outcome model and process it provides for assessing a broader concept of human well-being?

Information Gaps on Agricultural Value Chains – Focus on Smallholder/Family Farms

Liku, Justus - CARE International, jliku@care.org

Smallholder or family farms account for more than 500 million farms (more than 90%) and produce most (80%) of the world's food (FAO 2014: Towards Stronger Family Farms). Their contribution to economic growth is fundamental to face the challenges of eradicating rural poverty, food insecurity and malnutrition. Smallholders are business oriented similar to large farmers, and information on their products value chain analysis is equally essential to both. Whereas wealthier commercial producers have access to value chain information for their products (prices, markets, varieties, production techniques, services, storage, or processing), smallholders remain dependent primarily on word of mouth, previous experience, and local leadership. This asymmetry of information is a fundamental problem in agricultural production for smallholders and inhibits their ability to produce at profit. This lack of information creates opportunistic dealers/buyers who report lower than actual output quality, negatively affecting farmers' compensation given it is directly linked to quality. When farmers factor in the buyer's opportunistic behavior, underinvestment may occur, negatively affecting farm productivity /production.

Whereas farmers are making decisions to invest on most profitable products, this is happening at very slow pace and after long span of practice when they come to realize their investment are not profitable. For bigger companies this happens faster since they have all necessary information to make decision purely on profit basis. Opportunities for the farmers to close this information gaps have been few. The Value Chain Development (VCD) Initiatives implemented by Governments and NGO's have been tried mainly focused on linkage to markets and Inputs. Whereas the growing interest in VCD has led to development of tools for value chain analysis, its use and impact at farmer level is insignificant.

Smallholders need the whole package of VC analysis information that allows them to evaluate opportunities in their products and invest for profit. Information on the VC could be a catalyst for smallholders to gain a stronger negotiating position, explore alternative markets, or make better decisions on where and when to sell products. There is a demonstrable need for a new revolution that provides value chain analysis information and incentivize farmers (for example, through higher income) to increase their production. Farmers are business minded and ready to grab any opportunity to multiply income from their produce. Given the right value chain analysis information for their products, they will definitely invest in inputs, processing, and collective marketing, among others. We need to consider new ways of delivering extension service and present whole package that encompass the agricultural value chain analysis. Provide farmers with wholesome package that integrates profit margins for different stages of value addition in order for them to see farming from a business perspective. Appreciate small farmers as investors with ability to manage their farms for profit, and therefore presented with the VC information will likely adopt the most profitable pathways.

The Global Strategy: A contribution to the CAADP implementation

Fabi, Carola - FAO Statistics Division, carola.fabi@fao.org

Policy makers find many challenges in the changing face of agriculture in the twenty-first century. Agricultural development is now seen as a vital and high-impact source of poverty reduction yet the economic, environmental and social sustainability of policies are additional factors to take into consideration. While emerging policies issues generate new data and information needs, the availability and quantity of agricultural statistics has decreased in the last decades. The Global Strategy is the result of an extensive consultation process with national and international statistical organizations to address developing countries' lack of capacity to provide reliable statistical data on food and agriculture and provide a blueprint for long-term sustainable agricultural statistical systems in developing countries.

The Global Strategy provides a comprehensive framework to enable countries to produce and to apply the basic data and information needed to guide decision making. The Strategy is based on three pillars: (i) a minimum set of core data that countries will collect to meet current and emerging demands, (ii) the integration of agriculture into national statistical systems by implementing a set of cost-effective methodologies and (iii) improved governance and statistical capacity building. The programme is implemented through a Global Trust Fund managed by FAO and governance mechanisms at global, regional and country level. The African Development Bank and the UNECA are the regional partners for Africa, for the Technical Assistance and Training components respectively. The action plan for 2012-2017 focuses on some essential results that can trigger further improvements in the long term: the development and adoption of cost-effective methods and training of statistical staff at technical level, and the integration of Agricultural Statistical Plans (SPARS) in the National Statistics Development plans to ensure long term sustainability. Activities in Africa started with Country Assessments to identify priority areas and set a baseline. Development of Strategic Plans for Agricultural and Rural Statistics (SPARS) has started in 6 countries, as well as technical assistance in key areas of work.

The challenge is in helping countries creating a sustainable environment for agricultural statistical systems in the medium and long term. The Global Strategy helps building capacity but does not support the implementation of the countries' plans, i.e. data collection. An opportunity to support data collection would be to establish a direct link between countries investment plans within the CAADP (the NAIPS) and statistical plans at country level (the SPARS). This link would ensure that on the one hand the agricultural statistical systems will provide the required information of the CAADP results framework. On the other hand, the integration of agricultural statistical development into the new (or revised) investment plans (NAIPS) will raise the necessary resources for the collection of related primary data.

Action is already taking place in this direction by matching the Global Strategy minimum set of core data with CAADP results framework and by including in the SPARS guidelines the necessary linkage with CAADP. The remaining challenge is how to convey and leverage funds at national level, where the CAADP could be a major actor in the process, but data collection sustainability ultimately lies with the countries.

APHLIS - Towards an Information System for Improved Postharvest Management Planning

Rembold, Felix - JRC, felix.rembold@jrc.ec.europa.eu
Hodges, Rick - University of Greenwich,
Bernard, Marc - BLE

Keywords: *Africa, post-harvest losses, databases, networking*

The African Postharvest Losses Information System (APHLIS) provides estimates of the postharvest weight losses (PHLs) of cereal grains for Sub-Saharan Africa. These loss estimates support :

- agricultural policy formulation
- identification of opportunities to improve value chains
- improvement in food security (by improving the accuracy of cereal supply estimates), and
- monitoring of loss reduction activities

APHLIS is based on a network of local experts. Each country supplies and quality controls its own data that are stored in an exclusive area of a shared database. The APHLIS website displays the loss estimates as maps and tables. The APHLIS Network members also have the opportunity to post a 'Country Narrative' that gives a commentary on these postharvest losses in the context of the postharvest systems and projects of their countries.

The loss estimates are generated by an algorithm (the PHL Calculator) that works on two data sets, the postharvest loss (PHL) profiles and the seasonal data. Each PHL profile is itself a set of figures, one for each link in the postharvest chain. These figures are derived from a very detailed search of the scientific literature followed by screening for suitability. They remain more or less constant between years. The seasonal data are contributed by the APHLIS Network and address several factors that are taken into account in the loss calculation. They may vary significantly from season to season and year to year.
APHLIS estimates are not intended to be 'statistics' although they are computed using the best available evidence; they give an understanding of the scale of postharvest losses using a 'transparent' method of calculation.

APHLIS offers a robust system for the estimation of PHLs, is transparent in operation and can capture improvements in loss estimation over time by the accumulation of new and more accurate data. It encourages the collection of new data and offers advice on modern approaches to loss assessment. For the future, APHLIS is envisaged as a much broader communication hub that informs, motivates and coordinates efforts to optimize postharvest management.

Assessing resilience across BRACED countries - What information is available?

Simonet, Catherine - Overseas Development Institute, c.simonet@odi.org.uk
Wilkinson, Emily; Comba, Eva - ODI

The BRACED programme is supporting 15 NGO consortia to roll out resilience programmes at scale in 12 countries broadly considered to be 'fragile' in terms of their political and economic systems and vulnerable to climate extremes and disasters. These countries are located within the Sahel in West Africa, the Horn of Africa and south Asia. The contribution that these projects make to individual, household and community resilience will depend not only on the suitability of interventions to the local context, but also trends in the macro-economy.

The concept of resilience is used to understand how social and ecological systems cope with shocks and stresses and maintain their capacity to function in a changing environment. Resilience research has gone through several phases to understand this complexity: ecological resilience; socio-ecological resilience, and more recently social resilience. Understanding the nature of resilience in different contexts is a burgeoning field of inquiry. In part, this is due to the difficulty in gauging and measuring resilience. More robust methodologies are needed to complement some insightful attempts at filling this gap.

The scoping paper presented during the IMAAFS's conference draws a broad picture of how socio-economic resilience to climate extremes has changed over the last 40 years with a special focus on these BRACED countries. It characterises resilience by identifying the risks and the responses of these economies to various climate extremes. The approach of the paper is therefore purely empirical: we are looking what kind of information on current and past resilience of these countries can be extracted from statistical analysis. The purpose is dual: firstly, the paper provides an overview of where we stand, what the features are of risk in BRACED countries and whether it is possible to identify common trends and profiles; secondly, the analysis helps to identify gaps and challenges in the assessment of resilience at national level.

Over the period 1970-2012, the BRACED category has been disproportionally impacted by natural hazards particularly climate-induced disasters when compared to other groups of developing countries. Witnessing high levels of risk compared to other developing countries, the BRACED countries need to build particularly important levels of resilience to make sure they are able to "spring back from" the shocks they experience.

Bringing together different initiatives implemented at the community level with a scope at the sub-national, national or regional levels, BRACED programme will provide case studies that will be crucial to foster a better understanding of the resilience causality chain. The inter-scale nature of the programme will allow the identification of the multiple and complex factors that constitute resilience. Finally, the BRACED programme could also be useful in the collect of physical data especially on inundations and droughts that would complement the information contained in the international or national disaster databases and could be used as a baseline of future analyses of resilience in the BRACED countries.

Session 3 – Food Security and Nutrition Assessment: Revisiting the Role of Household and Nutrition Surveys

Linking Food Security and Nutrition Assessments - Lessons learnt from Karamoja, Burundi and Djibouti

Vhurumuku, Elliot - World Food Programme, Elliot.Vhurumuku@wfp.org
Kenefick, Eric ; Ogden, Kathryn ; Kiess, Lynnda ; O'Hiarlaithe, Michael; Nirina, Isabelle; Regi, Sergio - WFP

Assessments of both household food security and maternal and child nutrition are critical for health and nutrition programming in populations potentially subject to nutritional compromise, including in populations affected by acute and protracted emergencies. Despite the possible causal relationship between food security and nutritional status outcomes of children less than 5 years of age, and women in reproductive age, the two are rarely assessed together. This has called for the needs to develop protocols aimed to inform on key food security and nutrition indicators, as well as standards, methods and procedures to adopt in joint assessments.

The results from the joint assessment comes from a long and fruitful collaboration with experts in both food security and nutrition from the WFP, UNICEF, UNHCR, Government, NGOs and donors (USAID). It provides data from individuals within a household on maternal and child health and nutrition status, on the household's food security situation and thus ensures analysis of underlying factors with high precision. The joint food security and nutrition assessments (JAFSNA) allows harmonization of approaches, cost savings, integrated analysis, more effective joint programming of WFP, UNICEF and other partners in addressing underlying factors of food insecurity and malnutrition.

The JAFSNA was achieved through designing a joint sampling with international acceptable precision levels for both food security and nutrition. The joint assessment ensured that one household questionnaire is administered with pre agreed critical food security and nutrition indicators collected. The analysis was performed by simple *cross tabulation*, for example between the non-introduction of complementary food in children between 6 to 8 months and the number of meals of the households or health practices. *Bivariate correlation* was also used, for example between household diet diversity score and children score diversity to see if there is some type of food that mother/caregiver does not give to the child even if the household consume it. Finally a *Multivariate analysis* was done of the Z-scores on food consumption score or food security index, on livelihood strategies, on food expenditure and on wealth quintile or poverty index. Linkage was also explored for all children under five, children under 24 months, considering their feeding status and caregiver status.

The JAFSNA pilots in the three countries in three different contextual environments demonstrated beyond reasonable doubt that food security and nutrition assessment can easily be linked, thereby providing better information for programme design compared to when the assessments are conducted separately.

