2015

European Land use Institute (ELI)

Profile

Research and Development Strategy

ELI
EUROPEAN LAND-USE INSTITUTE

Global LAND Project

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European Land use Institute - Profile

Content

A – General guidelines

A.1 Introduction

The uppermost aim of European Land use Institute (ELI) is to build a sustainable and long lasting partnership in research, development, and capacity development in integrated land use. Our motivation is to bring together excellent R&D partners that are dealing with land use, land management and landscape planning covering research in agriculture, forestry, water management and urban systems from ecological, economic, political and technical point of view. Therefore, we decided to set up our cooperation in form of a virtual institute, where complementary thematic areas are identified which support connecting best the competences of our ELI partners.
ELI became an independent multilateral cooperation platform that started 2011/12 funded through the German Federal Ministry for Education and Research (BMBF) and continues now based on a collaboration agreement and in-kind contributions of the partners. Beyond, ELI maintains the partnership and its services on the basis of mutual collaboration projects and partially based on conferences. We are European Nodal Office of the Global Land Project (GLP) with a thematic focus on land management, land use planning and land use policies. We cooperate with the International Association of Landscape Ecology (IALE), International Union of Forest Research Organizations (IUFRO), Ecosystem Service Partnership (ESP) and German Alliance for Agricultural Research (DAFA). Fig. 1 shows the thematic structure of ELI.

Focus of our cooperation is to develop approaches how to further evolve interdisciplinary research in integrated land use, and to provide a platform for exchange and learning from other disciplines and for mutual support in project and publication activities. So far, 81 partner institutions from 24 countries signed the ELI cooperation agreement, which structures cooperation, integration and contribution of each partner.

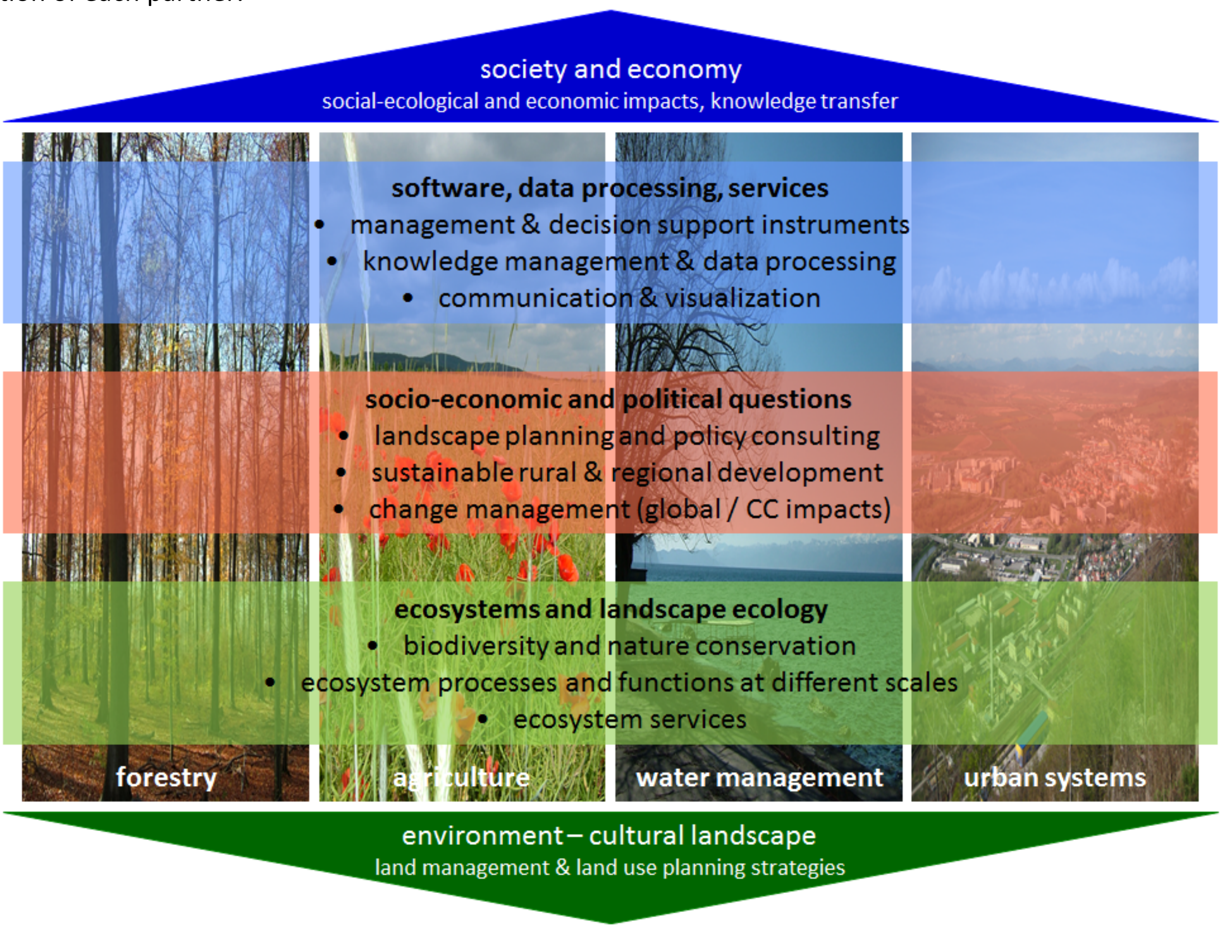


Fig. 1 Thematic cooperation matrix of ELI.

The ELI structure includes two member bodies, the Member Council and the Scientific Steering Board chaired by the ELI coordinator. The Member Council is the decision making body in ELI considering all fundamental collaboration aspects, such as structure, cooperation form and further development of the institute. The Scientific Steering Board is formed by elected ELI members who stand each for a specific ELI chapter (see Fig. 1). They are responsible for profiling the ELI chapters and providing a synthesis of research state of art and needs and for deciding upon current and future focus topics within ELI. The coordinator is responsible for integrating the chapter syntheses and develop the overall profile of ELI. Fig. 2 provides an overview on the organizational structure.

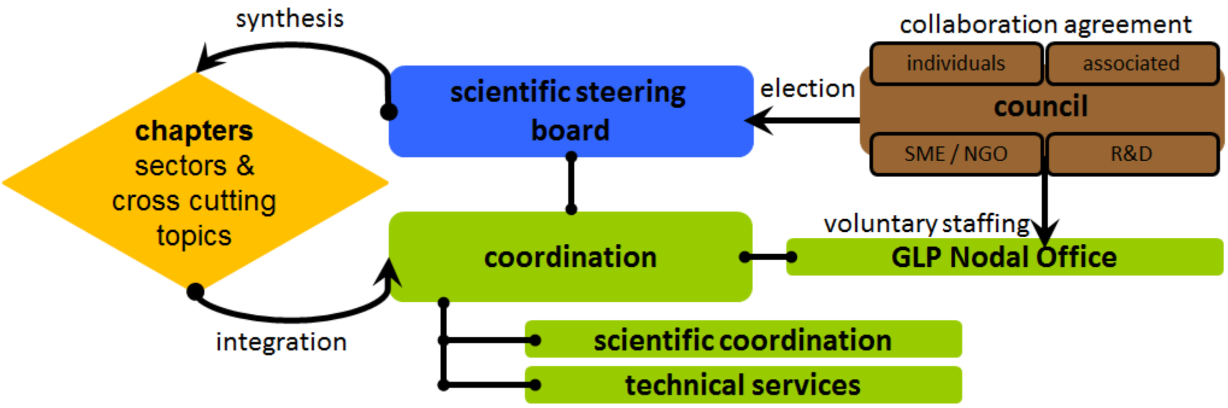


Fig. 2 Organizational structure of ELI.

ELI members can represent research or education institutions, SME, NGOs or can be or individual members. Members from outside Europe are associated members with full rights and access to all ELI services and full eligibility for the Scientific Board.

A central motivation of ELI is to create an added value for ELI members by bundling our forces and thereby being able to provide unique support and services. Services for ELI members, which we already established in a fruitful discussion and development process, are, for instance, an interactive partner data base which holds the partner profile and partner information and supports easy identification and selection of appropriate partners for projects or publication activities and enables also an automatic upload of all available partner information as basis for collaboration activities.

A.2 Why ELI – state of art and challenges in integrated land use research

Land system research is a multidisciplinary field that was faced since ever with a high and continuously increasing level of complexity. A well-known reason for an increase in the complexity is the dynamic nature of environmental parameters (climate, site conditions, etc.), which leads to large uncertainties in predicting their development and mutual interferences (i.e. ecosystem responses on climate change). Also, even though most environmental data are officially available from monitoring or public data bases, access is often difficult and accessible data are highly heterogeneous regarding their reference scale (temporal / spatial) and assessment purpose (ecosystem processes monitoring ⇔ socio-ecological systems parameter assessment). Related is the question of the selection and interpretation of suitable criteria and indicators which enable, for instance, an integrated assessment of the multiple processes and their effects on sustainability or – more concrete – provision of ecosystem services. There is an excessive number and variety of indicators to assess the impact of human activities on the environment at different scales – which impedes the interpretation and harmonization of indicator-based approaches and limits their usefulness in supporting land management and land use planning decisions.

Furthermore, multiple stakeholders with often conflicting interests are addressed and wish to participate in management and planning decisions. Policy making and decision processes happen at macro to micro scale and have to consider that actors might argue with different macro- or microeconomic point of view. Cross-sectoral policy making processes in agriculture and forestry as requested in realizing the renewable energy provision targets in Europe might serve as an example. In a society characterized by globalization effects, interactions between agencies and institutions at an international level impact additionally such processes at regional and local scale. Increasing demands from a public that is scrutinizing regional planning and land management decisions and their effects on environmental conditions and ecosystem services add additional complexity.

Researchers and practitioners in land management and land use planning are being confronted not only with an increasing number of demands, rules, regulations and directives but also with an increasing diversity and detailedness in knowledge: processes in single ecosystems might trigger large scale processes at global scale, taking Carbon sequestration and Climate Change as an example. Other processes or target variables such as species diversity might be dependent from the quality of single habitats, but also of their spatial context at landscape scale. Forest and agricultural land use models refer mostly to the micro scale and neglect the impact of different spatial constellations of the land use types and of their mutual impact, which – however – might be critical aspects for a proper understanding and assessment of ecological processes and functions. Also, only few models are compatible in their temporal and spatial resolution, an aspect which complicates, for instance, the impact assessment of land use changes if several models and model types are used in parallel.

