Federal Ministry
of Education
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FONA
Research for Sustainable
Development
BMBF

Sustainable Land Management

A Challenge for Everybody

RESEARCH

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Foreword

Land is our habitat and the basis for the existence of all people. We use and change the nature of land by building settlements and roads, planting crops, prospecting for sources of energy and raw materials or disposing of our waste. Global and regional developments, such as climate change and global population growth, or political decisions, such as the Energiewende in Germany, create a national and international need to intensify or adapt land use. However, such moves always involve the threat of overexploitation and the permanent loss of arable land and important ecosystems. Against this background, "sustainable land management" is a central task for the future. Players from research, municipalities, business and politics will have to find answers to urgent questions of the future, such as: How can we ensure long-term added value in the region without jeopardizing ecosystems and biodiversity? How can we increase the productivity of land use and, at the same time, protect soil and water resources and counteract climate change? How can we manage the competition over space between food production and the expanding bioenergy sector? How can we improve the quality of life in rural areas, and how do we link the development of urban and rural areas? These are the issues that the Federal Ministry of Education and Research (BMBF) is tackling with its research funding because research can make important contributions, particularly if it cooperates with users from the very start. The focus is on developing and implementing knowledge for action. The "Sustainable Land Management" funding activity is part of the BMBF's framework programme "Research for Sustainable Development (FONA)". Basic knowledge and forward-looking ideas for the land management of tomorrow are being developed in Germany and Europe as well as in Asia, Africa and South America. The main characteristic of sustainable land management is that it unites a large number of disciplines such as spatial planning, energy supply, agriculture, water management, urban development and forestry. This process involves both the scientific disciplines and the users.

This brochure presents the projects funded by the BMBF. It shows the great diversity of challenges and problems as well as the manifold approaches under which research and application are working to produce viable concepts. Sustainable land use and land management are indispensable for our future. I wish you informative and gainful reading.

Dr Georg Schütte
State Secretary, Federal Ministry of Education and Research

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Introduction

Land use and the consumption of natural resources are drawing increasing public attention. There are good reasons for this: the climate is changing, cities are growing, geographic distribution and the age structure of the population is changing, and the higher prices for agricultural products are increasing the pressure to make more intensive use of land area. As a result, land is in short supply and conflicts are bound to occur.

There is regional and global competition over productive arable land between the production of food and the cultivation of renewable energy feedstocks. The very real expression of this dilemma is the current political debate about "food versus fuel". Furthermore, the protection of the environment and climate must also be taken into consideration. Should priority be given to the expansion of settlement areas or to the preservation of valuable arable land? Is it better to protect biodiversity or to grow biomass on plantations? These are regional conflicts which are arising more and more frequently.

Solving these problems and finding a sustainable way to use available land areas calls for new ideas. The approaches to these issues taken in agriculture, municipal and urban planning, forestry, and in nature conservation and water management will have to be more closely interlinked in future. The functions and services that vital ecosystems provide for humans, biodiversity and regional value creation can be combined successfully. Energy and material flows, for example the water and nutrient cycles, are best and most wisely managed in regional urban-rural collaborations.

It is therefore the task of government, industry, society and science to draw up proposals which can be implemented at regional level. This will require new solutions from research – and a new kind of research. This is why the Federal Ministry of Education and Research (BMBF) launched the "Sustainable Land Management" funding measure.

The research projects funded by the BMBF will develop systems solutions that are innovative and easy to implement. The focus is on regions which are at a particular disadvantage as a result of change. These changes include loss of soil fertility, deforestation and erosion, rising sea levels, but also the migration of young people away from rural regions and increasing urban sprawl. Researchers are working on solutions which act as a model and can be implemented in other regions. Examples could be the establishment of new value creation networks for biomass through the management of peatlands, the development of new ways to organize land management, or sustainable farming methods in rice cultivation.

Scientists from a number of different fields and practitioners in the regions are working together in interdisciplinary and transdisciplinary projects. In cooperation with players from associations, initiatives, government, businesses, and land owners they are developing application-oriented strategies and measures. The objective is to provide local people with solutions that can be implemented over the long term and with ideas that can also be realized in other regions.

The "Sustainable Land Management" funding measure focuses on two key areas of interest.

The focus of research in **Module A** is on the interplay and interdependencies of land management, climate change and the services provided by ecosys-

Natural resources

Natural resources are materials and goods that are supplied by nature and can be used by people. In a broader sense, this includes water, soil and air; strictly speaking, the term refers to biotic and abiotic resources.

Ecosystem

An ecosystem is made up of a biotope (habitat, location) and community of organisms (biocenosis). A few examples of ecosystems are peat bogs, forests and agricultural land.

Ecosystem services

Ecosystem services refer to all the products and functions of an ecosystem from which people derive direct or indirect benefit. This includes clean water, food, wood but also services such as pollination, natural pest control and soil fertility.

tems. Twelve projects are analyzing the complex correlations between land use, globalization, climate change, loss of biodiversity, population growth and urbanization. Researchers are developing solutions that prepare the project areas for change. The knowledge gained will be used to implement measures in these regions. The researchers work together with local partners to develop and trial proposals for the preservation of vital ecosystem services. The twelve projects are being carried out in Africa, Asia, South America and Europe.

Research activity in **Module B** concentrates on integrated urban-rural development. Its objectives are to strengthen value creation at the regional level and to optimize energy and material flows between cities and rural areas. The focus of the 13 projects is to develop and implement new, sustainable and practicable approaches for regions in Germany facing different challenges. This demands an understanding of which factors influence land use and how they relate to one another. Typical issues in this context are to examine the interaction between energy, environmental, agricultural and structural policy as well as that between settlement and transport development. Or: how do land owners influence land use?

The scope of the projects is very diverse. They are concerned with such issues as the adaptation of technical infrastructure systems to the change in demand, resource-efficient and low-emissions settlement development, decentralized renewable energy supply systems, and the integrated use of land and water resources.

These projects are backed by two scientific coordination projects. They are located at the Helmholtz Centre for Environmental Research (UFZ) in Leipzig (for Module A) and at the Centre for Agricultural Landscape and Land Use Research (ZALF) in Müncheberg (for Module B). The scientific coordination projects support the projects in communications and public relations work. They also compile the results of the projects, adopting an integrated approach to develop their own findings. This generates new information, models of land use or recommendations for land management which are general enough to be transferred and applied to other, similar regions.

The aim of the Federal Ministry of Education and Research's "Sustainable Land Management" funding measure is to contribute to the development and implementation of practical solutions for global and regional challenges. It seeks to develop new perspectives on the responsible use of the scarce resource land.

Fig. 1: The Ruhr district (Source: Th. Weith).

Urbanisation

Urbanization is the term used for the spread of dwelling and land use in urban areas as well the rising proportion of a region's, country's or state's population living in cities.

Scientific coordination projects in the "Sustainable Land Management" funding measure

Common goals, communication and networking

The scientific coordination projects

The BMBF funding measure "Sustainable Land Management" brings together a large number of different stakeholders and perspectives in its projects. In order to make the numerous findings available to various user groups, the funding measure is supported by the overarching scientific coordination projects. **Module A (Interactions between land management, climate change and ecosystem services)** is coordinated by the scientific coordination project GLUES (Global Assessment of Land Use Dynamics, Greenhouse Gas Emissions and Ecosystem Services) located at the Helmholtz Centre for Environmental Research – UFZ in Leipzig. **Module B (Innovative system solutions for sustainable land management)** is coordinated by the scientific coordination project based at the Leibniz Centre for Agricultural Landscape Research (ZALF) in Müncheberg.

Communication and networking

The scientific coordination projects initiate and support communication among all those involved in the funding measure. Via **networking and collaboration**, they collect and synthesise results generated in the collaborative projects, and promote their **dissemination and implementation.** The main targets are national and international partners from research, government and local authorities as well as the private sector and civil society.

The main aims of the scientific coordination projects are to promote the funding measure and its research projects and to introduce new scientific findings to the **general public**. They serve as contacts for media representatives and others interested in sustainable land management.

The **communication processes** primarily include the networking of collaborative projects via joint events and communication platforms. The coordination projects develop and pursue a communication strategy specifically designed for the funding measure.

Implementation and transfer will include the analysis of positions and activities of different target groups. Concurrently, national and international political and scientific networking will be encouraged. The products of the collaborative projects and scientific coordination projects will be distributed via newly developed exchange platforms, such as teaching and learning modules.

To improve the **management of generated knowledge**, scientific collaboration will be initiated and learning processes encouraged via a web-based knowledge platform.

Fig. 2: Events are organized by the scientific coordination project of Module B (Source: ZALF).

Fig. 3: Closing plenary session of COP 10 of the CBD (Convention on Biological Diversity) in Nagoya. One of the tasks of GLUES is to support regional collaborative projects concerning the science-policy interface (Source: C. Paulsch).

Structure, synthesis and expected results

GLUES – scientific coordination project of "Interactions between land management, climate change and ecosystem services" (Module A)

Structure

In order to address a variety of the above-mentioned overarching tasks, GLUES works in the following areas:

Communication, support and public relations

- Outreach, networking and knowledge transfer to support synergies among disciplines
- Supporting stakeholder work and integration, and practical continuation strategies of project results
- Supporting the science-policy interface and integrating scientific findings in international processes and conventions

Research areas

- Building a platform for a common and consistent data pool and supporting information and data exchange (GLUES Geodata Infrastructure: http://geoportal.glues.geo.tu-dresden.de)
- Developing models and scenarios of global land use and climate as a common basis for the analysis of results from the collaborative projects
- Providing a framework for an analysis of results and a scientific synthesis

Synthesis

The scientific synthesis of **Module A** aims to provide a general framework for the evaluation of results from the individual collaborative projects and their up-scaling to the programme level. The main goals are:

- Developing new knowledge on general patterns and indicators of land use, ecosystem services and greenhouse gas emissions
- Providing a generally applicable framework for reporting case studies on ecosystem services
- Providing methods for the evaluation of trade-offs between ecosystem services, greenhouse gas emissions and economic activities

Fig. 4: Structure of the scientific coordination project GLUES (Module A) (Source: UFZ).

- Analysing trade-offs and off-site effects of regional land-use strategies
- Characterising and classifying collaborative projects in order to enable the transferability of results to other regions and spatial scales
- Deriving general recommendations through which findings and solutions to local environmental problems can be translated to global land management

Expected results

The scientific coordination project GLUES initiates networking between science and practice. The research projects are supported and guided with the help of a common database and standardised land-use scenarios, and the analysis and synthesis of global and regional impacts of land management on ecosystem services and greenhouse gas emissions. The synthesis integrates results of the regional collaborative projects with respect to the requirements of different user and stakeholder groups. The results will be provided to potential user groups and implemented into international political processes through continuous communication and the development of science-policy interfaces. In this way, GLUES aims to raise the profile of German land management research among the international research community.

GLUES partners	Responsibilities
■ Helmholtz Centre for Environmental Research – UFZ	■ Overall coordination, communication & networking, scientific synthesis
■ Technische Universität Dresden	■ Geodata infrastructure
■ The Kiel Earth Institute, Kiel Institute for the World Economy	■ Medium-term models & scenarios
■ Ludwig-Maximilians-Universität München	■ Medium-term models & scenarios
■ The University of Bonn	■ Medium-term agro-economic models & scenarios
■ Potsdam Institute for Climate Impact Research e. V.	■ Long-term models and scenarios
■ Institute for Biodiversity	■ Science-policy interface, international conventions
■ Moll & Zander	■ Stakeholder integration, practice-oriented continuation strategies
■ Metronom	Agency for communication and design	■ Design of all publicity activities, e.g. print media, website
■ Con terra, 52N	■ Technical implementation of geodata infrastructure

Fig. 5: GLUES partners and their areas of responsibility (Module A).

Contact

Scientific coordination and synthesis GLUES, Module A

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www.sustainable-landmanagement.net
(Module A / GLUES)

Scientific coordination project of "Innovative system solutions for sustainable land management" (Module B)

Metaanalysis and synthesis

The scientific coordination project of **Module B** deals with interdisciplinary topics and supports the further enhancement of discussions and results. Important topics and issues in Module B are:

- Models and scenarios in "Sustainable Land Management"
- Indicators for sustainable land management
- Design of regional material cycles and energy flows
- Management of participation and communication processes
- Regional water and land management
- Development of partnerships between individual collaborative projects, foundations, associations and other organisations

New results

Apart from substantial **dialogue** with stakeholders from government, local authorities, civil society and the private sector, the findings need to be carefully reflected in order to develop long-lasting, stable solutions for sustainable land management and to initiate new courses of discussion. The scientific coordination project offers special events for specific target groups (e.g. administrative staff, students) in order to promote the **continuation** of activities and the application of knowledge in other regions. In addition, outstanding results will be communicated through flagship initiatives.

The scientific coordination project also contributes to **interdisciplinary and transdisciplinary collaboration** between science and practice and to **knowledge and research management.** Furthermore, it addresses on **common issues of sustainable land management**, such as future urban-rural relations, innovations in land management and factors of land-use change.

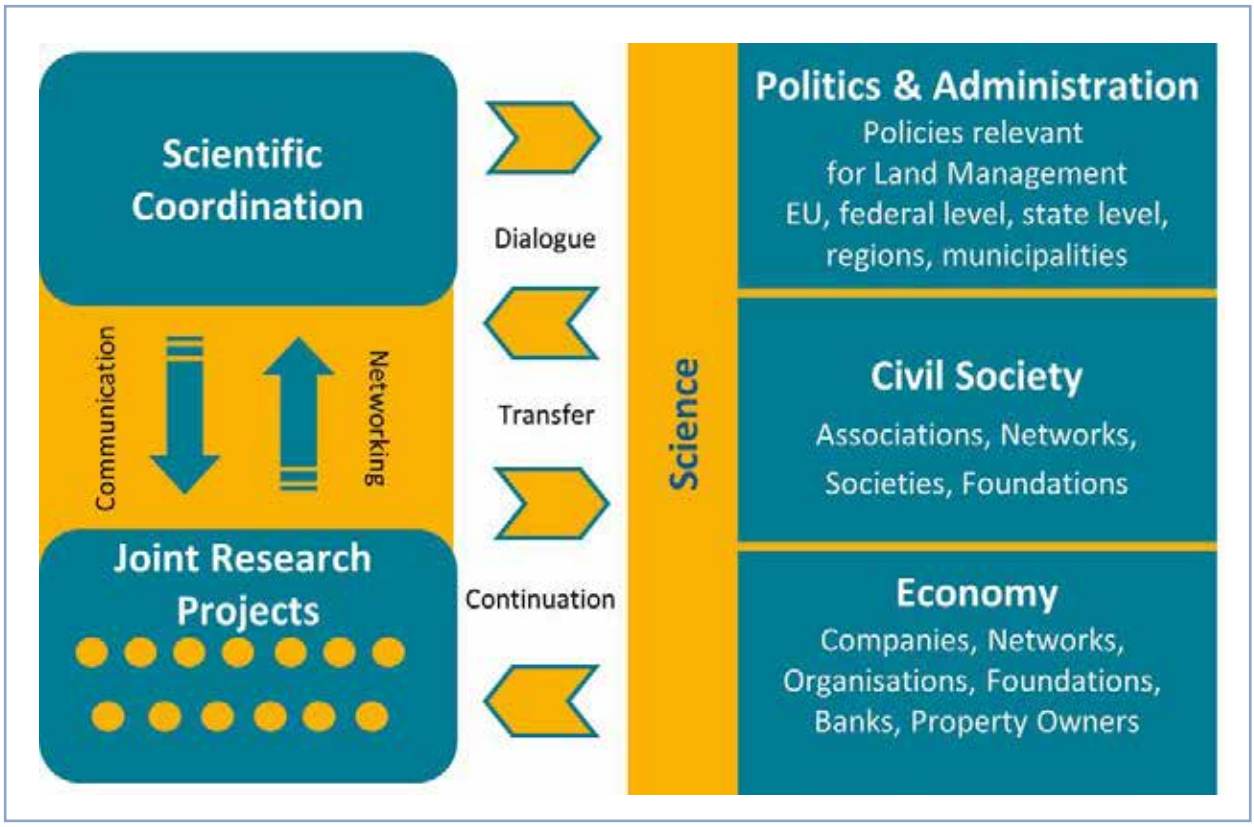

Fig. 6: Target groups and their integration in the scientific coordination project (Module B) (Source: ZALF).

The scientific coordination project tackles two core subjects: sustainable land management and interdisciplinarity / transdisciplinarity (see Fig. 7).

In addition to the research work in the thirteen collaborative projects, specific key issues will be addressed to further promote a debate within the funding measure. Such issues will include the impact of demographic change on land-use processes, opportunities for urban agriculture and new economic and legal frameworks. Additionally, experience gained through international exchange will be shared with all interested parties.

Structure

The scientific coordination project of Module B is based at the Leibniz Centre for Agricultural Landscape Research (ZALF). The coordination team at the Institute of Socio-Economics closely collaborates with scientists from other institutions to obtain specific expert opinions.

The central issue of sustainable land management

- Sustainable land management: What does it mean from the perspectives of different stakeholders?
- Innovations in sustainable land management: How can we influence land management innovation processes?
- Urban-rural interdependence: What are the relationships between rural and urban areas and what is their impact on land use?

The central issue of inter- and transdisciplinary research

- Inter- and transdisciplinary research: How effective are these approaches in sustainable land management?
- Knowledge management: What stakeholders have what knowledge? How can we make this knowledge available and maintain it in the long term?
- Implementation and transfer: What are the requirements for the for implementation of jointly developed solutions? How can success be measured?

Fig. 7: Key questions of the scientific coordination project (Module B).

Fig. 8: Cultural landscape at Ronneburg (Source: T. Weith).

Expected results

The sustainable land management puts emphasis on complex spatial cause-effect relationships. For instance, the regional solutions are discussed in an urban-rural context. The combination of various analyses, assessment methods and control tools offers new approaches and innovative system solutions, including:

- A combination of different knowledge bases used by various stakeholders for the development of new technologies, instruments and system solutions
- A combination of different technological and social innovations and different scientific know-how
- The development of new innovation-stimulating organisational structures for sustainable land management and to support interdisciplinary and transdisciplinary research
- The further development of innovative concepts, strategies and tools for land management;
- The design of knowledge transfer, innovation impulses and regional added values
- The promotion of international networking and dissemination of results

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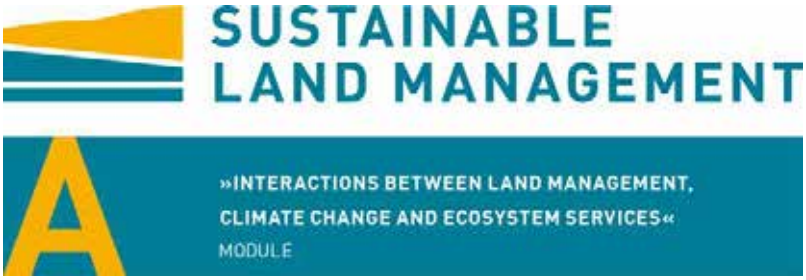
Fig. 9: Location of collaborative projects in Module A (Source: UFZ | Metronom).

Collaborative projects “Interactions between land management, climate change and ecosystem services” (Module A)

Twelve collaborative projects in Module A are located in various regions of the world. They develop model solutions for sustainable land management and, in close cooperation with partner countries, produce strategies for maintaining important ecosystem functions and services. On the next pages, the individual collaborative projects introduce their activities.



Carbiocial | Carbon sequestration, biodiversity and social structures in Southern Amazonia: Models and implementation of carbon-optimized land management strategies

Background

The Amazon rainforest plays a key role in the carbon cycle with repercussions for global climate change. The German-Brazilian collaborative project Carbiocial, in close collaboration with the Brazilian co-project Carbioma, investigates what land management options exist to preserve soil carbon and reduce greenhouse gas emissions. The main focus is therefore on the analysis and development of methods for carbon storage in soils, the reduction of greenhouse gas emissions, and the preservation of important ecosystem functions, such as soil fertility and water quality.

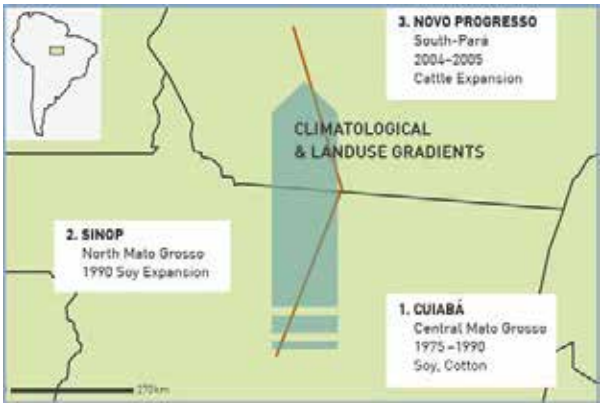


Fig. 10: Study area of southern Amazonia (Source: Carbiocial).