Do Farming Rural Households Benefit from High Food Prices? Panel Evidence from Rural Households in Ethiopia

Tefera, Nigussie - JRC, nigussie.tefera@jrc .ec.europa.eu
Demeke, Mulat - FAO,
Rashid, Shahidur - IFPRI,
Kayitakire, François - JRC

This paper examines the distributional impact of rising food prices on the welfare of rural households in Ethiopia, using the Ethiopia Rural Household Survey (ERHS) panel data of 2004 and 2009. The study employs second-order expansion of compensating variation (CV) to account for substitution effects. Results show stable high food prices improve the welfare of rural households at aggregate level by about 0.3 percent, improving further by 0.7 percent with substitution effects. This welfare gain, however, is not evenly distributed among rural households. Only marginal gains are received by households in the lowest two quintiles (even with substitution effects), while the range is from 0.4 to 1.4 percent for households in the top three quintiles; interestingly, households in the middle income bracket benefited most. Moreover, while net-cereal buyers lose by 1.9 percent, net-cereal sellers and autarkic households gain by about 2.2 and 2.5 percent, respectively. With substitution effects, the loss of net-cereal buyers declined to 1.6 percent and gains for later groups increased by 2.9 percent. Furthermore, results also show that only 55 percent of total net-cereal buyers are affected by high food prices. Since many poor rural households have their own land in Ethiopia, better access to improved seeds, fertilizer and input credit facilities as well as rewarding output prices, will contribute greatly to enhancing their productivity. Moreover, stable food prices would encourage production expansion; lead to lower food prices and ensure sustainable food and nutrition security in the long-run. In this case, only poor rural families with limited farm and non-farm income would need to be supported with safety net programs.

Agricultural Statistics and Food Security Monitoring System in Rwanda

Habyarimana, Jean Baptiste - Ministry of Agriculture and Animal Resources, Rwanda,
kradrimn@gmail.com
Dushimayezu, Bertrand - MAAR, Rwanda

Keywords: *Rwanda, agriculture, statistics, food security, monitoring*

In our presentation we characterize the Agricultural Statistics and Food Security Monitoring System and identify effective pathways of interactions between different actors in the system of Rwanda. The reviewed literature shows that 1994 genocide had destructive impacts on Agricultural Statistics System but the recent literature guarantees the availability of agricultural data to monitor food security and ensure a well-structured food security monitoring system in the country. A theoretical analysis shows that there exists consolidated interactions between Government and Non-Government Institutions to support a working Food Security Monitoring System. The interactions guarantee the flow of efficient food security information among food security actors. But to ensure the sustainability of this, the presentation suggests that there is a need of avoiding asymmetric information across the system, reinforcing capacity building in food security data collection and analysis. Another requirement lies on improving dissemination system and ensuring the periodicity of food security reports and bulletins. This presentation shows that it is worth to government institutions to facilitate integrated food security analyses and adopt collaborative researches. Collaborative researches "government – non government institutions" requires the adoption of flexible ways to discuss and validate information while facilitating and promoting data sharing and flow of efficient information.

Session 4 – Advances in Market and Price Information Systems

Monitoring and Evaluation of Food and Agricultural Policies: MAFAP and FAPDA initiatives of FAO

Demeke, Mulat - FAO, mulat.demeke@fao.org
Balie, Jean - FAO

Keywords: *markets, prices, information systems, agricultural policies*

Although M&E systems are known to provide decision makers with a road map of what needs to be done to achieve desired outputs, outcomes and impact, only the OECD countries and a few emerging economies have such systems for food and agricultural policies. Attempts to establish an effective M&E system in developing countries has failed in the past. Hence, FAO recently launched two major initiatives to bridge the gap: the Food and Agriculture Policy Decision Analysis (FAPDA) was launched in 2007 to collect and disseminate information on policy decisions in over 80 countries of Africa, Asia and Latin America and Caribbean through a freely accessible web-based tool, while the Monitoring and Analyzing Food and Agriculture Policies (MAFAP) was established in 2009 with the main objective of monitoring and analyzing policies and their effects on producers and other value chain agents in selected developing countries (mainly African).

MAFAP and its national partners monitor the effects of policy distortions and market inefficiency on price incentives for producers and other agents for key commodities. The level and composition of public expenditure on agriculture and the degree of coherence between national objectives and measures adopted are also analyzed. The results from the analysis of ten African countries show that existing policy and market environments have created disincentives, especially for producers. The second phase of MAFAP is designed to undertake further validation works and assess policy options through ex-ante analysis, in addition to supporting advisory and advocacy activities for policy reform through participatory process.

The FAPDA web-based tool allows users to directly access and retrieve country-level policies, which are classified into three broad categories: producer support measures, consumer oriented policies, and trade and market policies influencing both producers and consumers. The analytical work of FAPDA includes biennial global reports on emerging trends and issues, country policy factsheets, and contributions to regional reports (e.g. the Asia Food Price and Policy Monitor). FAPDA has a vision of expanding its scope and coverage to meet the demands of countries, regional organizations and other stakeholders for reliable and up-to-date food and agriculture policy-related information.

The International Comparison Program for Africa (ICP-Africa) as a basis for Food Price Data Collection

Adam, Abdoullaye - African Development Bank, Tunisia, a.adam@afdb.org

One of the objectives of the International Comparison Program for Africa (ICP-Africa) is to produce reliable and relevant Purchasing Power Parities (PPP). To that end, national annual average prices of comparable and representative items with the same quality and matching on the features that affect prices are computed after collecting the data using surveys with the same spatial and temporal coverage in all countries participating in the comparison.

The ICP-Africa product list used in the price collection contained 332 Food products in 27 basic headings (BH) and was established using the SPD approach through a participative and iterative process. Products of the list are comparable and representative in addition to meeting the other ICP data requirements.

The Africa Food Price Collection (AFPC) Project aims at collecting high frequency data focusing on staple food, which is a large share of the household budget in most African countries. The huge variety of goods and services produced and consumed in different parts of African and the need of making an efficient use of the available resources recommend focusing the data collection on the most representative products of the consumption of households in Africa. Also the products must be comparable for the purpose of undertaking economic analyses including comparison among countries and among sub-regions. The need of comparability and representativeness of the products of AFPC list, make the ICP-Africa list the first point of call for the establishment of the list of the AFPC.

The products of the AFPC were chosen from the list of the 2011 ICP-Africa Product List following a two stage selection process: (i) allocation of the required sample size to BHs proportionally to the average BH weight from the food expenditure weight (GDP decomposition from National accounts part of ICP-Africa; (ii) selection of products within BHs on the basis of their representativeness across African countries. Selected products comply with the representativeness and comparability requirements of the ICP and for comparison purposes, PPP can be computed at the BH level provided there are at least three products per BH.

Food Market Prices Collection in Africa

Donmez, Ayca - JRC, ayca.donmez@ec.europa.eu

The large agricultural commodity price swings observed especially in the last decade made the importance of accessible, timely, accurate, and high-frequency price data more visible. The time gap between the real time of collection and publication of the data series in addition to the frequency of data collection are still challenging when it is required to reach on-time information about the agricultural markets. Geographical scale can also be seen as an issue since the available data is generally aggregated into country level values; not in market level most of the time for instance. Besides, the series published are often indices; not even the prices itself. The objective of this pilot study is to refer to those questions while trying to deliver both a credible cost-efficient methodology using modern web-based tools and technologies through crowdsourcing and an open (easy to download and visualise – available online) weekly food price database for Africa.

Impact of Weather and International Price Shocks on Local Food Prices

Brown, Molly, E. - University of Maryland, **mbrown52@umd.edu**
Kshirsagar, Varun - Independent Consultant

Keywords: *local prices, vegetation index, state space model, food security*

In the context of a changing climate, there is an urgent need to better understand the impact that weather anomalies have on food availability in the developing world. Despite the large literature that has examined local food prices in developing countries, there is limited systematic evidence on the relationship between domestic weather shocks and local food prices. While the influence of international markets on local food markets has received considerable attention, in contrast, the potential influence of weather disturbances on local food markets has received much less attention. In fact, local weather anomalies may have an adverse impact on the poorest households in developing countries, especially those dependent on subsistence agriculture. Here we quantify the short-run impact of both weather anomalies as well as international price changes on monthly food prices across 554 local commodity markets in 51 countries during the period between 2008 and 2012. We find that almost 20% of local market prices were affected by domestic weather anomalies in the short run, 9% by international price changes and 4% by both domestic weather anomalies and international price changes. An improved understanding of the magnitude and relative importance of weather anomalies and international price changes on rural economies will inform public policies that are designed to mitigate the impact of adverse weather disturbances.

Developing a 10-year outlook for Eastern and Southern Africa: Partial Equilibrium modelling and farm-level analysis within a scenario planning framework

Meyer, **Ferdinand**, **Bureau for Food and Agricultural Policy (BFAP) University of Pretoria, South Africa.** **ferdi.meyer@up.ac.za**
Traub, Lulama - Bureau for Food and Agricultural Policy (BFAP) University of Stellenbosch, South Africa

The need for a regional network of national agricultural policy institutes within the Eastern and Southern African (ESA) region was recognized as early as 2009. At that time, it was realized that though countries within the region have their own national agricultural policy research institutes, these institutions were not effectively coordinating with each other in the areas of regional policy analysis, outreach and capacity building activities. As a result, in the absence of a platform for engagement, the ability of these national agricultural policy institutes to provide practical solutions to the regional policy challenges facing their member states was limited. To address this gap the national agricultural policy institutes from seven countries within ESA formed the Regional Network of Agricultural Policy Research Institutes (ReNAPRI) on November 16, 2012 in Lusaka, Zambia.

ReNAPRI is an African-led, African-driven regionally coordinated group of national agricultural policy research institutes duly established and operating in Eastern and Southern Africa member states. The vision of ReNAPRI is to support national agricultural policy research institutes in Africa to be centers of excellence that guide and inform national and regional agricultural and food security policy issues. The mission of ReNAPRI is to support dynamic collaboration amongst national agricultural policy research institutes to produce sustainable and high-quality research, outreach and capacity development that promotes national and regional agricultural policy objectives.

The development of an annual agricultural outlook is one possible way in which ReNAPRI can foster collaboration and create a platform for engagement with policy makers and private stakeholders. The outlook presents 10-year baseline projections generated by sector level partial equilibrium models, which include key components of supply and demand for specific agricultural commodities within the region. It further seeks to provide relevant and timely national and regional policy support to national governments and Regional Economic Communities (RECs). The analysis includes impact assessments of domestic policy on regional trade flow patterns as well as farm profitability. This can be achieved through a comprehensive scenario analysis exercise and a link between sector - and farm level models. To generate this outlook, ReNAPRI has partnered with various non-African institutions, which include; the Food and Agriculture Organization (FAO) of the United Nations (UN), Food and Agricultural Policy Research Institute (FAPRI) at the University of Missouri; and Michigan State University (MSU).

GEO Session – Towards more Coordinated Contributions to GEO Global Agriculture Monitoring across Africa

AGRICAB – Crop Production Use Cases

Ceccarelli, Tomaso - **Alterra**, **WUR, tomaso.ceccarelli@wur.nl**

Keywords: *Earth observation, agro-meteo modelling, crop forecasting, capacity building*

This presentation reports on a number of activities carried out in the EU-FP7 project AGRICAB (October 2011 – March 2015). Main concepts underlying the project are: stimulating the uptake of EO techniques, developing predictive models and use cases, and a sustained provision of EO data and tools. This was achieved through:

- Provision of reliable access to EO data, and free software models and tools (e.g. SPIRITS, GEONETCAST Toolbox)
- Focused national applications ('use cases')
- Training, supporting higher education, stimulating wider uptake.