Such complexity makes it difficult to simply answer the question which knowledge base or rule to apply and whose demands to consider primarily at different interdependent spatial scale levels. An example therefore is spatial planning, which addresses explicitly different scale levels in decision making and knowledge integration. Regional planers face the problem to bring together land management knowledge (micro scale) and needs of society. They should integrate both in estimating regional (meso – macro scale) potentials to provide requested resources and services while respecting at the same time land tenure aspects.

Another example –for the complexity to integrate different time scales - is forest management planning with its division into strategic (long term = at least one rotation period) planning, tactical (mid-term = up to 30 years) planning and operational (short term = up to 10 years) planning. Strategic planning in forestry must necessarily respect development, resource provision or protection targets from politics and society. Once a strategic decision such as conversion of coniferous into deciduous forest stands is made, tactical and operational planning are forced to translate this decision into concrete planning measures and operations. In case, a strategic decision must be revised due to new, complementary or competing regulations, managing the tree species composition and stand structure according to a new strategy is difficult or its adaptation takes at least several decades.

In conclusion, research on land systems and integrated land use requires bringing together knowledge and methodological approaches from different land use sectors, such as agriculture, forestry, water management, urban, commerce and industrial systems to ensure a holistic point of view. This comprises harmonization and integration of different datasets, standardization of indicator selection, consensus on the reference scale, and development of approaches or systems that support integration of qualitative and quantitative knowledge.

A.3 Our vision for the future

Bundling excellent partners in a virtual institute is only the first step on ELI´s way to become a leading and independent body in integrated land use. Our vision for the future is to form a multinational excellence center for integrated land use R&D, bundling sectorial knowledge and cross-cutting issues to a whole which is – as a result of its integrated approach - much more than the sum of its parts. Therefore, we formulated objectives for the three future pillars of ELI´s research, scientific and technological advances and capacity development. These will guide us through the next years and support us to make our thematic cooperation more focused on upcoming topics and needs.

Research areas that we will address comprise:

1. Improved knowledge integration:

A. *Integrative research:* how to develop model for highly "integrative research" that allows for inter- and transdisciplinary co-production of knowledge and co-development of capacities in integrated land use?
Integration of land management aspects in upper decision scales: which approaches are most appropriate or can result from our research considering the impact of land management practices at landscape scale on biodiversity and ecosystem services?
Advanced ways of knowledge management: how can technological advances be implemented to gather land system knowledge and make it accessible and applicable for a multitude of different user types?

2. Systems research:

B. *Social-ecological systems:* how can the concept of social-ecological systems be advanced for an improved guidance and support of sustainable (regional) development?

C. *Land system responses:* what kind of models need to be integrated to reveal emergence effects or risks for uncontrolled losses in regulative capacities of land systems exposed to increasing pressures from Climate and Global Change?

3. Innovation:

D. *Land management:* how can social and technological innovation in land management contribute to improve the sustainable provision of ecosystem services and maintain biodiversity?

E. *Natural resource use efficiency:* what kind of resource processing innovations including improved transport and connection of processing sites will be efficient to cope with increasing demands for natural resources in a globalized world?

4. Advanced communication:

F. *Data visualization:* how should advanced modelling / decision support systems ("landscape lab / theatre") be conceived to support improved actor involvement in participatory planning processes?

G. *Knowledge sharing and involvement of swarm intelligence:* how can data gaps be filled by supporting knowledge sharing processes and swarm intelligence consultation in integrated land use planning?

Complementary aims in capacity development that we will address comprise:

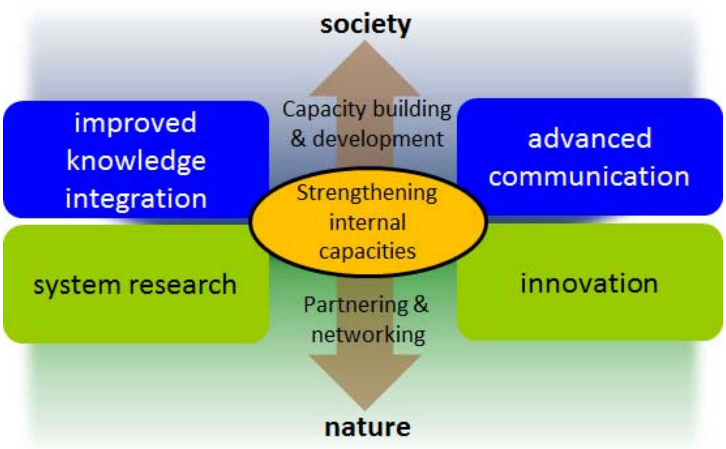
1. *Within the ELI partnership:*

A. *Strengthening our capacities and skills:* enhancing the institute internal knowledge exchange and transfer supported by instruments such as short term scientific missions at partner institutions and co-supervision of graduation works.
B. *Partnering and networking:* extended support in accessing appropriate cooperation partners by further developing the data base services and by testing and evolving innovative forms of partnering events; making use of the complementary capacities of our ELI partners and extending funding acquisition activities

2. External activities:

A. *Capacity building:* strengthening and forming common activities in capacity building (training and education offers) in collaboration with IALE, ESP or using the IPBES Matchmaking Platform
B. *Capacity development:* joint collaboration activities to form topical pools of excellence with European and international partners.

Fig. 3 provides an overview on the single elements of ELIs future vision and their interplay to connect best human and environmental aspects in a systemic view.



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ig. 3 Future vision for ELI in the research and development interface between nature and society.

A.4 Research and development plan for the upcoming years
A.4.1 Widening and / or refining the thematic scope
So far, ELI addresses four major land use sectors, agriculture, forestry, water management and urban systems and three cross-cutting topics, ecosystems and landscape ecology, socio-economic and political questions, and software, data processing, services. Though these three cross-cutting areas cover already a very broad thematic scope, they are partially not well differentiated enough to address more specific cross-cutting questions between the land use sectors.
For further evolving our research and development focus and our respective activities, we plan to extend our matrix either by further cross-cutting issues or refine our differentiation, e.g. to obtain more transparency in the field socio-economic and political questions.

Currently, particularly the demand in co-design and co-development of research and in knowledge generation poses challenges in the future conception of inter- and transdisciplinary research. Adaptive feed-back mechanisms need to be included as well as processes such as social learning or the formation of epistemic communities. Methodologies how to tackle with such processes at different scales in land system and integrated land use research are so far not separately addressed in ELI, but more inherent in sectorial planning and participation processes, particularly in urban, but also in rural development. Pathways how to integrate natural and social sciences research not only through research questions but through integrated concepts or hybrid approaches should be developed. Fig. 4 formulates a vision how the ELI cooperation could be built and advanced using interdisciplinary integration projects on topics that provide particular potential for inclusion of methods from natural and social sciences.

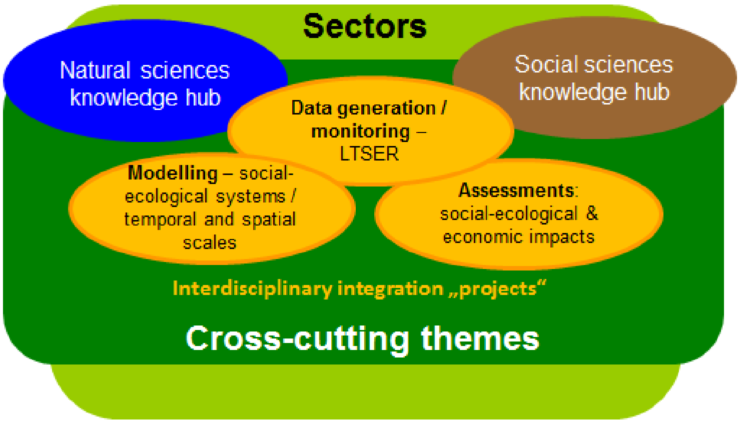


Fig. 4: Vision of a methodologically oriented structure.

A.4.2 Widening the knowledge basis and interfaces to international cooperation
Another aspect going along with an extended thematic scope of ELI is the question to better address and involve knowledge and experiences on integrated land use also from international partners beyond EU. Therefore, we plan (a) to complement our Scientific Advisory Board with additional representatives for new or refined cross-cutting issues to cover each of the fields in our thematic cooperation matrix and (b) to continue networking ELI with other international societies, projects or programs such as ESP, GLP, IALE, IPBES and IUFRO to make particular use of synergies in reshaping the research area, refining questions of interest, sharing communication pathways and providing access to publication and transfer instruments.

A.5 Cooperation examples - projects

A B **C** D E F **G** H I J K **L M** N O P Q **R** S T U V W X Y Z

CASTLE – Careers in sustainability excellence, Marie Curie Initial Training Network on sustainability impact assessment in the forest based and bioenergy, partners in Finland, Sweden, Germany, Austria
www.castle-itn.eu

CGCIA – Chinese-German Centre for Impact Assessment, a research platform for land use change impact assessment in Germany and China.
www.cgcia.org

GRABS - Green and Blue Space Adaptation for Urban Areas and Eco Towns (GRaBS) project website. The GRaBS project is a network of leading pan-European organizations involved in integrating climate change adaptation into regional planning and development.
www.grabs-eu.org

INTECRE – Network in the Baltic Sea area that collaborates on transboundary planning needs and instruments to ensure the sustainable development of border-crossing landscapes and ecosystems. Key issue is to characterize and profile requirements in technological innovations and planning methods.
http://intecre.eli-web.com/

LIAISE – Linking Impact Assessment instruments to sustainability expertise – European research network improving the evidence base for environmental policy.
www.liaise-noe.eu

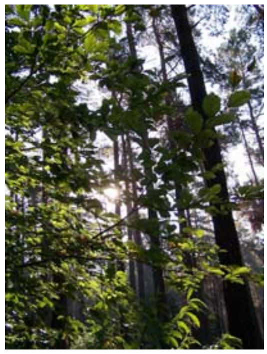
MACSUR Modelling European Agriculture with climate change for food security. European knowledge hub on competences in assessing climate change impacts on food security.
www.macsur.eu

RegioPower – ERA Bioenergy-WoodWisdom project, partners in Finland, Germany, Slovenia and Sweden, topic – development of a virtual feed-stock market for trading lingo cellulosic resources.
www.eli-web.com/RegioPower/

B - Guidelines for sectors and current cross-cutting issues

B.1 Research profiles in the land use sectors

Research in ELI addresses so far four major land use sectors, agriculture, forestry, urban systems and water management. To achieve an integrative research approach, interfaces and common questions of these four land use sectors are addressed in their profiles.