Objectives and research strategy

The researchers will adapt and use scientific models that will show farmers, environmental authorities and research institutions the effects of various climate and land-use scenarios in the Amazon region. These models will take into account important socio-economic processes and regional land-use change patterns. Another goal of the interdisciplinary research project is to develop a decision support platform, which should help to assess ecological and economic consequences of different land management strategies at a regional scale. The research is mainly conducted in the Brazilian states of Mato Grosso and Pará

Fig. 11: Rainforests are clear-cut to provide space for extensive cattle pastures (Novo Progresso) (Source: S. Hohnwald).

in southern Amazonia. The core study sites of the project are located along the Amazonian north-south transport corridor, the BR-163 federal highway from Cuiabá to Santarém. This road is due to be paved and widened in the near future allowing the soya exporters to deliver their goods faster to the port of Santarém. Most of the project studies and experiments are taking place in three important development regions

Fig. 12: Large-scale soy / corn cultivation with remaining rainforest patches in northern Mato Grosso (Sinop) (Source: S. Hohnwald).

Fig. 13: Nelore cattle are frequently used on large-scale farms because they are better adapted to the tropical climate (Source: S. Hohnwald).

around the cities of Cuiabá, Sinop and Novo Progresso, which form a spatio-temporal axis within the development of southern Amazonia (Fig. 10).

Subjects of investigation

In close collaboration with local farmers, one working group investigates the carbon turnover of different land use types and collects data and parameters during field surveys and carbon accumulation experiments. This data is then used for the modelling of greenhouse gas emissions, carbon cycling, erosion and water balances. Based on previous deforestation, land-use change, and socio- and agroeconomic parameters, the second working group develops scenarios of future land-use strategies that can minimize greenhouse gas emissions. The researchers incorporate climate change and stakeholder analysis into the LandSHIFT model and apply it to southern Amazonia, while also connecting different models such as the MP-MAS and MONICA Models. In doing so, they create a decision support platform that combines ecological aspects such as water and soil conservation as well as carbon storage with agroeconomic aspects like agricultural yields and farmer incomes.

Fig. 14: Agro-industrial cotton cultivation in central Mato Grosso (Cuiabá) (Source: S. Hohnwald).

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www.carbiocial.de

CC-LandStraD | Interdependencies between land use and climate change – Strategies for a sustainable land use management in Germany

Background

How can we counteract climate change and contribute to climate protection with a responsible use of land? Should we grow more energy crops? What could sustainable and climate adapted forests or settlements look like?

The question of how to use land in Germany in the context of climate change and climate protection often triggers conflicts because of differing social demands. Opinions vary on how much land should be used for the production of food, energy and wood, or for human settlement and transport. Additionally, the type and intensity of land use significantly affect the environment and landscape, and thus the recreational value of particular regions.

Currently, about half of the land in Germany is used for agriculture, one third for forestry and about 14 % for human settlement and transportation. The potential of land management to contribute to climate protection hinges on complex interactions between land use changes and the biogeosphere, but these are not yet completely explained.

Objectives and research strategy

The project objective is to analyse interactions between different forms of land use and climate change and to assess the contribution of land use strategies to climate protection in Germany. The particular goals are:

- To develop cross-sectoral land use scenarios for agriculture, forestry, human settlement and transportation based on a dialogue with stakeholders
- To analyse conflicts between land use strategies and other social demands and feedbacks from global markets
- To derive sustainable land use strategies for the study regions which would help to achieve the climate protection goals and which can be legally implemented in practice

The complex objectives are reflected in the research strategy. Based on global climate scenarios and economic development, land use scenarios are being developed for all of Germany and modelled separately for individual regions. Interdisciplinary models help researchers to analyse interactions between land use and climate change, and to provide scientific knowledge for stakeholders and decision makers. Using various indicators, biophysical and socio-economic models are applied to demonstrate the outcomes of land use change. In addition to the social requirements, legal frameworks are also considered. These models comprehensively evaluate contributions of land use strategies and systems to climate change mitigation and energy supply.

Fig. 15: Diverse land use in Germany: agriculture, forestry, settlement and transportation (Source: aid infodienst, Bonn).

Subjects of investigation

The research is focused on developing sustainable land use strategies for three significant land-use sectors in Germany: agriculture, forestry and urban development. Two case study regions with highly different land uses are investigated in detail: the Altmark in northern Saxony-Anhalt as a region dominated by agriculture and forestry, and the Rhein-Sieg and Rheinisch-Bergisch counties in North Rhine-Westphalia, which are heavily influenced by the Cologne-Bonn agglomeration (Fig. 16).

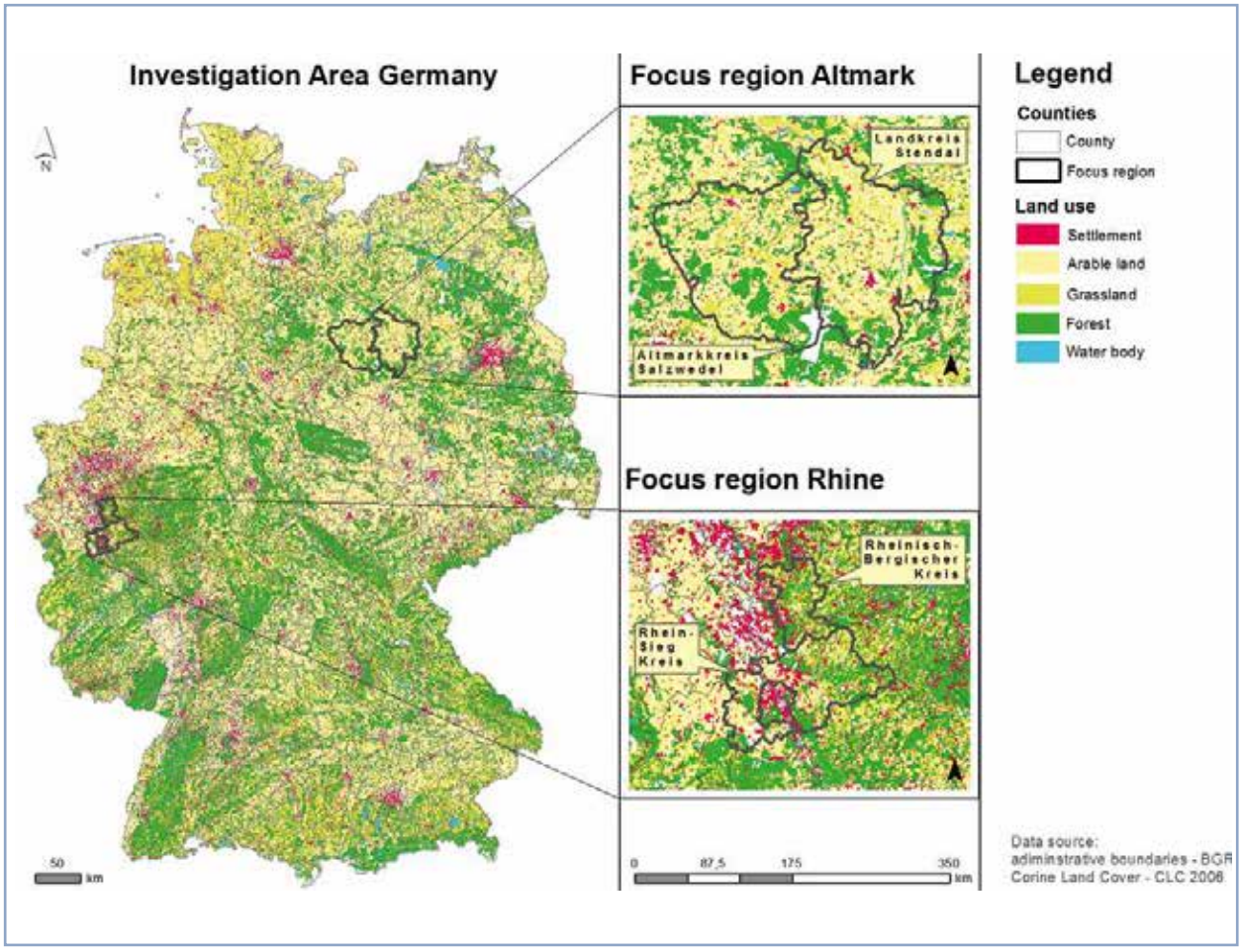

Fig. 16: CC-LandStraD study area: Germany and the case study regions of Altmark and Rhine (Source: CC-LandStraD).

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COMTESS | Sustainable coastal land management: Trade-offs in ecosystem services

Background

Sea level rise, stronger storm surges and heavier rainfall in winter are the potential consequences of climate change that could threaten coastal regions of the North and Baltic Seas. The collaborative project COMTESS (Sustainable COastal Land Management: trade-offs in EcoSystem Services) investigates impacts of the existing and new land use strategies in the coastal areas on ecosystem functions and services

Fig. 17: Typical coastline of the North Sea (Source: M. Kleyer).

under the influence of climate change. The researchers analyse environmental, economic and social conditions in the north-western European coastal areas and assess different land management options from sociological and economic angles.

Objectives and research strategy

The current coastal zone management is mainly based on the construction of dikes and the regulation (drainage) of groundwater to allow the lowlands to be used for farming. Therefore, the coastal areas are theoretically protected from flooding. However, the sea level rise and rainfall fluctuations can reduce the effectiveness of these measures and the sustainability of land use in the future.

By using different land management options and considering local ecological and socio-economic conditions, COMTESS aims to provide new land use strategies, assess and quantify the ecosystem functions and services, and extrapolate the results to the landscape level by means of statistical and process-based models. The results will be used in a socio-economic risk analysis and a socio-cultural assessment; researchers will analyse the risk perception and preferences of various stakeholder groups towards the land management options and the associated ecosystem services. Together with the stakeholders they will also develop local and regional, decision-oriented recommendations for promoting the sustainable use of vulnerable coastal areas with regard to possible climate changes. Based on these findings, COMTESS will provide a scientific and practical contribution to the design of multifunctional coastal management.

Subjects of investigation

The inter- and transdisciplinary studies investigate possible land management options for the German coastal regions.

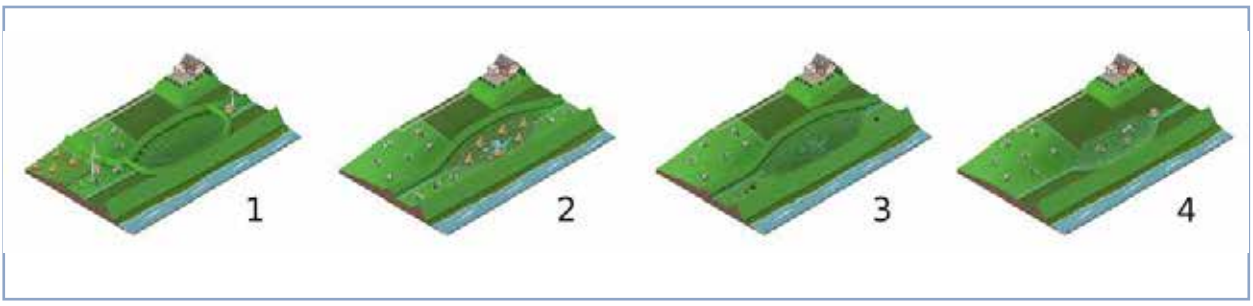

Fig. 18: North Sea land management options; 1 stakeholder-based; 2 water management; 3 carbon sequestration; 4 trend (Source: C. Fuhrmann Illustrationen).

Fig. 19: Baltic Sea land management options; 1 stakeholder-based; 2 multiple land use; 3 carbon sequestration; 4 trend (Source: C. Fuhrmann Illustrationen).

The "stakeholder-based" land management option is based on interviews with experts. In the "water management / multiple land use" option (for the North Sea and Baltic Sea, respectively), the researchers model alternative income possibilities for farmers (e.g. biomass production for energy generation). In this land management option, the dike hinterlands at the North Sea will be used to build freshwater polders and establish biomass production. The primary goal is to strengthen the resilience of the coastal zones against sea level rise and increased winter precipitation and to use reed beds as a source of renewable energy. The "carbon sequestration" option will lead to areas dominated by unused reed beds that contribute to active peat accumulation. In the "trend" land management option, a continuation of the current dairy farming and grassland management is expected. This form of management, however, may be seriously affected by flooding and associated costs for water drainage, which reduce the ecological and economic viability of this form of land use.

The ecosystem services are given different weights in the individual land management options; for example, food production has a different weight from water management or carbon sequestration. Additionally, synergies and conflicts with other ecosystem services (e.g. biodiversity and production of renewable energy) are considered.

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INNOVATE | Interplay among the multiple uses of water reservoirs via innovative coupling of substance cycles in aquatic and terrestrial ecosystems

Background

Water reservoirs represent a convenient source of both renewable energy and water for the growing population. At the same time, they are criticised because of their negative effects on specific social groups and the environment. Together with current climate changes these effects pose a new challenge for the management of river basins.

Objectives and research strategy

The INNOVATE project aims at defining governance options which promote sustainable ecosystem services and concurrently provide a solid economic base for the population. Twenty-two German-Brazilian working groups are seeking solutions for the entire São Francisco catchment and the Itaparica reservoir region in the semi-arid north-east of Brazil in particular (Fig. 20). Opportunities for their implementation are sought in collaboration with local stakeholders.

Fig. 20: Reservoir view (Source: M. Venohr).

Fig. 21: Location of the study area (catchment area). The Itaparica reservoir is located near the towns of Floresta and Petrolândia (Source: R. Koch).

Subjects of investigation

Aquatic ecosystem functions: Nutrient inputs from the river basin and altered processes in the artificial lake cause its eutrophication. Consequently, biological productivity increases, species change their distributions and greenhouse gases (e.g. methane) are released. The strategy to improve the management of this ecosystem includes the following key elements:

oligotrophication, the reduction of methane emissions, and the extraction of sediments, which will be reused to improve the quality of soils.

Terrestrial productivity: The productivity of irrigated agro-ecosystems is to be increased, carbon storage potential determined and greenhouse gas emissions minimised. To achieve these goals, mitigation measures are being explored, such as planting local tree species on depleted soils, improving the integration of animal husbandry in farming systems and adding biochar to soils. In addition, water and nutrient dynamics in soils are modelled.

Green liver and aquaculture: The eutrophication of water can lead to massive cyanobacteria outbreaks with serious health effects. Possible water contamination should be avoided by sustainable purification, enabling the safe use of water for various purposes. The researchers are developing a sustainable water purification system to supply clean water for drinking, agricultural irrigation and aquaculture. Developing a more sustainable aquaculture system complements the efforts to minimize eutrophication of the lake.

Biodiversity and ecosystem services: New land use strategies alter ecosystem services of water reservoirs and the surrounding Caatinga biome. For this reason, ecosystem services such as water supply, the buffering function of shores, carbon storage and biological pest control by amphibians in local farms are being evaluated. Both terrestrial and aquatic biodiversity are analysed comprehensively to improve nature conservation and exploit the ecosystem services of the study area in a sustainable way.

Modelling: The impact of climate and land use change on water quantity and quality is being modelled for the entire São Francisco catchment and the Itaparica reservoir in particular. Local results will be extrapolated to the scale of the entire river basin. The models and scenarios used provide an interface between INNOVATE and the coordination project GLUES.

Economy: The economic analysis aims at an integrated evaluation of strategies for the sustainable use of both the Itaparica reservoir and the land in the river basin. The researchers are modelling agricultural land use, water use and their connections through material flows at different levels. Furthermore, they are evaluating the economic consequences of land use change and possible policy actions for the reservoir. The results will be integrated in a cost-benefit analysis.

Decision support system and project coordination: With the help of a decision support system, the project coordination team identifies the potentials and limitations of natural resources governance, promote communication and cooperation, and support the overall project objective, i.e. the sustainable use of the river basin at different scales. Based on the constellation analysis, the team will compare the current governance approaches with possible future innovations, and derive conclusions for focused responsible future action.

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KULUNDA | How to prevent the next "Global Dust Bowl"? Ecological and economic strategies for sustainable land management in the Russian steppes – A potential solution to climate change

Background

The Kulunda Steppe in south-western Siberia, Russia, is part of an extensive conversion region in which approximately 420,000 km² of natural steppes and fallows were converted to arable land between 1954 and 1965. The type and intensity of agricultural practices used in this region caused the serious degradation of local ecosystems and especially soils (Fig. 23). As a result, the deterioration of the environment and crop yields has been exacerbated by the increasing production of greenhouse gases.

Changes to both in the society and climate have brought new challenges to this region since the collapse of the Soviet Union. The sustainable use of the agro-steppes with particular emphasis on soil and climate protection is one of them.

Objectives and research strategy

The KULUNDA project is based on an interdisciplinary research strategy. The German and Russian researchers from natural, agricultural and social sciences closely collaborate with local stakeholders and a German manufacturer of agricultural machinery.

Using this typical conversion region as an example, the KULUNDA project will generate, test and implement a location / climate adapted system of measures for sustainable land use and regional development. At the same time, the protection and restoration of the local grassland ecosystems will have to be taken into

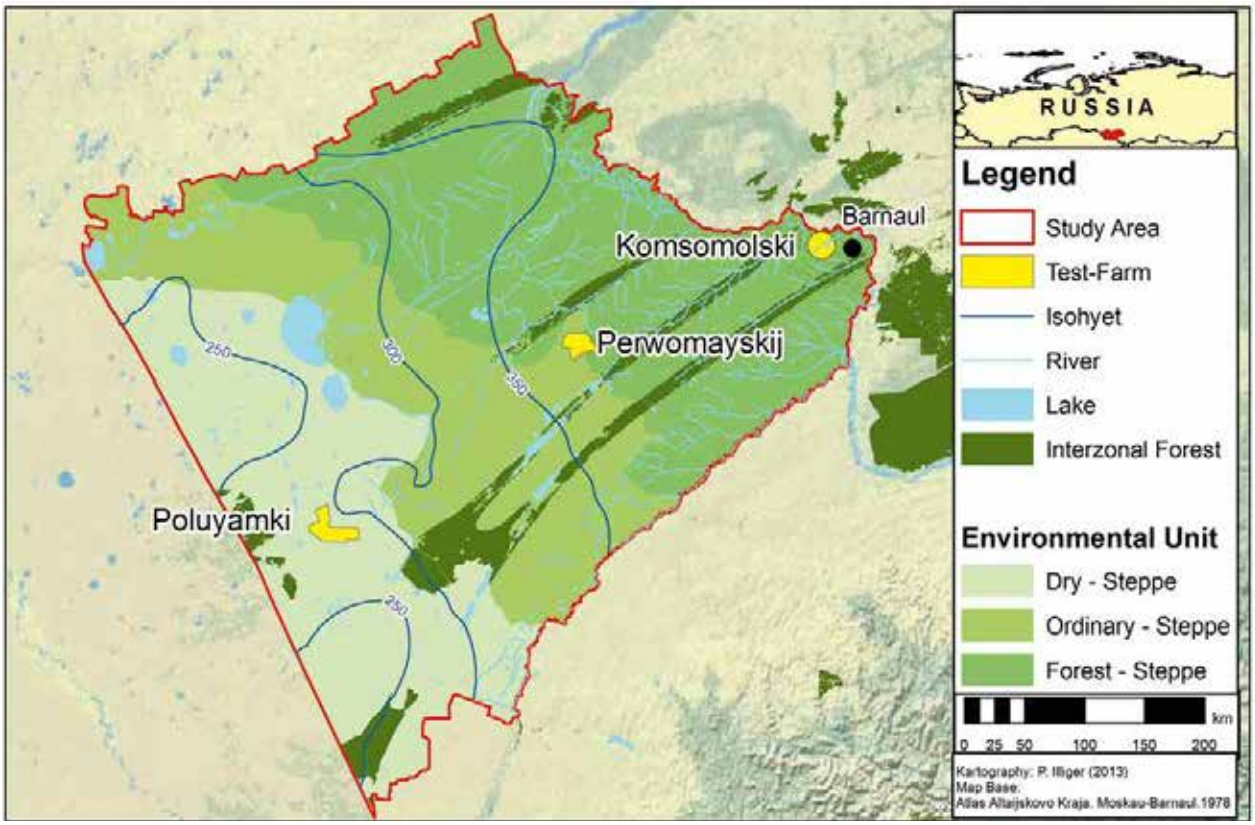

Fig. 22: Location of the study area and the three core research sites (test farms) (Source: KULUNDA).

Fig. 23: Devastating wind erosion in the Kulunda Steppe (Source: T. Meinel 5/2007).

account. The study will address not just adaptation to climate change, but also the implementation of mitigation measures focused on improving the function of soils as sinks for greenhouse gases.

The multi-scale research strategy of the KULUNDA project plays a special role in the collection of data at the experimental sites of three agricultural companies. Here, new methods are being tested and findings generated that will be implemented in collaboration with local stakeholders to ensure the multiplier effect for the entire region.

Subjects of investigation

The KULUNDA project concentrates on the following four working areas:

- An analysis of the fundamental impact of farming practices on soils, groundwater and vegetation under different climatic conditions
- The development, testing and implementation of adapted land use systems and options of steppe restoration
- An analysis of the effect of natural and social conditions on land use decisions
- The establishment of a planning and advisory platform for supporting the implementation of ecological and economic sustainable land use strategies

The experiences and results from the KULUNDA project study area ought to applicable to the entire Kulunda Steppe region and allow its long-term, and self-sustaining development. Ideally, they should also be used as examples for other regions of the continental Eurasian steppes and contribute to the improvement of global models.