Use cases are the result of the combination of 'tasks' (livestock, agricultural statistics, agro-meteorological modelling and crop forecasting, early warning, irrigation, forestry and fire mapping) and countries (North Africa, Senegal, Niger, Kenya, South Africa, Mozambique). The 'livestock systems use case' (in Niger, Kenya, Senegal) targeted:

- improved rangeland assessment and livestock monitoring using DMP (Dry Matter Productivity)
- modelling carrying capacity and livestock productivity
- providing inputs in Early Warning systems coupled with thematic data on livestock
- developing index-based insurance schemes for pastoralists
- training on methods for pasture monitoring and supporting 3 PhDs.

The 'forest and fire mapping use case' concentrated on:

- information on tree cover and volume in savannah / woodland ecosystems
- targeted research activities (e.g. 2 peer-review publications)
- support to a nationally funded research programme in South Africa.

The main focus of this work, however, is on the '**crop production systems use case'** and specifically on **agro-meteo modelling** (early warning, agricultural statistics and irrigation being covered by other contributions in the same session). As to agro-meteo modelling (which was carried out in Senegal, Kenya, Mozambique), the rationale behind this task is that current Early Warning systems for rainfed agriculture mainly use global data on weather, EO-based vegetation indices (e.g. NDVI) and simple water balances. Crop simulation models like WOFOST, by analyzing the very processes behind crop growth can:

- help evaluating the integrated effect of weather, soil, crop management
- deliver useful indicators for monitoring (crop specific, direct response, indication of phenological stages)
- provide advanced indicators for statistical crop yield forecasting

- enable studies on land and water management scenarios, adaptation to climate change, yield gaps, etc.

Achievements of the task included: setting up agro-meteo modelling with a "regional" implementation of WOFOST (CGMS). Use of location specific (daily) weather, soil and crop data. Calibration to define variety specific crop parameters. Crop yield forecasting using multiple regression or scenario analysis (CST). Validation of Rainfall Estimate Products – RFE (in Mozambique). All efforts were oriented towards setting up operational services in the three countries, strengthening capacity (Ministries of Agriculture and other relevant organizations) and creating a 'Community of Practice' in the relevant domains.

AGRICAB – Enhancing African EO Capacities for Agriculture and Forestry Management as contribution to GEOSS

Jacobs, Tim - Flemish Institute for Technological Research (VITO), Belgium, tim.jacobs@vito.be
Gilliams, Sven - VITO

Keywords: *capacity building, agriculture, forestry, Earth Observation, GEOSS*

Earth Observation (EO) contributes significantly to the information needed to sustainably manage agriculture and forest resources, which affect the livelihood of millions of people in Africa, and is therefore integrated more and more into the daily work of African institutes. With a focus on reinforcing those existing EO capacities, the project entitled 'A Framework for enhancing earth observation capacity for agriculture and forest management in Africa as a contribution to GEOSS' (AGRICAB, http://www.agricab.info) was launched in Oct 2011. To achieve its goals, the project, which receives funding from the EU's 7th Framework Programme for Research (FP7), builds upon 17 partners located in 12 different countries: 6 in Europe, 10 in Africa and one in South America.

The project is focused on the development of national-level use cases related to monitoring and management of agriculture (crop yield forecasting, crop mapping, statistics, early warning), livestock & rangeland and forest and fire, covering study areas in Kenya, Mozambique, Senegal, South Africa, Tunisia and Niger. Underpinning those efforts, its capacity building framework furthermore includes (i) reliable data retrieval through, among others, GEONETCast satellite broadcast and online sources, (ii) improvements to the data exchanges between free software tools, (iii) training and enhancing freely shared training materials and (iv) networking and awareness raising. The latter are all opened to wider, international scales, involving for instance UN bodies, Africa's continental (AUC) and economic regions (e.g. AMESD/MESA) and even the global GEO (in collaboration with AfriGEOSS).

With the project drawing to a close in March 2015, its achievements are reviewed, in particular focusing on training events and their impact and the sustainability of the efforts is discussed.

Towards a more Integrated Agricultural Production monitoring in South Africa

Chirima, George J. - Agricultural Research Council-Institute for Soil, Climate and Water, Pretoria, South Africa, chirimaj@arc.agric.za

How much is produced, and where are key questions when planning imports or exports for a country. How does one get to monitor agricultural production over such large spatial scales? This presentation is an outline of the South Africa experience on agricultural production monitoring across the country. In South Africa, a frequent and area-wide monitoring of main grain crops including yellow and white maize, sunflower soya-beans, dry beans, groundnuts, and sorghum is required annually to assess the current status, identify basic trends, mitigate major threats to production, and plan food imports or exports. A consortium comprising a state entity, the Agricultural Research Council (ARC), two private companies, GeoTerra Image (GTI) and Spatial Intelligence (SIQ) carryout the monitoring. Satellite-based Earth Observation provides an ideal basis for the area-wide and spatially detailed provision of grain crop production, yields and annually update changes in agricultural areas. The derived geo-information is integrated into a Geographical Information Systems, later combined with data from aerial and telephonic surveys, plus actual grains delivered to silos. The techniques provide data, statistics and information to markets and government, which can guide investment. The generation of this information, is key for several reasons including identifying areas where planting is successful, second, planning preparedness, and third, mitigating risks during the growing season. Furthermore, Space-based Earth Observations reveal problematic areas and develop specific hot-spot maps to assist farmers and government in planning mitigation actions.

Remote Sensing and Spatial Information System Applications for Smallholder Farmers in sub-Saharan Africa and South Asia

Dempewolf, Jan - **University of Maryland,** **dempewol@umd.edu**
de Bye, Rolf, ITC-University of Twente,
Schulthess, Urs - **CIMMYT**,
Traore, Sibiry, ICRISAT,
Mckenzie, Neil, CSIRO

Keywords: *smallholder agriculture, remote sensing, food security, maize, irrigation, field delineation, unmanned aerial vehicles*

Remote-sensing and spatial information systems are revolutionizing agriculture but there are significant barriers to adoption in poor countries and this is adversely affecting smallholder farmers. The Spurring a Transformation for Agriculture through Remote Sensing (STARS) project aims to overcome these barriers by exploiting remote sensing technologies for monitoring and increasing the productivity of crop-based smallholder production systems and livelihoods of smallholder farmers in sub-Saharan Africa (SSA) and South Asia (SA). Monitoring smallholder production systems through existing remote sensing techniques is highly challenged by: the substantial heterogeneity in crops, soils, farm practices, and climatic conditions; the often small and ill-defined farm plots, holding multiple crops and undergoing variable types of crop management; and also by data accessibility and availability issues, especially for high-resolution data. STARS is aiming to test the hypothesis that we can monitor crop growth at the scale of the farm management unit within the small farms of SSA and SA using remote sensing technologies in combination with other data sources.

STARS is a collaboration between five international institutions, led by the University of Twente / ITC in the Netherlands with sub-grants to the International Maize and Wheat Improvement Center (CIMMYT), the International Center for Research on the Semi-Arid Tropics (ICRISAT), the University of Maryland (UMD), and the Commonwealth Scientific and Industrial Research Organization of Australia (CSIRO). STARS has the following main objectives: 1) identify smallholder farm production constraints that can be better addressed using remote sensing and evaluate corresponding remote sensing technologies including satellite data and imagery collected by unmanned aerial vehicles (UAVs), 2) compile a repository of multi-temporal and multi-spectral remote sensing data and processing algorithms together with co-located ground data of crop condition and cropping system information, 4) determine existing and required institutional and human capacity to take advantage of remote sensing technologies to benefit smallholder farmers and local, private agro-businesses, 5) investigate to what extent we are capable of identifying cropland, cropping system types, monitor crop production systems and optimize surface water irrigation using remote sensing.

At the core of the STARS project are three regional experimental use case studies in East Africa (Tanzania and Uganda), West Africa (Mali and Nigeria) and South Asia (Bangladesh), led by the University of Maryland, ICRISAT and CIMMYT respectively. The African use-cases address questions of farm plot delineation, crop recognition, and crop condition monitoring. The East Africa use case has a focus on supporting food security assessments by the Government of Tanzania through the development and introduction of remote sensing techniques, analysis tools and efficient smart phone data collection technologies. The Asian use case investigates the potential for and impact of irrigation interventions for maize production. Complimentary to the regional use case studies, a

technical and institutional Landscaping Study of remote sensing investment opportunities, led by CSIRO, aims to identify where remote sensing can help to transform agricultural development.

Session 5a – Improved Information from New Satellite Sensors and Methods

The Agriculture Monitoring Service of the MESA SADC Thema Project

Marumbwa, Farai Maxwell - **MESA SADC Thema Project BDMS and SADC-CSC, farai@mesasadc.org**

Keywords: *agriculture, monitoring, remote sensing, EUMETCast, training*

The Monitoring for Environment and Security in Africa (MESA) program builds on the African Monitoring for Environment and Sustainable Development (AMESD) project and addresses the need for improved environmental monitoring towards sustainable management of natural resources in five regions of Africa namely SADC, CEMAC, ECOWAS, IGAD and IOC. In addition, a climate change monitoring service is being implemented by ACMAD for the African continent. The project is coordinated by African Union Commission and funded by the European Commission. MESA in the SADC region is developing four geo-information services, namely Agriculture, Drought, Wildfire and Flood. The MESA SADC Thematic Action is implemented by Botswana Department of Meteorological Services (BDMS) and SADC Climate Services Center (CSC).

The Agricultural Service provides products and tools to assist agricultural remote sensing analysts to describe factors affecting crops and rangelands during the season. The main goal of the service is to enable ministries of agriculture in SADC (Key users) to perform crop and rangeland condition monitoring, and also to provide them with tools and methods for yield forecasting.

The service is based on the AMESD/MESA station installed at ministries of agriculture across the SADC region. A MESA Station is a system for receiving, processing, displaying and analyzing Earth Observation data. The Station receives data from the EUMETCast data flow and additionally, from FTP and HTTP servers, and automatically computes value added products relevant for agricultural monitoring. BDMS is responsible for generating and disseminating the products primarily via the EUMETCast[1]. The output products from the station assists the analysts and decision-makers in answering the following questions:

• What crops grow where?
• What is the crop or rangeland condition?
• What is the crop stage?
• What is the likely yield?

Users of the service are trained in how to use the MESA station and also in data analysis using open source GIS software like ILWIS, SPIRITS and QGIS. Based on the analysis of the products from the MESA station, relevant information can be presented to decision makers in the form of a report or bulletin at regular time intervals of 10 days or monthly.

The European Union COPERNICUS Earth Observation Program and its Support to Agriculture Monitoring

Massart, Michel - **European Commission, Copernicus Services Unit, Belgium,**
michel.massart@ec.europa.eu

Keywords: *Earth Observation, European Union Programme, Biophysical variables*

Managing natural resources and biodiversity, observing the state of the oceans, monitoring the composition of the atmosphere: it all depends on accurate information delivered in time. The European initiative for the Global Monitoring for Environment and Security (COPERNICUS) provides data to help deal with a wide range of environmental issues including climate change. COPERNICUS services are based on Earth monitoring data, collected from space and in situ measurements. The program is thus considered as the Earth Observation Flagship of the European Union. After years of research investment, COPERNICUS is now a fully operational service programme. It has great potential for businesses in the services market, which will be able to make use of the data it provides free of charge. Six COPERNICUS services have been defined: Land, Marine, Atmosphere, Emergency, Climate change and Security.

