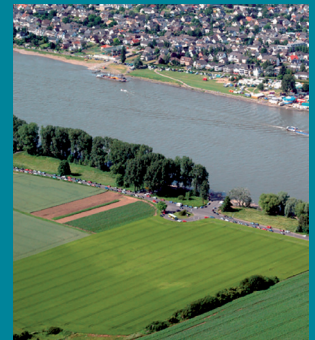
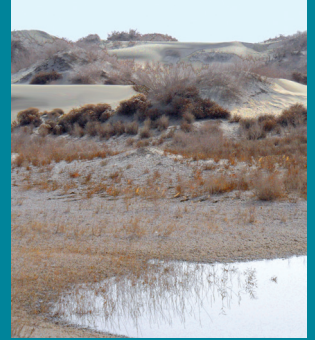




SUSTAINABLE LAND MANAGEMENT

Book of oral abstracts



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Topic 1

Integration across disciplines

Global midterm scenarios on possible pathways of global agricultural markets and land-use

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Land use and land use change are determined as much by economic and institutional drivers as it depends on the bio-physical conditions. The demand for different uses of biomass is increasing and thus land use change and the expansion of farming areas into natural habitats may threaten ecosystems and their services. Factors influencing this process include climate and demographic change but also an increasing globalisation of agricultural markets paired with an increasing divergence between regional supply and demand of biomass. On the supply side, agricultural yields as well as production stability are threatened by a changing climate. Socio-economic changes, such as increasing incomes and changes in consumption patterns already lead to increases e.g. in demand for animal feed that outgrows food demand for direct consumption. In the medium to long-run these consumption patterns may also alter the processes of global change. Such future pathways of socio-economic and environmental systems can only be assessed with scenarios which describe possible future paths of development.

To improve the understanding of interacting ecological and socio-economic systems, and to help design better land management policies, the German Federal Ministry for Research and Education (BMBF) launched the collaborative Sustainable Land Management research programme. It funds studies in 12 region distributed in Africa, Asia, Europe and South America. To make outcomes of these studies comparable, a set of six global midterm scenarios is developed and quantified by a modelling framework that combines a global economic model and a plant growth model. We defined midterm scenarios in the course of two workshops together with representatives of the regional projects. They include as baseline scenarios and scenarios on biofuel quotas, meat consumption and cropland expansion/contraction. In addition, two scenarios are defined to explore the upper and lower bounds of potential developments. In this paper we present results on global and regional prices of agricultural products, production quantities and bilateral trade flows for these scenarios, which can be used as global boundary conditions in regional studies.

**Methods of inter- and transdisciplinary research
– a trajectory of knowledge integration**

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Although applied science has found its way to the forefront of calls, funding and publications, there is no conceptual consensus and only limited research (Binder et al. 2015, Jahn et al. 2012, Wuelsner et al. 2012) on the nature of transdisciplinary scientific cooperation. Joint projects offer an abundant learning platform, usually without the need to budget additional funds or time. The scientific process is a research mode aimed at producing applicable scientific solutions for societal problems, for which knowledge integration remains the crucial challenge. After a brief historical retrospective (Fleck et al. 1980), we describe the trajectory of knowledge integration of a rather large research consortium attempting to overcome typical communicative and conceptual hurdles while sacrificing the strict preconceptions of the respective disciplines. We also point to some of the difficulties and pitfalls frequently encountered in a project of large size. A holistic analysis of the diverse aspects of the project requires an understanding of the forces, actors and driving forces who impact on land use change and how these changes relate to ecosystem factors such as soil nutrients, organic matter, soil erosion, water balance and greenhouse gas flows between the soil and atmosphere; such analysis is beyond the capabilities of a single discipline or scientific method. The project utilized on-farm methodology, such as field experiments and analysis of specific chemical and physical soil parameters and properties, as well as off-farm techniques, including remotely-sensed data assessments, statistical and spatial modeling, data analysis, stakeholder dialogues, interviews with land users and decision makers, workshops with international experts, biographical interviews, long-term micro-level field studies, extensive literature reviews, joint storyline and scenario development, and, finally modeling. We engaged in continuous dialogue among the various disciplines and approaches, enriching our knowledge base and sparking new insights. The fact that most results were directly integrated in the various and increasingly interlinked models led to constant communication among the subprojects involved. During the trajectory of knowledge integration presented here, it became obvious that a new generation of scientists is developing despite the disciplinary publication-based focus that implies disadvantages for inter- and transdisciplinary engagement: scientists with a grasp of both basic and applied sciences, combined with the soft skills necessary to reconcile both worlds.

A Cross-sectoral Approach to Analyse Land Use in Germany

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Global, national, regional and local driving forces affect land use in Germany. The talk presents modeling results, depicting the impact of global developments on the land use / land use change in Germany. The results are derived regionally differentiated to account for the spatial heterogeneity. We compare the impacts of several scenarios on environment and landscape with a baseline. These scenarios reflect societal demands on land use and land management, e.g. production of food, feedstuff or biomass, demand for settlement and transport areas, contribution to environmental protection and climate change. The scope of investigation is cross-sectoral and considers the major land uses in Germany: agriculture, forestry and settlement/transport. Greenhouse gas emissions due to land use and land use change are one focus, especially direct emissions by land use and land use change and the substitution potential of biogenic raw materials.

We analyze these questions with a network of biophysical and socio-economic models. We present indicative results of the models LAND USE SCANNER, RAUMIS, MODE and GAS-EM. The LAND USE SCANNER is a GIS based simulation model in which qualitatively formulated scenarios are underlaid quantitatively and are simulated in a spatially explicit way. Measures in settlement and transportation were analyzed more detailed especially regarding climate adaptation. Agricultural measures focus on contribution to climate mitigation. The model RAUMIS is a regionalised agricultural and environmental information system and simulates the impacts of agricultural and environmental policies on the regional agricultural land use, production, income and the environment. Adjustments are modelled in a comparative static setting. RAUMIS specifies the agricultural land use on county level. Interfaces between the models RAUMIS and MODE and GAS-EM allow regionalized analyses on greenhouse gases from agricultural sources. MODE simulates spatially stratified direct nitrous oxide emissions from mineral soils (annual resolution). The model GAS-EM simulates greenhouse gas emissions (nitrous oxide and methane) from animal husbandry and manure management on a district scale and with annual resolution.

Global price projections and information on the available agricultural area serve as inputs (inter alia from GLUES).

The used multi-level approach integrates global development (e.g. population growth, increase of meat demands), national trends (e.g. demographic change, energy system transformation / energy policy) and regional specifics (e.g. peat bogs or agricultural site quality) in a consistent framework.

COMTESS: Integration of results from different disciplines by modelling the impact of changing environmental conditions on ecosystem service provision

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Climate change threatens coastal regions of the North Sea and the Baltic Sea primarily through accelerated sea-level rise, higher rainfall in winter, lower rainfall and increasing temperatures during summer. This may reduce fresh groundwater reservoirs in summer and – with a rise in the sea level – increase the risk of salt water intrusion in unconfined coastal aquifers. The expected increase in precipitation in winter will necessitate an increased freshwater discharge in the sea, although sea level rise may impede future natural run-off into the sea. The collaborative research project COMTESS (Sustainable coastal land management: Trade-offs in ecosystem services) investigates the impact of climate change, sea level rise and different management options on the ecosystem service (ESS) provision by coastal vegetation at the German North and Baltic sea coast.

A causal chain of hydrological, ecological and socio-economic models predict the impact of changing climate and sea level rise on the hydrology, plant communities and finally ecosystem service provision for the study regions East Frisia and Mecklenburg-Pommerania from 2010 to 2100. Several scenarios of sea level rise, climate change and land management options serve as input for the modelling chain. Future ecosystem service provision is modelled in a spatio-temporally explicit way based on direct environmental effects (such as modelled groundwater and surface water levels) or as indirect effects mediated by the functional trait composition of the future vegetation modelled with species distribution models and a database of traits. Methods to evaluate services ranging from willingness to pay and habitat templates to plot-based quantifications are instrumental at different spatial and temporal scales.

Trade-offs between ecosystem services can be monitored over time as well as spatially explicit as maps. Valuation rules differ between stakeholder groups which implies another possible trade-off to be studied. Ultimately, an aggregated value for different ecosystem service groups can be compared between different combinations of several climate, sea level rise and management scenarios to inform land managers of the expected ESS provision under different environmental realities and political options.

Complexity of integration across disciplines: challenges and possible solutions

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This contribution aims first to present the structure of transdisciplinary KULUNDA project, to discuss the challenge of complexity of integration and interdisciplinary synthesis. As next, it suggests several strategies how to effectively deal with the named challenges.

The research work of interdisciplinary KULUNDA project is divided into nine research subprojects, one subproject for the scientific coordination and one subproject for the initiation of implementation project. German and Russian counterparts form tenders in each of the subprojects.

The project is organised in four Work Packages (WPs) which focus on the

- analyses of the effects of agricultural management practices on soil and other ecosystem properties with regard to climate conditions
- development, test and implementation of adopted land use practices and steppe restoration measures
- analyses of the effects of natural and social framework on land use decisions
- development and implementation of stakeholder driven planning and consulting platform which allows implementation of innovative land use strategies

Each of the WPs synthesises the results of several individual subprojects, by that combining the research work of social and natural science disciplines. The integrative syntheses of the WPs serve as a base for developing region specific sustainable land management strategies and recommendations.

Being an interdisciplinary and transdisciplinary project KULUNDA faced a common challenge of the complexity of integration across disciplines. In addition, different interests of the stakeholders on different levels had to be considered while formulating sustainable land management recommendations.

Several strategies were used to deal with the above mentioned challenges.

First, the project has highly benefited from an interdisciplinary coordination team, where the project leader and the Russian coordination team have natural science background while the project coordinator of German side has a social science background. This allowed a strong understanding of the viewpoints of different disciplines and an optimal facilitation of the communication in the project.

Second, so called matching method, facilitated by KULUNDA project structure, was used in organising the work of the overall project. By saying matching method it is meant that the individual subprojects worked independently to a certain degree but had an interface and crosscutting points. Examples of it are jointly prepared and organised field researches, data collections, workshops and publications. In collaboration with local stakeholders' jointly organised field days, advanced training measures and events present some other examples.

Third, the collaboration and cooperation with local stakeholders on different levels was organised and facilitated on a broader context than on an academic or disciplinary level. This was an essential strategy how to ensure and facilitate transdisciplinary collaboration.

By doing so the new and innovative knowledge was generated in close collaboration with different stakeholders that understand and incorporate the results produces by the research in their everyday decisions.

Flexible project coordination and co-production leads to innovative results - the LEGATO experience

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For place-based approaches to sustainable land management, which require that the specific ecological and social context is addressed properly, the co-production of knowledge is a must, but not easy to achieve. It demands reconciling well established scientific procedural standards with the implicit or explicit criteria of societal relevance. The difficulty of managing such tensions is amplified particularly in large integrated projects and represents a major challenge to project management. This presentation is based on GÖRG et al- (2015) and SPANGENBERG et al. (2015) and presents some lessons learned from large integrated projects, with an emphasis on project design and management structure, in particular from the LEGATO project (SETTELE et al., 2015). The challenges of ecosystem service management are addressed by a sequence of different project phases each with its own approach and level of integration. Whereas some phases are dealing with joint problem definition and co-production in a strict sense, others give more room for scientific methods and disciplinary approaches.