The KULUNDA project is intended to support the "Strategic objectives of the complex program for socio-economic development of the Altai region until 2025" and to encourage cooperation in the region.

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LEGATO | Land-use intensity and Ecological enGineering – Assessment Tools for risks and Opportunities in irrigated rice based production systems

Objectives and research strategy

In order to advance the long-term sustainable development of agricultural systems with different land-use intensities in the context of global change, LEGATO quantifies ecosystem services (ESS) and ecosystem functions (ESF) of irrigated rice landscapes in Southeast Asia. The researchers analyse local and regional land-use intensity and its socio-economic background, biodiversity, as well as potential impacts of future climate and land-use change on different ecosystem services.

The analysis employs a classification of the **Millennium Ecosystem Assessment** (MEA) – a United Nations study that provides an overview of 24 key ecosystem functions and services. Based on the definitions listed in this report, the researchers examine ecosystem services from three categories: firstly, provisioning services, such as nutrient cycling and food production, and their impact on yields; secondly, regulating services, such as biological pest control and pollination; and thirdly, cultural services, such as cultural identity and aesthetics.

The project is conducting its field research in Vietnam and the Philippines where the researchers selected seven regions with diverse land-use intensity and cultural identity. Here, they analyse interactions between irrigated rice fields, their adjacent landscapes and the local society. The central concept of this project is **ecological engineering**, a discipline that deals with the design, construction and management of ecosystems. Even though the project concentrates on the irrigated rice production systems, the LEGATO researchers plan to make their findings transferable to other systems as well.

As a core output, the researchers will develop guidelines for ecological engineering. These will be tested in terms of feasibility, acceptability, economic viability and transferability across the study area, and will be further developed by local agricultural agencies. Implementation of the guidelines will also require an assessment of the associated risks and opportunities, especially in the context of changes in land-use intensity, biodiversity and climate.

Additionally, the researchers from the LEGATO collaborative project test and improve already existing indicators of ESS, building upon the indicator sets of the Convention on Biological Diversity (CBD) and the Streamlining European Biodiversity Indicators (SEBI). They also plan to adapt these indicators for a transnational comparison of the respective conditions and scales.

Fig. 24: LEGATO research landscape Batad, a UNESCO World Heritage Site (Source: A. Künzelmann / UFZ).

Fig. 25: Farmers during rice transplanting (Bangaan, Philippines) (Source: J. Settele).

Furthermore, LEGATO develops methods for the monetary and non-monetary valuation of ecosystem services. The most important monetary costs are direct damage costs, such as those resulting from production losses or water pollution. Next, there is also damage compensation for replanting and water purification, as well as costs of preventive measures. Non-monetary costs, on the other hand, are crucial particularly (but not exclusively) for cultural services.

Expected achievements

Partners from science and practice (including about 70 local farmers) are working together in the LEGATO project to disseminate and implement the project results. The most notable economic accomplishments would be a reduction in the use of fertilizers and pesticides combined with sustainable and in some cases intensive agricultural production. An additional goal is to protect natural resources such as water and biodiversity. These aims are considered to be realistic due to cooperation with the major practical partners.

Fig. 26: Rice field inspection in Banaue (Philippines) (Source: J. Settele).

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LUCCi | Land Use and Climate Change Interactions in the Vu Gia Thu Bon River Basin, Central Vietnam

Objectives

The LUCCi research project aims at providing the scientific basis needed for the development of optimised land use and water management strategies. For this purpose, the researchers adopt interdisciplinary research methods which consider both natural and social science approaches. Firstly, they will measure greenhouse gas emissions from various land use types; secondly, they will analyse potential regional impacts of climate change on land and water resources, and develop adaptation strategies.

Study area

The study area of 12,382 km² includes the entire catchment of Vu Gia Thu Bon River and the provinces of Da Nang, Quang Nam, as well as parts of Kon Tum and Quang Ngai.

The total annual precipitation in the catchment ranges from 2,000 to 4,000 mm, out of which 60 to 80 % falls in the wet season of October and November.

The study area is dominated by the highlands in the west with mountains reaching up to 2,000 metres and the extensive lowlands along the eastern coast. About 75 % of the area is covered by forest, whereas agricultural areas cover about 11 %. Out of the 220,040 ha of agricultural land, more than 61 % are used for rice cultivation. Human settlements cover 5 % of the area.

The project region faces several significant challenges: frequent drought and flood events, as well as saltwater intrusion. These problems result from poor planning, the development of hydroelectric power plants, forest fragmentation and demographic change, accompanied by increasing demand for food, water and energy. This situation calls for the implementation of strategies for sustainable land and water management.

Research strategy

The following research activities are intended tocreate a reliable decision basis for the required strategies:

- The introduction of a regional information system (river basin information system);

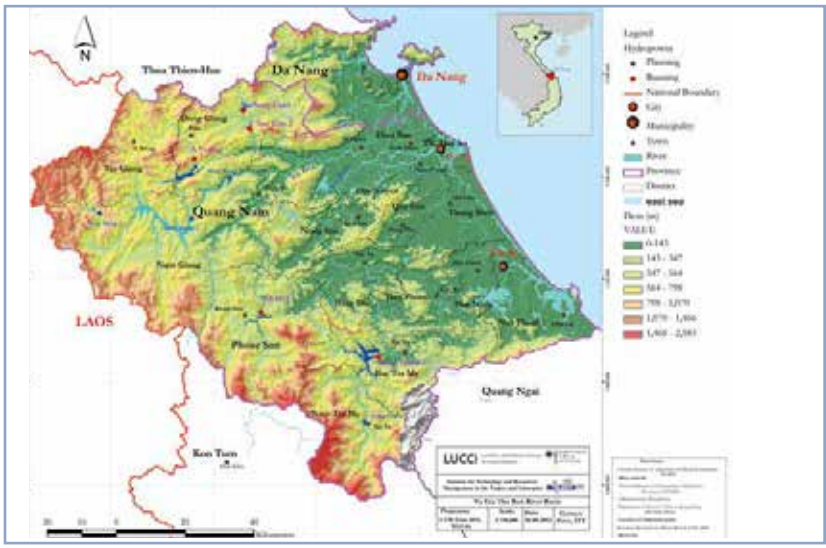

Fig. 27: Topography of the study area (Source: A.B.M. Firoz).

- The development of regional climate scenarios (regional downscaling of general circulation models)
- The evaluation of greenhouse gas emissions and potential carbon sinks related to land cover and agriculture
- The analysis of land use dynamics and socio-economic factors
- The analysis and evaluation of adapted agricultural cultivation practices
- Physically-based hydrological modelling

Fig. 28: The existing water reservoir and its impact on the landscape (Source: D. Meinardi).

- The modelling of nutrients in surface water
- The modelling and assessment of the risks of floods, drought and saltwater intrusion
- The introduction of a bio-economic optimisation model
- The integrated modelling and linking of results from individual models
- The development of land and water management scenarios
- The preparation of land and water management strategies.

Project structure

The LUCCi project comprises three main phases:

- Data collection, analysis and modelling
- The integration of the modelling results, scenario and strategy development
- The implementation and transfer of the results

During the first phase of the project, the research team collected hydro-meteorological, socio-economic and land-use data. The collected data is used to model scenarios within different areas of research. In the second phase, the consortium focuses on integrating model results and interlinking various modelling approaches. The indicators that have been determined based on stakeholder input, collected data and modelling results will be used to develop scenarios which will serve as a basis for the design of appropriate land use strategies. The last phase will concentrate on the implementation of strategies that have been previously agreed upon by the involved stakeholders. The results will then be transferred and implemented to the neighbouring regions in central Vietnam.

Fig. 29: Rice plantations in Que Son district (Source: A. Havemann).

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SASCHA | Sustainable land management and adaptation strategies to climate change for the Western Siberian corn-belt

Background

The study area of the SASCHA collaborative project is located in the Tyumen province in the West Siberian Plain, Russia. This region is of global importance for carbon storage, biodiversity conservation and food production. After the collapse of the Soviet Union, the existing system of state farms fell apart and large areas of agricultural land were abandoned. In recent years, however, the area used for agriculture has been expanding again, mainly due to the high world prices of wheat and other crops. This process was and will be accompanied by intensification and mechanisation of agriculture.

Climate models predict the increasing probability and frequency of droughts in the major wheat growing areas of northern Kazakhstan. At the same time, some parts of the southern Siberian taiga will probably become suitable for farming in the near future. These changes will trigger a northward shift of the West-Siberian corn belt.

In addition to a direct loss of habitats and biodiversity, negative impacts on many ecosystem services are expected. The cultivation of peatlands and productive chernozems would result in, greenhouse gases such as methane being released, the reduction of the carbon sink capacity, and climate feedback effects. Simultaneously, soil fertility, water quality and groundwater levels would be negatively affected.

Fig. 30: Species-rich meadow steppe, Omutinsk, southern Tyumen province, 15 June 2011. Such areas are important for biodiversity and carbon sequestration, but are threatened by agricultural expansion (Source: N. Hölzel).

Objectives and research strategy

SASCHA will provide baseline data as well as monitoring and management tools needed for the development of strategies for sustainable land use in the context of both current and future land-use and climate changes in the western Siberia.

Researchers will analyse and evaluate the influence of land-use form and intensity on ecosystem goods and services such as carbon sequestration, soil fertility, water resources and biodiversity. The data should help better predict future developments under different climate and land use scenarios.

In order to convert the project results in an operational planning framework, the project partners will first analyse administrative structures and socio-economic parameters. Later, they will develop tools for the implementation of sustainable land-use concepts and monitoring of future changes. These steps will require the involvement of stakeholders at various levels (such as government bodies, farms and research institutions).

Study sites

Three research sites (each 400 km^2 in size) along a steep climatic gradient between pre-taiga and forest steppe zones were selected for the project field work. In this area, particularly strong interactions between climate and land use can be anticipated. The northern study site east of the city of Tyumen represents the pre-taiga with deciduous forests, Brunizems and agriculturally used organic soils. This region is located at the current northernmost area where agriculture is still profitable. The region is characterised by technically advanced farms with access to markets. The second study site is located in the northern part of the forest steppe zone between the cities of Zavodukovsk and Omutinsk. It is known for its extremely fertile chernozems. This area has the best

Fig. 31 and 32: Rural subsistence farming and modern industrial agriculture co-exist in the study area. Near Ishim, 27 April 2012 (Source: I. Kühling).

soils for agricultural use in the entire project study area, and is also characterised by sophisticated and profitable agriculture. The southern study site is located south of the city of Ishim, just north of the border with Kazakhstan. This southern forest steppe has less favourable conditions for agriculture, such as low soil quality, salinised soils and poor market access.

Project structure and partners

The research project SASCHA consists of eight sub-projects (SP), which focus on the following topics: analysis and monitoring of land cover and current land use (SP2), modelling of water and material flows under scenarios of global change (SP3), quantification of greenhouse gas fluxes (SP4), sustainable agricultural use (SP5), carbon stocks and biodiversity (SP6), landscape planning (SP7), and institutions, property rights, governance structures and implementation potential (SP8). The central coordination (SP1) will guarantee the internal and external communication and work flow. The project is divided into three phases: data collection, assessment and tool development, and implementation.

The German partners are the Universities of Münster, Osnabrück, Berlin and Kiel, Osnabrück University of Applied Sciences, and the remote sensing company EFTAS (Münster). The Russian partners are based at various institutes of Tyumen State University and Tyumen State Agricultural University.

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SuLaMa | Participatory research to support sustainable land management on the Mahafaly Plateau in south-western Madagascar

Background

Madagascar is one of the poorest countries in the world. The local people as well as the environment in which they live are equally threatened by population growth, poverty, a lack of education and unfavourable impacts of climate change.

Only in few other regions of the world is the preservation of ecosystems is as closely related to the livelihood of the local people as in Madagascar. The majority of the Malagasy people live directly off natural products such as wood, fruit, tubers and meat (Fig. 34). However, the natural resources are overexploited, and the existence of ecosystems and their services and functions (ESS / F) is at risk. This threatens the very livelihood of the local population.

In light of the above, the SuLaMa researchers are exploring alternative land use techniques in a model region in the south-west of Madagascar. These techniques are intended contribute to the protection of ecosystems and their services, thus securing the long-term livelihoods of the local population.

The Mahafaly plateau is a unique, highly diverse, arid region with many endemic animal and plant species. At the same time, it is climatically and economically the most disadvantaged region of Madagascar. The population of the Mahafaly plateau suffers from periodic droughts and persistent poverty. This situation is exacerbated by the lack of income alternatives and the corresponding low economic development of the region.

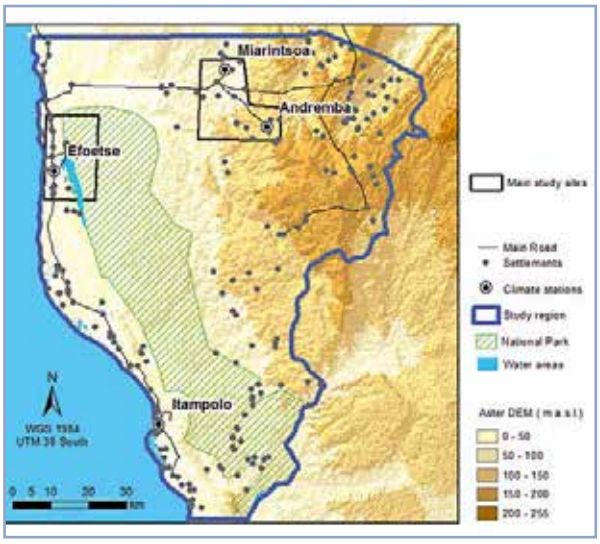

Fig. 33: Location of the study area Mahafaly Plateau in south-west Madagascar (Source: SuLaMa).

Objectives and research strategy

The main objective of the project is to work together with international, national and local stakeholders in order to establish an extensive land management plan for the region. Experts from various scientific fields such as ecology, socio-economics, landscape planning and the management of natural resources are investigating relationships and interactions between different forms of land use, important natural resources used directly by locals (e.g. wood and water resources, food and medicinal plants) and indirect ecosystem services (e.g. carbon sequestration and erosion prevention). In view of global change impacts and potential transformation processes, SuLaMa focuses on actor-based approaches in sustainable land use. The characteristic participatory approach of the project pays special attention to interests and habits of the local people, and promotes integration of their traditional values and knowledge. As a result of the transdisciplinary research and the accompanying implementation, SuLaMa aims to develop an ecologically sound, economically viable and socially equitable management plan for sustainable land use (Fig. 35).

The methods range from experimental research in agriculture, animal husbandry and forestry, through awareness-raising events, interviews and workshops, to the modelling and development of scenarios. Geographic information systems and remote sensing will be used for the classification of land use and land cover, for the development of an environmental information system and for a holistic evaluation of ecosystem services. The project results should provide methods, analyses and scientific instruments that could be transferred to other, similarly structured regions in other parts of the world.

Subjects of investigation

- Identification and assessment of relevant ESS/F in the region
- Analysis of dependencies and interactions between different land use forms and ESS/F by means of different spatial and temporal modelling techniques
- Development and implementation of an indicator system describing the status quo of the environment and biodiversity
- Analysis of current land use systems and development of land use alternatives that are sustainable and suitable for the preservation of ESS / F
- Integration of traditional knowledge into sustainable land use programmes
- Innovative experiments in the agricultural sector
- Decision support for a cost-effective and locally accepted payment system for ecological services

Subprojects and project partners

SuLaMa consists of seven subprojects: coordination, agronomy, animal husbandry, natural ecosystems & functions, socio-cultural aspects & governance, economics, and agroeconomics.

The project partners are the Universities of Hamburg, Cottbus, Greifswald, Kassel, Marburg and Göttingen, and the WWF.

Fig. 34: Example of local conditions in south-west Madagascar, manioc harvest (Source: J. M. Hammer).

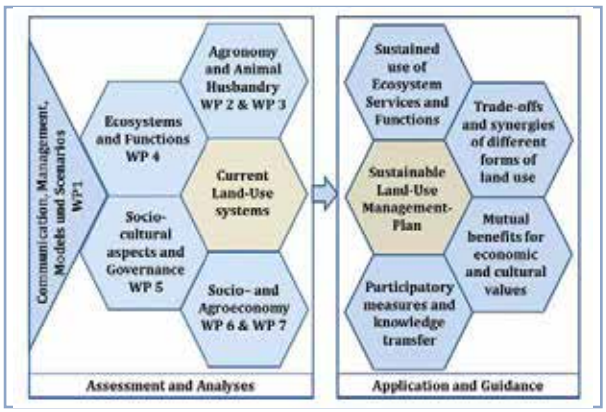

Fig. 35: Structure and objectives of the SuLaMa project (Source: SuLaMa).

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SuMaRiO | Sustainable management of river oases along the Tarim River / China

Background

The Tarim Basin is a hyper-arid region with a continental climate. The region is situated in north-west China, at the furthest distance from all oceans. Therefore precipitation is rare and very low, not exceeding 50 mm per year. Therefore, all economic sectors in the region, especially agriculture, urban life and ecosystems depend on the Tarim River as the main water supplier. The Tarim River flows along the northern rim of the Taklamakan desert. The river is fed by snow melt and glacier melt runoff, and precipitation in the surrounding mountains. The discharge of the Tarim River has increased in the last decade. But future scenarios regarding climate change predict a decrease in the water supply to the river in the twenty-first century. Irrigation agriculture, especially the water-intensive production of cotton, is taking more and more water from the Tarim River, altering ecosystems along the river, such as riparian forests and oases. As a result, a conflict between income generation from irrigation agriculture at the cost of ecosystem services and ecosystem functions provided by natural ecosystems has emerged. On some farmland, agricultural production is not possible due to the saliniation of soils.

Objectives and research strategy

The main question is how to manage land use, i.e. irrigation agriculture and utilization of the natural ecosystems, and water use in a very water-scarce region, with changing water availability due to climatic change, such that ecosystem services and economic benefits are maintained in the best balance for a sustainable development. The overall goal of SuMaRiO is to support oasis management along the Tarim River under conditions of climatic and societal changes. The

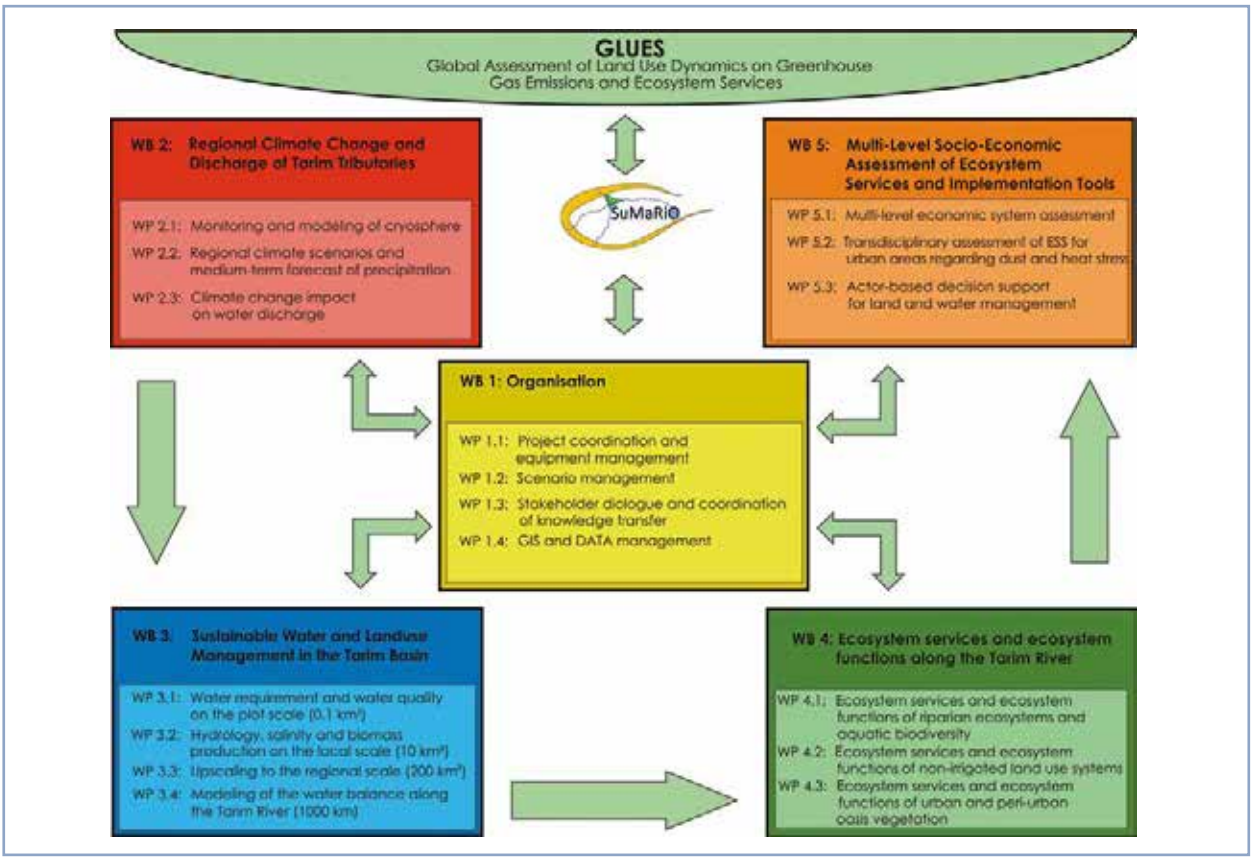

Fig. 36: SuMaRiO project structure (Source: SuMaRiO).