Challenges for formulating the research profiles in the sectors are, for instance, the choice of appropriate scales. For instance, agriculture and forestry "land management" or "land use" are more related to the local (micro) scale namely the "management planning unit", the forest stand or the agricultural parcel. Therefore, impact assessment within these two sectors is often not looking on landscape scale, and interactions at landscape scale are so far not so intensively researched or considered when conceiving monitoring approaches. Water management on the other hand, operates much on the meso to macro scale and its reference units (watersheds) comprise management units of all other sectors. However, the view on landscape scale when defining landscape as "a sum of different catchments or different ecological-economic systems and their processes including lateral and vertical fluxes" is in this area also often not really considered. Finally, urban systems represent a special case, where the human dimension is dominating in system dynamics, and where choices about land development and resources allocation are often more important than ecological processes.

To overcome these obstacles for integrated land use research, it is essential that all scales (micro, meso, macro) and the related issues and research to be done must be clearly addressed. Interfaces to other land use sectors should be built at landscape (meso) scale considering system interactions and their mutual impact and the resulting research interests. Priority topics for cooperation should be identified, where research from each sector can contribute to in close cooperation with the pro-files in the cross-cutting areas. Visions going beyond sectors should be formulated, such as (i) monitoring systems that focus on interactions between land use sectors to widen also the point of view how landscape systems respond to external pressures and how to assess their vulnerability / resilience, (ii) standardization of how the use (including active management / non-management) of land is described, classified and assessed (instead of land cover), and (iii) consensus building for reference units in modeling considering, for instance, aspects from hydrology, forest and agricultural growth, impact of urban development/activities and yield modeling, or also assessment with landscape metrics.

ELI EUROPEAN LAND-USE INSTITUTE

B.1.1 Agriculture *(Katharina Helming, Leibniz-Center for Agricultural Landscape Research)*

B.1.1.1 State of art of research

Agriculture worldwide is challenged by the ascending demand of the growing world population for biomass based food, energy and fiber products. By 2050, agricultural commodities have to satisfy the needs of 9 billion people, including a supply of food that is estimated to amount to about 170 % of the current figures (FAO, 2011).
At the same time, in many areas of the world, agricultural production is challenged by climatic changes as well as by land degradation through soil erosion, salinization, soil organic matter decline and other processes, which may dramatically reduce the land productivity.
The available land area is further restricted by the growing demands of other land uses including urbanization, infrastructure, mining, flood control and water retention, nature conservation, and tourism development (PBL, 2011). Consequently, an increasing demand for agricultural commodities has to be satisfied on a decreasing land area, the natural productivity of which is declining in many parts of the world.

In Europe, agricultural production exceeded the demand for agricultural commodities during the last three decades. This was the result of technological development (breeding, cultivation techniques, harvesting technologies) and structural changes (land consolidation, infrastructure development, efficiency gains in farm structures), which, to a considerable extend, was triggered by the European Common Agricultural Policies (CAP) that promoted production and protected markets in favor of European farming. Consequently, concerns of overproduction dominated strategic research, and the integration of non-commodity objectives (environmental issues, rural development, territorial cohesion) with commodity production emerged on the agenda of policy making. They were implemented e.g. through the introduction of agri-environmental schemes and cross-compliance mechanisms.

Multifunctional agriculture was coined as a key term for the simultaneous consideration of food and fiber production (commodities) with the provision of non-marketable services (non-commodities) such as biodiversity and habitat provision, water purification, carbon sequestration, provision of space for recreation (Maier & Shobaiashi, 2001).
Methods for assessing the multifunctionality of agriculture were developed at farming system level (Zander et al., 2007) and at landscape level (Piorr et al., 2009). A prerequisite for that was the transition of disciplinary, production oriented agricultural research towards interdisciplinary approaches that was leveraged by the interaction between social, economic, ecological, political and engineering sciences (Lichtfouse et al., 2010).
Landscape scale research was reinforced to fully accommodate the spatial patterns and processes underlying agricultural production and ecosystem functioning (Brandt and Vejre, 2003). It integrates agricultural with hydrological, ecological and socio-cultural approaches and can reveal tradeoffs between production-oriented resources utilization and resources conservation, provision and regulation for ecosystem services purposes (Wiggering et al., 2003). Implementation of the concepts of multifunctional agriculture and landscapes were seen as solutions for reducing overproduction through extensification, which permitted mitigation of agricultural impacts such as on soil degradation, nitrate leaching, carbon depletion, biodiversity and recreational value.

Today, in the light of emerging resources scarcities, demographic changes and the financial crisis, intensification and a dramatic increase of demands for agricultural products is anticipated. Foresight studies such as the Agrimonde study of France (Paillard et al., 2012), the UK study of the Government office for Science London (2011) and the 3rd foresight report of the European Commission Standing Committee for Agricultural Research (Freibaur et al., 2011) all point in the direction of the need for drastically increasing agricultural production also in Europe to feed the growing population that is anticipated to increase its livestock based diet, and to provide bioenergy and other non-food products for chemical engineering and replacement of non-renewable sources.

The trend for reinforced commodity production in agriculture can already be observed and is further triggered by constantly increasing factor prices and land prices. This poses particular challenges on the integration of environmental, ecosystem and socio-cultural concerns into the market oriented production which now cannot simply be achieved through extensification measures.

B.1.1.2 Visions

Systems oriented research is required on the integration of agricultural commodity production (food, fiber) with non-commodity agro-ecosystem service provision (regulation services, climate mitigation, flood, diseases and water regulation, biodiversity, cultural services). Constraints of business entities have to be confronted with ecosystem requirements in developing smart innovations and policy solutions that accommodate intelligent land management.

Landscape level approaches will allow for an analysis across all land use types including forestry, urban systems and infrastructure and to adequately capture underlying processes of the biotic, abiotic and socio-economic system components. Stakeholder demands and perceptions to agro-system functions and services will be revealed and confronted with agricultural supply to identify conflicts and mismatches.

To fully understand demand-supply interactions, the rural-urban continuum will be considered since demand is urban biased, while supply is rural biased. An ex-ante, forward looking approach making use of scenario analysis will be installed to identify upcoming trends and pressures on the production system and to develop early warning and adaptation measures. A comprehensive, consistent monitoring, indicator and data management system will be installed allowing for a continuum of ex-ante analysis with monitoring and ex-post assessments of policy and management strategies.

B.1.1.3 Upcoming research needs

To approach the vision of fully integrated, system oriented research that combines explorative research with solution finding and that integrated economic with environmental and social targets, the following items have to be addressed at landscape level:

- Integration of farming system level with watershed level and with administrative levels for nutrient and carbon management and soil degradation control
- Understanding the interactions of agricultural patterns and management instruments, biotic processes and habitat suitabilities
- Improve the understanding of socio-cultural systems of landscape management and agricultural production
- Understanding demands and perceptions of urban and rural populations with regards to agrosystem services
- Assess the impacts of agricultural production and policy taking full account of social, economic and environmental effects as well as of indirect effects on other regions or sectors
- Integration of ex-ante assessments with monitoring and ex-post evaluations of policies, management and planning systems to close the analytical cycle
- Develop common infrastructure of experimentation, monitoring and modeling that can be used across disciplines and scales
- Develop methods of transdisciplinarity, solution oriented research that includes stakeholders and decision makers from early on in the research process
- Identify synergy options emerging from integrated, cross-sectoral policy, planning and management approaches involving agriculture, agroforestry, tourism etc.

B.1.1.4 Interfaces to and cooperation opportunities with the other excellence areas

Land is a continuum that is characterized by spatial patterns of different land use types (agriculture, forestry, urban systems, infrastructure for transport and energy, nature conservation, mining). Hydrological and ecological processes act across these different land uses thereby mutually affecting and reinforcing or mitigating its impacts.

System oriented research on human nature relationships between land uses and ecosystem responses require an integration of the excellence areas. This is already realized or at least commenced in a number of research fields, such as land use impact assessment (Helming and Perez-Soba, 2011), ecosystem service appraisal (Burkhard et al., 2012), integrated water resources management (Volk et al., 2010).
However, joint concepts for integrated data, monitoring and indicator systems are still missing. Further, while research made considerable progress in joint, interdisciplinary approaches, the business and policy sectors are still somewhat distinct and show little effort for cross-sectoral approaches. This hinders integrated, system oriented policy and business approaches.
Potentials for future, system and solution oriented funding, involving researchers and stakeholders at business and policy levels, lies in the European bio-based economy strategy that is proposed to respond to the grand societal challenge of food security and that is planned to become an important part of the European Horizon 2020 strategy for research and innovation (CEC, 2011).

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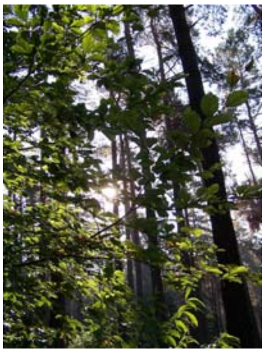

B.1.2 Forestry *(Carsten Lorz, University of Applied Sciences, Weihenstephan-Triesdorf)*

B.1.2.1 State of art of research

Forestry has undergone a considerable change of its socio-cultural acceptance and public perception since the 1950ies. Before, timber production, contribution to national economy, and the provision of employment in rural areas were major requests of society. After World War II the complexity of societal demands increased. Foresters faced more and more the need to integrate multiple and often contradicting demands on forest management planning (Fürst et al., 2007, Johann, 2007, Vos and Meekes, 1999). An agreed aim for future development of Europe's forests was to ensure their sustainable use and management. However, a broad variety of regional concepts and interpretations of sustainable forestry can be found for Europe (Kissling-Näf and Bisang, 2001, Andersson et al., 2000, Farell et al., 2000). Recently, the target to obtain 20 % of Europe's energy needs from renewable sources by 2020 (EU renewable energy policy) sharpened the discussion on the compatibility of an increased timber use from forests and the sustainable fulfillment of other functions of forests on landscape level, such as provision of drinking water, conservation of biological diversity, or provision of recreation areas (Stupak et al., 2007).

The majority of forests in Europe have multidimensional use, i.e. forests fulfill at the same time a number of ecological, economic, and social functions (Farell et al., 2000). A functional prioritization of forest is rather the exception then the rule, e.g. protective forests (water, erosion, and recreation), nature conservation areas or agroforestry systems, where substantially different management strategies must be applied (Führer, 2000). The broad variety of overlapping demands affects management strategies as well as operational plans and leads frequently to considerable target conflicts. Therefore, it should be discussed (i) how to deal with the resulting decision problems and (ii) how to improve the decision-making processes and decision support capabilities in the context of increasing complexity (Rauscher et al., 2005).