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Topic 2

Integration of researchers and stakeholders

Land-use measures and strategies in question: facilitating dialogues between researchers and stakeholders in Germany

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The paper presents findings from the inter- and transdisciplinary research project CC-LandStraD that analyzed interdependencies between climate change and land use in Germany. It mainly aimed at developing strategies to mitigate and adapt to climate change in the main land use sectors (agriculture, forestry, settlement and transportation by also taking into consideration nature and environmental protection). Methodologically, CC-LandStraD combined bio-physical and socio-economic modeling with socio-economic and juridical assessments as well as stakeholder participation. Stakeholders involved in the project cover a wide range of land use experts, including farm managers, forestry experts and their respective interest groups, as well as representatives of administrative bodies and regional planning. Regional and national stakeholders from all aforementioned sectors contributed to the project in several ways: in the process of selecting and prioritizing appropriate land-use measures for climate change mitigation and adaptation, in the assessment of current land-use conflicts within and between the different sectors, as well as in the validation of preliminary and final project results regarding their practical relevance and obstacles.

Climate change was but one motivation of the research. Rather, the project engaged with a revived and partial highly conflictual debate on appropriate land uses and legitimate land-use interests in Germany. The pertinent land use challenges are the increasing pressure on land available for rural production due to urbanization and transportation networks, as well as the competition for land between food and agricultural energy production. Due to the political agenda of ‘energy turnaround’ (*Energiewende*) away from fossil fuels and nuclear power as well as to the increasing regional disparities between growing and “shrinking” regions, land-use demands within and between the different sectors not only vary regionally, but also changed considerably within the past years. Distinct interests – wood vs. field, urban vs. rural, energy farmer vs. crop farmer – therefore need to be taken into account. Transdisciplinary projects can help to express and understand distinct land-use interests and contribute to their reconciliation. CC-LandStraD therefore involved organized and individual land-use actors on the regional scale as well as national land-use organizations by applying different methods (semi-structured interviews, focus groups, workshops, feedback interviews). These methods were used to enable different forms of stakeholder participation ranging from information to partnership.

The paper to be presented sheds light on the participation process itself, its methods and outcomes, as well as on critical issues.

Cultivating Contact – Concepts and Experiences on Integration of Stakeholders and Researchers

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The team of the Kulunda-Project (Southern Siberia) comprises natural, technical and social scientists. The project itself was accompanied actively as well as passively by stakeholders for its whole duration. Though the project's design of co-operation is generally highly estimated by all participants a number of challenges and problems in the contact of scientists with stakeholders could be observed. The presentation will discuss the favourable and obstructive elements for communication with and knowledge-transfer between stakeholders and researchers. It will consider reflexively the organisations, the practices of scientists in the field and their logics which produce wanted but also unwanted results. Finally it will make suggestions how to interpret the findings in order to reflect them as general challenges for projects alike.

While researchers were aware of the ecological problems of Kulunda-Steppe as a comprehensive societal challenge in the early conceptual phase of the project, stakeholders' views were only partly integrated into the description. With the start of the project the contact between both groups became much more intense due to a number of specific formats which were constantly or repeatedly essential elements of the work in the project. Starting from stakeholder workshops the range of talks, discussions and work comprised joint field visits, on-site-discussions, exchange of experiences in order to improve testing and development of technologies, preliminary reports and policy briefings, joint seminars and field days and others. The intensity of integration varied from sub-project to sub-project, but nevertheless the general trend was an increasing frequency of contacts and exchange in the course of the project. It also has to be stated that the contact was not developed in the same way to all groups of stakeholders and even this varied in the phases of the project. Even if the researchers came to know the stakeholders' demands better during joint work they could not serve it always, especially in the later phases of the project. Sometimes this was due to incompatible time regimes of practice and science, sometimes there simply was a lack of capacities for preparation and communication.

One may interpret such mismatches on the pragmatic level which should be "reparable" with adequate resources and the good will from both sides. Beyond such conclusions the presentation tries to sensitise for the one or the other cause which lies deeper and can be understood as rooted in the self-conception of researchers and their culture of communication.

Entertainment Education - soap operas for dissemination and education

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It has been demonstrated that participatory approaches increase the farmers' acceptance of new practices and promote the (informal) dissemination of knowledge (WATERS-BAYER et al. 2015). Analogous to advertisements of agro-chemicals, mass media campaigns can be highly efficient and cost-effective in order to reach and motivate millions of farmers to adopt ecological engineering practices (SINGHAL & ROGERS 1999; BENTLEY 2009). For instance, a multimedia campaign using posters and leaflets helped to successfully reduce early season insecticide spraying by 53% in South Vietnam (ESCALADA et al. 1999). To scale-up this success, a follow-up mass media campaign (locally named "Three Reductions, Three Gains") has been developed and reached more than 3 million farmers in South- and Central Vietnam (HUAN et al. 2008). Another way to use mass media is through entertainment education programmes. A weekly broadcast radio soap opera that featured stories on farmers' daily struggles in rice cultivation, management of pests, dangers of pesticides and social and family life helped to reduce insecticide applications by 60% (HEONG et al. 2008). More recently, a TV series to promote ecological engineering was developed within LEGATO and launched in Vietnam, helping to modify farmers' attitudes and practices and to reduce insecticide use by 19% (HEONG et al. 2014). For further recent details see also WESTPHAL et al. (2015). The presentation will focus on the most recent experiences and activities in the context of these TV base soap operas.

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Ecological Engineering - experiences from the implementation of LEGATO results

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New ways of research and development are needed to sustainably manage multiple ecosystem services with ecological engineering in agricultural landscapes. Over the last decades, participatory approaches have been developed that involve farmers, who are the main managers of agroecosystems, in the research and development of innovative environment-friendly practices (FEDER et al., 2004; WESTPHAL et al., 2015). With this presentation experiences will be shared on the implementation of Ecological Engineering activities and the close collaboration between farmers and researchers in one of the LEGATO regions (SETTELE et al., 2015; KLOTZBÜCHER et al., 2015) – an intensively used area in the province of Nueva Ecija, Central Luzon, Philippines.

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Stakeholder oriented research design – example of the Lucci project

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Applied research should consider stakeholder demands from the very beginning. Institutions and professionals coping on a daily basis with the natural resources management challenges typically are very aware of the pressing problems, the available information, and knowledge gaps.

The research project “Land use and Climate Change Interactions – LUCCI” organized a series of stakeholder workshops from 2010- 2015 in order to establish and maintain a close contact with the various actors from agriculture, water management, environment and hydropower development from local district, province and national level. The stakeholder consultations provided the key input for the subsequent research implementation and served as the main test for the validity of research results during the project. In several cases the stakeholder inputs revealed shortcomings of the initial research design. In the case of the Lucci project, for instance, it became particularly clear that any future study on sustainable land use needed to address the large scale hydropower projects and related reservoir constructions going on or being planned in the region with potentially significant impacts on local land uses and on the hydrological cycle.

After updating and consolidating the research design the consortium of German, Vietnamese and International partners could provide significant inputs by filling knowledge gaps revealed by stakeholders and by developing different “what-if scenarios” based on integrated modelling tools offering insights into possible future pathways of land and water resources management.

Finally, the products of the research were made accessible to the stakeholder through the Vu Gia Thu Bon River Basin Information Center (RBIC) which is now maintained by the main Vietnamese Partner of the project in its local office in Danang. Through an online open access data base stakeholders from various sectors can obtain all raw or analyzed data which was collected or prepared during the research project and it is expected that this will foster a new approach to integrated natural resources management and planning in the region.

Different methods for different purposes –

Experiences with participatory methods in the SuLaMa research project

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The contribution aims at reflecting the transdisciplinary research within the regional project *Sustainable Land Management in Madagascar* (SuLaMa) from a process-oriented perspective. We present the project's approach to stakeholder cooperation, with a focus on methods that facilitate the collaboration with the local population. Two participatory methods were applied in the frame of the project: *Rapid Rural Appraisal* (RRA) and *Role-Playing Games* (RPG). The positive and negative lessons learned may help other projects to plan and structure their research process.

The aim of the SuLaMa project was to develop sustainable land use strategies on the Mahafaly Plateau (south-west Madagascar). The project consisted of seven interdisciplinary work packages including agronomy, animal husbandry, natural ecosystems and functions, socio-cultural values, socio-economics and agricultural economics. Researchers from German and Malagasy universities were involved in the project and every German doctoral student had a Malagasy counterpart. The WWF in Madagascar was a direct project partner who provided logistical infrastructure and regional knowledge. At the local level, socio-organizers helped to facilitate the communication between researchers and local population. Among the rural communities, para-ecologists were trained and field experiments were conducted in cooperation with resource users. At different stages of the project, community workshops together with the local population were held using the methods *Rapid Rural Appraisal* (RRA) and *Role-Playing Games* (RPG). The Rapid Rural Appraisal was conducted at the beginning of the project with the aim to frame the research design, to get in touch with the local population and to obtain first information on social and environmental diversity in the region. As scholars from all disciplines were involved, the method also served to link the different research topics. RRA techniques were used such as participatory mapping, calendars, Venn diagrams, etc. After four years of research, a Role-Playing Game was designed and tested. The workshops helped to discuss decisions on subsistence activities for various types of households and scenarios like drought or cattle raiders with local people. The information obtained served to validate the project's modelling data and induced discussions on livelihood strategies. Participants stated that they reflected their own behavior in their real-life and discussed on solutions for their problems.

The SuLaMa experiences reveal both challenges and potentials for future projects. On the one hand, intercultural and transdisciplinary cooperation remains an additional effort and a challenge for scientists. Moreover, the validity of data and the legitimacy of decisions taken within participatory methods are controversial. On the other hand, participatory methods offer a potential which goes beyond scientific knowledge generation. For different stages of the research process, the SuLaMa project applied different methods to foster mutual learning for both scientists and local people; help to negotiate different points of view, and contribute to designing plans and strategies.

Key words: transdisciplinary research, Madagascar, participatory methods, Rapid Rural Appraisal, Role-Playing Games

Research-praxis integration in South China - the rocky road to implement strategies for sustainable rubber cultivation in the Mekong Region

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In this presentation we will discuss the approach to research-practice-integration in the SURUMER project. Furthermore we will discuss strengths and weaknesses, identify the mayor challenges and draw conclusions for future process management. The effort follows the assumption that the possibility for implementation will be the higher the more “realistic” the concepts are and the better they are communicated with stakeholders. Three key stakeholder groups have been identified so far, namely innovative rubber farmers and village heads, prefecture administration, and provincial politicians. For stakeholder involvement, a pragmatic communication approach has been chosen which consists of a range of discourse instruments such as bilingual information material, newsletters, focus groups, and a series of workshops with key stakeholders. One of its main elements is participatory scenario development including discussions on the economic and ecologic trade-offs of different land use.