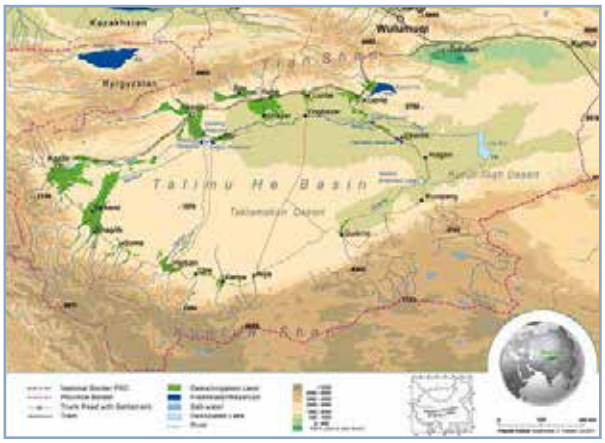

Fig. 37: SuMaRiO study area (Source: KU-Eichstätt).

main outcome of the project will be a decision support system (DSS). It will enable regional authorities to develop sustainability analyses for land and water management on the basis of different scenarios.

This overall goal will build on the results of the following scientific questions: How does climate change affect water availability? How can the interactions of floodplain biodiversity and their ecosystem services be determined? What are the links between runoff characteristics, water quality, oasis management and ecosystem services? What are the consequences of traditional, high-input and alternative land use systems on ecosystem services as well as economic and social aspects? How can stakeholders be involved in transdisciplinary research? How can internet-based tools be developed to support sustainable land management by quantifying system variables and ecosystem services?

These questions will be answered by five working packages, which are Organisation, Regional Climate Change and Discharge of Tarim Tributaries, Sustainable Water and Land-use Management in the Tarim Basin, Ecosystem Services and Ecosystem Functions along the Tarim River, and Multi-level Socio-economic Assessment of Ecosystem Services and Implementation Tools (Fig. 36).

Object of study

The study area consists of the Tarim River and its catchment area extending to the Tianshan mountains with peaks up to 7,000 metres is the study area. These peaks are covered with snow and glaciers the whole year which are the main water source for the Tarim River in summer during snow and glacier melt. Water is stored in several reservoirs along the river and is conducted through a network of canals to agricultural fields. Agriculture is the main water consumer in the region. Conflicts regarding water management between water users at the upper, middle and lower reaches of the Tarim River are the consequences. But the water is not distributed equitably either between agricultural production and the protection of the natural vegetation to maintain ecosystem services. The risk of soil salinisation is driven by the high evapotranspiration of 3,000 mm per year, intensive irrigation farming as well as other factors. The effects are land grabbing, land degradation and desertification.

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SURUMER | Sustainable rubber cultivation in the Mekong Region: Development of an integrative land-use concept in Yunnan Province, China

Background

Since the turn of the millennium, global production of natural rubber (NR) has increased by approximately 40 % to more than 11 million tonnes per year. This increase has been predominantly driven by emerging markets, particularly China, which already consumes more than 30 % of the world's NR production. The vast majority (approx. 90 %) of NR production takes place in Southeast Asia. The Mekong River countries, in particular, have experienced an extraordinary expansion of harvested area since 2000. In 2011, for instance, the area of rubber plantations increased by 42 % (to nearly 600,000 ha) in China, and by 99 % (to 460,000 ha) in Vietnam. The tremendous regional expansion of new plantations that have not yet produced an economic return, such as in Laos or Myanmar, is not even covered by the statistics. The rubber plantations are expanding especially at the expense of natural forests of the "Indo-Burma hotspot", one of the most outstanding global biodiversity hotspots.

This development has serious impacts not only on people's livelihoods and socio-economic settings. It also affects ecosystem functions by compromising provisioning of ecosystem services at different spatial and temporal scales. Safeguarding these ecosystem functions requires a deep understanding of the complex and interrelated factors of the current development. There are three major aspects that require attention:

- Eco-physiological and physical changes: fluctuations in water quantity and availability due to ecological characteristics of the rubber tree, as well as impacts on water quality as a consequence of using agrochemicals; changes to carbon storage, fluxes and dynamics, which affect biological processes, soil fertility and hydrological functions.
- Rubber monocultures replace traditional, highly diverse land-use systems and forests and affect pollinator services for food crops.
- Rubber cultivation is a highly profitable opportunity for smallholders. However, the abandonment of traditional land use systems in favour of a single tree crop implies higher vulnerability to climate extremes, pests and diseases, and to the volatility of global markets without flexibility for rapid adaptations.

Fig. 38: Natural forests are clear-cut to provide space for rubber plantations (Source: SURUMER).

Objectives

The overall objective of the SURUMER project is to develop an integrative, user-friendly and stakeholder-validated concept for sustainable rubber cultivation in Yunnan. Ideally, the project outcomes should also be applicable in other rubber-producing areas of the Mekong region, or even adapted to other extensive tropical monocultures.

On this basis, the project aims to achieve the following goals during three consecutive and overlapping phases:

- Analysis and quantification of important ecosystem functions and the impacts of rubber cultivation on ecosystem services. To achieve this goal, the researchers not only develop and apply methods from different scientific disciplines dealing with water balance, carbon dynamics and

biodiversity, but also evaluate economic and socio-economic conditions in the region.
- Development of scientific concepts based on interdisciplinary data and models. The concepts are used to identify practical management options that would secure the sustainable use of important ecosystem services.
- Assessment of developed concepts and systems of rubber cultivation. Researchers will evaluate conflicts and synergies between economic and ecological goals and provide baseline models applicable to other tropical land use systems (especially production systems of renewable resources).

Research strategy

The research strategy is based on the close cooperation of nine subprojects (representing different disciplines) and stakeholders, with the intention to identify trade-offs and synergies between ecosystem functions and services on the one hand and socio-economic goals and constraints on the other.

A suitable operational approach for the development of alternative land use concepts for rubber cultivation seems to be an agro-ecological diversification of the system. It provides a conceptual framework needed for the stabilisation of essential ecosystem functions, and for the expansion of the range of local farmers' products. Furthermore, it minimises the economic risks while increasing the social stability.

Study area

The study area is located in the Dai Autonomous Prefecture of Xishuangbanna (19,700 km^2) in Yunnan Province, south-west China. The mountainous area borders on Laos and Myanmar and is intersected by the upper Mekong River from north to south. About 95 % of the rubber plantations in Xishuangbanna are situated below 900 metres above sea level and cover 20 % of the total land area. The natural vegetation consists of tropical rain forest and seasonal monsoon forest. Xishuangbanna harbours the largest and most important tropical forest area of China and is well known for its cultural diversity characterised by ten ethnic minority groups with different traditions and land use practices.

Southern Yunnan and Xishuangbanna are one of the few regions in China with a suitable climate for rubber cultivation. The recent expansion of rubber cultivation is accompanied by the large-scale decline of natural forests and associated impacts on the socio-economic conditions of many ethnic minorities.

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TFO | The Future Okavango – Scientific support for sustainable land and resource management in the Okavango basin

Background

The Okavango River of Angola, Namibia and Botswana is one of the most important rivers in southern Africa. Its ecological and economic significance for these countries is immense. With its length of 1,300 kilometres and a catchment area half the size of Germany, the Okavango represents a region of enormous biological diversity that provides the basis for the livelihoods of about 1.3 million people. The Okavango basin is a complex mosaic of floodplains, vast wetlands and extensive savannah woodlands.

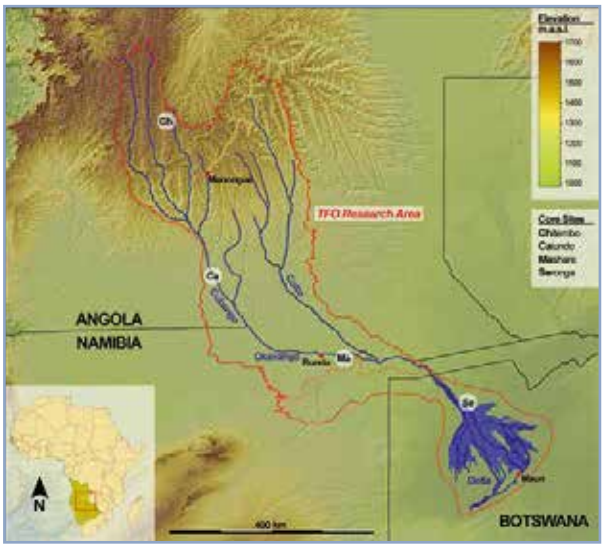

Fig. 39: Four TFO study sites in the Okavango basin (Source: TFO).

During the rainy season, the Angolan highlands accumulate enormous masses of water that reach the Kalahari Desert months later in the dry season.

The unique biodiversity and the livelihoods of the Okavango region inhabitants are directly threatened by changes resulting from climate change, population growth and overexploitation. Land and water conflicts are expected as irrigation farming intensifies and new dams for the generation of hydropower are built / planned. The pressure on the coveted natural resources of the Okavango, such as water, land and raw materials, is increasing as the population is growing and local producers have found access to global markets.

Fig. 40: Transportation of food (Source: M. Finckh).

The transnational course of the river and the typical regional upstream-downstream problems can exacerbate these conflicts. In order to preserve the Okavango and its natural functions and resources, extensive research is needed to provide answers to the following questions: What is the current situation in the Okavango region? What are the effects of the growing pressure on the utilisation of land? And how can we support sustainable land management and thus the long-term preservation of this unique habitat?

Objectives and research strategy

In order to gauge the current problems and to develop solution strategies, appropriate scientific contributions are urgently needed to optimise land use. The innovative and transdisciplinary approach of TFO combines natural sciences, humanities and socio-economics. In total, more than 140 researchers from twelve universities and nine research institutions from Germany and the African partner countries are involved in the project.

The long-lasting and successful collaboration of the German scientists with the researchers and decision-makers from southern Africa increases the chance of a direct implementation of the project results. Among others, TFO collaborates with the **Permanent Okavango River Basin Water Commission** (OKACOM) that brings together representatives of Angola, Namibia and Botswana. This organisation has already initiated specific activities in order to imple-

ment a management plan for the entire basin. OKACOM is therefore very interested in using the TFO project results.

Expected results

The TFO project will generate scientific knowledge that supports informed decision-making for the optimisation of land-use planning and management. Further, the project will develop scenarios of possible future land uses, their dynamics and the associated effects on the social-ecological system and human well-being. In addition to the increasing understanding of the system, the scenarios will for the first time provide a knowledge basis for the future management of the region. The decision support provided will help to establish different forms of sustainable land use which could be implemented by the individual households, villages and regions. The results of the research part two be transferred into practice through pilot projects and experiments, and by their dissemination to regional land-use planning authorities. The decision-makers from the partner states and organisations representing a variety of local stakeholders are closely involved in the transdisciplinary process; the results will be implemented by OKACOM, the Southern Africa Regional Environmental Program (SAREP) that assists OKACOM with the implementation of its activities, and several nongovernmental organisations such as the Kalahari Conservation Society (KCS), the Desert Research Foundation of Namibia (DRFN), the Namibia Nature Foundation (NNF) and the Associação de Conservação do Ambiente e Desenvolvimento Integrado Rural (ACADIR).

Fig. 41: Traditional way of fishing in Namibia (Source: T. Falk).

The TFO project will help to create new prospects for the people living off the Okavango. The project partners will offer scientific support for more sustainable livelihoods and conservation decisions affecting the valuable ecosystem with its important ecological resources and habitats. The results will also provide an improved understanding of the relationships between land use, ecosystem functions and climate impacts in other regions.

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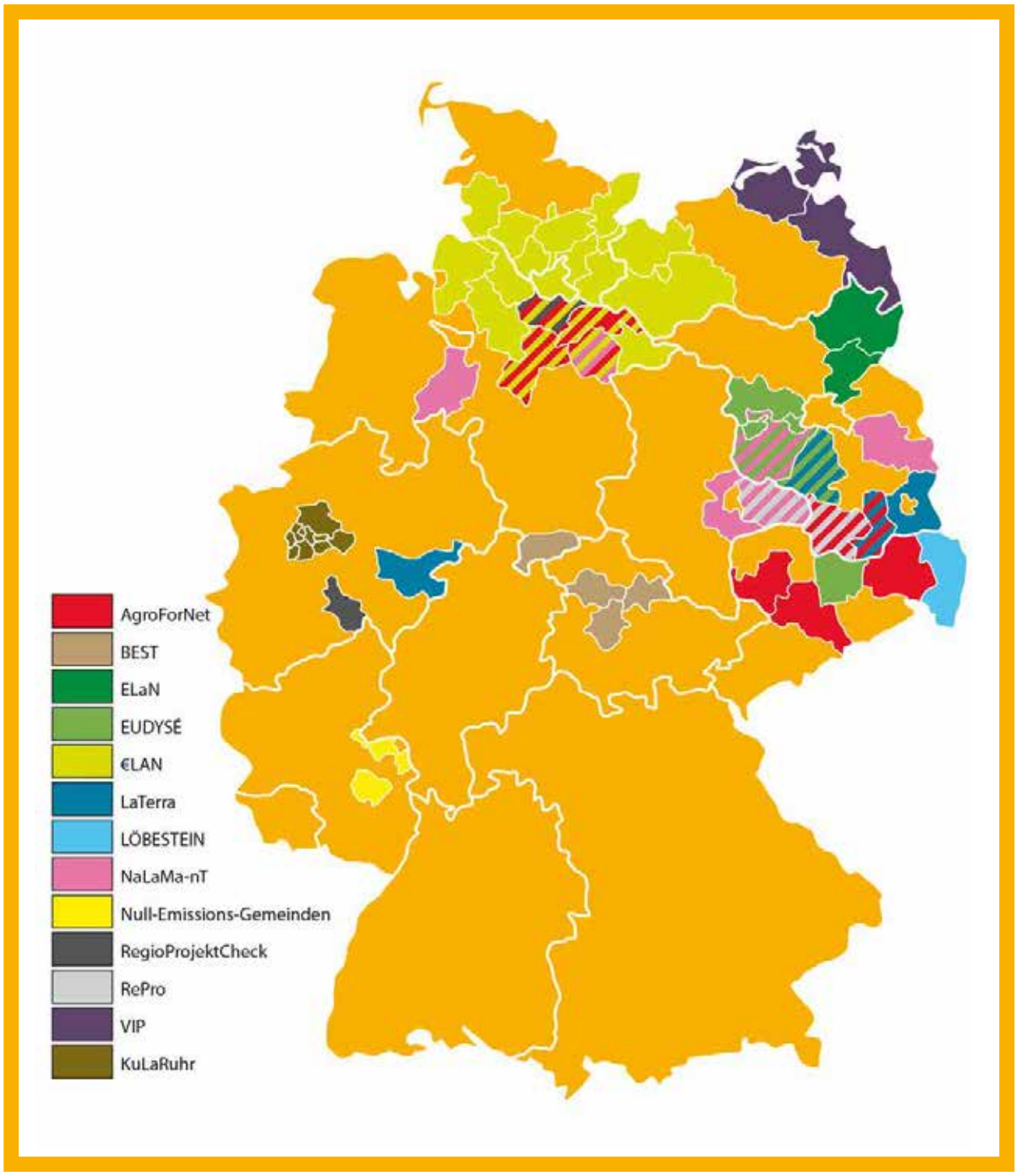

Fig. 42: Location of collaborative projects in Module B (Source: Dolezal / Scientific coordination project-Module B; simplified illustration at the county level)

Collaborative projects “Innovative system solutions for sustainable land management” (Module B)

Thirteen collaborative projects in Module B aim to develop and test innovative system solutions for sustainable land management. In specific model regions, researchers generate knowledge and decision-making principles for various aspects and issues of sustainable land management. On the next pages, the individual collaborative projects introduce their activities.

AgroForNet | Linking producers and consumers of woodfuel to contribute to the sustainable development of rural areas

Objectives and research strategy

The main objective of the AgroForNet project is to develop regional value chains and networks for a sustainable and efficient production and supply of fast growing dendromass from agriculture, forestry and the open landscape. These networks will be developed in three model regions: (1) Lausitz, (2) the loess hills of central Sachsen and (3) the southern metropolitan region of Hamburg.

In collaboration with agricultural and forestry enterprises, the dendromass harvested from forests, short rotation coppice (SRC) plantations and open landscapes will be transported, dried and compacted by companies from the region and used for energy generation by local communities, power stations and industry. All of the enterprises involved will be linked through regional value chains developed as part of innovative business models.

AgroForNet is divided into four subprojects: (1) landscape ecology / conservation of natural resources, (2) socio-economics and spatial planning, (3) production and services, and finally (4) communication and public relations. The scientific support provided by these subprojects together with the implementation efforts of the regional enterprises should increase the potential utilisation of dendromass in the model regions and promote regional economic development and sustainable land use.

AgroForNet will make valuable contributions to:

- Regional economic development
- Sustainable land management
- Strengthening communication and cooperation between regional stakeholders
- Providing a decentralised supply of dendromass for heat and electricity providers
- An efficient and sustainable use of dendromass for energy generation.

The model regions are diversely structured and are likely to be subject to different climatic, demographic and economic changes. The innovative value chains should guarantee an efficient production and distribution of dendromass and its use for energy provision.

The cultivation of SRC should help mitigate the economic risks for agricultural enterprises resulting from climate change. At the same time, the structure and ecology of the landscape will be enriched in a way that is compatible with sustainable land management, and a lasting supply of dendromass will be created to meet the needs of the providers of heat and power.

Scientific and technical objectives

The regional value chains for the sustainable production of dendromass developed during the AgroForNet project should function even after the end of the project and serve as inspiration for other regions in Germany.

The networks developed are expected to connect dendromass producers from agriculture, forestry and landscape management with communal, commercial and industrial consumers, as well as businesses, banks, legal advisors and public authorities based on participatory, regional and structure-specific business models. The regional focus ensures that the value created remains in the region. Thus, the project contributes to the stabilisation of the regional job market.

By integrating various aspects of production, nature conservation and landscape ecology, the research team is helping to create synergies between these areas and so improve the sustainability of land management.

The focus on dendromass partly results from the current situation with regard to the use of wood for energy provision in Germany. The competing microeconomic and social interests lead to a variety of conflicts. The project aims to identify and analyse these conflicts and take them into account when building up the value chains. The researchers intend to work together with the regional stakeholders in order to find a balance between the different interests.

The development of business models, sustainability criteria and spatial planning instruments is based on intensive cooperation and communication among regional stakeholders. Such cooperation ensures a wide acceptance of these instruments in the region.

The individual stakeholders within the model region, and throughout Germany can connect via a communication platform (www.energieholz-portal.de). The platform serves information exchange and knowledge transfer, and is available to all stakeholders during and beyond the project funding period.

The development of the value chains based on regional dendromass will only be successful if concepts for decentralised heat and power provision are developed at the same time. As the energy density of wood is lower than that of fossil fuels, transport over long distances is not worthwhile. The aim is, therefore, to initiate and improve regional distribution channels. The project also intends to support the opportunities for a decentralised heat supply for existing and planned housing developments in the vicinity of biomass co-generation power stations.

AgroForNet focuses on dendromass for a variety of compelling reasons. Recent studies show that the use of wood chips produced from forests and SRC is in many respects highly efficient for power and heat provision: comparatively high energy yields per hectare can be achieved. Thanks to the non-intensive farming, CO_2 avoidance is achieved at low CO_2 avoidance costs. In other words, the use of dendromass for energy production is characterised by low economic costs and a low carbon footprint.

SRC can be cultivated on areas that are not used for food production. However, it is also suitable in cleared and intensively farmed areas as it can help to enhance their ecological functions. Moreover, SRC helps mitigate the negative effects of climate change. The aims of AgroForNet are to evaluate and manage ecosystem functions and production potentials and to optimise sustainable dendromass cultivation while considering biotic risks.

Dendromass from managed forests remains especially important for energy production. Here, the focus is on improving the potential role of small private forests, using residual wood for energy production, and ultimately changing long-term forest management strategies.

Furthermore, the project will identify the possibilities and limits of formal and informal planning instruments for sustainable land management and provide recommendations for their implementation. For this purpose, methods for the assessment of landscape character and aesthetics will be developed and applied at various levels, e.g. business, recycling plant, landscape and region. In addition, the perceptions and opinions of local citizens and tourism experts will be integrated into concepts for dendromass cultivation.

