Scenario-based Landscape Planning

Influencing Decision-Making through Substantive Outputs and Social Learning

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Abstract

Many landscapes today experience intense anthropogenic influences that increasingly diminish their capacity to provide the ecosystem services humanity depends on. Counteracting these trends and navigating transitions towards more sustainable development is complex and one of the central challenges facing society.

Scenario-based landscape planning (SLP) is arguably well positioned to support decision processes concerning sustainable landscape development. It is increasingly applied in case studies around the world – the actual influence of generated knowledge on policy and decision making is however often limited.

The objective of this cumulative dissertation thesis is to enhance the understanding and influence of SLP in decision making concerning sustainable landscape development. The thesis examines implementation relevant properties of SLP and explores ways of integrating participatory approaches in SLP, focusing on two interrelated research questions: (A) What mechanisms and criteria of influential SLP outputs can be identified? (B) How can SLP facilitate social learning that enhances the understanding and skills of relevant actors for informed and cooperative decision making?

Key research approaches are literature analyses, case studies, planning experiments, and action research. Different qualitative and semiquantitative methodologies were employed, including participatory scenario development and exploration, content analyses, interviews, surveys and observations.

The first three papers address research question A. Paper I merges insights from relevant literature to identify mechanisms and criteria of influential outputs of scenario-based planning in general. It finds that influence depends strongly on suitable context conditions and that influential projects create or exploit policy windows of opportunity. A prior proposition of perceived credibility, salience, legitimacy and creativity as criteria of influential scenario outputs is confirmed and further specified. The paper closes with a discussion of trade-offs between the criteria.

Paper II tests the usefulness of the identified criteria to explain differences in influence of two SLP case studies in the USA. Both cases employed C. Steinitz' Framework for Alternative Futures Studies, but differ in context, the way of implementation, and effectiveness. The analysis confirms, concretizes and differentiates the criteria for application in landscape planning. It suggests that influential SLP outputs achieve at least minimum levels of compliance with all four criteria, and that diverse actors may evaluate the level and importance of the criteria differently.

Based on insights from nine European case studies, paper III explores approaches for designing and conducting SLP projects likely to result in outputs complying with the criteria of influence. It finds that promising projects consider the specific context conditions and user needs, systematically involve interested and affected actors, promote transparency of methods, outcomes, and uncertainties, and provide decision-relevant results. Methodological insights from the case studies are provided, for example to enhance salience through improving the connections to existing legal frameworks and illustrating economic impacts.

Taken together, the three papers suggest that compliance with the identified criteria indeed improves the chances of SLP output influence, but that actual consideration in decisions is also determined by external factors as well as relevant understanding and skills of affected actors. The second set of papers therefore addresses research question B to investigate how SLP can support the enhancement of these capacities of relevant actors through facilitating social learning.

Paper IV assesses the degree to which five recent SLP projects from Australia, Switzerland and the USA already fulfill requirements for social learning facilitation. Considered requirements, as derived from literature analysis, include diverse participants and methods, small group work, repeated meet-

ings, and participants' influence on process design. The analysis finds a few planning steps in the case studies that seemed to implement these features. However, it also realized that social learning was not explicitly strived for in the projects and that valuable opportunities for social learning facilitation were left unexploited.

Paper V uses a planning experiment to empirically investigate possible social learning outcomes of SLP with benefits for decision making. Building on the Alternative Futures Framework, an approach for participatory SLP is developed and tested in a three-month climate adaptation planning process involving up to 37 local actors in Gartow, Germany. The evaluation of social learning outcomes follows the premise of action research and employs a mixed-method approach. The research shows that when done well, SLP can successfully generate social learning outcomes among participants. Observed social learning outcomes include gains in substantive knowledge (e.g. on climate change impacts), procedural knowledge (e.g. on alternative adaptation strategies), understanding of different perspectives, as well as social and technical skills. Participants named several potential impacts of social learning outcomes on their future decision making, including enhanced awareness, altered agendas, and better social relations. The SLP process and its results formed the basis and inducement for further collaboration of local actors and external consultants in the development of a coordinated mission statement (*Leitbild*) for climate change adaptation. The *Leitbild* was unanimously decided for by the Gartow Community Council and shall be used as a guiding framework for future decision making concerning landscape development.

Paper VI investigates possible effects of an educational SLP workshop on social learning outcomes among participating graduate students, focusing on changes in conceptual planning understanding and skills. The workshop concerned future landscape development in the region of Cagliari, Italy, followed the Alternative Futures Framework and involved local stakeholders as well as 30 graduate students from different nationalities and disciplines. The results suggest that SLP workshops can enhance students' planning understanding and improve relevant skills with differences in the acquisition of sub-aspects. Particularly useful features for learning facilitation were iterative planning, the development of proposals as synergies of ideas from various student teams, and to require students to adopt several different perspectives within the SLP process. Some challenges and opportunities are discussed and recommendations for improving SLP workshop conduct and evaluation provided.

A final study (paper VII) assesses potential benefits of social learning outcomes for collective decision making. More specifically, it analyzes how learning outcomes can help addressing the problem of scale, one of the greatest challenges of knowledge to action transfer. The case study was the evolution of climate change adaptation governance in the Norfolk Broads landscape, UK. The paper found that the exchange of knowledge between actors from different disciplines and spatial levels in participatory planning processes can facilitate social learning. The social learning outcomes gained from this process lead decision makers to more strongly integrate participatory approaches in subsequent planning processes and to establish an intermediary organization as a platform for regional governance. These measures helped to enhance the salience of subsequent assessments and to mainstream climate change adaptation in regional planning policy.

The thesis shows that both strategies for enhancing SLP influence – either through improving perceived SLP output quality or through facilitating social learning – are of importance. The strategies can effectively complement each other, in particular when pursued in consecutive SLP cycles that first emphasize social learning facilitation and later focus on developing SLP outputs as direct basis for decision making. However, implementing the two strategies may also be confrontational when pursued simultaneously.

Although applications of SLP differ significantly, some general shortcomings of conventional SLP projects for yielding influence on decisions can be identified. Some projects only limitedly respond to challenges of the particular decision context and insufficiently adhere to decision-relevant aspects for potential users. Often, relevant actors are insufficiently involved in all steps of the SLP process.

SLP projects only partly comply with the criteria of influential SLP outputs and do not exploit valuable opportunities for facilitating social learning. Another deficit is that many SLP processes are not framed as part of the longer-term governance processes required for navigating transitions towards sustainable landscape development.

A framework for SLP was developed to enhance the likelihood of SLP to influence decision making. The approach builds upon the Alternative Futures Framework but stronger emphasizes the involvement of interested and affected actors in each step of the planning process as well as the establishment of social learning platforms. Methods for implementing the framework are proposed, procedures for complying with the identified criteria of influence and for meeting the requirements of social learning facilitation are recommended, and hints for conducting accompanying evaluations are provided.

More research is needed to better understand how different context conditions and variations in the design and conduct of SLP affect the perceived compliance with criteria of influential SLP outputs, the facilitation of social learning, and the influence of SLP on decision making. It would be helpful to conduct and evaluate more case studies that take place over longer time spans and involve a larger number of participatory planning workshops. In particular, further investigations should address the question of how qualitative approaches to participatory SLP as tested in this thesis can be complemented with computer-aided simulations of alternative futures and quantitative assessments of their respective impacts.

Keywords: landscape planning, scenarios, social learning

Zusammenfassung

Viele Landschaften sind heutzutage derart intensiven anthropogenen Einflüssen ausgesetzt, dass sie in ihrer Fähigkeit, wichtige Ökosystemdienstleistungen zu erbringen, stark eingeschränkt werden. Es ist daher eine zentrale Aufgabe der Gesellschaft, dieser Entwicklung entgegenzuwirken und Transformationsprozesse in Richtung einer nachhaltigen Landschaftsentwicklung zu lenken.

Szenariobasierte Landschaftsplanung (SLP) gilt als gut geeignet, um die Entwicklung und Umsetzung von Strategien für eine nachhaltige Landschaftsentwicklung zu unterstützen. Sie kommt sowohl in Deutschland als auch international zunehmend zum Einsatz – ihr tatsächlicher Einfluss auf lokale Diskussions- und Entscheidungsprozesse ist jedoch oft gering.

Ziel dieser kumulativen Dissertation ist es daher, das Wissen über SLP zu vertiefen und aufzuzeigen, wie der Einfluss von SLP auf Entscheidungen zugunsten einer nachhaltigen Landschaftsentwicklung verstärkt werden kann. Die Dissertation setzt sich mit umsetzungsrelevanten Eigenschaften von SLP und Herangehensweisen zur Integration von partizipativen Ansätzen auseinander. Zwei miteinander verknüpfte Forschungsfragen stehen im Mittelpunkt: (A) Welche Mechanismen und Kriterien von einflussreichen Ergebnissen aus SLP können identifiziert werden? (B) Wie kann SLP soziales Lernen fördern, so dass das Wissen der lokalen Akteure vertieft und deren Fähigkeiten zugunsten einer fundierten und kooperativen Entscheidungsfindung erweitert werden?

Wichtige Forschungsansätze der Dissertation sind Literaturanalysen, Fallstudien, Planungsexperimente und die Aktionsforschung. Verschiedene qualitative und halbquantitative Methodologien kommen zum Einsatz, unter anderem die partizipative Szenarioentwicklung und -erkundung, Inhaltsanalysen, Interviews, Umfragen und Beobachtungen.

Die ersten drei Artikel setzen sich mit der Forschungsfrage A auseinander. Artikel I trägt Erkenntnisse aus relevanter Literatur zusammen, um Mechanismen und Kriterien einflussreicher Planungsergebnisse zu identifizieren. Es zeigt sich, dass der Einfluss von Planungsergebnissen stark von Kontextfaktoren abhängig ist und dass es einflussreichen Projekten gelingt, günstige Gelegenheiten für politische Entscheidungen in ihrer Entstehung zu fördern bzw. sie zu nutzen. Von anderen Arbeitsgruppen vorgeschlagene Kriterien für einflussreiche Planungsergebnisse – wahrgenommene Glaubwürdigkeit, Relevanz, Fairness und Kreativität – werden bestätigt und spezifiziert. Außerdem werden die Zielkonflikte zwischen den Kriterien selbst diskutiert.

Artikel II analysiert die Nützlichkeit der identifizierten Kriterien, um Unterschiede hinsichtlich des Einflusses von SLP auf Entscheidungen zu erklären. Als Grundlage dienen zwei SLP-Fallstudien, die beide auf dem von C. Steinitz entwickelten „Framework for Alternative Futures Studies“ basieren. Die Fälle unterscheiden sich jedoch im Hinblick auf den Planungskontext, die Art der Umsetzung von SLP und die Effektivität. Die Analyse bestätigt, konkretisiert und differenziert die Kriterien für die Anwendung im Bereich der Landschaftsplanung. Es wird vorgeschlagen, dass bestimmte Untergrenzen aller vier Kriterien erfüllt werden müssen und dass unterschiedliche Akteursgruppen die Ausprägung und Bedeutung der Kriterien auch unterschiedlich bewerten.

Basierend auf Erkenntnissen aus neun europäischen Planungsfallbeispielen beschäftigt sich Artikel III mit den Ansätzen zur Gestaltung und Durchführung von SLP-Projekten, die möglichst geeignet scheinen, um die Kriterien zu erfüllen. Partizipative Ansätze können vielversprechend sein, wenn sie die spezifischen Kontextbedingungen und Nutzerbedürfnisse berücksichtigen, interessierte und betroffene Akteure systematisch einbeziehen, Kommunikation fördern, die Transparenz hinsichtlich der Methoden, Ergebnisse und Unsicherheiten wahren und entscheidungsrelevante Ergebnisse liefern. Nützliche Methoden umfassen unter anderem die Verbesserung der Relevanz durch die direkte Verknüpfung mit existierenden rechtlichen Rahmenbedingungen und das Aufzeigen ökonomischer Auswirkungen.

Zusammengenommen legen die drei Artikel nahe, dass die Erfüllung der identifizierten Kriterien die Wahrscheinlichkeit des Einflusses von SLP-Ergebnissen zwar erhöht, die tatsächliche Berücksichtigung bei der Entscheidungsfindung jedoch nicht nur von den Kontextbedingungen, sondern auch von dem relevanten Wissen und den Fähigkeiten der relevanten Akteure abhängig ist. Die zweite Gruppe von Artikeln widmet sich daher der Forschungsfrage B, um zu analysieren, wie SLP durch die Förderung sozialen Lernens zu einer Verbesserung des Wissens und der Fähigkeiten der beteiligten Akteure beitragen kann.

Artikel IV untersucht, inwieweit fünf kürzlich abgeschlossene SLP-Projekte aus Australien, der Schweiz und den USA die Voraussetzungen erfüllen, um soziales Lernen zu fördern. Die betrachteten Anforderungen umfassen die Nutzung vielfältiger Methoden, unterschiedliche Teilnehmergruppen, Kleingruppenarbeit, wiederholte Treffen und die Möglichkeit für die Teilnehmer, die Gestaltung des Planungsprozess beeinflussen zu können. Die Analyse zeigt, dass die Anforderungen in einigen Planungsschritten erfüllt wurden. Jedoch wurde auch festgestellt, dass das soziale Lernen an sich kein explizites Projektziel darstellte und dass wertvolle Gelegenheiten zur Förderung von sozialem Lernen oftmals ungenutzt blieben.

In Artikel V wird ein Planungsexperiment durchgeführt, um empirisch zu analysieren, ob und wie SLP zu sozialem Lernen mit Vorteilen für Entscheidungsprozesse führen kann. Auf Basis des bereits oben genannten „Alternative Futures Framework“ wird ein konzeptioneller Ansatz für partizipative SLP entwickelt. Der Ansatz wird anhand eines partizipativen Planungsprozesses getestet, der sich mit der Anpassung der Landschafts- und Siedlungsentwicklung der Samtgemeinde Gartow an die Folgen des Klimawandels beschäftigt. Die Evaluation der Ergebnisse folgt den Prämissen der Aktionsforschung und basiert auf einem Methoden-Mix. Die Untersuchung zeigt, dass SLP bei erfolgreicher Durchführung das soziale Lernen unter den Teilnehmern fördern kann. Beobachtete Lernergebnisse umfassen die Anreicherung von substanziellem Wissen (bspw. über Auswirkungen des Klimawandels) und von Prozesswissen (bspw. zu alternativen Anpassungsstrategien), das Verständnis unterschiedlicher Sichtweisen sowie die Verbesserung von sozialen und technischen Fähigkeiten. Die Teilnehmer nannten verschiedene mögliche Auswirkungen des sozialen Lernens auf zukünftige Entscheidungsprozesse, unter anderem ein geschärftes Bewusstsein, verbesserte Fähigkeiten, veränderte Agenden und bessere Beziehungen der Akteure untereinander. Die Ergebnisse des Szenarioprozesses veranlassten lokale Akteure und externe Partner zu einer weiterführenden Zusammenarbeit, in der ein abgestimmtes Leitbild zur Anpassung an mögliche Folgen des Klimawandels entwickelt wurde. Das Leitbild wurde vom Rat der Samtgemeinde einstimmig beschlossen und soll als Orientierung für künftige Entscheidungsprozesse über Landschaftsentwicklung dienen.

Artikel VI untersucht mögliche Effekte eines pädagogischen Workshops auf das soziale Lernen von teilnehmenden Studierenden hinsichtlich der Vermittlung von konzeptionellem Verständnis über SLP und den spezifischen Fähigkeiten für SLP. Der Workshop orientierte sich wiederum an dem „Alternative Futures Framework“, beschäftigte sich mit zukünftiger Landschaftsentwicklung in der Region Cagliari, Italien, und wurde in Zusammenarbeit mit lokalen Akteuren und 30 Studierenden aus verschiedenen Ländern und Studienrichtungen durchgeführt. Die Ergebnisse deuten an, dass SLP-Workshops das Planungswissen und relevante Fähigkeiten von Studierenden fördern können, es jedoch Unterschiede bei der Aneignung unterschiedlicher Wissenstypen und Fähigkeiten gibt. Besonders nützliche Herangehensweisen zur Unterstützung von sozialem Lernen waren iterative Planungsprozesse, die Erstellung von Entwürfen anhand der Ideen der verschiedenen Arbeitsgruppen sowie die Notwendigkeit für Studierende, im Planungsprozess wechselnde Perspektiven einzunehmen. Vor diesem Hintergrund werden ausgewählte Herausforderungen und Chancen des verwendeten Workshop-Ansatzes diskutiert und Empfehlungen zur Verbesserung der Durchführung und Evaluierung von SLP-Workshops gegeben.

Die letzte Studie, Artikel VII, erörtert, welche positiven Auswirkungen soziales Lernen auf gemeinschaftliche Entscheidungsprozesse haben kann. So wird vor allem herausgearbeitet, wie Erkenntnisse aus sozialen Lernprozessen dazu beitragen können, dass besser mit dem Problem unterschiedlicher

Maßstäbe umgegangen wird – eine der größten Herausforderungen für die Umsetzung von wissenschaftlichen Erkenntnissen in der Praxis. Als Fallbeispiel diente die Entwicklung von Governance zur Klimawandelanpassung in der Norfolk-Broads-Landschaft in Großbritannien. Es wurde deutlich, dass der Austausch von Wissen zwischen Akteuren aus unterschiedlichen Disziplinen und räumlichen Ebenen in partizipativen Planungsprozessen soziales Lernen fördern kann. Die bei diesem Lernprozess gewonnenen Erkenntnisse veranlassten lokale Entscheidungsträger dazu, in weiterführenden Planungsprozessen verstärkt partizipative Ansätze einzubeziehen und eine intermediäre Organisation als Plattform für regionale Governance ins Leben zu rufen. Dank dieser Maßnahmen war es möglich, Planungsergebnisse mit einer höheren Entscheidungsrelevanz zu produzieren und die regionale Planungspolitik besser an die Herausforderungen des Klimawandels anzupassen.

Die vorliegende Dissertation zeigt, dass beide Strategien zur Verbesserung des Einflusses von SLP auf Entscheidungsprozesse – einerseits die Erhöhung der wahrgenommenen Qualität von SLP-Ergebnissen und andererseits die Förderung von sozialem Lernen – von Bedeutung sind. Die Strategien können sich sinnvoll ergänzen, insbesondere wenn sie in aufeinander folgenden Planungszyklen zum Einsatz kommen, bei denen zuerst die Förderung von sozialem Lernen betont und später der Fokus auf die Entwicklung von SLP-Ergebnissen als direkte Entscheidungsgrundlage gerichtet wird. Die Verbesserungsstrategien können jedoch auch im Konflikt zueinander stehen, wenn versucht wird, sie gleichzeitig umzusetzen.

Obwohl sich die Anwendungen von SLP in der Praxis deutlich voneinander unterscheiden, können im Hinblick auf den Einfluss auf Entscheidungen einige grundsätzliche Mängel konventioneller SLP-Projekte festgestellt werden. Ein Defizit besteht darin, dass viele Projekte nur in unzureichendem Maß auf Herausforderungen der jeweiligen Entscheidungskontexte sowie auf entscheidungsrelevante Aspekte für die potenziellen Nutzer Bezug nehmen. Darüber hinaus werden die relevanten Akteure in vielen Projekten nicht ausreichend in allen Stufen der SLP involviert. Viele Projekte erfüllen die Kriterien einflussreicher SLP-Ergebnisse nur ansatzweise und nutzen Möglichkeiten zur Förderung von sozialem Lernen nicht aus. Ein weiteres Defizit besteht darin, dass viele SLP-Prozesse nicht ausreichend als ein Teil langfristiger Governance-Prozesse konzipiert und durchgeführt werden – die Unterstützung dieser Prozesse ist jedoch essenziell notwendig, um Transformationsprozesse in Richtung einer nachhaltigen Landschaftsentwicklung lenken zu können.

Für SLP wurde ein konzeptioneller Ansatz entwickelt, um die Wahrscheinlichkeit der Einflussnahme von SLP auf Entscheidungsfindungen zu erhöhen. Der Ansatz basiert auf dem „Alternative Futures Framework“, stellt jedoch die Partizipation von interessierten und betroffenen Akteuren auf jeder Stufe des Planungsprozesses sowie die Einrichtung von Plattformen für soziales Lernen stärker in den Vordergrund. Es werden Herangehensweisen für die Umsetzung des Ansatzes vorgeschlagen und Verfahren empfohlen, wie die Kriterien einflussreicher SLP-Ergebnisse und die Anforderungen für soziales Lernen erfüllt werden können. Zudem werden Hinweise zur Durchführung von prozessbegleitender Evaluation gegeben.

Forschungsbedarf besteht dahingehend, wie sich verschiedene Kontextbedingungen und Variationen in der Gestaltung und Durchführung von SLP auswirken, und zwar auf die wahrgenommene Erfüllung von Kriterien einflussreicher SLP-Ergebnisse, die Förderung von sozialem Lernen und den Einfluss von SLP auf Entscheidungsprozesse. Hilfreich wäre dabei die Durchführung und Evaluierung weiterer Fallbeispiele, die zum Beispiel über einen längeren Zeitraum laufen und eine größere Zahl an partizipativen Planungsworkshops einbeziehen. Vor allem aber sollten sich zukünftige Forschungsarbeiten der Frage widmen, wie qualitative Ansätze zu partizipativer SLP mit computergestützten Simulationen von möglichen Landnutzungsänderungen und quantitativen Abschätzungen der jeweiligen Auswirkungen kombiniert werden können.

Schlagworte: Landschaftsplanung, Szenarien, Soziales Lernen

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1 Introduction

1.1 Background

Landscapes in many regions of the world are experiencing intense anthropogenic influences (Lambin and Geist, 2006, Turner et al., 2007, Vitousek et al., 1997) that increasingly diminish their capacity to provide the ecosystem goods and services humanity depends on (Daily, 1997, Millennium Ecosystem Assessment, 2003, Reid et al., 2005). Counteracting these trends and supporting transitions towards more sustainable development is complex and one of the central challenges facing society (cf. Annan, 2000, Gunderson and Holling, 2002, Gunderson et al., 1995, Kates and Parris, 2003, NRC, 1999, UNEP, 2007).

Scenario-based landscape planning (SLP) is arguably well positioned to support decision making concerning sustainable landscape development: Landscape planning in general may provide relevant information as the basis for decision making (Selman, 2006, Steinitz et al., 2003, von Haaren et al., 2008). It is explicitly place-based and implementation-oriented, contributes integrative approaches to coupled human-environment systems, and provides theory and methods for studying spatial heterogeneity as well as metrics for quantifying sustainability (cf. e.g. Blaschke, 2006, Naveh, 2007, NRC, 1999, Rindfuss et al., 2004, Wu et al., 2006). In addition to the provision of relevant information, landscape planning may also facilitate participatory processes for strategy development and implementation. Landscape planning has been suggested as an important link between science and practice (Nassauer and Opdam, 2008) and provides long-time experiences with transdisciplinary planning tools and methods (Luz, 2000, Tress et al., 2005). As part of the interdisciplinary field of landscape ecology, it has been interpreted as part of the core of sustainability science (Wu, 2006).

SLP has the potential to merge the theoretical and methodological contributions of landscape planning with the advantages of the scenario-tool. Scenarios have been suggested as key instruments of efforts to supporting transitions towards sustainable development (Swart et al., 2004). They may help addressing and dealing with the inherent complexity and uncertainty of the future and integrate across different types of data, disciplines, institutions, spatial and temporal scales and perspectives (cf. Alcamo, 2008b, Jäger et al., 2007, Swart et al., 2004). Scenarios are further are claimed to be particularly useful for participatory planning and to facilitate knowledge co-production and social learning (Alcamo and Henrichs, 2008, Berkhout et al., 2002, Jäger et al., 2007, NRC, 1999, Robinson, 2003, Swart et al., 2004, Wiek et al., 2006).

The practical implication of SLP is to create scenarios of potential future landscape developments, spatially illustrate associated future land use configurations (alternative futures), and assess their respective consequences (Ahern, 2006, Hulse et al., 2004, Selman, 2006). Scenario-based approaches are of increased interest and application in the field of landscape and environmental planning, reflected in the growing number of relevant publications over the last years (e.g. Bohnet and Smith, 2007, Fritsch, 2002, Grêt-Regamey et al., 2008, Hulse et al., 2004, Nassauer and Corry, 2004, Schroth et al., 2009, Shearer, 2005, Steinitz et al., 2003, Stock et al., 2007, Tress and Tress, 2003, Walz et al., 2007, Xiang and Clarke, 2003).

1.2 Problem description

The numerous applications of scenario-based approaches to landscape planning have resulted in successes as well as failures in fostering sustainable landscape development (cf. Alcamo et al., 2006, White et al., 2003). This diagnosis is not specific to SLP, but holds true for many environmental assessments and planning in general (Mitchell et al., 2006b). Reasons for the incomplete knowledge to action transfer may lie in both the form and properties of SLP as well as in the context of application.

The limited application of available knowledge in decision making and implementation is problematic since potentials for navigating landscape change towards more sustainable pathways are not exploited. The continuation of unsustainable landscape developments may lead to negative and sometimes irreversible changes in ecosystems with high economic and social costs for society.

We thus face a situation in which many landscapes are deteriorating, knowledge for supporting more sustainable development is potentially available from SLP, but where the influence of this knowledge on actions is often limited.

Against this background, this thesis is motivated by the need to increase the likelihood of SLP to yield influence on efforts for supporting sustainable landscape development. It concerns the questions of what determines SLP influence, and how SLP processes can be designed and conducted to be most likely to be influential. Before formulating the thesis' research objective and questions, relevant literature will be reviewed and synthesized in order to gain an overview of the state of research, a conceptual understanding of SLP influence, and current knowledge gaps.

2 State of Knowledge

2.1 Approaches for supporting sustainable landscape development

According to the European Landscape Convention (2000), landscape can be understood as "an area, as perceived by people, whose character is the result of the action and interaction of natural and/or human factors". This definition implies that a landscape is relatively distinct area, that human perception is needed for its recognition, and that it stems from a history of actions and interactions between human and natural drivers.

Landscapes are thus typical examples for social-ecological systems (cf. Berkes et al., 2003, Folke et al., 2005) (also termed coupled human and natural systems, see Liu et al., 2007) in which both human actions and ecological processes strongly interact. Social systems influence ecological ones through changes in landscape management decisions and practices. Vice-versa, the provision of ecosystem goods and services affects human well being. Both systems-types are impacted by dynamics at larger scales: Social systems are influenced by wide-ranging issues such as globalization and population change. Ecological systems experience impacts from the atmospheric, biogeochemical and biophysical dimensions of global change. Changes in ecological systems may also feed back to higher scales, for example through the land use change-induced emissions of green house gases (cf. GLP, 2005).

What is sustainable landscape development?

"Sustainable landscape development" is frequently referred to in landscape ecology and planning literature as a general principle or objective (Bastian, 1999, von Haaren, 2002). However, a recent review by Selman (2008) found that its concrete meaning remains often undefined or defined in relation to specific professional or stakeholder interests and spatial contexts. This corresponds with the finding of Kates et al. (2005) that the term "sustainable development" in general is today used ambiguously and almost always discordance exists about what exactly is to be developed, to be sustained, in which relationship, and for how long. A unifying consensus seemed to be that sustainable development would meet basic human needs without destroying or irrevocably degrading the natural systems on which society depends.

Further disagreement exists concerning the conceptualization of the dynamics of sustainable landscapes. Some authors understand sustainable landscape to be a relatively constant spatial configuration. As one example, Forman (1995) defines sustainable landscape as "an optimal spatial arrangement of ecosystems and land uses for achieving basic human needs and for creating a sustainable environment". In contrast, Haines-Young (2000) proposed to think of sustainable landscapes as a range of landscape configurations that may be more or less sustainable. Building on this notion, Potschin and Haines-Young (2006) define sustainable landscapes as those that are "able to maintain the outputs of ecosystem goods and services that people value or need".

This thesis understands sustainable landscape development as a continuous reconciliation of society's development goals with landscape's capacities to deliver ecosystem services over the long term (cf. Clark and Dickson, 2003, Kates et al., 2001, NRC, 1999, Turner, 2008). Based on the notion of landscapes as complex, adaptive, and tightly coupled social-ecological systems (GLP, 2005), it follows Potschin and Haines-Young (2006) in assuming that the presence of a single, continuously sustainable landscape configuration is unlikely. To make progress towards sustainable landscape development, long-term transformations of the underlying social, economic and ecological systems that drive landscape change must be initiated and facilitated. Recent literature refers to such systems transformations as transitions towards sustainability (Kates and Parris, 2003, NRC, 1999).

The concrete definition of what sustainable landscapes are will always depend upon the conditions of the local ecosystems as well as relevant actors' interests and needs at the point in time. Efforts for supporting sustainable landscape development must therefore aim at making process on a transition towards sustainability (Kates and Parris, 2003, NRC, 1999), interpreted as a long-term transformation of the social, economic and ecological systems driving landscape change.

How can sustainable landscape development by supported?

As noted in the background section, the development of many landscapes around the globe can be regarded unsustainable (Daily, 1997, Millennium Ecosystem Assessment, 2003, Reid et al., 2005). Navigating landscape development towards more sustainable pathways is complicated, since dominating social and economic forces and governance structures must be counteracted. Needed are transitions towards sustainable development, understood as long-term transformations of the complex, adaptive and coupled social, economic and ecological systems that the underlie and transcend the landscapes (cf. Gunderson and Holling, 2002, Gunderson et al., 1995, Kates and Parris, 2003, NRC, 1999, Olsson et al., 2006, Raskin et al., 2002).

Recent research concerning the question of how transitions of social-ecological systems can be effectively addressed and governed often refers to two major theoretical frameworks, namely transition management and adaptive management.

Transition management (Elzen and Wieczorek, 2005, Kemp et al., 2007, Kemp et al., 2005, Martens and Rotmans, 2002, 2005, Rotmans et al., 2001) evolved from studies of long-term transitions of socio-technical systems (such as energy innovation) in the Netherlands. It is understood as a framework for shaping or modulating socio-technical regimes towards sustainable development. According to Loorbach and Rotmans (2006), key elements of transition management are systems-thinking, long-term thinking, back- and fore-casting, a focus on learning-by-doing; an orientation towards system innovation and experiments; learning about a variety of options; and participation of and interaction with stakeholders.

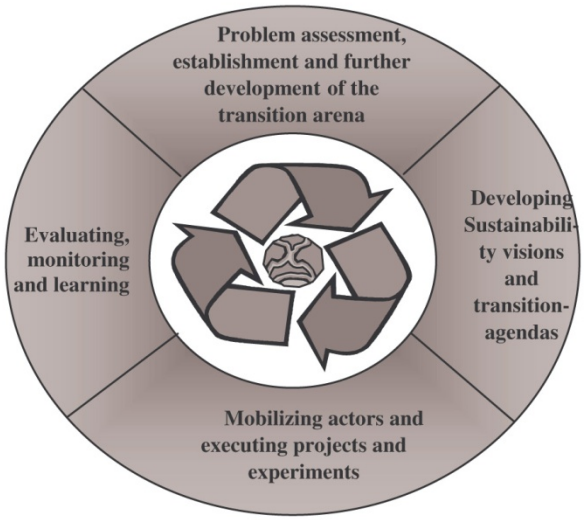


Figure 1: The transition management cycle (Loorbach and Rotmans, 2006)

Adaptive management was originally developed in the context of ecosystem and natural resources management (Holling, 1978, Walters, 1986). It acknowledged the complexity, uncertainties and unpredictability of ecosystem development and attempted to address them through systematic efforts to learn from practical experience. More recently, the concept found rapidly growing applications also in coupled social-ecological systems (Berkes and Folke, 1998, Folke et al., 2005, Gunderson and Holling, 2002, Olsson et al., 2004, Olsson et al., 2006). The core idea of adaptive management is to formulate policies as hypotheses, to consider management actions as experiments to test the hy-

potheses, to implement monitoring systems for acquiring reliable data about the consequences of the experiments, and to develop effective management institutions for learning from successes and failures (Clark, 2002, Gunderson et al., 1995). Early and ecosystem-focused approaches remained rather technical (Lee, 1999). Later applications of adaptive management for navigating social-ecological systems stronger incorporated the human dimension through processes of adaptive governance (see Dietz et al., 2003), transdisciplinary participation, and collective action (e.g. Lee, 1993, McLain and Lee, 1996, Parson and Clark, 1995). The adaptive management process can be conceptualized as a cycle of identifying system boundaries, context, problems, and desired goals, developing and testing hypotheses, implementing policy strategies and monitoring results as a basis for evaluations and alterations of goals and means in case changes are justified (cf. figure 3).

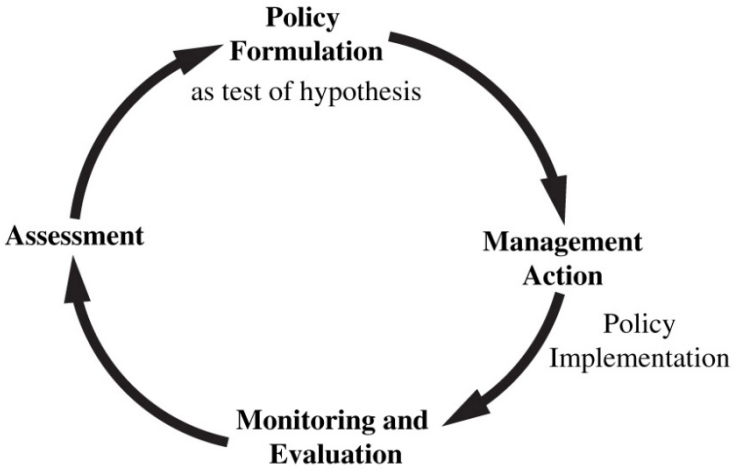


Figure 2: The adaptive management cycle (Sendzimir et al., 2007)

Foxon et al. (2008) provide insights into commonalities and differences between the two frameworks: They share the notion that supporting transitions towards sustainable development requires complex systems thinking to understand how systems of diverse, interacting factors evolve. The concepts stress that detailed control and management of complex systems change is impossible and rather propose an iterative, learning-based approach. Needed are further the involvement of a wide range of stakeholders in planning and decision making processes as well as institutional innovations to create arenas for joint learning and adaptive decision making. A key difference is that adaptive management aims at building resilience, understood as the ability to maintain important system functions in case of disturbance, while transition management focuses on developing capacity to steer long-term changes in the functioning of systems. The review finds adaptive management to provide more experiences with input from various stakeholders than transition management that rather worked with public-private collaborations.

A very useful overview of the requirements that efforts for supporting transitions towards sustainable development would need to fulfill is provided by Wiek et al. (2006). The authors synthesize requirements into four thematic areas: (i) knowledge generation, (ii) integration, (iii) adaptation, and (iv) transdisciplinarity.

Relevant knowledge could be distinguished into system, target and transformation knowledge. The first type included concepts and data about the current and potential future functioning of the system under consideration. Target knowledge provided guiding ideas of what shall and can be achieved. Transformation knowledge compiled information on how to realize the transition from the current to the target state. Integration involved both the integration of different knowledge kinds (qualitative and quantitative, different sectors etc.), and the integration of forward and backward planning. Adaptation was needed to implement a learning-based, decentralized facilitating process.

Transdisciplinarity refers to the participation of planners, scientists, decision makers and stakeholders within the planning process under a common goal (cf. Tress and Tress, 2001, Tress et al., 2005).

Based on this literature review, it can be suggested that critical aspects of supporting sustainable landscape development are to adopt a systems-thinking perspective and an iterative-learning based approach that involves a wide range of decision makers and stakeholders. Key requirements are knowledge generation, integration, adaptation, and transdisciplinarity.

2.2 The potential role of scenario-based landscape planning

Characteristics of scenario-based landscape planning

Scenario-based landscape planning (SLP) is an approach to landscape planning that consists of developing scenarios of future landscape change, modeling the land use and land cover changes (LUCC) potentially resulting from these scenarios (alternative futures), and to assess their respective consequences (cf. Hulse et al., 2004).

Given that the terms landscape planning, land use, land cover, scenarios, alternative futures and modeling are differently interpreted in the literature depending on context and discipline, some further clarifications are needed. Landscape planning is understood as "a strong forward-looking action to enhance, restore or create landscapes", following the definition of the European Landscape Convention (Council of Europe, 2000). Land use refers to how people use land, for example urban and agricultural land. Land cover, in contrast, is the physical material at the surface of the earth (cf. Fisher et al., 2005). For scenarios, the Millennium Ecosystem Assessment's definition as "plausible and often simplified descriptions of how the future may develop based on a coherent and internally consistent set of assumptions about key driving forces and relationships" is employed (Reid et al., 2005. While scenarios describe potential pathways of change, alternative futures are understood as possible end states, illustrating the land use and land cover configuration of the respective landscape that may result from the changes within a particular scenario at a specified point of time in the future (figure 3, cf. Shearer, 2005, Steinitz et al., 2003). Modeling LUCC change is meant as producing a simulation of potential future landscape patterns, which may be based on a formal computer model or intuitive reasoning, based on simple decision rules.

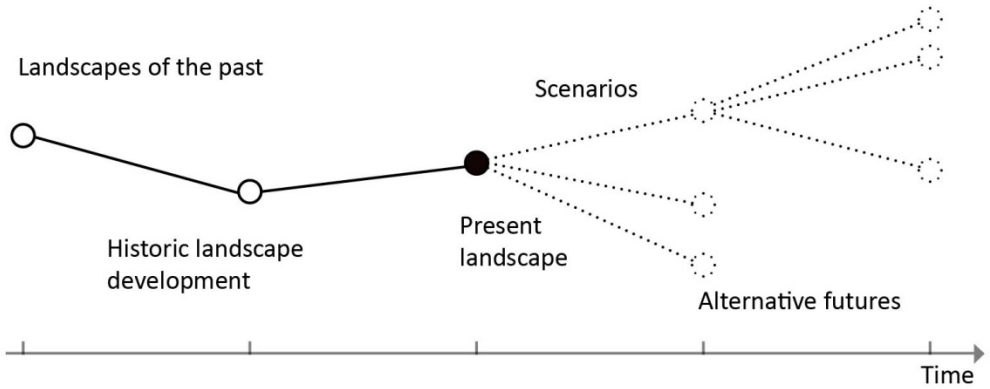


Figure 3: Scenarios and alternative futures.

Formal use of scenarios began at the end of World War II in the field of war game analysis (Shoemaker, 1993, van der Heijden, 1996). The civilian use of the scenario technique in planning was pioneered by Herman Kahn and others (1967) and further developed and applied in business planning (e.g. Gausemeier et al., 1995, Georgantzas and Acar, 1995, Schwartz, 1996, van der Heijden, 1996, von Reibnitz, 1987, Wack, 1985a, b). At least since the "Limits of Growth" study by Meadows et al. (1972), scenarios have been applied to numerous long-term issues of public concern, ranging from

studies at the global and regional to local scale (Gallopin et al., 1997, Nakicenovic et al., 2000, Raskin et al., 2002) to the local scale (e.g. Peterson et al., 2003, Ringland, 2002).