Various aspects supporting or hindering implementation have been analysed: Generally, communication amongst researchers but mainly between researchers and practitioners takes more time and resources than initially estimated. This mainly affects the testing of new approaches. For example, “scenarios” are discussed in a complete different way within the group of researchers than amongst practitioners, which means that there is need for translation not only from English to Chinese and vice versa, but between abstract modeller-thinking and concrete needs of practice. “Demonstration plots” on intercropping with endangered tree species can show only the very initial planting processes; evidence that intercropping is more sustainable than conventional rubber cultivation is limited.

Stakeholders are open towards innovative solutions. Most of them are aware of ecological problems such as water quantity and quality even if they do not necessarily link them with rubber cultivation. More important is the fact that prices for latex have decreased to less than a quarter in recent years and farmers may have lost two-third of their income. Many farmers either search for work in town or they rent their community land to investors. If farmers rent out land to external investors there is a threat that rubber might be replaced by ecologically more adverse cultures such as banana.

Despite the time constraints and limited resources for interaction with stakeholders, SURUMER has shown ways to mutually develop solutions amongst research and practice. Experience shows that communication processes must be managed carefully. It is obvious that significant resources are needed, and that even long research projects of five years can not expect full implementation.

Transdisciplinary research – a reality check. Experiences from TFO.

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Transdisciplinarity has been promoted as an adequate approach to address more effectively today's urgent challenges in human-environment interactions. Recognizing the limits of traditional disciplinary knowledge production, transdisciplinary research aims to grasp the complexity of real-world problems by crossing disciplinary as well as professional boundaries. The aim is to integrate the different bodies of knowledge in order to produce solution-oriented and applicable knowledge. With these prospects in mind, the concept of transdisciplinarity enjoys a boom not only in scientific debates but is also increasingly demanded by funding agencies. Accordingly, in the case of the BMBF-programme 'Sustainable Land Management' transdisciplinary approaches have been encouraged. Looking into the practical implementation however, challenges remain. The new approach for joint knowledge production between scientists and stakeholders seems difficult to reconcile with research realities and the concept runs the risk not to live up to its own claims.

With this talk we contribute to a better understanding of the practices of transdisciplinary research in action and the challenges faced using the TFO project – a transdisciplinary research project dealing with sustainable land management in Southern Africa (Angola, Botswana, Namibia) – as a case study. We provide empirically based insights into the collaborative research process and critically reflect on the experiences made. The analysis is based on semi-structured interviews that were conducted with research partners from Germany and the African partner countries as well as with stakeholders from the local up to the transboundary level in the Okavango Basin. Additionally, observations of project meetings, activities and communications will be analysed along with project documents. We investigate the perceived roles, motivations and understandings regarding the project's transdisciplinary character among those involved and explore their patterns of interactions and constellations of interests in the sometimes conflicting field. Looking at the specific case of the collaboration between German and African partners, a special emphasis is put on the analysis of the structural conditions and post-colonial settings that shape the knowledge production as well as on power relations emerging in such North-South partnerships. By demonstrating some of the underlying causes of the challenging practice of transdisciplinarity with our case study, we reveal entry points for institutional changes that allow a more reflexive and fruitful transdisciplinary knowledge production.

Topic 3

Science policy interface

The science-policy interface of GLUES - facilitating contact between scientists and political decision makers

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Decision making in land management is done on different levels, from individual farm level to cooperative level, regional or national policy level up to global environmental policy level. Each of these levels can integrate scientific findings and conclusions in its decision making if such findings are accessible and understandable for the respective decision makers. To facilitate this contact and mutual understanding between scientists and decision makers is the purpose of a science-policy interface. Within GLUES as coordinating unit of the sustainable land management programme the Institute for Biodiversity Network e.V. (ibn) was entrusted with the science-policy interface, especially at the level of global environmental policy processes as e.g. the Convention on Biological Diversity (CBD), the UN Convention to Combat Desertification (UNCCD), the UN Framework Convention on Climate Change (UNFCCC) or the Intergovernmental Platform on Biodiversity and Ecosystem Services (IPBES). In this respect ibn informed scientists of the regional projects on the targets and strategic goals of these international agreements and on opportunities to contribute to the scientific and policy meetings of these conventions. Such contributions had i.a. the format of side events where scientists presented their target-related results directly to political delegates of member countries and discussed implementation possibilities. Over the full time span of the programme this science-policy interface was a two-way process between scientists and political decision makers.

Brazil's program on low-carbon agriculture: Will farmers behave as policy-makers expect?

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Concerns of balancing agricultural production and environmental protection shifted the focus of Brazilian policies towards sustainable intensification of agricultural land use. Low-carbon agricultural and forestry systems are currently promoted by the Brazilian government as ways of preventing deforestation, improving the productivity of degraded lands and reducing emissions from land use and land use conversions. For instance, in 2010 Brazil established preferential credit lines for financing investments in sustainable agricultural systems (ABC Program). This measure is aimed to foster the adoption of low-carbon production practices such as integrated agroforestry systems and commercial forest plantations. Widespread implementation of such practices requires them to generate economic benefits for the land users adopting them. Moreover, the benefits of adoption should outweigh the benefits of the other competing land use alternatives. Yet, little is known about farm-level economic impacts of adopting these low-carbon production systems and the effectiveness of the ABC Program in relaxing farmer investment constraints (GIL ET AL., 2014). This contribution presents a modeling-based empirical assessment of the systems promoted by the current instruments of the ABC Program. For the assessment we parameterized MPMAS (SCHREINEMACHERS AND BERGER, 2011) and MONICA (NENDEL ET AL., 2011) for five municipalities in the state of Mato Grosso. The coupled software simulates the behavior and dynamics of all commercial farms in our study area, reflecting the farm differences in resources, natural conditions, and crop yields. The whole-farm modeling approach of MPMAS then permits comparison of low-carbon farm systems with soybean–cotton and soybean–maize double-crop systems, currently dominant in the study area. Based on this comparison, we assess the potential of sustainable agricultural intensification in Mato Grosso and identify farm types that are likely to adopt low-carbon agriculture. In addition, we test the effectiveness of current instruments of the ABC Program and provide recommendations for possible policy improvement.

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The German sustainability strategy and its 30 hectare objective – recent progress, outlook and policy options

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Land use decisions in the sector settlement & transport are facing new challenges caused by climate change. Action approaches are meeting climate change mainly by targeting climate adaptation, such as flood prevention or the handling of urban heat islands. But the development of settlement and transport areas can also contribute to climate protection by reducing land consumption in order to preserve carbon sinks and to reduce land use conflicts. In 2002 the German government passed the National Sustainability Strategy, which addressed the topic by setting up the objective to reduce land consumption in Germany to 30 hectares per day until 2020, mainly by prioritizing the inner urban development of towns and cities instead of developing settlements on greenfields.

In consequence of this political ambition widespread policy actions were undertaken to diminish land consumption. This encompasses statutory modifications (Spatial Planning Act, Building Code etc., for example the promotion of inner urban development), new subsidy policies (Demonstration Projects of Spatial Planning (MORO), Urban Development Funding etc.) and different informal activities to sensitize relevant actors and stakeholders for the topic. These activities have led to various projects and measures on all administrative scales, e.g. regional monitoring systems or municipal activities to foster inner urban development.

Since 2002 we can observe a magnificent reduction of land consumption in Germany, as the daily utilization for settlement and transport has decreased from around 129 ha in the late 1990s to 73 ha in 2013. Thereby the process is still characterized by obvious regional distinctions and differences between rural and urban as well as central and peripheral regions. Nevertheless, actual findings can forecast that the objective of the National Sustainability Strategy won't be achieved until 2020.

Within the SLM project CC-LandStraD different measures were modelled and visualized via the land use change model "Land Use Scanner", trying to develop possible strategies to reach the objective in a long term and to contribute to the climate mitigation and adaptation objectives of CC-LandStraD. Among others these measures take up the potential of an enhanced inner urban development, an increased building density or a more restrictive protection of open space. The measures were not only modelled, but also assessed according their instrumental feasibility. Thus, the project addresses not only scientific-technical aspects in developing sustainable land use strategies, but also ensures that planning and socio-economic aspects are taken into consideration by identifying needs of modification in the actual governance systems in Germany.

The presentation will – after giving an overview of the recent development of land consumption in Germany – introduce chosen results of these analyses, highlighting the most effective measures to reduce land consumption. Based on this, further policy options to reduce land consumption will be discussed, including formal and informal instruments on different administrative scales, reaching from more restrictive approaches of spatial planning and innovative aspects of regional governance to an increased consideration of land consumption in subsidy policies.

Valuation of ecosystem services in outranking stakeholder driven land use plans

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The research project COMTESS developed and applied a set of different means to tie the ecosystem services approach and the practice of local and regional stakeholders together. The set covers (i) qualitative research combining ecosystem services with stakeholder preferences and land use, (ii) contingent valuation methods and (iii) a mixture of qualitative and quantitative multi-criteria analysis.

The presentation will focus on participatory integrated planning and assessment (PIPA) processes on adaptive land use at North Sea coastal communities. PIPA as a scheme to support regional foresight planning enabled the stakeholders to deal with multi-criteria problems, to include qualitative and quantitative data covering economic, ecological and social values, to consider multi-sectoral perspectives, to outrank different future land use management options, and to develop a platform for discussion and consensus finding.

The results of the PIPA process clearly indicate that inclusion of various decision-makers in the co-designed and stakeholder-science driven processes was successful and led to the (partly) implementation of the outranked actor-based scenario: the regional planning authority published a new regional spatial plan in September 2015 which designates a present agricultural site as water retention area to tackle possible impacts of climate change.

How regional projects contribute to international resource management and nature conservation: Science-policy-interface in the German-Brazilian regional project INNOVATE

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Within the programme “Sustainable Land Management”, international scientific projects were encouraged to contribute to political processes on major UN conferences. The German-Brazilian regional project INNOVATE incorporated this Science-Policy-Interface into project management and participated in conferences to the Convention on Biological Diversity (CBD) and to the United Nations Convention to Combat Desertification (UNCCD). The objective of our contribution was providing UN delegates with information on regional scientific solutions to combat desertification and biodiversity loss in caatinga dry forests in NE Brazil. In particular, we showed how the scientific results relate to important targets of the UN organizations.

In the case of CBD (COP12 in Pyeongchang, Republic of Korea), we linked the project achievements to the Aichi targets (5, 7, 14 and 15). To ensure that areas under agriculture, aquaculture and forestry are managed sustainably and biodiversity is better protected by 2020 (Aichi Target 7), the project supports the establishment of protected areas, environmental education and sustainable agriculture in collaboration with the relevant stakeholders of the region. Local assessments and regional modeling of biodiversity are in addition combined with a decision support system complemented by identifying opportunities and threats to the governance of natural resources. For reducing the rate of loss of natural habitats, degradation and fragmentation by 2020 (Aichi Target 5), INNOVATE analyzed and modelled changes in land cover. Surprisingly, the cover of caatinga dry forests increased during the last decade in many areas, which is also supported by results on the population structure of the most abundant trees. Still, the species number in forests with historic human impact remains low. Therefore, efficient restoration strategies are developed together with decision makers to slowdown the species loss in natural dry forests within the project area. To safeguard ecosystem services (Aichi target 14), INNOVATE transfers knowledge on ecosystem functions and services to relevant institutions with the aim of influencing decision making via adequate incentives. In particular, ecosystem functions such as carbon sequestration, pest control by herbivore predators and water purification in the reservoir are assessed and translated to ecosystem services. Grazing of caatinga forests leads to a decrease in aboveground and topsoil carbon stocks. INNOVATE therefore proposes adaptations of the existing grazing regime and a reduction of animal loads to intermediate levels to counteract carbon losses and desertification (according to Aichi target 15).