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BEST | Boosting bioenergy-regions: New system solutions in the divergence of ecological, economical and social demands

Background

The utilisation of bioenergy (i.e. energy generated from biomass) can make an important contribution to a sustainable and climate-neutral energy supply. However, bioenergy is confronted with various user interests that are based on limited land resources and rising competition for space. Therefore, the environmental consequences of bioenergy production need to be assessed in a comprehensive manner.

Objectives

The main objective of BEST is to develop regionally adapted concepts and innovative system solutions for biomass production, and to assess their ecological and economic impacts.

The research activities are located in two German "bioenergy regions": Göttingen County and the Thuringian field plain. Their development represents ongoing processes in similar regions throughout Germany. The project results will be discussed with stakeholders and then translated into practice.

Fig. 43: "Alley cropping" design of an agroforestry system; grassland strips alternate with short rotation coppice (SRC) (Source: N. Lamersdorf).

Research strategy

The research project consists of seven thematic work areas (clusters) which focus on environmental, economic and regional socio-economic consequences of land use concepts:

- Ecological landscape functions
- System solutions for the mobilisation of timber reserves
- Innovative production systems and techniques
- System solutions for the cascade utilisation of materials and energy
- Ecological impact assessment of different cultivation techniques
- Socio-economic assessment of utilisation concepts
- Integration of results, implementation and participation.

Fig. 44: : Installing bulletin boards at the first BEST regional conference in April 2011 (Source: N. Lamersdorf).

Using this approach, the utilisation concepts are formulated and comprehensively evaluated.

The project coordination team integrates the results generated by individual sub-projects, summarises them, and communicates the outcomes with stakeholders at regional conferences.

New approaches to utilisation of biomass potential

Because fossil fuel reserves are finite, new, innovative approaches to the generation of energy are required.

Ideally, these should offer sustainably produced energy with minimal transport losses along the way to the place of consumption. Agroforestry systems and short rotation plantations offer a possibility to produce biomass for resource-effective energy production and material use. In short rotation plantations, fast-growing trees such as willows and poplars are grown with the aim to produce highest possible biomass yields in a short time. In agroforestry systems, the cultivation of perennial crops (e.g. trees with quality timber wood) is combined with annual crops. The subproject "Agroforesty and short rotation coppices" will demonstrate that ecological and economic added value can be achieved by using woody plants in agriculture for production of biomass and bioenergy.

The subproject "Grasslands" will investigate the suitability of different grassland areas for their use in energy production. The agroforestry system consists of fast-growing tree species in short rotation plantations with alternating grassland areas.

Agroforestry systems can, especially in cleared landscapes, form very important structures with a positive impact on environmental conditions. Since the existence of meadows and pastures is threatened by declining animal husbandry, the utilisation of extensive grasslands in the agroforestry systems can secure their preservation, and thus the protection of their high biodiversity. Reasonable and efficient management following the principle of "conservation through use" is therefore needed. Innovative conversion methods using such agroforestry systems for energy production can help to reduce the competition for land.

Fig. 45: BEST field survey attended by an NDR reporter in November 2010 (Source: M. Bredemeier).

Project structure

The project BEST is based on close, interdisciplinary collaboration among researchers from different scientific disciplines (ranging from climatology and wood material science to soil science, forestry and resource economics) and therefore requires an efficient coordination. The coordination team is expected to identify opportunities of biomass-based energy systems and material uses for integrated regional development strategies. The unbiased evaluation of all options is to be documented in a spatially explicit manner using geographical information systems. The coordinators are also responsible for transferring the knowledge to the regional stakeholders.

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ELaN | Developing an integrated land management scheme for the sustainable use of water, nutrients and carbon in north-east Germany

Background

Today, it is a common practice to discharge purified wastewater into surface waters. But once discharged, it is lost and cannot be used for other purposes. In the ELaN project, scientists from various disciplines studying potentials for the utilisation of purified waste water in sustainable water and land management. They analyse the extent to which the regional water balance can be stabilised and whether the valuable wetlands can be preserved. Plant biomass harvested from these wetlands could then be used for energy and material production. In addition, the researchers evaluate techniques of recycling wastewater nutrients and test whether they can be used as fertilisers in the regional agriculture.

Objectives

The objectives of the ELaN research project are to develop new sustainable solutions in the area of water, nutrient and land management, and to demonstrate benefits arising from reusing the purified waste water. The researchers focus on various aspects of ecotoxicological safety, water balance, wetland ecology, nutrient recycling and the production of energy crops. At the same time, they have to review political and legal regulations and requirements for the application of the purified waste water on soils, and to strengthen the regional value chains.

Hobrechtsfelde, near capital
Region: Barnim County

The former sewage farms in the vicinity of Berlin are heavily contaminated by untreated sewage that was utilised in the past decades. ELaN links the reuse of purified wastewater with agricultural and forestry production in the form of short rotation plantations (SRP) and landscapes designed for recreational use.

Biesenbrow, Welse lowlands, countryside
Region: Uckermark County

The researchers will develop strategies to balance conservation in the Welse lowland fens with the adapted production of biomass for energy or material use. Sustainable biomass production in fen areas reduces production pressure on agricultural areas. Therefore, competition for food production is also reduced. Nature conservation focuses mostly on the protection of peatlands and carbon sequestration via rewetting.

Fig. 46: ELaN study areas (Source: ELaN).

Study areas

The research will take place in the counties of Barnim and Uckermark, two regions north-east of Berlin. The actual study sites will be located on two different land cover types: sewage irrigation fields and fens. The first type will be represented by a former sewage farm in Hobrechtsfelde, an area with dry mineral soils in the vicinity of the densely populated city of Berlin. A degraded fen in the vicinity of Biesenbrow in the Randow-Welse lowlands, a sparsely populated rural area in north-eastern Brandenburg, will represent the second type (Fig. 46).

Project structure

In total, twelve institutions are involved in the ELaN research project. Besides four universities and seven research institutions mostly from Berlin and Brandenburg, the 'Berliner Wasserbetriebe' (waterworks facility) is also directly involved as a project partner. The project's advisory board consisting of eleven members from the fields of water management, land use, planning, administration and nature conservation is responsible for the critical reflexion of the project objectives, research strategies and results, and the examination of their relevance for practice.

The natural, technical and social scientists work in close collaboration with regional stakeholders from water management, agriculture, regional planning, government and administration in order to find ways of using the purified wastewater. They examine water / material flows, land use and socio-economic regulations. Their findings will be integrated into locally applicable model solutions and tested in the two ELaN study sites (Fig. 46).

In a second step, these model solutions will be further developed into general system solutions, strategies and future scenarios for the Berlin-Barnim-Uckermark study region, and also transferred to comparable regions (Fig. 47). The involvement of regional stakeholders in the development of the solutions during the entire project period should guarantee that the ELaN results will still be used after the project has ended.

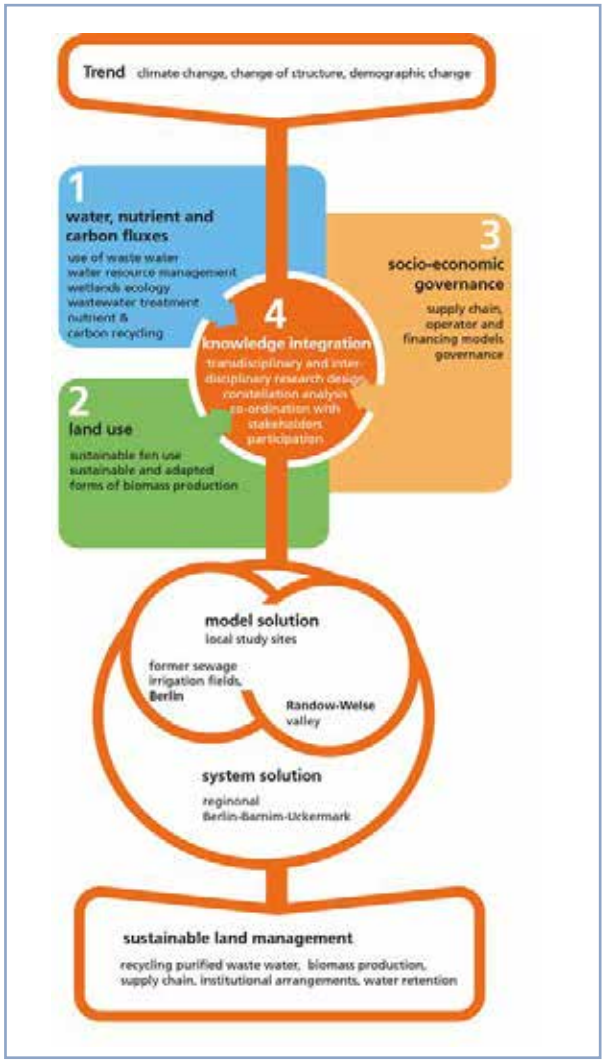

Fig. 47: ELaN project structure (Source: ELaN).

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EUDYSÉ | Efficiency and dynamics of settlements in times of spatially and temporally disparate development trends

Objectives

The project aims to identify strategies for the implementation of a "resource-efficient and low-emission urban development model" under the influence of spatially and temporarily varying trends. The main focus is on natural resources such as raw materials, energy and land, and greenhouse gas emissions. The term **efficiency** stands for the provision of general public services with the minimal use of resources. The term **dynamics** relates to the demographic trends and changes in socio-political conditions. The project covers the following topics: settlement development, transportation, energy, agriculture / energy crops, water, and municipal / construction waste in two model regions, Meissen County in Saxony and the Havelland-Fläming region in Brandenburg (Fig. 49).

Research strategy

The project is divided into three phases. In the first phase, specific content for the individual topics will be defined, and particular focus areas within the model regions with increased need for action will be selected. In the second phase, sectoral policy options will be outlined and evaluated in terms of their contribution to the overall objective. In the third phase, researchers want to precisely specify the objectives, strategies and measures, and then formulate practical recommendations for a generic model and its implementation.

Land-use model

An important methodological basis of this project is a land-use model based on geographic information system. This spatial projection / analysis platform allows the 'small-scale' characterisation and analysis of land use in residential and open areas, and supports debate about strategies for action. The land-use model is designed at a fine spatial scale and is therefore useful for analyses of land use and related planning criteria regarding the water, energy, waste and transportation.

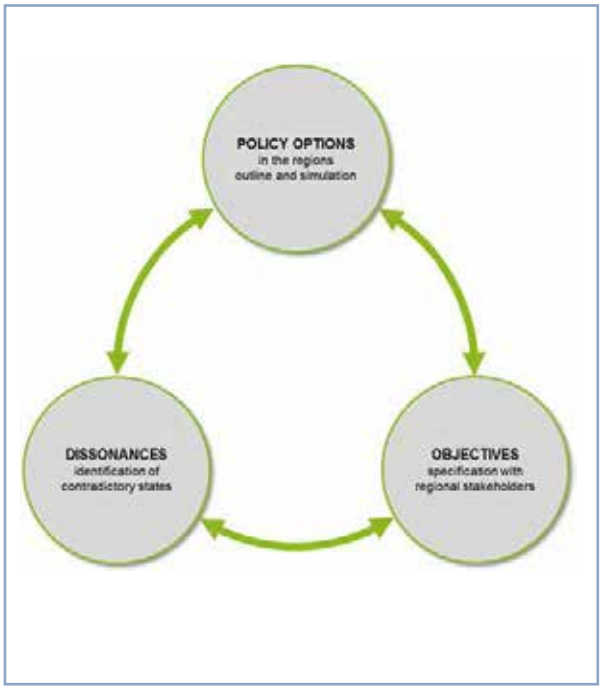

Fig. 48: Iterative discussion of policy options, dissonances and objectives (Source: EUDYSÉ).

Fig. 49: Topics of the EUDYSÉ project: water management, energy / agriculture / energy crops, municipal and construction waste, settlements and transportation (Source: Stutzriemer, Wachler, Tittel, Oertel – IÖR; Zentner – TU Dresden).

Scenario process

EUDYSÉ adopts an approach of general and action-oriented scenarios (Fig. 48). The traditional procedures of back-casting will be methodologically expanded to address contradictions, tensions and dilemmas between regional stakeholders on multiple levels. These contradictions serve as an indicator of increased pressure for action and provide a starting point for the implementation of resource-efficient strategies. The strategic and operational goals will be discussed together with relevant local stakeholders in the context of resource efficiency and simulated strategies for action. Examples of these goals are 'regional energy self-sufficiency', 'adjusted decentralised water supply structures', 'optimised use of biowaste and material from landscape management', and 'settlement development in the existing building stock'. The measures and actions required to bring the EUDYSÉ model to life will be tested on specific examples and developed together with stakeholders in order to identify feasible ways to achieve the project goals.

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€LAN | Energy prices and land use

Background

Housing and transportation are two important land use factors that are associated with high energy costs. German households already spend approximately 50 % of their net income on housing and transportation. It is expected that this percentage will rise even more due to the increasing prices of fossil fuels caused by supply shortages and global economic growth.

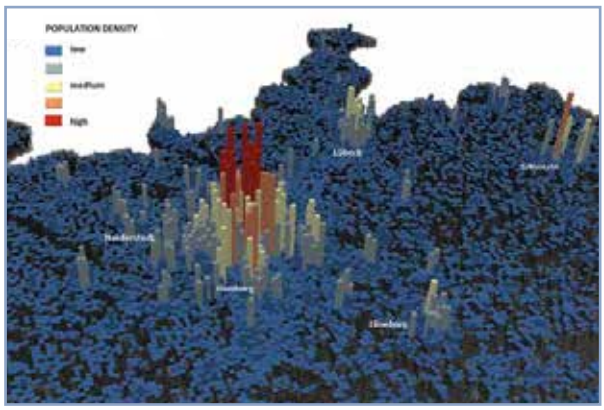

Fig. 50: Population density per km² in northern Germany in 2010 (Source: €LAN).

Objectives and subjects of investigation

The €LAN research project deals with the impacts and associated risks of rising energy prices on settlement and mobility patterns. The research team aims to identify these impacts in the metropolitan area of Hamburg between 2010 and 2030. Additionally, they will test instruments for political decision-making, which could be also applied to other regions and problems.

In 2008, a short period of high energy prices exemplified how much our daily life and infrastructures depend on fossil fuels. The increasing energy prices are expected to exacerbate ongoing processes. For example, population growth will be higher in towns and cities than in the adjacent areas. The rising costs will mostly affect rural areas whose infrastructure and transportation systems have lower energy efficiency. Many residential areas that have been built since the 1950s and can only be reached by car are located far from places where people work. Since these areas usually offer poor public transportation services, their attractiveness will decrease with rising fuel and heating costs.

Simultaneously, real estate prices and rents in centrally located neighbourhoods with good public transportation services will rise. In this situation, low-income families may not be able to afford to live in such areas and will be forced to seek cheaper housing. Therefore, rising energy prices are expected to have uneven spatial and social effects.

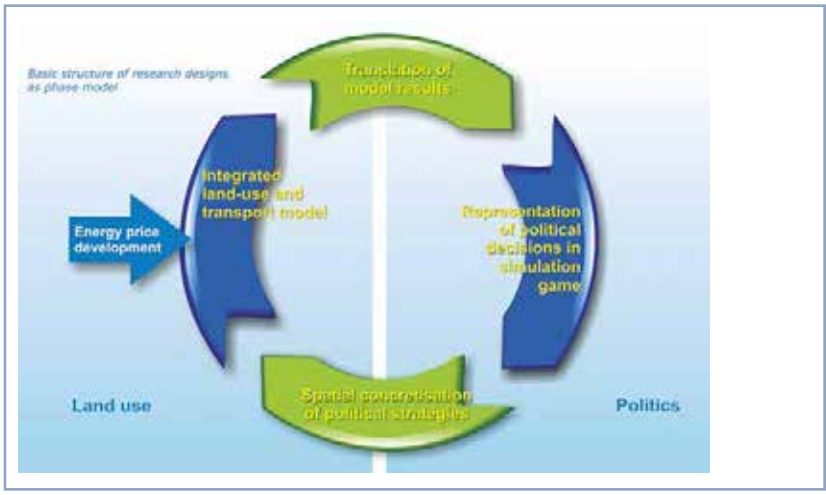

Fig. 51: Integration of the political science experiment and the integrated land use and transport model as the methodological approach in the €LAN project (Source: €LAN).

Research strategy

The analysis of changes in both land use and transportation that trigger the rise of energy prices is based on an integrated model, which realistically simulates the complex processes of spatial development. The €LAN model incorporates infrastructure networks, land use, the job market, the real estate market, demographic trends and passenger transportation, and thus allows the spatial simulation of location choices and reactions of households, businesses and regional authorities.

Based on logical and mathematical functions, the model will simulate the behaviour of artificial individuals, households and businesses as well as their mutual interactions, and allow the development of future scenarios. It will differentiate between various household types, economic sectors and spatial structure types according to their vulnerability to the increase in energy prices.

The project also aims to answer the question of how government and administrative bodies respond to situations that arise from the development of energy prices. The reactions of the decision-makers will be collected in a political science experiment. Afterwards, politicians and administrative staff will be confronted with the model results. In a series of meetings, selected representatives will discuss different policy options and formulate responses to the predicted scenarios. The serious game involves leaders the local, state and federal authorities. Decisions taken during the serious game sessions will then be used as input parameters for the next simulation period. Thus, the serious game will complement the spatial analytical methodology of the model with realistic, practice-oriented components (Fig. 51).

Potential political responses are expected mainly in the following areas:

- Fiscal policy: subsidies for commuters, for construction and the use of energy efficient vehicles and technical innovations in the automotive industry, and for housing and energy-efficient buildings; active rent control; construction of social housing and adjustments in energy policy
- Transportation policy: improvement of the services offered; introduction of new transport systems (e.g. light rail) and bus/rapid-transit projects in order to improve accessibility; expansion of the road network in order to improve the accessibility of suburbs and rural areas and to decrease travel times and traffic congestion at rush hours; adopting new measures in the area of traffic management (e.g. road toll and parking space management)
- Land management (housing policy): coordination of spatial policies, which should guarantee the better distribution of residential and business areas in towns and the cities; avoiding the development of suburban areas dependent on private motorised transportation; supporting the development of central city areas.

The interdisciplinary €LAN project couples the modelling of spatial impacts with examples of political actions and decision-making. This experimental closed loop system serves as a basis for deriving practical recommendations which can be progressively advanced.

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KuLaRuhr | Sustainable perspectives for urban cultural landscapes in the Ruhr metropolitan region

Background

The Ruhr metropolitan area is characterised by various structural changes following the decline of mining and heavy industry. In addition to bringing new challenges for the local infrastructure, this transition requires new strategies for the sustainable development of the region.

Fig. 52: View from the Gasometer industrial monument, Oberhausen (Source: C. K. Feld).

Objectives

The goal of this project is to increase both the quality of life and attractiveness of the region through the sustainable use of land, water and energy. The project is divided into three clusters.

Subjects of investigation and research strategy

The first working cluster concentrates on the Emscher Landschaftspark, a green area that represents the most important 'green infrastructure' of the Ruhr region. In this place, new opportunities for the economically viable integration of agriculture and forestry in the urban cultural landscapes will be developed. KuLaRuhr will foster communication between numerous public and private stakeholders in order to strengthen the management of the Emscher Landschaftspark. By investigating possibilities of a regional biomass strategy (which represents one of the crosscutting topics of KuLaRuhr), the agriculture, forestry, waste management and the maintenance of green spaces on both a municipal and a private level can be better interconnected. The goal is to build economically feasible structures, which would help to maintain and shape the open space of the urban cultural landscape in the long term. Moreover, opportunities will be explored for the stronger functional and aesthetic connection of the urban landscape with the particularly dense infrastructure such as roads, railways, channels and energy routes.

Another goal is to link the optimisation of energy consumption in urban areas with the unfulfilled energy and climate potentials of open space. Additionally, concepts for the stronger functional and aesthetic linking of the Emscher Landschaftspark with the existing and new commercial areas will be devised. For example, areas that are not yet commercially utilised could be temporarily used for biomass production. Further, the KuLaRuhr project plans to build and optimise the inter-municipal networks for the integration and development of key transport and infrastructure corridors, for the stabilisation of the existing structures, and for the development of high-quality commercial and industrial sites. These concepts should provide direct guidance for the development of 53 cities in the Ruhr metropolitan area. The research findings will be directly used by regional authorities and integrated into planning processes.

The subprojects of the second cluster test new methods and approaches for the sustainable use of land, energy and water in the Ruhr metropolitan area. The individual measures are thematically and spatially linked to the first cluster and will be evaluated in the third cluster. This approach allows working on crosscutting topics, including the development of biomass strategy or the optimisation of energy consumption in urban areas while considering findings and methods from various disciplines. The researchers will also examine the possible use of microclimatic functions of open space and the improvement of energy efficiency in urban areas. At the same time, this approach will take into account the large-scale development of residential areas and ensure that the Emscher Landschaftspark is also considered.

Wastewater heat recovery and the combined use of wastewater and renewable resources for energy production help optimise the management of renewable

resources and the efficient use of existing infrastructure. The project will scientifically support the transformation of the Emscher Landschaftspark, and thus the separation of sewage and surface water. This reintegration of the central wastewater infrastructure into the urban cultural landscape of the Ruhr metropolis represents one of the most important infrastructure projects in Germany. To sum up the subprojects of the second cluster provide technical solutions as well as planning and ecological advice for the sustainable design of the urban environment. The research results will be technically implemented and provide a useful contribution to the structural change of the region.