The concept of multifunctionality forces forest managers to consider a broad range of ecosystem attributes at various spatial and temporal scales (Baskent and others 2008). In consequence, multifunctional use of forests became subject to critical discussions (e.g. Parviainen and Frank, 2003, Buttoud, 2002, Führer, 2000). In many European countries even the importance of forestry as a key supplier of renewable resources is questioned. Instead, the provision of non-marketable goods and services, such as recreation, biodiversity, C-sequestration, climate protection, and nature conservation became more and more important (Spieker, 2002). However, the provision of industrial wood is worldwide still of highest importance and has led to overexploitation and destruction of natural forests (e.g. Castella et al., 2006, Shimamoto et al., 2004, O´Didia 1997). In addition, political decisions influenced by regional and local pressure groups prevail often over general societal needs, which have no or only a minor lobby (e.g. Montiel and Galiana, 2005, Weiss, 2004). Impacts and consequences of political decisions for forest and environmental management have to be analyzed in a way that biased overemphasis of economic or ecological aspects is avoided and unwanted impacts on environment and society are minimized (Wohlgemut et al., 2002).

As a further complication, changing environmental conditions must be considered in forest management (Martinez de Anguita, 2008). These might affect the degree of fulfillment of ecosystem services and might even lead to the unattainability of socially desirable management tasks. An example is the output of biomass for energy production, which depends strongly on regional climate. Changing annual precipitation and temperatures might impact the amount of produced timber, the production time (rotation period) and the production risk.

These facts emphasize the need for tools, which support forest management on and its integration into landscape level and in context with other land use types to balance the effects of possible future threats on ecosystem services provision. In this regard, modern forest management might benefit from a scientific view on forest ecosystems and from tools for modeling, decision support, and Information and Communication Technology (ICT). Due to the general complexity of management questions, a system analysis including feedback and dependencies between the different system elements seems to be the most reasonable approach (Wolfslehner and Vacik, 2008).

The rationale is to combine the strengths of available tools, methods, and models for supporting forest management at strategic and operational planning level and for improving the compatibility with landscape or regional development. However, the use of support tools in practice requests the acceptance by the user. Systems, which deal with complex questions address often only scientists and run the risk to become too complicated for the end-user in practice (Uran and Jansen 2003). Therefore, consideration of user requirements must be a crucial part of the technical development from the beginning on.

B.1.2.2 Visions

The management and evaluation / assessment philosophy in forest management differs so far from more broadly applied concepts such as the concepts of ecosystem services (MEA, 2005) or land use functions (Perez-Soba et al., 2008). This complicates to assess and take full benefit of the contribution of forest management opportunities to provide ecosystem services in a landscape context. Furthermore, this lowers public recognition of the forest management contributions; as an example, afforestation as a means to contribute to climate change mitigation and adaptation at landscape scale is much more often discussed then adapted forest management strategies. We formulate therefore the vision, that the ecosystem services or land use function concept is introduced in forest management as a concept to assess the success of management strategies and as a basis for formulating management targets. This includes also that management practices are described, assessed and documented in sufficient detail to make this information compatible and accessible at landscape scale.
Hereon building is the vision, that forest modeling will leave the single-tree or stand scale and will grasp the (integrated) landscape perspective. This includes an improved consideration of borderline effects and the mutual impact of forests with other land use types to better describe the specific role of forests and their spatial pattern for ecosystem services provision. Subsequently, also forest monitoring approaches should be revised and leave their single stand perspective. Much more favorable would be nested or combined approaches with monitoring done in other sectors or based on another perspective. Soil monitoring could serve as an example.
Finally, participative forest management strategies and enhanced communication of targets and measures with residential / concerned stakeholders should be improved to increase public recognition and acceptance of forest management operations. Here, participatory decision and management support approaches, enhanced assessment and visualization tools based upon more landscape oriented modeling approaches should be introduced in the future.

B.1.2.3 Future research needs

Based upon our visions, we formulate the following future research needs and areas:

- Development of integrated, landscape-scale oriented assessment approaches for ecosystem services provision of forests as a contribution to regional ecosystem services provision potentials
- Integration of forest management information in land cover data sets and standardization of assessment methods for ecosystem services provision by a set of generalizable (broadly spatially relevant) forest ecosystem / management types
- Development of assessment methods to account for spatio-temporal processes of ecosystem services provision by such long-lasting but highly dynamic ecosystems such as forests
- Development of integrative landscape-scale related forest modeling approaches going beyond single tree or stand wise growth and yield models, (i) that consider mixed and multilayered stands, (ii) that provide sufficient interfaces to the assessment of ecosystem services (structural indicators, process indicators, etc.), (iii) that address also the issue of interrelations with other land use types and the spatial pattern of the forests at landscape scale
- Development of advanced, landscape compatible monitoring approaches and networks

- Enhanced use and further development of participatory decision and management approaches and creation of a tools framework that supports also visualization and enhanced ecosystem services provision assessment routines

B.1.2.4 Interfaces to and cooperation opportunities with the other excellence areas

Thematic interfaces with all other land use sectors and societal needs are given by the contribution of forests to ecosystem services provision. Examples therefore are

- Drinking water provided preferably by forests to avoid to high Nitrate contents puts limits of forest management that are not accounted to equal extend in agriculture.
- Water regulation in catchment areas (catchment yield, flooding) is greatly dependent from the forest spatial pattern, however biased impacts might occur – catchment yield, for instance, can be higher if the forest cover is reduced in favor of pastures
- Quality of life in urban areas is among others also a function of the proximity to forests as most favored recreation spaces, while this demand impacts greatly the way and intensity how forest management can be done to avoid acceptance conflicts with residents
- The contribution of forests to provide ligno-cellulosic biomass and to support regulating services at landscape scale is broadly acknowledged, however short rotation coppices and other agro-forestry systems with greater economic impact gain in importance and could be favorable on sites that were previously foreseen for afforestation
- Ability of forests to contribute to global climate change regulation is estimated to be tremendously high; however, mostly only the vegetation cover is accounted and the C-sequestration potential in forest, but also in agricultural soils is not accounted, neither in regional economic development programs, agricultural funding policies nor in emission trading approaches

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B.1.3 Urban Systems *(La Rosa, Daniele, University of Catania, Dept. of Architecture; Artmann, Martina, Bavarian Academy of Nature Protection and Nature Management, Urban Ecology, Laufen, Germany; Breuste, Jürgen, University of Salzburg, Urban and Landscape Ecology, Austria; Inostroza, Luis, TU Dresden, Institute of Photogrametry and Remote Sensing)*

B.1.3.1 State of art of research

Urban systems are spatial concentrations of people whose lives are organized around non-agricultural activities (Weeks 2012). Urban areas cover just a small part of Earth´s surface but have crucial effects on the global ecosystem and their impacts on ecosystems are particularly evident for urban landscapes (Alberti et al. 2008). These impacts tend to modify land covers mostly by soil sealing. Several ecological process are affected, such as urban water balance (Haase and Nuissl, 2007; Pauleit and Duhme 2000) and urban heat islands (Kuttler 1998).

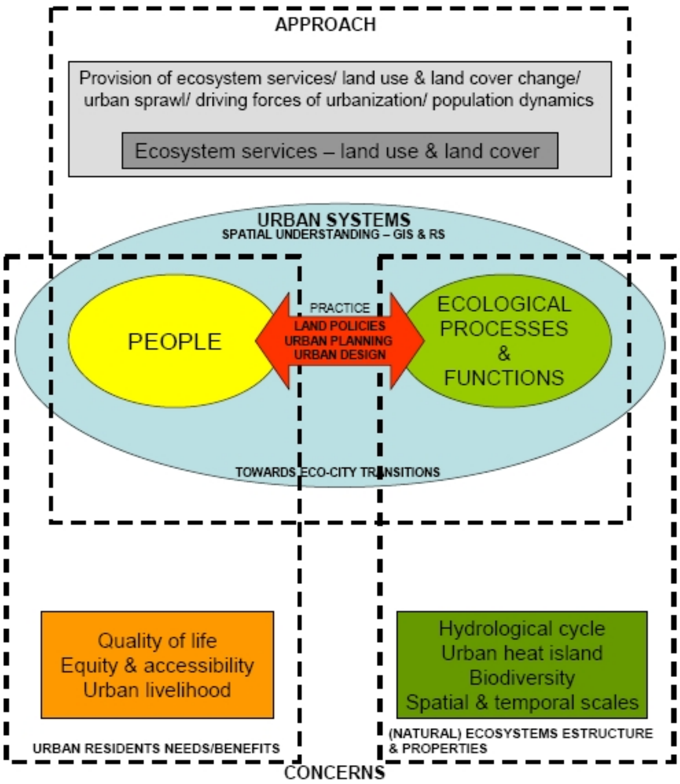
Urbanization is the more powerful driving force in urban systems, producing changes in life-style and spatial patterns due to development of residential, infrastructure and socio-economic factors (Antrop, 2004). Two types of spatial behavior for urban development can be distinguished. The first type takes place along the boundaries of already urbanized areas and implies how growth attracts further growth. A second spatial behavior typical of contemporary urban contexts is the tendency to escape from the city core and to spread urban development over hinterlands, where the sprawled pattern is characterized by a fragmented urbanization and pulverization of the urban tissues (Inostroza et al., 2013, Kasanko et al. 2007). Urban sprawl is seen as one main territorial challenge in Europe as due to further land consumption despite of shrinking population ecological resource are overexploited and biodiversity gets lost (EC 2011).

Urban systems have also a particular feature, which is the complex arrangement of landscape features with a large number of different land covers and increased spatial mixing of the same (Myeong et al., 2003). This “spatial complexity” makes urban systems special contexts where cross-sectoral approaches in research are particularly important.

The spatial scale used so far in researches, has been often limited to municipality boundaries, sometimes partially encompassing also peri-urban areas. The interaction of urban with non-urban has been rarely assessed, but it has important consequences both the provision of ecosystem services (Gutman, 2007). An example for this can be the effect of urban heat island particularly generated by human land uses that should not be assessed simply considering a single urban area or municipality: the effect of big conurbations should be assessed together at a landscape or metropolitan scale.

Some main streams concerning environmental land use science can be highlighted in the current research and literature, such as the effects of Climate Changes (Gill et al., 2007), Green Infrastructure and externalities of urban sprawl (Furberg and Ban, 2012), resources scarcity (Domènech and Saurí, 2010), equity in natural resources allocation (Lindsey et al., 2010), safety. These topics are often interconnected and land use plays always a fundamental role for all of them. For these topics, Ecosystem Services (ES) can be used as a key and common concept to understand ecological patterns and processes in cities and to plan urban system according to the needs of urban dwellers. ES describe the range of benefits provided by nature to humans, the society and economy (Boyd and Banzhaf 2007; de Groot et al. 2002). For characterizing urban ES, the integration of provision of conditions and processes by natural ecosystems and needs by urban residents is of crucial importance (Breuste et al., 2013; Bolund and Hunhammar 1999). This dualism makes the concept of ES a promising approach for science but also for policy and planning practice to build better cities with improved overall quality of life and integration between urban development and ecological processes.