The Global Land component of the Land Service has been built initially to support European Union policies at international level and European commitments under international treaties and conventions, such as the Rio conventions. The Global Land component is also a major contribution of the European Union to the Global Earth Observation System of Systems (GEOSS). The Global Land component started its operational activities in January 2013. It delivers in near real time 11 mid resolution (1 km) bio-geophysical variables at worldwide level. The reprocessing of historical data to ensure re-analysis, inter-annual comparisons and to constitute a consistent archive is also part of the activities, as well as the development of an efficient cataloguing system and an easy access data dissemination service through EUMETCast or INTERNET at the following address:

http://land.copernicus.eu/global.

The Global Land component provides information for the Agriculture sector with the production of biophysical variables relevant for crop monitoring and for crop production forecast. It is also supporting environmental policies in Africa in the domain of biodiversity, desertification, drought and water monitoring, and the setup of early warning systems. The Global Land component is supported by an Open and Free Data Access Policy allowing a wide use of the data, fostering the development of downstream applications by African partners and thus strengthening the Earth Observation sector. The sustainable delivery of the products is fully ensured allowing the development of reliable business models.

The evolution of the component is towards an increase of the number of variables currently produced, but also towards an improvement of the resolution, moving from 1 km to 300 m products thanks to the already existing PROBA V satellite and the upcoming Sentinel 3 satellites. The concept of the COPERNICUS program is also currently applied in Africa with the GMES and Africa initiative.

Humanitarian Applications of Remote Sensing and Climate Data - Current Practice at WFP

Bonifácio, Rogerio, World Food Programme, rogerio.bonifacio@wfp.org

Climate related initiatives have assumed increasing importance at the World Food Program over the last 5 to 6 years, given that climate shocks are a major driver of food insecurity in the world and have been a root cause of the majority of WFP beneficiaries. Climate and remote sensing datasets have therefore assumed essential importance for WFP in order to serve the technical needs of climate related initiatives as well as the information requirements of early warning and emergency preparedness work, and the planning of WFP interventions.

We show the widely varied ways in which WFP addresses the handling and processing of multi-year, gridded datasets on rainfall, temperature, vegetation, snow and land cover. Analysis is focused on averages (climatology), inter-annual variability, long term trends and descriptions of seasonality as well as comparisons between ENSO phases. Particular emphasis is devoted to the newly launched Seasonal Monitor, a service that assimilates and processes RFE and NDVI data in order to produce tailored information to Country Offices and Regional Bureaus.

Space-Derived Phenology, Retrieval and Use for Food Security Monitoring

Meroni, Michele, JRC, michele.meroni@ext.jrc.ec.europa.eu
Rembold, Felix; Kayitakire, Francois; Urbano, Ferdinando; Schucknecht, Anne; Leo, Olivier - JRC.

Monitoring vegetation conditions is a critical activity for assessing food security in Africa. Rural populations relying on rain-fed agriculture and livestock grazing are highly exposed to large seasonal and inter-annual fluctuations in water availability. Monitoring the state, evolution, and productivity of vegetation (crops and pastures in particular) is important to conduct food emergency responses and plan for a long-term, resilient, development strategy in this area.

The timing of onset, the duration, and the intensity of vegetation growth can be retrieved from space observations and used for food security monitoring to monitor seasonal vegetation development and forecast the likely seasonal outcome when the season is ongoing. In this contribution we present a set of phenology-based remote sensing studies in support to food security analysis. Key phenological indicators are retrieved using a model-fit approach applied to SPOT-VEGETATION FAPAR time series. Remote-sensing phenology is first used to estimate *i)* the impact of the drought in the Horn of Africa, *ii)* crop yield in Tunisia and, *iii)* rangeland biomass production in Niger. Then the impact of the start and length of vegetation growing period on the total biomass production is assessed over the Sahel. Finally, a probabilistic approach using phenological information to forecast the occurrence of an end-of-season biomass production deficit is applied over the Sahel to map hot-spots of drought-related risk.

The reported case studies add confidence to the use of space-derived phenology for food security monitoring, both for an end-of-season analysis to map crop yield and biomass production anomalies and a within-season analysis to provide early warning information. Advantages of exploiting phenological information include: focus the analysis on the actual growing season year by year and pixel by pixel, take the progress of the season into account so that the information provided to analyst can be automatically "weighted" for its reliability. Nevertheless, the case studies also show that caution should be taken with the direct use of specific phenological indicators (e.g. SOS) for seasonal forecast, i.e. this is meaningful only where the indicator has been demonstrated to be relevant. Ways forward of the presented work include: the operational implementation of the probabilistic approach for the automated early drought hot-spot detection at the JRC (and FAO within the ASIS system), use of other satellite sensors to increase spatial resolution (MODIS 250 – 500 m, Proba-V 100-300 m, Sentinel2), development of a simplified vegetation growth model assimilating remote sensing data.

Crop Area Estimation Using Remote Sensing: What Did We Learn from 35 Years of Experience?

Kerdiles, Hervé - JRC, herve.kerdiles@jrc.ec.europa.eu
Gallego, Javier - JRC

Keywords: *remote sensing, crop area estimates, lessons from experience*

The launch of the first Landsat satellites in the 70s raised the hope that crop areas could be derived from satellite images with no or few ground data. After 30 years of tests, experience tells us that ground survey data is needed in most cases in order to derive unbiased crop area estimates with high resolution remote sensing data. Among the various ground systems used by ministries of agriculture to collect rural statistics (farm census, administrative data, expert estimations or village statistics, samples based on list frame or on area frame), the area frame sample is the system with the highest synergy with remote sensing imagery: first, very high resolution – Ground Sampling Distance (GSD) around 1m or less - wall to wall coverage of a region is very helpful for building the frame, i.e. the population of objects, from which a sample will be drawn; this type of imagery is also very useful as background of ground survey documents while current year high resolution images (GSD of the order of 10m) may be used as an auxiliary variable to enhance the ground survey results.

From the many tests carried out in particular in Europe, the following lessons can be drawn:

- Among the three area frames tested in Europe, namely segments with physical boundaries, square segments and points (clustered or not), the point frame was found to be the cheapest to set up;
- point sample also showed the highest cost-effectiveness in terms of survey for the European landscapes; this is probably also the case for the African landscapes too;
- High resolution images improves the ground survey estimates provided that a certain quality level in the classification is reached; in sub-Saharan Africa, the very few tests carried out up to now have shown difficulties with classification because of cloud coverage during the cropping season, small parcels, mixed cropping and large variability in sowing dates among other factors. In addition to these factors, the cost and relatively small frame of high resolution images have limited the operational use of this data for crop area estimation.

The availability of large swath free sensors such as Landsat 8 since 2013 and Sentinel 2 in 2015 should ease the use of high resolution remote sensing for crop area estimation at country level. Additional tests of area frame sampling combined with remote sensing are needed, in particular in countries eager to improve their crop statistics.

Utilizing Passive Microwave SMOS Imagery for Correcting Soil Moisture Estimates within USDA's Crop Explorer

Reynolds, Curt A. - US Department of Agriculture, **Foreign Agricultural Service (FAS),**
curt.reynolds@fas.usda.gov

Keywords: *Soil moisture, passive microwave, SMOS (Soil Moisture Ocean Salinity), and SMAP (Soil Moisture Active and Passive) imagery*

A global soil moisture product corrected with SMOS (Soil Moisture Ocean Salinity) passive microwave imagery was introduced into USDA's Crop Explorer[1] in 2014. The global SMOS-corrected soil moisture product is now used by commodity traders and USDA/FAS crop analysts who monitor global crop production every month. The global SMOS-corrected soil moisture product is greatly superior to previous global soil moisture products used by USDA/FAS because previous soil moisture products did not utilize passive microwave imagery to correct errors introduced by poor precipitation data sets which have technical limitations with known biases and errors. For example, previous soil moisture products used by USDA/FAS did not properly monitor drier soil conditions within the Rift Valley because input rainfall products performed poorly within the Rift Valley from orographic effects caused by the surrounding highlands. However, the global SMOS-corrected soil moisture improved soil moisture values within East Africa's Rift Valley which is an important region for monitoring food security because it is highly susceptible to drought, crop failure and food insecurity from lower annual rainfall than the surrounding highland escarpments. Similar soil moisture improvements are being discovered for different regions within the world because spatial rainfall products are known for poor performance where ground stations are not present; orographic effects within mountain regions cause rain shadows; or coastal and lake effects can increase precipitation near surrounding inland areas. In summary, the global SMOS-corrected soil moisture product helps to correct known precipitation product errors and enables USDA/FAS crop analysts to better monitor soil moisture in regions where global precipitation products perform poorly. In addition, the SMOS passive microwave imagery of 45-kilometers square spatial resolution can be replaced by NASA's upcoming SMAP (Soil Moisture Active and Passive) imagery which will combine both active and passive microwave imagery with 10-kilometers square spatial resolution.

1. USDA's Crop Explorer, http://www.pecad.fas.usda.gov/cropexplorer/

Integrating Satellite Data and Hydrologic Modeling for Operational Monitoring of Crop and Rangeland Systems

Senay, Gabriel - U. S. Geological Survey Earth Resources Observation and Science (EROS),
senay@usgs.gov
Velpuri, Manohar; Bohms, Stefanie; Verdin, James, USGS/EROS

Satellite data can be manipulated and organized to provide globally consistent and locally useful indicators for monitoring and assessing crop systems, water- and natural- resources at multiple spatiotemporal scales. The U.S. Geological Survey Famine Early Warning System Network (FEWS NET) project, an activity of the U.S. Aid for International Development, has been at the forefront in the developments of data integration techniques and modeling approaches to produce daily, dekadal (~10 day) and seasonal anomalies of key environmental indicators such as rainfall, evapotranspiration (ET), vegetation greenness and pond water level for food insecure regions of the world. This presentation focuses on the use of satellite-derived ET and pond water level for monitoring and early warning applications in crop and range lands systems of the Greater Horn and Sahel Regions of Africa. Seasonal ET Anomalies, updated every 8-day, monitor the water use response of the landscape as a result of rainfall and/or irrigation for every 1 km^2.

Field-based qualitative reports corroborate the reliability of remote-sensing based ET anomaly in providing a near-real time diagnosis of the negative impact of drought or excessive moisture. For example, the seasonal (May- August) ET anomaly of 2014 accurately depicted the unusual drought in the Arsi region of Ethiopia which killed thousands of livestock and affected the food security of the people. Similarly, the online water point monitoring tool (http://earlywarning.usgs.gov/fews/waterpoint/) for agro-pastoral regions of Africa (Mali to Somalia) monitors more than 200 small farm ponds and provides a daily qualitative indicator of the relative fullness of each pond that is color coded into "normal", "watch", "alert" and "near-dry" classes. The source data and products are available for download from the FEWS NET data portal at http://earlywarning.usgs.gov. Availability of timely, online, environmental indicator products support the drought-related decision making processes in FEWS NET. The drought-hazard monitoring approach perfected by the USGS FEWS NET through the integration of satellite data and hydrologic modeling can form the basis for similar decision support systems that require drought-hazard monitoring, impact assessment and management. Such systems can operationally produce reliable and useful regional information that is relevant for local, district-level, decision making.

Developing an Automated Indicator Based on Remotely Sensed Variables – the DSI

Husak, Gregory J. - Department of Geography, University of California, Santa Barbara,
husak@geog.ucsb.edu
Budde, Michael; Landsfeld, Marin; Verdin, James P.; Rowland, Jim; Gebre, Meron A.; Anthony,
Michelle ; Funk, Chris C. - USGS.