The third cluster evaluates land use in the Ruhr metropolitan area from economic, environmental, logistical and landscape aesthetics points of view. These evaluations are conducted mainly in two selected study areas and will process the results of the other two clusters. This allows a comprehensive evaluation of the land use alternatives and technical solutions tested in these clusters. Researchers will carry out an ecological assessment of brownfields, roadsides, parks and areas used for biomass production, focusing on the local flora, fauna and ecosystem services provided. Public opinions on the landscape changes will be collected during phone interviews.

In addition to the general changes in the landscape, the KuLaRuhr investigations focus on individual outstanding projects such as the conversion of coal mining areas into cultural sites, or the conversion of wastewater channels into a river system fully integrated in the landscape. KuLaRuhr will also examine and logistically assess the opportunities for the use of biomass in urban areas. Based on a comprehensive analysis of the status quo, the researchers will develop a logistic concept that incorporates the entire process chain from waste collection systems to an evaluation tool. They will also conduct individual studies focusing on the alternatives for the utilisation of urban brownfields or the revitalization of wastewater streams. Here, the researchers will use non-monetary and environmental economy methods that take into account the effects of socio-economic and environmental factors on the quality of life.

The KuLaRuhr research strategy will allow policy recommendations resulting from a transdisciplinary assessment to be formulated.

Fig. 53: Phoenix Lake, Dortmund
(Source: www.luhnen-lichtkunst.de).

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LaTerra | Sustainable land use by regional energy and material flow management using “Terra-Preta-Technology” on military conversion areas and low-yield locations

Objectives

This interdisciplinary and transdisciplinary research project applies an integrated approach to develop innovative system solutions for the efficient use of resources, climate protection and improving the value of contaminated areas. The project implements a zero emission-strategy, establishes a resource-efficient and regional material flow management system, and applies “Terra-Preta-Technology” as an innovative system component.

The Terra Preta substrate (TPS) is an anthropogenic black earth with high resistance to degradation. Compared to conventional soil improvement measures, TPS has several advantages: it enables the accumulation of organic matter and release of nutrients, and increases soil activity. In consequence, TPS promotes the biological and chemical transformation of soil matter and improves soil productivity. Additionally, the increased soil activity leads to the quicker decomposition of organic soil pollutants.

The Terra Preta substrate will be used by way of example to optimise biogenic material flows in model regions.

The project objective is to provide a significant contribution to a sustainable land management in regions with significant shares of former military areas, in post-mining areas with infertile soils, and in forested areas severely damaged by extreme weather events.

Research strategy

In order to achieve this objective, the researchers analyse material flows of organic waste and renewable raw materials used for the production of TPS in selected model regions and predict scenarios for their future development. Further, they investigate the impacts of Terra Preta technology on the closure and optimisation of the biogenic material cycles.

The researchers also identify the ecological and socio-economic potential of the Terra Pretta substrate. The laboratory and lysimeter measurements and field studies will help determine the efficiency of crop cultivation and the environmental impacts of TPS.

Study area and specific issues

Terra Preta technology, the associated closure of material cycles, and the properties and potentials of TPS will be tested in the model regions that are impacted by strong economic, demographic and climate change processes.

In research project 1 (Brandenburg state, Teltow-Fläming County), TPS will be used on military conversion areas contaminated with polycyclic aromatic hydrocarbons and mineral oil hydrocarbons. It will be examined whether the use of TPS contributes to the faster degradation of pollutants and whether these areas could be used for production of renewable raw materials.

In research project 2 (Western Lusatia, Oberspreewald-Lusatia County), the priority is to restore areas that were previously used for lignite mining. In this case, the project aims to achieve an agronomic enhancement of degraded soils, i.e. the restoration of soil functions and the accumulation of organic soil matter.

In research project 3 (North Rhine-Westphalia, town of Schmallenberg), the TPS will be used to

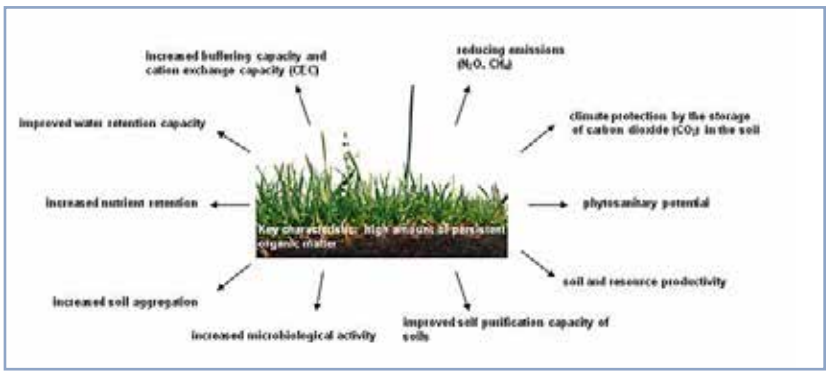

Fig. 54: Overview of the Terra Preta substrate characteristics and potentials (Source: LaTerra).

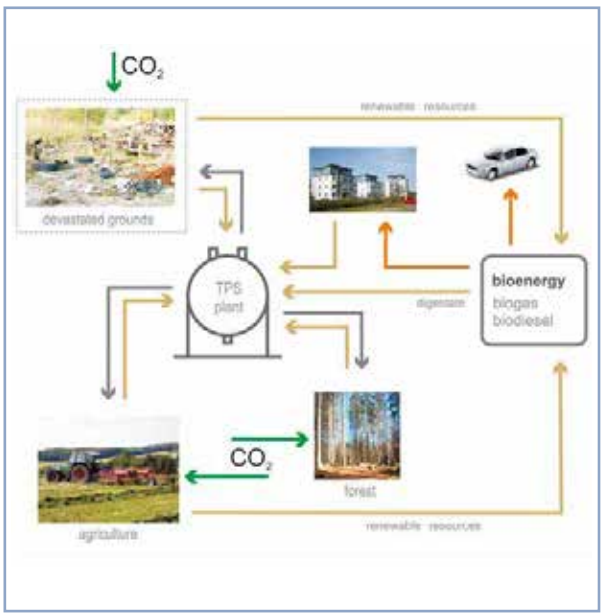

Fig. 55: Energy and material flows based on Terra Preta technology (Source: LaTerra).

support the reforestation of areas that will serve as large-scale windbreaks. The major goals of this project are to stabilise soils, increase the growth and survival of young trees, and reduce Nutrient losses.

Project structure

In order to achieve the above objectives, the following tasks will be pursued in the study regions:

- Analysis of relevant material flows, development of scenarios and their comprehensive evaluation from the environmental, operational and economic perspectives
- Development of regional value chains for the utilisation of biogenic waste and renewable raw materials for the production of TPS in close cooperation with small and medium-sized enterprises, local stakeholders and decision-makers
- Preparation of quality standards for the production of TPS and clarification of legal regulations with respect to possible contaminants
- Assessment of the effects of TPS on soil functions and plant growth based on laboratory and lysimeter measurements and field studies
- Introduction of practical recommendations for the generalisation of the findings and their transfer to other regions

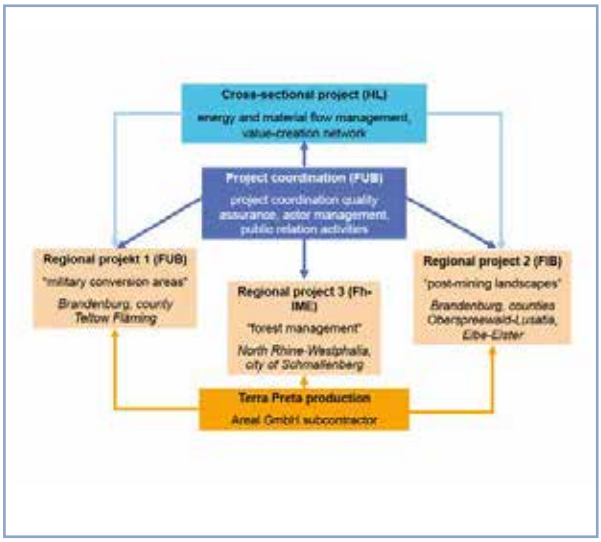

Fig. 56: Structure of the LaTerra project (Source: LaTerra).

- Communication and public relations for the transfer of results into practice
- Focus on key stakeholders before the launch of TPS production or application

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LÖBESTEIN | Land use management systems, ecosystem services and biodiversity: The development of regulatory measures using the example of biomass for energy purposes

Objectives

The LÖBESTEIN project contributes to the protection and sustainable provision of ecosystem services under the conditions of the increased cultivation of energy crops. The goal is to improve the integration of ecosystem goods and services into decision-making processes by combining climate protection activities with biodiversity and ecosystem conservation (Fig. 57).

Research strategy

The LÖBESTEIN project is based on the concept of ecosystem services that describes and evaluates the benefits and services that people obtain from ecosystems. These services are usually grouped in three categories: provisioning services (e.g. provision of food), regulating services (e.g. groundwater recharge) and cultural services (e.g. attractive landscape for recreational purposes).

Fig. 57: Colourful wild herbs such as Weasel's Snout (Misopates orontium) are becoming increasingly rare due to the intensification of agriculture (Source: IÖR, O. Bastian).

While some services such as the provision of food and energy crops (e.g. maize [Fig. 58] or wood chips) are marketable, others, for instance flood protection, the diversity of species and ecosystems or attractive landscapes, usually have no commercial value. Nonetheless, they are essential for human well-being.

The concept of ecosystem services plays an important role in the development of sustainable land management strategies by linking scientific data and social action. For this reason, the United Nations used this concept as a major methodological approach for the "Millennium Ecosystem Assessment". This study, which analysed the state of the Earth's ecosystems, revealed that 15 out of 24 defined ecosystem services were severely and sometimes permanently impaired. This concept has an attractive psychological perspective: The better we protect and the more sustainably we use the nature, the more prosperity it brings. Using this concept, the added value provided by nature is assessed and given a monetary value. This approach creates an economic motivation for nature conservation. However, negotiating the importance of ecosystem services is a great challenge.

LÖBESTEIN carries out a practical test of this concept in order to determine whether it can help regulate the cultivation of energy crops. The project identifies thresholds and minimum requirements for the cultivation of energy crops in order to maintain all relevant ecosystem services in the long term.

Target groups

Researchers and stakeholders from practice examine various control, planning and funding instruments. They investigate whether ecosystem services can still be provided under the conditions of the intensive cultivation of energy crops. Their common goal is to develop recommendations for the optimisation and redesign of the control instruments, and thus to

Fig. 58: Increase in maize production as a result of the 'biogas boom' (Source: IÖR, O. Bastian).

Fig. 59: Looking from the Königshain Mountains over the Landeskrone hill near Görlitz towards the Izerskie Mountains (Poland / Czech Republic) (Source: O. Bastian).

enhance the ecosystem services and preserve biodiversity. It is necessary that these instruments are implemented from an economic, legal and planning point of view, and that they are widely accepted by practitioners. The recommendations will be disseminated among decision-makers and stakeholders by the Leibniz Association. The practitioners and competent authorities involved in the project will help with the practical implementation of the findings in the regions.

Study area

Görlitz County in Saxony (Fig. 59) was chosen as a study area for several reasons. Firstly, it encompasses all central European landscape types except for coastal areas and high mountain ranges. Secondly, some parts of this region already show signs of the predicted climate change. These include dry weather periods, declining groundwater levels and extreme weather conditions with serious flood events. Moreover, some parts show socio-cultural changes such as population decline and ageing. Uckermark County in Brandenburg serves as a control area for comparing and validating the project results.

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NaLaMa-nT | Sustainable land management in the North German Plain considering changing ecological, economic and social conditions

Objectives

These days, it is impossible to develop strategies for sustainable land management without considering the impacts of expected global changes. Current changes of global markets and climate as well as structural changes within regions strongly influence the opportunities and risks for German forestry, agriculture and water management, and require the adaptation and reorientation of land management strategies. In view of the rising uncertainties, these adjustments have to be designed to enable flexible reactions to changing environments and to consider interactions between land-use systems.

The NaLaMa-nT project provides a knowledge and decision-making basis for sustainable land management in the North German Plain. Researchers will examine forestry, agriculture and water management and their mutual interactions in four model regions. Close cooperation between scientists and regional stakeholders will help produce additional findings, speed up the development of general concepts, and produce effective adaptation measures.

Research strategy

Four model regions in the North German Plain will be analysed in terms of ecological conditions, the utilisation of land and natural resources, regional value creation, risk management, and interactions between land-use systems under current and future conditions.

The analysis of the status quo will be based on a group of key indicators that includes regional climate variables, location factors, the local water budget, production processes, risks, economic indicators, production criteria, recreation and conservation services, and landscape perception.

Specific regional goals for the sustainable land management strategies will be formulated in close collaboration with local stakeholders. Subsequently, the impacts of climate and market changes will be analysed and modelled for different land-use systems using three scenarios. Based on this analysis, regional concepts will be improved and necessary adaptation measures derived.

In order to accomplish the complex research tasks, the NaLaMa-nT project brings together 21 working groups from various disciplines (water management, agriculture, forestry, climatology and socio-economics) and five regional partners from four model regions. The project partners operate important monitoring networks and conduct long term experiments to study environmental, economic and social aspects of land use, global change, climate impacts and sustainable development.

Fig. 60: Development concept of the NaLaMa-nT project (Source: NW-FVA).

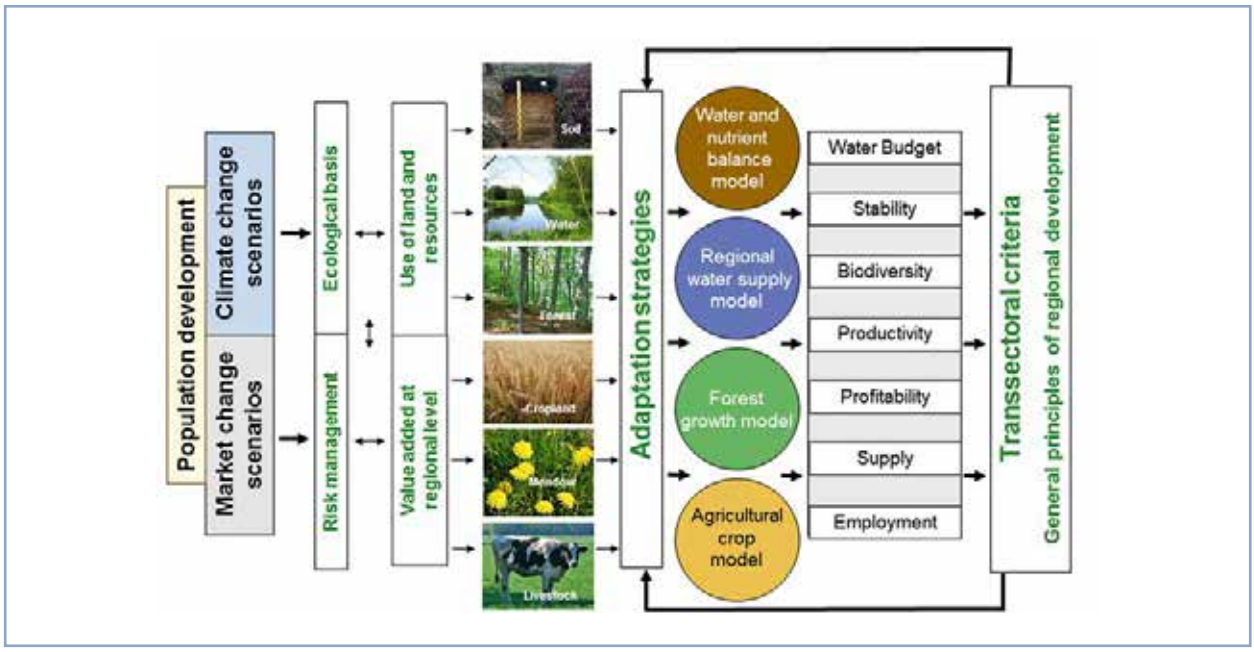

Fig. 61: Modelling concept of the NaLaMa-nT project (Source: NW-FVA)

Study area

The German rural areas differ in their sensitivity and adaptability to climate changes. Within the North German Plain study area, four model regions along a west-east line between the Dutch and Polish borders will be examined:

- Diepholz County
- Uelzen County
- Fläming region
- Oder-Spree County

The regions differ significantly in their natural features, land use, economic factors and societal demands. This setting will allow better understanding of the interactions between different land use systems as well as regional consequences of climate change and increasingly globalised markets.

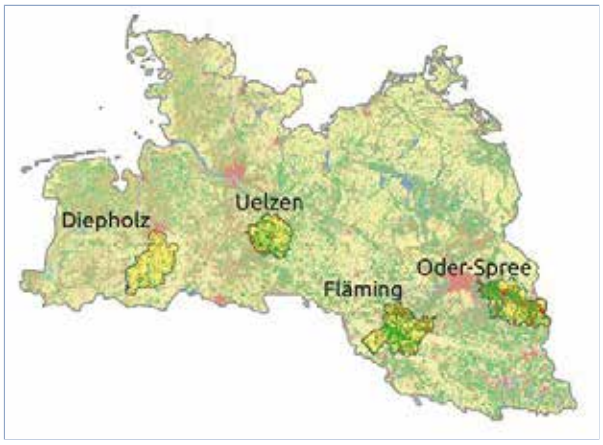

Fig. 62: Study area (North German Plain) and four model regions of the NaLaMa-nT project (Source: NW-FVA).

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Null-Emissions-Gemeinden | Zero-emission villages as a strategic target of sustainable land use management

Background

Many municipalities and regions have great potential to reduce resource consumption and environmental pollution and, at the same time, strengthen innovations and economic performance. The key lies in combining specific responsibilities and activities, and in improving synergy potentials.

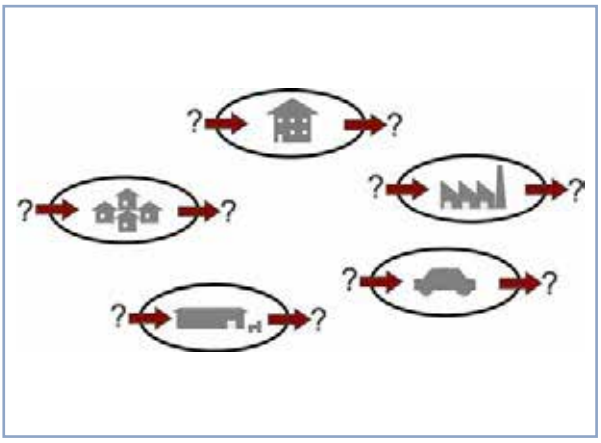

Fig. 63: Current sectoral view of local material flows (Source: IfaS 2011).

Objectives

The project concentrates on the fundamental reorganisation and systematic innovation of material and energy flow management by local authorities. The main goal is to achieve zero emissions, minimize the consumption of resources, and generate regional added value.

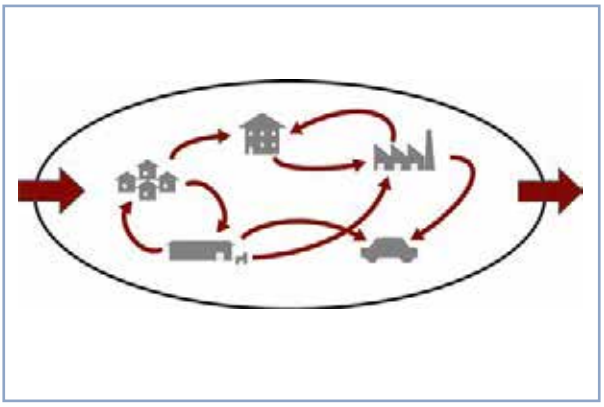

Fig. 64: Integrated view of local material flows (Source: IfaS 2011).

The Zero-Emissions Villages concept, which was developed at the Institute for Applied Material Flow Management (IfaS) at Trier University of Applied Sciences, will be used and further developed into a strategy for sustainable land management in order to meet the project objectives.

The project partners will develop strategies for practice and prepare the "Next-Practice-Projects". These are intended to lead to a "new generation" of integrated material flow management and the development of sustainable land use. Additionally, regional value chains will be created and implemented. For the time being, administrative, political and economic restrictions will be left aside in order to achieve the best results, i.e. to reach the goal of zero emissions.

Research strategy

The term zero emissions refers to the continual optimisation of energy, material and financial flows in economically and regionally defined systems. The following tasks will be addressed during the project:

- Analysis of material flows in the subprojects
- Examination of interactions between individual material and energy flows and land use (e.g. energy and material requirements per land consumption) and their inter-dependencies in the urban-rural environment
- Development of strategies and measures for sustainable land management that consider potential conflicts and synergies (e.g. agro-forestry systems)
- Simulation of scenarios for the improvement of ecological and socio-economic conditions (i.e. sustainable use of resources, additional job opportunities, greater participation of citizens)
- Demonstration of specific opportunities for restructuring regional material flows via innovative "Next-Practice-Projects".