B.1.3.2 Visions



Integrated assessment of ES in urban areas may lead to a wise and complete understanding of ecological patterns and processes and needs from citizens (fig. 1). This kind of assessment must conduct to a sound based and effective planning of urban systems. Decision on land use planning should be aimed at the optimization/maximization of ES provision (La Rosa and Privitera, 2012). This aspect cannot be reached without an integrated and cross-sectoral approach, involving the value assessment of different existing ES, which depends on the spatial configuration of the patterns of land uses as well as the views and needs of stakeholders (Vermeulen and Koziell, 2002). GIS mapping and modeling approaches can redefine and evaluate services that are related to spatial distribution and configurations of lande uses (Chen et al., 2009). Different scenarios may be assessed based on the economic resources that are needed to achieve land transformations. For this reason, more sophisticated approaches than ecosystem mapping or spatial visualization may be required (Herzig, 2008). Research on urban systems should also address how to support planning, policy and urban dwellers towards an eco-city transitions where environment protection is able to meet socio-economic development (Meirong et al. 2013, 4-5).

B.1.3.3 Upcoming research needs

Research needs can be identified with relation to the integration of planning aspects at landscape scale and the special role of urban ES. Although a lot of research is done for assessing urban ES, there are still conceptual challenges to overcome. One crucial discussion when assessing ES is the question of their classification and clear concepts/definitions to understand how ecosystem structures, processes, properties, functions and human benefits are interlinked are still needed (Haines-Young and Potschin 2010; Oudenhoven et al. 2012). Another challenge for an accurate evaluation of ES is the subject of temporal and spatial scales which are very diverse (Burkhard et al. 2009). Moreover, ES have been rarely addressed at the operational level and little has been said on how the ES approach may contribute to better incorporate non-economic values in urban planning (Gómez-Baggethun and Barton, 2013). Moreover, how can the ES concept can become actionable, practical, efficacious, effective and efficient in informing the contemporary practice of urban planning?

In general, questions that arise in urban systems research are often related to the appropriate scale needed when dealing with issues related to land use and ES:

- Which is the limit of “urban” in current urban development trends?
- How to look at urban areas inside a more extended landscape: e.g. do they need different assessing tools than non-urban contexts?
- Which is the role of urban land uses in providing landscape functions and ES?
- How to ensure equal accessibility to ES and functions?
- Which policies to be used to limit urban sprawl, while enhancing urban quality and ecological functions?

As examples of this cross-sectoral approach, researches can be address to the following issues:

- models for land use/land cover planning aimed at maximization/optimizations of Urban ES and their accessibility for citizens.
- methods for the design of urban multi purposes Green Infrastructure.
- assessment of the role of urban land uses with reference to climate change issues (increasing of run-offs, heat island effects, sea level rise) both at urban and landscape level. These may need appropriate and detailed monitoring of the relation between land use patterns, land covers, socio-spatial structure and driving factors of exposure: urban temperatures, hydrological cicles (floods), coastal management, among others.
- identification of possible conflicts in urban and regional land use planning.

From an operational side, further research needs to address the topics of data and technologies. There is a need to have available good and easy-to-get base geographical data, e.g. detailed land use maps (with scale from 1:10000 to 1:25000), or, whether these may not be available, to have fast, consolidated and easy accessible technologies able to derive these data from primitive aerial imagery. For planners or local public administrators some ready-made packages of derived land use data may be helpful to make prompt and well informed decisions (e.g. customize GIS based software).

B.1.3.4 Interfaces to and cooperation opportunities with the other excellence areas

A close and well consolidated cooperation, e.g. in catchment area management case studies, is given between urban forestry and urban hydrology though some more deep research on how to integrate both at landscape scale might be needed.

Enhanced should be the understanding of rural-urban interactions. Urban agriculture, for instance, is still a field that needs attention and more research, especially for European contexts where food may not be the first aim of this kind of agriculture that is more oriented in providing social cohesion, environmental education or leisure.

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B.1.4 Water Management *(Martin Volk, Helmholtz Centre for Environmental Research GmbH - UFZ , Dept. of Computational Landscape Ecology)*

B.1.4.1 State of art of research

The European Water Framework Directive was implemented in the year 2000 with the objective to achieve a good ecological and chemical status of the water environment (water bodies) until 2015. Many European countries were faced with a new integrated approach that included the cross-country and cross-state collaboration of all sectors acting in a river basin (as reference unit) and hence are responsible for river basin water quality and quantity. Examples of such sectors are water management, urban development and urban water management, agriculture, forestry, nature protection, tourism, etc. Other challenges were that economic assessments were needed to evaluate the costs of measures to mitigate pollution and overexploitation and to implement the polluter principle (Brouwer and Hofkes, 2008).

The public also had to be informed and involved by participation procedures (Jessel and Jacobs, 2005). The further procedure was the definition the actual environmental status of basins, sub basins and water bodies by monitoring programs. Next steps were the generation of measure pools, the planning of modeling procedures and the generation of management plans to achieve the objectives.

National ministries announced several calls for research projects on integrated river basin analysis, modeling and management to get support by research institutions. The related projects worked mostly on concepts for integrated ecological-economic river basin management and specific decision-support systems (Mysiak et al., 2005; Guiponni et al., 2007; Volk et al., 2008). Some of them developed scale-specific solutions for the micro-, meso- and macro-scale, where the methods (monitoring, modeling, management) were adjusted. Other projects included additionally visualization components to improve system understanding, communication between stakeholders and public participation.

By addressing the whole scale range from water bodies to entire river basins, the landscape scale is included. Despite the considerable progress in water management caused by integrated cross-sectoral analysis and management, the previously mentioned challenges of implementing the WFD seemed to be too ambitious – for instance, for most of the German water bodies the good ecological and chemical status will not be achieved until 2015 (Borchardt et al., 2010). There are still lacks existing in appropriate monitoring-modeling strategies (Bende-Michl et al., 2011, Ullrich and Volk, 2010), cross-scale methodologies that are able to link lateral and horizontal flows (but also from economic modeling) (Quinn, 2004; Bouwer & Hofkes, 2008; Hewett et al., 2009), serviceable decision-support systems (Volk et al., 2010; McIntosh et al., 2011) and the link to the ecosystem services concepts (blue and green water management, consideration of trade-offs between and amongst ESS) (Hering and Ingold 2012; Lautenbach et al., 2012; Willaarts et al., 2012).

B.1.4.2 Visions

Appropriately bounded integration can be a basis for sustainable management of water resources. A more towards the ecosystem services concept oriented management strategy could evaluate the trade-offs between land use and water-related and other ecosystem services or amongst such ecosystem services. This would enable a more integrated consideration of different objectives of the concerned sectors on the landscape scale. Examples could be the common achievement of objectives such as maximum food production, maximum bioenergy production, minimum nutrient concentration in the river (or limit values), maximum low flow conditions, and maximum biodiversity. There are already promising methods to simulate that by using models combined with optimization methods simulating numerous optimal (non-dominant) solutions along a pareto front (Lautenbach et al., 2012). In such a way, measures could be integrated in assessment procedures that help to mitigate the impacts of energy and food scarcity, droughts and floods. The level of international acceptance of IWRM warrants a concerted effort on the part of the technical community to overcome barriers to its implementation. With regard to “complexity vs. simplicity”, Hering and Ingold (2012) propose a pragmatic approach for integration that uses case- and site-specific conditions to set both the appropriate geographic scale and scope of integration. They concur with the lesson drawn from South Africa that "less ambition may result in better delivery".

B.1.4.3 Upcoming research needs

There are still ongoing discussions about the spatio-temporal configuration of appropriate monitoring strategies to cover the relevant processes and serve as calibration and validation basis for the models (Bende-Michl et al., 2011). There are several promising approaches that use statistical, sensor- and remote-sensing-based methods or even inverse model simulations to find the best monitoring and measurement strategies (Joergensen et al., 2007; Seibert and Beven, 2009). Related to this, there is still a need to estimate the uncertainties of methods that interpolate the monitoring results (from concentration to load) on the base of different sampling strategies. The statistical interpretation of results from different sampling strategies – which is a common practice – causes differences in the calculated loadings and has also consequences when used for model calibration and evaluations (Ullrich and Volk, 2010). More emphasis has to be given also to a better identification of priority substances (including pesticides, biocides, industrial chemicals, pharmaceuticals, etc.), which have to be differentiated from each other. From a modeling point of view, there is a need of useful and transferable systems that are able to represent the water and nutrient cycle and all the related processes (and uncertainties) in a sound way without ignoring the practical needs of the stakeholder – or vice versa (complexity versus simplicity) (Beven, 2008). Related to that is the increasing development of (model-based) decision-support systems for integrated river basin management (but also in other fields) that seems to be not used by stakeholder in the most cases. Reasons therefore are for instance complexity, inflexibility, project- and research- but not practice-based development (missing involvement of stakeholders), communication problems and many others (Volk et al., 2010, McIntosh et al., 2011). Other important research needs in water management are the development of adaptation strategies for global change, for increasing droughts and floods as well as a management strategy that is more oriented more towards the ecosystem services concept -related management philosophy. Basic needs are a better integration of forestry (Lorz et al., 2007) and urban development in integrated river basin management.

B.1.4.4 Interfaces to and cooperation opportunities with the other excellence areas

Several integrated river basin management projects during the last decade have shown that the collaboration and integration of different sectors is fruitful and supports sustainable water and land use development. There is a need for better integration of urban development and forestry into integrated water management. In addition, the development of decision support systems should be oriented more towards the needs and demands of the user. Europe's freshwater supplies are under pressure. Hence, the European Commission already an-announced a preparatory Action on development of prevention activities to halt desertification in Europe. One of these projects is "Assessment of water Balances and Optimization based Target setting across EU River Basins (ABOT)" (http://www.abot.it/). Connected with such actions and to improve the understanding and management of water resources, the European Environment Agency (EEA) has created ECRINS. ECRINS is acronym for European catchments and Rivers network System. It is a fully connected system of watersheds, rivers, lakes, monitoring stations, dams made from the JRC CCM2.1 and many other sources. In 2012, the European Commission will present a Blueprint to Safeguard Europe's Water Resources. This document will assess the implementation and achievements of EU water policy as well as identify gaps and shortcomings. On the basis of this analysis, the Blueprint will identify actions to strengthen water policy and to address ongoing vulnerability of the water environment. The EU has developed a comprehensive water policy over several decades. The Water Framework Directive is a central component for the protection and restoration of clean water across Europe and its long-term, sustainable use.