The field of landscape and environmental planning has seen the application of scenarios since several decades. Within the last years, they received increasing interest and application, reflected in a growing number of publications in relevant journals (e.g. Baker et al., 2004, Bohnet and Smith, 2007, Fritsch, 2002, Grêt-Regamey et al., 2008, Hulse et al., 2004, Nassauer and Corry, 2004, Santelmann et al., 2004, Schroth et al., 2009, Shearer, 2005, Sisk et al., 2006, Steinitz et al., 2003, Stock et al., 2007, Theobald and Hobbs, 2002, Tress and Tress, 2003, Walz et al., 2007). Excellent reviews of the history and use of scenarios in spatial planning are available in Shearer (2005) and Xiang and Clarke (2003) and will not be reproduced here.

SLP can be of various types and embody various approaches. A characterization of the different types of SLP could draw on a variety of typologies recently suggested for classifying scenarios and scenario planning in general. For example, Bradfield et al. (2005) describe the evolution of three "schools" of scenario development. Börjeson et al. (2006) differentiate between predictive, explorative and normative scenarios with two sub-categories for each type. Bishop et al. (2007) focus on the different techniques for developing scenarios. Van Notten et al. (2005, 2003) present a scheme consisting of three main themes (project goal, process design, and scenario content) with various parameters and spectrums of their respective characteristics. The following characterization of SLP will relate to the much cited classification approach of Van Notten and colleagues, addressing alternative SLP objectives, processes, and outputs. It aims at illustrating major differences between SLP types – a more detailed classification is provided in paper I.

The objective of SLP can be on a spectrum from exploration to decision support. Explorative scenarios aim at awareness raising, facilitating creative thinking, and studying the complex interactions of different processes over time. Decision support-oriented SLP uses scenarios that are more or less desirable. The vantage point of the scenarios may be either forecasting or backcasting. Forecasting scenarios start from the present and explore how the future might evolve. Backcasting scenarios assume a specific future situation and explore the range of actions or developments necessary to attain (or not attain) the projected condition.

The SLP process addresses aspects such as the degree of quantitative and qualitative data and approaches used, the choice of methods, and the level of involvement of decision makers and stakeholders. At one end of the data dimension is the intuitive approach that relies strongly on qualitative methods. The approach may use narrative outlines, texts, storylines, diagrams, pictures and/or collages to describe future developments with high levels of complexity and uncertainty. It may include non-quantifiable, normative aspects like values, mental maps, and expectations. At the other end of the spectrum is the formal approach. It perceived SLP as a rather rational and analytical exercise and often employs quantitative methods and computer models. They offer structural consistency and scientific rigor through explicit assumptions. Both approaches have their advantages and recent efforts increasingly aim at combining them (e.g. Alcamo, 2008a, van Vliet et al., 2010).

The involvement and input of stakeholders and decision makers in SLP varies on a gradient form citizen-driven to expert-driven approaches (Hulse et al., 2004). The gradient can be further classified into five different levels of involvement (Arnstein, 1969, Pahl-Wostl, 2008, Volkery et al., 2008). At the lowest level, stakeholders and decision makers are only *informed* about the process and results of a scenario exercise. More intensive participation occurs when non-scientific actors are *consulted* during the exercise to provide input. *Co-thinking*, the third level, means that participants are actively involved in the development of the scenarios, but do not make decisions. At the *co-designing* stage, participants are furthermore engaged in the structuring of the scenario process and the joint definition of "game rules" for collaboration. Finally participants can *co-decide* and assume responsibility for the scenario process design, the analysis and the recommendations derived from them.

The third theme is SLP outputs. These can take various forms, including reports, maps, diagrams, tables, stories, visualizations, drawings etc. They can be of different degrees of complexity. Complex outputs are based on scenarios with a high number of drivers, interactions and dynamics. Simple scenarios are more limited in scope, often focusing on a single topic and more immediate first-order effects. They must not necessarily be of low quality, given the benefits of requiring less time to build and more effective for communication.

Having broadly characterized SLP project types, how can such projects actually be conducted? Over the last decade, a range of approaches and frameworks have been proposed (cf. Ahern, 2006, Horlitz, 1998, Scholles, 2008, von Haaren, 2004b, Wollenberg et al., 2000). While the approaches differ, most share the notion of SLP as consisting of steps to define scenario assumptions, model potential land use and land cover changes, and to assess the consequences.

One of the most prominent approaches to SLP is the Alternative Futures Framework developed by Carl Steinitz (1990, 1993, 2003). It has been employed in a large number of proejcts around the world (e.g. Baker et al., 2004, Hulse et al., 2004, Santelmann et al., 2004, Steinitz, 2006, Steinitz et al., 2010, Steinitz et al., 1994, Steinitz et al., 2005a, Steinitz et al., 2005b). The framework consists of six questions that need to be addressed in any SLP study (Figure 4).

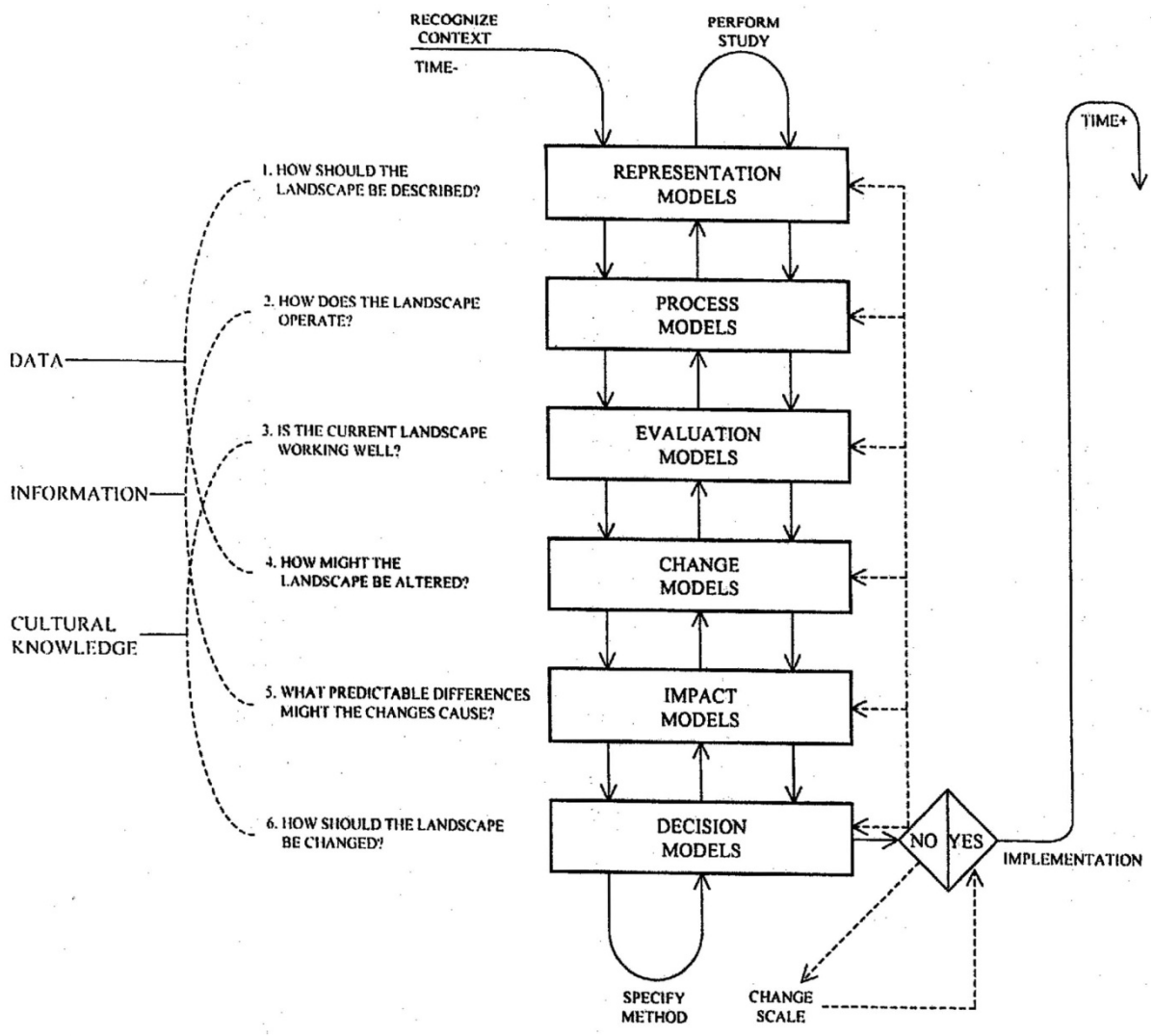


Figure 4: The framework for alternative futures studies (Steinitz et al., 2003)

The framework should be passed through three times. The first cycle defines the context and scope. Within the second cycle, the methods are specified. The last cycle contains the implementation of the methods to conduct the study. The following paragraph will describe the six questions in sequential order:

QUESTION 1, REPRESENTATION MODELS: How should the state of the landscape be described? This includes considerations of the location and extent of the study area, its history, and geography. QUESTION 2, PROCESS MODELS: How does the landscape operate? Here processes and their interactions are assessed. QUESTION 3, EVALUATION MODELS: Is the current landscape working well? This question refers to current problem issues and their location. QUESTION 4, CHANGE MODELS: How might the landscape be altered? This refers to which changes are foreseen for the region, which policies and actions might be developed. QUESTION 5, IMPACT MODELS: What predictable differences might the changes cause? This refers to the evaluation of the foreseeable change and an assessment of their seriousness. QUESTION 6, DECISION MODELS: How should the landscape be changed? This refers to the kinds and interests of major stakeholders.

Contributions of scenario-based planning to support sustainable landscape development

Which contributions could SLP provide to the above described approaches for supporting transitions towards sustainable landscape development? A few papers have recently been published that can provide helpful insights. For example, Sondeijker and colleagues (2006) explored the added value of scenarios in transition management. Wollenberg et al. (2000) reflected upon the use and benefits of scenarios in community forest management. More specific functions and benefits of scenarios and scenario-based planning have been elaborated by Swart et al. (2004) concerning sustainability science, and Wiek et al. (2006) with a focus on transition management. Table 1 provides a summary comparison of key contributions identified by the two latter research teams, organized according to the key requirements for supporting sustainable development discussed in section 2.1.

Table 1: Comparison of requirements for supporting transitions with contributions of scenarios and scenario-based planning

Key requirements for supporting transitions (Wiek et al., 2006)	**Contributions of scenarios and scenario-based planning**	
	… to sustainability science (Swart et al., 2004)	**… to transition management (Wiek et al., 2006)**
System knowledge generation	- Integration of qualitative expert knowledge allows for reflecting functional complexity and multiple stresses - Creativity in scenario development offers a way to consider the possibility and potential consequences of discontinuous changes, surprises and abrupt changes in complex, non-linear system dynamics - Scenarios can help eliciting and reflecting on mental models of the world	- Scenarios represent future system knowledge, are based on analyses of current and historic conditions, and include uncertainties.
Target knowledge generation	- Scenarios contribute to explore normatively distinct future visions	- Scenarios do not represent target knowledge but they can provide the basis for assessment of preferred future situations
Transformation knowledge generation	- Scenarios and scenario planning can contribute to exploring ways to attain normative future visions	- Scenarios do not represent transformation knowledge. - Scenarios can provide the basis for strategy building if they describe the pathways of necessary changes and actions between today and the sought future conditions.
Integration	- Scenarios can integrate across spatial scales and link local to global perspectives - Scenarios can link long-term goals with today's decisions - Scenarios can integrating across themes and issues and help discovering interconnections - Scenarios can incorporate (and link) qualitative and quantitative features	- Integration of qualitative and quantitiave approaches and diverse information is possible. - Scenario-based planning can help in the integration of system, target and transformation knowledge.
Adaptation		- Scenario-based planning can facilitate a learning process within the planning process in which means and/or ends can be adapted to new insights. - Scenario-based planning is not appropriate for monitoring and evaluations of actual changes
Transdisciplinarity	- Scenarios can help reflecting different perspectives on system functioning, goals of sustainability transition and ways to get there - Scenarios and scenario development can engage stakeholders, promote communication, facilitate iterative feedback, offer a way to test (and influence) human perceptions and goals	- Scenario development allows for participation of diverse experts, decision makers and stakeholders

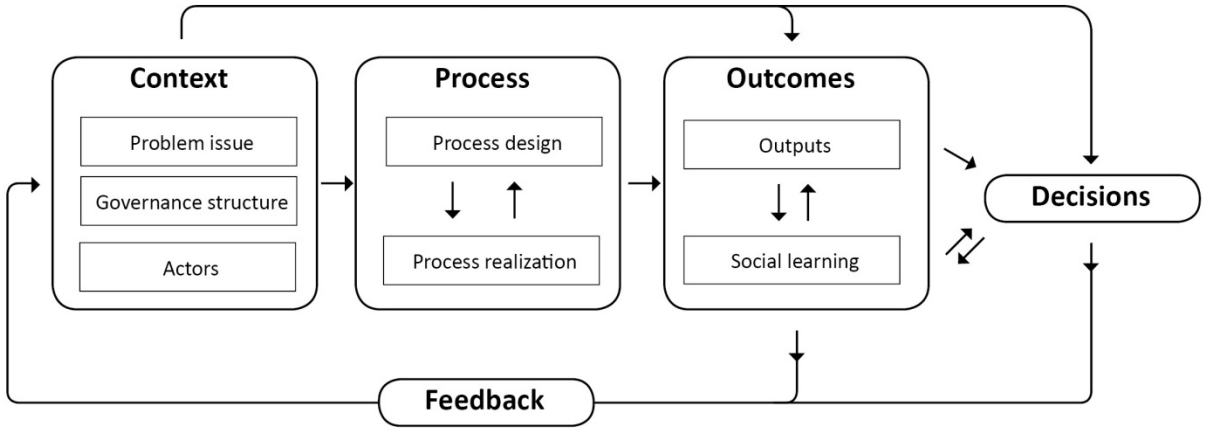
Sources: Wiek et al. (2006) and Swart et al. (2004), adapted.

The review of publications shows that scenarios and scenario-based planning are claimed to fulfill many key requirements of efforts for supporting sustainable development. Scenarios can help in co-generating relevant knowledge, facilitating the integration of diverse knowledge and approaches, allow for adaptation within the planning process, ease communication, and engage diverse actors.

However, it must be noted that scenarios and scenario-planning do not necessarily fulfill these functions simultaneously. For example, projects that solely employ explorative scenarios of extreme future development paths can be particularly effective in facilitating awareness raising and learning, but may provide little knowledge with direct relevance for decision making. It must also be mentioned that scenario-planning is only one of several useful tools in efforts to navigate transitions towards sustainable development and should be combined with additional approaches. Finally, while scenario planning can provide important insights for strategy development, it cannot facilitate direct support of implementation, monitoring, and evaluation.

2.3 The influence of scenario-based landscape planning on decision making

This section suggests a model of the influence of SLP. The model is the result of a literature review (including Beierle and Cayford, 2002, Clark et al., 2006, Newig, 2007, Pahl-Wostl et al., 2007a) concerning possible and plausible conditions and mechanisms of how participatory planning in general influences – or could influence – landscape development. The framework is based on the assumption that the influence of SLP depends on the design and implementation of the SLP process which is embedded in planning context and leads to specific outcomes. These outcomes in turn can feed back to the context, resulting in changes of the original conditions. SLP influence therefore ultimately depends on the degree to which such feedbacks can be successfully achieved.



CONTEXT	PROCESS	OUTCOMES
Problem issue - Problem structure (type, complexity, scale) - Environmental state and human impacts ***Governance structure*** - Legal and institutional setting - Cultural and socioeconomic setting - Framing (discourse and agenda) ***Actors' capacities and attitudes*** - Goals, interests and agendas - understanding and skills - power and resources - relationships (conflicts, willingness to participate?)	***Process design*** - Goals, methods, durations, kinds and timing of involvement ***Planning process realization*** - Actual implementation - Actual participation	***Outputs*** - Kinds of outputs - Kinds of dissemination ***Social learning outcomes*** - Changes in understanding (knowledge, cognitions, attitudes) - Changes in skills

Figure 5: Conceptual model of participatory SLP- categories and attributes (Own conceptualization, based on prior works by Clark et al., 2006, Newig, 2007, Pahl-Wostl et al., 2007a)

The context involves the problem issue, the governance structure as well as the relevant actors. It provides the framing for any planning project and therefore strongly influences its processes and outcomes. The context changes over time in response to various factors unrelated to a planning process, for example if economic crises alter public attention and political agendas (cf. Clark et al., 2006). Planning processes are only one of multiple factors influencing change in the context – a condition that must be acknowledged in any study of planning influence.

The process is determined by its design and the actual implementation. Process design considers the chosen SLP goals, organization, methods, and tools. Apart from the mere design, the way of its implementation also plays an important role in determining SLP influence. Implementation considers aspects such as the actual involvement of various stakeholders in the planning process and the way their contributions come to bear.

Outcomes can be distinguished into two kinds: First, planning processes result in outputs such as synthesis reports, maps, and diagrams which may or may not form the basis for decision making. An example for influence on decisions is if one of the scenarios and its inherent assumed measures are adopted as the new policy for future landscape development. The second type of SLP outcome is social learning, understood as changes in understanding and skills that may emerge among the participants of the SLP process (see the definition and more detailed description below).

Both outcomes may or may not contribute to decision making. SLP outputs can serve as the basis for decision making, for example if one of the scenarios and its inherent policy measures are adopted as the new policy for future landscape development. The altered understandings gained through social learning may also influence decision making, but its benefits lies mostly in changing the attitudes and improving the capacities of local actors for joint implementation and future planning or decision making.

Feedback summarizes the impacts of SLP outcomes on the context conditions, i.e. the influence of SLP on future landscape development. One kind of feedback is actions based on decisions. If decisions are implemented, they can lead to changes in the problem issue or governance structure of the context that actually improve the issues at stake. Examples are if the decision to establish a nature protection zone is implemented or if an organization for addressing the problem issue is initiated. In many cases however, implementation deficits occur that decrease the degree to which decisions are actually translated into actions and to which actions result in context changes.

Another kind of feedback is consolidated social learning, understood as social learning that persists at a sufficiently large population of the participants. If these social learning effects extend to a large enough share of the relevant actors' population, they may lead to altered actors' capacities and attitudes as part of the context conditions.

The framework emphasizes that SLP influence on landscape development is thus dependent on factors that are not related to the SLP project and its outcomes and factors that directly concern the SLP project. Factors unrelated to the SLP project are part of the context conditions and play a major role in determining the influence of SLP outcomes on decision making. One of the most important external factors is the governance context within which SLP takes place. For example, modern democratic societies do not longer consider decision making as solely a task of elected officials based on disciplinary experts' advice. Instead, decision making is rather perceived as a complex multilayered process in which numerous actors with different interests and powers are involved. Within this process, science is no longer granted unchallenged authority to create knowledge for decision support. Instead, the legitimacy and sometimes even credibility of decisions based solely on scientific findings is questioned. Scientific information is seen as only one of several sources of knowledge that are taken into account when making a decision (cf. Funtowicz and Ravetz, 2001, Kates et al., 2001, Nowotny, 2005, Nowotny et al., 2001). Furthermore, the complexity of many decisions around sustainable landscape development often leads decision makers to rely on personal experience and other heuristics that decrease the need to collect and process information (Kahnemann et al., 1982, Simon, 1982, Simon,

1983). However, many studies have shown that cognitive and normative uncertainties sometimes create contexts of so called 'policy windows of opportunity' (Kingdon, 1984, Lee, 1993) in which innovative and creative ideas from science and planning are considered by decision makers. In summary, SLP influence is generally dependent on conducive context conditions, the presence of policy windows of opportunity, and the timely availability of SLP planning outcomes to exploit such policy windows once they appear.

Acknowledging the great importance of external factors, and the potential implementation deficits on the feedbacks from decisions to altered context conditions, this thesis concentrates on the influence of SLP on decision making as a proxy for overall influence. The question becomes how the SLP process and its outcomes may influence decision making in case suitable context conditions arise. The two pathways of SLP influence on decision making illustrated in the framework, namely through SLP outputs and SLP social learning outcomes, are described in detail in the following sections.

Influence on decision making through SLP outcomes

Outputs of assessment and planning processes can influence decision making through providing relevant information of options for action and their respective consequences. What attributes determine the degree to which outcomes are considered in decision processes?

For quite some time, research on the influence of environmental assessment and planning outcomes on decision making has shown that credibility alone is insufficient for science coming to bear in decisions (Functowicz and Ravetz, 1993, Ravetz, 1971, Social Learning Group, 2001a). Along this line, the seminal Global Environmental Assessment project (Mitchell et al., 2006b) suggested that assessments are more likely to be influential if their processes and results are perceived as not only *credible* but also *salient* to political concerns and *legitimate* by the assessment's audiences (see also Cash et al., 2003, McKnie, 2007, NRC, 2007). *Credibility* is described as the degree to which the users of environmental assessments consider the science as correct and its evidence and argumentation as adequate (Cash and Buizer, 2005, Cash et al., 2003). *Salience* asks if an assessment is relevant to its audience and if the objectives are adequately addressed (Mitchell et al., 2006a). *Legitimacy* considers the degree to which the assessments have been "respectful of the stakeholders' divergent values and beliefs, unbiased in its conduct, and fair in its treatment of opposing views and interests" (Cash et al., 2003). *Legitimacy* may be criticized for example if relevant concerns of one stakeholder group have not been considered in the assessment. The criteria have been successfully applied in a number of evaluations of environmental assessments (e.g. Lynch et al., 2008, Siebenhüner, 2002a), including one study from the field of landscape ecology (Nassauer and Opdam, 2008).

Scenario-based planning can be considered a special kind of assessment that primarily does not address the current, but the future state of the environment (cf. Alcamo, 2001). Recognizing the inherently complexity and uncertainty of scenario-based studies, Alcamo and colleagues (2008, 2006) extended the initial proposition of *credibility*, *salience* and *legitimacy* with '*creativity'* to reflect the need for innovative thinking.

An important aspect is to recognize potential trade-offs between the criteria (Cash et al., 2003). For example, efforts to enhance creativity or salience may easily be in conflict with credibility. These trade-offs need to be considered and should be balanced.

How could the attributes and thus the influence of assessments be successfully enhanced? Cash et al. (2003)., Mitchell et al. (2006b) and McNie (2007) see reconciling the needs and interests of decision makers and stakeholders with the temporal, technical and financial capacities of planners and scientists as a key approach. This reconciliation would require participation of the various actor groups in the assessment process. To enable a successful problem solving among such diverse actor groups, the authors propose sensible boundary management (see Guston, 1999). This boundary management would facilitate three functions (Cash et al., 2003): *Active, iterative and inclusive communication* among the actors involved, *translation* to facilitate mutual understanding across disci-

plines and professions, and *mediation* to resolve situations in which strong conflicts persist among the actors that cannot be resolved with mere communication and translation.

Based on the above described findings form other fields, it can be assumed that SLP outcomes are more likely to be influential on decisions if they are perceived as simultaneously credible, salient, legitimate, and creative. To develop high values on these attributes, SLP would need to facilitate continuous and constructive communication between the producers and users of the SLP outcomes in order to implement the needed reconciliation of needs and capacities. SLP is arguably well conditioned to facilitate such communication in offering various participatory planning approaches and information and communication tools.

Despite SLP's potentials to develop relevant outputs, studies of SLP output influence on decision making often find it to be quite limited. (e.g. Brody, 2003, Macias and Mizgajski, 2010, Prendergast et al., 1999, White et al., 2003). This corresponds with the skeptical perception of many commentators concerning the influence of environmental science on decisions in general (cf. e.g. Cash et al., 2003, Mitchell et al., 2006b).

Reasons for the little influence of SLP outcomes on decision making again lie in both external factors and factors related to the SLP outputs. If external factors such as economic crises or dominant political agendas are unsuitable, even highest quality outputs will not be heart. The quality of the outputs themselves also played a role. For example, SLP projects may have missed salience if the outcomes of were delivered at a scale inappropriate for the level of decision making. An example for missing *credibility* is if the models used in SLP could not adequately explain observed interactions between human activities and landscape change.

Influence on decision making through social learning facilitation

SLP can influence decisions through facilitating social learning by enhancing the understanding and skills of relevant actors for informed and cooperative decision making. The influences of social learning outcomes on decision making can be either direct or indirect. Social learning outcomes may directly contribute to decision making, for example if enhanced understanding and skills among decision makers and stakeholders facilitate the reaching of a consensus decision. Social learning outcomes may indirectly influence decision making if they feed back to the context conditions and thus improve (or deteriorate) the conditions for future planning and decision processes. One form of this feedback takes place if enhanced understanding and skills developed among members of the participatory process become adopted by a sufficiently large portion of local actors and if these learning effects persist over longer time periods. Another form of feedback from social learning to context occurs when social learning yields additional outcomes such as enhanced trust and social relationships.

Within the last decade, the concept of social learning is increasingly interpreted as an essential element of successful natural resources management and governance for sustainable development (cf. Andersson, 2008, Bouwen and Taillieu, 2004, Collins and Ison, 2009, Keen et al., 2005, Leeuwis and Pyburn, 2002, NRC, 1999, Pahl-Wostl et al., 2007a, Pahl-Wostl and Hare, 2004, Parson and Clark, 1995, Social Learning Group, 2001a, b, Webler et al., 1995). Social learning is thereby often interpreted in the line of the adaptive management approach in ecology (Folke et al., 2005, Holling, 1978, Lee, 1993) and as a way to implement Habermas' (1984, 1987) concept of communicative rationality. However, different interpretations of the concept also have roots in works in the fields of psychology, education, and organizational development (e.g. Argyris and Schön, 1978, Bandura, 1977, Senge, 1994).

Definitions of social learning concerning environmental and sustainable development issues are legion and often very broad (cf. Armitage et al., 2008, Reed et al., 2010). For example, Ison and Watson (2007) understand social learning as "achieving concerted action in complex and uncertain situa-

tions" and Pahl-Wostl et al. (2008) use the framing of "learning how to collaborate". Reed et al. (2010) argue that the present lack of conceptual clarity and consensus had reduced the applicability of the concept in evaluations and complicated efforts for social learning facilitation in practice. Building on a proposition by the latter group of authors, this research project uses a more narrow definition of social learning as *a change in understanding and skills that becomes situated in groups of actors/communities of practice through social interactions*. Understanding refers to knowledge about the values, interests, and concerns of interested or affected actors as well as about the range of possible actions and their respective consequences and uncertainties. Skills includes capacities to employ the best available knowledge and tools, to incorporate emerging information, concerns and methods, and to adapt planning and implementation strategies accordingly (cf. Dietz and Stern, 2008). Communities of practice are understood as groups of actors from different backgrounds in which knowledge concerning a common issue is constructed (Lave and Wenger, 1991, Wenger, 1999).

Table 2: Characteristics of social learning as understood in this thesis, derived, synthesized and altered from Dietz and Stern (2008), Keen et al. (2005), Muro and Jeffrey (2008), and Reed et al. (2010)

Aspects of social learning processes	Social learning outcomes	Features of participatory planning that may facilitate the social learning processes
- Recognizing participants' goals and perspectives - making explicit underlying values - Iterative reflection on mental models (considering new insights and rethinking assumptions) and actions (through monitoring and evaluations) - co-creating knowledge, - understanding interdependence and the complexity of the management system	- changed understanding (knowledge about values, interests and concerns of interested or affected actors; knowledge about the range of possible actions; knowledge about respective consequences and uncertainties) - changed skills (to employ best available knowledge; to incorporate emerging issues, to adapt planning and implementation strategies, to collaborate with other actors, to consider the implications of complexity and uncertainty)	- facilitation - small group work - egalitarian atmosphere - repeated meetings - opportunities to influence the process - open communication - diverse participation - unrestrained thinking - multiple sources of knowledge

Social learning is both a process (of various actors learning collaboratively) and an outcome (the changed understanding and skills among participants that emerge from collaborative learning). The conceptual framework concentrates on social learning as an outcome to emphasize its potential role in influencing decision making. However, also the process of social learning needs to be explained.

The process of social learning involves aspects such as recognizing participants' goals and perspectives, making explicit underlying values, co-creating knowledge, as well as understanding interdependence and the complexity of the management system. It is important to stress that the process of social learning is not identical to participation. Participatory planning and decision making processes may initiate and facilitate social learning, but do not inevitably lead to social learning (Bull et al., 2008, Tippett et al., 2005). If a participatory process shall be effective in social learning facilitation among its participants, it needs to have certain features including small group work, an egalitarian atmosphere, repeated meetings, opportunities to influence the process, open communication, diverse participation, unrestrained thinking, and multiple sources of knowledge (Muro and Jeffrey,

2008). Keen et al. (2005) propose to establish so-called learning platforms that would provide the framing for participatory processes fulfilling these features to take place.

The outcomes of social learning are perceived in this thesis as changes in understanding and skills (see above). Other potential additional outcomes such as improved ecosystem management and enhanced trust are not considered part of social learning itself. These additional outcomes may indeed emerge from the enhanced understanding and skills, but they do not necessarily need to. Some additional outcomes may even develop without social learning taking place at all, due to alternative processes such as monetary incentives or changes in the governance structure (cf. Reed et al., 2010). Various scholars have further pointed to the different levels of learning outcomes that can occur. Drawing upon earlier research on organization learning by Argyris and Schön (1978), recent studies (ADAM, 2007, Hall, 1993, Pahl-Wostl and Hare, 2004, Siebenhüner, 2002a, b) differentiate *single-loop*, *double-loop*, and, in several cases *deutero* (Argyris and Schön, 1978) or *triple-loop* (King and Jiggins, 2002) learning. *Single loop* learning refers to the simple adaptation of new knowledge to the existing knowledge base. *Double-loop* learning takes place when learning also leads to alterations of the underlying theory of action, including the objectives, values, norms, and belief structures. *Deutero* learning happens on a meta-level and considers the ability to learn itself. The upper levels of learning are believed to be most substantive but also most difficult to achieve that also explains relatively little evidences of double- and especially triple-loop learning (Hall, 1993, Siebenhüner, 2002a).

Drawing on scholarship in the field of natural resources management, it can be argued that SLP processes are likely to facilitate social learning if they succeed in establishing learning platforms that constructively involve diverse actors in the planning process and that fulfill the requirements for effective social learning facilitation.

SLP can be considered well qualified to facilitate social learning for several reasons: The landscape scale may serve as a very useful setting for social learning processes (Selman, 2008). Landscape planning provides much experience and tools in leading participatory planning processes that can be drawn upon for creating social learning facilitation processes (Luz, 2000, Oppermann, 2001, Selman, 2004, von Haaren, 2004a). Scenarios may integrate qualitative and quantitative approaches and be thus useful for participatory planning. In exploring potential future developments and their potential consequences, connecting future visions with today's actions, scenario- based approaches are claimed to be well suited to facilitate knowledge co-production and social learning (Alcamo and Henrichs, 2008, Berkhout et al., 2002, Jäger et al., 2007, NRC, 1999, Robinson, 2003, Swart et al., 2004, Wiek et al., 2006).

Little research has so far addressed the role and influence of landscape planning to facilitate social learning. Bohnet and Smith (2007) named social learning and capacity building as two objectives of an effort to explore scenarios of future landscape development, but neither provided a distinct definition of the terms nor evaluated planning effectiveness to achieve these objectives. Wollenberg et al. (2000) aim at facilitating anticipatory and social learning for supporting adaptive co-management of community forests, but also do not further define learning or assess learning outcomes.

Although formal evaluations of the effectiveness of existing SLP projects to facilitate social learning are so far nonexistent, it can be assumed that SLP often missed opportunities to facilitate social learning. Some SLP projects organized only little involvement of decision makers and other stakeholders within the planning process, thus failing to establish a platform for fruitful communication and interaction. In cases where participatory approaches were followed, deficits are likely to have occurred in the degree to which the requirements of effective social learning facilitation have been fulfilled.

Interactions and trade-offs between the two pathways of influence

The two pathways of SLP influence on decision making, either through planning outputs or social learning outcomes, have been described separately but interact in reality as indicated by the two-sided arrows in the framework concept diagram. SLP outputs influence the kind of social learning outcomes that can be achieved. For example, created maps of alternative future land use changes can be important tools for facilitating learning. Vice-versa, social learning processes taking place during the SLP process may impact the kinds of outputs created. Social learning outcomes may lead to a reframing of the problem issue, the integration of additional perspectives and concerns, or a change of scale in the assessment.

Apart from their interactions, the two pathways must not necessarily be complementary. Alternative approaches to SLP design and implementation are differently effective for yielding influence on decisions through SLP outputs or social learning outcomes. As described above, the objectives of a SLP project may lie on a spectrum from exploration to decision support. Explorative SLP projects that develop extreme scenarios of future landscape development may be highly instructive for social learning and developing capacity for future planning and implementation. However, they may have little outputs with direct relevance or input for short-term decision making. SLP projects that explicitly aim at providing decision support might be influential on decisions without social learning taking place at all, for example if a strong political actor simply decides for one of the presented policy option scenarios. Of course, combinations of the two kinds of SLP projects and thus an exploitation of both paths of influence on decisions are possible. SLP projects may first explore the broad range of alternative scenarios to induce social learning, and later focus on a smaller set of policy scenarios for providing outputs relevant to influence decisions.

2.4 Knowledge gaps

Although scholars already started to reflect upon potentials for increasing the influence of scenario-based approaches around land use change issues (cf. Alcamo et al. 2006, Shearer 2005), systematic scholarship of mechanisms of and approaches for conducting influential SLP is so far lacking. Knowledge gaps exist concerning both pathways of SLP influence on decision making, as well as relating to their interconnections.

In the case of influence through SLP outcomes, it is not yet understood how exactly the attributes of influence should be defined and understood in the context of SLP. It also has not yet been thoroughly assessed if the proposed attributes can indeed help explaining the influence of scenario-based environmental assessments in general and SLP in particular. So far, no studies exist that conducted empirical or literature-based assessments of the validity and usefulness of these criteria for explaining SLP influence. Finally, knowledge is missing concerning approaches and tools for enhancing the degree to which SLP projects are perceived as fulfilling the attributes of influence and, at the same time, enable participation and facilitate boundary management. More information on useful approaches is necessary if the likelihood of conducting influential SLP projects shall be fostered.

Major gaps of knowledge are also present concerning the role and effectiveness of SLP to facilitate social learning around efforts to support sustainable landscape development. This is an important task, given the great relevance attributed to social learning in sustainable development literature and practice, the arguably large contributions that SLP could provide, as well as the current lack of related studies in this field. Further conceptual and empirical research is needed concerning various aspects (cf. Armitage et al., 2008, Muro and Jeffrey, 2008, Reed et al., 2010), including how social learning facilitation and outcomes in SLP be conceptualized, how the effectiveness of SLP projects to generate social learning outcomes can be evaluated, and if the concept proves applicable to explain the influence of projects and consult upon the design of future projects. Furthermore, so far only little understanding exist if and how SLP induced social learning outcomes actually contribute to decision making, and which project designs, methods, and implementation approaches of SLP are most promising to facilitate social learning.

3 Research Organization

3.1 Research objective and questions

The objective of this dissertation thesis is to enhance the understanding and influence of SLP in decision making concerning sustainable landscape development. The thesis examines implementation relevant properties of SLP and explores ways of integrating participatory approaches in SLP. The thesis focuses on two interrelated research questions:

Research question A: What mechanisms and criteria of influential SLP outputs can be identified?

Hypothesis: The influence of SLP outputs on decision making is strongly determined by context factors. However, distinct criteria can be found that help explaining why some SLP projects are more effective than others in coming to bear in decision making in case policy windows of opportunities arise. Integrating participatory approaches into SLP can help enhancing the perceived levels of compliance with the identified criteria of influence.

Research question B: How can SLP facilitate social learning that enhances the understanding and skills of relevant actors for informed and cooperative decision making?

Hypothesis: SLP can facilitate social learning if the SLP process fulfills certain requirements and employs appropriate methods. The outcomes of SLP-induced social learning are enhancements in understandings and skills among participants of the SLP process. Social learning outcomes from SLP may benefit decision making through enhancing the capacities of involved actors for informed and collaborative decision making. Participating planners (or students of planning) benefit from social learning outcomes in the forms of greater conceptual planning understanding and improved planning skills. Social learning outcomes may also transcend a single planning process and influence decision making in the medium- to long-term.

3.2 Research overview

The starting points of the research are the two research questions and associated hypotheses (see figure 1). The main part of the thesis consists of seven work packages that each addresses a specific aspect of the main research questions. The results are reported in separate papers and are published independently.

The first three papers address research question A.

- Paper 1 merges insights from relevant literature to identify mechanisms and criteria of influential outputs of scenario-based planning in general. The research methods include a review of literature form science-policy studies and qualitative content analysis of publications on scenario planning. In particular, prior propositions concerning criteria of influential environmental assessments shall be tested and further specified.
- Paper 2 tests the usefulness of the identified criteria to explain differences in influence of two SLP case studies in the USA. Both cases employed C. Steinitz' Framework for Alternative Futures Studies, but differ in context, the way of implementation, and effectiveness.
- Based on insights from nine European case studies, paper III explores approaches for designing and conducting SLP projects likely to result in outputs complying with the criteria of influence.

Taken together, the three papers suggested that compliance with identified criteria of influence indeed improves the chances of SLP output influence, but that actual consideration in decisions is also determined by external factors as well as relevant understanding and skills of affected actors. The

second set of papers therefore addresses research question B to investigate how SLP can support the enhancement of these capacities of relevant actors through facilitating social learning.