Model communities

Previous municipal zero-emission projects have focused on reducing carbon dioxide emissions through optimised material flow management and achieving carbon dioxide neutrality in the power supply sector.

Within the Null-Emissions-Gemeinden project, this approach is to be expanded and further developed in the municipalities of Sprendlingen-Gensingen and Rockenhausen in the German state of Rhineland-Palatinate.

The Sprendlingen-Gensingen municipality is considered an economically strong and growing region located in the suburbs of the state capital, Mainz, in the Rhine-Neckar metropolitan area. Both its population and economic power are steadily growing. In contrast, the agricultural added value is decreasing as cropland is being lost at the expense of human settlements and transportation infrastructure. The value of land in Sprendlingen-Gensingen is higher than in Rockenhausen.

The Rockenhausen municipality is a rural, structurally poor region in Donnersbergkreis affected by consequences of demographic change. The proportion of agricultural land in this region is high in spite of unfavourable conditions (dry and nutrient-poor soils, low precipitation).

Expected results

The project aims to produce the following outcomes:

- Long-term CO_2-neutral energy supply that combines energy efficiency and the use of renewable resources
- Closure of hydrological cycles through sustainable use of water (cascade utilisation). This ranges from wastewater purification, through the reuse of substances contained in the wastewater (e.g. nitrogen and phosphorus), to further recycling. In addition, a regional circular economy will be developed
- Recycling residual materials from production and waste disposal as secondary raw materials in value chains (e.g. use of organic waste in biogas plants or use of fermentation residues as agricultural fertilisers)
- Regionally adapted agricultural systems that increase structural diversity, biodiversity and humus levels, and thus contribute to the goal of zero emissions
- Adaptation of administrative, political, legal and economic frameworks that help achieve the long-term goal of zero emissions
- Economic stabilisation of municipalities by introducing regional value chains and encouraging public engagement.

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RegioProjektCheck | New instruments to evaluate the impacts of housing, industry and retail projects at a regional level. A contribution to the field of sustainable land management

Background

The development of urban areas and the use of land are increasingly dominated by individual development projects, such as new residential areas or industrial and retail parks. Besides their local effects, these developments have large structural impacts on regional settings. Not only formal planning instruments such as regional land use planning or environmental impact assessment are used in these projects. Today, negotiations between politicians, planners and business representatives are also of growing importance. These negotiation processes, however, are often hindered by spatially and professionally limited competences and diverging problem perceptions. As a result, the manifold effects of these projects often remain insufficiently determined and assessed.

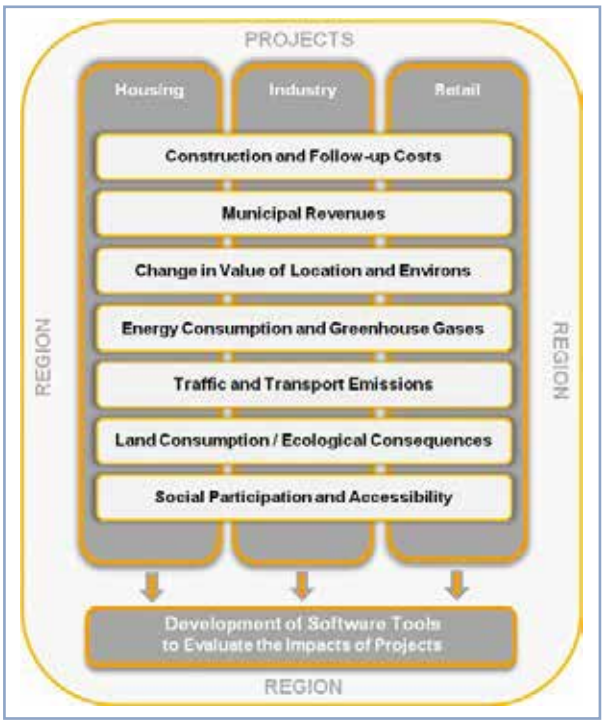

Fig. 65: Research scheme of seven impact realms that are examined in the areas of residential, industrial and retail development (Source: RegioProjektCheck).

Objectives

This issue sets the starting point for the RegioProjekt-Check (RPC). The project aims at facilitating an early-stage assessment of urban development projects and their consequences. The objective is not to assess individual technical issues, but rather to review combined environmental, economic and social aspects, particularly focusing on the effects that reach beyond the administrative borders of a single municipality.

Research strategy

To achieve this objective, a computer-based "tool-set" will be developed and implemented. At an early planning stage, this tool-set allows a quick and efficient evaluation of positive and negative effects of new developments and their interactions and side-effects. Often, the stakeholders' views are dominated by particular interests. RegioProjektCheck aims to expand these narrow perspectives in favour of comprehensive, problem-oriented decision-making based on clear assessment criteria.

Designing new instruments that support decision-making for development projects requires considering various factors and their relationships. Therefore, RegioProjektCheck addresses the following main tasks:

- Analysis and assessment of different problem perceptions by regional stakeholders
- Analysis of regional frameworks and transformation processes, such as economic and population trends, and the creation of development scenarios
- Analysis of relationships between residential, industrial and retail development areas. These include settlement and migration patterns, traffic flows and transportation choices, commuting and consumer behaviour
- Monitoring, modelling and assessment of project impacts in seven thematic areas (Fig. 65);
- Reflexion of experiences with the "tool-set" in a dialogue with stakeholders in two model regions.

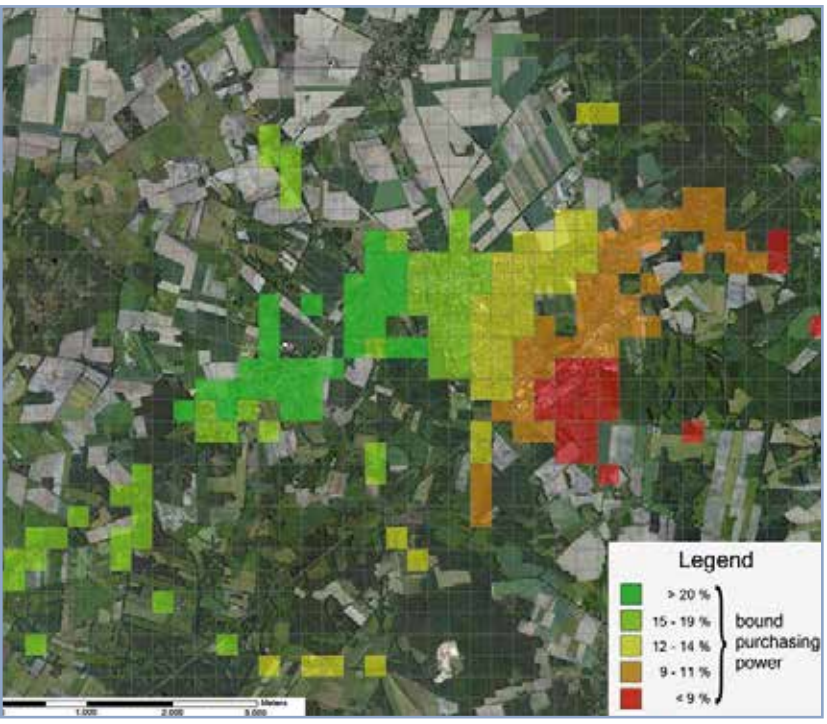

Fig. 66: Illustration of the catchment area for a large-scale retail project in the Harburg County based on the modelling of purchasing power (Source: RegioProjektCheck).

Study area

It is hoped that the RPC tool-set will be used by practitioners in different regions throughout Germany. Whether this new instrument is actually accepted in practice, however, largely depends on how it tackles potential problems of the stakeholders and if it provides appropriate solutions. Two research areas have been selected as model regions: the Harburg County located south of Hamburg in the state of Lower Saxony, and the Rheinisch-Bergischer County located east of Cologne in the state of North Rhine-Westphalia. In these model regions, the tool-set will be improved and adapted in close collaboration with local stakeholders and then tested in practice. This approach ensures that only those projects will be evaluated that are regionally relevant from the perspective of local practitioners, and that the software tools will be designed to improve the rationality of planning decisions in different regional settings.

Fig. 67: Typical local shopping site located on the outskirts of a new residential area (Source: RegioProjektCheck).

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RePro | Regional reuse value chains in water and energy infrastructure in shrinking regions

Objectives

Green waste, residual wood, sewage, sludge and waste heat: rural areas dispose of many secondary resources that could be reused and processed in regional water and energy facilities. Faced with rising prices of energy and raw materials, local authorities and businesses are highly interested in the development of reuse value chains (RVCs), in which secondary resources are used either for the generation of energy or the development of new products.

The aim of the RePro project is to combine water and energy infrastructure in rural areas in such a way safeguard utility services but at the same time contribute to regional value creation. In this project, economically viable RVCs will be implemented in the "climate protection region" Elbe-Elster and the "bioenergy region" Wittenberg by 2013. These value chains will promote the smart, sustainable use of materials and energy resources.

The scientific goal is to combine technical and economic knowledge, spatial and environmental analyses, recommendations for action, and funding and business models in a GIS-based tool-set which is transferable to other regions.

Fig. 68: Forest residues in the Middle Elbe Biosphere Reserve near the town of Vockerode (Source: F. Drießen, Wittenberg County).

Research strategy

The concepts and instruments of sustainable land management that are needed to establish RVCs are being developed according to the regional requirements for knowledge and technology, and generalised for use in other regions. The project focuses on harnessing commercial principles to optimise the RVCs in rural regions. Particular emphasis is put on preparing suitable expert information for decision-makers in local authorities and businesses.

The RePro team created a portfolio of seven typical RVCs which would be technically and economically feasible under current conditions. Using the included RePro information flyer and checklist, representatives of the local authorities and businesses are able to easily find out whether specific project ideas can be transferred into practice. Individual profiles provide detailed expert information to support the establishment of RVCs.

Additionally, the "RePro compact" series were produced. These eight-page brochures provide expert information about the benefits of each reuse system for local authorities, citizens and businesses and thus encourage their adoption. In the next step, the project research team will develop the Spatial Business Intelligence System (SBIS). This GIS-based, decision support tool should provide additional help when establishing the RVCs.

In the Elbe-Elster climate protection region, the researchers identified four regional RVCs for local heat supply. They are based on the utilisation of forest residues, waste wood and biogas waste heat, and the irrigation of short-rotation plantations with treated wastewater. They are organisationally and financially supported by specific operator and investor models. In the Wittenberg bioenergy region, the RePro team is supporting three community projects utilising forest residues, sewage sludge and green waste.

The regional RVCs have indisputable advantages: they increase the regional added value, strengthen the active participation of communities and businesses, and enhance the status of shrinking regions as

Fig. 69: Winkel waste treatment pond, town of Uebigau-Wahrenbrück (Source: town of Uebigau-Wahrenbrück).

pioneers of integrated land management. Nevertheless, the establishment of regional RVCs is complicated. Many stakeholders are involved and need to produce coordinated investment decisions. However, a promising opportunity-oriented analysis has been carried out, which is based on a thorough consideration of economic, environmental and social risks and their distribution, and which should promote the acceptance of the RVCs.

In the early phase of developing the RVCs, it is important to support the municipal and business decisions by early risk management and participation management. For this reason, efforts to consider and minimise the risks have played an important role in the development of the RePro tools: either as excluding criteria in the checklist or in the form of action recommendations in the brochures.

Fig. 70: Vegetation along a drainage channel at Wörlitz is later used as green waste (Source: F. Drießen, Wittenberg County).

Contact

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www.reproketten.de

VIP | Vorpommern Initiative Paludiculture: Developing and implementing sustainable productive utilisation of rewetted peatlands

Background

In undrained, pristine peatlands, waterlogging creates anoxic conditions that inhibit the complete decomposition of plant material, which is then accumulated as peat. In Germany, peat deposits cover around 1.4 million ha. Over 910,000 ha (65 %) is used in agriculture (Fig. 71).

Conventional use of peatlands in agriculture (as grassland or cropland) requires drainage and leads to many problems (Fig. 72). Drainage of peatlands allows microbial oxidation of the peat and results in soil degradation, land subsidence and loss of soil carbon. The consequences are increased costs, growing management problems and decreased agricultural production (Fig. 73). In Germany, drained, agriculturally used peatlands release more than 36 million tonnes of carbon dioxide each year.

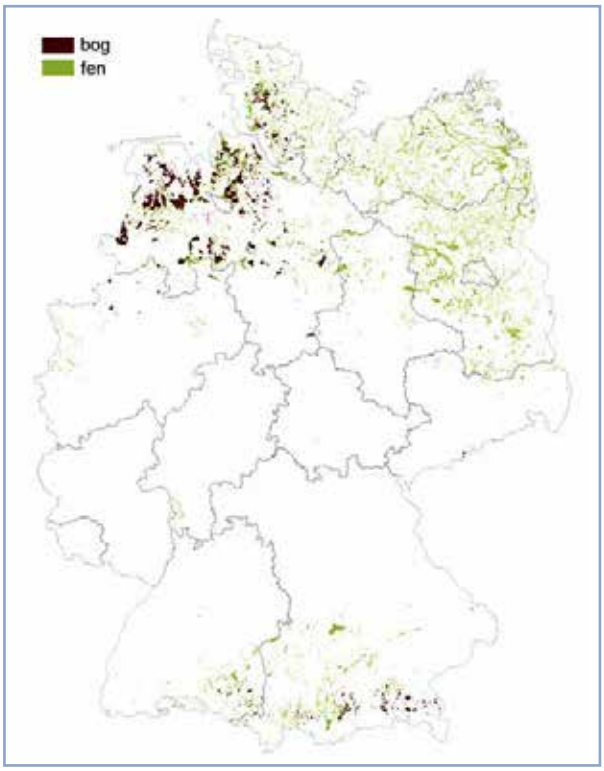

Fig. 71: Distribution of peatlands in Germany (Source: NABU 2012, (database GÜK 200, BGR 2011; M. Sommer; Institute of Soil Landscape Research)).

Fig. 72: Deep drainage ditches are necessary for conventional farming (Source: M. Succow).

Fig. 73: Drainage of peatlands leads to soil degradation, land subsidence and management problems, and results in long-term loss of agricultural areas. (Source: B. Herold).

Fig. 74: Paludiculture: managed wet peatlands along the Biebrza River in Poland (Source: C. Schröder).

Objectives and research strategy

The drained peatlands in the federal state of Mecklenburg-Western Pomerania release 6 million tonnes of carbon dioxide each year, representing 27 % of the total greenhouse gas emissions of the state. In order to reduce these emissions and curb the degradation of

productive land, new concepts for sustainable peatland management have to be developed and implemented (Fig. 74).

Paludiculture (*"palus"* – latin for swamp) refers to the utilisation of peatlands under wet conditions that preserves the peat soil and thus protects the climate and the environment. Paludiculture produces renewable resources on marginal lands without competing with food production and offers an alternative income in structurally poor regions.

Paludiculture plants are adapted to high groundwater levels. The most frequently used are common reed (Phragmites australis), reed canarygrass (Phalaris arundinacea), cattails (*Typha sp.*) and sedges (*Carex sp.*).

Within the VIP project (Vorpommern Initiative Paludiculture), the innovative paludicultural utilisation of wet peatlands has been studied and developed. The project focused on the Vorpommern-Greifswald County where the foundation was laid for the implementation of paludiculture as a sustainable land management option for peatlands. VIP focused on the following activities:

- Development and implementation of adapted harvesting techniques (Fig. 75)
- Development of new products from reed and cattail
- Analysis of peat biomass potential for energy production (biogas, pellets and briquettes)
- Assessment of the profitability of paludiculture for the production of energy and raw materials
- Analysis of legal and socio-economic conditions
- Consulting services for farmers and decision-makers
- Evaluation of biodiversity and climate benefits of paludiculture
- Assessment of the public perception of peatlands and reasons for their protection
- Dialogue with regional stakeholders from government, local authorities agriculture and the general public
- Evaluation of the potential adoption and sustainability of paludiculture
- Development of a national and international framework for the implementation of sustainable land management of peatlands
- Analysis of paludiculture potential in Belarus, Indonesia and China.

Fig. 75: Harvesting biomass with adapted harvesting machines (Source: C. Schröder).

Contact

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www.paludiculture.com

Appendix: Basic information about the collaborative projects of the “Sustainable Land Management” funding measure

Interactions between land management, climate change and ecosystem services (Module A)

Scientific coordination project

GLUES | Global Assessment of Land Use Dynamics, Greenhouse Gas Emissions and Ecosystem Services

Coordination:
- Helmholtz Centre for Environmental Research – UFZ

Project partners:
- Technische Universität Dresden
- Kiel Institute for the World Economy
- University of Bonn
- Ludwig-Maximilians-Universität München
- Potsdam Institute for Climate Impact Research e.V.
- Institute for Biodiversity
- M&Z Consulting Science for Sustainable Development
- con terra – Gesellschaft für Angewandte Informationstechnologie mbH
- 52° North Initiative for Geospatial Open Source Software GmbH

International project partners:
- United States Environmental Protection Agency, NC, USA
- Programme on Ecosystem Change and Society
- Stockholm Resilience Centre
- ICSU and UNESCO
- Global Land Project part of the ihdp, igbp, essp, diversitas (s. GLP background)

Website:
- www.sustainable-landmanagement.net (Module A / GLUES)

Collaborative projects, Module A

Carbiocial | Carbon sequestration, biodiversity and social structures in Southern Amazonia: Models and implementation of carbon-optimized land management strategies

Coordination:
- Georg-August-University of Göttingen

Project partners:
- Helmholtz Centre for Environmental Research – UFZ
- TU Bergakademie Freiberg
- Leibniz Universität Hannover
- Christian-Albrechts-Universität zu Kiel
- Humboldt-Universität zu Berlin
- Universität Hamburg
- University of Kassel
- University of Hohenheim
- Leibniz Centre for Agricultural Landscape Research (ZALF)
- Freie Universität Berlin

Brazilian project partners:
- Embrapa Arroz e Feijão, Santo Antônio de Goiás
- Universidade Federal do Mato Grosso – Cuiabá
- Universidade Federal do Pará, Belém
- Núcleo de Altos Estudos Amazônicos
- Embrapa Amazônia Oriental, Belém
- Universidade Federal do Mato Grosso – Campus Sinop

Study regions:
- South Amazonia, Brazil

Website:
- www.carbiocial.de

CC-LandStraD | Interdependencies between land use and climate change – Strategies for a sustainable land use management in Germany

Coordination:
- Thünen Institute of Rural Studies

Project partners:
- Federal Institute for Research on Building, Urban Affairs and Spatial Development
- Potsdam Institute for Climate Impact Research e.V.
- Institute for Ecological Economy Research
- Westfälische Wilhelms-Universität Münster
- Leibniz Centre for Agricultural Landscape Research (ZALF)

Study regions:
- Germany

Website:
- www.cc-landstrad.de

COMTESS | Sustainable coastal land management: Trade-offs in ecosystem services

Coordination:
- University of Oldenburg

Project partners:
- Technische Universität Braunschweig
- University of Potsdam
- University of Rostock
- Leuphana University of Lüneburg
- University of Hohenheim
- Ernst-Moritz-Arndt-University Greifswald

International project partners:
- NIOZ Royal Netherlands Institute for Sea Research, Yerseke, Netherlands
- Aarhus University, Aarhus, Denmark

Study regions:
- coastal areas of north-western Europe

Website:
- www.comtess.uni-oldenburg.de

INNOVATE | Interplay among the multiple uses of water reservoirs via innovative coupling of substance cycles in aquatic and terrestrial ecosystems

Coordination:
- Technische Universität Berlin

Project partners:
- University of Hohenheim
- Forschungsverbund Berlin e.V.
- Potsdam Institute for Climate Impact Research e.V.
- Senckenberg Naturhistorische Sammlungen Dresden

Brazilian project partners:
- Universidade Federal de Pernambuco
- Universidade Federal Rural de Pernambuco
- Instituto Agronômico de Pernambuco
- Instituto de Tecnologia de Pernambuco
- Instituto Federal de Educação, Ciência e Tecnologia de Pernambuco
- Empresa Brasileira de Pesquisa Agropecuária-Solos
- Instituto Nacional do Semiárido

Study regions:
- Itaparica Reservoir, north-east Brazil, and the entire catchment area of the São Francisco River

Website:
- www.innovate.tu-berlin.de

KULUNDA | How to prevent the next "Global Dust Bowl"? Ecological and economic strategies for sustainable land management in the Russian steppes – A potential solution to climate change

Coordination:
- Martin Luther University Halle-Wittenberg

Project partners:
- Helmholtz Centre for Environmental Research – UFZ
- Leibniz University Hannover
- Friedrich Schiller University Jena
- Georg-August-University of Göttingen
- Potsdam Institute for Climate Impact Research e.V.
- Amazonen-Werke H. Dreyer GmbH & Co. KG
- Leibniz Institute of Agricultural Development in Central and Eastern Europe
- Leibniz-Institut for Regional Geography
- Senckenberg Museum for Natural History