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B.2 Crosscutting Issues

Within ELI we address currently three cross-cutting topics, ecological integrity and ecosystem functioning, socio-economic and political questions, and technologies and products.

A major challenge for ensuring an integrated research is that the cross-cutting areas should carefully consider the interfaces to all land use sectors and identify their contributions and roles to answer the questions which are brought up by the cross-cutting topic. Furthermore, the cross-cutting topics themselves built up on each other and cannot be seen totally isolated, while probably (a) ecological integrity and ecosystem functioning is merely the basis for (b) policy and economics areas and (c) technologies and products should involve elements of (a) + (b).

Again there might be different reference scales within the cross-cutting areas. For instance, questions addressed in the field ecological integrity and ecosystem functioning can focus either on single ecosystems or on landscape systems, and these can be ecological-economic systems as interface to the cross-cutting area socio-economic and political questions. Considering the latter, economic assessment and evaluation approaches might focus on management planning unit level or on scale of ecological-economic systems which must not necessarily identical with a region or landscape. Finally, research addressed in the cross-cutting issue technologies and products can reach from data assessment at a single monitoring plot, over processing and modeling of single management planning units up to complex modeling and visualization instruments at landscape scale.

To solve these problems, it is again essential to clearly address all scales (micro, meso, macro) and the related issues and research to be done and to address also the hierarchy of the scales to be involved, e.g. from management planning unit (e.g. forest stand, agricultural parcel) to group of management planning units (forest district / field blocks) to landscape scale.

Focus should again be laid on landscape scale, for instance addressing ecological-economic systems in a regional context and the methods, tools and approaches which are suitable or demanded to act on this scale. An important point is that the cross-cutting topics take the lead in setting priority research and cooperation topics where all sectors contribute to, and where an added value of our integrated way of research is clearly visible, taking the vulnerability and resilience of ecological-economic systems or rural-urban interactions as examples. This includes building up visions for making best use of the contributions of each of the cross-cutting issues to integrated research, such as (i) approaches and tools for landscape design or ecological-economic system design approaches, (ii) methods for stakeholder involvement and participation, or (iii) instruments and approaches for knowledge building and transfer, and for communication and visualization.

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B.2.1 Ecosystems and Landscape Ecology *(Larisa Khanina, Pushchino Research Centre, Institute for Mathematical Problems in Biology)*

B.2.1.1 State of art of research

Ecological research addresses many scales, from single ecosystem to landscape scale. However, research approaches at these scales are mostly not compatible and also nested approaches that would support to better connect ecosystems research with landscape (ecology) research are often not well elaborated as a clear nesting or up- and down-scaling strategy is missing (Higgins et al., 2012). Often, isolated items considering the abundance of single species or their life cycle are put into the research focus and ignore more or less the necessary look on interactions – not only at ecosystem, but at landscape scale (Termorshuizen and Opdam, 2009), as the latter should be understood as a continuum of environmental factors that favor or disfavor the establishment of more specialized or more generalist species communities.

Ecological research gained most recently more in importance with the Millenium Ecosystem Assessment (MEA, 2005) and The Economics of Ecosystems and Biodiversity (Ring et al., 2010) that related the provision of ecosystem services as constituents of human well-being to occurrence and functionality of ecosystems and even went so far to put prices on ecosystem-specific services. Problematic in this context was the question of the assessment of the ecosystem state (Carpenter et al., 2009; de Bello et al., 2010). While well-functioning ecosystems can provide their services to the highest, locally possible extent, degraded ecosystems might only be partially able to provide the services or even unable. To describe the degree of degradation and to set thresholds between well-functioning and degraded needs further research efforts. Little bit ignored in this context was also the landscape aspect and the question of the impact of the spatial pattern of the single ecosystems. Here, landscape ecology approaches such as landscape metrics could form a meaningful complementation of ecosystem research, but a clear integration into ecosystem services assessment approaches is still at the very beginning, while especially comparative studies and validation basis are missing.

Also, the question of how to link spatial and temporal pattern of ecosystem and landscape processes needs further investigation (e.g. White et al., 2010; Seidl et al., 2012). Landscape as the targeted spatial unit for integrated ecological research must be seen as a colorful mosaic of interrelated systems with completely different temporal dynamics. Best examples therefore are agricultural and forest systems. While process-relevant time slots in agricultural systems are mainly intra-annual, they can cover years, decades or centuries in forest systems. Even more complicated is the integration of water systems, which span totally different spatial dimensions compared to forest, agricultural or urban systems and which are related to vertical and especially lateral fluxes where the later impact and are even dependent from neighbored land uses.

The great challenge for ecosystem research and ecological functioning is therefore, where the system boundaries should be drawn to ensure sufficiently profound research, but to enable at the same time integration at landscape scale (Müller et al., 2010). Probably, reference not to single ecosystems, but more to ecosystem types as a transferable topical and spatial entity should be given.

B.2.1.3 Visions

Our vision of better enhancing ecosystem research and ecological integrity as cross-cutting issue between the single sectors addressed in ELI is to define landscape as the spatial integration entity in which nested and cross-linked modeling approaches help to integrate (i) ecosystem processes with different temporal scale, (ii) system-overarching processes such as lateral fluxes and (iii) mutual impact of the systems based on their spatial constellation. We need to define an approach how nesting across the scales to be integrated in the landscape view should be done and where we set integration limits to avoid the production of over-complex model frameworks whose results cannot be interpreted anymore. Our vision is also to support with such landscape-related model systems understanding of relations between vulnerability and resilience of landscape as a pool of spatially and temporally interlinked systems. Ecosystems research should further be much more connected to economic research considering assessable indicators that enhance the understanding of the value of biodiversity as such and of losses in ecosystem functionality or disturbance of ecological processes (Fisher et al., 2008). So far, we are still away from producing communicable knowledge that supports reasonable policies and helps to consider better trade-off of land use decisions at landscape scale.

B.2.1.2 Upcoming research needs

Based on our visions, we formulate the following upcoming research needs:

- Tools for analyzing combined ecological and economic processes at different scales should be further developed to allow up- and downscaling of relevant processes and to account better for different for temporal dimensions.
- A clear methodological focus is needed on integration among the hierarchical levels in models. This includes linking the slow and large scale processes related to landscape and climate with the fast and small scale processes within habitats, e.g. population dynamics of individual species.
- It is important to predict the thresholds that separate two alternatives, qualitatively different ecosystem states: well-functioning and degraded. The relationship between the condition of ecosystems and the services they provide is not a simple linear one, but rather more complex.
- It is necessary to improve the understanding of how combinations of natural and anthropogenic processes interact across scales of space and time, and to develop tools that facilitate quantitative analysis of these interactions and up-scaling and down-scaling the processes.
- The sensitivity of ecosystem functions to changes in species composition has to be analyzed to improve understanding on the resilience and resistance of ecosystem processes.
- It is important to assess how biodiversity changes can affect the capacity of ecosystems to maintain processes, such as nutrient cycling and availability, biomass production, regeneration, and services that are essential to human welfare.
- In conservation planning information on the current habitat distribution and future changes in the landscape structure should be accounted. Predicting landscape dynamics, for instance changes in structure and composition of managed forests, is complex because of the importance of local conditions, stochastic natural phenomena (e.g., winds, fire, floods, insect outbreaks), anthropogenic drivers such as climate change, and the difficulties of forecasting decisions made by land owners.
- The spatial distribution of selected habitat types (e.g. grassland or unmanaged old-growth forest) has to be defined according to the habitat requirements of focal species.
- For biodiversity supporting and conservation, planning has to be also done at the meso - macro scale. Managed forest and unmanaged old-growth forest also as tillage and pasture are very different in ecosystem functioning though they are forest lands and agro lands, respectively. For ecological integrity and entire ecosystem functioning, it would be desirable to put more emphasis on the spatial constellations and interactions of such ecosystems at meso scale (regions) and to allow also for a pattern of regions with different priorities in ecosystem services provisions at macro scale.

B.2.1.4 Interfaces to and cooperation opportunities with the other excellence areas

Interfaces of the cross-cutting topic "ecological integrity and ecosystem functioning" are per se given with all other topics in the ELI matrix. Interfaces that should be enhanced in the future consider mainly the question of how to relate ecosystems research with economic assessment and policy support and how we can better integrate ecosystem models in meaningful manner in more technical tools addressing decision or management support of visualization of results.

Cooperation opportunities are currently given in the frame of the RURAGRI call in the field land use and land management, supporting linking with agricultural systems research, ecosystem services assessment and policy support. Further cooperation opportunities arise from FP 7 call identifier FP7-ENV-2013 (first stage deadline October, 16, 2012). Also, Horizons 202 will offer a cooperation opportunity where integrated ecosystem research as cross-cutting issue is of special relevance in the topics sustainable natural resource management (ecosystem functioning and assessment, decision support), sustainable resource provision (knowledge base, practices, risks), sustainable agriculture and forestry (combined!) focusing on production efficiency, ESS provision and rural development.

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B.2.2 Socio-economic and political questions *(Luca Montanarella, Land Resource Management/ SOIL action UNIT, Joint Research Center of the European Commission)*

B.2.2.1 State of art of research

The topic socio-economic and political questions is not only a cross-cutting issue between the land use sectors, but also the major interface for the later use and application of the results in land management practice and policy consulting. Problems in this area are two-fold: on the one hand, the question or the right stakeholder at the right scale to communicate land use and land management research results in most efficient way is still not really answered and so far we mostly fail to adequately communicate the right results to the right user with the consequence that many innovative results are not known or ignored in land use planning and policy making.

On the other hand, especially policy makers might not be interested in the most correct results, but sometimes in the results that support best their policy strategies and personal acknowledgement. Partially competing land use policies in climate change mitigation (increase of carbon sequestration), use of bioenergy (less sustainable and long lasting forest management practices due to high resource demands, “maize-deserts” in agricultural landscapes, both with the result that C-sequestration potentials in the soils are reduced or destroyed) underpin that the interface between science and land use policies is not so well developed.

Furthermore, policies such as the soil strategy, national and EU forest program which failed at least partially due to differing national views though scientific results at EU scale went well in accordance represent further challenges in creating better cooperation between land use research and policy making. Taking both – economic and political aspects into account, pathways for setting incentives in agriculture and forestry after the ending of the current European Agricultural Fund for Rural Development (EAFRD) that aim at taking the ecosystem services provision as one decisive criterion must be developed and validated in their efficiency and operability. Here, land use research is requested to provide meaningful assessment criteria and indicators and – as highlighted in the ecological cross-cutting issue – to better link these criteria and indicators with believable and reproducible monetary values.