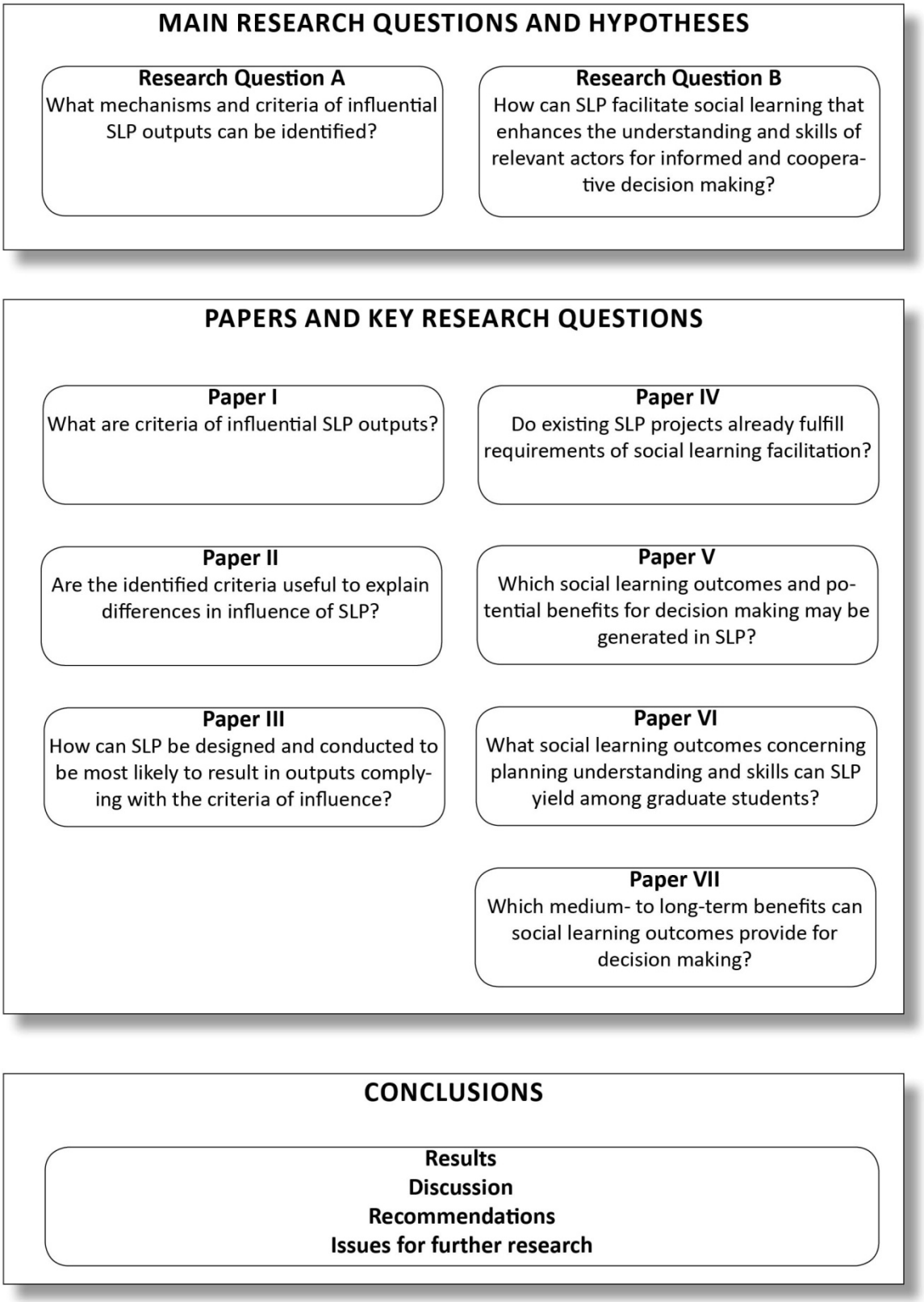


Figure 1: Research overview

- Paper IV assesses the degree to which five recent SLP projects from Australia, Switzerland and the USA already fulfill requirements for social learning facilitation. Considered requirements include diverse participants and methods, small group work, repeated meetings, and participants' influence on process design.
- Paper V uses a planning experiment to empirically investigate possible social learning outcomes of SLP with benefits for decision making. Building on the classic Steinitz model for Alternative Futures studies, a framework for participatory SLP is developed that emphasizes the establishment of social learning platforms where diverse actors can meet, elicit and reflect upon perspectives, co-generate knowledge, and further develop skills. The framework is tested in a climate adaptation planning process involving up to 37 local actors in Gartow, Germany. The evaluation of social learning outcomes follows the premise of action research and employs a mixed-method approach.
- Paper VI investigates possible effects of an educational SLP workshop on social learning outcomes among participating graduate students, focusing on changes in conceptual planning understanding and skills. The workshop concerned future landscape development in the region of Cagliari, Italy, followed the Alternative Futures model and involved local stakeholders as well as 30 graduate students from different nationalities and disciplines.
- A final study (paper VII) assesses potential benefits of social learning outcomes for collective decision making. More specifically, it analyzes how learning outcomes can help addressing the problem of scale, one of the greatest challenges of knowledge to action transfer. The case study is the evolution of climate change adaptation governance in the Norfolk Broads landscape, UK.

In a final step, the results of the several papers are synthesized and overarching responses to the main research questions are provided. The validity and transferability of the results is discussed. A framework for designing and conducting SLP projects most likely to influence decision making is developed and directions for further research are proposed.

3.3 Research methods

The seven papers employ a range of research approaches that can be categorized into planning methods as well as assessment and evaluation tools.

3.3.1 Planning methods

Two papers involved the design and conduct of scenario-based landscape planning. The designs of the planning processes in both projects relate to the Alternative Futures Framework Method for Landscape Planning (Steinitz, 1990, 1993, 2003) which has been described in section 2.2 above.

Paper 6 extends the framework to stronger emphasized social learning facilitation and to suit the certain requirements of landscape planning for climate change adaptation together with up to 37 local actors. Paper 7 used the framework in the context of an intensive educational planning workshop with about 30 graduate students and seven local actors. An overview of the participatory planning methods used in both cases is given in table 1.

Table 1: Participatory planning methods employed

	PAPER V	PAPER VI
DEFINING ISSUE AND SCOPE		
- Moderated discussions	X	
GENERATING REPRESENTATION MODELS		
- Lectures	X	X
- Site visits		X
GENERATING PROCESS MODELS		
- Diagramming important processes for a particular theme		X
- Card technique	X	
EVALUATION MODELS		
- Definition of four criteria relevant for a particular theme		X
- Evaluation of current conditions on the basis of a land use map		X
- Rank-ordering and mapping important local risks and opportunities	X	
CHANGE MODELS		
- Sketching projects		X
- Jointly proposing projects in a “actions and consequences” matrix	X	
- Hand-drawing and integrating selected projects into alternative futures	X	X
IMPACT MODELS		
- Evaluation of Alternative futures on a scale concerning relevant aspects	X	X
- Assess overall evaluation results	X	X
DISCUSSION		
- Plenum discussion on results, implications and next steps	X	X
DECISION		
- decision to use the results as the basis for the development of a mission statement (Leitbild)	X	

3.3.2 Assessment and evaluation methods

The investigation of the effects of SLP on decision making and social learning involved three main kinds of methodological approaches. First, published literature and other documents were reviewed and comparatively assessed to gain cross-cutting insights of previous research results. Second, case study approaches (cf. Scholz and Tietje, 2002, Yin, 2003) were employed to collect and analyze empirical evidence and to reflect findings from literature with practical experiences. Third, the action research approach (cf. Coghlan and Brannick, 2001, Dickens and Watkins, 1999, Heron and Reason, 1997, Lewin, 1946) was used in case studies in which the authors were partly involved in both leading the planning process and simultaneously assessing its effects on decisions and social learning. Action research describes a variety of approaches (Coghlan and Brannick, 2001). The main idea is to consider the case study as two processes running in parallel; one consisting of the actual actions, the other representing a continuous inquiry into the effects of each action taken. Table 2 lists the particular methods used, grouped into qualitative and quantitative tools.

As noted in the review, SLP influence on decisions often takes considerable time to become evident and is determined by numerous factors unrelated and related to the SLP project. The thesis therefore suggests interpreting the quality and extent of SLP outputs and social learning outcomes as proxies for influences on decisions in cases where SLP impacts on decisions cannot be assessed.

Table 2: Assessment and evaluation methods applied

	PAPER I	PAPER II	PAPER III	PAPER IV	PAPER V	PAPER VI	PAPER VII
QUALITATIVE METHODS							
- Literature reviews	X	X	X	X	X	X	X
- Qualitative content analysis	X						
- Interviews		X			X	X	X
- Questionnaires					X	X	
- Observations					X	X	
- Focus group discussions			X		X		
SEMI-QUANTITATIVE METHODS							
- Surveys					X	X	

3.3.3 Case studies

The seven papers assessed a total of 19 different case studies of landscape planning (see table 3). Most case studies address landscape planning projects in European regions. Five cases focus on landscapes in the USA and one considers an area in Australia.

Table 3: Case studies of landscape planning considered

	CASE STUDIES OF LANDSCAPE PLANNING CONSIDERED AND KEY REFERENCES
Paper II	- The Upper San Pedro River Basin, Sonora, Mexico, and Arizona, USA (Steinitz et al., 2003) - Monroe County, Pennsylvania, USA (Steinitz et al., 1994)
Paper III	- Vilhelmina municipality, Sweden (Angelstam, 2009) - Auvergne, France (Peyre et al., 2009) - Potsdam, Germany (Lipp, 2009) - Isarwinkel region, Germany (Probst, 2009) - Several municipalities, Portugal (Quintas and Curado, 2009) - Lengau, Austria (Damyanovic, 2009) - Forest region in Lombary, Italy (Digiovinazzo et al., 2009) - Edinburgh and the Lothians, Scotland (Whitehead, 2009) - Island of Gozo, Malta (Cassar et al., 2009)
Paper IV	- Upper San Pedro River Basin, Sonora, Mexico, and Arizona, USA (Steinitz et al., 2003) - Summit County, Colorado, USA (Theobald and Hobbs, 2002) - Buck Creek and Walnut Creek Watersheds, Iowa, USA (Nassauer and Corry, 2004, Santelmann et al., 2004) - Willamette River Basin, Oregon, USA (Baker et al., 2004, Hulse et al., 2004) - Mossman and Julatten Landscapes, Queensland, Australia (Bohnet and Smith, 2007, CSIRO, 2005) - Davos Region, Switzerland (Walz et al., 2007)
Paper V	- Greater Community of Gartow, Germany (Albert et al., accepted)
Paper VI	- Region of Cagliari, Italy (Steinitz et al., 2010) (Albert et al., 2010)
Paper VII	- The Broads Ecosystem, UK (Albert and Falaleeva, accepted, Falaleeva and Albert, 2009)

3.4 Research collaborations and responsibilities

Four papers were developed in collaboration with colleagues.

Research for paper III was conducted together with J.C. Vargas-Moreno from the Department of Urban Studies and Planning at the Massachusetts Institute of Technology, USA. C.A. assumed responsibility for conceptualizing and writing the final manuscript. J.C.V.M. provided valuable comments and wrote two of four sections on cross-cutting findings.

The assessments for paper V were executed by the author together with T. Zimmermann, J. Hildebrandt and J. Knieling from the Chair of Urban Planning and Regional Development at HafenCity University Hamburg, Germany. T.Z. and J.K. were involved in designing the planning experiment process and provided comments on the manuscript. T.Z. also co-lead the planning process and drafted paragraphs on the rationale of the planning process and the case study context. C.A. co-designed and co-lead the planning process, developed and conducted the social learning evaluation, assessed the empirical data gathered, and wrote the manuscript.

Paper VI was developed in collaboration with M. Falaleeva from the Coastal and Marine Resources Centre, University College Cork, Ireland. While most parts were written collaboratively, C.A. was mainly responsible for the literature review and development of a conceptual assessment framework. M.F. conducted document analyses and interviews and drafted the parts on empirical findings.

Investigations for Paper VII were conducted together with C. von Haaren, Institute of Environmental Planning at Leibniz University of Hannover, Germany, and J.C. Vargas-Moreno from MIT, USA. Tess Canfield commented on the questionnaire. C.v.H. and J.C.V.M. drafted the survey questions, contributed empirical insights from observations of the planning process, and provided comments on the manuscript. C.A. was responsible for collecting and assessing empirical evidences and writing the manuscript.

3.5 Thesis structure and references of published articles

This thesis is mainly based on seven papers. The first chapter describes the thesis' background and main research problem.

Chapter 2 summarizes the state of knowledge concerning approaches for supporting sustainable landscape development and the potential roles of SLP in such approaches. Based on a review of existing literature, it presents a conceptual model of SLP influence on decision making.

Chapter 3 introduces the research organization of the thesis. It lists the objective and research questions, describes the research design and methodologies, and explains the research collaborations and thesis structure.

Chapter 4 (Paper I) reports on the literature reviews and qualitative content analysis conducted to identify mechanisms and criteria of influential scenario projects. It is accepted for publication.

> Albert, C. (accepted): Participatory Scenarios in Developing and Implementing Long-Term Policies – Potential Contributions and Attributes of Influence. In: Siebenhüner, B., Arnold, M.,, Eisenack, K. and Jacob, K. (Eds.): Long-Term Policies – Governing Social-Ecological Change, Routledge.

Chapter 5 (Paper II) tests the usefulness of the criteria in the field of SLP at the example of two case studies of scenario-based landscape planning.

> Albert, C. (2010): On the Influence of Scenario-based Landscape Planning – A Comparison of Two Alternative Futures Projects. *The Problems of Landscape Ecology*, Vol. 28, 33-44.

Chapter 6 (Paper III) explores planning approaches for enhancing the criteria.

> Albert, C. & Vargas-Moreno, J.C. (2010): Planning-Based Approaches for Supporting Sustainable Landscape Development. *Landscape Online*, 19, 1-9.

Chapter 7 (Paper IV) assesses the degree to which process features of SLF are already fulfilled in innovative SLP projects.

Chapter 8 (Paper V) uses a planning experiment to empirically investigate the social learning outcomes with benefits for decision making that can be achieved in SLP.

> Albert, C., Zimmermann, Th., Knieling, J., and von Haaren, C. (in press): Social learning can benefit decision-making in landscape planning: Gartow case study on climate change adaptation, Elbe valley biosphere reserve. *Landscape and Urban Planning*

Chapter 9 (Paper VI) assessed the effects of SLP on social learning outcomes among participating graduate students, focusing on changes in conceptual planning understanding and skills. The paper is currently under review in an international journal.

> Albert, C., von Haaren, C., and Vargas-Moreno, J.C. (under review): Testing Alternative Futures Planning Methodology: Learning Effects for Graduate Students and Options for Improvement.

Chapter 10 (Paper VII) assesses potential benefits of social learning outcomes for collective decision making.

> Albert, C., and Falaleeva, M. (accepted): Social Learning for Bridging Scales and Levels: The Case of a Local Strategy for Climate Change Adaptation. In: Antunes, P., Santos, R., Lobo, G., Videira, N., and Vatn, A. (Eds.) *Methods and Tools for Environmental Appraisal and Policy Formulation*, Faculdade de Ciências e Tecnologia, Universidade Nova de Lisboa, Lissabon, Portugal.

Finally, chapter 11 summarizes the findings of the thesis, discusses the results, and proposes a framework for SLP as well as directions for further research.

3.6 Definition of key terms

A few terms are used throughout this thesis that require further clarifications.

Alternative futures:	illustrations of the land use and land cover configuration of the respective landscape that may result from the changes within a particular scenario at a specified point of time in the future (Shearer, 2005, Steinitz et al., 2003)
Land Use and Land Cover:	Land use refers to how people use land, for example urban and agricultural land. Land cover, in contrast, is the physical material at the surface of the earth (cf. Fisher et al., 2005).
Landscape:	"an area, as perceived by people, whose character is the result of the action and interaction of natural and/or human factors" (Council of Europe, 2000)
Landscape planning:	"a strong forward-looking action to enhance, restore or create landscapes", following the definition of the European Landscape Convention (Council of Europe, 2000)
Scenarios:	"plausible and often simplified descriptions of how the future may develop based on a coherent and internally consistent set of assumptions about key driving forces and relationships" (Reid et al., 2005)
Scenario-based Landscape Planning (SLP):	an approach to landscape planning that consists of assessing the functioning of the landscape system, developing scenarios of future landscape change, modeling the land use and land cover changes (LUCC) potentially resulting from these scenarios (alternative futures), and to assess their respective consequences (cf. Hulse et al., 2004)
SLP influence on decision making:	The influence that a particular SLP project yields on political decision making concerning the sustainable development of the respective landscape, e.g. decisions on land uses, zoning, the placement of settlement areas, restrictions on agricultural land uses in particular regions, the designation of conservation areas, landscape management measures for valuable areas
SLP outputs:	The substantive results of an SLP excercies, e.g. reports, maps, diagrams, tables
Social learning:	a change in understanding and skills that becomes situated in groups of actors/communities of practice through social interactions (building on Reed et al., 2010)
Social learning process:	The process of diverse actors learning collaboratively
Social learning outcomes:	The changed understanding and skills among participants that emerge from a social learning process
Sustainable landscape development:	a continuous reconciliation of society's development goals with landscape's capacities to deliver ecosystem services over the long term (cf. Clark and Dickson, 2003, Kates et al., 2001, NRC, 1999, Turner, 2008)

4 Participatory Scenarios in Developing and Implementing Long-Term Policies – Potential Contributions and Attributes of Influence (Paper I)

Christian Albert

Draft version of an accepted book chapter in Siebenhüner, B., Arnold, M.,, Eisenack, K. and Jacob, K. (Eds.): *Long-Term Policies – Governing Social-Ecological Change*.

4.1 Introduction and Methods

Long-term policy development and implementation presents society with two key challenges: the high degree of complexity and uncertainty in the evolution of the coupled economic, social and ecological systems (e.g. Gunderson and Holling, 2002, NRC, 1999), and the need to integrate various kinds of information and perspectives of societal actors in this process (cf. Kates et al., 2001).

Participatory scenario development and assessment is frequently considered a key instrument for responding to these tasks (NRC, 1999, Swart et al., 2004, Wiek et al., 2006). While numerous definitions for scenarios exist, a broad and generally agreed-upon consensus seems to be that scenarios are "descriptions of how the future might unfold, rather than predictions of what the future will be. They reflect different assumptions about the evolution of current trends, the possible effects of critical uncertainties, and emerging influential factors" (UNEP, 2002).

Participation in scenario processes means that societal actors beyond the core group of scenario developers are involved in the creation and assessment of alternative futures. Approaches for involving scenario users in the development process were originally developed in the business world (e.g. van der Heijden, 1996, Wack, 1985a), and increasingly find application in public policy. Recently, a number of publications reflected upon the potential roles and contributions of scenarios in addressing long-term policy issues, but so far it has not been explicitly reviewed how scenarios could contribute to long-term policy development and implementation. Furthermore, despite the increasing use of participatory scenarios in long-term policy development, the level of effectiveness reached in actually influencing the relevant debates and political decision making often leaves room for improvement (Alcamo et al., 2006).

This chapter attempts to provide an overview of the characteristics of participatory scenarios, to discuss the ways in which they can contribute to long-term policy making, and to investigate attributes of participatory scenarios to be influential in public discussions and decisions. The first section of the chapter proposes characteristics for classifying participatory scenarios and synthesizes their potential contributions to policy making. It is based on a comprehensive review of relevant literature. The second section develops attributes of participatory scenario processes and outcomes that need to be fulfilled for yielding influence. A hypothesis on the attributes is developed by drawing on studies on the influence of science on policy, in particular the seminal Global Environmental Assessment Project (Mitchell et al., 2006b). A qualitative content analysis (Mayring, 2000, 2008) of scenario publications is conducted to further qualify the hypothesis and to propose a conceptual framework of attributes of influential scenarios.

It is beyond the scope of this article to provide specific guidelines of how participatory scenario processes should be designed and which methods should be used. However, based on the analysis, the

paper will provide some preliminary recommendations for applying participatory scenarios in practice as well as issues for further research.

4.2 Participatory Scenario Types and Potential Contributions

Scenarios as a tool for planning and policy development have been used for more than five decades: Formal use of scenarios began at the end of World War II in the field of war game analysis (Shoemaker, 1993, van der Heijden, 1996). The civilian use of the scenario technique in a variety of planning purposes was pioneered by the work of Herman Kahn and others (Kahn and Wiener, 1967) and further developed and applied in business planning (e.g. Gausemeier et al., 1995, Georgantzas and Acar, 1995, Schwartz, 1996, van der Heijden, 1996, von Reibnitz, 1987, Wack, 1985a, b). At least since the seminal "Limits of Growth" study by Meadows et al. (1972), scenarios have been applied to numerous long-term issues of public concern, ranging from studies at the global and regional (Gallopin et al., 1997, Nakicenovic et al., 2000, Raskin et al., 2002) to the local scale (e.g. Bohnet and Smith, 2007, Peterson et al., 2003, Ringland, 2002, Steinitz et al., 2003, Walz et al., 2007).

Facing the great number and diversity of studies in the field of scenario-based planning and assessment, recently various scholars aimed at better understanding and characterizing scenario types. The studies take different approaches and have resulted in typologies with distinct differences. They can support the study of existing scenarios and provide guidance to the design and conduct of future scenario exercises (cf. Alcamo and Henrichs, 2008). Examples include a study by Bradfield et al. (2005) that describes the evolution of three "schools" of scenario development. Börjeson et al. (2006) differentiate between predictive, explorative and normative scenarios with two subcategories for each type. Van Notten et al. (2005, 2003) present a typology of scenario approaches consisting of various parameters and spectrums of their respective characteristics.

While these typologies are valuable for classifying scenarios, they necessarily remain broad in order to cover the range of scenario types available and do not focus on participatory scenarios for long-term policy development and implementation. The much-cited typology by van Notten et al. (2005, 2003) is a very useful basis, but it also needs to be altered and amended since essential features of participatory scenarios are not included and relevant aspects of scenarios dealing with public governance issues cannot be usefully mapped into it (as exemplarily shown by Sondeijker et al., 2006).

All participatory scenarios for supporting long-term policy development and implementation share some common characteristics: They focus on a long-term time horizon of generally at least 20 years, describe both pathways of future change and the potential outcomes, and are participatory in involving decision makers, stakeholders, scientists, and/or lay citizens beyond the core team of scientists or consultants who facilitate the scenario exercise. Besides, participatory scenarios differ in the specific characteristics of eight important parameters (see Table 1).

Table 1: Characteristics of Participatory Scenarios for Long-Term Policy Development

PARAMETERS	CHARACTERISTICS
1. Function	Process – Product
2. Subject	Area, Issue, and Institution
3. Vantage Point	Exploratory – Anticipatory
4. Inclusion of Values	Primarily Descriptive – Primarily Normative
5. Inputs in the Scenario Process	Qualitative – Quantitative
6. Level of Involvement	Co-Decision, Co-Design, Co-Thinking, Consultation, Information
7. Frequency of Involvement	Entire Process – Episodic
8. Meeting Characteristic	Synchronously – Asynchronously
9. Resources Availability	Extensive – Limited

Sources: Based on Van Notten et al. (2003) and Van Notten (2005), with amendments from Alcamo and Henrichs (2008), Pahl Wostl (2008), Swart et al. (2004), and Jäger et al. (2007).

1. Function: Participatory scenarios may place different emphases on the two key functions supporting long-term policy development. Product-focused scenarios concentrate on the production of information. Process-oriented scenarios aim more at facilitating discussions, developing mutual understanding, and initiating social learning (cf. Van Notten, 2005).
2. Subject: The focus of participatory scenarios can be a specific issue (e.g. the future of small scale agriculture), a geographic area, or a specific institution (cf. Van Notten et al., 2003).
3. Vantage point: The vantage point of participatory scenarios can be either exploratory (forward-looking) or anticipatory (backcasting). Participation in exploratory studies allows participants to start from the present and explore how the future might evolve. Anticipatory scenarios assume a specific future situation and explore the range of actions or developments necessary to attain (or not attain) the projected condition.
4. Inclusion of values: Primarily descriptive scenarios explore consequences of plausible futures, while primarily normative ones assess the implications of probable, preferred, or undesired futures. Involvement of participants is possible in both variants, but it may be argued that stakeholder participation increases the normativity of a scenario. However, all scenarios are to some extent normative since they always reflect the mindsets of the people creating them (cf. Swart et al., 2004).
5. Inputs: Qualitative scenarios use narrative outlines, texts, storylines, diagrams, pictures and/or collages to describe future developments with high levels of complexity and uncertainty. They may include non-quantifiable, normative aspects like values, mental maps, and expectations of participants. Participation of non-scientific actors has a long tradition in qualitative scenario development. The participants can help developing a joint system understanding, identify key driving forces and uncertainties, and develop the actual scenarios (cf. Kok et al., 2006a, Kok et al., 2006b). In contrast, quantitative scenarios apply numerical approaches and often use formal models. They offer structural consistency and scientific rigor through explicit assumptions. Non-scientific actors can contribute to the development of quantitative scenarios in providing judgment for making assumptions in scenarios. A disadvantage is that participation in quantitative scenario development decreases its usual transparency since the thought process of the participants in making the judgments cannot be made fully explicit (Alcamo and Henrichs, 2008).

6. Level of involvement: By building on Arnstein's (1969) classical "Ladder of Citizen Participation", recent amendments from public participation research (e.g. Mostert, 2006) and scenario literature (Alcamo and Henrichs, 2008, Pahl-Wostl, 2008), the following levels of participation in scenario development can be derived (cf. Volkery et al., 2008). At the lowest level, stakeholders and decision makers are only *informed* about the process and results of a scenario exercise. More intensive participation occurs when non-scientific actors are *consulted* during the exercise to provide input. *Co-thinking*, the third level, means that participants are actively involved in the development of the scenarios, but do not make decisions. At the *co-designing* stage, participants are furthermore engaged in the structuring of the scenario process and the joint definition of "game rules" for collaboration. Finally participants can *co-decide* and assume responsibility for the scenario process design, the analysis and the recommendations derived from them.
7. Frequency of involvement: Participants may be constantly involved in scenario development or take part only sporadically for certain phases of the process (cf. Pahl-Wostl, 2008). Continuous involvement may foster mutual understanding, developing trust and a feeling of ownership among participants. Episodic meetings may involve changing participants and can be more appropriate if large numbers of participants are to be included.
8. Meeting characteristic: One way to facilitate participatory scenario development is to hold workshops with the various participants. Another option is to organize an asynchronous process to which participants can contribute at different times and in different locations (for example via internet). While the first approach is strongly advisable for facilitating social learning, meeting asynchronaly may be more useful to obtain judgments and information from a large group of individuals (cf. Pahl-Wostl, 2008).
9. Resource availability: Participatory scenarios differ in the availability of temporal and financial resources as well as available manpower. For example, the urgency of issues or political time frames may force scenario developers to produce results very quickly. In other cases, longer time scales of several years can be invested. Involving participants is very complicated and time consuming - the higher the desired degree of involvement, the more resources are needed (cf. Alcamo and Henrichs, 2008, Van Notten et al., 2003).

A few studies explored the potential contributions of participatory scenarios to the development and implementation of responses to complex, long-term, and uncertain-laden societal challenges. For example, Swart et al. (2004) explored how scenario analysis can serve as a key tool of sustainability sciences. Wiek et al. (2006) addressed the question of which functions scenarios can adopt in efforts for supporting sustainability transitions. Sondeijker et al. (2006) studied in greater detail the characteristics of so-called "transition scenarios" within the overall transition management concept (cf. Kemp et al., 2007, Rotmans et al., 2001). Others focused on scenarios in public policy (e.g. Ringland, 2002), for addressing environmental issues (e.g. Alcamo, 2001, Alcamo, 2008b, Alcamo et al., 2006, Pahl-Wostl, 2008, Wollenberg et al., 2000, Xiang and Clarke, 2003), and as mechanisms to facilitate organizational or social learning (e.g. Berkhout et al., 2002, Chermack et al., 2006, Robinson, 2003). From this array of publications, a range of potential contributions can be deducted that participatory scenarios may provide for long-term policy development and implementation.

First, participatory scenarios can contribute to the exploration of alternative future developments and their potential consequences. In this respect, involvement of societal actors is beneficial as it may enrich scenarios with local knowledge and creativity and ensure that relevant aspects are taken into account (Alcamo and Henrichs, 2008, Pahl-Wostl, 2008). The information created through participatory scenarios can take three main forms:

Participatory scenarios may enhance understanding about the dynamics and evolution of complex and coupled human-environment systems beyond the control of the scenario users (Alcamo, 2008b,

Jäger et al., 2007). They can address complex issues and their interactions and integrate across different types of data, disciplines, institutions, as well as temporal and spatial scales and perspectives (cf. Alcamo, 2008b, Swart et al., 2004). This exploration may include identifying "weak signals" of change and their potential cumulative impacts (Jäger et al., 2007, Kasemir et al., 2003), and the possibilities of inconsistencies, breaches-of-trends, and surprises (Jäger et al., 2007, Swart et al., 2004, Van Notten, 2005, Wollenberg et al., 2000). As such, scenarios may raise awareness about future challenges (Alcamo, 2008b, Jäger et al., 2007), and thus serve as an important input for long-term policy development (Jäger et al., 2007, Wiek et al., 2006).

Participatory scenarios may also provide information about the implications and robustness of alternative policy options. Such forward-looking scenarios assume different policy options and assess them concerning their consequences and the degree to which they might achieve specific objectives (cf. Alcamo, 2008b, Jäger et al., 2007, Shoemaker and van der Heijden, 1992, van der Heijden, 1996).

Participatory scenarios can link normative, long-term policy objectives with decisions necessary to attain them. Following this backcasting-approach, scenarios can serve as a guiding framework for interventions in the short and medium term (cf. Pahl-Wostl, 2008, Quist and Vergragt, 2006, Robinson, 2003, Sondeijker et al., 2006, Swart et al., 2004).

Second, participatory scenarios may initiate and facilitate social learning through eliciting, critically discussing and challenging different perspectives and mental maps of system interdependencies, the future evolution of the issues at stake and the range and kinds of possible solutions (cf. Alcamo and Henrichs, 2008, Berkhout et al., 2002, Jäger et al., 2007, NRC, 1999, Robinson, 2003, Sondeijker et al., 2006, Swart et al., 2004, Wollenberg et al., 2000). The key idea is that involving diverse societal actors may enhance legitimacy and mutual understanding, lead to the development of a feeling of ownership, and ease subsequent implementation (cf. Alcamo and Henrichs, 2008, Pahl-Wostl, 2008). In particular, participatory scenarios can fulfill the following functions:

Participatory scenarios may ease and facilitate communication and discussions through providing a "language" that is understandable by diverse audiences (cf. Jäger et al., 2007, Swart et al., 2004), thus offering a way for stakeholders to take part in the creation and discussion of long-term policies (Alcamo, 2008b).

On the basis of this improved communication, participatory scenarios may facilitate discussions and conscious reflections on different perspectives and understandings (cf. Alcamo, 2008b, Jäger et al., 2007, Swart et al., 2004). As a result, scenario participants may adapt their mental models to new understandings. Through such "reperceiving" (Wack, 1985a), scenarios have the potential to overcome various cognitive biases (for a review, see Wollenberg et al., 2000) and to serve as "heuristic tools that encourage social learning" (Berkhout et al., 2002).

Finally, scenarios may initiate and structure short and medium-term collaborations towards a shared long-term objective (cf. Jäger et al., 2007, Wiek et al., 2006). Sondeijker et al. (2006) argue that scenarios – as a tool to bring together various perspectives – can initiate collaboration towards a common vision. Along these lines, Pahl-Wostl (2008) finds scenarios useful for supporting initiatives to put learning-based adaptive management approaches into practice.

Recent studies have stressed that the scenario process is at least as important as the results and the tools itself (Robinson, 2003, Sondeijker et al., 2006, Swart et al., 2004). However, although scenarios are claimed to contribute to this diverse range of functions, their capacity to do so in practice is often limited. Furthermore, it is often impossible to fulfill multiple functions simultaneously.

4.3 Towards a Hypothesis on Influential Participatory Scenarios

Given the manifold potential contributions of participatory scenarios to the development and implementation of long-term policies, the question arises of which attributes determine the influence of scenarios in discussions and decision making. Before addressing this issue in detail, this section will

review models for explaining the influence of science on policy and develop a hypothesis of attributes of effective scenarios. It is important to note that scenarios cannot be equated with science but rather blend design elements with scientific modeling and assessments. However, against the background of the little scholarship on the influence of scenarios on public policy, it is useful to draw on findings made in the science-policy field to develop a hypothesis for scenario influence.

Science-policy studies remain skeptical on the effectiveness of scientific input on policy making. On the one hand, the influence of scientific information on decision making processes seems to be quite limited (cf. Funtowicz and Ravetz, 2001). Decision makers cannot be assumed to solely base their decisions on objective scientific assessments on the issue at stake and on the various policy options to address it. Instead, they face substantial constraints on temporal resources and cognitive capacities when trying to make "good" decisions, especially on such complex issues like sustainable development. Consequently, decision makers usually act 'boundedly rational' and tend to rely on personal experience and other heuristics that decrease the need to collect and process information (Kahnemann et al., 1982, Simon, 1982, Simon, 1983).

On the other hand, many studies have shown that cognitive and normative uncertainties sometimes create contexts of so called "policy windows" or "fluid moments in history", in which innovative and creative ideas are considered and decision makers are receptive to and interested in new information (e.g. Kingdon, 1984, Lee, 1993). Baumheier (1993) notes that promoters of new policies need to react quickly since policy windows open up for only short time periods. Due to public debate and emerging political pressures, policy windows can have significant influence on decisions (Heiland, 1999, Rucht, 1994).

The Global Environmental Assessment project (Mitchell et al., 2006b) went further in asking how environmental assessments must be designed and conducted to be most likely to make use of opening "policy windows" and, in effect, influence decision making in public policy. On the basis of a number of empirical case studies from national and international environmental assessments (see Mitchell et al., 2006b), the authors concluded that environmental science is more likely to influence policy if the assessment process is perceived as not only scientifically credible but also salient to political concerns and legitimate by the assessment's audiences (Cash et al., 2003, Mitchell et al., 2006b, cf. NRC, 2007). While other concepts for explaining the effectiveness of scientific assessments in policy making exist, this set of criteria has been identified as one of the most comprehensive (McKnie, 2007).

Scenarios however can be perceived as a special kind of assessment that address not the current, but the future state of the environment (Alcamo, 2001), resulting in dramatic increases of the degree of complexity and uncertainty involved. To reflect the need for innovative thinking about possibilities and surprises in scenario-based studies, Alcamo and colleagues (2008, 2006) proposed "creativity" as an additional criterion.

On the basis of these findings from the literature, the hypothesis becomes:

> *Scenarios tend to be influential in policy to the degree that they are perceived as simultaneously credible, salient, legitimate, and creative by the scenario users.*

4.4 Attributes of Influential Participatory Scenarios

To further investigate the attributes of influential scenarios, a qualitative content analysis of scenario literature was conducted. The approach followed the inductive category development procedure as proposed by Mayring (2000, 2008). A criterion of definition was formulated as "characteristics of scenarios mentioned in the material as important for yielding influence". Published material was collected that considered the attributes of influential scenarios (see Table 1). Finally, the criterion of definition was applied in the analysis of the material and categories (in this case, sub-attributes) were deducted and iteratively revised. Figure 1 illustrates the resulting proposed framework of attributes for influential scenarios.

THEMES	REFERENCES
Definitions of credibility, salience, legitimacy and creativity	Cash and Buizer (2005), Cash et al. (2003), Mitchell et al. (2006a), Alcamo et al. (2006), Alcamo and Henrichs (2008), NRC (1999), NRC (2007)
Scenarios in environmental studies	Alcamo (2001), Alcamo et al. (2006), Alcamo (2008a), Berkhout et al. (2001), Wollenberg et al. (2000)
Scenarios in public policy	Leney et al. (2004), Ringland (2002)
Scenarios in business	Götze (1991), Van der Heijden (1996), von Reibnitz (1987), Schwartz (1996), Wack (1985a, b), Shoemaker (1995), Ringland (1991, 1998, Schwartz, 1996, Shoemaker, 1995, van der Heijden, 1996, von Reibnitz, 1987, Wack, 1985a, b)

Table 1: Literature considered in the content analysis

4.4.1 Credibility

Credibility describes the degree to which the audiences consider the scenarios as correct and its arguments and conclusions as adequate (cf. Cash and Buizer, 2005, Cash et al., 2003), or at least more correct than competing claims (cf. Mitchell et al., 2006a). It is an often cited attribute of effective scenarios that relates to four distinct qualities.

Most importantly, a scenario's credibility is determined by the degree to which its audiences perceive it as *plausible* (Alcamo et al., 2006, Götze, 1991, Leney et al., 2004, Schwartz, 1996, van der Heijden, 1996, von Reibnitz, 1987), or at least "not-implausible" (Alcamo, 2001). Plausible scenarios are considered feasible and attainable within a given timeframe (Leney et al., 2004) and are based on a sound and empirically verified analysis of the existing conditions (Götze, 1991, Wack, 1985b). Only plausible scenarios are considered capable of serving as a basis from which the users can further develop knowledge and understanding (van der Heijden, 1996) and failure in attaining plausibility thus risks easy dismissal by scenario users (Alcamo, 2001).

Internal consistency both within each scenario (Alcamo, 2001, Götze, 1991, Leney et al., 2004, von Reibnitz, 1987) and among the set of scenarios (Shoemaker, 1995) is the second quality. It requires that the assumptions and causal relationships are consistent with existing information (Alcamo et al., 2006, Shoemaker, 1995) and that the scenarios "grow logically (in a cause/effect way) from the past and the present" (van der Heijden, 1996).

Another aspect of credibility is *comprehensiveness*, the degree to which the set of scenarios produced covers the range of available alternatives or possibilities (Götze, 1991, van der Heijden, 1996). Although there seems to be consensus that scenarios need to be comprehensive, it is not clear if the range of considered scenarios need to include all options (Wack, 1985a), a wide range of possible or plausible options (Götze, 1991, Leney et al., 2004, Shoemaker, 1995), or at least the extremes of the assumed future alternatives (von Reibnitz, 1987). Scenarios should highlight competing perspectives and describe generically different alternatives rather than variations on one theme (Shoemaker, 1995). However, most authors propose sets of two to four scenarios as most effective to reflect the uncertainties and at the same time keep the number of scenarios at a manageable size (e.g. van der Heijden, 1996).

Enhancing credibility requires a highly transparent and sufficiently documented scenario development process that is retraceable by the actors involved (Alcamo, 2001, Alcamo et al., 2006, Ringland, 2002, Schwartz, 1996). Since sustainable development allows for multiple perspectives and mental models, the rationales for choosing a particular set of assumptions must be communicated (Alcamo et al., 2006, Götze, 1991, Leney et al., 2004).