INNOVATE also participated in UNCCD conferences (scientific conferences in Bonn and Cancun, COP12 in Ankara). The contributions highlighted the link to aspects of land degradation neutrality, restoration, economic aspects of land degradation, applicable management solutions for sustainability and again on knowledge transfer, including decision support systems. Overall, the project thus provided ideas how scientific research can contribute to international resource management and nature conservation. The solutions developed may be applied by various stakeholders at different institutional levels. Consequently, such projects may give scientific backstopping to political processes on UN conferences and provide decision makers with sound and timely knowledge.

Science policy interface in the field of climate change mitigation in Russia's agricultural sector

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During the Khrushchev era an area as big as 2.3 Mio ha in Russia's Kulunda region has been converted from steppe to arable land. Its potential began to be exploited and yet overexploited leading to massive soil degradation and unsustainable agricultural production practices in the Kulunda steppe. The KULUNDA project reveals drivers that lead to the appearing unsustainable land use. These drivers represent a starting point for economic and hierarchical mitigation policy measures. With that our results relate to targets and strategic goals such as to combat land degradation and to mitigate climate change, in turn an aim of various multilateral environmental agreements.

The objective of this paper is twofold: First we show various drivers in Russia's agricultural context that hamper or facilitate a transformation to more sustainable land use and production practices of farmers in the Altai Krai in Russia's Kulunda steppe. These factors are the results from one overarching work package that consolidates the research from various subprojects of the KULUNDA project. Second, we exemplify the benefit of studying such drivers with a showcase from the science policy interface which we study in KULUNDA.

We take the political will to stop burning of harvest residues on Russia's steppe soils in the Kulunda region as an example to show why policy implementation to combat green-house gas emissions face so many challenges. Based on statistical data and supported by remote sensing data, we estimate for spring 2014 a quite high area of agricultural land under fire in the Altai rayon. Smoke, methane and nitrous oxide contaminates the air, fires spread to adjacent forest and often fauna and flora is badly impacted. Subsequent massive wind erosion afterwards contributes to soil degradation.

We will provide empirical answers to the question, what are the reasons that let the agricultural producers – despite the banning by law – continue to burn their harvest residues? What are the institutional constraints of the current command and control policy?

Our contribution to the science policy interface aims at awareness raising that a policy which is difficult to monitor and face difficulties to sanction offenders should not be the only mitigation strategy. Integrating the outcome of various subprojects in the KULUNDA project shows that a comprehensive approach is needed that takes cultural and demographic aspects of the local communities and technological production facts into account. Such additional policy measures could be for instance educational programs and payment schemes that should be tied to prerequisites which consider environmental-sound agricultural practices.

In that regard, we facilitated a science policy debate with a discussion forum conducted in the frame of the KULUNDA project. This selective event joined respective stakeholders at a two-days moderated exchange of interests.

The potential of ecosystem-based approaches to mitigate the impacts of coastal hazards and climate change in Central Vietnam

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The coast of Central Vietnam faces severe threats from typhoons, storm surges, and coastal flooding that will likely be aggravated in both intensity and frequency by the impact of climate change. At the same time, ongoing land use intensification, accompanied by degradation or entire loss of near-natural coastal ecosystems will intensify coastal erosion processes, while sea-level rise leads to increased salinization of coastal aquifers, surface waters, and soils. Ecosystem-based Disaster Risk Reduction (Eco-DRR) and Ecosystem-based Adaptation (EbA) are considered suitable strategies to reduce the risk of coastal hazards, mitigate climate change impacts and sustain local livelihoods. We present results from the LUCCI project in the Vu-Gia Thu Bon catchment of Central Vietnam, where we assessed the potential for ecosystem-based management, conservation and restoration of coastal dune systems (CDS) and mangroves. For these two types of coastal ecosystems we (a) assessed the ecological status and protective functions in the study region; (b) analyzed in how far protective ecosystem services are considered in legislation, institutional frameworks and management practices from national to regional level; (c) assessed the perception and awareness of coastal residents with respect to ecosystem-based approaches, and (d) designated potential areas for conservation and restoration measures. With our research we want to stimulate the science-policy and science-society dialogues with respect to community and ecosystem-based coastal management and show possible approaches to better integrate disaster risk reduction, climate change adaptation and biodiversity conservation in a long-term management strategy.

Grain marketing institutions and agri-food policy in Russia

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Grain marketing arrangements in modern Russia are far from what they were in the 1990s. Over the years, state procurement of grain has lost in importance, barter has virtually disappeared, and intermediaries have come to be indispensable to the functioning of the entire agri-food system. At the policy level, another development has been remarkable. Mirroring the federal level, the Tyumen region introduced its Food Security Programme, thus committing itself to the goal of self-sufficiency in agricultural products. If regional self-sufficiency illustrates a dominant discourse on the political arena, how do grain marketing institutions function and what role does the state play in grain marketing transactions? Inspired by these questions and taking into account profound post-Soviet transformations in the agri-food sector, this paper examines the reality of contemporary grain marketing institutions in the Tyumen region.

Semi-structured interviews with farmers, grain buyers and regional authorities were conducted in the region of Tyumen in 2013-2014. The research found that grain marketing transactions are, in fact, not constrained by the regional border and agricultural producers engage in active marketing cross-border interactions. The food security policy, hence, is in practice limited to the stage of agricultural production. However, grain marketing institutions demonstrate a number of other features that require policy-makers' attention to support long-term functioning of the agri-food sector.

Regional grain elevators and traders (independent or processor-affiliated) are the two main types of marketing partners of agricultural producers in the region, offering two different types of contracts. The analysis grounded in new institutional economics found that the traders' contracts, compared to those offered by grain elevators, are often better tailored to account for uncertainty as a salient property of marketing transactions, but discourage quality improvements and differentiation. Furthermore, both contract types encourage strategic behaviour of grain buyers.

The conducted analysis offers a number of policy implications pertaining to a range of areas. Key issues concern independent grain quality assessments, direction of agricultural extension, economies of scale in grain marketing as well as cross-regional marketing interactions.

Keywords: grain marketing, institutional economics, agricultural policy, Russian agriculture, West Siberia

Topic 4

Integrated water/river basin management

Investigating the influence of different land management strategies on water availability and salt concentration in a coastal area in Northwest Germany

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Coastal areas are highly vulnerable to the impact of climate. Two aspects of climate change need to be taken into account. First, global sea level rise, increased precipitation during winter and higher storm surge frequency will have a direct impact on local drainage management. Second, the increase of temperature and enhanced evapotranspiration during summer periods will lead to decreasing groundwater recharge rates in combination with salinization through geological faults.

In this study we investigate how different land management options affect the regional hydrology of a coastal area in North West Germany and the local effect on salinization on the plot scale.

Landuse is dominated by grazing. As 30 % of the area is below sea level, permanent drainage is required. The predominant marsh soils are characterised by low permeability which prevents an interaction with the confined brackish aquifer. We use a hydrological model which couples surface and groundwater. The meteorological boundary conditions are regionalized climate simulations based on the IPCC emission scenarios in combination with three sea level rise scenarios. Additionally, to simulate the effect of a dyke breach by a storm surge event, the extent and duration of a possible flooding is taken into account.

The investigated land management options include a scenario in which the technological level of management will be adapted to rainfall and sea level. Three land management options include the adaptation to increasing precipitation and sea level rise using an embanked area for water storage and wetland areas designated as potential buffer for winter storm surges and inland floods as well as freshwater storage for dry summer periods. In two land management options, large polder areas are created for nature conservation and carbon sequestration or extensive farming. In a third land management option, stakeholders developed a system of several smaller polders in combination with an intensification of the water resource management. In the “trend” option, coastal defence structures and pumping guaranteed the land was dry enough for the current farming strategy, but the cost intensive pumping rates increased. This land management option was highly affected by the storm surge event. While the large polder systems were able to buffer the increasing precipitation volumes, land use extensification and the cessation of agriculture on 20 percent of the area greatly changed the appearance of the landscape. The polders were used effectively to store fresh water in summer periods and prevented salinization. In these land management options, the storm surge event was effectively mitigated. The land management option developed by stakeholders included small distributed polders and had a comparable effect with the added benefit of preserving the original landscape and thus higher acceptance by the local residence. The storm surge did not have the severe inundation effect.

To conclude, we have shown different land management options and their effect on pumping rates, groundwater recharge rates and their vulnerability to a severe storm surge event for different climate and sea level rise scenarios. In any case there will be loss of agricultural land through salinization or water management, and the maintenance costs will increase.

The Itaparica reservoir – Aquatic ecosystem functions: Impact, vulnerability and development of an adapted management.

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Today multiple use of reservoirs is a public agreement, but conflicts between stakeholders for ecological, economic and sociological reasons are frequent. Sustainability of the aquatic ecosystem functions must be the aim for any reservoir management, and a sufficient water quality, at least mesotrophic conditions, is necessary. However, eutrophication processes of many tropical reservoirs are advanced, and a re-oligotrophication is needed, being successfully applied up to now only to temperate lakes.

Studies on Itaparica reservoir, São Francisco river, located in the semi-arid Northeast of Brazil, are carried out to quantify impacts on ecosystem functions and to develop an adapted reservoir management to guarantee sustainability of ecosystem services. Large reservoirs such as the Itaparica possess a high dynamic of water quality due to high inflow. Main disturbance factor of tropical reservoirs are extensive water level changes due to dry and rainy season, as well as operational hydropower conditions. Hydrodynamics simulations were conducted with the software TELEMAC-2D on Icó-Mandantes Bay, a branch of the Itaparica reservoir. Low and high water level scenarios were investigated with the purpose to deeper understand their effect on transport of substances and the exchange of the main stream with the bay. Littoral desiccation areas are of high significance for nutrient release after rewetting by sediment mineralization; after drying sediment composition shifted towards a relatively larger mobile P pool. Increasing water level promotes the water pest (*Egeria densa*), a pioneer plant. *E. densa* was found to be the dominant species in the bay, with negative impacts on the aquatic ecosystem services. Growth success of this plant is related to recurrent water level changes. *E. densa* accumulates large quantities of P and is therefore an important P sink beside the sediment. The trophic level of the reservoir and the Ico-Mandantes bay differ significantly due to reduced water exchange processes. P-chlorophyll *a* relationship as P use efficiency model was applied for critical P load estimation of 25 µg P L⁻¹. After impoundment, the P load highly exceeded the carrying capacity, because of leaching of the inundated vegetation and sediments; too of high significance is the export of nutrients from the sub-watershed with the dominant Caatinga biome. But lake sediments have a high P absorption capacity, and the trophic level has been changing towards mesotrophic with sediment deposition within the reservoir after the trophic upsurge. Intensive aquaculture fish production with net cages leads to an overcharge of the reservoir. Itaparica reservoir, was found to be a minor source of greenhouse gases in contradiction to higher emissions seen in many other Brazilian reservoirs. Ebullition of methane is the main factor explaining higher emission rates in shallower waters up to 3 m depth. Multiple water uses and sustainability of aquatic ecosystem services are focus of an adapted reservoir management. Hereby key factors are re-oligotrophication, sediment management and blue aquaculture. An advanced and adapted reservoir management lead to a better ecological status with a more stable water level, without seasonal breakdown of *Egeria densa*, supported by a sediment management with erosion control, sediment abstraction and re-use for soil amendment.