Finally, the important issue of ecosystem services consumption and food (and other natural resources) security as interface between natural systems research and socio-economic systems research plays will gain increasing importance. So far, policies to reduce soil sealing and unsustainable land consumption, to fight land degradation and to set a common frame for sustainable planning of the scarce resource land failed due to more powerful economic considerations. Only, if we bring together research approaches to better understand the functioning, the threats and the ways how to coordinate socio-ecological systems in regional (landscape), national and EU context, sustainable provision of all needed resources, goods and services can be ensured in the long run.

B.2.2.2 Visions

The core of the land use economics and policy related research is sustainable economic development and the question how can we assure economic growth while limiting land degradation and consumption? Our vision is to better understand the limits of economic growth given by local and regional environmental conditions, regional typology and structure dependent cultural and economic drivers and overarching impacts such as climate change to better adapt policy regulations to realizable targets and to better support the ex-ante assessment of interrelations between policies that might provoke conflicting impulses in land use planning and management decisions.

Hereby we strive also for increasing the acceptance and applicability of policies to avoid disappointing applications processes as they were observed (see sector water management) in the context of the EU Water Framework Directive.

Therefore, an important task will also be to put more effort into applying knowledge and methods from socio-economic and policy research in management and decision support tools and their conception and development.

B.2.2.2 Upcoming research needs

Land use, land allocation, spatial planning, land grabbing, land tenure, land consumption are just few of the terms that are recurrently coming up in the political debate of the last months. The fact that land degradation is a major threat to human development has been fully recognized at the Rio+20 conference on sustainable development. A clear target of zero net land degradation has been discussed and research needs to focus on how to implement and monitor such a target.
The basic research question is how can we preserve the non-renewable natural resource of fertile soils for feeding future generations while maintaining economic growth and maintain biodiversity? This overall research question will need to address crucial issues like land tenure, land grabbing, National sovereignty, land allocation and spatial planning, soil sealing urban expansion and brownfield recycling.
Further research need is to better assess, understand and document land management practices and to embed this knowledge in data bases such as the Corine Land Cover Classification to make them usable and accessible for evaluating future regional potentials to provide food, fodder and fiber and other urgently requested natural resources to base thereon spatial planning decisions that allow for a tolerable level of land consumption for economic growth.
Research and development focus will be put therefore on methods and tools frameworks that include GIS, Remote Sensing, soil and land monitoring and survey, land use modeling and participatory scenario building and scenario analysis.
Also research efforts will have to be spent on analyzing rural-urban interactions and rural system dynamics including the relevant socio-economic and cultural drivers to build hereon strategies for improved funding policies to allocate best the right incentives to ensure private and national economic aspects and public goods.

B.2.2.4 Interfaces to and cooperation opportunities with the other excellence areas

A clear identification of actors and stakeholders will allow defining the spatial entities to be addressed. Economic and political decisions are taken at administrative level, starting with communes and municipalities. Research should start from there and avoid continuing its focus on biophysical entities (catchments, Eco regions, soilscapes, landscapes, etc.…) which might be interesting from a purely biophysical research angle, but are usually irrelevant for decision making at political and economic scales.
ELI needs to federate the existing land use research and assessment initiatives in Europe, starting with the EEA Topic Centre on Land cover/land use, the ESPON, the Land Resource Management unit of the DG JRC of the European Commission, the ELD initiative and others.

B.2.3 Software, data processing, services *(Marc Jaeger, Centre de recherche français qui répond, avec les pays du Sud, aux enjeux internationaux de l'agriculture et du développement, Unité Mixte de Recherche AMAP, EPI DigiPlante)*

B.2.3.1 State of art of research

Support tools for enhancing integrated land use and land use planning, comprise models, simulators and also visualization tools whose technologies and product typology can be *classified* and described by nature, scope, scale, diffusion , owner and other property related rights and status.

Coming to the single classification criteria, *nature* of such tools can be split into numeric and not numeric models.

Under numeric tools we understand any program, applet, application controlling or processing data acquired by devices, or processing land use oriented data under user or process control. It concerns thus analyzers, simulators, optimizers, decision support systems, etc.
It also concerns communication classical dedicated tools such as web site, portals, specific communication devices drivers and more generally any program, application bringing information to user, allowing or not interaction between the user(s) and other programs or information sets. In our context shared working plays an important increasing role (FAQ, Forums, shared data: documents definition, exchanges, agenda, tools, up to computation power -i.e. Cloud computing)
For these processes, nature is also expressed by the software codes in general (from high level application to contributions), such as platforms, software suite, stand alone, software application, plug-in software pieces, embedded software piece, or algorithms. Besides processes, numerical information data is of course the hot point in land use applications. Information may be organized (Data bases, including geographic information systems, Numerical diagrams, work flow scripts, Model (data) descriptors (XML, UML). Unorganized collections (Numerical documents, bibliography, templates) are often also considered.

Under non-numeric tools, we understand a wide range of products and activities potentially leading to profitable activities. Among these we can make a clear distinction between materials (devices), methods and their related documentation, and services.
Material devices can concern any specific task in a process (sensors, passive device -i.e. filtering, active i.e. automate). Methods and their related documentations can concern protocols, regulations and legal issues, standards, norms, know-how, tutorials, maps, table/decision guides, conversion tables, and so on). Services cover a wide range of domains, among them expertise and formation play key roles. Diagnosis definition, reporting, state of art, scientific study impact study, public inquiries, meeting animation, dialog facilitation are also typical services of interest.

Scope can be defined by the specific technological components as described in the land use sectors agriculture, forestry, urban areas, and water management. Examples therefore are crop models in agriculture, growth and yield models in forestry, urban sprawl models for urban systems or flood simulators in water management. Technological components can also cover the interface of several land use sectors, such as associate culture models, or water resource maps. Some of them include generic technological components which are however dedicated to land use applications such as GIS, land use specific tools such as tree growth modeling, integrated dedicated applications for critical topics such as water erosion / flood / fire risk, land use dedicated tools showing multi-functionalities such as DSS, or tool boxes open to many applications such as R for statistics. Another scope is to organize (specifically for numerical products), their positioning towards the information use, data organization and interaction with the user. This comprises features such as data acquisition, data organization, data processing, data restitution and data interaction with the user.

Scale of the tools can range from micro over meso to macro scale. Under micro scale we understand the scale of the different elements interacting within the management unit (for instance the single plant, the single tree, etc.). At this stage we do not consider an area but a single bio-physical/social component system as the unit. Under meso we understand either a management unit or (more oriented on geographical definition) a region in which different elements are interacting. Under macro scale we understand national, EU or global scale (dependent from the application area of a tool), i.e. a superior spatial entity, where different meso scale systems are interacting. This differentiation is made for practical reasons. First, for land use and land management, it is essential to deliver integrated indicators at high integration level which meets the scale where decisions are made (meso) or where policies are evaluated (meso to macro). Second, for "integrated land use" we need to define a spatial entity where this integration happens and we refer here mainly to the meso (= landscape) scale.

Diffusion and IP: The way and the right technology and product uses and their diffusion are defined might be discussed in critical manner considering land use applications, since dedicated these are particularly meant to "share something". Decision for specific of, for instance GPL for a software piece, may become a deadlock for its valorization, contaminating the software suite the piece is plugged in.
There must also be a clear situation for data (acquired, simulated, etc.) and data owner ship. There must also be room for non-commercial and commercial applications. A good practical way to start with is to define the rights of products/production inspired from Creative Commons Licenses. Making clear according to owner ship, commercial, derivatives, shared : BY-NC-ND-SA allows a wide range of potential uses. All of Creative Commons licenses require that users provides attribution (BY) to the original creator and licensor (where those are different) when the content is used and shared. Some licensors choose the BY license, which conditions reuse only on that condition. The other licenses combine BY with one or more of three additional conditions: NonCommercial (NC), which prohibits commercial use of the work; NoDerivatives (ND), which permits reuse provided the work is not modified; and if modifications are allowed, ShareAlike (SA), which requires modified works be released under the same license.

Status can be research, prototype, operative, validated , in practical use. The qualification can be addressed to tools, documents, norms protocols among others

Further criteria we can use *to describe* tools functionalities are, material (type of devices), services which are provided, output which is provided.

Material can be acquisition systems dedicated (Lidar, T-Lidar, images, weather data acquisition tools...), acquisition systems not dedicated (GPS, smartphones, etc.), specific scope related material (sensor, automate, etc.), restitution devices generic (screen, tablets, smart phone, cave), and restitution devices specific. Specific communication devices are any program or application bringing information to user, allowing or not interaction between the user(s) and other programs or information sets.

Services which are provided by the tools can be expertise, diagnosis, reports, maps, state of art analysis, scientific study support (research tool), impact study support (analytical tool), public inquiries (data gathering tool), meeting animation (moderation tool, and dialog facilitation (communication dedicated tools such as web sites or portals). Specific services are shared working spaces such as FAQ / WIKI, forums, shared documents definition, exchanges, shared agenda, shared data, shared tools or cloud computing.

Output, which can be generated are, for instance, information documents (recommendations, tables, maps), norms, regulations and rules, Know How (courses, tutorials, technical books, etc.), or protocols.
Output can also be organized numerical collections, such as numerical documents, bibliography, templates.

B.2.3.2 Visions

A wide range of technologies listed above should and will be applied in land use practice in future, from public low cost up to advanced collaborative cloud computing.

The overall evolution thread lies in the way development and research are organized, leaving the classical analytic local path to collaborative global approaches. Disciplinary methods and specialized tools have to be interfaced/ connected to answer global questions, with help of distributed data, power and knowledge.

Some examples should illustrate such future visions:

(I) Project communication to public and public assessment (2015). We set the case of a 3 scenario land plan, where public feedback is taken in to account. A typical realistic frame could be:

- the three scenarios are made available from Web (but not advertised specifically)
- from smartphone people can access to the scenario, for instance, from a google map/ google earth entrance, at the position they are currently staying and see the project (if we are advanced in future with augmented reality), post comments either to connected people, either available for other neighbors, or just for authorities
- the scenario definition can be performed from classical current technologies

(II) Advanced scenario planning (simulating functional landscapes in 2030). We suppose that advances in the various sectors are significant, that process metadata, input and output specification are reliable, as well as climatic, socio economical and land cover data.