Keywords: *remote sensing, vegetation monitoring, NDVI, decision support*

With the development of new satellite data resources and derived products there is a flood of information for drought monitoring. Previously there were challenges to find data, but difficulty now lies in the interpretation of these differing and unique resources in a way that can aid decision makers. Understanding rainfall and related products (anomalies, percent of normal, standardized precipitation index), the Normalized Difference Vegetation Index (NDVI), crop models and other potential inputs in order to assess the conditions for crop development during the growing season. The user needs to understand the nuances of different products to capture the relevant timing and accumulation to best capture how they relate to the impacts on crop performance. Characterizing crop conditions based on these different indicators is the goal of the Decision Support Interface (DSI).

The core monitoring unit of the DSI is the primary crop-growing region of each first sub-national administrative unit. All analysis is performed on the spatially average values for that zone. Each crop zone is attributed with a crop type and start/end dekads of monitoring to indicate when the growing season generally occurs. During the monitoring season spatial averages of for select accumulation intervals of rainfall and NDVI are calculated at each dekad for each crop zone.

The Drought Monitor (DM), produced by the National Drought Mitigation Center at the University of Nebraska – Lincoln, characterized drought in five different classes and designated ranges of variables for each class of drought. These spatially averaged rainfall and NDVI values calculated above are then compared to the historical distribution to determine the percentile of the spatial average, which is then converted to a DM value.

One aspect of the DSI is the web portal allowing users to navigate through spatial and tabular representations of the calculated DM values. This website allows decision makers to get a better understanding of the severity of existing dryness, and also investigate the evolution of dry conditions. This website allows users who may not have a sophisticated understanding of statistics an opportunity to assess dry conditions and compare to previous seasons. The DSI is currently undergoing a transformation and will soon include evapotranspiration data and the Water Requirement Satisfaction Index (WRSI) values in the assessment of crop conditions over Africa.

Filtering of NDVI Time Series for Getting More Reliable Information for Drought Information

Atzberger, Clement - University of Natural Resources and Applied Life Sciences (BOKU),
clement.atzberger@boku.ac.at
Klisch, Anja; Vuolo, Francesco - Institute of Surveying, Remote Sensing and Land Information (IVFL), Vienna, Austria

Keywords: *Drought monitoring, Kenya, Whittaker smoother, MODIS*

The University of Natural Resources and Life Sciences (BOKU) in Vienna (Austria) in cooperation with the National Drought Management Authority (NDMA) in Nairobi (Kenya) has setup an operational processing chain for mapping drought occurrence and strength for the territory of Kenya using the Moderate Resolution Imaging Spectro-radiometer (MODIS) NDVI at 250 m ground resolution from 2000 onwards. The processing chain employs a modified Whittaker smoother providing consistent NDVI "Monday-images" in near real-time (NRT) at a 7-daily updating interval. The approach constrains temporally extrapolated NDVI values based on reasonable temporal NDVI paths. Drought indicators are derived from MOD13Q1 and MYD13Q1 NDVI collection 5 products of the MODIS Terra and Aqua satellites from LP DAAC (from 2000 onwards). These products are gridded level-3 data in approximately 250m spatial resolution in Sinusoidal projection with a (combined) temporal resolution of 8 days. The level-3 data are calculated from the level-2G daily surface reflectance gridded data (MOD09 and MYD09 series) using the constrained view angle – maximum value composite (CV-MVC) compositing method (Solano et al., 2010).

The offline smoothing step uses the Whittaker smoother (Eilers, 2003), (Atzberger and Eilers, 2011a) and (Atzberger and Eilers, 2011b). It smoothes and interpolates the data in the historical archive (2000 to 2012) to daily NDVI values. The smoothing takes into account the quality of the data and the compositing day for each pixel and time step based on the MODIS VI quality assessment science dataset (Solano et al., 2010). For a detailed description of the filtering procedure and settings, see (Atzberger et al., 2014). Only every 7th image corresponding to "Mondays" is stored. The 7-day interval reduces the storage load of the archive but permits at the same time an easy restoration of daily data whenever needed. From the smoothed data, weekly statistics are calculated describing the typical NDVI paths for a given location and time. This information serves for "constraining" the Whittaker smoother during the NRT filtering.

The near real-time (NRT) filtering step also uses the Whittaker smoother. However, the filtering is executed every weekend and only uses available observations of the past 175 days. Filtered NDVI images of the successive Monday are stored but also for the past four Mondays, representing different consolidation phases of the filtered NDVI (see Figure 2 "output 0" to "output 4"). Obviously, "output 4" is more reliable (e.g. better constrained through available data) compared to the "output 0" which is always extrapolated as (reliable) MODIS observations become available only after some days.

Conceptually, the VCI enhances the inter-annual variations of a vegetation index (e.g. NDVI) in response to weather fluctuations while reducing the impact of ecosystem specific response (e.g. driven by climate, soils, vegetation type and topography). To get a more concise picture of the vegetation development in the ongoing season and to identify drought-affected areas, we temporally and spatially aggregate the weekly VCI maps. Temporal aggregation includes 1-monthly and 3-monthly weighted VCI averages using the VCI images of the recent 4 and 12 weeks of the according month, respectively.

The Supply and Demand of Net Primary Production in the Sahel

Abdi, Abdulhakim - Department of Physical Geography and Ecosystem Science, Lund University,
hakim.abdi@nateko.lu.se
Seaquist, Jonathan; Tenenbaum, David; Eklundh, Lars;Ardö, Jonas - Lund University.

Keywords: *Net primary production, Sahel, supply and demand, vulnerability*

Net primary production (NPP) is the principal source of energy for ecosystems and, by extension, human populations that depend on them. The relationship between the supply and demand of NPP is important for the assessment of socio-ecological vulnerability. We present an analysis of the supply and demand of NPP in the Sahel using NPP estimates from the MODIS sensor and agro-environmental data from FAOSTAT. This synergistic approach allows for a spatially explicit estimation of human impact on ecosystems. We estimated the annual amount of NPP required to derive food, fuel and feed between 2000 and 2010 for 22 countries in sub-Saharan Africa. When comparing annual estimates of supply and demand of NPP, we found that demand increased from 0.44 PgC to 1.13 PgC, representing 19% and 41%, respectively, of available supply due to a 31% increase in the human population between 2000 and 2010. The demand for NPP has been increasing at an annual rate of 2.2% but NPP supply was near-constant with an inter-annual variability of approximately 1.7%. Overall, there were statistically significant (p < 0.05) increases in the NPP of cropland (+6.0%), woodland (+6.1%) and grassland/savanna (+9.4%), and a decrease in the NPP of forests (−0.7%). On the demand side, the largest increase was for food (20.4%) followed by feed (16.7%) and fuel (5.5%). The supply-demand balance of NPP is a potentially important tool from the standpoint of sustainable development, and as an indicator of stresses on the environment stemming from increased consumption of biomass.

Satellite data modelling: the future tool for mitigating and adapting to Food Security and Food production challenges under a changing climate in semi-arid Africa

Chirima, George J. - Agricultural Research Council-Institute for Soil, Climate and Water, Pretoria, South Africa, chirimaj@arc.agric.za

Keywords: *Satellite data, modelling, mitigation and adaptation, crop yield forecasting*

Although investment in agricultural is central to reducing poverty, food insecurity, and promoting environmental sustainability, African farmers in the low- and middle-income categories face an unconducive environment and weak incentives to invest in agriculture. Regions where hunger and extreme poverty are most widespread, investments in agriculture have been stagnant or declining, and basic infrastructure is absent. Rural smallholder farmers still face extreme poverty, weak property rights, poor access to markets and financial services, are vulnerable to shocks, and have limited ability to tolerate risk. In these regions, agriculture is predominantly rain fed and thus, the increasing frequency and severity of droughts, floods, shifts in onset of rains, and intensity of mid-season dry spells will be a major consequence of climate change. This paper outlines the use of satellite data and modelling approaches in South Africa as an option to increase food productivity and enhance the ability of smallholder farmers and the government to plan, and increase the adaptive capacity of farmers to climate change. Satellite data based modelling approaches that assess crop sensitivity to climate change, make yield predictions, provide disease and pest outbreak early warnings systems, identify where and what to plant and monitor crop development are outlined. Information dissemination platforms to smallholder farmers, which enhance their preparedness, are also discussed. In conclusion, the modelling approach enhances South Africa's ability to achieve sustainable development in line with the Millennium Development Goals.

Session 5b – Improved Climate Information

Modeling Framework for Scenarios for Major Agricultural Production Systems

Cumani, Renato - Land and Water Division, (FAO), renato.cumani@fao.org
Latham, John - FAO

Keywords: *Climate change prediction, impacts and adaptation, CLIMAFRICA*

Presentation of the results of the work package 4.1 "Scenarios of major production systems in Africa" as part of the "Climate change predictions in Sub-Saharan Africa, impacts and adaptations (ClimAfrica) FP7 project. The methodological approach is based on the FAO methodology for framework for land evaluation and agro-ecological zoning to develop scenarios of major production systems in Sub-Saharan Africa. Three main indicators are used to analyze a number of models and scenarios which include dynamic land use, climate, and CO-2 fertilization effects, considering sliding 30 year long-term averages (LTA), such as anomaly analysis (for 3 future periods) for 9 crops (rain-fed and irrigated) and 40 parameters derived from the agro-climatic assessments and climatic models outputs; changes in the suitability analysis for 12 major crops combining the FAO ECOCROP database with the agro-climatic parameters; shifts in Agro-Ecological Zones (AEZ) due to climate change and variability. The outputs of this delivery include a number of spatial datasets, tabular information, metadata and technical report.

Additional information available at http://www.climafrica.net/index_en.jsp

An Overview of WMO-GFCS Actions in Support of the Provision of Climate and Weather Information for Smallholder Food Producers in Africa

Camacho, Jose -World Meteorological Organization, jcamacho@wmo.int
Stefanski, Robert - WMO

Keywords: *Food security, climate, decision making*

After the famines of 1970-80s in the Sahel, a strong coordinated effort was made to build institutional structures where experts in food security, food production, weather and climate and communications could meet and deliver, as a single team, valuable information for users ranging from top governmental officers to smallholder farmers. The experience of the so-called Inter-disciplinary Working Groups and the experience of Roving Seminars or moving the information to the farmers by meeting them at their villages by a visit from an inter-disciplinary training team, were the key values developed by the METAGRI project in Western Africa.
From 2008 to the 2013, more than 300 Roving Seminars in Western Africa were conducted and close to 15000 farmers were trained on the use of weather and climate information enabling them to build their capacity to improve production systems, identify their problems in relation to weather and climate hazards and to apply best practices and solutions to secure food.

The Severe Weather Forecasts Demonstration project in Southern and Eastern Africa, has built up a structure to enable NMHS access to regional numerical weather prediction models outputs that can be used to derive warning and alerts on wind gusts, thunderstorms, cold and heat waves, coastal sea conditions and heavy rains. A pilot project coupling those new products and mobile phone tools was developed for users at the Uganda shores of Lake Victoria, contributing to secure fishery and transport activities through the delivery of a four color warning scheme to the fishermen. A similar project was conducted in Kasese Region (Western Uganda) providing warnings and advice to farmers in relation with climate and weather hazards. Finally, the Ethiopian National Meteorological Agency (NMAE) conducted a four year project on training of trainers in cooperation with the Ministry of Agriculture. Joint working teams have performed training from the main headquarters in Addis Ababa to small villages at the "Woredas" also performing Roving Seminars.