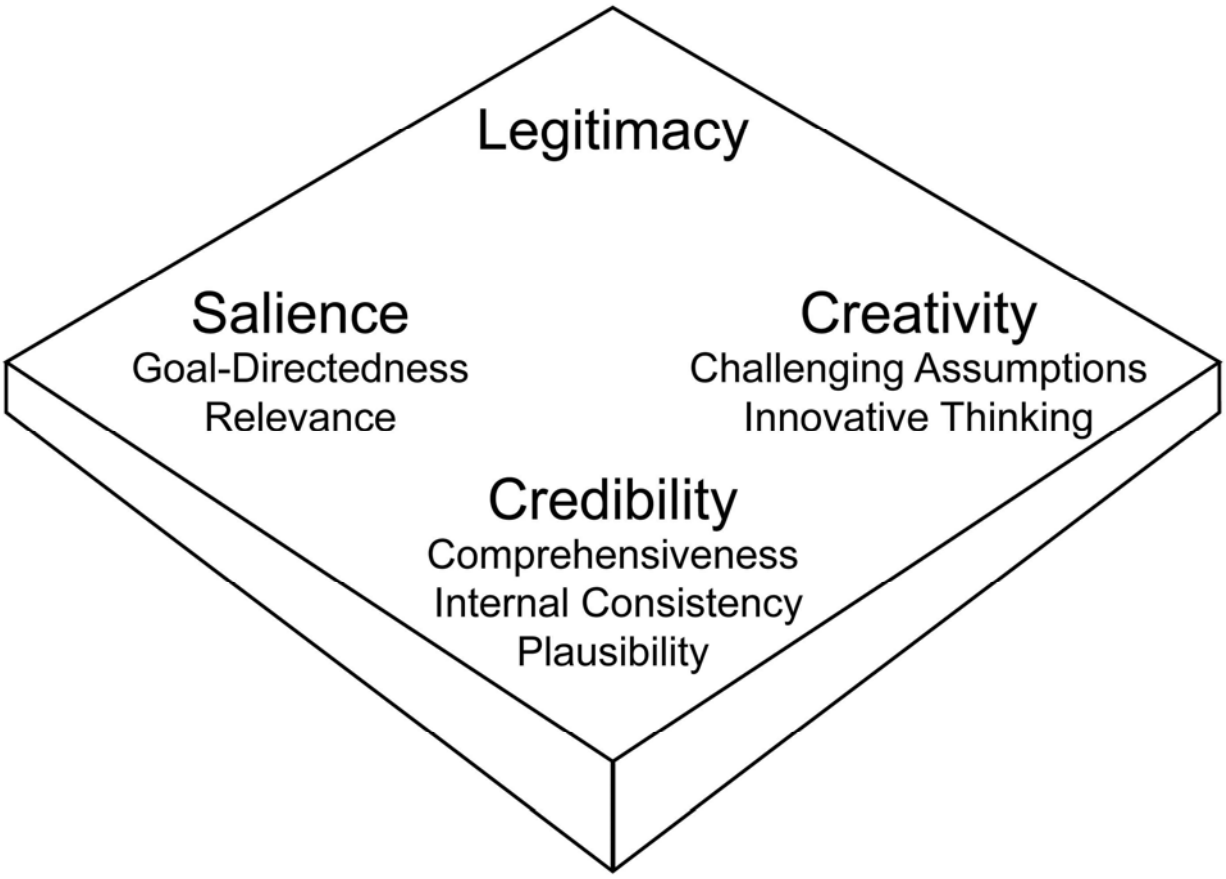


Figure 1: Proposed framework of attributes of influential scenarios. Own conceptualization, based on Alcamo et al. (2006), Cash et al. (2003), Mitchell et al. (2006b), NRC (2007), and a content analysis of scenario literature.

4.4.2 Salience

Salience is another crucial requirement that asks if a scenario is relevant to its audience and if the objectives are adequately addressed. The information must be provided in a way that is responsive to local conditions and issues of concern, must connect to aspects that the decision makers find relevant and that they can influence, and must be provided at an appropriate time period before relevant decisions are made (cf. Mitchell et al., 2006a). Salience has been interpreted as of uttermost importance for ensuring the effectiveness of scenarios and it should be sustained under all circumstances (van der Heijden, 1996).

One aspect of salience, *goal directedness*, asks if the scenarios are explicitly attuned to address the issues at stake (Ringland, 1998) and prove useful for acquiring the information necessary to make decisions among alternative options (Götze, 1991, Leney et al., 2004).

Relevance, another aspect, includes that scenarios must be tailored to the existing knowledge, cognitive abilities, current concerns and mental maps of the potential scenario users (Shoemaker, 1995, van der Heijden, 1996). They should explicitly draw upon the audience's own language, history, and context (Ringland, 1998) and specifically address the "deepest concerns" of the users (Wack, 1985b) so that they can easily assume ownership and consider the scenarios' implications in their activities (Schwartz, 1996).

Scenario salience can be enhanced by designing and conducting the scenario development process explicitly according to the needs of the users, specifically adapted to the temporal and financial re-

sources available (Berkhout et al., 2001), and with a constant focus on the decisions to be made (Alcamo, 2001). Linking scenario exercises into current ongoing visioning, planning, and implementation processes and facilitating constant exchanges and collaboration between scenario developers and users can heighten saliency through harmonization of the scenario agenda, its goals and expected results (Alcamo, 2001, van der Heijden, 1996, von Reibnitz, 1987, Wack, 1985a). However, such iterative reconciliations between scenario users and developers most often proved particularly difficult which led Wack (1985b) to identify the missing interface between developers and decision makers as one of the key problems of scenario planning.

4.4.3 Legitimacy

Legitimacy concerns the degree to which scenarios are perceived as unbiased in their conduct and respectful and procedurally fair to the divergent perspectives, interests, and beliefs of various stakeholders (cf. Alcamo et al., 2006, Cash et al., 2003). It includes considerations of the composition of the actors involved in the development of the scenarios, the evaluation of their consequences, as well as the decision making and dissemination process (cf. Mitchell et al., 2006a). If the scenarios results shall be adopted as a basis for decisions, the process of producing them must be perceived as "fair and legitimate by those whose future they might affect" (NRC, 1999).

The importance of legitimacy is noted mostly implicitly in publications on scenario methods by highlighting the need for joint scenario development (e.g. Ringland, 2002). Very similar to the credibility criterion, the legitimacy of scenarios can be enhanced by making the process of information production, evaluation and dissemination open, transparent, and observable (cf. Cash and Buizer, 2005). Fostering interactions between users and producers of scenarios in a transdisciplinary setting and being explicit in the values and assumptions underlying the scenarios can be assumed to further improve the scenarios' scores on the legitimacy criterion (cf. NRC, 1999). Participation should begin at an early stage of the process (Berkhout et al., 2001), include representatives with disparate sets of interests (Ringland, 1998), and employ a simple framework for facilitating communication and collaboration across a wide range of divergent user groups (Ringland, 2002).

4.4.4 Creativity

Creativity evaluates to what extent the process provokes unconventional and innovative thinking. It was found particularly important in scenarios and scenario development for imagining future surprises and non-linear trends that would not have been considered by following only "conventional" thinking. This notion is based on the finding that knowledge relevant for planning for the future can broadly be categorized into three classes: Things we know we know, things we know we do not know, and things we do not know we do not know (Shoemaker, 1995). Conventional lines of thought often omit at least the latter category of future developments and thus leave many potential risks and opportunities not conceived.

The first quality of creativity is *innovative thinking*, the degree to which scenarios initiate and facilitate exploring the effects of nonlinear, interrupted, and unprecedented trends (Alcamo, 2001). In some instances, scenarios may be particularly useful that shed light on a new perspective to the issues at stake (van der Heijden, 1996) and engage their audiences to think outside of the conventional realm (Leney et al., 2004).

Challenging assumptions refer to the need to recognize, question, and alter their mental models of future developments, in case such modification is justified and necessary (Alcamo, 2001, van der Heijden, 1996, Wack, 1985b). Scenarios can be surprising (Leney et al., 2004), can have the capacity to break old stereotypes (Schwartz, 1996), and broaden the understanding of the users (Alcamo, 2001). One important aspect is to also consider scenarios that might be "low in probability but high in consequence" (cf. Alcamo, 2001).

4.5 Interrelationships and relative importance of the attributes

The content analysis of scenario publications suggests that significant trade-offs exist between the attributes. This insight is consistent with the result of the Global Environmental Assessment Project that constituted a tight coupling of the criteria so that efforts to enhance one of them often undermine the others (Cash et al., 2003, Eckley et al., 2002, Mitchell et al., 2006a). However, a low value or decrease of one of the attributes must not necessarily mean that the scenario influence in general diminishes. The attributes should rather be understood as basic requirements of which minimum levels have to be attained if a particular study shall influence policy making (William C. Clark, pers. comm., April 17, 2008).

It can be assumed that the relative importance of the criteria differs among the phases of a participatory scenario process. While salience and creativity may be particularly important at the beginning of a scenario exercise in order to get people involved, questions of legitimacy and credibility gain in relative importance in designing and conducting scenario phases of actual scenario creation and assessment. Moreover, the relative importance of the attributes seems to vary across different participatory scenario purposes (cf. Alcamo and Henrichs, 2008):

Credibility is of particularly high importance if the prime goal of participatory scenarios is planning. If credibility cannot be attained, scenarios may not withstand criticism of implausibility and they may easily be disregarded. Enhancing credibility may result in a lowering of the creativity value: The more scenarios are credible in resonating with current mental models, the less they may be creative and surprising for challenging and influencing the users' thinking (Alcamo and Henrichs, 2008, Leney et al., 2004, van der Heijden, 1996, Wollenberg et al., 2000). Along these lines, Vygotsky (1986) coined the term "zone of proximal development" in referring to the interface at which the newly acquired knowledge of the scenario users come together with the logic of experienced reasoning. The learning capacity of the scenario users would ultimately be limited to this zone of proximal development.

Salience is especially important in scenarios focusing on policy advice in order to be considered relevant to the decisions at stake. If salience cannot be achieved, the scenario outcomes are perceived as useless. An example of salience trade-offs is that by heightening its value, credibility may be lowered if the focal issue cannot be addressed with existing and rigorously validated models.

Legitimacy is crucially important in scenarios for policy development and implementation. If the process of scenario development and assessment is perceived as unfair and disrespectful by some stakeholder, they may oppose any conclusions drawn from the studies and organize resistance to approaches to implementation. Higher values of legitimacy could be achieved through involving a greater diversity of participants (in particular democratically elected representatives) and the strengthening of qualitative methods that are more easily understood by the scenario audience. However, such approaches often occur at the cost of transparency and replicability, thus risking lower levels of credibility and salience.

Creativity is especially relevant in scenarios with an education-objective in order to convey aspects of alternative future developments that had not been considered before. The degree of creativity that scenarios for policy development need to obtain can however be relatively low – the more scenarios are framed within a specific decision context, the smaller the possibility space of options becomes that can be considered (cf. Pahl-Wostl, 2008). Enhancing creativity may result in lower degrees of perceived credibility and salience.

The difficult task of enhancing scenario attributes without lowering some of them below the necessary minimum level could most promisingly be performed through sensible *boundary management* (see Guston, 1999) between divergent actors in the process of scenario co-production. For heightening credibility, salience, and legitimacy, three basic functions have been suggested (Cash et al., 2003,

Mitchell et al., 2006b): *Active, iterative and inclusive communication* among the actors, *translation* to facilitate mutual understanding across disciplines and professions, and *mediation* to resolve situations in which strong conflicts persist among the actors which cannot be resolved with mere communication and translation. For enhancing creativity, the function of *inspiration* is required to reflect the need to involve imaginative people and to create an open and receptive climate in which unconventional ideas are embraced (cf. Ringland, 1998). Integrating various stakeholder groups can result in a wide spectrum of perspectives on an issue that allows for innovative ideas and new considerations.

4.6 Conclusions and Recommendations

This chapter shed light on participatory scenarios in long-term policy development and implementation. It summarized and categorized the contributions that participatory scenarios can provide, developed a characterization of participatory scenarios, and discussed the context and attributes of scenario influence in policy making.

The characterization showed that participatory scenarios share some commonalities, but also have several variants. The function, subject, vantage point, inclusion of values, inputs in the scenario process, level and frequency of involvement, meeting characteristic, and resource availability were identified as important parameters of participatory scenarios. The synthesis of potential contributions of participatory scenarios to policy development and implementation illustrated several benefits both to the exploration of future changes and the facilitation of social learning processes. It was proposed that to be influential, participatory scenario processes and outcomes must be perceived by their audiences as simultaneously *credible*, *salient*, *legitimate*, and *creative*. The qualitative content analysis of scenario literature lead to the proposition of sub-categories for these attributes. Finally, trade-offs between the attributes and their relative importance for different scenario purposes were discussed. In general, it must be kept in mind that besides the identified criteria, context factors and personal issues are also of critical importance.

A few recommendations for the design and conduct of participatory scenario processes can be derived from this chapter's findings:

The purpose of the exercise, the type of scenario to use and the range of participants to involve should be discussed and decided in the very beginning of a participatory scenario exercise. It must be made explicit how and to what degree participants will have influence on the design and outcome of the scenario process and common rules of collaboration should be adopted. Furthermore, it needs to be clarified how scenario results shall be used in subsequent discussions or decision making. It is important to remember that there are also limits to participation, since rising degrees of involvement require more time and resources. More and stronger participation does not always mean the best solution.

The selection of participants in the process depends upon the specific objective of the exercise. For example, if decision support is the prime objective, it is crucial to actively involve policy and decision makers in the process. In other cases, if public education has been decided as the main focus, the involvement of "remarkable people" (Schwartz, 1996) and "free thinkers" (cf. Kok et al., 2006a) like poets and artists who are used to think imaginatively is important to enhance the degree of creativity of the scenarios and thus engage people in new and innovative thinking.

The design of the participatory process and the choice of scenario methods require a careful reflection of the desired levels of relative importance of the scenario attributes and the implicit trade-offs that come with enhancement efforts. Recognizing and accounting for stakeholders' motivation to participate (cf. Alcamo and Henrichs, 2008) and making arrangements for implementing effective boundary management between actors in the design and implementation of the scenario process promises to be helpful.

The core scenario team needs to be aware that heightening the level of participation in scenario processes has implications for its social role. The more participants are responsible for the creation of

the scenarios, the more the task of the core team changes from actual scenario development to facilitation and support of a collaborative process.

Questions for further research include:

Empirical verification of the proposed attributes of participatory scenario influence on policy making through comparative case study research

Development of an overview of methods for facilitation of participatory scenario processes and experimental testing of their respective capacity to simultaneously enhance the attributes of scenario influence

Development of framework guidelines for conducting participatory scenarios to be most influential in policy

Development of guidelines for facilitators on how to best fulfill the role as mediator and boundary manager between scientists, decision makers and stakeholders in scenario processes.

4.7 Acknowledgements

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5 On the Influence of Scenario-based Landscape Planning – A Comparison of Two Alternative Futures Projects (Paper II)

Christian Albert

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Abstract

Many publications report on processes and products of scenario-based landscape planning (SLP) but often place attention on its effectiveness to change local governance. This paper aims at enhancing understanding of the influence of SLP on decision making. First, qualitative case study methods are employed to assess the decision processes following two completed SLP projects. Second, potential reasons for the level of influence achieved in the projects are discussed in the light of a recently developed conceptual framework on the influence of scenario planning. The case studies are SLP projects in Pennsylvania and Arizona, USA. Both projects followed the Steinitz Framework for Alternative Futures Studies, but differed in context conditions and ways of implementation. The case study analyses resulted in the surprising finding that the graduate student planning process employed in the Pennsylvania case seemed to stronger influence local decisions than the multi-year research effort in the Arizona case. The analyses reconfirm prior propositions on the importance of context, but also strongly emphasizes that credibility alone is insufficient for yielding influence. Perceived levels of salience and legitimacy seemed crucial for local actors to consider planning results in decisions and creativity appeared to be essential for attaining public interest.

6 Planning-Based Approaches for Supporting Sustainable Landscape Development (Paper III)

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Abstract

Planning often yields only limited influence on policy making. This paper explores how planning could address this challenge and support most effectively transitions towards sustainable landscape change. In merging insights from sustainability science research and nine recently concluded case studies of landscape planning, the paper reflects upon the applicability of the concept of "transition support", discusses planning approaches and their perceived effectiveness to induce change in landscape governance, and identifies lessons learned. The paper's outcomes include insights and potentially useful approaches that can be attributed to four emerging cross-cutting themes: approaches for (i) dealing with the high degree of complexity and uncertainty of landscape systems, (ii) integrating the various perspectives of experts, decision makers, and stakeholders in the assessment process (transdisciplinarity), (iii) enhancing policy influence, and (iv) initiating and sustaining learning and adaptive governance.

7 Scenarios for Sustainable Landscape Development – A Comparative Analysis of Six Case Studies (Paper IV)

Christian Albert

Abstract

Scenario-based landscape assessments arguably have great potential for fulfilling the requirements of a land-based sustainability science and effectively supporting transitions towards sustainable landscape development. However, an assessment of the degree to which contemporary scenario-based studies of landscape futures make use of this potential is so far nonexistent. This paper presents preliminary results of a study addressing three key questions: (1) how can landscape scenario exercises be conceptualized, (2) how and with what outcomes have contemporary landscape scenario studies been conducted, and (3) which lessons can be drawn for the further development of landscape scenario approaches and their implementation in practice?

The research design includes the development of a conceptual framework of scenarios for supporting sustainable landscape development, and an empirical analysis of recently concluded scenario-based landscape assessments. The case study analysis considers six projects from Australia, Europe, and North America. The cases are comparatively assessed concerning the environmental and governance contexts, the scenario characteristics and processes employed, as well as outcomes achieved.

A key conclusion is that scenario-based landscape assessments realize their potential to implement a land-focused sustainability science only partially. Future applications should stronger emphasize the explicit discussion of complexity and uncertainty through qualitative approaches, enhance the involvement of diverse actors in the scenario development process to co-produce knowledge and know-how in a solution-oriented manner, and take proactive measures for facilitating social learning and adaptive management.

7.1 Introduction

Sustainable landscape development requires reconciling society's development goals with the capacities of landscape systems to deliver ecosystem services over the long term (cf. Clark and Dickson, 2003, Kates et al., 2001, NRC, 1999, Turner, 2008). Since landscape systems are comprised of complex, adaptive, and tightly coupled social-ecological systems (GLP, 2005), continuously sustainable states of landscapes are unlikely and efforts for supporting sustainable landscape development should always aim for making progress on a transition towards sustainability (Kates and Parris, 2003, NRC, 1999).

The sustainability sciences (Clark, 2007, Clark and Dickson, 2003, Kates et al., 2001) and the emerging field of land change science (Rindfuss et al., 2004) provide insights of how research and practice can best support transitions towards sustainable landscape development. Basic requirements of land-focused sustainability sciences can be summarized as (a) reflecting complexity and uncertainty, (b) accounting for the diversity of perspectives, (c) conducting integrated, place-based, and issue-focused assessments, and (d) fostering adaptive management and social learning:

Reflecting complexity and uncertainty in the evolution of coupled social-ecological land systems is essential in assessing resilience, vulnerability, and possible future states, and exploring the possibilities of surprises, shocks and nonlinear development trends (Swart et al., 2004, Turner et al., 2003a).

Accounting for the diversity of perspectives is fundamental for ensuring salience and legitimacy of the processes and outcomes of assessments. It can best be achieved through transdisciplinary involvement of academic researchers, experts, decision makers, and stakeholders in a solution-oriented process of knowledge co-production (Hirsch Hadorn et al., 2006, Tress et al., 2005).

Conducting integrated, place-based, and issue-focused assessments is needed. Integration across sectors, problems, approaches, disciplines, and scales is crucial for addressing the systemic character of sustainability issues (Swart et al., 2004). Place-based analysis (cf. NRC, 1999) accounts for the high variances in sustainability challenges by location and the most often local concerns of the stakeholders involved (Holling, 1997b, Turner et al., 2003a, Walker et al., 2002). Addressing sustainability issues of land systems requires a differentiated, spatial approach (Blaschke, 2006, Chan et al., 2006).

Fostering adaptive management and social learning is important for successfully navigating social-ecological systems amid complexity and uncertainty (NRC, 1999). Adaptive management (Gunderson and Holling, 2002, Holling, 1978, Walters, 1986) attempts to facilitate systematic efforts to learn from experience. It proposes to formulate policies as hypotheses, to consider management actions as testable experiments, to implement monitoring systems for tracking changes, and to learn from successes and failures (cf. Clark, 2002, Gunderson et al., 1995). The related concept of social learning (e.g. NRC, 1999, Parson and Clark, 1995, Social Learning Group, 2001a) emphasizes the transdisciplinary character of these processes and the need for procedures of exchanging perspectives, conflict resolution, and joint decision making (Pahl-Wostl et al., 2007a).

Scenario-based landscape planning arguably has large potential for addressing these requirements and successfully implementing land-focused sustainability science in practice. Scenarios are key instruments for addressing complexity and uncertainty, integrating various kinds of information, and facilitating knowledge co-production among diverse actors (cf. Albert, 2008, NRC, 1999, Swart et al., 2004). Landscape planning (cf. Steinitz, 1990, 1993, von Haaren, 2002, von Haaren, 2004a) applies transdisciplinary approaches for solving land use conflicts at the local to regional scale considered as most relevant for global sustainability (cf. AAG, 2003, Kates and Parris, 2003). It is rooted in the interdisciplinary field of landscape ecology that already has developed a wealth of theories and practical methods for integrated and holistic assessments of society-nature interactions (e.g. Helming and Wiggering, 2003, Naveh, 2001, Palang et al., 2000), quantitative and spatial-pattern dependent analyses of landscape capacities to provide ecosystem services (e.g. Blaschke, 2006, Mander et al., 2007, Opdam et al., 2006), and dealing with issues of scaling and uncertainty (cf. Wu and Hobbs, 2006). Wu (2006) therefore interpreted landscape ecology as “part of the scientific core of sustainability science”. However, an assessment of the degree to which contemporary scenario-based studies of landscape futures make use of this potential is so far nonexistent.

Against this background, the study whose preliminary results are reported herein addresses three key questions: (1) how can scenarios for supporting sustainable landscape development be conceptualized, (2) how and with what outcomes have contemporary landscape scenario studies been conducted, and (3) which lessons can be drawn for the further development of landscape scenario approaches and their implementation in practice? This paper summarizes preliminary results.

7.2 Methods

The research design includes the development of an analytical framework for landscape scenarios, and an empirical analysis of contemporary landscape scenario studies. The framework synthesizes insights from a review of relevant literature. Suitable projects for the case study analysis are identified and selected based on a systematic literature search. The cases are comparatively assessed concerning the environmental and governance contexts, the scenario characteristics and processes, as well as the technical and social-relational outcomes (cf. Mostert et al., 2007, Pahl-Wostl et al., 2007a). The discussion section reflects upon the degree to which the case studies were successful in

fulfilling the key requirements of land-focused sustainability sciences. The paper closes with recommendations for future applications and suggestions for further research.

The paper reports preliminary results that are primarily based on peer-reviewed publications. The findings are currently being amended with interviews with experts from the case study regions. A more in-depth analysis of scenario effects on the local debate and decision making, including semi-structured interviews with former scenario participants, was conducted in one case study (Albert, accepted). Furthermore, only relevant cases from the northern hemisphere (plus Australia) were available (to the knowledge of the author). With new case studies emerging, this assessment's findings need to be complemented with insights from the South where conflicts among development, livelihood security, and the sustained capacity of landscapes to provide ecosystem services are often much more severe.

7.3 Framework of scenario development

Scenarios as tools of sustainability sciences can be understood as "coherent and plausible stories, told in words and numbers, about the possible co-evolutionary pathways of combined human and environmental systems" (Swart et al., 2004). Five basic steps are required to develop landscape scenarios (cf. Alcamo et al., 2006, Jäger et al., 2007, Kemp-Benedict, 2004, Kok et al., 2006b, NRC, 1999, Peterson et al., 2003, Robinson, 2003, Swart et al., 2004, Van Notten et al., 2003, Wollenberg et al., 2000): The first step, defining scenario design, includes decisions about the focal issue and objective, the participants to involve as well as the scenario types and methods to employ. Step two, developing system understanding, describes the integrated consideration of the main elements and dynamics that might influence the evolution of the landscapes' coupled social-ecological systems. In the third step, qualitative scenarios are created by combining assumed evolutions of selected critical uncertainties, defined as drivers with potentially large impact on a landscape's future. Quantitative and spatial modeling allows testing for consistency and plausibility and provides insights into possible future patterns of land use and land cover change (LUCC). It requires making assumptions about plausible values for selected critical uncertainties, the development and application of numerical models describing the interactions within land systems, and employing geographic information systems (GIS) technology to develop maps of land patterns that might emerge from the scenarios. Finally, scenario impacts can be assessed on the basis of the results of qualitative, quantitative, and spatial modeling in scenario development. Furthermore, this information can serve as input for disciplinary models to assess potential scenario consequences on societal, economic, and ecologic indicators.

7.4 Case Studies of Scenario-Based Assessments of Landscape Futures

To identify relevant case studies for the analysis of methods and outcomes of contemporary scenario-based assessments of landscape futures, a systematic literature search was conducted in four leading landscape journals. The query was "scenario OR scenarios" within the title, abstract, or keywords of all covered articles published before the end of 2007. To select cases of greatest potential to fulfill the requirements of a land-focused sustainability science, only projects were considered that employed spatial modeling and involved more diverse actors than just the research team in scenario development.

The query yielded a total of 165 scenario-related papers on landscape issues, within which 74 case studies of scenario-based projects are described. The number of scenario projects reported annually increased dramatically within the last two decades, from about 1.2 cases in the 1990s and 4.2 cases from 2000 to 2004, to 6, 7, and 28 studies in the years 2005 to 2007, respectively. 25 projects included spatially explicit modeling of future land changes and only three of them also facilitated multidisciplinary participation. These remaining cases were amended by three suitable projects that had been published in book-form and other journals, yielding a total of six studies for in-depth analysis.

The case studies include projects from Australia, Europe, and North America (table 1). The considered landscapes are delineated by either watershed or administrative boundaries and their area sizes vary between circa 15,000 and 3,000,000 hectares. The main sustainability issues addressed are the potential consequences of population and development growth and/or intensive agriculture. Only the Swiss case differs in its focus on the possible impacts of declining support for extensive mountain agriculture. Four cases employ a primarily descriptive approach and forward-looking vantage point to study the effects of alternative evolutions of key uncertainties. Two cases use primarily normative backcasting approaches to develop and evaluate LUCC patterns that might fulfill societal goals, and subsequently discuss appropriate policy measures for achieving these patterns in reality. The number of scenarios developed in each case study is between two and ten, the time scale considered varies between 25 and 60 years, and the spatial resolutions of the LUCC maps are 3 m, 30 m, and 1 km. The level of stakeholder involvement differs across both the stages of scenario development and the individual projects. In general, the cases show more intensive actor involvement in early stages of scenario development, while quantification, modeling, and evaluation were most often conducted by the scenario team in iterative consultation with the audiences. The composition of the scenario panel was transdisciplinary in one half of the cases and interdisciplinary in the rest. All cases assess the impacts of scenarios on the basis of tables and maps of LUCC and evaluate consequences on biodiversity. Less often considered are economic performances and effects on hydrology, visual character, or other ecosystem services.

Table 1: Case study characteristics (part A)

	UPPER SAN PEDRO RIVER BASIN, ARIZONA, USA, AND SONORA, MEXICO	**SUMMIT COUNTY, COLORADO, USA**	**BUCK CREEK AND WALNUT CREEK WATERSHEDS, IOWA, USA**
Landscape boundary	Watershed	Administrative	Watersheds
Area size	1,060,000 ha	160,400 ha	14,390 ha
Sustainability challenge	Conflict about land and water use among development pressure and biodiversity preservation	Rapid development of private land causes conflicts with efforts to conserver biodiversity	Intensive agriculture and demographic changes induce negative impacts on water and biodiversity
Scenario objective	Primarily descriptive	Primarily descriptive	Primarily normative
Vantage point	Forward-looking	Forward-looking	Backcasting
Time scale	20 years	n.s.	25 years
No. of scenarios	10	8	3
Resolution	30 m	30 m	3 m
Level of stakeholder involvement in:			
- issue and scope definition	3	3	1
- system understanding dev.	2	3	1
- qualitative scenario creation	2	2	3
- quantification and modeling	1	2	3
- impact evaluation	1	3	1
Sectors considered in impact assessmt.			
- Maps and tables of LULC change	X	X	X
- Biodiversity	X	X	X
-Hydrology	X		X
- Economy	X	(X)	X
- Visual character	X		X
- Other ecosystem services			
References	Steinitz et al. (2003); Albert (accepted)	Theobald and Hobbs (2002)	Nassauer and Corry (2004); Santelmann et al. (2004)

Note: The level of stakeholder engagement is classified into three broad categories (cf. Arnstein, 1969, Mostert, 2006): 1 – Information Provision and Elicitation, 2 – Consultation, and 3 – Co-Design.

Table 1: Case study characteristics (part B)

	WILLAMETTE RIVER BASIN, OREGON, USA	MOSSMAN AND JULATTEN LANDSCAPES, QUEENSLAND, AUSTRALIA	DAVOS REGION, SWITZERLAND
Landscape boundary	Watershed	Administrative	Administrative
Area size	3 million ha	N.D.	25,443 ha
Sustainability challenge	Increasing pressures between development, biodiversity conservation, and continuation of rural lifestyles	Increasing land use conflicts among agriculture, tourism, urbanization, and recreation	Declines in support of mountain agriculture causing negative social, economic, and ecological consequences
Scenario objective	Primarily explorative	Primarily normative	Primarily explorative
Vantage point	Forward-looking	Backcasting	Forward-looking
Time scale	60 years	20 years	50 years
No. of scenarios	3	3	2
Resolution	1 km	1:50,000	n.s.
Level of stakeholder involvement in			
issue and scope definition	1	1	3
system understanding dev.	2	3	3
qualitative scenario creation	2	3	2
quantification and modeling	2	2	1
impact evaluation	3	1	1
Sectors considered in impact assessmt.			
Maps and tables of LULC change	X	X	X
Biodiversity	X	X	X
Hydrology	X		
Economy	X		X
Visual character		X	X
Other ecosystem services			X
References	Baker et al. (2004); Hulse et al. (2004)	Bohnet and Smith (2007); CSIRO (2005)	Walz et al. (2007)

Note: The level of stakeholder engagement is classified into three broad categories (cf. Arnstein, 1969, Mostert, 2006): 1 – Information Provision and Elicitation, 2 – Consultation, and 3 – Co-Design.

The six case studies differed substantially concerning their respective contexts, processes, and outcomes (table 2). The kinds of platforms for stakeholder involvement created in the projects range from anecdotal meetings and stakeholder consultations to intensive, long-term, and multilevel involvement. The focal issue, objective, type, and design of the scenario process seem to be predetermined in three cases and emerge from document analyses, stakeholder interviews, and surveys in the other projects. Most often, consultative meetings with key decision makers and/or stakeholders are held to ensure adequacy and relevance. System understanding is developed through applying sensitivity model methodology in stakeholder workshops, landscape character assessments and community workshops, or on the basis of integrating disciplinary maps and models. Various processes were chosen for developing qualitative scenarios, quantifying assumptions, modeling LULC change, and evaluating scenarios. The scenario impact assessment in all cases consists of disciplinary modeling of the effects of land changes on selected economic, social, and ecological indicators, and the use of tables and diagrams to compare results among each other, against the current situation,

or relative to baseline conditions. The reported outcomes include influences on local discussions and debates, capacity building to engage in collaborative planning, the establishment of a clearing house for natural resource information, and subsequent integration of scenario team members and results in official land planning. Identified barriers for effectively influencing change were inadequate spatial resolution to provide useful information to very local land use decisions, data and modeling limitations in developing LUCC maps and assessing scenario impacts, time constraints, decision makers' neglect of scenario recommendations, as well as trade-offs between involving stakeholders for facilitating capacity building or for joint scenario elaboration. The case studies in general included little critical reflection upon the degree to which the knowledge and know-how produced actually influenced policy development and decision making. In-depth research by the author in one of the landscapes (Albert, accepted) suggests that scenario influence can be quite limited and is influenced to a large degree by the governance context and the characteristics of the sustainability challenge.

Table 2: Case study contexts, processes, and outcomes (part A)

	UPPER SAN PEDRO RIVER BASIN, ARIZONA, USA, AND SONORA, MEXICO	SUMMIT COUNTY, COLORADO, USA	BUCK CREEK AND WALNUT CREEK WATERSHEDS, IOWA, USA
CONTEXT	- Long conflict among various actors, multiple prior studies	- First time consideration of impacts of development on private lands	- Increasing awareness of potentially negative consequences
Platforms for stakeholder involvement (no. of events, in case specified)	- Survey among interested citizens - Advisory group workshops with diverse participants - Public presentations (6)	- Stakeholder workshops (11)	- E-Mail exchange among experts - Small group field workshops - Plenum discussions - Elicitation of farmer preferences
Scenario issue and scope definition	- Derived from document analyses, questionnaires, and interviews - Consultations with key stakeholders	- Defined by research team	- Defined by research team
System understanding development	- Derived from questionnaires and interviews - Integrative analysis of disciplinary maps and models	- Workshop to analyze current issues and review relevant scientific information - Integration of disciplinary maps and models	- Integrative analysis of disciplinary maps and models and historic landscape patterns
Qualitative scenario creation	- Based on combined assumptions on key uncertainties - Derived from questionnaires and interviews - Validated through consultations with key stakeholders	- Based on assumed alternative build-out scenarios - Validated through expert workshops	- Based on national policy goals - Developed in expert e-mail exchange -
Scenarios quantification	- Derived from questionnaires - Additional assumptions	- Defining zoning regulations	- Field and plenum workshops
LULC change modeling	- Based on land suitability for development and population growth projections	- Assuming build-out development	- Joint process with scenario quantification
Scenario impact assessment	- Comparison among scenarios and relative to baseline - Evaluation according to 11 tests	- Comparison relative to baseline - Development of list of impact indicators in consultation with stakeholders - Comparison relative to baseline	- Comparison among alternatives and relative to current situation - Evaluation according to 10 indicators
Outcomes (as reported in case study publications)	- Scenarios informed planning by military installation	- Scenarios informed local debate and subsequent planning - Suggestion to implement field-based monitoring not adopted	- Scenarios informed and improved planning
	Steinitz et al. (2003); Albert (accepted)	Theobald and Hobbs (2002)	Nassauer and Corry (2004); Santelmann et al. (2004)

Table 2: Case study contexts, processes, and outcomes (part B)

	WILLAMETTE RIVER BASIN, OREGON, USA	MOSSMAN AND JULATTEN LANDSCAPES, QUEENSLAND, AUSTRALIA	DAVOS ADMINSTRATIVE AREA, SWITZERLAND
CONTEXT	- Large and five-year long project with strong political support	- Increasing awareness, no prior integrated studies	- Increasing awareness, not an urgent issue
Platforms for stakeholder involvement (no. of events, in case specified)	- Willamette Valley Livability Forum, ~100 governor-appointed leaders (12) - Willamette Restoration Initiative, 27 governor-appointed citizens (8) - Possible Futures Working Group, 20 citizens chosen by research team (30) - Technical expert groups	- Semi-structured interviews with landholders (30) - Community workshops (7)	- Advisory group workshops with diverse participants (3) - Satellite workshops with homogenous stakeholder groups (6) - Public meetings
Scenario issue and scope definition	- Defined by research team	- Derived from interviews and landscape character assessments (see below)	- Co-design in advisory group workshop
System understanding development	- Integrative analysis of historic landscape patterns, disciplinary maps and models, further iterative development	- Landscape character assessments (document analyses and interview data) - Community workshops	- Sensitivity model methodology, applied in satellite workshops
Qualitative scenario creation	- Iterative process of qualitative scenario creation, parameter quantification, and LULC change modeling - Intensive and multilevel participation across various platforms	- Based on contrasting sets of priorities - Developed in community workshops	- Based on results of sensitivity model methodology - Validated in advisory group workshops
Scenarios quantification	- Joint process with qualitative scenario creation	- Partly defined in community workshops - Inferred by planners	- Quantifying parameters in scenario table - Literature review
LULC change modeling	- Application of six interacting process models	- Defining LULC conversion rules	- Calculating future land requirements and combination with sensitivity map -
Scenario impact assessment	- Comparison relative to baseline	- Comparison of maps and tables	- Comparison relative to baseline
Outcomes (as reported in case study publications)	- Scenarios informed local debate and subsequent planning - Establishment of clearing house for natural resource information - Successful capacity building - Limited influence on local decisions	- Scenarios informed local debate and helped discovering further research needs	- Effective in raising interest and initiating discussions - Invitation to contribute to developing an overall future concept
	Baker et al. (2004); Hulse et al. (2004)	Bohnet and Smith (2007); CSIRO (2005)	Walz et al. (2007)

7.5 Discussion

The objective of the scenario-based projects reported in the case studies was to provide answers to particular questions, rather than to specifically support sustainable landscape development. However, due to the selection criteria applied, the chosen cases are the ones most likely to having provided valuable contributions. This discussion is therefore not meant as an evaluation of the adequacy or success of the projects, but aims at assessing to what degree and through which approaches the basic requirements for land-focused sustainability sciences (cf. introduction) seem to be fulfilled.

7.5.1 Reflection of complexity and uncertainty

The way the complexities and uncertainties inherent in the evolution of landscape systems were identified, jointly discussed, and communicated differed across the cases.

The consideration of complexity in the scenarios varied between qualitative and quantitative approaches, and ways of their application. The Switzerland and Queensland cases support findings by Jäger et al. (2007) and Swart et al. (2004) that qualitative methods are particularly well suited for capturing the complexities of numerous factors and dynamics influencing the future in a coherent, contextualized, engaging, and easily understandable way. However, none of the projects seemed to explicitly consider the possibility of nonlinear development trends and surprises.

In all cases, the quantitative and spatial modeling of scenarios appeared useful for exploring the kinds and magnitudes of scenario impacts on various indicators. The Oregon case study illustrated that iterative processes of making quantitative assumptions, modeling LUCC change and impacts, discussing the resulting maps and tables, and eventually revising assumptions and models allow a group of more than twenty diverse participants to co-produce knowledge about complex landscape systems and useful policy interventions.

Although numerical and spatial models of coupled land systems are always complex (cf. Turner et al., 2007), the case studies showed that they are inferior to qualitative approaches for reflecting upon the large number of potentially interacting dynamics. For example, the Switzerland case found that the translation from qualitative to quantitative scenarios results in a loss of complexity, due to the specific focus and sensitivity of the numerical models applied, inherent uncertainties, and the interfaces between coupled models. The coupling of qualitative, quantitative, and spatial approaches was also identified as an essential challenge of the scenario studies in Colorado, Queensland, and Switzerland, supporting similar conclusions by Alcamo et al. (2006), Kemp-Benedict (2004), and Pahl-Wostl (2002).