Distributive Hydrological Modelling a Monsoon Dominated River System in Central Vietnam, influences of Land Use and Climate Change

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Vietnam is regarded as a country which is strongly impacted by climate change. Population and economic growth provides additional pressure on the ecosystems in the area. In particular building of hydropower dams, urbanisation, and higher demand of water for industrial and drinking water provides stress to the water balance.

The Vu Gia-Thu Bon catchment is a typical river system in central Vietnam with a tropical monsoon climate and an area of 12000 km². For the estimation of the impacts of climate- and land use change a distributed hydrological model J2000, available through the JAMS modelling framework, was used to simulate the water balance of this catchment. Furthermore sheet erosion in the area will be estimated.

For the representation of future climate change results of a WRF-simulation will be used. The results of the J2000 simulation will be utilized for hydro dynamic models (Mike 11 and Mike Flood) to estimate the impact of land use and climate change on flooding and saltwater intrusion. The effect of the increasing use of hydropower will be represented with a Mike Basin model.

The different results of the modelling tasks will be used to provide the national and local stakeholders with information of different future scenarios.

Integrated ecohydrological modelling of Western Siberian river basins

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Climate and land-use change affect the behaviour of hydrologic systems and result in alterations of landscape water regimes. As a consequence, impacts on crop production, food security, carbon sequestration and biodiversity are to be expected. The study area of Tyumen region, Western Siberia, is vulnerable to these global changes and the ecosystem's resilience is important for future land management. As part of the Western Siberian Grain Belt, the study area was investigated within the frame of the interdisciplinary joint project SASCHA (Sustainable land management and adaptation strategies to climate change for the Western Siberian Grain Belt).

The following interdisciplinary methodological framework was used: An ecohydrological model was set up by using information e.g. of land-use and agricultural management, weather and hydrological data. Global climate scenarios were downscaled, agricultural management scenarios were developed, and both run for depicting impacts on hydrological components.

Results of the current hydrological status show that the dominating hydrological processes are snowmelt, retention and groundwater flow. Within the three studied river basins Pyshma, Vagai and Loktinka, high seasonal and spatial variability was observed. Due to snowmelt, the considerable flood events occur during spring time. Additionally, surface runoff, evapotranspiration and groundwater flow are important features over the year.

Climatological analyses show that the study area is becoming more homogenous with an in future drier and warmer climate in the southern forest steppe zone and a wetter and less warmer (compared to the south) climate in the northern taiga vegetation zone. Climate change scenarios result in a possible increase in both minimum and maximum temperature as well as partly in precipitation, especially an increase in autumn and winter precipitation. Hence, the annual streamflow tends to increase at all selected catchments under different climate scenarios, mostly with highest predicted increase in cold seasons.

Sustainable adaptation strategies need to consider future agricultural development and livelihoods in the grain belt region. Results from field experiments and related research showed options for sustainable intensification of crop production systems. Reduced tillage intensity increased significantly the plant available soil water storage and therefore enhanced the water-use efficiency. The loss of water through evapotranspiration was estimated with a simple approximation formula based on standard meteorological data.

Sustainable integrated river, agricultural and land management should be based on interdisciplinary international cooperation preserving livelihood, natural resources and ecosystem functions.

Changes of the cryosphere in the Aksu-Tarim Catchment and its impact on river discharge

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Tarim River is the main artery for the oases at the northern margin of the Taklamakan desert in Xinjiang, North-West China. The streamflow of the transboundary Aksu River, the most important tributary to Tarim River increased by ~30% over the last decades. With ongoing climate change, further streamflow changes in the future are expected in the snow and glacier melt dominated catchments. The correct assessment of the contribution of the meltwater of snow and ice to the total runoff is hampered by the lack of measurements of snow cover, glaciers and their changes. Remote sensing offers suitable tools to assess these changes for the entire catchment.

Snow cover time series have been generated starting from 1986 using AVHRR scenes as well as the preprocessed MODIS snow cover product. Results show that significant snow accumulation begins in October and melting starts in March. Significant snow fall could also be detected in summer and permanent snow cover can be expected above an elevation of ~5200 m asl. Anomalies are very indicative and reveal a high interannual variability of snow cover. Change detection shows on average a slight decrease of snow cover in lower altitudes up to 4000 m asl. and an opposite trend above. This could be explained by increasing temperature accompanied by increasing precipitation.

Area and mass changes of the glaciers in the catchment (glacier cover ~6500 km²) were investigated since the mid 1970s using KH-9 Hexagon and Landsat imagery, the SRTM digital terrain model, and some additional sources. Highest mass loss accompanied by the most pronounced glacier retreat was found for the outer Ak-Shirak massif whilst moderate mass loss was observed for the Central Tien Shan. The latter region also revealed the lowest glacier shrinkage. The total glacier mass loss of 0.35±0.34m w.e. a⁻¹ is, however, within the global average whilst the glacier area shrinkage is comparatively low. On average, the glacierized area shrank by 0.11±0.15% a⁻¹ only. In the recent decade, glacier mass changes were slightly lower than before.

The additional contribution to the runoff of Aksu River due to glacier imbalance has been determined at ~20% for the 1975–2000 period. Hence, glacier mass loss is an important reason for the past streamflow increase. To further investigate possible causes for the increase, two glacierized headwater catchments were investigated based on the hydrological model WASA. The model was evaluated with respect to daily and interannual streamflow variability, and glacier mass balance data. The comparison of simulations with original temperature and precipitation time series to detrended simulations showed that discharge increases in the highly glacierized Sari-Djaz catchment were largely caused by temperature and glacier melt increases. In contrast, discharge increases in the less glacierized Kakshaal catchment were attributed to both temperature and precipitation increases.

Climate model scenarios for the 21st century were used to simulate future glacial and hydrological changes. Results show an initial further increase in river discharge in the first scenario period (2011–2040) and a general decline in discharge in the last half of this century. The decreasing streamflow is mainly caused by the projected further glacier mass loss. There are indications for an increase in precipitation which would partially counterbalance melt water decrease. Although high uncertainties exist and the projections are strongly scenario-dependent, these projections are an important basis for long-term planning and decision making with respect to the water management in the arid Xinjiang province.

Large-scale Hydrological Modelling and Decision Support for Sustainable Water Allocation along the Tarim River in Northwest China

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The Tarim River Basin, located in Xinjiang, Northwest China, is the largest endorheic river basin of China and one of the largest in whole Central Asia. Due to the extremely arid climate with an annual precipitation of less than 100 mm, the water supply along the Aksu and Tarim River solely depends on river water. The on-going increase of water consumption by agriculture and other human activities in this region has been enhancing the competition for water between human needs and nature. Against this background, 11 German and 6 Chinese universities and research institutes formed the consortium SuMaRiO (www.sumario.de), which aims at gaining a sustainable land and water management in the Tarim basin.

A large-scale hydrological model (MIKE HYDRO) was established for the purpose of sustainable agricultural water management in the main stem Tarim River. Scenarios with change on irrigation strategies and land use distributions were investigated. The results of this study provide a scientific basis for decision-making on agricultural water consumption and allocation.

Subsequently, a Decision Support System (DSS) was built up. It is based on ecological indicators (Ecosystem Services, ESS) and designed to train stakeholders to assess possible consequences of their actions. Under climatic and socio-economic scenario assumptions for 2013, 2030 and 2050, impacts of planned possible management measures can be calculated in a quantitative way and evaluated with the help of ESS indicators. All indicators have been elaborated in SuMaRiO stakeholder workshops or derived from model results.

The DSS starts with an input section of five steps:

1. Definition of three years for planned management measures.
2. Choice of a climate scenario. On the basis of this climate scenario the potential inflow into the Tarim is calculated, which is the basis for the calculations in the DSS.
3. Choice of socio-economic indicators for the planning years.
4. Choice of management measures.
5. Choice of objectives and weights. The DSS provides a list of ESS indicators for each sub-region on which the evaluation of the management measures is based.

Afterwards, the impact on the ESS indicators for each year are calculated for each management measure with the help of multivariate functions and fuzzy logic. The results are illustrated in the output section in tabular form, graphically and with the help of maps. Based on these results and the objectives assigned to the ESS indicators by the user, an achievement level respectively an utility value between 0 and 1 is calculated, indicating to what extent the objectives have been achieved with the respective measure. In addition, the trade-offs between the ESS indicators can be identified. By the weighted aggregation of the utility values of the ESS indicators a normalized measure is obtained for each management measure, so that they can be compared with each other.

The DSS has gained high recognition by the water authorities in Xinjiang and will be tested as a prototype management tool for the Tarim River in the 13th five year plan of China.

Integrated Water Resources Management and measures for a more sustainable rubber cultivation

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Rubber monoculture increased rapidly Yunnan (China) since 1976 and in 2010 occupied more than 22 % of land area. This development was accompanied by various socio-economic and ecological changes. While people benefited from economic growth they also encounter increasingly environmental changes like the availability of sufficient water with safe drinking water quality. In order to quantify these challenges and to develop stakeholder validated measures to improve the situation for humans and the environment an integrated water management concept has been developed and implemented in an agricultural-dominated watershed. Key components of the concept are, besides conventional water and soil monitoring, workshops for capacity development, interviews and workshops with relevant stakeholders. Models like SWAT and CASIMIR are used as decision support tools to assess the possible impact of suggested measures.

Interviews with tourists, residents in the local town Jinghong and in Shanghai showed that water and soil erosion issues are of high concern for every group. The water quality monitoring (amongst others nitrogen, phosphorous, selected pesticides like atrazine, turbidity, conductivity, oxygen, total coliforms) showed that especially after rain events turbidity as well as concentrations of microbial pollutants and agricultural chemicals (nitrogen, phosphorous, pesticides) are increased. In terms of water quality for human uses and for the environment especially peak concentrations of turbidity, total coliforms and some pesticides need to be reduced. E.g. chlorpyrifos, an insecticide used in rubber cultivation, was detected at 50% of the LC50 for (rainbow trout) *Oncorhynchus mykiss*. Prospective measures to avoid hazards to humans and the environment are the establishment of water protection zones and riparian buffer zones. With regard to drinking water quality this is particularly important because non-treated surface water is used as drinking water in this region.

The riparian buffer zone and the water protection zone concept are based on literature, field experiments, and workshops. National and international literature, guidelines and recommendations provide the foundation of the structure of these concepts. Special attendance has been given to develop the concepts in accordance with local regulations and management strategies. For example, reduced chemical weeding instead of maintaining a weed free understory in rubber plantations lead to reduced run-off and soil erosion and hence sediment supply to water pathways. In combination with intercropping trials in rubber plantations, these experiences are being used to define the width of different protection zones and to develop specific management measures.