Development and Exploitation of TARCAT: a 30-year, Temporally Consistent Satellite Rainfall Dataset for Africa

Maidment, Ross, University of Reading, r.i.maidment@reading.ac.uk
Grimes, David; Allan, Richard; Black, Emily; Tarnavsky, Elena; Stringer, Marc - University of Reading
Hewison, Tim; Roebeling, Rob - EUMETSAT

Keywords: *precipitation, satellite, climate, trends, variability*

The sensitivity of African societies to a highly variable rainfall climate makes it important to have a good understanding of the past and present rainfall climate. A sparse and temporally inconsistent gauge network over most parts of Africa has led to merged satellite-gauge algorithms assuming greater importance. However, such satellite datasets are usually derived from an amalgamation of satellite sensors and gauge data whose proportions vary each year, potentially introducing biases into the rainfall record. Whilst such artefacts are difficult to assess Africa-wide, we have created a temporally consistent, 30-year satellite-based data set that is aimed to complement existing datasets, thus advancing our knowledge of the recent rainfall climate over Africa.

We have developed this data set by utilizing the Meteosat thermal-infra archive (1983-present) and the TAMSAT rainfall estimation algorithm. By applying climatological gauge-derived calibration parameters to the Meteosat archive, we have created the 30-year TAMSAT African Rainfall Climatology and Time-series (TARCAT) dataset. Unlike other satellite-gauge based datasets, year to year variations in TARCAT are driven purely by the Meteosat satellite observations.

Inter-comparisons between TARCAT and other long-term rainfall datasets demonstrate that TARCAT is able to replicate the spatial and seasonal rainfall patterns well. Comparisons of inter-annual variability indicates that TARCAT is similar to these datasets over the regions with most gauge coverage (Sahel, Eastern Africa and Southern Africa), although over regions where there is a shortfall in gauges, such as the Congo Basin, there are substantial differences between the datasets considered. Over such regions, rainfall trends inferred from TARCAT may be more realistic as the data are unaffected by large gauge sampling biases brought about by a temporally inconsistent gauge network. Over the whole of Africa, the differences in inter-annual variability between datasets, lead to significant differences in the long-term trends. Such inconsistencies underline the need for improved methodological understanding for robust quantification of trends in rainfall.

Enhancing National Climate Services to Agriculture in Africa

Dinku,Tinfa, International Research Institute for Climate And Society (IRI), tufa@iri.columbia.edu
Cousin, Remi; del Corral, John - IRI

Keywords: *Climate, Data, climate services, satellite, rainfall, temperature*.

The International Research Institute for Climate and Society (IRI,) in collaboration with National Meteorological Agencies and Regional Climate Centers has been leading an effort to simultaneously improve the availability, access and use of climate information at the national level. This effort, named Enhancing National Climate Services (ENACTS), focuses on the creation of reliable climate information that is suitable for national and local decision-making. Data availability is improved by blending national observations with satellite and other proxies. Data access and use is improved by providing online tools for data visualization and download and training users. The online tools are integrated into the National Meteorological Services' web pages. The ENACTS approach has five major components:

1.   Building technical capacity at the National Meteorology Agency to generate and use climate information;
2.   Generating over a 30-year of rainfall and 50-yeasrs temperature time series for every 4 km grid across each country;
3.   Customizing and installing the very powerful IRI Data Library at the National Meteorology Agencies;
4.   Developing an online mapping service providing user-friendly tools for the analysis, visualization, and download of climate information products; and
5.   Engaging stakeholders on the use of new products and services, training them on available tools, as well as incorporating their feedbacks and requirements into further product development.

The ENACTS approach overcomes traditional barriers in data quality and access. The spatially and temporally continuous datasets allow for characterization of climate risks at a local scale, and offer a low-cost, high impact opportunity with major potential to support climate-resilient development. Making this type climate information available to the agriculture community supports a suite of solutions that can shore up development gains and improve the lives of the most vulnerable in the face of climate variability and change.

ENACTS has so far been implemented in Ethiopia, Madagascar, Tanzania, Rwanda, and The Gambia at national levels, and at the regional level for the CILSS countries. It is expected to be implemented soon in Ghana, Mali and Burkina Faso.

Session 6 – Linking Information and Decision Making: Risk Management Systems Inputs and Outputs

Drought Early Warning Phase Classification for Disbursement of Contingency Funds

Luminari, Luigi - NDMA National Drought Monitoring Authority, Kenya,
luigi.luminari©dmikenya.or.ke

Keywords: *Drought Contingency Funds (DCFs): Early Warning System (EWS); Drought Cycle Management (DCM) drought indicators and triggers*

The traditional reaction to drought and its effect has been to adopt a crisis management approach. This reactive approach is not good policy and should be replaced by a risk management approach which is anticipatory and preventive. The National Drought Management Authority (NDMA)'s function is to protect the livelihoods of vulnerable households during drought. NDMA uses Drought Contingency Funds (DCFs) to finance drought mitigation activities.

The disbursement of DCFs is based on the Drought Cycle Management (DCM) approach. The DCM model identifies five drought-warning stages based on drought monitoring data, i.e. (i) normal, (ii) alert, (iii) alarm, (iv)emergency, and (v) recovery. The phases of DCM are triggered by a set of indicators that include both biophysical indicators measuring the severity of drought and socio-economic indicators showing impact of drought. By combining the two sets of indicators it is possible to define the specific EW Phase as shown below:

NORMAL: The normal phase occurs when all *drought indicators show no unusual fluctuations* and remain within the expected ranges for the time of the year
ALERT: The alert phase is declared when some *environmental indicators show unusual fluctuations outside expected seasonal ranges*
ALARM: The alarm phase occurs when environmental**, *production and access indicators fluctuate outside expected seasonal ranges* affecting the local economy.
EMERGENCY: In the emergency phase*, all indicators are outside of normal ranges*, local production systems have collapsed within the dominant economy.
RECOVERY: Environmental *indicators returning to seasonal norms*.

The trigger points between warning stages are defined through the combination of four categories of drought indicators: environmental indicators (impact on biophysical); production indicators (impact on production, i.e. crops and livestock); access indicators (impact on markets and access to food and water), and utilization indicators (impact on nutrition and coping strategies)

The DCF business process provides a clear outline of the systems and procedures that are used to regulate the disbursement of drought response funds. In particular, the drought EWS provides a number of objective indicators to measure the severity of drought and its impacts on the populations exposed to drought risks. The declaration of the EW phase depends on the combination of biophysical and drought impact indicators with the use of specific thresholds that signal the shift from one phase to the next. This methodology contributes to enhance transparency and accountability in the use of DCFs and cushion against politically motivated false alarms.

Sustainable Livestock Insurance for Pastoralists - Evidence and Insights from the Index-Based Livestock Insurance programs in Kenya and Ethiopia

Mude, Andrew - International Livestock Research Institute, a.mude@cgiar.org

Keywords: *weather-indexed insurance, livestock, Kenya, Ethiopia*

One problem inspires the ILRI's IBLI agenda: Finding a sustainable way to help pastoralists to quickly recover from the considerable livestock losses they incur during severe droughts. Our objective is to develop a risk-management solution that is market-based and focused on the provision of complementary services that could enhance pastoralist livelihoods as a whole.

The IBLI agenda has problem-driven from the outset with needs and challenges identified through extensive survey work and interaction with the target community. Among others, the agenda incorporates:

- Elements of institutional innovation to engage regulatory and other agencies on a new concept in insurance provision and financial service delivery;
- Partnership development to rally commercial, governmental, and other entities into novel public-private agreements to support provision of the product;
- Extension and marketing efforts to educate the target clientele and their representative institutions on a previously alien concept;
- Cutting edge science using novel techniques at the intersection of spatial econometrics and remote sensing for contract design; and a rigorous research design for impact assessment to analyze the welfare benefits of IBLI.

IBLI contracts are being offered by insurers in 5 counties of Northern Kenya and by an Ethiopian insurer in the Borana zone of Southern Ethiopia. In order to evaluate the impact of the insurance scheme, ILRI carried out a baseline survey of over 900 Marsabit households in October 2009 which was then repeated annually to track the dynamics and drivers of change. A similar survey was launched in Borana, Ethiopia, in March 2012 covering 515 households. This produced a body of information upon which IBLI impacts across a range of key livelihood indicators could be assessed, with the same households resurveyed annually for comparisons to be made. IBLI has been shown to have positive impacts ranging from improved livestock productivity and income, to enhanced livelihood resilience and better nutritional outcomes.

The Role of TAMSAT's pan-African Rainfall Products for Weather-Related Risk Assessment

Tarnavsky, Elena - TAMSAT, e.tarnavsky@reading.ac.uk

Keywords: *Africa, rainfall products, risk assessment*

Since the 1980s, TAMSAT (Tropical Applications of Meteorology using Satellite data and ground-based observations) research group at the University of Reading have provided near real time satellite-based rainfall estimates and derived products mainly for drought monitoring carried out by national meteorological agencies (NMAs) and agricultural extension services in African countries. The coverage of the TAMSAT rainfall estimates was limited to respective rainy seasons in the Sahel and southeastern Africa.

Recent efforts to assess weather-related risk (e.g. for provision of agricultural weather index based insurance) highlighted the need for information on historical rainfall occurrence and amount derived from a long-term and temporally consistent record with continent-wide coverage that is also accurate in both space and time, available in near-real time, and preferably, accompanied by information on uncertainty and skill scores. In order to provide the required capabilities for assessing anomalous weather conditions (below- or above average rainfall) across Africa, in 2011 we completed the extension of TAMSAT's coverage to the entire continent and back to 1983, providing a 30+ years of internally consistent dataset termed TARCAT (TAMSAT African Rainfall Climatology and Time-series). TARCAT v2.0 is derived from Meteosat thermal infra-red (TIR) imagery record calibrated against 28-year (1983-2010) gauge-based climatology and hence, TAMSAT's rainfall estimates are not susceptible to bias that is due to varying gauge data input or calibration parameters over time.

As part of TAMSAT's pan-African operational rainfall monitoring, daily, dekadal (10-daily), monthly, and seasonal rainfall estimates are produced at the end of a 10-daily time period (1st, 11th, and 21st of each month for the preceding 10 days (dekad), or in 8-11 days for the last dekad of the month) at approximately 4-km spatial resolution. Through monthly validation reports, which include a set of commonly used statistical measures of skill, we compare TAMSAT's dekadal rainfall estimates for each month's three dekads to gauge observations from gauges reporting on the World Meteorological Organization (WMO) Global Telecommunications Stations (GTS) network. TAMSAT data are disseminated to users in near-real time through our web site1 and EUMETSAT's data broadcasting service, GEONETCast. For example, TAMSAT's 10-daily rainfall estimates and anomalies calculated against a 30-year climatology are used in JRC's ad-hoc drought monitoring bulletins (e.g. drought in Namibia in 2012/2013), and skillfully capture flood events (e.g. floods in Namibia in March 2014 and in Nigeria in August 2014).

Access to Information and Price Expectation of Smallholder Farmers in Ethiopia: Theory, Empirics, and Policy Implications

Haile, Mekbib G., Bonn University, mekhaile@uni-bonn.de
Kalkuhl, Matthias, Bonn University

Keywords: *price expectations, smallholders, Ethiopia, distance to market*

Price expectation plays a crucial role in production, marketing and agricultural technology adoption decisions of farmers. Using survey data from rural Ethiopia, this study explores the role of access to information – measured by access to Information and Communication Technologies (ICTs) – on the quality of smallholder farmers' price expectations. The empirical findings suggest that farmers who invest more in acquiring better price information and who reside closer to grain markets are more likely to have smaller price forecasting error margins. Nevertheless, the effect of distance to grain markets vanishes among household who have access to information. On the contrary, farmers with high discount rates are more likely to have larger forecasting errors. Accordingly, it might be necessary for the government to provide market information as a public good through organized market information systems (MIS). Thus, improving both information and physical infrastructure is vital. Our simulation analysis shows that there is a significant production loss that would be saved if the government invests in providing information access to smallholders in the country.