The consideration of inherent uncertainties seemed to differ with the type of scenario used. The four cases employing primarily descriptive approaches dealt with uncertainty in assuming trends and assessing their respective consequences. Three of them included controllable uncertainties as key drivers underlying the scenarios, thus pointing to the large influence attributed to policy options on future landscape development. In Arizona and Colorado, controllable and uncontrollable uncertainties were considered, including federal level decisions concerning the future of a major military installation, variations of projected population growth, changing public support for restrictive development policies, and specific policy options. The Colorado case solely explores implications of policy alternatives. Only the project in Switzerland concentrated exclusively on an uncontrollable uncertainty in exploring the future of marginal agricultural land. The two primarily normative scenario studies proved successful in engaging various actors in a creative process of developing preferred scenarios and respective LULC, but did not explicitly address the multiple influences and development trends that may inhibit society from obtaining these land configurations and their associated benefits.

7.5.2 Consideration of the diversity of perspectives

Researchers in the cases acknowledged the normative character of scenarios in reflecting the assumptions and interests of the people creating them (cf. Van Notten et al., 2003). For example, the scenario team in Oregon realized that the group composition making scenario assumptions influences the emerging LUCC patterns. Scenario developers in Colorado acknowledged that even defining which species and habitats should be considered for evaluating scenarios is already a political process.

To account for the diversity of perspectives, various approaches for participation in the scenario processes were employed. Three cases exhibit active and transdisciplinary involvement. In Oregon, a group of about 20 citizens from various backgrounds jointly defines and assesses scenarios. Stakeholders in Queensland collaborate in heterogeneous community workshops in which scenarios are developed from contrasting sets of priorities. The Swiss case engages homogenous actor groups in workshops to develop system understanding and subsequently asks for stakeholder feedback on intermediary results. The cases in Arizona, Colorado, and Iowa use primarily interdisciplinary participation of experts, but include perspectives of stakeholders and decision makers through interviews, surveys, presentations of intermediary results, and regular consultations.

Limitations to stakeholder involvement most prominently included the time and other resources available (cf. e.g. Jäger et al., 2007). It cannot be expected to be possible to always conduct five year long participatory scenario development processes like in Oregon. The Swiss case found that stakeholder interest and long-time involvement is most likely if focal issues of high relevance and urgency are addressed.

7.5.3 Realization of integrated, place-specific, and issue-focused assessments

Due to the criteria applied in the case study selection, all considered projects took an integrated and place-based perspective and focused on a specific issue of sustainable landscape development. The cases varied concerning the degree to which these requirements were fulfilled and the particular approaches used.

The case analysis revealed that integration is required in all steps of the scenario framework. As highlighted in Iowa, it is in particular the spatial modeling that forces integration in the development of a single map of future landscape change. LUCC models of high integration were applied in Arizona, Oregon, and Switzerland. Less dynamics were considered in Colorado where LUCC maps simply emerged from assuming complete build-out development of designated areas. In Iowa and Queensland, interactions were only implicitly considered in developing LUCC maps based on experts and/or stakeholders judgments of patterns to achieve the scenario priorities.

The focus on landscapes enabled case studies to account for local conditions and integrate considerations of influences from dynamics at larger scales. In all projects, the scope and the spatial modeling resolution chosen proved adequate for landscape-level considerations, e.g. proposing policies that allow for both additional development and sustained landscape capacity to deliver ecosystem services. However, criticism was raised in Arizona and Oregon that the spatial resolution was too coarse to support very local-level decision making.

Although the case studies generally focused on a specific issue of landscape change, difficulties in providing results adequate for addressing the issues became apparent. In Queensland for example, answering stakeholder-defined research questions was hampered due to shortcomings of current knowledge of ecosystem conditions and dynamics. Furthermore, while all of the cases compared scenario impact assessment results among alternatives and relative to baseline conditions, only some of them considered potential limits from which on landscape evolution might abruptly change course and ecosystem services provision decrease dramatically (cf. Gunderson and Holling, 2002). These situations are obviously difficult to determine and the evaluation of what is considered an undesirable level of ecosystem service provision is always a political question that needs to be decided by

local decision makers and stakeholders. However, providing knowledge about these limits is essential for allowing scenario audiences to realistically evaluate the scenario impacts (cf. Theobald and Hobbs, 2002).

7.5.4 Facilitation of adaptive management and social learning

Social learning seemed to be facilitated well in workshops employed in Oregon, Queensland, and Switzerland, in which participants consciously reflected on different perspectives concerning causes, consequences of current landscape dynamics, possible futures, and policy interventions (cf. Wollenberg et al., 2000). Particularly effective social learning seemed to be facilitated through the surprising insights gained from spatial modeling and assessment in Oregon and Iowa.

Most cases lacked an explicit communication of the need for adaptive management for successfully inducing change. Solely the Colorado case included a discussion of appropriate indicators for evaluating change in scenarios and tracking developments in reality. The initiative to establish a clearing house for collecting and publicly providing information on the state and evolution of the landscape's natural resources in the Oregon case can be interpreted as an important step towards adaptive management.

7.6 Conclusion

This paper illustrated that landscape planning increasingly employs scenario-based assessments to explore possible landscape futures, but realizes their potential to implement a land-focused sustainability science only partially. From the comparative case study analysis, some conclusions, recommendations for future applications, and suggestions for further research can be drawn.

First, while the case studies used scenarios to assess alternative developments, they often did not explicitly consider the complexities of landscape systems and the uncertainties inherent in the scenario results. Although scenario developers were certainly aware of the complexity and uncertainty involved, the implications for understanding and influencing landscape systems were in most cases not elaborated together with scenario participants and the wider stakeholder community. From a sustainability science perspective, the little explicit consideration limits the users' opportunities to learn and may result in incorrect conclusions and costly management failures (cf. Farrell, 2006, Kates et al., 2001, Lee, 1993, Lee, 1999). However, it can also be convincingly argued that conducting assessments of higher complexity and more explicitly communicating uncertainty is impossible in practice, given the required time and resources, the limitations of modeling, and the challenges of involving stakeholders in scenario processes (cf. Steinitz and Faris, 2006, Walz et al., 2007).

To simultaneously fulfill the objectives of exploring complexities and uncertainties of landscape futures and keeping the effort for modeling and assessing LUCC at a manageable level, I suggest a more balanced mix of qualitative and quantitative approaches that harnesses their comparative advantages. In practice, this would mean emphasizing the consideration of landscape systems' complexities through the application of transdisciplinary, qualitative approaches in a series of workshops in the stages of developing system understanding and creating scenarios (cf. Walz et al., 2007, Wollenberg et al., 2000). The following quantitative assessments could then be based on prior gained mutual trust and social-relational knowledge and focus on a jointly defined scope. Through this approach, scenario users could more easily understand the quantitative approach as a focused and necessarily simplified analysis of one aspect of the landscape system. Cognizant of the landscape systems' complexity and the uncertainties of modeling, the audiences could more realistically evaluate the scenario results, be better prepared to gauge emerging risks and opportunities, and devise intervention strategies informed by this awareness (cf. Farrell, 2006, Kemp-Benedict, 2004, Walz et al., 2007).

Second, the degree to which the cases accounted for the diversity of perspectives seemed to depend on the nature of the participation strategy and the way of its implementation. Conducing workshops

with participants from various backgrounds as in Oregon and Queensland proved particularly useful for exchanging perspectives and social learning, but has disadvantages if power differentials exist. Holding workshops separately as in the Swiss case allows for clarifying perceptions and developing opinions of particular groups.

Future scenario projects should stronger emphasize transdisciplinary participation in all stages of scenario development, at best through active involvement in scenario workshops that allow for open reflections of various perspectives. The design of such processes needs to be attuned to the particular governance and decision-making context, the urgency of the focal issue, the time required to build trust and joint understanding, and the level of stakeholder experiences. Appropriate methods are transparent and easily understandable and facilitate communication between the panel and the wider audiences who cannot participate in the entire process, especially decision makers (cf. Peterson et al., 2003, Swart et al., 2004, Wollenberg et al., 2000).

Third, the considered projects generally well implemented the integrated, place-specific, and issue-focused approach demanded by sustainability sciences, but some cases did not succeed in providing useful knowledge concerning issues of interest to stakeholder and limits of landscapes' capacities to provide ecosystem services. Recommendations for future scenario projects are to define research-questions together with local actors at the beginning, to allocate time and resources to develop data and models necessary for addressing the issues, to early involve disciplinary scientists to develop necessary assessment models, and to deliver scenario products in a way useful for multi-level decision making, future updates, extensions, or downscaling. The scenario framing should initially be broad to consider multiple options, and specified in greater detail in the early stages of scenario development as understanding of the landscape's dynamics and main issues develops (cf. Peterson et al., 2003).

Further research may address the development of a set of easily adaptable models for assessing potential economic, social, and ecological consequences for expected land change, and methods for identifying the boundaries of a pathway towards sustainable landscape development, drawing for example on the work of Potschin and Haines-Young (2006) on "sustainability choice spaces". In many cases, simple models, rough estimates, and "fast-track" assessments may suffice for providing guidance and ranking policy options, aiming at delivering approximate answers to the complex issues at stake instead of precise results on aspects of less relevance (cf. Holling, 1997a).

Fourth, many case studies provided opportunities for social learning, but most often did not implement measures for initiating adaptive management or communicating its importance for successfully inducing change. Social learning seemed to be facilitated well in projects that included active stakeholder involvement, and less well in cases that involved stakeholders only through surveys or responses to presentations. Future scenario projects should therefore emphasize the provision of opportunities for knowledge co-production and the exchange of perspectives and mental maps among landscape actors. Workshop settings with heterogeneous participants seem to be most promising, although power differentials need to be accounted for (Wollenberg et al., 2000).

Since adaptive management and the need to define and monitor indicators were explicitly considered in only one case study, a generally little awareness of scenario participants of these aspects can be inferred. Implementing adaptive management might often be impeded by the complexity of the social-ecological systems, the high political and economic stakes involved, and prevalent institutional and governance structures (Clark, 2002, Steinitz and Faris, 2006). However, in order to at least provide local actors the chance to manage for increasing resilience and preventing their landscape from abruptly changing to undesirable states (Farrell, 2006, Folke et al., 2002), scenario processes need to be complemented with introductions to the ideas of adaptive management as well as discussions and selections of appropriate indicators to use in both the assessment of scenario impacts and actual monitoring of landscape change in the field (cf. Theobald and Hobbs, 2002). Without monitoring, stakeholders will have less opportunities to track the evolution of the landscape systems and identify

emerging risks or opportunities, thus limiting their ability to adapt (Gunderson and Holling, 2002, Holling, 1978, Lee, 1993). Further research is needed on possibilities for combining scenario-based assessments of landscape futures with participatory and interactive simulations and games (e.g. Krolikowska et al., 2007, Martin et al., 2007) that could enhance scenario effects on learning about landscape complexity as well as about the potentials of adaptive management.

Finally, to effectively induce change, the scenario-based assessments must be updated and repeated once assumptions are outdated, governance contexts change, new information becomes available, and conflicts or surprises arise.

7.7 Acknowledgements

This PhD research is endorsed by the Global Land Project, a joint research initiative by the International Geosphere-Biosphere Programme (IGBP) and the International Human Dimensions Programme on Global Environmental Change (IHDP). Funding was provided by a dissertation research grant from the German National Academic Foundation (Studienstiftung des deutschen Volkes); it is gratefully acknowledged.

8 Social learning can benefit decision-making in landscape planning: Gartow case study on climate change adaptation, Elbe valley biosphere reserve (Paper V)

Christian Albert, Thomas Zimmermann, Jörg Knieling, Christina von Haaren

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Abstract

This paper uses a planning experiment to empirically investigate possible social learning outcomes of landscape and urban planning with benefits for decision making. Building on C. Steinitz' Framework for Alternative Futures Studies, a framework for participatory scenario-based landscape planning (SLP) is developed and used in a three-month climate adaptation planning process involving up to 37 local actors in Gartow, Germany. The evaluation of social learning outcomes follows the premise of action research and employs a mixed-method approach. The research shows that SLP can successfully generate social learning outcomes among participants. Observed social learning outcomes include gains in substantive knowledge (e.g. on climate change impacts), procedural knowledge (e.g. on alter-native adaptation strategies), understanding of different perspectives, as well as social and technical skills. Participants named several potential impacts of social learning outcomes on their future decision making, including enhanced awareness, altered agendas, and better social relations. The SLP process and its results formed the basis and inducement for further collaboration of local actors and external consultants in the development of a coordinated mission statement (Leitbild) for climate change adaptation. The Leitbild was unanimously decided for by the Gartow Community Council and shall be used as a guiding framework for future decision making concerning landscape and settlement development.

9 Assessing student learning effects in an intensive landscape planning workshop setting: The Cagliari case study (Paper VI)

Christian Albert, Christina von Haaren, Juan Carlos Vargas-Moreno, Carl Steinitz

This paper is currently under review in an international journal.

Abstract

Landscape design education should aim at equipping students with competencies for collaborative, scenario-based planning approaches. This paper investigates the contributions of an intensive educational workshop to advance students' relevant understanding and skills. The research design involves the conduct of a case study workshop in Cagliari, Italy, and multi-stage and in-process evaluation. Workshop participants were 30 students from Italy and Germany, with the support by regional stakeholder experts. The workshop was a remarkable achievement, given the very limited working time. It resulted in six different alternative futures for the region of Cagliari, and a seventh combined version that was considered best by regional reviewers. The students' evaluation was conducted in five stages throughout the workshop, and results suggest that the experience yielded substantial advances in their understanding and skills for scenario-based landscape planning. Key aspects of the workshop pedagogy and the evaluation are discussed, and recommendations for future evaluations presented.

9.1 Introduction

Students of landscape planning and design should be equipped with competencies for collaborative, scenario-based planning approaches. Scenario-based approaches assume alternative development trends and explore their respective consequences (e.g. Carpenter et al., 2005, Hulse et al., 2004, Steinitz, 1990, Steinitz et al., 2003). They are increasingly applied for dealing with the high degree of complexity and uncertainty inherent in planning for future landscape change (Alcamo, 2008a, Shearer, 2005, Xiang and Clarke, 2003).

Gaining experience in interdisciplinary collaboration is essential for students since planning processes today increasingly involve scientists, policy makers, and stakeholders in co-generating knowledge for jointly addressing the issues at stake (e.g. Antrop and Rogge, 2006, Luz, 2000, Selman, 2004). Planning is increasingly not seen as a solely expert-based endeavor, but rather a public process that involves active participation of relevant actors (Albert and Vargas Moreno, 2010, Selman, 2006, Wissen-Hayek, 2011).

Planning education thus needs to find effective means for supporting students to develop knowledge and know-how for such collaborative, scenario-based approaches. One approach arguably well suited for teaching both planning understanding and skills is the educational studio or workshop pedagogy (cf. Lusk and Kantrowitz, 1990, Vakil et al., 1990). Planning workshops are organized around a realistic problem in a specific region and involve analysis, design, policy, and strategy development (Frank, 2006). They may last from a few hours to one or two semesters and serve as an experimental laboratory for "learning by doing" (Lang, 1983) in testing and practicing planning skills and methods.

To effectively exploit the potentials of workshop pedagogy, and to achieve and sustain high educational quality, evaluations – and iterative learning from their findings – are an essential instrument (Agouridas and Race, 2007). However, formal evaluations, as institutionalized in many educational

programs, often do not shed light on the rather implicit issues of conceptual understanding and planning skills. Scholarly assessments of educational planning workshops provide more detail, but so far focus on other questions:

Several studies addressed students' learning styles and their possible influence on design performance (e.g. Brown et al., 1994, Kvan and Jia, 2005, Roberts, 2006). Lusk and Kantrowitz (1990) report on the assessment of the effectiveness of an introductory communication methods and professional practice studio to teach written, oral, graphic and integrated communication skills in brief reality based-team projects. Vakil et al. (1990) describe a systematic evaluation of a planning workshop course that offered technical assistance to a local community, focusing on pedagogy, student learning, and benefits of communities. They conclude that learning broadens students understanding of different perspectives and objectives for development. Grant and Manuel (1995) report on efforts for enhancing peer learning (students facilitating each other's learning) in workshops and find that such learning fosters students' confidence in their abilities and expertise. Stolz and Brown (1994) are interested in enhancing the independence of learning in studio teaching and use assessments of content and maturity of thought in student submissions as indicators. Finally, Steinitz (1986) presents a special issue on landscape planning education, focusing mainly on different cultural traditions and national structures instead of learning effects (e.g. papers by Kiemstedt, 1986, Linke, 1986).

This paper investigates the extent to which planning workshops can contribute to the development of relevant understanding and skills for scenario-based landscape planning among participating students. It asks two research questions:

- Do short and intensive educational planning workshops advance participating students' planning understanding, defined here as knowledge of the design and procedures of scenario-based planning processes?
- Do educational planning workshops contribute to the development of relevant planning skills among participating students?

The central innovation of the paper lies in the conduct of multi-stage and in- process evaluation research which so far – to the knowledge of the authors – is nonexistent in the literature. The evaluation methods were not selected from a known set, but invented to fit the circumstances.

An educational alternative futures planning workshop in the region of Cagliari, Italy, serves as a case study. The workshop's educational goal was to equip participating students with understanding of and skills for scenario-based planning through the practical involvement in the creation and assessment of alternative futures for the case study area. It was expected that the learning would be reflected in responses to survey questions, statements in interviews, and observed changes of behavior.

The remainder of this paper introduces the evaluation method used, reports on the case study workshop process and its outputs, and describes the results of the workshop evaluation. The results will help assessing the educational effects of planning workshops, and may assist in designing and conducting workshops most likely to achieve learning success.

9.2 Method

The research design involves the organization and conduct of a workshop case study, and a multi-method approach for the acquisition of evaluation data and its analysis.

9.2.1 Case study workshop approach and methods

The case study was a one week educational planning workshop in Sardinia, Italy, during five days in March 2009. The objective of the workshop was to develop and assess alternative futures for the region of Cagliari, the capital of Sardinia. The study area (Fig. 1) covered about 16 hectares and involved the City of Cagliari, the Molentargius – a breeding ground for flamingos and protected area of

international importance – as well as the surrounding urban and rural landscape. Participants were 12 students from Leibniz Universität Hannover (LUH), Germany, and 18 students from Università degli studi di Cagliari (UC), Italy. LUH students were enrolled in Bachelors', Masters' or PhD programs in Landscape Architecture and Environmental Planning. UC students majored in Territorial Engineering and Architecture. The number of female and male participants was almost even (14 to 16) and the average age was 26 years.

Figure 1: Study Area

The Cagliari workshop was based on the Alternative Futures Framework Method (Steinitz, 1990, 2003), of which readers of Environment and Planning B will likely be familiar. The framework consists of six questions that need to be addressed in any alternative futures study *(cf. Steinitz, 1990, Steinitz et al., 2003; Fig. 2)*:

1. How should the landscape be described?
2. How does the landscape operate?
3. Is the current landscape working well?

4. How might the landscape be altered?
5. What difference might the changes cause?
6. How should the landscape be changed?

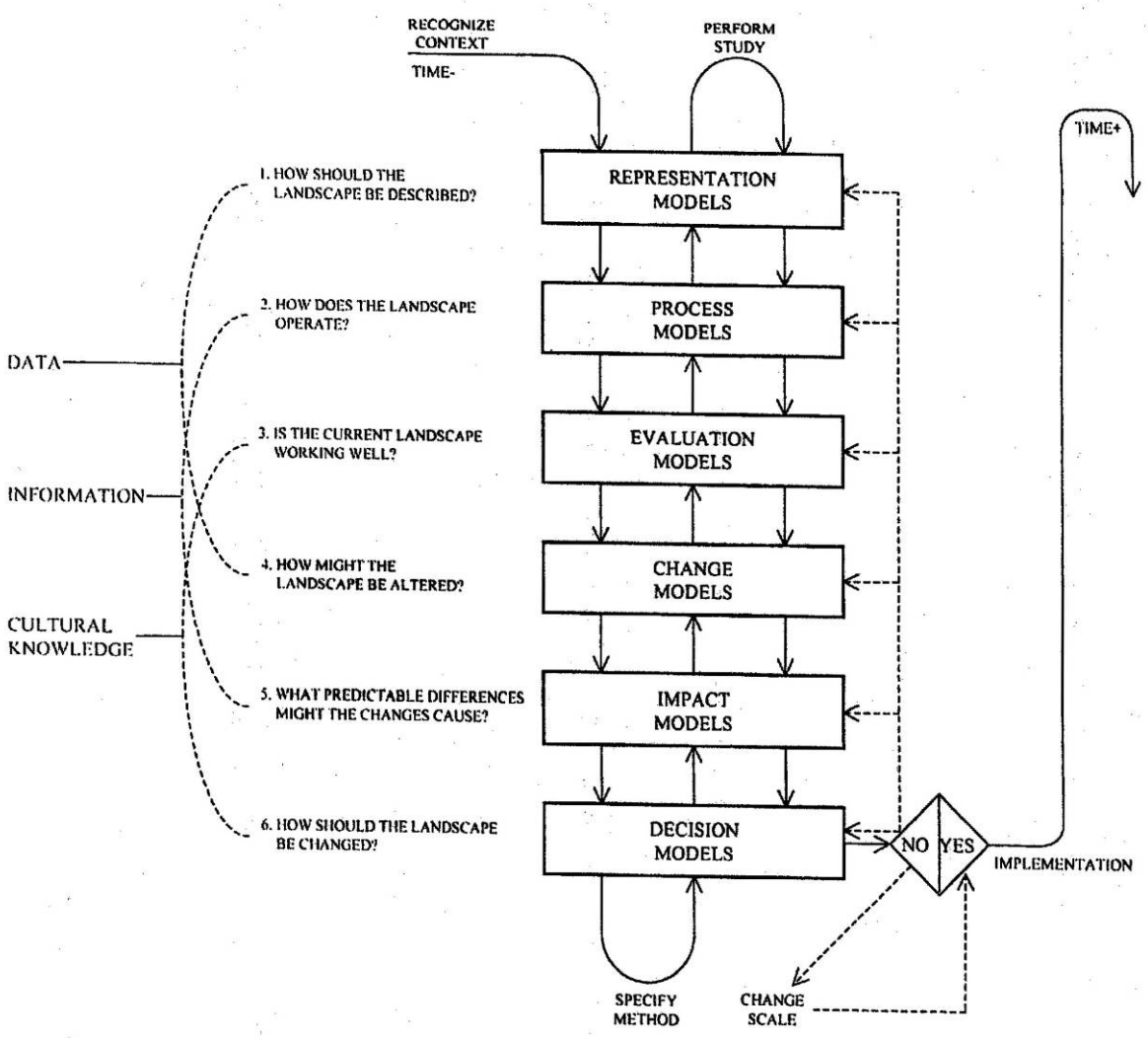

Figure 2: The Steinitz Framework for Alternative Future Studies

Over the course of a study, each of the six questions is asked three times: first to define the context and scope of the work (WHY questions); second to identify the methods of study (HOW questions), and third, to implement the study method (WHAT, WHERE and WHEN questions).

The practical application of the framework in the Cagliari case study required an adaptation to the workshop schedule and technology. The adapted framework (Fig. 3) needed to accommodate the approximately 24 hours of workshop time, a reliance on hand drawn graphics, as well as limited digital data availability and computer access. Due to these constraints, the workshop followed a design-oriented strategy, acknowledging that in practice, study areas of this scale would require comprehensive (GIS-based) assessments. A detailed description of the workshop process is provided in Steinitz et al. (2010), from which the following summary is partly quoted:

Question 1: How should the landscape be described?

The workshop began with two intensive days for a general introduction to the study area, its history, its current characteristics and future projections. It included a series of lectures by local experts, and

a half-day guided fieldtrip throughout the study area. Provided data included current land use, a terrain model, several sector plans and the relevant section of the recently published Sardinian Regional Landscape Plan, many photographs taken by students on the field trip, and Google Earth.

The students were divided into 10 teams that each addressed a different theme of interest (and potential impact) for the future of the region: habitats, the visual landscape, the cultural and recreational landscape, residential development, tourism, transport, hydrology, and due to a particular interest among some German students, geothermal energy, solar and wind energy, and biomass energy. On the field trip, each theme-team was asked to be particular attentive to issues relating to their respective topic, and to take photos illustrating issues of relevance.

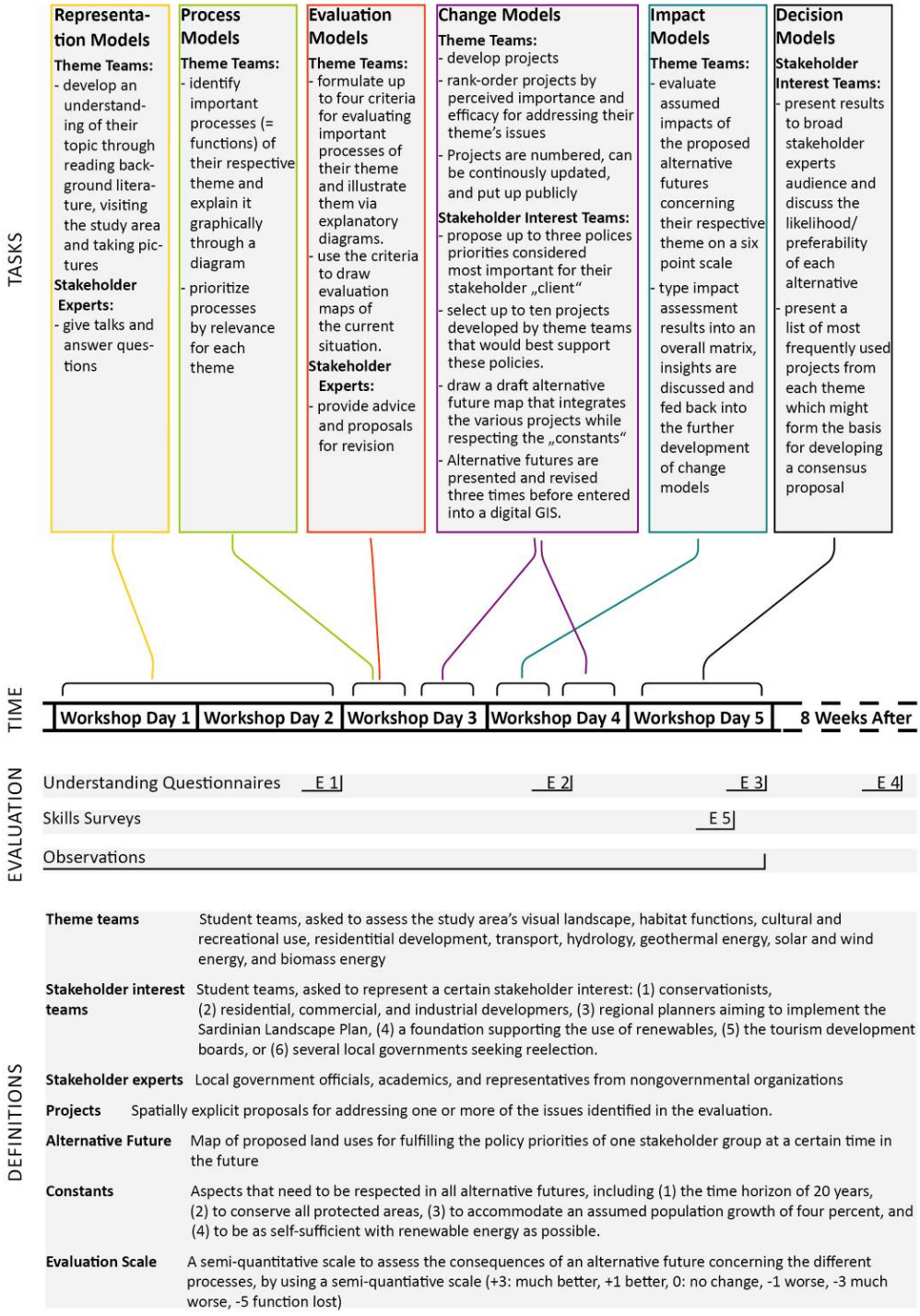

Figure 3: Overview of workshop processes, evaluation events, and definitions

Question 2: How does the landscape operate?

To address the second question, each theme team was asked to identify important processes (=function) of their respective theme and to explain it graphically through a diagram. Each team then prioritized its processes by relevance for their respective theme.

Question 3: Is the current landscape working well?

The evaluation of the current landscape and its processes was done by theme groups in formulating up to four criteria for evaluating important processes of their theme, and illustrating them via diagrams. Each team produced a map in two colors where green represented highly valuable elements which sustained the theme-process and which should be protected. Red illustrated areas of problem or threat to the process that should be improved. Stakeholder experts were invited to provide advice.

Question 4: How might the landscape be altered?

Change models were developed in several design cycles that were intersected by their iterative impact assessments (see Question 5). Theme teams developed diagrams that illustrated proposals for projects to change the processes of their theme. Projects could either aim at protecting valuable areas or improving problem areas. Projects were drawn on thin plastic sheets, color-coded with a different color applicable to each of the 10 theme teams. Projects were then rank-ordered concerning their importance and perceived effectiveness as judged by the team. Each theme team was then given two minutes to concisely present its work. Local experts met with student teams to propose revisions. Finally, all projects were uniquely numbered by their ranks and systematically ordered on a long table.

Figure 4: Impressions from the workshop process

Then, the student participants were organized into six larger teams, each representing a different "stakeholder". These teams were (1) conservationists, (2) residential commercial and industrial developers, (3) regional planners emphasizing the Sardinian Regional Landscape Plan, (4) a foundation

for the support of renewable energy, (5) the tourism development board, and (6) the several local governments in the area each seeking re-election.

Each stakeholder team proposed up to three policy objectives considered most important for its stakeholder client and it selected up to ten projects that would best support these policies from the overall set of approximately 150 projects. The teams proposed the policies and selected the projects based on their experience, knowledge gained from discussions with experts, lectures, readings, and the field trip. Then, each team had to make a proposal for land use changes which would support those objectives over the next 20 years. In addition, each proposal had to accommodate a 4% growth in population and its concomitant land-use changes and it had to be as self-sufficient in energy as possible. The process of overlaying and combining the drawings was rapid, using an overhead projector as a light table and a digital camera for recording.

The resulting Alternative Future designs were based on a selection of the projects. Any new or varied projects were announced and then numbered and placed on the long table so that they were available for use by anyone else.

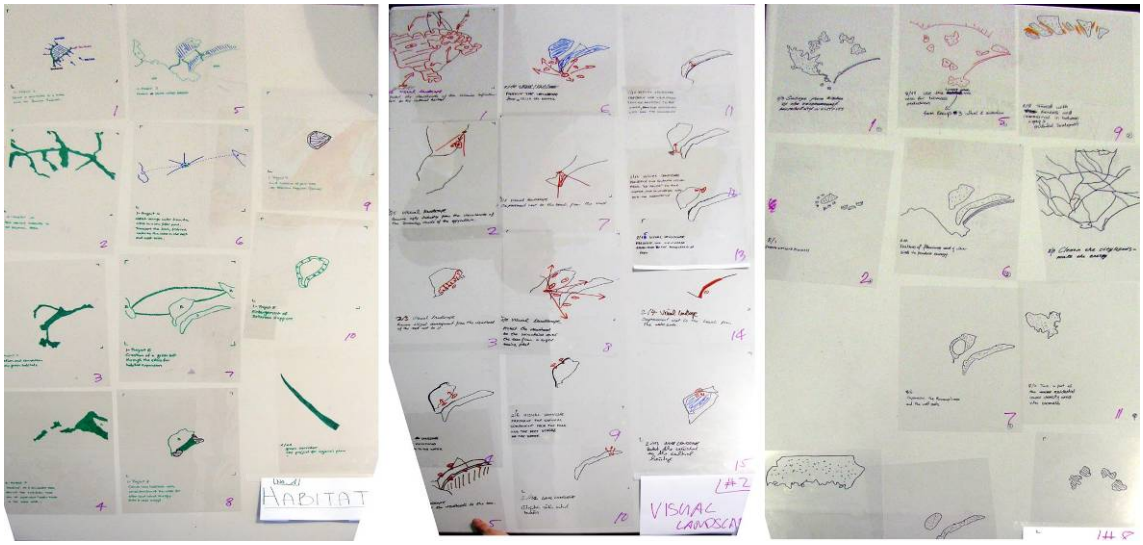

Figure 5: Project proposals, rank-ordered by importance for each theme

The next step consisted in the assessment of each alternative future concerning their potential impacts to each of the ten process and evaluation themes. The students were regrouped into their theme teams as described in the next section. Afterwards, a second design cycle was started in which the stakeholder teams could revised their proposalsEach altered or new project was again publicly announced and put on the long table for common use.

The second set of designs was presented to the entire group, followed by another round of impact assessments. Each stakeholder team then delegated one person to make a digital representation of each project that could be combined into an alternative future for the final presentation.

Question 5: What predictable differences might the changes cause?

Impact assessments were conducted in that each process theme team evaluated each of the six stakeholder change proposals on a simple scale with six levels. All evaluations were noted on a chart and green or red circles were used to indicate the team that was doing relatively best or worst among the alternatives. The main intend was to engage in a consultation between process theme teams and stakeholder teams to improve the designs in consecutive cycles.

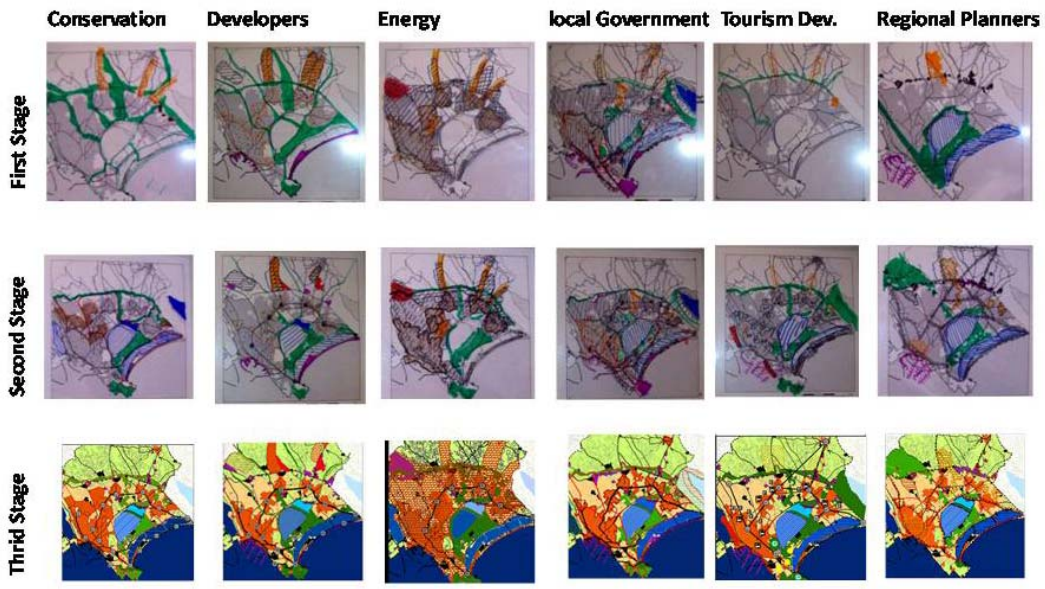

Figure 6: Comparison of the six different Alternative Futures for the region of Cagliari. The alternative futures are based on students' assumptions of stakeholder interests, with rows representing interim and final versions of the maps. For a detailed description of the results, please see Albert et al.(2010).

Question 6: How should the landscape be changed?

The Cagliari workshop was not expected to result in a direct decision on the future of the region, and did not do so in practice. However, a presentation and discussion of the results and their potential meanings for future landscape development was organized among the entire workshop group, all of the local experts who had participated, and many additional faculty and students from the University of Cagliari.

Each stakeholder team prepared a graphic product as specified by the faculty. It consisted of (i) three to five images illustrating the stakeholder team's principal policy objectives in order of importance, (ii) a slide with all projects chosen of greatest relevance for this stakeholder, (iii) a map of existing conditions, (iv) a map of the proposed changes, (v) a comparison of the alternative futures for Cagliari (existing and proposed conditions), and (vi) a summary slide showing the selected projects and the resulting alternative future.

In the final presentation that was held entirely in Italian, each team was given ten minutes to present its results before the entire group. Each presentation was followed by questions and answers. Each of the local experts commented on which of the alternative best met his or her expectations for the future development of Cagliari.

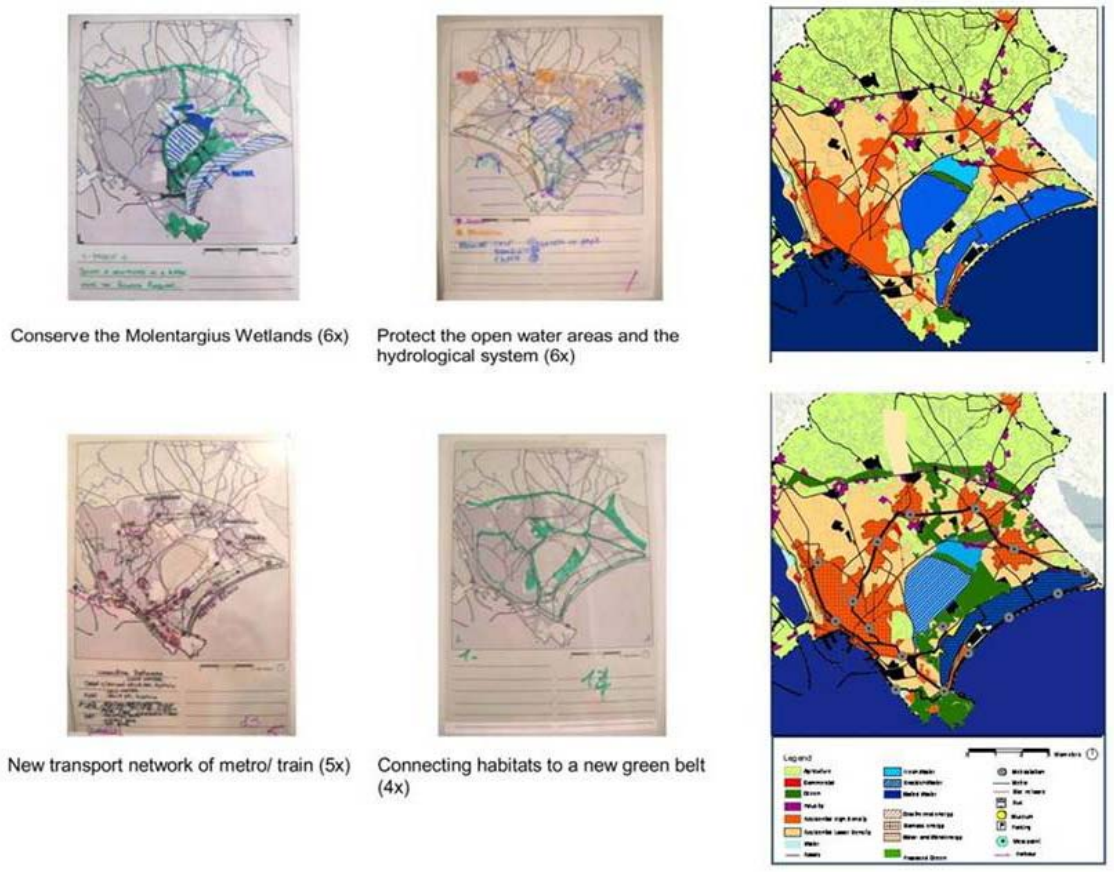

Figure 7: Towards a seventh alternative future

The four diagrams on the left illustrate the most frequently used project proposals by the six stakeholder interest teams (in brackets is the number of teams that integrated the respective proposal). The two maps on the right show the current land use (above) and a new proposal - the seventh alternative future - that integrates the selected projects.