The implementation of integrated water resources management in combination with stakeholder and transdisciplinary expert involvement from science, practice and administration led to water protection zone and riparian buffer zone concepts which not only will improve the aquatic ecological condition and human health situation, but also may lead to improved overall ecological conditions.

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Assessing future water resources development in the Okavango River Basin under changing climate, management and governance

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As a result of changing climate conditions and rapid economic development with associated land-use changes, water resources and associated ecosystem services of the Okavango River Basin (ORB) are projected to face notable changes in the next decades. In order to identify possible changes and to quantify their temporal scale and amplitude on different spatio-temporal scales from the Angolan headwaters of the Okavango River through Namibia towards its inland delta in Botswana, various research activities in the context of the “The Future Okavango (TFO)” were undertaken.

The intra-annual runoff regime differs considerably, showing very high runoff variability in the Cubango (MQ-Apr. 418 m³s⁻¹, MQ-Oct. 45 m³s⁻¹) and a smoothed behaviour in the Cuito (MQ-Apr. 231 m³s⁻¹, MQ-Oct. 115 m³s⁻¹). These different runoff patterns leading to the peakflow runoff contributions during the flood season while assuring baseflow-driven runoff in the dry season. The yearly flood pulse is the basis for the near pristine Okavango Delta’s rich biodiversity. Nevertheless, more than 90% of the overall basin runoff is generated in the Angolan headwaters tributaries Cubango and Cuito, utilized for crop production and Biodiversity by Namibia and Botswana. To avoid transboundary conflicts the permanent Okavango River Basin Commission (OKAKOM) was formed in 1994. In order to represent the hydrological process dynamics in the ORB and to assess the impacts of future changes, hydrological simulation models of various tributaries of the basin were developed. Using different climate and land-use change scenarios (e.g. reflecting deforestation, irrigation) as inputs, these models allow for the projecting of changes of the runoff regime. For this purpose, global climate projections were dynamically downscaled by means of a regional climate model to generate regional climate data with a high spatial resolution, which has been applied.

Furthermore unplanned and unmitigated commercial irrigation and the presumed degradation of riparian lands by local populations are assumed to affect the water quantity and quality resources in the riparian countries. At the same time, they are at the heart of land use disputes and potential conflicts, where conservation, agro-industrial agriculture and smallholder traditional land use are supported and opposed by different cohorts of stakeholders. These different interests and objectives, which are also reflected in traditional rules and transboundary activities of local communities, are partly based on beliefs about the impact of each of the different land uses on the water resources. These beliefs can be modified or confirmed by making available robust, science-based information, which our models are able to provide, related to water resources management.

In our contribution, we will present how changing climate, and land-use conditions will impact on hydrological ecosystem functions of the ORB. As one of the major results, we show that deforestation in the upper part of the basin might result in intensified flood runoff in the rainy season, due to higher surface runoff generation. In contrast, impact of climate change up to 2030 is less pronounced. However, the delta model showed a highly variable outflow from the delta, which may be an indicator for some internal dynamics in the system.

Topic 5

Climate change adaptation/mitigation/carbon storage

Simulation of regional nitrous oxide emissions from German agricultural mineral soils: A linkage between an agro-economic model and an empirical emission model

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Agricultural soils are an important source of nitrous oxide, a greenhouse gas whose global warming potential is around 300 times that of carbon dioxide. Therefore nitrous oxide emissions from soils contribute around 40% to total GHG emissions from German agriculture. In soils, nitrous oxide is produced by microbial processes. The availability of reactive nitrogen, coming from mineralisation or fertilisation activities, is one of the most important key drivers of nitrous oxide production. Beyond available nitrogen and carbon sources geophysical and geochemical conditions in the soil determine whether and how much nitrous oxide is being produced. In contrast to widely applied emission factor approaches, the empirical model MODE estimates the influence of geophysical and geochemical properties by proxies of meteorological data, soil properties and land use data (Dechow and Freibauer et al. 2011)

Aiming to examine the regional influence of mitigation strategies on direct nitrous oxide emissions from land use in Germany the model MODE was coupled to the agro-economic model RAUMIS by regionally stratified emission factors generated by MODE. National nitrous oxide emissions were quantified for the Baseline 2007-2020 and compared to N₂O emissions computed by an emission factor approach. Spatial distribution and trends of national nitrous oxide budgets differ between both methods. While the IPCC approach computes an increase of nitrous oxide emissions by 12% the increase is only 9% when using the MODE approach.

An assumed tax on purchased mineral nitrogen was tested for its efficiency in nitrous oxide mitigation and its effect on productivity. The nitrous oxide emission from land use decreased by 12-13% compared to the baseline scenario. Using the IPCC approach for N₂O emission estimation reductions were most pronounced in regions with low live stock densities and less fertile soils (Brandenburg, Mecklenburg Vorpommern, Sachsen). In these regions water limitation by low annual precipitation rates and soils characterized low usable field capacity is controlling crop production. Denitrification as the major process contributing to nitrous oxide production requires oxygen limitation often caused by high soil water contents limiting the gas exchange between soil and atmosphere. Therefore these regions are small sources of direct nitrous oxide emissions with a general low mitigation potential as shown by the model results with MODE (Henseler and Dechow, 2014). The results of the agrar-economic model RAUMIS indicate that a tax on purchased mineral nitrogen fertilizer will affect agricultural production in those regions not susceptible to high direct nitrous oxide emissions. Effective mitigation strategies have to adress the regional variability of nitrogen surplus of land use systems.

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Spatio-temporal variability of methane emissions from coastal ecosystems in Northern Germany

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The coastal regions of North Sea and Baltic Sea are considerably threatened by climate change and resulting sea level rise. Hence, the project COMTESS (Sustainable Coastal Land Management: Trade-Offs in Ecosystem Services), funded by the Federal Ministry of Education and Research, examines the impact of coastal protection measures on ecosystem functions and ecosystem services by the force of climate change.

As a part of the overall project we measured methane emissions from various coastal marshes and peatlands on eleven different vegetation classes. We measured CH₄ fluxes using the non-steady state chamber method. Methane fluxes varied strongly among all sites ranging from -3.17 to 118.90 g CH₄ m² h⁻¹. At the Baltic Sea and North Sea sites the annual emission estimates ranged from -23.16 ± 11.22 to 365.94 ± 54.76 kg CH₄ ha⁻¹ a⁻¹ and from 11.70 ± 0.57 to 757.03 ± 48.22 kg CH₄ ha⁻¹ a⁻¹, respectively. The largest explanatory power for methane fluxes and annual emission estimates is given by ground water level and soil properties while vegetation class does not have much explanatory power. The estimation of site-specific emission estimates for the all study sites can only be given containing large uncertainties due to severe spatial and temporal variability in the measured methane fluxes.

In the context of a sustainable coastal land management we have to consider different water management scenarios and their impact on the release of methane and other greenhouse gases. On the other hand we have to find management scenarios that sustainably develop coastal regions at the North and Baltic Sea ecologically and economically.

Climate and land use change impacts on the water-energy-food nexus in the arid northeast of Brazil – scenario analysis and adaptation options

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Within the German-Brazilian project INNOVATE the interactions of hydrology, water resources management, land use, climate variability and climate change in the São Francisco river basin (Northeast Brazil, catchment area approximately 640 000 km²) are analysed with a focus on the Itaparica reservoir in the Sub-Medio São Francisco. The accumulation of major drought events in the northeast of Brazil over the last years serves as a reminder to decision makers and water management executives that this is a peak peril. It may become more damaging and prevalent as climate patterns change. Impacts of land use change (e.g. further increase of irrigated agriculture already responsible for approximately 80 % of water withdrawals) on water availability, water quality and food production are another major concern. In order to define sustainable management strategies for the water and land resources in the river basin, integration of different water-using sectors and actors is needed, considering upstream-downstream and other user conflicts.

In our presentation we will show how water resources and water quality will develop under different climate and land use scenarios, using a chain of simulation models driven by global climate and land use scenarios. Quantitative hydrology and water resources management (reservoir regulation, hydropower production, withdrawals for irrigation and other water users), water quality and (changing) land use pattern are integrated for the whole river basin. These results are used in follow-up analyses, e.g. reservoir dynamics (2-D; 3-D) for the Itaparica reservoir and an optimization model for water resources allocation in the Sub-Medio São Francisco.

Quantifying greenhouse-gas fluxes and carbon stocks in Western Siberia to guide sustainable land-management

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The growing demand for agricultural products has led to an expansion and intensification of agriculture around the world. The regions of the former Soviet Union could play a key role in this context. More and more land that was abandoned after the collapse of the Soviet Union is currently reclaimed in vast regions of Russia and northern Kazakhstan (Estel et al., 2015, Kraemer et al., 2015, see also talk by Kühling et al.). In the context of increasing climate change it is crucial to study the consequences of land-use change with respect to carbon cycling as an important contribution to the development of a profound and comprehensive concept of sustainable land-management. Therefore, the soil organic carbon (SOC) pools and the surface-atmosphere carbon exchange of different land-use and soil types were studied in the region of Tyumen.

Different land-use types had a significant influence on the SOC pool of the uppermost 5 cm of the soil profiles. The SOC pool was found to be significantly lower for croplands and ex-arable fields than it was for grasslands and forests. But restoration of the surficial SOC pool seems possible as the time since abandonment had a positive effect on carbon stored in ex-arable lands. Ploughing strongly enhanced CO₂ emissions and thus lowered the SOC content. Near-natural grasslands, in contrast, are very valuable for the preservation of the SOC pool. On ex-arable land, SOC stocks of Chernozems partly recovered depending on local and regional environmental conditions.

Histosols, i.e. peatland soils, are highly sensitive to land-use change through drainage and cultivation, too. In how far future developments in our research area may threaten these ecosystems is still matter of concern. They contain large SOC stocks in the northern test area near Tyumen, where huge areas of natural peatlands have already been drained. Comparing eddy covariance measurements over a grassland and an arable field on drained Histosols revealed that the grassland served as a carbon sink, whereas the arable field was identified to be a clear carbon source. The conversion from non-used grasslands to cultivated fields on drained Histosols is therefore considered to have an undesirable positive feedback on climate change. In contrast to findings of many other studies, drainage alone did not result in net carbon emissions through accelerated peat degradation.

Measurements of in-situ pore water CO₂ and CH₄ production rates revealed additional knowledge on the carbon turnover of near-natural peatlands. The results indicated that both CO₂ and CH₄ pore water production is high in young pristine peatlands, but declines in the course of raised-bog evolution.

Overall, our results emphasize the importance and sensitivity of Western Siberian ecosystems to land-use change regarding regional carbon cycling, and can serve as an essential contribution in guiding sustainable land-management in the study region.

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Topic 6

Integrated ESS, Biodiversity and Agrobiodiversity

Land-use effects on biodiversity – global synthesis of local effects

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Land use and land-cover changes (LUCC) are considered as major threat to global biodiversity. However, evidence is mixed how this relates to local and regional scales. Recent global synthesis studies provide a mean of generality but also highlight large variation of local realities. This is because, first, land use comes in many variations. Second, land use directly affects the environment, but indirect effects extend beyond the boundaries of the land in use. Third, land-use effects greatly depend on the environmental, historical and socio-economic context. Hence, place-based studies are essential to develop strategies for sustainable land management.