Improving Agricultural Risk Management in Sub-Saharan Africa: Remote Sensing for Index Insurance

Gilliams, Sven - VITO, <u>sven.gilliams@vito.be</u>

Keywords: *weather-indexed insurance, relevance of remote sensing, West Africa*

The Weather Risk Management Facility (WRMF) was established by the International Fund for Agricultural Development (IFAD) and the World Food Programme (WFP) in 2008 to reduce smallholders' vulnerability to weather and other agricultural production risks, to encourage and protect investments in smallholder agricultural production, and to enhance food security. In 2012, with financial support of the "Agence Française de Développement" (AFD), WRMF began implementing an innovative project managed by the team at IFAD, which is designed to evaluate the feasibility of satellite-based technology for index insurance to benefit smallholder farmers at village level. This project aims to contribute to finding a sustainable approach to index insurance that can help smallholders better manage their risks – due to weather, but also other perils. The project will run to 2017, and it is focused on testing in Senegal, but with lessons applicable to the entire sector.

A wide range of different actors working in remote sensing, insurance and reinsurance, aid and development, and agricultural research are united in the project. Seven remote sensing service providers (RSSPs) were selected according to the project's needs to test a variety of relevant remote sensing approaches. The selected RSSPs are: EARS, FewsNet, GeoVille, IRI, ITC, Sarmap, and VITO. The different techniques being tested range from vegetation indices, to remote sensing-based estimations of rainfall, soil moisture, and evapotrans-piration. Each RSSP was supported by the project team on how to develop index insurance structures, and each was encouraged to introduce any potential innovation in product design that would be compatible with the methodologies they had developed.

After each croping season,VITO as the Technical Coordinator, leads the performance analysis exercise which analyses and presents the technical performance of the different remote sensing methodologies using historical field data and validating against contemporary season ground data.

The African Risk Capacity (ARC) – Linking Early Warning to Early Action

Doehnert, Federico - African Risk Capacity, federico.doehnert@africanriskcapacity.org

Keywords: *African Risk Capacity, Africa RiskView, African Union, Early Warning, Drought, Risk Financing, Drought Insurance, Capacity Building, Index-Based Weather Insurance*

The *African Risk Capacity* (ARC) is a ground breaking extreme weather insurance mechanism designed to help African Union Member States resist and recover from the ravages of drought and other natural hazards. ARC is an African solution to one of the continent's most pressing challenges, transferring the burden of climate risk away from governments – and the farmers and pastoralists whom they protect – to the ARC that can handle that risk much better. This African-owned, AU-led financial entity uses *Africa RiskView*, an advanced satellite weather surveillance software to estimate and trigger readily available funds to African countries hit by severe drought.

The objective of *Africa RiskView* (ARV) is to estimate the number of people affected by a drought event during a rainfall season and then the dollar amount necessary to respond to these affected people in a timely manner. To do this, ARV translates satellite-based rainfall information into near real-time impacts of drought on agricultural production and grazing using existing operational early warning models; by then overlaying this data with vulnerability information, the software produces a first-order estimate of the drought-affected population, and in turn response cost estimates. Through this process, ARV combines four well-established disciplines: crop monitoring and early warning, vulnerability assessment and mapping, operational response, and financial planning and risk management. It covers all of Africa's different rainfall seasons and employs four basic information layers that are joined to estimate drought response costs per season. The layers, in subsequent order of interaction in ARV analysis, are: rainfall, drought index, estimated populations affected and estimated response costs. ARV thus allows to monitor the progress of different rainfall seasons in near real-time, and to estimate the potential impact on vulnerable populations on the ground.
The software converts the numbers of affected people into response costs in a fourth and final step. For countries participating in the insurance pool, these national response costs are the underlying basis of the insurance policies. Payouts are triggered from the ARC Insurance Company Limited – the commercial affiliate of the ARC Agency – to countries where the estimated response cost at the end of the season exceeds a pre-defined threshold specified in the insurance contracts. They are disbursed within 2-4 weeks of the end of the rainfall season, thereby allowing participating countries to begin early intervention programmes before vulnerable populations take negative coping actions.

Four countries form the first ARC Risk Pool (Kenya, which is insuring two seasons, Mauritania, Niger and Senegal). Due to the poor performance of the 2014 rainy season in West Africa, Mauritania, Niger and Senegal have received payouts totalling more than US$ 25 million by the ARC Insurance Company Limited in January 2015, ahead of the 2015 humanitarian appeal for the Sahel. The experiences of the first ARC insurance pool in 2014/15 highlight the functioning and purpose of ARC, which effectively links traditional early warning tools and practices to a transparent funding mechanism, to enable African governments to implement early action to vulnerable populations.

The importance of Market Information Systems for Food Policy Design: an Overview of Two Case Studies

Araujo Bonjean, **Catherine - CNRS, CERDI, University of Auvergne, France**
c.araujo-bonjean@udamail.fr
Brunelin, Stephanie - Consultant, World Bank

1. Preventing food crises by using price signals

The study covered three countries - Burkina Faso, Mali, and Niger – which have devoted significant efforts to the monitoring of agricultural markets since the end of the 80s. Analyses are based on data collected by national MIS and focused on millet which is the main food crop in the region and the staple diet. Millet is a regional good which price is given by local conditions of supply and demand and exhibits a quite regular seasonal pattern. These two important characteristics of prices are exploited to define warning indicators for a price upsurge and to identify leading markets at the regional level.

Warning indicators are based on the spread between the current price and its trend value. Comparing actual price and trend value allows to identify alert and crisis periods. Most episodes of price spikes are preceded by a period of abnormally high prices, during the harvest and post-harvest season. These indicators perform quite well and the WFP adopted this methodology to calculate alert indicators for price spikes (ALPS) for a wide range of markets worldwide.

Leading markets are defined as markets which actual prices help to predict future prices in distant markets. This is the case of the Maradi market which should be given particular attention in the early warning disposal. The importance of this particular market appears also when examining the propagation process of the 2005 crisis in the three countries.
Results argue for a regional approach to food insecurity based on a regional early warning system. It means enhancing market information systems in each country, sharing information at the regional level and setting up a regional disposal for price monitoring and analysis.

2. Assessing the effectiveness of regional integration

Analyses based on formal recorded trade data in Sub-Saharan Africa omit an important element of economic activity, namely informal cross-border trade. Informal cross-border trade is vibrant in Sub-Saharan Africa, especially in agricultural commodities. It plays a crucial role in ensuring food security by allowing food commodities to move from food surplus production zones to deficit consumption zones.

In the absence of reliable agricultural trade statistics, prices of agricultural commodities can be used to understand how agricultural markets are connected. Our results highlight the role played both by distance and borders in explaining price deviations between markets. Overall, distance seems to lead to larger price differentials between markets than borders. However, the average border effect hides large discrepancies by bilateral borders. We find that countries not members of WAEMU or ECOWAS have larger borders. Belonging to an economic union and sharing the same currency appear as major determinants of market integration. Our results argue in favor of deepening regional integration within West African countries. Besides, our research underlines the importance of providing adequate hard infrastructure in order to reduce the role played by distance.

The Performance of Weather Index Insurance Systems and Data Requirements

Sarris, Alexandros - Department of Economics, University of Athens, Greece, aleko@alum.mit.edu

Production and market risks affect agricultural and especially smallholder households in ways that make and keep them poor, because of the need to self-insure by accumulating unproductive assets. Hence reducing risk via insurance could have significant development impacts. Traditional agricultural insurance (based on individual loss assessment) is costly and susceptible to moral hazard and adverse selection, and hence uneconomic for smallholders. It also has a poor performance record. Weather index insurance (WII) on the other hand, where indemnity is based on a cheap to measure index, is much less costly, and eliminates moral hazard and adverse selection. In order for WII to be appropriate, the index must be correlated with individual losses.

Experience with WII in Africa has included drought insurance for pastoralists in Kenya, with an index based on NDVI, and which seems to have payout correlated with drought livestock losses, and has induced reductions in asset sales and reduced meals by poorest households. Such positive impacts can be had when farmers get paid when losses occur. This, however, is not always easy due to so-called basis risk. Nevertheless recent contract design innovations such as indices based on satellite information, or contracts combining a rainfall index with crop cutting, reduce basis risk. The ex-ante uptake of WII theoretically depends on basis risk, learning and understanding and cost and price of the contracts. In actual experiments (e.g. in Ethiopia) the uptake depends mostly on cost factors, such as the amount of premium subsidy, and is not related to ex-ante willingness to pay for WII. Uptake is highest among those farmers who use high amounts of fertilizer, suggesting that WII is used for protection, and may not induce additional fertilizer use and hence productivity increases.

It appears that the greatest payoff in future WII work is in designing flexible finance-cum-insurance packages to allow transfers to households in times of income shocks, by combining WII with savings. Available weather station data is insufficient for designing WII contracts. Need to combine all sources of ground based and satellite based information.

Session 7 – Integrated Analysis Approaches for Linking Information to Decision Making

1. Integrated Analysis Methods

IPC: Promoting Continent Wide, Comparable, Standardized, Food Security Information for Decision Making

Holleman, Cindy - FAO, cindy.holleman@fao.org

Keywords: *IPC; Food Security Analysis; Africa; Informing decision-making; Food Security Standards; Continent-wide analysis*

The Integrated Food Security Phase Classification (IPC) is a multi-partner initiative to inform food security policy and programming, contributing to the global food and nutrition security. IPC consists of standardized protocols for classifying both acute and chronic food insecurity, thus improving the rigor, transparency, and comparability of food security analyses for decision makers. In practice, an IPC analysis provides key information on: the severity of the situation (How bad), most affected areas (Where), the magnitude of the problem (How many), the duration and timeframe (When), the population most in need (Who), and the driving factors (Why).

In Africa, IPC and the partner initiative *Cadre Harmonisé* (CH), led by CILSS, have potential to provide continent-wide, comparable food security information for decision making. IPC and CH analyze data from existing national information systems, by applying internationally recognized standards, developed in the African context. IPC has been already adopted by over 19 governments in Africa and all over the world. Building on this experience, the IPC Partnership is working to respond to the increasing demand for enhancing and expanding IPC within the African continent. To this purpose, the IPC Global Steering Committee has launched the IPC Global Strategic Programme 2014-2018 (GSP). The GSP is interlinked to Regional Strategies and outlines an action plan for addressing challenges at country level.

As shown by the IPC Impact and Use Baseline Study, conducted in 2014, IPC encourages a broader understanding of food security, particularly among high-level policy makers and government stakeholders. This is the reason why countries affected by acute food insecurity have incorporated IPC into national food security policy mechanisms. For instance, IPC is fully led by the Kenya Food Security Steering Group (KFSSG) to guide national and district level plans. IPC has also had strong influence on resource allocation in crisis-prone countries, where IPC products are effectively used in regular humanitarian appeal processes (e.g. in Somalia, South Sudan, Democratic Republic of the Congo, and Central African Republic). Moreover, IPC acute and chronic analyses help governments, UN agencies, NGOs and donors design short-, medium- and long-term strategic plans, based on reliable assessment and analysis. In this context, IPC protocols are also useful for monitoring and evaluation of food security programs.

There is unanimous agreement among stakeholders that IPC multi-partner processes have contributed to improved coordination and collaboration among food security actors in participating countries. For instance, in Somalia, an NGO consortium (SomReP) is using IPC as a basis for designing a resilience program, while in South Sudan IPC is playing an active role in building evidence-based

technical consensus on the severity of food insecurity**,** producing coordinated and unified messages for decision makers.