Finally, a discussion was organized around the question of whether one should choose among the six alternatives, or whether it was possible to select projects from the alternative and to develop a new plan that could compromise the interests of various stakeholder groups. A frequency assessment of the number of times each of the projects had been selected for integration into the change proposals was used to choose the most-frequently used projects in the alternative futures liked most be the participants. In a rapid experiment in real time, the plastic sheets with the selected projects were overlaid on the overhead projector. Finally, a digital composite image was created (see Fig. 7).The closing discussion revealed that this was a very good proposal.

9.2.2 Evaluation data gathering procedures

Changes in participants' planning understanding were assessed though observations, interviews, a quantitative survey, and an open questionnaire that was handed out three times over the workshop and once two months afterwards (ex-post).

The questionnaire asked students to imagine that they were invited as consultants and charged with the task of designing and conducting a planning study for the case study region. Within this frame-work, they should answer the following questions on essential issues of planning design and conduct: What is your understanding of the planning problem? What is the planning objective? What would you propose as working steps, methods and tools? What planning products do you suggest and what three criteria should be used to measure success?

The quantitative assessment of the workshop's perceived contribution on the development of alternative futures planning skills was realized through a scaled survey handed out at the end of the workshop as well as nine additional interviews and observations. Unfortunately, the tight workshop schedule made it impossible to hand out two surveys before and after the planning process that would have allowed for assessing changes in stated levels of understanding and skills. The sample was the student participants of the planning workshop (N=30) who all submitted data points. The distribution among sub-groups was as follows: LUH=12, UC=28; female students=19, male students=11. The instrument for the analysis was a set of 23 skills considered of importance for participatory alternative futures planning. This list was derived from the key challenges of contemporary planning (see introduction), as well as the current draft of generic competencies for landscape architecture and planning, developed by the European Council for Landscape Architecture Schools (ECLAS, unpublished). Students were asked to evaluate the perceived degree to which the workshop had contributed to the development of each skill. The survey used five point scales, with five standing for "very much", and one representing "very little".

Observations were conducted independently by one author who was not directly involved in the workshop. The other authors reported participatory observations as part of the teaching team. The observations specifically aimed at identifying changes in student's behavior and verbal expressions that could indicate gained understanding or skills. Observation data was collected through immediate note-taking.

Additional interviews were semi-structured, following an interview guide that allowed for ordered but flexible questioning (Hay, 2005). Interview data was also collected through note-taking. All collected information was transcribed and converted into a typed format as soon as possible to improve the breadth and depth of coverage.

9.2.3 Evaluation data analysis

Analyzing the responses to the repeatedly handed out questionnaire on planning understanding followed two pathways. The first approach aimed at gaining insights into changes in planning understanding among all participants. It developed codes for assessing the responses to the open questions, matched the responses to these categories, and determined the proportion of responses addressing each category. The second approach addressed individual learning, and looked for changes in series of responses of individual participants.

The data gathered in the quantitative assessment of the workshop's contribution to the development of planning was analyzed using descriptive statistics (Min, Max, Mean and Standard Deviation). Comparisons were drawn between analysis results for the whole student group, as well as for different student cohorts differentiated by home university and sex. Statistical tests of differences between groups were omitted due to time constraints.

Observations were documented as notes taken while and immediately after the workshop. Notes were sorted into aspects qualifying findings on learning effects and altered planning understanding, identified workshop issues that could be improved, and recommendations for future applications.

9.3 Evaluation Results

9.3.1 Workshop effects on participants' planning understanding

The questionnaire on planning understanding, which was handed out four times, had an overall response rate of 53 percent or 63 copies. Its results suggest that the planning understanding of those who responded changed significantly over the workshop and afterwards.

The evolution of the considered planning challenges between the first and last assessment shows a dramatic increase in mentioning of governance issues from none to about 34 percent and a moder-

ate increase in the awareness of multiple problem dimensions from about 65 to 78 percent (Fig. 8, A). As expected, the rate of responses focusing on only one dimension decreases.

An example for the increase in problem dimensions is presented by one student who in the beginning only mentioned the need to integrate considerations of producing renewable energy as a focus of the study. At the third and fourth questionnaire, she also addressed endangered protected areas, unsustainable urban development trends, and development challenges within the city. Another student illustrates the increased consideration of governance in first proposing to develop a plan that "fosters the development of the region without disturbing the sensitive nature", and later emphasizing the need for integrating and balancing the different interests of various stakeholder groups.

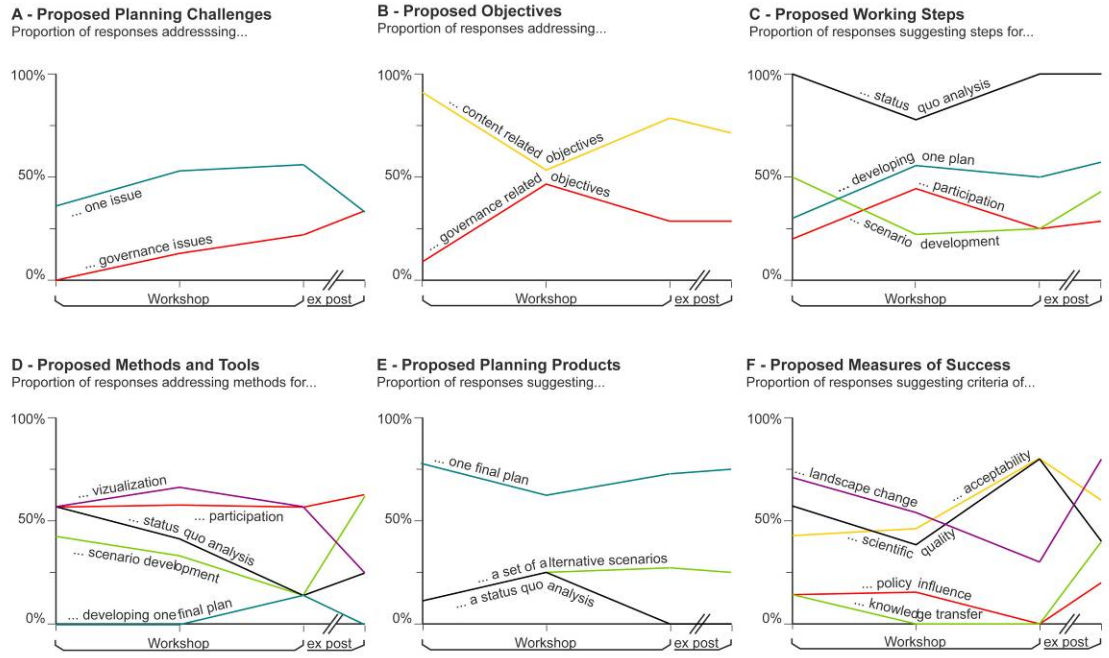

Figure 8: Changes in planning understanding over the workshop and ex-post.
Indicated are the proportions of responses matched to each given category. The remainder to 100 percent reflects the proportion of no or not applicable answers. The total numbers of returned questionnaires differed between workshop start and mid-workshop (N=17 each), and workshop end and ex-post (N=15 each).

The planning objectives proposed by respondents (Fig. 8, B) decreasingly considered primarily content-related objectives, and increasingly addressed primarily governance related aims. The mid-workshop evaluation saw a particular height in the proportion of responses focusing on governance objectives, and a respective low for content-related ones. This effect might be explained by the pressure of teamwork experienced for the first time for most participants.

A well suited example for the alteration of the proposed objective is provided by one student who in the first questionnaire suggests the development of new housing areas with the goal of achieving a maximum output of renewable energy generation. In the second assessment, the student proposes to develop "a plan which is acceptable for all participating parties". In the following assessment, he argues to find a consensus that "considers all interests at best", and finally "to create a selection of plans which balance as many different interests as possible".

The analysis of the proposed working steps (Fig. 8, C) shows little changes between the first and last assessment in the proportion of responses addressing steps for status quo analysis, participation, and scenario development. The mid-workshop survey again showed reverse trends for these issues. Surprisingly, the percentage of responding students suggesting steps for developing one final plan increased from 30 to 51 percent.

While the responses in general show only little changes of understanding of working steps, some individual responses indeed suggest educational benefits. For example, one student in the beginning only proposed to assess current settlements, renewable energy supply, and environmental aspects in order to create a planning proposal. In the last survey, she then explained to adopt an iterative procedure of expert-based planning and stakeholder consultation.

The responses concerning proposed planning methods (Fig. 8, D) show much greater changes across the four surveys. The proportion of responses considering scenario development methods rose from 43 to 63 percent from the first to fourth assessment. Two students provide examples of how the understanding of useful tools and methods can develop over the workshop. In the beginning, one student proposed brainstorming, project proposals, and presentations. At the next questionnaires, the individual emphasized group work, discussions, and continuous revisions. Finally, he proposed questioning stakeholders as key, highlighting that taking into account the interests of local actors is crucial for planning.

Another student already at the beginning of the workshop named public discussions, expert interviews and visualizations as relevant methods and approaches. This participant's proposed tools and methods however become increasingly sophisticated, including scenario techniques, public discussions, creativity methods, and specific communication procedures like "world café".

Student's responses concerning proposed planning products (Fig. 8, E) show an increased recognition of the benefits of alternative scenarios (11 to 25 percent) and a decreased mentioning of solely status quo analysis. The proportion of responses suggesting status quo analyses as planning products only slightly decreased.

A well suited example of how students learn to see the relevance of developing alternatives is given by an individual that first proposed a map of "optimal" land use configurations as the final product. Towards the end of the workshop, the student proposed the illustration and description of various scenarios, their evaluative assessment, and comparison between them.

Students' suggestions for measures of success of the hypothetical planning workshop (Fig. 8, F) confirmed the expectations: Responses mentioning solely product quality criteria (suitability to local conditions, understandability, usefulness, etc.) decreased from 57 to 40 percent. At the same time, the proportion of responses considering criteria of landscape change, acceptance, discussions and governance, and knowledge transfer all rose by between 6 to 26 percentage points. Interestingly, comparatively higher proportions of respondents mentioned acceptance criteria and quality criteria in the surveys two and three than in the post-workshop survey, suggesting that these learning effects were only of short-term character. A surprisingly large proportion of responses named "knowledge transfer" as a measure of success in the last assessment.

One example for the evolution of the understanding of useful success measures is given by a student who first proposes product quality and acceptance measures, then – in the later questionnaires – proposes also the contribution of local peoples opinions, if it helped to find a compromise, and if it provided information to facilitate discussion and decision making.

9.3.2 Workshop contributions to participants' acquisition of planning skills

The quantitative survey on planning skills had a very high response rate of 96 percent. It showed that participants perceived the workshop's contribution to the development of planning skills as generally quite positive. Students rated the workshop's effect on all planning skills named in the survey with 4.0 units on the five point scale (meaning "high" contribution to the skills improvement). For individual skills, the average values given ranged from 3.3 units (medium contribution) to 4.6 units (very high contribution).

The list of 23 individual planning skills and the average ratings provided in decreasing order of perceived workshop contribution are illustrated in Figure 9. Skills given highest ratings include time

management, conducting teamwork, and leading and structuring teamwork. Least evaluated were skills for using information technology, presenting in public, as well as up- and downscaling information and knowledge.

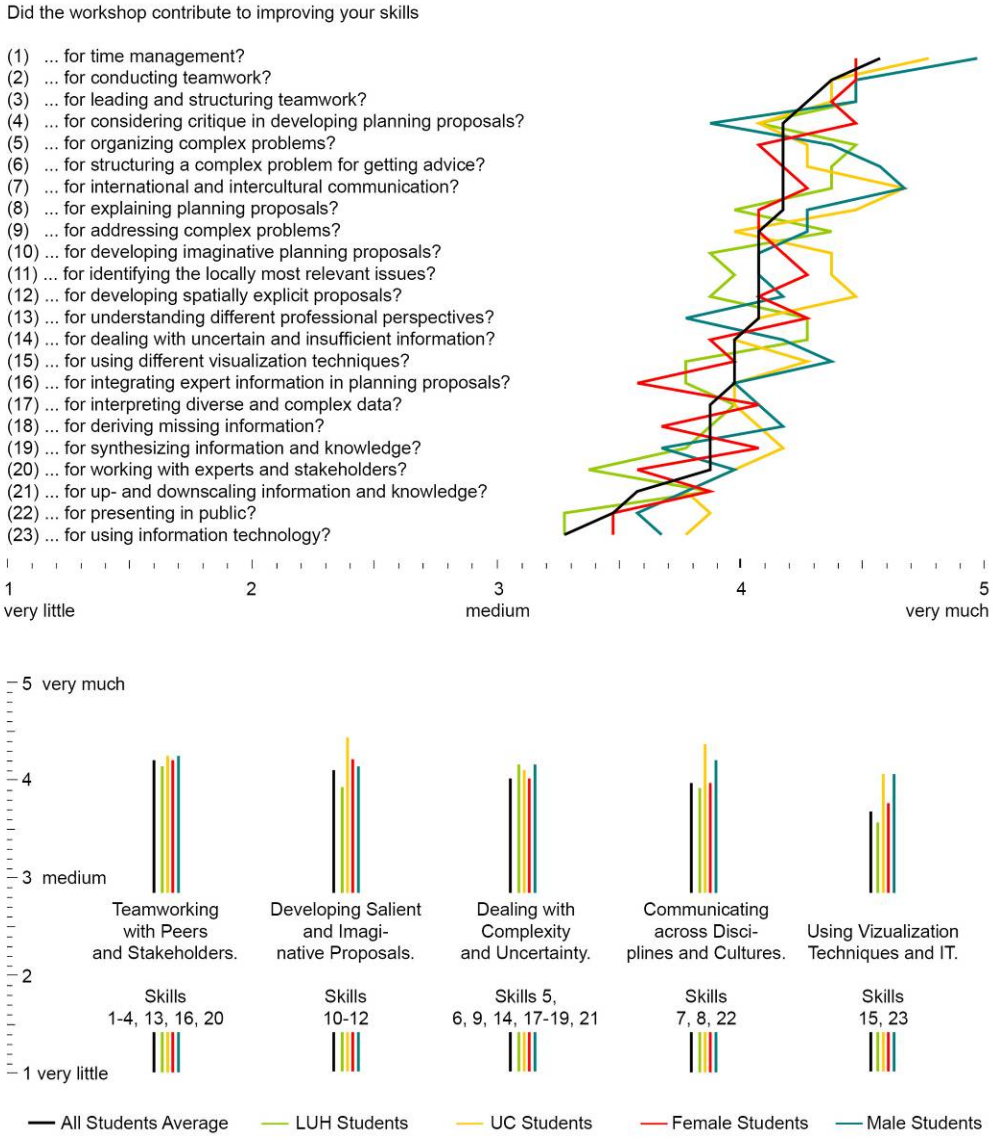

Figure 9: Perceived workshop contributions to the acquisition of planning skill.
Means of scores provided by the participants of the whole student group (N=30), as well as separately for students from LUH (N=12) and UC (N=18), female students (N=19, and male students (N=11).

To gain understanding of the types of skills to whose development the workshop particularly contributed to, three skills categories were defined and average evaluation values calculated. The skills category “teamwork with peers and stakeholders” was evaluated best, followed by slightly less average values for “developing salient and imaginative proposals” and “dealing with complexity and uncertainty”. Least average values were achieved for “communicating across disciplines and cultures”, and “using technology”. In addition to examining overall average values for individual skills and skill

categories, the evaluation data was further assessed concerning differences in responses between different student cohorts.

Looking at the average evaluation value across all skills, LUH students exactly matched the general average value of 4.0 units, while UC students evaluated slightly more positive (4.2 units). Male LUH students provided more positive ratings than female LUH students (4.4 and 3.9 units, respectively), and female UC students were more positive than their male co-students (4.4 and 4.2 units, respectively).

Greatest differences in the evaluation of individual skills by different student cohorts were found for "working with experts and stakeholders" and "developing spatially explicit proposals" that both received about 0.6 units more positive ratings by UC students than by their LUH colleagues. In contrast, LUH students were 0.4 units more positive than UC students about the workshop's contribution to skills for addressing complex problems. Female students found the workshop more effective in teaching skills for considering critique in planning proposals and understanding different professional perspectives (0.6 and 0.5 units higher than males, respectively). Male participants provided about 0.5 units higher ratings than females in evaluating skills for time management and deriving missing information.

The differences between average student cohort evaluations are also apparent in the comparison of the average values given for some planning skills categories. "Developing salient and imaginative proposals", "communicating across disciplines and cultures", and "using technology" were all evaluated more positive by UC students than by their LUH counterparts. The latter two skills categories also saw differences between more positive evaluations by male students than female students. Only marginal differences between student cohort evaluations are seen for "teamworking with peers and stakeholders" and "dealing with complexity and uncertainty".

The participatory observation data supported the described learning developments. It seemed that students – after one or two days of getting acquainted with each other and the teaching process – engaged very enthusiastically in their work. Students intensively discussed, worked, and collaborated to understand the planning procedures, to share factual information, and to reflect upon different perspectives. The workshop was perceived as stressful, but in a positive sense, allowing for great learning effects in little time. Students became thoroughly engaged in their work and were eager to improve their designs and proposals, even after a full workshop day. The intermediate presentations were regarded of great importance, and spurred intense collaborative efforts for finishing the planning products in time. Students increasingly developed understanding of the workshop process and the alternative futures planning method, and developed procedures for effectively communicating across language and cultural barriers.

The observation further suggested that the workshop's success in teaching planning skills was mainly due to the three features: (a) the multiple changes in perspectives required, (b) the time pressures and the forced revision and structured process and (c) the several exchanges with stakeholders. The changes of perspectives forced students to actively consider different relevant landscape processes and stakeholder interests. Time pressures made students to develop ideas rapidly, and the potential for future revisions helped significantly in raising planning quality. The conversion of drawings into GIS seemed to be particularly useful in forcing greater precision and another loop of revision, while the more professional illustration enhanced students' self-confidence. Stakeholder collaborations compensated for most students' little factual knowledge about the study area and relevant landscape functions, and helped enhancing the credibility and relevance of the proposals.

9.4 Discussion and conclusions

Given the very limited "net" studio working time of only about 26 hours, the workshop can be regarded a remarkable achievement: First, it resulted in six substantially different and quite elaborated proposals for the future landscape development of the region. The produced maps and impact eval-

uations found the interest and attention of local planners and decision makers. Asked about their interpretation of the quality of the six developed alternative futures, the local experts did not select a single one but argued that a consensus plan was needed that integrated the "best" projects from each alternative. A preliminary draft of such a "seventh alternative", developed a live-experiment in the final workshop meeting together with stakeholder, was interpreted by the local actors as being a quite good proposal. The proposal's quality was seen in both its substantive content as well as in its recognition of the governance structure and political reality of the region.

Second, the evaluation results indicate that the workshop resulted in substantial learning of responding students about relevant planning understanding and skills. Increases in respondents' planning understanding were found concerning the challenges, objectives, products, and possible success measures of scenario-based landscape planning. However, the stated understanding of required workshop steps and appropriate methods changed relatively little which may be due to difficulties of students to comprehend the complex workshop process. The fact that many positive learning effects became only apparent in the ex-post questionnaire which was handed out 8 weeks after workshop completion suggests that students sometimes require additional time to reflect learning experiences.

The workshop's contribution to the development of planning skills was successful for most skills. Greatest developments were seen in skills that addressed skills for collaboration, the creative designing of alternative futures, dealing with complexity and uncertainty, and communication. The little improvements in skills development for using technology is understandable due to the little emphasis put on this aspect in the workshop design.

The validity of these results cannot be thoroughly assessed. The questionnaire on planning understanding had a relatively low return rate of only 53 percent. Students who did not return their questionnaire may have experienced less improvement of their planning understanding, or they were not comfortable in English. Observations, responses, data interpretation and analysis may be biased. However, the relatively large total participant cohort, the use of triangulation methods, and the – for most surveys – high response rate make the authors confident about the outcomes.

Various aspects of the workshop pedagogy seem to have been particularly effective in facilitating student learning (and had purposely been decided for by Carl Steinitz in the design of the workshop process):

- Many decisions about the scope of the workshop planning problem, the methods and expected outputs were pre-defined by the faculty. This one the one hand limited students' freedom to define their procedures (compared with a semester-long studio), but minimized time needed for orientation and enabled an immediate start of the planning process.
- All interim results, ideas, and planning proposals of student teams were publicly presented and made available for use by other groups (e.g. the long table of change proposals). This limited the personal attachment of students to "their" particular ideas and facilitated collaborative designs and more objective searches for appropriate solutions.
- Student groups were always mixed by disciplinary background and nationality. This made teamwork more difficult but also enhanced mutual understanding and facilitated practicing communication skills and intercultural collaboration.
- Student team composition and focus was changed from process and evaluation themes to different stakeholder interests after the mid-workshop presentation. This procedure had the benefit that stakeholder interest teams included members knowledgeable about different landscape processes who now served as quasi-experts on their theme. Also, students further enhanced teamwork skills in being required to again adjust to a new group setting.
- The time provided for working periods was strictly limited. This, one the hand, led to a relative crudeness of initial diagrams. On the other hand, it fostered concise thinking, facilitated rapid de-

velopment and concretization of ideas and allowed for iterative improvement and intertwined collaboration between student groups.

- The time limitations of presentations to only two minutes also fostered conciseness and thoughtful preparation.
- Rotating the obligation to present interim results between students enhanced individual skills for public speaking.
- General "time-outs" for addressing questions in public enabled joint learning across all student groups and the possibility to build-upon each others' works.
- Providing examples and templates for expected products in each planning step significantly enhanced understanding of the workshop process among students.
- The use of pre-determined color code schemes for drawing process models, change diagrams and projects, for completing evaluations and land use maps was essential to allow for mutual understanding, quick presentations, and joint learning.

Despite the general workshop success, some challenges were identified: First, the international collaboration caused communication problems. Some participants did not understand English, thus requiring translations. Due to time constraints, presentations needed to be shortened and internal student team discussions often became difficult. Second, students experienced some problems in understanding the terminology of the framework that was not intuitively comprehensible to every participant, and experienced resulting problems in executing the suggested tasks. Third, some students had difficulties keeping up with the many changes of perspectives required. In being trained as environmental planners, they experienced problems to adopt unilateral perspectives for educational purposes.

The evaluation methodology proved useful and yielded interesting insights. However, it became apparent that much time was needed during the workshop for filling out the surveys and questionnaires, as well as after the workshop for digitalization, coding, and analysis. Furthermore, some students had difficulties in comprehending the questionnaire on planning understanding. While they were asked to imagine that they would be independent consultants to the region, they assumed that we asked them in their role as students, and responded with respect to their tasks in the workshop. To assess changes in planning skills, future evaluations should rather use a smaller number of quantitative survey questions. These would be fast to complete and could be used at the beginning and several times of the course of the workshop. If changes in planning understanding should be assessed, appropriate time must be provided. Since this evaluation showed that changes in planning understanding sometimes only become apparent with some time for reflection, the respective questionnaires should be handed out two times, once at the beginning and once some time after the workshop. This principle should also be considered in the teaching evaluations conducted at universities. Further research should evaluate a greater number of case studies, and draw comparisons between different methods and procedures for teaching alternative planning workshops to enhance the effectiveness of workshops for student education.

Further research is needed to test the generalizability of the findings from this workshop to other case studies. An interesting issue for further reflection is thereby to assess if the learning success as achieved in this case study workshop would be replicable in other cases without the long-time teaching experience and the charismatic personality of the leader of the faculty team.

10 Social Learning for Bridging Scales and Levels – The Case of a Local Strategy for Climate Change Adaptation (Paper VII)

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Abstract

Climate Change is a complex phenomenon that spans multiple geographical and temporal scales and levels along these dimensions. Designing and implementing successful strategies for climate change adaptation thus requires cross-scalar and multi-level assessments and integration of diverse information, knowledge, and perspectives.

Social learning arguably has large potential for helping society to develop capacity for bridging scales and levels in climate change adaptation assessment, planning, and implementation. Through involvement of actors from various perspectives in a joint learning process, effective approaches for adaptation can be found over time, amid the great complexity of the social and ecological systems involved.

Although the relevance of social learning for bridging scales and levels in climate change adaptation has been recognized by various scholars, systematic and empirical analyses on this issue are only just emerging. This paper aims to develop a theoretical conceptualization of social learning for bridging scales and levels and to validate this concept in an empirical case study of climate change adaptation in the Broads ecosystem, United Kingdom. Methods of the case study analysis include document reviews and semi-structured interviews with key stakeholders.

We conclude that social learning can provide valuable contributions for addressing the challenges of bridging scales and levels in climate change adaptation. It can be conceptualized as an iterative and long-term process of deliberative/analytical co-production and application of substantive and procedural knowledge and know-how by actors from different disciplinary backgrounds, scales, and levels. On the basis of the successful social learning process on climate change adaptation in the Broads case study, we shed light on how social learning processes for bridging scales and levels can be initiated and facilitated in practice.

10.1 Introduction and Methods

Climate change is a complex phenomenon that spans multiple geographical and temporal scales and levels along these dimensions (cf. Clark, 1987, Reid et al., 2006, Wilbanks, 2007, Wilbanks and Kates, 1999). For example, incremental local activities like land use changes contribute to the global dynamics of climate change, which have reverse impacts on local environment and economy.

Designing and implementing successful strategies for climate change adaptation thus requires cross-scalar and multi-level research and action that integrates information and knowledge hosted by actors at various locations along the scales and (institutional) levels (Cash and Moser, 2000). While appropriate climate adaptation responses can in many cases only be determined locally (cf. Downing, 2004, McEvoy et al., 2008) their implementation largely depends on structures and resources at

global and national scales (AAG GCLP Research Team, 2003). To successfully address this complexity and diversity of perspectives, pluralism in ideas and approaches is required (cf. (Functowicz and Ravetz, 1993, Kates et al., 2001, Turner II et al., 2003). Through participation of various collective and individual actors, different types of knowledge and information can be integrated and the plurality addressed (Arnstein, 1969, Blackstock et al., 2007, Dryzek, 2000, Fischer, 2000, O'Neill, 2001, Rauschmayer and Wittmer, 2006, Renn et al., 1995, Stirling, 2004).

The concept of social learning arguably has large potential for analytical understanding the processes and driving forces behind the changes of policies and practices in society. At the operational level, social learning concepts is applied to advise upon the initiation and facilitation of collaborative processes for climate change adaptation amid complexity and uncertainty (cf. King and Jiggins, 2002, NRC, 1999, Pahl-Wostl et al., 2008). In general terms, social learning aimed to address the challenges of changing climate can be described as "processes of agent and institutional reconfiguration derived from a conscious awareness and willingness to act and deal with the common problem [of climate change]" (Tàbara et al., 2009). Over time, participants can develop and change mechanisms and procedures for overcoming the past, present and forthcoming challenges of climate governance e.g. effectively bridging scales and levels for climate change adaptation.

There is an increasing number of studies exploring social learning from both theoretical perspective (e.g. Ison et al., 2004, Pahl-Wostl et al., 2007a, Pahl-Wostl and Hare, 2004) or from operational point of view analyzing empirical evidences of learning in environmental decision-making (Pahl-Wostl, 2006, Pahl-Wostl et al., 2007b). A number of studies recently emerged that addressed the entangled issues of scales, information, and knowledge (e.g. Cash et al., 2006), and highlighted the need for social learning to span scales and levels (Pahl-Wostl, 2006, Pahl-Wostl et al., 2007a).

To contribute to the further development of understanding of social learning, this paper focuses on two central questions: (1) how can social learning for bridging scales and levels be conceptualized, and (2) does the developed concept prove useful for understanding the obstacles and opportunities in a practical case study of local climate change adaptation?

In the first part of the paper, we employ a comprehensive literature review to characterize the relevance of the concept of scales and levels for structuring the problem of climate change adaptation. Furthermore, we reflect on how the concept of social learning can be applied to analyse and to operationalise the ways society address the issues of sustainability governance. The review of two concepts grounds further reflections on how the concepts of social learning can be used to address the deficits of cross- scale and levels interaction in climate governance.

In the second part, we study the case of climate change adaptation in the Broads ecosystem, United Kingdom, to empirically test our concept and to draw some lessons learned for other climate change adaptation initiatives. The analysis draws upon the literature sources and documents including management plans, legal documents and proceedings, Internet forums and media sources reflecting the changes of decision-making processes and practices over the last 20 years. A valuable source of information was four interviews conducted in 2007-2008 with the representatives of key stakeholder groups: the Broads Authority, the Broads Forum, Environmental Agency, and independent local NGO. Semi-structured face-to-face and phone interviews (approximately one hour each) have been transcribed. The observation made during a stakeholder consultation workshop and informal communications with the participants has added to understanding the complexity of issues and history of decision-making and learning processes in the case study.

The concluding section summarized the results including theoretical understanding of social learning for bridging scales and levels for climate adaptation, practical insights derived from the case study and supported by the evidences from literature, and directions for future research.

10.2 Results Part A: Towards a Conceptual Understanding

10.2.1 The challenge of bridging scales and levels

The issue of scales and levels is increasingly recognized as an important aspect for understanding and addressing global environmental changes, and related issues of climate change adaptation.

In following Gibson et al. (2000) and Cash et al. (2006), we understand scale as the spatial, temporal, jurisdictional, or analytical dimensions employed to study and address any phenomenon, and levels as the units of analysis at different positions on a scale. For example, social and ecological phenomenon can occur at one or across a range of different spatial levels or at various "time frames" such as durations or frequencies. Furthermore, the understanding and analysis of a phenomenon is influenced by the level at which it is developed, with more traditional and contextualized knowledge at the local and more generalized and formalized knowledge at higher levels.

Each scale and level has specific types of information and knowledge that are all important for understanding processes of global change (AAG GCLP Research Team, 2003, Wilbanks, 2006, Wilbanks and Kates, 1999). Since phenomena at different levels are tightly coupled, the driving and constraining factors of higher and lower levels need to be considered (Holling, 1978). Focusing on only one scale "tends to emphasize processes operating at that scale, information collected at that scale, and parties influential at that scale - raising the possibility of misunderstanding cause and effect by missing the relevance of processes that operate at a different scales" (Wilbanks and Kates, 1999). Therefore, no one scale, time frame, or approach to creating knowledge is correct or fundamentally privileged over others. All offer insights, and each has contributions to make (Berkes et al., 2006).

Effectively addressing issues of global change thus requires integration of information across all scales and levels. Instead of looking solely at a single level of analysis, the different scales and levels must be considered simultaneously to exploit their comparative advantages (Cash and Moser, 2000). For example, local scale data helps increasing the accuracy of global models and higher level assessments are downscaled to study the impacts of global developments on specific regions. Furthermore, policy makers from all scales are interested in understanding how measures for adaptation or mitigation at one scale might influence the opportunities at other scales (Alcamo et al., 1996, Cash and Moser, 2000, Wilbanks and Kates, 1999). As Cash et al. (2006) found, consciously addressing scale issues and the dynamic linkages across levels increases the chances for assessing problems and finding solutions that are politically and ecologically sustainable.

Successfully bridging scales and levels is realistically possible (Berkes et al., 2006), but presents society with many challenges that can be summarized as ignorance, mismatch, and plurality (Cash et al., 2006).

1. Ignorance describes the fact that important interactions of scales and levels with others are often not considered (Holling, 1978, Cash and Moser, 2000, Gunderson et al., 1995). In many cases, understanding the dynamics of systems at one level alone is of such a high degree of complexity that interactions with other levels are neglected for reasons of manageability. However, ignoring important interactions in the analysis often causes subsequent management problems.
2. Mismatch exists when human actions do not adequately correspond to the geographical scale or dynamic of an environmental problem (i.e. an institutional fit problem, cf. Young, 2002) or when the knowledge produced by an assessment is at a different scale than needed to usefully inform management (a scale discordance problem) (cf. Cash and Moser, 2000, NRC, 1996). Consequences of mismatch are often unsustainable resource management (Lee, 1993, Folke et al., 1998).

3. Plurality describes the failure to recognize heterogeneity in the way scales are perceived by different actors, even at the same level. If only singular perspectives are considered, inequitable outcomes and ineffective decisions often prevail (Cash and Moser, 2000, Ostrom, 2002).

Conceptual understanding of the structure of scales and levels and their interaction provides a basis for theoretical reflection on the causes of the problems related to sustainability (climate) decision-making. How can society react on these challenges? How these reactions can be analyzed and, possibly, steered towards more effective decision-making and practices? Our review of relevant literature suggests that successfully addressing the challenges of bridging scales and levels can be achieved most promisingly through implementing mechanisms for interaction and co-production of knowledge between institutional and personal actors from different scales and levels (cf. Berkes et al., 2006, Cash et al., 2006, Cash and Moser, 2000, Reid et al., 2006, Wilbanks, 2006, Young, 2002). In the following section we discuss the concept of social learning as a theoretical and operational tool to analyze and facilitate the processes of knowledge production and utilization by society.

10.2.2 Social learning for climate change adaptation

Numerous definitions exist of the meaning of learning. In this paper, we draw on the work of Siebenhüner (2002a) who proposes to understand learning as "a process of long-lasting change in the behavior or the general ability to behave in a certain way that is founded on changes of knowledge". The knowledge gained in this process, according to Siebenhüner, can then be of either substantive or procedural nature. *Substantive knowledge* involves the actual problems considered, and the details and level of integration of the analysis. *Procedural knowledge* refers to how the process is designed, including which actors are involved, which methods of collaborative problem solving are employed, and how complexity and uncertainty is dealt with.

As discussed above, climate change adaptation requires processes of co-production and application of knowledge between various actors. Learning must therefore not only occur at the level of individuals, but rather at the level of the collective body of individuals involved. The idea of collective, organizational, or social learning has being developed and explored in the social sciences since about three decades to describe changes at the level of collectives (e.g. organizations) and society at whole.. Major advances in inquiry into social learning have been made in the fields of psychology (Bandura, 1977), organization theory (Argyris and Schön, 1978, Argyris and Schön, 1996), and policy and development studies (Dunn, 1971, Hall, 1993, Heclo, 1974). In this literature, social learning is understood as going beyond the composition of individual learning processes in that it also includes alterations of processes and shared knowledge, based on the contributions of members of the collective body i.e. "society"(cf. Siebenhüner, 2002a).

Various scholars have pointed to the different kinds of social learning processes that can occur. Drawing upon earlier research on organization learning by Argyris and Schön (1978), recent studies (ADAM, 2007, Hall, 1993, Pahl-Wostl and Hare, 2004, Siebenhüner, 2002a, b) differentiate *single-loop*, *double-loop*, and, in several cases *deutero* (Argyris and Schön, 1978) or *triple-loop* (King and Jiggins, 2002) learning. Single loop learning refers to the simple adaptation of new knowledge to the existing knowledge base. Double-loop learning takes place when learning also leads to alterations of the underlying theory of action, including the objectives, values, norms, and belief structures. Deutero learning happens on a meta-level and considers the ability to learn itself. The upper levels of learning are believed to be most substantive but also most difficult to achieve that also explains relatively little evidences of double- and especially triple-loop learning (Hall, 1993, Siebenhüner, 2002a).

Recent studies by Mostert et al. (2007) and Pahl-Wostl and Hare (2004) conceptualized social learning as an open-ended, iterative process that may involve several cycles and stages: At its core is a *process* (1) of interaction and collaboration between multiple actors that is influenced by the specific *context* (2), and results in *outcomes* (3) in a form of practical action, policy responses or

behavioral changes. The context may include internal (structural and cultural) and contextual or ex-external factors (Siebenhüner, 2002a).

Assessing the outcomes of social learning is not easy. Some commentators consider changes in practices (i.e. actions, policies) and behaviors of the actors as indicators of social learning (Hall, 1993, Siebenhüner, 2002a). For example, Siebenhüner (2002a, b) proposes to look for "crucial learning events" in which past experiences are reflected and incorporated into changes of the design of collaborative assessment, planning, and implementation efforts. According to this view, successful social leaning means that a specific policy or management goal was achieved (Heclo, 1974, Siebenhüner, 2002a). Others stress the spontaneous character of learning processes (ADAM, 2007) and suggest the rather abstract notion of "enhanced capacity of the social-ecologic system to cope with sustainability challenges" should be seen as ultimate goal of a learning process (Folke et al., 2003, Tompkins and Adger, 2004). Both positions, however, are complementing each other. For example, social learning can be successful if the actors achieved a specific goal of considering new information they possess. At the same time it also matters if this new knowledge was taken into account and had been used to enhance capacity of the actors to address sustainability challenges.

In this light, the concept of social learning is increasingly applied in the study of and consultancy for processes and dynamics of collaborative knowledge production and decision making of multiple actors on natural resources' management and sustainable development issues (cf. NRC, 1999, Pahl-Wostl, 2006, Pahl-Wostl et al., 2007a, Pahl-Wostl and Hare, 2004, Social Learning Group, 2001a, b). Extending the focus of learning processes from specific organizations or policy issues towards the evolution of complex social-environmental systems brings new challenges and opportunities to "learning societies". In this broader understanding, social learning can not be reduced to mere transfer of information between the actors but should be seen as taking place in a wider environmental and social context (Folke et al., 2003, Mostert et al., 2007, Pahl-Wostl et al., 2007a, Tompkins and Adger, 2004).

10.2.3 Conceptualizing Social Learning for Bridging Scales and Levels

The different but complimentary perspectives on sustainability decision-making reflected by the concept of scales and levels and the concept of social learning may supplement each other in grounding the efforts by society on climate adaptation. Looking at the history of action and decision-making through the prism of "social learning" helps to understand and, possibly, to facilitate dynamics of social processes towards more adaptive planning and actions. At the same time, reflecting on the problems, capacities and interests associated with different scales/levels sheds light on the structures of socio-environmental systems and related problems, therefore, helps to set up specific targets for social learning processes.

In this paper we argue that processes of social learning are needed to improve the cross-scalar and multi-level climate adaptation assessment and. First, bridging scales and levels is most often an unprecedented effort related to new challenges of complex decision-making in the field of environment and sustainable development. Society needs to accumulate knowledge on complexity of issues related to multi-level structures of social-environmental systems and experience on how to address this complexity. Through social learning, appropriate strategies can be identified, tested, and further developed over time. Second, our understanding of the complex cross-scalar and multi-level dynamics of many environmental issues is constantly evolving. Only continuous learning processes of all affected actors will allow to identify and to respond to changing conditions.