New management approaches for silvopastoralism and agriculture in semi-arid areas

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Most tropical dry forests in the world are threatened by unsustainable land use and subsequent desertification, which also applies to the Caatinga vegetation in NE Brazil. Such land-use practices may particularly affect crucial ecosystem functions (ESF) such as carbon sequestration, pest control and water supply along with the biodiversity of dry forests. However, the impacts of different land-use options on ESFs are not sufficiently studied and quantitative forecasts which address the intensity and specific quality of management approaches are as yet largely missing. In the German-Brazilian regional project INNOVATE, we investigated biodiversity and ESF within different land management systems adjacent to the Itaparica Reservoir, NE Brazil, ranging from agrarian systems (e.g. coco, banana) to silvopastoralism (mainly goats within the native Caatinga) and preserved Caatinga areas. The results on ESF are translated to ecosystem services. The scientific findings are discussed with stakeholders and decision makers and incorporated into a guideline that aims at improving land-use strategies and at maintaining and enhancing ESF.

From an ecological point of view, grazing should be performed at low stocking rates (< 1 small ruminant ha⁻¹; Tiessen et al., 1998). Yet, results of our studies show that most farmers strongly depend on livestock husbandry and stocking rates of 3–7 small ruminants ha⁻¹ are common in the region. High stocking rates, however, have been shown to cause pronounced losses of biodiversity and organic carbon (OC) stocks. Therefore, we recommend an improved forage and grazing management. In addition, we propose an adopted cutting practice of forage plants (e.g. the bromeliad *Encholirium spectabile*) to reduce negative effects on reptile species which in turn act as biocontrol agents. Further, we recommend the replanting of degraded areas with the native pioneer species *Mimosa hostilis*. This would have the advantage of facilitating soil and vegetation regeneration while providing livestock-fodder as the leaves and fruits are very palatable. Despite an overall stable forest cover, some species such as the economically important fruit tree species Umbuzeiro (*Spondias tuberosa*) show a pronounced lack in natural recruitment. Consequently, such species require specific conservation measures such as enrichment planting. Agrarian systems showed high carbon stocks with a different species composition of herbs compared to the Caatinga. To optimize these systems in terms of biodiversity and ESF, the production of permanent crops (coco, banana, fruits) should avoid herbicide use and prefer organic fertilizer (goat manure). Both proved neither to be related to losses in yield and food security nor to losses in OC stocks. In addition, field margins play a major role for agrarian biodiversity (fauna and flora) and should hence be preserved. Overall, we recommend a conservation strategy which combines the delimitation of protected areas with unique biodiversity as source habitats and scattered natural reserves with lower conservation value but also low human impact for the facilitation of species migration. All these measures are currently implemented in corporation with the stakeholders. We are confident that the project thus contributes to more sustainable land use and more pronounced climate-change resilience of the study area.

Connectivity conservation in Central Vietnam: a biodiversity corridor for Vu Gia Thu Bon Watershed based on tree species data

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The Vu Gia Thu Bon (VGTB) watershed of Central Vietnam is enclosed by the foothills of the Annamite Mountains in the north, west and south. The Annamite Mountains are known for their elevated level of biodiversity, but the VGTB watershed faces increasing pressures from economic growth, urbanisation, and agricultural expansion. Particularly fragmentation induced by agriculture, by extension of the road network, and by plantations of non-native *Eucalyptus* and *Acacia* hybrid species leads to a decreasing cover of nature-near forest in VGTB. The main objective of this research is to identify priority areas for integration into a biodiversity corridor, based on tree species distribution patterns in VGTB. Species distribution models showed highest levels of potential tree species richness in the highlands in the south at the border to Kon Tum province, and in the west at the border to Laos. The midlands showed lower levels of potential tree species distribution. The protected area network covers a proportion of the areas of higher potential tree species richness, but leaves a gap in the north western part of VGTB. In order to close that gap, a new protected area should be established in the north western area of VGTB, and be connected to existing protected areas with stepping stones, small areas of elevated high potential tree species richness. Also plantations of endemic tree species could act as stepping stones, since native tree species need less fertilizer and weeding effort, thus allowing for more diverse understorey vegetation. A selection of endemic tree species with high economic and ecological value has been identified which could be used as plantation trees. Household interviews (450) carried out in highlands and midlands of VGTB revealed that awareness for biodiversity conservation is low. Awareness-building measures for both, the need of biodiversity conservation in general, as well as for the use of endemic tree species for income generation have to be carried out to sensitise local communities. This will also facilitate the work of the forest rangers, who frequently suffer from low acceptance by the local communities and even get attacked by illegal loggers.

Land-use change, sustainable land management and biodiversity conservation in Southwestern Siberia

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Since the break-down of the Soviet Union in 1991 and the associated collapse of the state farm system Southwestern Siberia has undergone significant changes in land use. In the Tyumen region alone, about 400.000 ha of cropland comprising ca 25% of all arable land were abandoned. At the same time, livestock numbers declined by 60 % leaving large tracts of pastures and hay meadows without management. Since 2000, a moderate recultivation of ex-arable land has taken place, accompanied by an overall intensification in cropland management, especially in terms of pesticide and fertilizer application. In contrast, due to stable-based feeding of cattle, grassland management by hay-making and grazing decreases. For the future, intensification as well as area expansion of arable use can be expected which will probably be reinforced by a northward shift of the western Siberian grain belt in the course of climate change.

Within the SASCHA-project we studied the effects of recent and projected future changes in land-use on biodiversity. We performed an assessment of various taxonomic groups such as vascular plants, birds, butterflies and grasshoppers across major land-use types namely cropland, abandoned arable land, grassland and forest. Despite relatively low land-use intensity, cropland generally exhibited low levels of species diversity and abundance across all taxonomic groups. Contrary, old grasslands - and especially those within small-scale grassland-forest mosaics - turned out to be particularly rich in plants, butterflies and grasshoppers, whereas managed wet meadows harboured significant populations of meadow birds. Similarly, open light birch forests were found to be particularly rich in vascular plant, bird and butterfly species. Grasslands that established via spontaneous succession on ex-arable land became more similar to old grasslands over time, but even after 24 years of abandonment differences in species richness and species composition could be found. Nevertheless, these grasslands had a high significance for mobile animal species.

Most of these positive trends may be quickly reversed in the near future by the reclamation of abandoned arable land and the cessation of grassland management. The recultivation of ex-arable land will be driven by regional, national and international policies (see talk of Stupak) as well potential losses of cropland due to increasing drought severity in the steppe zone of adjacent northern Kazakhstan in the course of climate change. As shown in our project, even under relatively low management intensities croplands are of minor significance for biodiversity conservation across almost all studied taxonomic groups. Thus, to prevent arable expansion to abandoned cropland or even so far unploughed grasslands and wetlands, raising yields on the existing cropland through improved management appears to be the most promising strategy (see talk by Kühling et al.), with positive effects on carbon sequestration (see talk by Wertebach et al.) and regional water resources (see talk by Schmalz et al.).

Counteracting the decline in grassland management requires the promoting of low input systems based on grazing and hay-making. Subsidies and infrastructural help for private households and farms engaged in animal husbandry, as well as the development of new structures for the production and marketing of high quality animal products from low-input systems such as organic meat and dairy products could be suitable strategies in this context.

Effects of land use practices on biodiversity in dry southwestern Madagascar

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Madagascar is one of the world's most important biodiversity hotspots. Among the Malagasy ecosystems, the south-western deciduous spiny forests were identified to be of highest priority for conservation. It was estimated that only 3 % of the original forest area remained of which the largest part is located on the Mahafaly plateau, where the National Park Tsimanampesotse is located. Outside the protected area, forests have been mostly replaced by a cultural landscape mosaic of pastures and crop fields. The local population relies on ecosystem services provided by forest biodiversity for maintenance of food security, health care, construction and cultural life. The lack of alternative sources of livelihood leads to increasing pressure to convert the remaining forests to arable land, with the side effect of increased grazing pressure on the remaining area.

The aim of our work was to assess the effects of land use on biodiversity and ecosystem service provisioning and to identify the capacity of used lands to contribute to biodiversity conservation in the study area. For this, we analysed the impact of the main land use practices on the diversity of various taxa, including plants, invertebrates and vertebrates.

Moderately grazed pastures retained the highest proportions of autochthonous plant biodiversity, while crop fields were generally poorer in species and more homogenous concerning community composition. They were dominated by introduced species. In contrast, local species richness of invertebrates was only marginally affected by land use. However, disturbance by land use had high impacts on the composition of ant and ground beetle assemblages. Compositional changes were non-random and a result of trait-based environmental filtering.

Land use associated landscape structures serve as refugia for forest species and act as corridors or buffer zones around protected areas. Reptile species richness was clearly associated with structural heterogeneity of the surrounding landscape. It declined in areas with less than 30% remaining woody vegetation cover. Likewise, reptile assemblage structure changed markedly at low woody vegetation cover. The incorporation of hedges into cultivated areas as well as a high connectivity between habitats maintained high reptile species richness in all land use types and increased similarity between crop fields and forests.

Our results underpin the urgency of maintaining vegetation cover outside the protected areas, as especially intensive grazing and the conversion of forest to crop fields pose major threats to biodiversity on all levels. Under the present boundary conditions, biodiversity conservation may only be achieved by decreasing the pressure on the remaining forested areas through sustainable crop production on already existing arable land and the development of alternative sources of livelihood for the local community.

**Performance of *Populus euphratica* trees and forests at the fringes
of the Taklamakan Desert, NW China: effects of use and distance to the groundwater**

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Along the fringes of the Taklamakan Desert (Xinjiang, NW China) with its hyper-arid climate, *Populus euphratica* (Euphrates poplar), the predominant tree species of riparian forests, relies on permanent access to groundwater. Its wood has been used for centuries by the local population. Since wood harvesting has been banned from Xinjiang, the biggest threat to the forests is the decrease in the groundwater level due to withdrawal of river water for irrigation of agricultural land.

Generative regeneration of the poplars is only possible after inundation by rivers, when the soil is wetted thoroughly enough to allow a rapid vertical root growth of the seedlings. During the life history of the stands, the distance of the tree crowns to the groundwater can increase due to changes in the rivers' courses or to withdrawal of water from the rivers or the groundwater. Then, the trees can only regenerate vegetatively by forming "root suckers", but this capability decreases with increasing distance to the water table. Therefore, poplar stands whose canopies exhibit a large distance to the groundwater (up to 25 m) are relatively old and sparse, whereas dense poplar stands with generative regeneration and a large fraction of young trees can only be found at sites with a relatively short distance to the water table.

From < 4 m to 12 m of groundwater distance, the water use of poplar stands can vary between 30 and 400 mm a⁻¹ in dependence on tree age and stand density. At sufficient water supply, the above-ground biomass production (up to 6 Mg ha⁻¹ a⁻¹) can reach that of forests growing in a temperate climate. Stands with a larger groundwater distance are less productive due to a lower stand density. However, individual trees of higher age classes can be equally productive across groundwater distances of up to 12 m. The growth increment of the trees with a short distance to the groundwater (~ 2 m) responds most susceptibly to decreases in the water supply. This has to be considered in future schemes of water management: under conditions of limited water availability, it seems more reasonable to keep forests with short distances to the water table alive and fully functional instead of diverting large amounts of "ecological water" towards old stands with large (> 6 m) groundwater distances, which can be kept alive for a certain period of time, but are foredoomed to die off due to a dwindling regeneration capability.