Food and Nutrition Security Assessment and Needs for Decision Making. What we Know so far and What is Missing?

Nkunzimana, Tharcisse - JRC, tharcisse.nkunzimana@jrc.ec.europa.eu

Keywords: *food security, nutrition, assessments, decision making, data*

On one hand, the objective of the presentation was to show some key elements that help decision makers to decide from the outputs of integrated methodologies in food and nutrition security assessment. Linking information do decision making and actions: risk management systems inputs and outputs. On the other hand, the second objective was to highlight the questions still need to be responded. Estimation of the population in need, the targeting of both vulnerable and people at risk, the communication of the output content to the beneficiaries are some areas where improvements are highly needed.

Measuring Resilience: the FAO Resilience Index Measurement and Analysis (RIMA) model

Russo, Luca - Agricultural Development Economics Division, FAO,
luca.russo@fao.org

In a food-insecure household with low resilience, even small changes can be devastating. As resilience declines, it takes an increasingly smaller external event to cause a catastrophe. Working with partners, FAO has developed a methodology to measure households' resilience to food security threats caused by natural and human-induced shocks. FAO's Resilience Index Measurement and Analysis (RIMA) model identifies and weights what factors make a household resilient to food insecurity and traces the stability of these factors over time. It provides an evidence base to more effectively design, deliver, monitor and evaluate assistance to populations in need, based on what they need most.

Against this background, the presentation briefly illustrated the concept of resilience and provided a working definition for its measurement and analysis. It then presented the key challenges in measuring resilience (e.g. different units and levels of analysis, context specificity, and outcome of interest, population of interest, shock specificity, data availability and dealing with resilience as a dynamic concept). The RIMA model uses the Household as unit of analysis and through a two stages factorial analysis identifies resilience dimensions and related contributing factors. The presentation then briefly outlined some case studies from different countries (Niger, Kenya, Somalia, Burkina) illustrating different use of the RIMA model for decision making (targeting, Programme and policy and investment design and impact assessment). It also illustrated an example of mixed method approach employed in Somalia, by FAO, UNICEF and WFP, where RIMA has been integrated with more qualitative approaches. Finally, the presentation illustrated on-going efforts in terms of technical development of Resilience Measurement and the technical support provided by FAO and partners in establishing resilience analysis and measurement capacities in the Sahel and in the Horn of Africa through CILSS and IGAD.

Household Resilience for Food and Nutrition Security: Empirical Evidence from Rural Households in Ethiopia

Tefera, Nigussie - JRC, nigussie.tefera@jrc.ec.europa.eu
Kayitakire, Francois - JRC

Resilience is a multidimensional concept consisting of three interconnected capacities: absorptive, adaptive and transformative capacities. Resilience programming outcomes could be measured in terms of improvement in wellbeing such as food and nutrition security, health status or related factors. This study, using Ethiopia Rural Households Survey data in 2004 and applying Structural Equation Modeling (SEM), shows building resilience significantly influences household per capita consumption and vice-versa; there is a non-recursive process between resilience and household per capita consumption. Moreover, resilience (a latent variable) significantly influences absorptive and transformative capacities (latent variables by themselves). Further analysis reveals absorptive capacity of the households positively and significantly influences household per capita income (crop, livestock, on-farm and off- farm wage income), total livestock owned (in TLU), cultivated land (in ha), and involvement in social network (*iddr, equb, wonfel/debo)* as well as borrowing and lending (in-cash or in-kind) among community members. Furthermore, transformative capacities is positively and significantly influences use of modern technologies such as fertilizer, irrigation scheme, and advice/services from extension agent as well as access to basic information services. Thus, we conclude building resilience means improvement in consumption level, increase in income, avoid depletion of assets at household level such as livestock as well as investment on landholdings, use of modern technologies (agricultural inputs) as well as participation in social network so as to withstand future shocks and stresses, will it occur, and reducing the need for humanitarian response.

2. Capacity Building

Improving Statistics for Food Security, Sustainable Agriculture, and Rural Development: An *Action Plan for Africa 2011-2015*

Ilboudo, Joseph - African Center for Statistics, United Nations Economic Commission for Africa, jilboudo@uneca.org

The Global Strategy for Improving Agricultural and Rural Statistics is an initiative of the United Nations Statistical Commission and partnership between International Agencies, developed and developing countries. The purpose of the GS is to provide a framework to enable national and international statistical systems to produce the basic information to guide decision-making in the 21st century. The strategy has three components, one of which is Training in Agricultural Statistics. The UNECA is the implementing partner for this component since is onset. The overarching objective of the training component is to ensure improved capacity to produce, disseminate and use quality agricultural statistics**.** The training component attains this objective via strengthening the supply, demand and capacity for the provision of agricultural statistics. On the supply side, it focuses on expanding the availability of training in agricultural statistics through the development and adoption of research outputs and strategies into training curriculum, modules and syllabi, developing training courses in new adopted methods in agricultural statistics. On the demand side, the component implements a short and long term scholarship programmes for those experts working in agricultural statistics agencies to study towards postgraduate diploma and masters in Agricultural statistics. On the capacity development aspect, the training component helps strengthen the statistical training centers in Africa with infrastructure support to help improve the training process by supplying state of the art technological aids and software for training. At the same time, the component also provides technical support for agricultural statistics agencies in the continent to identify and prioritize their training needs as well as efficiently manage their agricultural statistics human capital. The component does this by capacitating human resource managers in these agencies through tailored frameworks and policy guidelines for agricultural statistics human capital development.

The GeoCLIM Software for Gridding and Analyzing Precipitation and Temperature Data

Magadzire, Tamuka - FEWS NET, SADC FANR, Gaborone, Botswana, tmagadzire@fews.net
Funk, Chris; White, Libby, - UCSB,
Pedreros, Diego; Rowland, James; Verdin, James - USGS,
Galu, Gideon – FEWS NET - USGS

Keywords*: gridding, temperature, rainfall, climate trend, in-situ stations, station-satellite blending interpolation, GeoCLIM, CHIRPS, BASIICS, SPI*

The GeoCLIM is an analytical software tool that facilitates climatological analysis of historical gridded rainfall and temperature data, providing decision support in sectors like climate-smart agricultural development. Analytical processes within the GeoCLIM enable the user to develop a better understanding of different aspects of the local and regional climate through the calculation of various statistical parameters such as median, coefficient of variation, and percentiles, for both rainfall and temperature. Additionally, the software facilitates the calculation of climate trends over long periods of time, usually 30 years or more. GeoCLIM also provides users with the capability to analyze current climate conditions, including calculation of the standardized precipitation index, and GeoCLIM-generated datasets can be used in downscaling of future climate scenarios. The software supports the use of a variety of gridded rainfall and temperature datasets, one of which is the Climate Hazards Group Infrared Precipitation with Stations (CHIRPS) dataset, a freely available, quasi-global, 30+ year pentadal rainfall dataset that incorporates satellite imagery with in-situ rain gauge data. In the absence of nationally maintained, higher density rain gauge station data, CHIRPS allows users to work with the GeoCLIM to analyze historical climate trends. For example, using the CHIRPS data, GeoCLIM analysis suggests that December to March seasonal rainfall totals have increased on average between 1981-82 and 2012-13 in central parts of the southern Africa region, and decreased in the northern parts of the region. Where locally maintained in-situ station data are available, the GeoCLIM provides a module to blend the station data with background gridded datasets such as CHIRPS and other gridded climate data, thereby helping to fill in observational gaps in often-sparse in-situ data networks. Various GIS-type utilities are included with the GeoCLIM to allow the user to map the results of climatic analyses. Extraction of polygon-aggregated statistics facilitates building of time series for inter- and intra-seasonal analysis, and scripting utilities enable the automation of repetitive analytical processes. A comprehensive set of training resources are also available for GeoCLIM, including a detailed manual, video tutorials, and training PowerPoint files. Due to the importance of a collaborative approach to developmental issues, future plans for GeoCLIM include improved inter-operability with similar and related developmental initiatives.

Strengthening Capacity in Crop Monitoring with Remote Sensing for Food Security

Rembold, Felix - JRC, felix.rembold@jrc.ec.europa.eu

Keywords: *food security, food production, monitoring, remote sensing, capacity building*

Since 2001 the FOODSEC group in JRC has been monitoring agricultural production in food insecure areas by using agro-meteorological data and remote sensing. The results of this near-real time monitoring is usually summarized in crop monitoring bulletins. Most of the processing going from original satellite images, ground data and auxiliary data to the final bulletin, is done by using software tools produced in house in collaboration with VITO (BE). These tools are freely shared and training in remote sensing and times series data processing has been provided to numerous partner organizations in Africa. This presentations shows 2 of the main examples of training material produced over the years:

An E-learning module produced together with FAO and entitled: Remotely sensed information for crop monitoring and food security. The target audience for the module are: a) Food security analysts with different who are commonly confronted with spatial data including remote sensing derived information when it comes to the analysis of early warning products and crop monitoring bulletins in food insecure countries; and b) crop monitoring experts who want to deepen their understanding of remote sensing products in a food security context. More info on the course can be found at:

http://www.fao.org/elearning/#/elc/en/course/FRS.

A free software for Processing and Interpreting Remote Sensing Image Time Series (SPIRITS). The SPIRITS software is a stand-alone toolbox developed for environmental monitoring, particularly to produce clear and evidence-based information for crop production analysts and decision makers. It includes a large number of tools with the main aim of extracting vegetation indicators from image time series, estimating the potential impact of anomalies on crop production and sharing this information with different audiences. SPIRITS offers an integrated and flexible analysis environment with a user-friendly graphical interface, which allows sequential tasking and a high level of automation of processing chains. It is freely distributed for non-commercial use and extensively documented. The website offers download of the software, information and data: http://spirits.jrc.ec.europa.eu/

AGRICAB – Enhancing African EO Capacities for Agriculture and Forestry Management as contribution to GEOSS

Jacobs, Tim - Flemish Institute for Technological Research (VITO), **Belgium; on behalf of the AGRICAB project consortium, tim.jacobs@vito.be**
Gilliams, Sven, VITO.

Keywords: *capacity building, agriculture, forestry, Earth Observation, GEOSS*

Earth Observation (EO) contributes significantly to the information needed to sustainably manage agriculture and forest resources, which affect the livelihood of millions of people in Africa, and is therefore integrated more and more into the daily work of African institutes. With a focus on reinforcing those existing EO capacities, the project entitled 'A Framework for enhancing earth observation capacity for agriculture and forest management in Africa as a contribution to GEOSS' (AGRICAB, http://www.agricab.info) was launched in Oct 2011. To achieve its goals, the project builds upon 17 partners located in 12 different countries: 6 in Europe, 10 in Africa and one in South America.

The project is focused on the development of national-level use cases related to monitoring and management of agriculture (crop yield forecasting, crop mapping, statistics, early warning), livestock & rangeland and forest and fire, covering study areas in Kenya, Mozambique, Senegal, South Africa, Tunisia and Niger. Underpinning those efforts, its capacity building framework furthermore includes (i) reliable data retrieval through, among others, GEONETCast satellite broadcast and online sources, (ii) improvements to the data exchanges between free software tools, (iii) training and enhancing freely shared training materials and (iv) networking and awareness raising. The latter are all opened to wider, international scales, involving for instance UN bodies, Africa's continental (AUC) and economic regions (e.g. AMESD/MESA) and even the global GEO (in collaboration with AfriGEOSS).

With the project drawing to a close in March 2015, its achievements are reviewed, in particular focusing on training events and their impact and the sustainability of the efforts is discussed.

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