For the specific focus of this paper, we consider social learning as successful when the participants of the climate change adaptation process increase their joint capacities or general ability to integrate cross-scalar and multi-level interactions in their research and implementation activities. Along these lines, substantive knowledge involves information about the dynamics and interactions of phenomena at and across different levels and scale. Procedural knowledge deals with the way the process of integrating information is designed and the approach used to facilitate cross-scale and

multilevel co-production of knowledge. Single loop learning occurs if information from another level or scale is integrated that has not been considered before. Double loop learning happens if the learning process has lead to significant alterations of the processes and structures of integration.

To analyze in detail how social learning could help in bridging scales and levels in climate change adaptation, we draw on Cash et al.'s (2006) three main challenges for bridging mentioned above. Table 1 describes how social learning could contribute to addressing each of the challenges. The table summarizes, first, how social learning may help to identify the problems and the gaps related to the particular challenge, and, second, how learning process may lead toward solutions to address these problems and gaps.

Table 1.Social learning for addressing challenges for cross-level and cross-scale interaction

CHAL-LENGES	POTENTIAL CONTRIBUTIONS OF SOCIAL LEARNING FOR ADDRESSING THE CHALLENGES
Ignorance	SL can help to identify levels and scales that was previously not considered (either because of lack of knowledge that they exist or reluctance to take them into account); SL can help to identify the links between levels and scales that actors were not aware or might have ignored if they had acted individually; During the process of SL actors may find out or develop ways to take into account levels and scales that have been previously ignored.
Mismatch	SL can help to identify mismatches in the way how the problem is addressed (e.g. lack of fit between biogeophysical system and social institutions, between long-term objectives and short terms of policy objectives, etc.) and possible risks associated with them for decision-making; SL may help to identify mismatches between knowledge production (e.g. content and form it is presented) and type of knowledge needed for credible and legitimate decision-making. SL can enhance developing the knowledge and know-how necessary to fit institutions to levels of problems (if we learn from previous failures or predicted problems).
Plurality	SL can help identify the actors associated with different levels and scales, their interests and visions on the problem (e.g. identifying and transferring local visions into scenarios based on global environmental models and vice versa); SL is explicitly attuned to facilitate discussion among various actors that may support informational exchange and communicate plurality of visions and interests and contribute to possible solutions.

Following the argumentation of Cash and colleagues (2006), we can suggest that social learning has great importance for developing responses to the problem of levels and scales i.e.: *institutional interplay*, *co-management* and operation of *boundary organizations*. Remarkably, all three "responses" also play an important role in establishing and facilitation of the learning process in a society. Institutional interplay is necessarily for transfer of information, establishing communications and building trust between the actors (Pahl-Wostl et al., 2008); co-management supports the processes of learning by doing by "communities of practice" and also helps to avoid management overlaps (HarmoniCOP Team, 2005, Pahl-Wostl et al., 2008); and boundary organizations provide an independent platforms for actors' interaction, accumulation and transfer of knowledge and facilitation of the learning processes (Olsson et al., unpublished manuscript, cited by Borowski et al., 2008, Cash et al., 2006, Tàbara et al., 2009). Therefore, social learning processes may use institutional interplay, co-management and boundary organization as a platform for information transfer and communication. At the same time, it is a part of the social learning process to learn how these three responses can be employed more effectively e.g. to enhance cross-scale and cross-level interaction. Therefore we can suggest that institutional interplay, co-management and boundary organizations as such represent rather *potentials* than ready-to-use responses. These potentials may not be necessarily realized and used by society. It is a social leaning process in which society finds how to create, use and improve social responses (e.g. institutional interplay, co-management and boundary organization) for bridging levels and scales.

Evidence from empirical case studies suggests that social learning for cross-scale and multilevel integration is most feasible if it is place based (AAG GCLP Research Team, 2003, Kates et al., 2001, NRC, 1999, Wilbanks, 2003). Developing an understanding of the complex relationships among environmental, economic, and social dynamics seems to be only possible when conducting relatively focused and place-based assessments, integrating various types of knowledge from the global to local scale (NRC, 1999). For example, potentials for adapting to climate change most often strongly depend on locally specific contexts, options, and avenues for action while decisions are often taken at the upper levels of administrative and scientific hierarchy (Burch and Robinson, 2007, Wilbanks, 2007).

From the broad theoretical perspective, the paper analyses social learning as a process of knowledge acquisition and actions taking place at different levels over the time and implemented by different actors – participants in a "learning society". Creating a complex vision is essential for understanding driving forces and processes influencing decisions and action at the local level. At the same time, this broad view does not allow reflecting on the dynamic and effectiveness of learning process in a specific case and by specific local agent(s). Neither, it answers how learning processes can be organized, and which lessons can be learnt for local decision-making on adaptation. In the following sections we put two perspectives together, focusing on the local authority as the main "learning agent" which operates in and affected by the larger multi-scale and multi-level social learning process.

10.3 Results Part B – Social Learning in Climate Change Adaptation in The Broads

10.3.1 Climate Change Adaptation in The Broads Ecosystem

The Broads ecosystem is situated in the East Anglia, south-eastern United Kingdom, at the border of the Norfolk and Suffolk regions (Figure 1). It includes the Broads National Park (about 301 km²) as well as adjacent river catchments and coastal zones (Broads Authority, 2004).

The Broads area features of fens, marshes, and shallow lakes (broads) drained by rivers and man-made canals. Due to the great diversity of landscapes and floristic and faunistic species, the ecosystem has been identified as a unique wetland and lowland complex of national and international importance (Natural England, 2008). The ecosystem further includes a mosaic of agricultural lands, industrial and housing areas (water-side villages and peripheral urban lands), and zones of recreational use (boatyards, holiday accommodations, etc.) (Broads Authority, 2004).

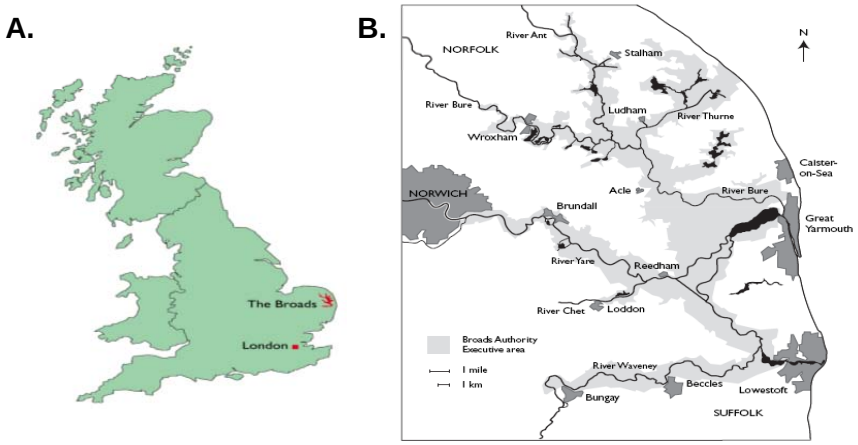

Figure 1. The Broads area: A. The Broads in UK; B. The Broads National Park *(Broads Authority, 2004)*

The region has a long history of economic development in water related sectors. Traditional economic and recreational activities include agriculture, fishing, tourism, and navigation. Intensive recreational activities and agricultural exploitation of The Broads' landscapes resulted in a notable decrease of environmental quality from the 1950s to the 1970s that threatened nature conservation and wildlife preservation as well as economic activities relying on healthy ecosystems (e.g. tourism). The subsequent implementation of policy measures and significant investments in nature conservation in the area helped to maintain and restore the ecosystem conditions and strengthened its status as one of the most popular recreational sites in UK.

The potential impacts of climate change are among the main current threats for the future of the Broads sensitive ecosystems. Temperature rises of about two to five degrees Celsius are predicted for the next 100 years (Broads Authority, 2004) that, in combination to the natural sinking of the coastline, are expected to cause sea level rise and derogate fresh-water ecosystems through salt-water intrusions.

Increased magnitude and lowered predictability of river and tidal floods and changing climate patterns will impact land-use and economic activities, including greater demand and lower quality of water for agriculture and tourism. At the same time, new climate conditions may bring opportunities for the area including lengthening of the growing season and wetland creation for biodiversity and recreation (Broads Authority, 2004).

The Broads' history of adaptation to natural disasters is almost as long as the history of human activity in the area (George, 1992). Public and policy awareness of risks of devastating floods was already raised after severe storms in the North Sea in 1937 and 1950. Today, climate change and its possible resulting impact on flood risks is recognized as one of the most important factors influencing economic development from the national to local levels.

The Broads Authority holds management and planning duties in the national park. Besides, management system in the area involves multiple interests and supporting institutions at different levels: EU policies; national legislation on planning and development, sectoral and climate policies and responsible governmental agencies; regional development plans; administrations of the bordering areas and multiple interest groups (wildlife conservation, navigation, business, tourism, land-owners and others) (Figure 2)

In the remainder of this section, we employ the concept for social learning for climate change adaptation as described above to reflect on two decades of actions (e.g. knowledge generation, assessments, planning and implementations) towards more climate-proof development in The Broads. Local climate adaptation cannot be seen as a separate "domain" but only in the context of other planning and development decisions in the area. Therefore, "learning for adaptation" in The Broads can be hardly separated from broader "learning for better management". Figure 2 represents a "road-map" of this process including factors and events at different levels that have had (or still have) an influence on decision-making on climate adaptation in the Broads. Based on official documents (Broads Authority, 2004, 2007, 2008, Communities and Local Government, 2007, DEFRA, 2005, 2007, EERA, 2004, EU, 2007) and interviews, we represent 20 years of "climate learning" in the Broads as two cycles including context, process and outcomes (Pahl-Wostl et al., 2007a, Tàbara et al., 2009) with several "key learning events" (Siebenhüner, 2002a) also reflecting on first- and second-order learning in the case study. Overview of these broader learning processes at different levels over time represents an important part of the case study description. It provides a clear view on a larger system of reference within which the local agents need to operate i.e. to build their responses and to establish learning activities. Detailed description of the cycles of multi-level social learning process grounds the analysis of social learning for bridging scales and levels at the local level represented in the next section.

10.3.2 Fist cycle: from The Broads Act (1998) to The Broads Plan (2004)

Context: In 1988, the UK Government Norfolk and Suffolk Broads Act established The Broads National Park and introduced the Broads Authority (BA) as the main management body responsible for navigation,, tourism and nature conservation at both terrestrial and water spaces (Broads Authority, 2004). Important step had been made towards spatial and administrative integrity of management that was previously shared between Norfolk and Suffolk County Councils.

In the beginning of 1990s, increasing evidences of climate change and information campaigns at global and national levels stressed the importance of integrating adaptation measures in local development planning. The adaptation focus in The Broads started to shift from the traditional reliance on technical approaches to flood protection towards a long-term perspective that, among other factors, also considered the potentialy emerging issues like salinization and loss of fresh-water ecosystems. Growing industrial and agricultural development pressures in close-by areas increased water pollution and eutrophication, resulting in negative effects not only for biodiversity but also for navigation.

At the same time, environmental policies at the national and EU level provided new, and often stricter, standards for environmental quality and safety. The EU Birds and Habitat directive applied within the boundaries of the national park and the new EU Water Framework Directive (WFD) established higher standards for water quality. River Basin Management Schemes (RBMS) introduced by the WFD expanded planning schemes beyond the borders of the national park, thereby increasing the complexity of management and, to some extent, limiting the capacity of the BA to plan adaptation responses within its borders. At the national level, the Flood Alleviation Program reduced possibilities for economic activity in the zones qualified as “flood-prone” - which form only part of the area – that further increased management fragmentation. Although significant financial support existed in the national park, the majority of funds are appropriated for ecosystem preservation while funding for adaptation measures is still limited.

Scientific research on The Broads ecosystem has been immense (cf. George, 1992). Starting form 1990s, new series of research in the area increasingly stressed social and economic aspects including considerations of risks of flooding and possible adaptation measures (Turner et al. 2003, 2004), climate change scenarios (Lorenzoni et al., 2000a, Lorenzoni et al., 2000b) and schemes for complex environmental management (Turner et al., 2003b, Turner et al., 2004). Several studies, supported by initiatives at national and EU levels, argued for more participatory approaches (Lorenzoni et al., 2000a, Lorenzoni et al., 2000b, Turner et al., 2003b).

Process: New conditions of management and increasing effects of climate change forced the Broads Authority to look for alternative management solutions. The development of a new management strategy spreaded over two years and included several phases: initial planning and design; identification of stakeholders; public consultations to identify key issues; preparation of a draft Plan and following consultations; and finalization of the new Broads Plan (Broads Authority, 2004). The process was organized by the BA and independent consultants were involved in the process to assess the design and facilitation of dialogues (Broads Authority, 2004).

Outcomes and key learning events: In 2004, the Authority adopted the new Broads Plan (BP), a guiding document providing management objectives for the four themes of ‘living landscapes’, ‘water, habitat and wildlife’, ‘tourism and recreation’, and ‘understanding the Broads’ (Broads Authority, 2004). Climate change was increasingly considered as one of the factors with most potential influence on The Broads development. The BP developed a five-year Actions Plan, considered visions of future developments within the next 20 years, and uses a one hundred year interval as reference line for evaluating possible consequences of global climate change (Broads Authority, 2004). The administrative structure of the BA was revised to implement a more pragmatic and problem-oriented approach which enhanced its position as a coordinating body. The Broads Authority further initiated the Broads Forum (BF) as a consultative stakeholder body, aiming at in-

volving stakeholders' knowledge and to share awareness of and responsibility for complex decisions. The Broadland Flood Alleviation Project, focused on flood protection in river section (e.g. constructing of banks) and based on 20-years public and private partnership funding scheme, started to operate.

10.3.3 Second cycle: from the Broads Plan to the modern challenges.

Context: From 2004 to 2008 several changes happened at the national and regional levels. To support a strategic move toward sustainable development at the local level (Turnpenny and O'Riordan, 2006) the UK government significantly revised planning standards. The Local Development Framework (LDF) supported an integral system of planning and management at the local level by combining different development objectives. Later on, Regional Spatial Strategies (RSS) had been introduced to set up development frameworks at the regional level. By introducing LDF and RSS, the UK government attempted to enhance the role of regions in planning and management (EERA, 2004).

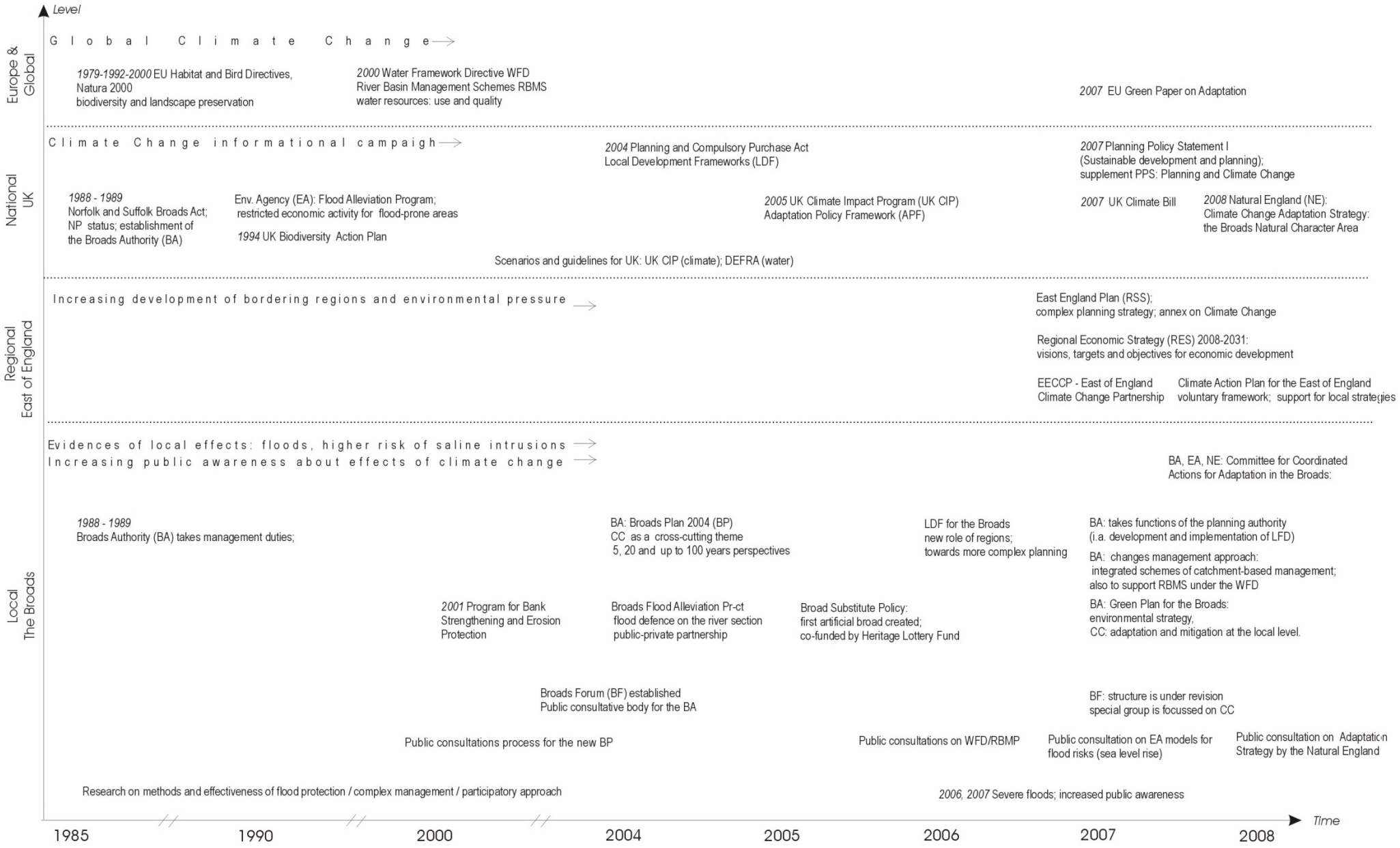

Figure 2. A road-map of the decision-making process on climate adaptation in The Broads: decisions, actions, institutions and factors of influence

Advances in climate policy development (UK Climate Impact Program, Adaptation Framework Program and Climate Bill (DEFRA, 2005, 2007) brought climate issues to a fore. Climate change became an important factor for strategic planning and was integrated into development policies and guidelines (Communities and Local Government, 2007, EERA, 2004). Nevertheless, the main policy focus remained on mitigation. The EU Green Paper on Adaptation (EU, 2007) aimed to balance adaptation objectives with the mitigation agenda at the EU level. At the local level, increasing evidences of disastrous events (e.g. storms of 2006 and 2007) raised public awareness and emphasized necessity to protect population from climate-related risks. However, alongside with the local development and adaptation, the BA needed to support the standards for water management and biodiversity conservation (EU WFD and Habitat Directives) controlled by, respectively, the Environmental Agency (EA) and Natural England (NE). Fragmentation of management was recognized as an important barrier: BA did not have control over flood protection at the coast (responsibility of the EA) and nearby areas.

Process: According to new planning regulations, the BA got full planning and management functions including responsibility for development and implantation of the LDF. To overcome fragmentation and meet the demands at upper levels, the BA revised its management structure and initiates institutional cooperation with the EA and NE. The BA also expects possible changes in planning structure according the new RSS - The East England Plan (EERA, 2004). In 2008, Natural England (NE) prepared a draft version of the Adaptation Strategy for the key natural character areas in UK, including the Broads (Natural England 2008). The strategy suggested several scenarios of adaptation depending on the way the society will face climate change (i.e. from complete reluctance to accepting climate-related changes in ecosystems); the document had strong focus on ecosystem protection and less on other aspects of development in The Broads.

Several public consultations were organized in the area. River Management Basin Schemes (RBMS) were presented for public discussion according to the WFD requirements. Climate impact models developed by the EA were discussed at the BF; stakeholder consultations were organized on the adaptation strategy by the NE. At present, the Broads Forum looks for new ways to enhance capacity for stakeholder participation, e.g. to contribute to and to communicate possible climate change strategies.

Outcomes and key learning events: BA, EA and NE established the Committee for Coordinated Action for Adaptation., which subsequently became an important step towards more effective and less fragmented management. To address the complexity of addressing adaptation challenges and to support the standards of RBMS/WFD, the BA introduced new “whole valley” management schemes based on river catchments. A new Green Plan suggests climate action for the area, combining mitigation targets by the BA with adaptation strategies based on the objectives defined by the Broads Plan 2004.

At present, the balance of development objectives at the regional level and trade-off between long- and short-term priorities at the local level are among the most important challenges for climate policy and climate learning in the area. New planning regulations (RSS) shift responsibility for planning to Regional Development Agency (EERDA) that may give more priority to the economic development and less to environmental issues, that may “*make it a lot more a challenge to get climate change at the regional level”*(Interview 2). Continuing reliance on traditional technical measures for flood protection may preserve the areas from flooding and reduce the risk for the population in a short and medium perspective while accepting unavoidable natural changes in land-use structure may deliver effective solutions in a longer run.

10.3.4 Social Learning Processes in Climate Change Adaptation in the Broads Ecosystem.

We interpret the above described evolution of climate adaptation in the Broads ecosystem as a relatively successful social learning process, because evidences of changing practices, management policies, institutional structures, and actors’ behavior can be identified. The changes can in many cases be directly linked to the availability of new information, the input of innovative knowledge by various

actors, insights gained from scientific research, and changes in the decision making context. Many challenges remain before an effective mechanism of social learning for bridging scales and levels will be implemented in The Broads national park.

To assess in greater detail how social learning has contributed to building channels for cross-scale and multi-level integration in climate change adaptation in the case study, we will now shed some light on the question of if and how the problems of ignorance, mismatch, and plurality have been addressed, what type of social learning has occurred, and which factors seem to have been particularly important for the social learning to happen.

In our empirical analysis of the Broads case study, we found many examples illustrating both the challenges of bridging scales and levels in climate change adaptation and how social learning processes can help addressing them:

10.3.5 Social learning for addressing ignorance of scales and levels

The common problem of ignorance was and is prevalent in various aspects, including scientific information about scenarios and effects of climate change in the area, multi-level management and integration of local knowledge.

Before the 1990s when climate change was not yet on the agenda of sectoral planning agencies, ignorance of scientific information about possible long-term effects of climate change existed. At present, notwithstanding several advances and learning efforts in the field of climate scenario development at various levels, local development planning is still insufficiently attuned to the potential impacts of climate change. For example, local climate change data only starts to be scaled down to local impacts. Knowledge is rare of how exactly the different global IPCC scenarios would play out in terms of expected changes in precipitation patterns, average temperatures, and sea level rise and how this information can be integrated in local planning. At the same time, scenarios at global and national levels (which also ground guidelines for local development) as well as standards for environmental quality (e.g. the WFD and the Habitat Directive) usually do not take into account information about specific local effects, e.g. eutrophication and decreasing water quality as result of climate change in the Broads.

The later example of the EU directives can also indicate ignorance related to management. EA and NE as national-level agencies responsible for implementation of the WFD and Habitat Directives may ignore local objectives of more flexible climate-proof development. Ignorance is also apparent in that the WFD does not directly include the aspects of climate change adaptation. In absence of any guidance form the EU, member states and local watersheds are still lack information of how to include aspects of climate change adaptation in the plans (cf. Interview 2). Another persisting example of ignorance can be seen in the possible neglect of the potential impacts of climate change and need for adaptation measures in new regional development plans (Interview 2). Furthermore, platforms and procedures for integration of the local knowledge need to be further developed.

Nevertheless, several advances in overcoming ignorance have been made that can be attributed to effective social learning processes: better integration and more local assessments of potential climate change impacts are now available. Actors in regional and national instructions (e.g. EA) are collaborating with scientific counterparts and stakeholders at the local level (the Broads Forum) which increases the usefulness of the assessments and advices. The Broads Authority in its attempt to create alliances with the institutions as different spatial and administrative levels (e.g. EA and NE, and bordering authorities), experiments with ways to deliver the local information to the other levels and create “communities of practices” for co-managing the Broads area. Another example can be seen in the creation and current re-framing of the Broads Forum for better integrating local knowledge which is a response to new political conditions and changes in management behavior of the Broads Authority.

10.3.6 Social learning for addressing mismatch of scales and levels

Mismatches in climate change adaptation can exist between the ecosystem boundaries, the administrative borders and management structures, the scales of scientific information and management requirements, and resources allocated at different levels and for different purposes. Such mismatches exhibit important barriers to the creation and implementation of complex adaptation strategies. If assessment and management do not address a phenomenon at the level at which it occurs, understanding of the system must remain incomplete and changes in the ecosystem behavior cannot be induced effectively.

The case of climate change adaptation in the Broads shows numerous examples of mismatch between the spatial and administrative scales. Particularly relevant is the mismatch between the ecosystem boundaries and the area administrated by the Broads Authority since the coastal zones, upstream parts of river catchments and other areas adjacent to the national park are still outside of the Authority's influence. Furthermore, the adaptation strategy prepared by Natural England delineates the Broads as a natural character area on the bases of its natural habitats while important interactions with local land use dynamics, economic activities and development in the broader ecosystem remain only vaguely considered. Another example can be seen in the national flood-protection regulations that are concentrated only on some designated "flood-prone areas" and thus increasing the fragmentation of management.

An example for the mismatch between scientific information and management objectives is apparent in that data on water availability and risk management are dispersed between assessments at different agencies responsible for the climate change scenarios at the national level (UK CIP) and evaluation of flood risk (DEFRA).

At odds are also the local stakeholders' long-term objectives of climate change adaptation and the rather short term oriented financial investments from the national level. Local stakeholders perceive the resources provided by the national level as insufficient and rather ineffectively distributed.

In addition to these persisting problems, positive examples of social learning for overcoming issues of mismatch can be found. The Broads authority, after gaining the management responsibility over the area in 1989, has successfully increased its capacity to address climate change adaptation issues at the ecosystem scale. The last extension of the BA's control over the planning in the area may also be seen as an effect of learning processes at upper levels that finally led to the decision to empower local administrations as a condition for more sustainable planning. Besides, several re-framing of the BA structures e.g. toward more integral management of river catchments, indicate an effort to reflect on the management practices and to adapt to policy changes at the upper levels. Similar to the challenge of ignorance, the creation of the Committee for Coordinated Actions for Adaptation between the BA, the EA and the NE can be considered as a significant advance in learning for overcoming mismatch between spatial and administrative scales of management for climate adaptation. At the same time, the Broads case shows how the introduction of polices with good intentions may also have the side-effect of further complicating the governance structures: new planning system introduced by the RSS may interfere with the established planning and management structures.

To address current mismatches between management objectives at different scales (i.e. meeting the standards for water quality as defined by the WFD), the Broads Authority currently applies at the national level to have the Broads National Park designated as an experimental area for local adaptation strategies in UK. The proposal, which for example includes the introduction of flexible water quality standards, is a highly innovative response to the management problem and can be interpreted as a result of successful learning.

The mismatch between scientific information and management targets is currently being addressed in involving local stakeholders in discussing the allocation of measures for coastal flood defense, evaluating risks related to sea level rise by the EA, and scenarios suggested in the Adaptation Strate-

gy by the NE (Natural England, 2008). The stakeholder involvement can be seen as a result of learning at the local and upper levels, aimed at designing more effective practices of decision-making.

One of the most crucial factors for overcoming mismatch might be local leadership to facilitate better communication between scientific results and the people making decisions (Interview 2).

10.3.7 Social learning for addressing plurality of scales and levels

The challenge of plurality in cross-scale and multi-level climate change adaptation lies in the need to identify and consciously address the multiple perceptions of the impacts and potential mechanisms for effective adaptation. The Broads case exhibits two examples of plurality challenges: the multiple objectives of actors representing different scales and levels and the trade-offs between short- and long-term approaches to climate change adaptation.

Multiple objectives, interests, and future visions are advocated by actors at different levels and cross-scale. The various sectors involved such as navigation, tourism, agriculture, nature protection etc. all have independent and sometimes conflicting perspectives on climate change adaptation. Furthermore, actors from one sector but different levels in the hierarchy may have slightly different objectives as well. It is important to stress that these cross-scale and multi-level plurality relates to issues of power distribution and prioritization between objectives. For example, the objectives of ecosystem preservation lobbied at the national level obviously receive more priorities including financial support. At the same time, responsibility for complex strategy for local adaptation to greater extent remains at the local level with less resources and capacity to act.

Plurality also becomes apparent in valuing trade-offs between short- and long-term management solutions for adaptation. Flood protection (i.e. based on technical measures including holding a sea line as long as possible by banks) is seen as primary short-time goal and supported by number of actors. At the same time, other actors, including scientists and stakeholders at the upper levels (NE and, also, BA) may advocate for longer-term solutions, i.e. supporting scenarios which imply unavoidable changes of ecosystem and land-use (see Box 1).

Social Learning about approaches for addressing the issue of plurality is reflected in the advances made towards more complex planning. A salient example is the introduction of broad stakeholder consultation in the development of the Broads Plan which can be seen as a major result of learning for better management. Additionally, a reframing has taken place in that climate issues are now one of the cross-cutting themes of regional development in the Broads plan. In this regard, climate change and the need for adaptation can be seen as a boundary object that allows multiple stakeholder perspective and helps integrating the formerly competing sectors of nature and landscape protection, industry, and recreation. It has been recognized among the actors that co-management is crucial for effective climate change adaptation (Interviews 1, 2, 3).

Box 1. *Let Nature to Take Its Course?*: debates around adaptation measures.

One of the four scenarios the Adaptation Plan for the Broads Character Area by Natural England (NE) (Natural England, 2008) suggests to "Let Nature to Take Its Course". The scenario implies that the areas along the North Sea coast now protected from flooding e.g. by "beach feeding" for the cost of significant financial investments, will be let for gradual flooding by the sea as a result of climate change and sinking of the coast line. The option implied a loss of land now partly used for agriculture. Several villages along the coast would need to be relocated. As the benefits, this scenario suggested creating new wild-life habitats in the abandoned areas and significant decrease of the climate change risks in the longer run. The draft version of the plan was discussed at the stakeholder workshop with the representatives of the Broads Authority, local communities, municipalities and scientific experts in February 2008. Shortly after the workshop BBC reported on public oppositions against the plan

(http://news.bbc.co.uk/2/hi/uk_news/england/norfolk/7338079.stm) supported by the NGO Broads Society and local communities. The NE needed to provide explanation, i.e. that all the options had suggestive character and was developed by the Adaptation Plan alongside with the other strategies following more "business-us-usual" passes.

This example may illustrate how learning, triggered by a crisis in relations between the actors (Holling and Sanderson, 1996), revealed the challenge of "plurality" in cross-scale and cross-level interaction. The actors at different levels had different perceptions of the time-span of adaptation strategies (longer in case of NE and shorter for protesting public) and of at which level the decisions should be located. The case also stressed the importance of adequate and timely representation of information across the levels that can be also done thorough a boundary organization.

Social learning concerning plurality in the "time-frames" of the visions has also occurred through conducting wide stakeholder engagement (Interview 2). As a result of this learning, almost all actors involved are now at least aware about the existence of alternative strategies for future development. However, reaching agreements on which pathway to choose is still an ambitious goal. From this perspective, consultation by the Natural England on the adaptation strategy for the Broads' valuable ecosystem became an important event that triggered a conflict but also helped to clarify positions of actors at different levels and scales. Other examples are the consultations conducted between the Environmental Agency and local stakeholders to discuss how to respond to the potential local effects of climate change and the remaining degree of uncertainty in the Broads. In this effort, internal and external communication has been identified as the main factor of success.

10.3.8 Types of social learning for addressing issues of scales and levels

Most social learning in the Broads represents single-loop learning or "adaptation of information" (cf. Siebenhüner, 2002a). For example, the introduction of the new "whole river valley management" system which resulted in better integration of spatial and administrative scales occurred rather in compliance with requirements of the WFD than as a result of changing management behavior of the Broads Authority. Single loop learning may also refer to new technological solutions and funding schemes to maintain the existing system of flood protection based on banks along the rivers and the coast. These solutions address the issues of cross-level and cross scale interaction but only aim for changes of management tasks (like seeking financial resources from institutions at levels that where previously not considered appropriate) rather than challenging existing power structures (e.g. convincing the Government to prioritize the issues of complex planning at the local level against sectoral interests of nature protection and water management).

However, there are also several learning events that can be interpreted as double loop learning. The Broads Plan 2004 is an innovative management approach that combines different development objectives and introduces new management structure to respond to the challenges of climate and other environmental changes (Interview 1). Remarkably, the Broads Plan combined previous academic research results with intensive stakeholder consultations, thus integrating information and visions from different scales and levels. An institutional response to overcome plurality, ignorance, and mismatch between spatial and management scales is the establishment of a joint committee on local adaptation that includes representative from the BA, EA, and NE. In this committee, the organizations aim at *"looking for adaptation strategies that all three agencies can agree on and can implement even though they have different implementation areas of responsibility"* (Interview 1). Another example of double loop learning was the shift in problem perception towards realizing and accepting the possible long-term impacts of unavoidable climate change. As one interviewee remarked, *"there have been a lot of people maintaining the Broads at their current states. But we have to understand that the Broads will […] likely to become more saline in character. […] That process will notably continue. I think we have to accept this when we starting to understand how we will manage the sys-*

tem." (Interview 3). Although controversial, this vision indicates an attempt to match the current management objectives and responses to the temporal scales of the ecosystem dynamic under climate change. Currently implemented "substitute policy" (i.e. creating new artificial lakes further in land to replace the existing broads) and Natural England's (2008) suggestion to replace areas with limited agricultural value with flooded wildlife habitats represent two possible examples of such "reframed" responses.

10.3.9 Promising strategies for effective social learning for addressing issues of scales and levels

The Broads case exhibits many examples in which the strategies of establishing structures of co-management, creating arrangements for institutional interplay, and implementing boundary organizations have led to the creation of effective mechanisms of social learning for bridging scales and levels. The Broads example also shows how society iteratively learns to use these structures more effectively for integration and use of the information and capacities at different levels and scales adapting to the current demands and situation. Whereas several solutions related to co-management and institutional interplay have been already mentioned, in our view the Broads Authority as boundary organization deserves particular attention.

Since its installation in 1989, the Broads Authority has increasingly served as a boundary organization for social learning and for enhancing capacities for bridging scales and levels in climate change adaptation. In many cases, the authority assumed a critical role in acquiring, transferring and applying information (e.g. scientific information and policy decisions), initiating cooperation between the actors and institutions at different levels and scales, raising awareness (both at the local and upper levels) about the effects of climate change for the Broads, and enhancing participation. Many actors in the region recognize and value the Broads Authority's function as a boundary organization. Despite some criticism, it is perceived as legitimate platform for communication and facilitation of information transfer, stakeholder dialogue and learning. In the nearest future, the role of the Authority may even increase due to increased awareness of the Authority's capacity as a boundary organization and support from national tendencies to empower local administrations.

Although the Broads Authority presents us with a case in which a local planning and management authority serves as a boundary organization for facilitating social learning, institutions of other governmental or non-governmental status can also successfully assume this role. For example, in the Helgeå River catchment in Sweden, a non-governmental institution (the Ecomuseum Kristianstads Vattenrike) helps facilitating communication and knowledge transfer for adaptive co-management (P. Olsson et al. unpublished manuscript referred by Cash et al., 2006). Since various kinds of institutions of different official status adopt boundary organization functions, flexible and locally adapted strategies for establishing and fostering such organizations seem appropriate, rather than prescriptions of certain institutional settings.

10.4 Conclusions

Our analysis of social learning for bridging scales and levels in climate change adaptation shows that social learning is crucial for getting better at integrating and addressing cross-scale and multi-level issues since society in general does not know how the inherent complexity can be addressed and because our knowledge about climate dynamics is far from complete but continually evolving. Over time, social learning helps society to become better at assessing and integrating information from different levels and scales and to make better informed and more legitimate choices informed by this awareness. At the same time, understanding of the structure of socio-environmental systems and related challenges of climate governance through a "prism" of scales and levels may help to structure the responses and, therefore, to provide a specific - although flexible - target for social learning processes.

We suggest conceptualizing social learning for bridging scales and levels as an iterative and long-term process of deliberative/analytical co-production and application of substantive and procedural knowledge and know-how by actors from different disciplinary backgrounds, scales, and levels. Substantive knowledge reflects the dynamics and interactions at and across levels and scales, while procedural knowledge concerns effective mechanisms for designing and conducting participatory processes for integrating capacities and information from different levels and scales. The process of social learning can be either single-loop learning when information from another level or scale is newly considered, or double-loop learning when the learning lead to alterations of processes and structures for integration across scales and levels.

As such, social learning has much capacity to address the three main challenges of bridging scales and levels in climate change adaptation, namely ignorance, mismatch, and plurality. Social learning can be fostered through the mechanisms for enhancing participation and collaboration of various actors from different scales and levels (e.g. institutional cooperation, co-management and installation of boundary organizations) and, in a course of an iterative learning process, to contribute to more effective use of these mechanisms.

Our analysis of the history of climate change adaptation in the Broads ecosystem, UK, empirically validated the above described conceptualization of social learning for bridging scales and levels and shed light on chances for practical implementation.

First, the factors that hindered and still complicate bridging scales and levels in the case study could well be attributed to the three main challenges of ignorance, mismatch, and plurality.

Second, a number of activities of climate change adaptation in the Broads can be interpreted as the result of social learning. Several of learning and resulted management activities were directly aimed at overcoming the issues of mismatch, ignorance and plurality. Nevertheless, these cases represent rather spontaneous management reaction than systematically designed learning process for bridging levels and scales. In most cases, this social learning has taken the form of single-loop learning, but some incidences of double-loop learning can also be found.

Third, of the various strategies that proved successful in fostering more cross-scale and multi-level considerations in the case study, the function of the Broads Authority and Forum as a regional boundary organization seemed to be most relevant.

Despite many advances in bridging scales and levels in the case study, problems remain that need to be addressed through continuous social learning, for example the need to better balance development objectives from stakeholder groups of different scales and to reconcile trade-offs between long- and short-term priorities of adaptation.

Based on our theoretical and empirical analysis, we conclude that bridging scales and levels in climate change adaptation is not easy, but realistically possible. Given the importance of social learning in this regard and the scarce of related theoretical reflection and empirical analysis, further research is needed on how processes of social learning for bridging scales and levels in climate change adaptation can best be designed and facilitated.