Russian project partners:
- Altai State University
- Altai State Agrarian University
- Institute for Water and Environmental Problems, Siberian Branch

Study regions:
- Kulunda Steppe, south-western Siberia, Russia

Website:
- www.kulunda.eu

LEGATO | Land-use intensity and Ecological enGineering – Assessment Tools for risks and Opportunities in irrigated rice based production systems

Coordination:
- Helmholtz Centre for Environmental Research – UFZ

Project partners:
- Christian-Albrechts-Universität zu Kiel
- Martin Luther University Halle-Wittenberg
- OLANIS GmbH
- Potsdam Institute for Climate Impact Research e.V.
- Science4you
- Technische Universität München
- Georg-August-University of Göttingen
- Ernst-Moritz-Arndt-University Greifswald
- Philipps-Universität Marburg

Project partners from Southeast Asia:
- International Rice Research Institute, Philippines
- Vietnamese Academy of Agricultural Sciences
- Visayas State University, Philippines
- Center for Policy Studies and Analysis, Vietnam
- Institute of Ecology and Biological Resources, Vietnam
- Philippine Rice Research Institute
- CABI International, Malaysia

Study regions:
- Philippines (3 sites in Luzon)
- Vietnam (1 site in southern Vietnam, 3 sites in northern Vietnam)

Website:
- www.legato-project.net

LUCCI | Land Use and Climate Change Interactions in the Vu Gia Thu Bon River Basin, Central Vietnam

Coordination:
- Cologne University of Applied Sciences

Project partners:
- Friedrich Schiller University Jena
- Ruhr-Universität Bochum
- Karlsruhe Institute of Technology

Vietnamese project partners:
- Center for Training and International Cooperation, Vietnam

- Academy for Water Resources, Hanoi
- Hue University of Agriculture and Forestry
- Hue College of Economics
- Da Nang University of Technology
- Institute of Meteorology, Hydrology and Environment
- International Rice Research Institute, Consultative Group on International Agricultural Research
- Secretariat for the International Hydrological Programme of UNESCO

Study regions:
- Vu Gia Thu Bon River Basin, Central Vietnam

Website:
- www.lucci-vietnam.info

SASCHA | Sustainable land management and adaptation strategies to climate change for the Western Siberian corn-belt

Coordination:
- University of Münster

Project partners:
- EFTAS Remote Sensing Transfer of Technology
- Kiel University
- University of Applied Sciences Osnabrück
- Humboldt-Universität zu Berlin
- Osnabrück University

Russian project partners:
- Tyumen State University
- Tyumen State Agricultural Academy

Study regions:
- Tyumen Province, West Siberia, Russia

Website:
- www.uni-muenster.de/SASCHA/

SuLaMa | Participatory research to support sustainable land management on the Mahafaly Plateau in south-western Madagascar

Coordination:
- Universität Hamburg

Project partners:
- University of Kassel
- Ernst-Moritz-Arndt-University Greifswald
- Philipps-Universität Marburg
- Brandenburg University of Technology Cottbus-Senftenberg
- Georg-August-University of Göttingen

Malagasy project partners:
- University of Antananarivo
- University of Toliara
- World Wildlife Fund, Madagascar

Study regions:
- Mahafaly Plateau in south-western Madagascar

Website:
- www.sulama.de

SuMaRiO | Sustainable management of river oases along the Tarim River / China

Coordination:
- Technische Universität München

Project partners:
- Catholic University of Eichstätt-Ingolstadt
- Technische Universität Dresden
- Helmholtz-Zentrum Potsdam – GFZ German Research Centre for Geosciences
- University of Hohenheim
- Universität Trier
- Technische Universität Berlin
- Ernst-Moritz-Arndt-University Greifswald

- Eberswalde University for Sustainable Development
- Johann Wolfgang Goethe University Frankfurt am Main
- Potsdam Institute for Climate Impact Research e.V.

Chinese project partners:
- Chinese Academy of Sciences, Xinjiang
- Xinjiang University
- Nanjing Agricultural University
- Xinjiang Agricultural University
- Tarim University
- China Meteorological Administration
- Xinjiang Normal University
- Chinese Academy of Social Sciences

Study regions:
- Tarim Basin, China

Website:
- www.sumario.de

SURUMER | Sustainable rubber cultivation in the Mekong Region: Development of an integrative land-use concept in Yunnan Province, China

Coordination:
- University of Hohenheim

Project partners:
- University of Stuttgart
- Humboldt-Universität zu Berlin
- Leibniz Universität Hannover
- EFTAS Remote Sensing Transfer of Technology

Chinese project partners:
- Beijing Normal University
- China Agricultural University
- Tongji University Shanghai
- Tsinghua University
- Guangxi University, Nanning
- World Agroforestry Centre, Kunming
- Naban River Watershed National Nature Reserve, Jinghong
- Yunnan State Farm Group, Kunming
- Center for Chinese Agricultural Policy, Chinese Academy of Sciences, Beijing
- Xishuangbanna Tropical Botanical Garden, Chinese Academy of Sciences, Menglun

Study regions:
- Yunnan Province, China

Website:
- www.surumer.uni-hohenheim.de

TFO | The Future Okavango – Scientific support for sustainable land and resource management in the Okavango basin

Coordination:
- Universität Hamburg

Project partners:
- Friedrich Schiller University Jena
- Climate Service Center, Helmholtz-Zentrum Geesthacht
- Justus Liebig University Giessen
- Philipps-Universität Marburg
- Universität Trier
- Universität Bremen
- Leibniz Institute DSMZ – German Collection of Microorganisms and Cell Cultures Braunschweig

African project partners:
- University of Namibia
- University of Botswana
- Universidade Privada de Angola, Angola
- Universidade Agostinho Neto, Angola
- The University Centre for Studies in Namibia
- Polytechnic of Namibia
- Namibia Nature Foundation, Namibia
- Ministry of Agriculture, Water and Forestry, Namibia
- Kalahari Conservation Society, Botswana
- Instituto Superior Ciências da Educação da Huila, Angola
- Instituto de Investigação Agronomica, Angola

- Desert Research Foundation of Namibia, Namibia
- Community Economic Development Programme, Namibia
- Centro de Estudos Africanos, Portugal

Study regions:
- Okavango region, Africa

Website:
- www.future-okavango.org

Innovative system solutions for sustainable land management (Module B)

Scientific coordination project

Leibniz Centre for Agricultural Landscape Research (ZALF), Müncheberg, Germany

Project partners:
- Technische Universität Dresden, Germany
- HafenCity University Hamburg, Germany
- Humboldt-Universität zu Berlin, Germany
- Technische Universität Berlin, Germany
- Neubrandenburg University of Applied Sciences, Germany
- Helmholtz Centre for Environmental Research – UFZ, Germany
- Institut für Städtebau Berlin, Germany
- Academy for Spatial Research and Planning, Germany
- University of Liverpool, United Kingdom
- Global Land Project, Brasilia

Website:
- http://modul-b.nachhaltiges-landmanagement.de/en/modul-b-info/news/

Collaborative projects, Module B

AgroForNet | Linking producers and consumers of woodfuel to contribute to the sustainable development of rural areas

Coordination:
- Technische Universität Dresden

Project partners:
- Martin-Luther-University Halle-Wittenberg
- Leibniz Institute for Regional Geography
- Leibniz Universität Hannover

- Johann Heinrich von Thünen-Institut, Institut für Internationale Waldwirtschaft und Forstökonomie
- Ostdeutsche Gesellschaft für Forstplanung mbH
- Landratsamt Bautzen
- Landratsamt Mittelsachsen
- Hüttmann GmbH
- Agraset-Agrargenossenschaft e.G.
- Biomasse Schraden e.V.
- Lehmann Engineering GmbH
- P&P Dienstleistungs GmbH & Co. KG
- Dettendorfer Wertstoff GmbH & Co. KG
- Sächsisches Landesamt für Umwelt, Landwirtschaft und Geologie DLG e.V.
- Federal Institute for Vocational Education and Training
- Büro für Landschaftskommunikation
- Ingenieurbüro Neumeister
- Forstprodukte Diecke
- NABU – Nature and Biodiversity Conservation Union
- Viehweger, Hartmann & Partner
- Cofely Deutschland GmbH
- Vattenfall Europe New Energy GmbH
- Xella Deutschland GmbH
- The Chamber of Agriculture Lower Saxony

Study regions:

- Lausitz, loess hills of Mittelsachsen and southern metropolitan region of Hamburg, Germany

Website:

- www.energieholz-portal.de

BEST | Boosting bioenergy-regions: New system solutions in the divergence of ecological, economical and social demands

Coordination:

- Georg-August-University of Göttingen

Project partners:

- Fraunhofer Society for the Advancement of Applied Research
- Johann Heinrich von Thünen Institute, Bundesforschungsinstitut für Ländliche Räume, Wald und Fischerei
- Nordwestdeutsche Forstliche Versuchsanstalt
- University of Kassel

Study regions:

- Göttingen County and the Thuringian field plain (BERTA), Germany

Website:

- www.best-forschung.de

ELaN | Developing an integrated land management scheme for the sustainable use of water, nutrients and carbon in north-east Germany

Coordination:

- Leibniz Centre for Agricultural Landscape Research (ZALF)

Project partners:

- Leibniz-Institut für Agrartechnik Potsdam-Bornim e.V.
- The German Federal Institute of Hydrology (BfG)
- Research Institute Bioactive Polymer Systems
- Berliner Wasserbetriebe
- ECT Oekotoxikologie GmbH
- Eberswalde University for Sustainable Development
- Leibniz-Institute of Freshwater Ecology and Inland Fisheries (IGB)
- Freie Universität Berlin
- Humboldt-Universität zu Berlin
- Leibniz-Institute for Regional Development and Structural Planning
- Technische Universität Berlin

Study regions:

- Barnim County, Uckermark County, Germany

Website:

- www.elan-bb.de

EUDYSÉ | Efficiency and dynamics of settlements in times of spatially and temporally disparate development trends

Coordination:
- Leibniz Institute of Ecological Urban and Regional Development

Project partners:
- Leibniz-Institut für Agrartechnik Potsdam-Bornim e. V.
- Beckmann Institute for bio-based product lines e. V.
- HafenCity University Hamburg
- Dresden University of Applied Sciences
- ILS – Research Institute for Regional and Urban Development
- Technische Universität Dresden
- Regionale Planungsgemeinschaft Havelland-Fläming
- Landkreis Meißen

Study regions:
- Meissen County, Havelland-Fläming region, Germany

Website:
- www.eudyse.de

€LAN | Energy prices and land use

Coordination:
- Hamburg University of Technology

Project partners:
- University of Stuttgart
- Institute for Public Economics at the University of Cologne

Study regions:
- Metropolitan area of Hamburg, Germany

Website:
- www.energie-landnutzung.de

KuLaRuhr | Sustainable perspectives for urban cultural landscapes in the Ruhr metropolitan region

Coordination:
- University of Duisburg-Essen, Center for Water and Environmental Research

Project partners:
- Technische Universität Darmstadt
- Landwirtschaftskammer Nordrhein-Westfalen
- The Ruhr Regional Association
- Emschergenossenschaft / Lippeverband
- Technische Universität Braunschweig
- University of Applied Sciences Ostwestfalen-Lippe
- Ruhr-Universität Bochum
- University of Kassel

Study regions:
- Emscher Landschaftspark, Germany

Website:
- www.kularuhr.de/

LaTerra | Sustainable land use by regional energy and material flow management using "Terra-Preta-Technology" on military conversion areas and low-yield locations

Coordination:
- Freie Universität Berlin

Project partners:
- Research Institute of Mining Landscapes Finsterwalde Association
- Fraunhofer Institute for Molecular Biology and Applied Ecology
- Brandenburg University of Technology Cottbus - Senftenberg

Study regions:
- counties of Fläming, Hochsauerlandkreis and Lusatia, Germany

Website:
- www.laterra-forschung.de

LÖBESTEIN

LÖBESTEIN | Land use management systems, ecosystem services and biodiversity: The development of regulatory measures using the example of biomass for energy purposes

Coordination:
- Leibniz Institute of Ecological Urban and Regional Development

Project partners:
- Leibniz Centre for Agricultural Landscape Research (ZALF)
- Saxon State Agency for Environment, Agriculture and Geology
- International Meeting Centre of St Marienthal

Study regions:
- Görlitz County, Germany

Website:
- www.loebestein.de

NaLaMa-nT | Sustainable land management in the North German Plain considering changing ecological, economic and social conditions

Coordination:
- Northwest German Forest Research Station

Project partners:
- Georg-August-University of Göttingen
- Martin-Luther-University Halle-Wittenberg
- University of Rostock
- Christian-Albrechts-Universität zu Kiel
- Technische Universität Berlin
- University of Vechta
- Potsdam Institute for Climate Impact Research e.V.
- Helmholtz Centre for Environmental Research – UFZ
- Leibniz Centre for Agricultural Landscape Research (ZALF)
- Landesbetrieb Forst Brandenburg
- Landkreis Diepholz
- Landkreis Uelzen
- Regionale Planungsgemeinschaft Havelland-Fläming
- Regionale Planungsgemeinschaft Oderland-Spree
- Regionale Planungsgemeinschaft Anhalt-Bitterfeld-Wittenberg

Study regions:
- Diepholz County, Oder-Spree County, Uelzen County, Fläming region, Germany

Website:
- www.nalama-nt.de

Null-Emissions-Gemeinden | Zero-emission villages as a strategic target of sustainable land use management

Coordination:
- Trier University of Applied Sciences, Environmental Campus Birkenfeld

Project partners:
- Trier University of Applied Sciences, Environmental Campus Birkenfeld
- Verbandsgemeinde Rockenhausen
- Verbandsgemeinde Sprendlingen-Gensingen
- areal GmbH Corporation for Sustainable Water Management
- IZES gGmbH
- Peschla + Rochmes GmbH

Study regions:
- municipalities Sprendlingen-Gensingen and Rockenhausen, Germany

Website:
- www.null-emissions-gemeinden.de

RegioProjektCheck | New instruments to evaluate the impacts of housing, industry, and retail projects at a regional level. A contribution to the field of sustainable land management

Coordination:
- HafenCity University Hamburg

Project partners:
- ILS – Research Institute for Regional and Urban Development

Study regions:
- Harburg County, Rheinisch-Bergischer County, Germany

Website:
- www.regioprojektcheck.de

RePro | Regional reuse value chains in water and energy infrastructure in shrinking regions

Coordination:
- inter 3 Institute for Resource Management

Project partners:
- town of Uebigau-Wahrenbrück
- Brandenburg University of Technology Cottbus-Senftenberg
- Anhalt University of Applied Sciences
- Technische Universität Berlin
- Landkreis Wittenberg

Study regions:
- Elbe-Elster County, Wittenberg County, Germany

Website:
- www.reproketten.de

VIP | Vorpommern Initiative Paludiculture: Developing and implementing sustainable productive utilisation of rewetted peatlands

Coordination:
- Ernst-Moritz-Arndt-University Greifswald

Project partners:
- University of Rostock
- University of Applied Sciences Stralsund
- ECOLOG – Institute for Social-Ecological Research and Education gGmbH
- Humboldt-Universität zu Berlin
- Eberswalde University for Sustainable Development
- University of Applied Sciences Neubrandenburg
- Institute for Sustainable Development of Landscapes of the Earth DUENE e.V.
- Kranemann GmbH
- MRG Mineralische Rohstoffmanagement GmbH
- Hanffaser Uckermark
- Gut Darß GmbH & Co. KG
- IBZ Innovations- und Bildungszentrum Hohen Luckow e.V.
- Leda – Landentwicklung durch Agrarkultur
- Bilse – Institut für Bildung und Forschung

Study regions:
- Mecklenburg-West Pomerania, Germany

Website:
- www.paludiculture.com

Glossary

Agroforestry systems:
Agroforestry systems are production systems that combine elements of agriculture and forestry.

Biochar:
A solid material produced by the pyrolytic carbonisation of plant matter.

Biodiversity:
Diversity of life forms: plants, animals and microorganisms, the genes they contain and the ecosystems they form. Biodiversity is usually considered at three different levels: genetic diversity, species diversity and ecosystem diversity.

Biomass:
Biological material derived from living or recently deceased plants and animals. When using biomass to generate electricity, heat and fuel, it is necessary to distinguish between renewable materials (or energy crops) and organic waste.

Carbon sink:
Carbon sink (also carbon dioxide sink, CO_2sink) refers to a reservoir that temporarily or permanently accumulates and stores carbon. This term should not be confused with carbon storage. While storage is static, i.e. it can bind a certain amount of CO_2, sinks are dynamic, i.e. they also store carbon but can grow in their capacities (e.g. newly planted forests). In the context of climate change, carbon sinks are of high significance because they absorb the greenhouse gas carbon dioxide (CO_2) from the atmosphere and thus counteract global warming.

Cascade utilisation:
Multiple use of resources (raw materials) in several steps over time.

Decentralised energy supply:
Production of energy near the sites of demand.

Degradation:
Deterioration or destruction of ecosystem services.

Dendromass:
Woody biomass that can be used as a raw material and energy source.

Desertification:
Type of land degradation in relatively dry (arid, semiarid and dry sub-humid) areas which is caused by various factors, including climate change and human activities. This degradation leads to the spread and formation of deserts or desert-like conditions.

Dust Bowl:
A period of severe dust storms during the "Great Depression" that caused major environmental and agricultural damage to the American and Canadian prairie lands ("Great Plains") in the 1930s (especially 1935 – 1938). The extensive agriculture (focused mostly on producing wheat) displaced the native, deep-rooted prairie grasses that normally kept the soil in place and protected it from erosion, and the long periods of drought became fatal. The drought and dust storms destroyed crops and people were forced to leave their farms.

Ecosystem:
An ecosystem consists of a biotope (environment, habitat, locality) and living organisms, i.e. biotic community (biocoenosis). Examples are peat bogs, forests as well as agricultural lands.

Ecosystem services:
Ecosystem services are all products and functions of an ecosystem that provide direct or indirect benefits to people. Examples are clean water, food, wood, but also services such as pollination, natural pest control and soil fertility.

Geographic information system (GIS):
Computer-based tool for capturing, processing and displaying spatial (geographic) data.

Grassland:
Areas dominated by grasses, i.e. permanent meadows and pastures.

Green liver:
Biological system for water purification.

Greenhouse gasses (GHG):
GHG are atmospheric gases that absorb the infrared radiation and trap heat in the atmosphere. Working

much like the glass panels of a greenhouse, they warm the atmosphere. Natural greenhouse gases are water vapour, carbon dioxide, ozone, methane and nitrous oxide. Anthropogenic greenhouse gases are halo-alkanes, chlorofluorcarbons (commonly known as freons), and sulphur hexafluoride.

Humus:
Consists of all organic matter in the soil, which has been formed by the decomposition of dead plants. A major role in the conversion of organic matter into microscopic humus particles is played by earthworms, mites and bacteria. Humus contains a high proportion of substances that can be absorbed by plant roots and promote the growth of plants.

Interdisciplinarity:
Cooperation between two or more academic disciplines.

Knowledge management:
Strategy for influencing individuals and / or organisations in order to effectively transform implicit knowledge concerning sustainable land management into explicit knowledge in order to make it available for other people / organisations.

Life cycle assessment (LCA):
Life cycle assessment (also known as ecobalance or cradle-to-grave analysis) evaluates the entire product life cycle, the material and energy turnover and all associated environmental impacts.

Natural resources:
Natural resources are materials and goods that are provided by nature and can be used by people.
In general terms this includes water, soil and air. In technical terms we speak of biotic and abiotic resources.

Paludiculture:
Utilisation of wet peatlands, e.g. for the production of energy from peat biomass.

Reuse systems:
Use of local resources to provide electricity, gas, heat, water and fertilisers, which are then marketed within the same region.

Saltwater intrusion:
Saltwater intrusion is the movement of saline water into freshwater aquifers. This process occurs naturally in most coastal areas due to different densities of salt and fresh water.

Short rotation coppice (SRC) plantations:
Cultivation of fast-growing woody plants (e.g. willow and poplar) that produce a large amount of biomass in a short time and harnesses the species' natural capacity for vegetative reproduction.

Terra Preta substrate:
The Terra Preta substrate (TPS) is an anthropogenic black earth with high resistance to degradation. Compared to conventional soil improvement measures, TPS has several advantages: it enables the accumulation of organic matter and the release of nutrients, and increases the soil activity.

Transdisciplinarity:
Integration of decision-makers, users, stakeholders and other parties in a research process.

Urbanisation:
Urbanisation describes the expansion of urban areas and utilisation of land, as well as an increasing proportion of the total population living in towns within a region, country or a state.

Value chain:
Value chain refers to a chain of value-adding activities which aim to deliver a valuable product or service. These activities can range from cultivation or extraction of raw materials, through processing and trading, to the utilisation and reuse and / or disposal of used products. The value chain includes all aspects of the product's life cycle.

Value network:
A value network is created by a group of companies or institutions that cooperate in different stages of the value chain.

Woodfuel:
Wood used to generate energy via combustion.

Disclaimer
For better readability, gender differentiation is omitted in this publication. Terms used automatically imply equal treatment of both genders.

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