- scenario simulation can be requested from any sector without integrating models from the others
- the user launches a request of simulation in a given area. In a first step landscape components are requested (cloud computing) in order to gather the main controls the various simulators will have to be specified (in the various sectors). In a second step, those parameters will be recombining for higher level ones, more qualitative and integrated, able to be controlled by the user.
- the simulation performs looking for the requested maps, simulators, optimizers. The main difference compared to nowadays lays in the fact that all resources are distributed - and that - theoretically - data and simulators are under the responsibility of each sector
- the user can receives overview of the simulation results and can inquire/interact with the process

B.2.3.3 Upcoming research needs

Considering scale aspects and sector relevance, we can outline a few global threads. Integrated landscape studies are underlying a wide range of multidisciplinary, multilevel interactions. The related questions are thus related to complexity, as shown here under.

In fact, so far, agronomy, forestry and water management had developed efficient micro scale practices and tools in their own sectors, targeting a high productivity. One could say similar things when considering transportation aspects in urban areas. There is thus a basis of precise data raising from efficient data acquisition devices and protocols and several decades of production studies, modeling and simulation at micro stage level (on the basis of intensive production, at constant climatic conditions, without stress implication).

Spatialized data and information processed from the sectors can usually be share and compared with GIS at more or less compatible scales. Overview of the sectors and their dynamics can thus be explored at macro-meso scale from various entries and level from single figures to 3D exploration.

The common pressure (global change, biodiversity, food quality, resource optimization, pollution level) hold on the sector push them to explicit their “implicit” input and output. At the same time alternatives leading to heterogeneous crops are pushed. These changes implies deep practices changes, the production systems are to be seen as dynamic systems (in terms of underlying mathematics), and no more as simple servo mechanical systems. For these both reasons, knowledge in the management units is deeply revisited in the past decade, focusing in the unit component interaction (i.e. the under micro state).

With increasing technological evolution of data acquisition and cost drops (images, GPS, smart phone, laser, etc.) specialized information volume becomes huge and heterogeneous in nature, quality, and density.

The society is getting more and more concerned by the environmental aspect and the economic potential of appropriate land use policies. So far, at least, when concerned by the urban areas sector, in most European countries, communication towards public and deciders is already involving numerical technologies, through single maps up to virtual reality scenes. However, simulations are nowadays still far away from being generalized. In fact, except specific areas, simulations are seldom validated - the way models are defined and used in biology, ecology, social sciences are very far from physics, but there is a general tendency to push to a stronger formalism inside the agriculture sector (see previous paragraph), and some cases (risks) where simulation is deeper involved
Critical risk aspects are promoting researches contribution to technological developments, using intensively massive acquisition, numerical simulation, optimization and communication. This point can be developed at regional scale (survey of villages risking slide slopes up to European scale: considering for instance the JRC FLOODS program)

B.2.3.4 Interfaces to and cooperation opportunities with the other excellence areas

One of the most important needs is to tackle with increasing knowledge in each sector and making it available. Of course, each sector is putting great efforts to increase its understanding. What we could underline here, is a quest to explicit more deeply the interaction between the usual kernel of the sector and the resources potentially provided/or in competition with another factor. The reason is that, in most applications at local and macro scale, it is difficult to couple in a same study several dynamic processes. The coupling can thus be performed from the resource point of view, i.e. modeling through fluxes. At the same time, potential coupling gets easier when using meta-data describing data and process. It may allow at mid-term the use of procedure, simulators by specialist from other sectors, with a minimal critical quality set. Another need is to enhance communication and interaction from the end user point of view. This includes access to data acquisition and retrieval, development of standardized user inquires and feedback retrievals, imaging technologies (virtual reality, augmented reality) and positioning (GPS through smart phones for instance. Further, we need to enhance collaborative work. Collaborative tools are far to be efficiently used, while the land use context pushes to.
Finally, the way how models and simulators are defined should be rethought. In most biophysical dynamic models, the cycles are defined from the sector uses (thermal time for crops, years for forestry, some minutes for flood, day for catchments, etc.). Rewriting the models at arbitrary time schedules (very far from being easy) allows coupling them easier, and studying their behavior under formal approaches. This would greatly enhance our understanding of (socio-)-ecological systems and help us to better consult land use planners, decision and / or policy makers.

We should also give more room to open applications and products from the existing ones. This point lies both on technical and legal aspects. On the technical point of view, numerical resources (data, diagrams, programs) must be defined as modular as possible with clear documentation, in the aim of being reused in very various conditions. By associating the rights the owner chose to attribute, we could define the context of use, evolution and valorization of tools in integrated land use. This is a key for both technology spread and economic developments.
Thematic and technological interfaces especially considering integrated land use (socio-ecological) system modeling are established to all sectors and cross-cutting areas. More intensively we need to set an interface to the socio-economic and policy sector as the strength in technological development is to provide sectoral research results in a manner that makes it usable for decision making and policy assessment. A successful example are applications in the integrated water management, however, a broad and standardized form how to use enhanced technologies for integrated land use management decision and policy making at landscape as integrative spatial entity is far beyond from what is so far achieved.

B.3 Synthesis

As a conclusion from our different sectors and cross-sectoral topics we should define the meso to macro scale (landscape, region and beyond) as spatial integration entity for our research where we need an improved understanding of interactions between land uses and their spatial pattern. We should however leave the viewpoint of the landscape or region as purely biophysical unit and start our research from the actors (decision and policy makers) which are concerned by ecosystem processes, ecosystem services provision and trade-offs or future land use decisions.

That would demand a change in philosophy in many of our research activities from a way where nature sciences first provide results that are then digested by social sciences toward a way, where research questions and focus is first identified by social sciences together with the actors and then communicated and researched together with natural sciences. Also the question of early stage actor involvement in defining and designing research will be demand of a better integrated research that is not only interdisciplinary but to a much higher degree transdisciplinary. Early stage actors involvement and the opportunity to drive research rather than to participate somehow would also greatly contribute to increase attractiveness of integrated land use research for the actors and contribute much to better public perception of our research.

Integrative concepts such as ecosystem services or land use functions provide already a framework for integrative land use research because they necessitate translating biophysical findings into more aggregated terms that can be communicated and used in land use planning. However, so far these concepts when applied in research lack also the involvement of the concerned actors from the early stage on, who might agree, disagree with or complement the original services or functions to objectives in land use planning practice that are relevant for their decisions. Only, if we allow for such actor-driven research, additional benefit will result in providing and enhancing services to society by making use of research to support land management and land use planning practice. Only if we increase actor involvement from the scale where the decisions are made that we wish to support with our land use research, research results will be understood, absorbed and used. For integrated land use research this would also mean to be more scale specific in the research approaches and to orient the assessment and aggregation methods in research to the knowledge demand and needed degree of detailedness at the addressed spatial scales and their actors.

A major challenge in handling socio-ecological systems research will be the understanding of their different drivers and the different nature of these drivers. Uncertainty in data basis and models, uncertainty or even impossibility to foresee land owner decisions and behavior of social-system components, complexity of different scales to be considered and lack of knowledge on interactions between the different socio-ecological system components impact considerably the reliability of results from integrated land use research and validation is in most cases impossible. The only way we could go is to work in an integrative way on identifying the different system components, add knowledge on their potential behavior and interactions, their spatial and temporal variability and assess stepwise their impact on each other system component and the system itself.

Pre-requests for such iterative approaches are sufficient information base and knowledge access. Our current monitoring and assessment systems might fail to provide the necessary basis as they are way from considering interactions between different land uses and providing the basis to assess the necessary parameters to monitor changes in integrative concepts such as ecosystem services provision. Knowledge accessibility and communication could greatly profit from making increased use of available data aggregation, simulation and transfer technologies instead of blowing up data bases that will never been explored.

Finally, “integration in land use research” would also address the integration of different research types such as environmental and socio-ecological systems research, research on consensus building in different cultural systems and development research, communication research and global transformation research. This would go clearly beyond what we understand so far by interdisciplinary and would request mutual learning from and management of different research philosophies, cultures and understanding of what research and science as such mean and can contribute together with society for the future.

Seven focal research topics that we can formulate from our sectoral and cross-sectoral analysis are:

1. Innovative monitoring and survey systems that support the assessment and monitoring of the provision of ecosystem services or land use functions as integrative concepts to support sustainable land use planning.
2. Transferable framework for model integration at different scales and cross scales and approaches how to handle uncertainty and validation problems
3. Approaches on how to assess and describe the role and contribution of specific land use types within a socio-ecological system context to ecosystem services provision and new concepts for their land use type specific and system specific assessment (e.g. agro-ecosystem services, urban ecosystem services, hydrological ecosystem services, forest ecosystem services).
4. Approaches for accounting better on land use interactions and their spatial pattern in assessing the ecosystem services provisioning capacity in a socio-ecological system context.
5. Approaches to account better for the status of ecosystems and the land as such in assessing their potential to sustainably provide services, taking different degrees from non-impacted to highly degraded into account.
6. Improving technologies and their use in enhancing knowledge accessibility, knowledge comprehensibility and communication with actors as a basis for integrated land use research
7. Innovative concepts for actor driven research and early stage actor involvement in integrated land use research design

B.4 Definitions

Adaptive system management strategies: Management of a (land use) system in a manner that takes the permanent dynamics and responses of the system on changes into account. An end status (climax) of the system can therefore not be defined.

Adapted system management strategies: Management of a (land use) system in a manner that defines an expected future status of an environmental / socio-economic driver / condition and tries to adapt the system to this future condition.

Ecosystem functions: Physical, chemical, and biological processes or attributes that contribute to the self-maintenance and resilience of an ecosystem.

Ecosystem services: Assessable activities, characteristics, functions, or outputs of ecosystems for which a value for human welfare or contribution to human / societal needs can be formulated.

Integrative land use management: Open land use system management concept that allows for permanent consideration of new elements that might impact the performance of the land use system

Integrated land use management: Land use system management concept that provides a framework for integrating pre-defined system elements in optimal way.

Landscape: Spatial entity that is characterized by a context and position specific bio-geo-physically and socio-culturally driven land use (pattern). In contradiction, a region is more defined in a socio-cultural and administrative understanding that allows defining borders (system boundaries) even if these are not justified by environmental conditions.

Landscape service: Comparable to ecosystem service, but with a perspective on the whole landscape as (socio-)-ecological system.

Land use: Way how land as biophysical resource is made accessible, managed, exploited or sealed.

Land use function: Benefits that are provided and can be quantified or at least put into value from using land, where "use" is seen in a wider sense and comprises also "non-use" options.

Land use system: Spatially connected and interacting cluster of different land uses in a landscape or regional context.

Scale – micro: local scale, management planning unit scale

Scale – meso: landscape or regional scale, land use planning scale

Scale – macro: global scale, scale of macro-drivers

Socio-ecological system: (Problem) context specific bio-geo-physically defined spatial entity including related and dependent social actors and institutions.