11 Synthesis

11.1 Results

11.1.1 Overview

The objective of this thesis was to enhance the understanding and influence of SLP in decision making in support of transitions towards sustainable landscape development. This aim was approached in two parts and several working steps:

Part A considered the influence of SLP on decision making through its substantive outputs. First, criteria of influential SLP outputs as well as details of their respective properties were explored through reviews and qualitative content analysis of scenario planning literature in general (Paper I). Then, the identified criteria of influence were further refined and verified in two SLP case studies from Monroe County, Pennsylvania, and the Upper San Pedro River Basin, Arizona, USA (Paper II). Third, approaches for designing and conducting SLP projects likely to result in outputs complying with the criteria of influence were discussed in a comparative review of nine European landscape planning case studies (Paper III).

Part B investigated how SLP can facilitate social learning that enhances the understanding and skills of relevant actors for informed and cooperative decision making. It began with an assessment of the degree to which five recent SLP projects from Australia, Switzerland and the USA already fulfill requirements for social learning facilitation (Paper IV). This was followed by a planning experiment to empirically assess the social learning outcomes and potential decision making benefits that may be generated in SLP. Here, the case study was a participatory SLP process for climate change adaptation in the Greater Community of Gartow in northern Germany (Paper V). Another planning experiment was conducted to investigate the effects of SLP on social learning outcomes among participating graduate students, focusing on changes in conceptual planning understanding and skills. The case study was an intensive educational SLP workshop in the region of Cagliari, Italy (Paper VI). Finally, further light on potential medium- to long-term benefits of social learning outcomes for decision making was shed in the investigation of the evolution of climate change adaptation governance in the Norfolk Broads landscape, UK (Paper VII).

11.1.2 Answers to research questions

Research findings collected in these different study components provide some answers to the key questions underlying this thesis:

Research question A: What mechanisms and criteria of influential SLP outputs can be identified?

Importance of context

The thesis reemphasized the notion that context conditions strongly influence the degree to which SLP outputs come to bear in decision making. Context conditions include the specifics of the issue at stake, the pertinent governance structure, and the capacities and attitudes of relevant actors. For example, the comparison of two SLP case studies Arizona and Pennsylvania (paper II) showed how different characteristics of the environmental issue at stake and different attitudes of local actors towards outside expert advice can affect the degree of planning influence. To yield influence, SLP needs to create or exploit policy windows of opportunity (cf. Kingdon, 1984) in which policy and decision makers are receptive for SLP outputs.

Criteria of influence of scenario-based planning in general

The question thus becomes what determines the degree to which SLP outputs are being considered in decisions in the case that policy windows arise. Based on prior propositions by Clark et al. (2006) and Acalmo et al. (2006), the thesis proposes that outputs of scenario-based planning tend to be influential to the degree that they are perceived as simultaneously credible, salient, legitimate and creative by their audiences (paper I). A qualitative content analysis confirmed and further specified these criteria for application in the field of scenario-based planning: Credibility is here interpreted as relating to plausibility, comprehensiveness and internal consistency. Salience refers to the goal-directedness and relevance of the outputs of scenario-based planning. Legitimacy concerns the consideration and integration of different perspectives and interests. Creativity considers the degree to which outputs challenge assumptions and spur innovative thinking.

Testing and itemization of the criteria of influence in SLP

Application of the criteria in the field of SLP was successfully tested in the evaluation of two completed SLP case studies in Monroe County, Pennsylvania and the Upper San Pedro River Basin, Arizona, USA (paper II). The criteria helped explaining the surprising finding that the Pennsylvania case study, conducted as a semester-long graduate student studio, was more effective on decision making than the Arizona project, a multi-year research effort involving distinct experts in their respective fields. Despite the influence of the contexts in determining SLP influence in both cases, the perceived degree of compliance with the criteria of influence seemed to be also important. In the Arizona study, a number of stakeholders questioned the study's credibility concerning the hydrological model (which may also be a way to justify ignorance). In contrast, the credibility of the Pennsylvania study was minimally contested, maybe due to the publicly understood intention to serve primarily as a 'thought experiment' rather than a detailed research project. Perceived creativity of the planning process and its results seemed to be of great importance for raising the interest among local actors. In Pennsylvania, bold propositions for conservation strategies and the establishment of public transportation systems created attention and seemed to animate audiences to further engage with the study's findings. Although the ideas were not necessarily credible within the near future, they appeared to raise public interest that could later be translated into support for more salient proposals such as measures for the preservation of open space. The Arizona case can also be perceived creative in including scenarios departing from conventional thinking, but did not succeeded in conveying the new ideas to the public. Criticisms of the saliency of the scientific advice arose in Arizona because the study's results were considered too coarse and inflexibly for day-to-day decision making. In contrast, the Pennsylvania Study was perceived by local actors as addressing the relevant questions well.

Some criteria of influence were further itemized for application in the field of SLP, based on insights from the thesis' case studies (Papers II, V, VI). Salience can be seen as relating to the accessibility and flexibility of SLP outputs and the adequacy of the resources needed for their development. Credibility includes considerations of the capacity of the employed models to simulate perceived landscape (change) processes. Creativity relates to the range of issues and interactions considered in the development of system understanding, construction of the scenarios and the impact assessment of their respective alternative futures. The case studies evaluation also found that the perceived levels of the criteria often do not relate exclusively to the outputs of an SLP project, but indirectly also to the process that lead to their creation. This is particularly the case for the legitimacy criterion which always connotes procedural aspects.

Relationships, interactions and dynamics between the criteria of influence in SLP

Experiences made in many of the reviewed case studies (papers II, III, V, VI) resulted in several additional insights concerning the criteria of influence:

First, the perceived compliance with the criteria of influence varied between the different actor groups and participants of a SLP project (papers II, V). Along this line, also the perceptions of involved planners did not always correspond with the evaluations provided by actors (paper VI). This suggests that different kinds of stakeholder needs and perspectives should be taken into account when designing planning processes for reaching high levels of compliance with the criteria.

Second, trade-offs became apparent between attempts to enhance the perceived levels of compliance with the criteria. In particular, efforts to enhance a project's credibility and salience may be add odds with efforts to enhance creativity. While credibility requires SLP outputs to be based on expert-driven and "scientific" assessments, creativity emphasizes the inclusion of unconventional ideas whose credibility cannot be assessed (for example the consideration of surprising events in "wild-card" scenarios). Similarly, salience requires that SLP outputs are relevant for decisions which may be in contrast to constructing creative scenarios that include extreme development options that have little direct decision making implications.

Third, it appears that the criteria may have different levels of relative importance for determining the degree of SLP output influence, depending on differences in context and objective. This trade-off relates to the fact that SLP projects may be conducted for different objectives on a spectrum between immediate decision support and exploration (see introduction). Creativity appears to be of minor importance for SLP projects that exclusively aim at direct decision-support. Vice-versa, credibility may be of less importance in SLP projects that aim at exploring scenarios of extreme developments or surprises. However, based on the experiences in the case studies, this thesis proposes to aim at achieving minimum levels of perceived compliance with the criteria in order for SLP outputs to be considered in decisions. It is argued that without some degree of perceived credibility and salience, even highly creative scenarios may be seen as too extreme to be considered in decisions.

Fourth, the research shed light on the development of relative importance of perceived compliance with the criteria over the process of a SLP project. SLP exercises can combine rather explorative parts in which creativity seems to be of major importance to get people engaged, with processes for the identification of policy options in which the other three criteria gain in importance.

Approaches for enhancing the criteria

The thesis further provided some insights concerning approaches for enhancing the perceived degrees of SLP compliance with the criteria and thus the likelihood of SLP outputs to influence decision making (cf. Paper II, III). Of major importance seemed to be to involve interested and affected actors in the process of SLP from early on, to elicit actors' needs and interests in SLP outputs, and to respond to them in the design and conduct of the SLP process. Needed are special efforts to facilitate communication, to increase mutual understanding, and to foster the reconciliation between the expectations of potential SLP output users and the capacities of the planning team. Participants must have the opportunity to raise concerns and to contribute to adaptations of SLP processes and outcomes in case noncompliance with the criteria is identified.

Many of the assessed case studies suggest that diverse methods for facilitating communication and knowledge exchange should be tested and applied. One approach for enhancing the criteria is that salience is fostered through linking the planning process to existing legal and legislative frameworks and making the results accessible for community-level decision making. Creativity can be significantly enhanced by using inspiring methods and to involve participants with unconventional thinking, for example high school students.

Research question B: How can SLP facilitate social learning that enhances the understanding and skills of relevant actors for informed and cooperative decision making?

Importance of social learning

The review of the literature and the experience from the case studies suggests that social learning outcomes of SLP play an important role in determining its influence on decision making. Social learning outcomes (understood here as enhanced understanding and skills) may directly contribute to decision making, for example if enhanced understanding and skills among decision makers and stakeholders facilitate the cooperative reaching of an informed decision. Social learning outcomes may indirectly influence decision making if they feed back to the context conditions and thus improve (or deteriorate) the conditions for future planning and decision processes. Implementation may be enhanced through better understanding of underlying reasoning and skills for collaboration.

Social learning outcomes can be one of the longest lasting effects of SLP that may transcend a single planning and decision making process and potentially ease (or complicate) subsequent implementation efforts. However, the research reported in this thesis also pointed to a range of challenges: First, generated social learning outcomes may dissolve over time, thus limiting the time frame within which social learning outcomes can have an influence on decisions. Second, social learning in SLP occurs primarily among the participants whose number is limited, given the necessity for interactions in small groups. Third, representatives of relevant institutions who participate in the SLP processes must not necessarily be the ones that finally make the decisions. If this is the case, the influence of social learning outcomes on decision making also depends on the degree to which SLP participants can instruct the respective decision makers.

Recent SLP projects' fulfillment of social learning facilitation requirements

Recent SLP projects do not explicitly strive for facilitating social learning (paper IV). Requirements of social learning facilitation, as proposed in the relevant literature, are only rudimentary fulfilled. Insights from all case studies suggests that social learning may nevertheless have taken place when planning participants had repeatedly come together in small groups to jointly discuss the issues under consideration and to plan collaboratively. However, the lack of specific consideration and efforts for nurturing social learning may have left valuable opportunities for social learning unexploited.

Capacities of SLP to generate social learning outcomes

Research conducted as part of this thesis resulted in empirical findings of social learning outcomes that were generated among participants of three SLP processes. The first study (Paper V) evaluated a climate adaptation planning process with up to 37 local actors. Here, observed social learning outcomes include gains in substantive knowledge (e.g. on potential climate changes and associated impacts on future landscape change), procedural knowledge (e.g. on alternative adaptation strategies), social-relational knowledge (e.g. about different concerns and interests of participants), as well as social and technical skills for communication, collaborative planning and decision making. The second study (Paper VI) investigated possible effects of an educational SLP workshop on social learning outcomes among 30 participating graduate students, focusing on changes in conceptual planning understanding and skills. The results suggested that SLP workshops can enhance students' planning understanding and improve relevant skills with differences in the acquisition of sub-aspects. A third study (Paper VII) illustrated that the exchange of knowledge between actors from different disciplines and spatial levels in participatory planning processes can facilitate social learning.

Identified benefits of social learning outcomes for decision making

Insights concerning potential benefits of generated social learning outcomes for subsequent decision making were gained in two case studies of this thesis.

Participants of the SLP process on climate change adaptation suggested several potential impacts of the generated learning on their future decision making (Paper V), including enhanced awareness,

altered agendas, and better social relations. Participants also explained that knowledge and skills gained would not only make informed decisions, but also relevant follow-up activities such as additional research on impacts and more collaborative planning more likely. In fact, the SLP process and its results formed the basis and inducement for further collaboration of local actors and external consultants in the development of a coordinated mission statement (*Leitbild*) for climate change adaptation. The *Leitbild* was unanimously decided for by the Gartow Community Council and shall now be used as a guiding framework for future decision making concerning landscape development.

Medium- to long-term influences of social learning outcomes on decision making were elicited in paper VII. It showed that social learning outcomes may lead decision makers to more strongly integrate participatory approaches in subsequent planning processes and to establish an intermediary organization as a platform for regional governance. These measures helped to enhance the salience of subsequent assessments and to mainstream climate change adaptation in regional planning policy.

Approaches for facilitating social learning in SLP

Insights concerning useful approaches for facilitating social learning in SLP were primarily gained in the development, testing, and evaluation of a framework for participatory SLP in two planning experiments (Papers V and VI). The methods employed in both case studies are in themselves not new, but the combination of participatory SLP, an explicit focus on social learning facilitation, and comprehensive accompanying evaluation research was innovative. The main aspect for facilitating social learning seems to be to actively engage participants in each step of the SLP process. A framework for participatory SLP was developed that is based on the classic Steinitz Model for Alternative Futures Studies but stronger emphasizes the establishment of social learning platforms where diverse actors can meet, elicit and reflect upon perspectives, co-generate knowledge, and further develop skills. The framework adds additional planning steps for (a) collaborative framing of the scope, objective, design and conduct SLP processes, (b) iterative exploration of the impacts of different combinations of drivers external and internal to the decision space of local actors, and (c) to jointly discuss findings, implications for further management, and pathways for implementation. Given the complexity and difference between cases of application, the framework is meant as conceptual guidance for landscape planners and planning participants interested in the dual goals of producing high quality planning products and facilitating social learning.

A number of features of participatory SLP were identified that are particularly important for facilitating social learning: Working in small groups allowed for close cooperation and to elicit, explain, discuss, and reflect upon different perspectives. Iterative planning helped learning from the revision of prior propositions. Using different methods was supportive for keeping the planning process interesting and engaging. Providing clear objectives for each working step that could be reached within relatively short periods of time gave participants responsibility and lead to satisfaction concerning results. Facilitation was important to keep discussions focused, to stay on time, and to balance differences in power and capacities. Diversity helped in discussing issues from different perspectives. Requesting participants to change perspectives multiple times during the planning process seemed to significantly contribute to their understanding of different standpoints and interests. Developing proposals as synergies of ideas from various teams helped to consider other ways of thinking. The future perspective seemed to ease collaboration between experts and non-experts, since the inherent uncertainty of future development (nobody really knows how the future will develop anyway) lowered the barriers for non-experts to become involved. It also fostered innovative, unconventional thinking because new ideas could be proposed and tested without immediate reflection of its plausibility under current conditions. However, some participants had difficulties in engaging in speculation and were hesitant to get involved.

If landscape planners aim to serve as social learning facilitators, they must balance two equally important roles: Being a teacher of relevant information, and serving as boundary manager between participants from different backgrounds. Planners seem to be well equipped to serve as such facilitators in the early stages of a SLP project. Planners are trained to synthesize knowledge from different

fields and often experienced in employing participatory methods and moderating collaborations. At later project stages however, when the emphasis of planning turns to the elaboration of conflicts and the search for potential consensual solutions, it is advisable to involve independent moderators that are less likely to be perceived as biased to a particular perspective.

Involving participants in SLP processes raises some significant challenges, among others constraints of temporal, financial and personal resources. For example, little funding is often available, sometimes decisions need to be made fast, and most often decision makers and stakeholders cannot afford to allocate much time to attend participatory sessions. In one of the thesis' case studies, the planning process originally conceptualized for three full days needed to be reduced to three four-hour evening workshops in order to provide important actors a chance to participate.

It must be noted that social learning must not be beneficial for landscape planning in all cases. Social learning in SLP poses the risks that some participants use the planning workshops as forums to push through individual agendas. Avoiding this requires particular attention among the planners and moderators to balance interests.

11.2 Discussion

Findings

The thesis resulted in several innovative contributions to the field of landscape planning. It

- presents the first study – to the knowledge of the author – that explicitly focuses on the influence of SLP in decision making concerning sustainable landscape development,
- merges previously little connected insights from various related research fields, in particular science-policy studies, social learning, scenario construction and assessment, and landscape planning.
- proposes – based on insights from other fields – criteria of influence of SLP outputs on decision making and potential approaches for enhancing compliance with the criteria (Paper I, II, III),
- develops empirical insights on the influence of SLP projects on decision making (Paper II, III, V, VI).
- identifies requirements for facilitating social learning in SLP and assesses recently completed SLP case studies concerning fulfillment of the requirements (Paper IV)
- proposes a revised framework for participatory SLP and tests it in a case study on climate change adaptation (Paper V,)
- assesses of SLP-induced social learning effects and related benefits for decision making action research in two case studies (Paper V, VI)
- develops insights concerning longer-term effects of social learning on decision making (Paper VII),
- and provides recommendations for future applications (Synthesis Chapter).

Methods and results of qualitative case study research

The case study methods proved very useful for examining SLP influences on decision making in their particular context. Results in all but one paper included in this thesis draw on insights from either one or multiple qualitative case studies. According to Yin (2003), the reliability and validity of results from case study research depends on the adherence to three key quality criteria:

To ensure construct validity, the papers in this thesis used as many data sources as possible, including document analyses, interviews, observations, surveys, and focus groups. Data interpretation was guided by theory-based propositions and hypotheses.

Internal validity of the results were difficult to achieve, since it is not easy to track the influences of a planning process on perceived levels of compliance with criteria, on decision making, or on social learning. Inferences needed to be made based on statements, observations and documented results.

Various potential sources of error exist, including the influences from factors external to the planning process, the limited number of interviews that can possibly be conducted, the reliance on statements of interviewees and observations which may be biased, and the need for interpretation of the interview data by the author. Triangulation of data from different approaches was performed to further ensure internal validity. Some papers included additional measures for enhancing internal validity: In the assessment of the influences of SLP outcomes on decisions (Paper II), interviewees were asked for a review of the draft results. The Gartow case study (Paper V) used a focus group discussion to test the interpretations made by the research team. In the Cagliari case study (Paper VI), the relatively large total participant cohort, the use of triangulation methods, and the – for most surveys – high response rate make the authors confident about the outcomes.

External validity or generalization of the data is also difficult to achieve in case study research. Findings from the case studies must be interpreted within their respective context conditions. If these conditions are altered, the results will probably differ as well. Cross-case comparisons are an important approach to merging insights form different case studies to enhance the generalizability of the findings. In this thesis, many papers (II, III, IV) and this synthesis chapter in particular draw on insights from such comparisons across different case studies in an effort to enhance generalizability. Transferability of the results is however not possible without restrictions. SLP influences will always be strongly context dependent (governance system, legal structure, etc.) and even the planning process itself will vary significant depending on the issues considered, the actors involved, their prior experiences with planning, the data and resources availability etc. The suggestions and propositions made in this thesis are therefore not meant as a blueprint method, but rather as principles and guidelines to consider in SLP design and conduct with relevance in different context conditions alike. The empirical findings on SLP influence are limited because only a relatively small number of cases could be thoroughly assessed. Also, all case studies addressed planning efforts processes in democratic countries – the findings can therefore not be simply translated to other governance systems. To enhance generalizability of the empirical findings of SLP influence on decision making and social learning, more research is needed that cuts across a greater number of case studies and a range of different context conditions.

Methods and results of action research

Employing action research approaches in two case studies (papers V, VI) to assess the effect of SLP on social learning proved useful and yielded interesting insights. Ensuring rigor in action research refers to the processes of data collection and analysis, and the way events are questioned and interpreted. Therefore, this thesis placed particular emphasis on demonstrating the use of action research cycles and access of multiple data sources, and how conclusions drawn are supported by the development of theory or usable knowledge (Coghlan and Brannick, 2001). Due to the difficulty of detecting changes of understanding and knowledge among participants, it proved useful to employ mixed method approaches to acquire evaluation data and to use triangulation to identify common patterns and differences.

Methods and results of applying the framework for participatory SLP

The dissertation explicitly focuses on conceptual and procedural approaches for enhancing the influence of SLP in decision making. Due to constraints in resources and the time available among local decision makers and experts to participate, the conducted planning experiments could only employ qualitative approaches and necessarily needed to refrain from employing computer-based simulations of alternative futures and quantitative assessments of their respective consequences. The reported planning processes therefore reflect only a part of real-world planning projects. However, the insights gained in the experiments nevertheless provide important insights on the effects of participatory SLP on decision making and social learning, an aspect that has so far not been explicitly addressed in research.

The application of the framework for participatory SLP, a revised version of Steinitz' Alternative Futures model, was effective in facilitating social learning among participants. Implementing the

framework in the two planning experiments however faced significant limitations in time and resources: The participating experts and decision makers could only afford to attend few meetings and devote little time for collaborative work. The projects' overall duration was too short for conducing multiple, iterative planning cycles, taking steps for backcasting, crafting strategies for future landscape development, and discussing barriers and bridges for adaptive governance. The resource constraints also lead to the missing of computer-based spatial simulations and numerical modeling, thus limiting the availability of quantitative information in the discussions. A major shortcoming also seemed to be that it was not specified how exactly the results of the participatory process should be used in subsequent decision making.

The production of substantive information in SLP was not the focus of this thesis, but evolved as a "by-product" of the planning experiments in both the Cagliari and Gartow case studies (papers IV and V). The substantive SLP outputs were created in qualitative, stakeholder-driven assessments. As such, they did not involve comprehensive analyses, computer-aided modeling, or the complete integration of all available scientific knowledge. The Cagliari planning process resulted primarily in six alternative futures for the future development of the region, reported in detail in Steinitz et al. (2010). The Gartow case study considered regional climate change challenges and adaptation opportunities for the next 50 years. Together with an ongoing research project on in the Greater Everglades Ecosystems conducted at the Massachusetts Institute of Technology (MUSIC, 2010), this thesis presents one of the first applications of the Steinitz framework on the subject of climate change adaptation planning. The case study included explorations of risks and opportunities, the development of adaptation scenarios and alternative futures, assessments of their respective consequences, and discussions of implications for further planning and decision making. The substantive results are described in Albert et al. (accepted).

The direct influence of the generated SLP outputs on decision making were relatively little. Stakeholders acknowledge the qualitative and preliminary nature of the results. They were not interpreted as precise information to base decisions on, but rather as a first indication of potential tendencies and trends. In the Gartow case however, the planning processes succeeded in raising the interest and awareness of local actors. Here, planning participants perceived the SLP results as interesting and relevant for their work. Local decision makers supported the conduct of more detailed assessments and planning that culminated in the development of a strategic vision (*Leitbild*) for climate adaptation of land use and settlement development in the region.

Benefits of merging insights from different scientific fields

The research reported in this thesis merged insights and concepts from several disciplines and fields of research, in particular landscape planning, science-policy studies, and social learning. Bringing ideas from these different areas together was helpful and instructive to address the key research questions. In particular, the following mutual benefits were identified:

Landscape planning can benefit from social learning in the explicit focus on the generation of learning outcomes as an additional objective to the development of planning outputs, and a greater consideration of requirements for learning facilitation. The focus on social learning also puts landscape planning within the broader framework of regional governance of landscape change. In this context, landscape planning not only provides information but also contributes to the generation of relevant knowledge and skills that transcend a single planning process, thus enhancing the likelihood for continued adaptive planning and implementation.

Research on social learning may benefit from several experiences and insights in the field of landscape planning, in particular the explicit focus on implementation within given legal frameworks, the provision of concrete, spatially explicit results, and a range of available methods and tools for participatory planning.

Landscape planning benefits from insights and concepts of sustainability science, post-normal science and related fields in drawing on theories, propositions and explanatory models developed across

various disciplines for how science and planning most successfully could provide knowledge and support for decision making.

Landscape planning may contribute to these disciplines in particular through providing insights of participatory planning at the interface between science and practice, in the development of place-specific, spatially-explicit assessments, the orientation towards implementation and information needs for different users.

11.3 Conclusions

The papers show that the participation of interested and affected actors in SLP can enhance the likelihood of SLP influence on decision making if certain criteria and requirements of the planning process and its outputs are met. If participation of relevant actors succeeds in enhancing the perceived levels of compliance with the identified criteria of SLP influence, the likelihood of SLP outputs to be considered in decision making increases. If participation fulfills specific requirements, it may facilitate social learning that enhances the capacities of relevant actors for informed and collective decision making.

Both strategies for enhancing SLP influence – either through improving perceived SLP output quality or through facilitating social learning – are of importance. The strategies can effectively complement each other, in particular when pursued in consecutive SLP cycles that first emphasize social learning facilitation and later focus on developing SLP outputs as direct basis for decision making. In the beginning, more explorative approaches should be used to initiate and facilitate social learning among participants. Qualitative and intuitive scenario construction are useful in this step that support raising interest, enhancing understanding, and developing skills and confidence for collaboratively working with scenarios among participants. Later on, SLP cycles with more direct decision-relevant assessments should be conducted that can build upon the understanding and skills developed in prior cycles, and that can focus on specific issues identified as particularly relevant. These planning cycles address issues in greater detail and put more emphasis on computer-aided modeling and quantitative assessments.

However, implementing the two strategies may also be confrontational when pursued simultaneously. SLP projects with high levels of perceived compliance with the criteria of influence on decisions may be little effective in facilitating social learning, for example if they fail to elicit and reflect upon different perspectives or to facilitate the development of skills for collaboration among relevant actors. Vice-versa, SLP projects that successfully generate social learning outcomes may sometimes provide little insight for immediate decision making, for example if they considered only extreme scenarios.

11.3.1 Major limitations of conventional applications of SLP

As noted throughout this thesis, influence of SLP projects on decision making around sustainable landscape development is always strongly dependent on suitable context conditions and policy windows of opportunity. Unsuitable external factors (such as dominating economic interests, political agendas and media attention focusing on other issues, legal structures for potentially implementing recommendations from SLP) significantly limit the degree to which SLP projects can have the chance to yield influence. This thesis therefore focused on the question of how SLP processes can be designed and conducted to be most likely to be considered in decisions in case suitable context conditions arise.

Although applications of SLP differ significantly in context, design, and conduct, some general shortcomings of many conventional SLP project for yielding influence on decisions can be identified. Shortcomings of conventional SLP to result in outcomes with a high likelihood of influencing decision making may include:

- insufficient efforts to assess the specific context conditions and to design the SLP process to best overcome identified challenges and exploit potential opportunities,

- insufficient efforts to elicit the needs and interests of potential user groups and to adhere to them in the design and conduct of SLP, and
- insufficient involvement of relevant actors in the different steps of SLP, thus limiting the chances for contributions of relevant (tacit) knowledge, reviews of outcomes, and opportunities for improving the perceived degrees of compliance with the criteria of influential SLP.

Concerning the effectiveness of SLP to facilitate social learning with benefits for decision making, conventional SLP projects often show the following limitations:

- Insufficient involvement of interested and affected actors in collaborative planning processes that adhere to requirements of social learning facilitation,
- insufficient efforts to convey the complexity and predictive uncertainties in exploring potential future developments of the of the coupled and adaptive social-ecological systems underlying and transcending landscapes,
- insufficient deliberation of the implications of results and uncertainties for decision making, and of efforts needed for implementation, and
- too little framing of the SLP process as part of the longer-term governance processes required for navigating transitions towards sustainable landscape development.

In general, it must of course be noted that improving the two aspects is not easy since more active and systematic involvement of interested and affected actors will require additional time and resources that are not always available. Also, projects should clarify the purposes of the SLP exercise, and define at which planning phase either social learning or direct influence of outputs on decision making are more important.

11.3.2 A framework for SLP

Framework steps

A framework for SLP was developed to enhance the likelihood of SLP to influence decision making. The approach builds upon the Alternative Futures Framework as developed by Steinitz (1990, 1993, 2003) but stronger emphasizes the involvement of interested and affected actors in each step of the planning process as well as the establishment of social learning platforms. To do so, the developed framework proposes some additional planning steps as well as participatory implementation methods. The framework is not meant as a blueprint for all studies, but rather as a list of essential issues that should be considered. It is also important to note that the goal is not to conduct the whole process together will all participants, but to involve relevant actors at least once in each framework step and to attempt to appropriately balance expert-lead assessments and participatory methods. In some cases however, participation approaches may even be also inappropriate, for example if fast decisions are needed to prevent a major disaster.

As the Steinitz approach, the proposed SLP process consists of a series of steps that should be passed through several times. This iterative implementation is crucial in that it allows pursuing both strategies for enhancing SLP influence – either through improving perceived SLP output quality or through facilitating social learning. Within consecutive planning cycles, SLP may first emphasize social learning facilitation and later focus on developing SLP outputs as direct basis for decision making. In this way, the two strategies can effectively complement each other, thus overcoming the problem that the two strategies may be confrontational when pursued simultaneously.

Each planning cycles consists of all or some of the following steps (table 1):

Table 1: A framework for SLP

FRAMEWORK STEPS	CONTENT	CONTRIBUTIONS TO SOCIAL LEARNING
Context analysis	- What are the issues and problems around sustainable development in the respective landscape? - What is the pertinent governance and implementation context? - Who are the interested and affected stakeholders, and what are their interests, information needs and capacities?	
FRAMING	- What is the problem, objective, scope, design, methods, and expected result of the exercise? - How shall the particular contextual challenges identified in the context analysis be addressed and responded to? - What are the prime objectives of each step of the planning process, in particular if either providing information for decision making or facilitating social learning should receive greatest emphasis? - How should the SLP process contribute to decision making, which timing should be followed in relation to options for decision making, and how decisions shall be implemented in the context of existing legal frameworks? - What are the process design, methods and tools to employ? - What is the role of participation in SLP – for what purpose, with what kinds of methods, with what degree of participants' influence on decision making? - How shall contributions of participants be incorporated in the development of SLP outputs? - Who should be a member of the scenario panel to form an appropriately diverse group of representatives of interested and affected actors that will be involved in each step of the SLP process? - How and at which point should additional actors be involved?	- Reconciliations between scenario process leaders, participants, and audiences
REPRESENTATION MODELS - How should the landscape be described?	- Which aspects of landscape functioning and change are important?	- Integrating tacit and formal knowledge
PROCESS MODELS - How does the landscape operate?	- How can the complex and adaptive interactions among the social, economic and ecological systems and dynamics at other scales be understood and modeled? - What do the complexity of these interactions as well as resulting predictive uncertainties mean for the results of the SLP process and their implications for decision making?	- Integrating tacit and formal knowledge Developing syst. understanding - Recognize complexity - Eliciting mental models

FRAMEWORK STEPS	CONTENT	CONTRIBUTIONS TO SOCIAL LEARNING
EVALUATION MODELS - Is the current landscape working well?	- How do different actors value aspects of the landscape? - What are issues of particular importance?	- Eliciting different perspectives on current and emerging issues
CHANGE MODELS - How might the landscape change?	- Which are the most important drivers? - How can they be compiled into scenarios? - Which number of scenarios is appropriate? - How can the scenarios best capture the interests of relevant actors?	- Identifying and describing different future pathways
IMPACT MODELS - What predictable differences might the changes cause?	- What are the implications of uncertainties in the assessment?	- Reflecting upon different future developments or preferred futures in the light of potential consequences
ELABORATION AND DISCUSSION	- What do the findings mean for decision making? - What further steps are needed for making progress in supporting sustainable landscape development? - What are areas of conflict and consensus for decision making? - What are barriers and bridges for implementation? - What should be done next? - Can the findings serve as a basis for developing a mission statement (*Leitbild*) for preferred future landscape development? - What would be necessary measures for implementation of this *Leitbild*? - What are strategies for implementation? - How can processes for monitoring change, evaluating results, and adaptive governance be implemented?	- Developing a basis for continued collaborative planning and implementation
DECISSION MODELS - How should the landscape be changed?	-	

Based on Steinitz (1990, 1993, 2003), amended.

Approaches for implementing the SLP framework with participatory approaches

From a perspective of integrating participatory approaches, several recommendations can be made for implementing the framework:

- to publicly invite interested and affected actors to be involved in the planning process. However, the number of individuals participating in each SLP session need to be limited to allow for intensive and meaningful collaboration.
- to ensure adequate funding and administrative support for the participation of actors in each step of the SLP planning process.
- to employ deliberation methods to define the core problem and to decide about the framing of the SLP project in close collaboration with the scenario panel, in particular concerning the objectives of the SLP process, the purposes of participation, appropriate meeting locations, the specific SLP steps to be taken, methods and tools to apply in each working step, and "game-rules" for interaction and collaboration.
- to aim at differentiating between facts, assumptions, and values in the assessment of scenario outputs. Jointly assess the implications of SLP outputs and the inherent uncertainties for decision making. Differentiate between findings with high degrees of confidence, assumptions, and values attached to different aspects.
- to iterate between the steps of scenario construction, modeling and impact assessment to consider both the impacts of external drivers (for example national economic crises), and interactions of local policy changes in combination with particular developments of external drivers.
- to employ (spatial-) backcasting methods for exploring necessary measures for implementation of preferred alternative futures.
- to implement accompanying evaluation research to track the effectiveness of the SLP process (see recommendations below), and to alter SLP objectives, process design and methods in case justified.

Procedures for enhancing SLP output influence on decision making

Some recommendations can be made for enhancing the likelihood of SLP outputs to be considered in decision making:

- to conduct context and stakeholder analyses and to elicit the needs of different user groups before the start of the actual planning process, and to design the SLP process in response to identified requirements, challenges, and opportunities
- to strategically consider the different stages of the SLP process, their respective objectives, and the relative importance of the identified criteria of influence in each of them and for different actor groups.
- to explicitly aim at achieving perceived compliance with identified criteria of influence. (1) To enhance credibility, to be as specific as possible about objectives, methods to employ, and to ensure reviews of SLP methods and results by external experts and/or interested and affected actors. Provide transparency of the SLP process, the employed methods and the outputs created as well as important assumptions and uncertainties in findings. (2) To enhance salience, conduct the SLP process specifically adapted to the main problem identified, explicitly responding to user needs, and with a continuous orientation towards implementation. Link the SLP process to existing legal frameworks and clearly state how SLP outputs shall be used in subsequent decision making. Ensure iterative improvement of SLP outputs so that they can be adapted to new information. (3) To enhance legitimacy, invite a broad range of decision makers, stakeholders and experts to participate in SLP, and to set up an appropriately diverse panel of representatives from interested and af-

fected parties to be involved at each step of the SLP process. Be as specific as possible about expected outputs as well as opportunities for input and co-decision making by local actors. Also, jointly decide about appropriate planning methods and decision making procedures that allow for relevant perspectives to be considered. (4) To enhance creativity, employ methods that promote unconventional thinking, and involve local actors that can provide new ideas (e.g. students and artists).

Procedures for facilitating social learning in SLP

Some procedures for enhancing the facilitation of social learning in SLP are suggested, including:

- to ensure a useful composition of the SLP panel. Panel members should also be responsible for subsequent implementation so that individuals that gain understanding and skills in social learning are also the ones responsible for decision making. Furhtermore, continuity of participants should be strived for to ensure that they can build opon prior experiences.
- to design the SLP process in ways that provide ample opportunities for involvement and interaction of participants in each step of the planning process
- to choose participatory methods for SLP that are appropriate for fulfilling the requirements for SL facilitation, in particular recognizing actors' goals and perspectives, making explicit underlying values, eliciting and reflecting upon mental models, co-generating knowledge, as well as practicing relevant skills for collaborative planning and adaptive implementation. Useful approaches include collaborative planning in small groups, using diagrams and maps for making explicit different perspectives, as tools for concrete discussion and for fostering mutual understanding, crafting results that participants are satisfied with, balance opportunities for formal and informal interactions among participants (much social learning is happening in informal situations).
- to strategically consider and assign the persons responsible for facilitating and moderating the participatory SLP processes. Planners are well suited as facilitators in that they can build on experiences in serving at the science-practice interface and working towards implementation. However, additional training in learning facilitation may be supportive, for example to enhance awareness of requirements for social learning, knowledge of available methods for social learning facilitation, and to train skills for applying these methods. In later stages of preparing policy options for decision making, independent moderators may be more effective.
- to improve participants' understanding of SLP outputs and decision options in the broader framework of the complex and uncertain interactions driving landscape change.
- to convey approaches for navigating landscape change towards more sustainable development: communicating the uncertainties in the assessment of policy options and their consequences, the importance of contious monitoring, the evaluation of carefully selected indicators, and adaptive governance. Surprising developments may happen, and local actors should be best equipped to deal with unexpected developments and to respond to them.

Recommendations for conducting accompanying process evaluations

Using action research to evaluate the effects of SLP in real-world situations was instructive for enhancing understanding of SLP influence on decision making. It is also is recommended for future applications as a way to monitor and improve the influence of planning projects. Drawing on the experiences form the case studies, useful aspects to consider in future application are:

- to assess the levels of relevant understanding, skills, and compliance with the criteria of influence at several points of the SLP process. An assessment before the start of the SLP process is needed to serve as the basis for comparison and evaluation. Assessments conducted while the planning process may help to track progress and to identifying potential shortcomings that could be ad-

dressed. Assessments at certain points after completion of the SLP process reflect its short-, medium-, or long-term impacts.

- to employ appropriate methods and to allocate sufficient time for assessing changes. Qualitative assessments may provide more contextual detail, but require more time for collecting and interpreting data. Semi-quantitative assessments via surveys and ordinal scale may be more useful for application in practice in that they require less time to conduct and evaluate.
- to use the results from the SLP process evaluation to alter objectives and processes if needed to overcome identified problems or shortcomings.

11.3.3 Issues for further research

This thesis has shown that focusing on the influence of scenario-based approaches adds an important perspective to landscape planning scholarship and practice. It resulted in various contributions to the understanding of and approaches for fostering the quality of SLP to better influence decision making and facilitate social learning. However, both aspects still offer possibilities for further research.

To test and possible enhance the generalizability of the findings, more participatory SLP case studies should be evaluated concerning the relationships between the collaborative planning methods used, the perceived values of the suggested quality criteria, the influence on decision making, and the effectiveness and benefits of social learning facilitation. The case study research may be retrospective, using document analyses and in-depth interviews with participants of completed SLP projects. Accompanying evaluations of ongoing projects will be supportive for attaining greater understanding of processes and incidents that enhance or diminish perceived criteria value and the facilitation of social learning.

In particular, it would be interesting to assess participatory planning processes that take place over long time spans. Longer planning processes with a greater number of meetings promise to be more effective in facilitating social learning. As paper VI has shown, short-term planning processes may be supportive for facilitating knowledge and skills, but yield only limited effects on the more deeply rooted issues of trust and social relationships. Longer planning processes however pose the risks that participants may lose motivation to participate. More realistic planning processes would present a greater need for change and a clearer objective and time window in which decisions would have to be made. Such projects would also need to have a better idea of how the results developed in the participatory process would actually be considered in the politically legitimated decision making process. Evaluating the perceived quality criteria value and social learning effectiveness under such conditions is expected to yield results particularly relevant for practice.

Finally, and most importantly, more research is needed on approaches for usefully combining the herein successfully tested qualitative methods of participatory SLP with GIS-based, expert-driven simulations of alternative futures and quantitative impact assessments. The tested methods for qualitative scenario development and hand-drawn alternative futures enhanced awareness and initiated social learning – yet, quantitative data generated according to scientific standards is needed if the planning results are to be used as justifications for making decisions about important issues such as zoning, conservation, and the direction of development.

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