Pollarding (cutting branches from the living trees) results in a long-term decrease in growth increment. However, *P. euphratica* can recover from pollarding by enhanced formation of secondary shoots, which is facilitated by increased rates of photosynthesis. Therefore, the use of poplar wood as a renewable resource (e.g., for producing wood chips for house heating) should be reconsidered.

Keywords: groundwater, hyper-arid desert, productivity, regeneration, riparian forest, Tarim River, water use, wood harvesting

Biodiversity and Ecosystem Services - A case study for the Assessment of Multiple Levels of Species and Functional Diversity in a Tropical Cultural Landscape

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The expansion of large-scale tree plantations has a major impact on landscapes in the Tropics and Subtropics. Crops like soy bean, oil palm and rubber have, over the past decades, led to drastic changes in land cover, altering functions and services derived from these landscapes. Frequently cited are changes in climate regulation services, erosion and water cycles, biodiversity as well as soil fertility or the provisioning of raw materials. While there exist several models and software solutions (InVEST, MIMES, ARIES) to assess such impacts on Ecosystem Services (ESS) on a general scale, suitable methods for the integration of biodiversity are less available.

By combining genuine data derived from up to 8 years of multidisciplinary field work in botany, zoology, agricultural sciences and landscape ecology within our main study site (Naban River Watershed National Nature Reserve in Yunnan Province, PR China), associated with extensive literature reviews (all along the Greater Mekong Subregion) we have developed a common classification scheme that enables the integration of different facets of biodiversity (species and functional diversity) to complete an interdisciplinary ecosystem service assessment. Genuine datasets on the distribution of vascular plants, pollinator species, ground beetles, ungulates and other selected mammals have been collected in two research sites in Southwest China and Southern Thailand. The sites have been selected because they share similarities in land use and include rubber plantation bordering protected areas. These datasets have been supplemented with comparative literature studies on the impact of rubber cultivation on the diversity of amphibians, reptiles and birds in their respective landscapes taken from various sources.

Species diversity (e.g. bees) as well as functional diversity (e.g. abundance of pollinators) have been subjected to a normalization process to allow a broad assessment of the impact rubber has on multiple levels of biodiversity. This resulted in a matrix of different land use types and their suitability as habitat for the species groups included in this study. The findings have been applied to different land use scenarios of our main research site, to highlight the potential effects of land use and land management decisions on species and functional diversity.

The process presented in this session allows for an adaptation into established ESS/ESF software programs, in our case InVEST using aggregated indices. At the same time the matrix used to compile the information from the disciplinary analyses maintains enough details to supply information on the expected impact the analyzed scenarios have on specific species groups.

The aim of this study is to introduce a potential methodology to incorporate multiple levels of species diversity into models to supplement the evaluation of Ecosystem Services. The concept itself can be applied to a variety of land use systems and case studies, as well as under different magnitudes of data availability or spatial scales. This enables researchers and planners to estimate the impact that land use decision will have on biodiversity and to consider these in concert with potential changes in other ecosystem services.

Topic 7

Integrated soil management, agriculture production

Global agricultural potentials: Challenges and Chances

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Global demand for food, feed, fiber, and bio-energy is expected to double by 2050 due to rising population, income growth, changing lifestyle, and diet shift towards increasing meat consumption. While current yield trends are not sufficient to fulfill the increasing demand, climate change is expected to impact on global food systems by increased temperature and changing water availability. For ensuring food security, sufficient quantity and quality of food as well as access to food are essential. Within GLUES, we identified potentially suitable areas for cropland expansion and analyzed trade-offs between these areas and areas that hold high biodiversity. Further, we quantified potentials of agricultural intensification. We identified three dimensions of intensification that inevitably go along with improved crop and farm management through better technology and knowledge.

First, potential yields under optimized nutrient supply are simulated globally by using the biophysical crop growth model PROMET. We found that optimal crop management has the potential to increase global production by 79 % compared to the year 2000 on existing cropland with the highest potentials identified in Sub-Saharan Africa. Second, we identified the potential number of multiple harvests per year. Exhausting the number of potential crop cycles globally would result in an additional exploitation of global production by 39 percentage points compared to the year 2000 on existing cropland. Third, we investigated the impact of reallocating crops according to economic conditions. By coupling the general equilibrium model DART-BIO, representing the world economy, with the biophysical crop growth model PROMET, ecological and economic drivers of land use are considered at the same time in an interdisciplinary approach. Hence, crops are spatially reallocated by maximizing farmers' profit. As a result of crop reallocation, potential global production increases by 148% compared to the year 2000 on existing cropland. The reallocation of crops according to commercial and market-orientated practices has the highest impact in countries of the Global South. From this approach, different scenarios are developed and simulated.

Strategies for a sustainable agricultural land use in Germany

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Against the background of high GHG emissions originating from agricultural land use, measures suitable for GHG reduction were identified via a literature review and stakeholder discussions. The suitability of the measures to address further current social demands than GHG reduction, namely biomass production for bioenergy and nature and environmental protection, was estimated. The measures were assigned to the land use strategies climate protection (CP), bioenergy (BE) and nature and environmental protection (NEP). The strategies were modelled with the agro-economic supply model RAUMIS (Regionalized Agricultural and Environmental Information System) simulating effects on agricultural income, production and environment in the year 2030.

The CP strategy includes an afforestation of 10% of the existing forest area, mitigation payments of 100€/tCO_{2equ} for the re-wetting of organic soils and a nitrogen tax on mineral fertilizer enhancing the reference price by 40%. In the BE strategy, paludiculture, in terms of Common Reed production on re-wetted fens and half-bogs outside of protected areas, is fostered by mitigation payments of 100€/tCO_{2equ}. The payments refer to emission reduction from re-wetting and from substitution of fossil fuels. Further, energy maize production is supported by 100€/tCO_{2equ} for substitution of fossil fuels. The NEP strategy includes mitigation payments of 100€/tCO_{2equ} for the re-wetting of organic soils and an ecological set-aside of 10% of the agricultural area (either grassland or cropland), meaning that these areas are out of production.

Compared to the baseline simulating the development of the German agricultural sector under 'business as usual' (BAU), by 2030 all three strategies contribute to the reduction of GHG emissions. The agricultural production clearly decreases in the strategies NEP and CP. In the BE strategy, the production of biomass for bioenergy increases massively at the expense of food production and with negative impacts on the environment and results in an increase of income. With regard solely to the emissions of the agricultural sector, GHG emission reduction is greatest for the BE strategy and almost equal for the CP and NEP strategy. Taking emission savings due to reduced mineral fertilizer production (industry sector) into account shows slightly higher emission savings for the NEP than for the CP strategy. Including the carbon sequestration from fifteen years of afforestation (forestry sector) clearly enhances GHG emission savings of the CP strategy and the difference to the BE strategy decreases. Simulations over longer time periods would lead to a much better performance of the CP strategy. The inclusion of GHG emissions from iLUC especially impacts the GHG balance of the NEP negatively and has the least effect on the CP strategy. Correcting the agricultural income by deducting mitigation payments and EEG apportionment above the amount paid in the BAU, and by adding the income from afforestation, shows that the BE strategy is the most expensive and the NEP strategy is the cheapest.

For a comprehensive evaluation indicators from outside of the agricultural sector and iLUC must be taken into account. Impacts of measures differ regionally showing that regional conditions must be considered.

Impact of land use management on soil quality along a climatic gradient in the Kulunda steppe, western Siberia – challenges and possible solutions

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In the Kulunda Steppe about 6.2 Mio ha native land was converted into intensively used farmland until 1963. The large-scale farming during the last decades did mostly not take into account measures of sustainable soil management, nor did it reconsider regional environmental heterogeneity. This has led to a severe deterioration of major soil parameters (erosion of topsoil, loss of organic carbon and water storage capacity) along with a decline and larger variability of the crop yield. In this presentation we will assess the effects of agricultural management practices on indicators that determine soil quality and soil services with respect to biodiversity, carbon sequestration and crop production under different climatic conditions. By that we aim at developing a scientific basis for decision making, adaption, and implementation of more sustainable and carbon conserving land-use systems. The research was carried out along a climatic gradient from the forest steppe in the north to the typical steppe in the central parts and to the dry steppe in the south. In a hierarchical work scheme experimental work focuses on on-farm test sites in each of the three biomes, and is accompanied by a regional assessment of more basic parameters, while remote sensing and modelling efforts were used for upscaling, reconstruction of past changes and development of future scenarios. Our results showed that establishment of intensive agriculture resulted in a strong fragmentation and differentiation of the native vegetation, accompanied by a loss of genetic diversity of key species. This land-use change in the Kulunda Steppe also led to a soil organic carbon loss of 25%. This concurs with loss in aggregate stability and increasing susceptibility of wind and water erosion. Spatio-temporal trends in land-use change have been developed, and based on ground truthing and remote sensing/GIS techniques spatial trends of soil and land degradation could be developed for the different regions and depending on land-use types. Soil management exerts strong impact on major soil quality parameters such as soil moisture, soil organic carbon storage, and aggregate stability. While all these parameters are in a close causal relationship, mini-till and no-till managements proved to be generally superior as compared to conventional tillage, likewise leading to a higher and more stable yield. We conclude that organic matter losses in the Kulunda Steppe due to land-use change were smaller than in other steppe ecosystems. However, negative consequences of conventional land use and soil management on soil mechanical parameters and the soil water budget, both largely depending on organic matter, appear to be yield limiting. From a natural science perspective mini-till and no-till management appear to be best options for a sustainable and resource saving soil use. An intensive agriculture with modern equipment and well-balanced nutrition generates high yields and, likewise, improves soil quality with respect to organic matter contents and stocks, aggregate stability, resistance against erosion, and soil water storage. Intensification of agriculture may also give the opportunity to set aside areas for steppe restoration, for which basic knowledge has been gained in the project.

Agronomic and technical solutions for sustainable cropping in South Siberia

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Apart from developing new crop cultivation strategies, the main goals of WP3 within the Kulunda project are to develop and adapt agricultural technology for the conditions of the steppe regions of the Altai-Krai. After intensive surveying of the requirements of the farmers working the land and based on WP1 and WP2, the following objectives were defined:

- Development and testing of technologies with minimal soil tillage for row crops and cereal crops
 - Direct seeding methods
 - Soil tillage in strips (strip-till)
- Improving the efficacy of crop protection measures
- Reducing fuel costs during seeding and soil tillage
- Improving the nutrient supply for crops

The results from the field trials in various steppe regions of the Altai region demonstrated that a significant reduction in soil tillage intensity right up to no-till provides the comparable or higher yields. Of course, bare fallow is omitted and alternative crops are incorporated in the crop rotation. The higher sales revenues for these crops and the savings achieved in fuel and working hours increase the contribution margin using modern methods, even when considering the investment for the required new agricultural technology. However, to be successful with modern, reduced methods, it is very important to pay attention to good crop protection and fertilizer application.

For the use of minimal soil tillage technology, the most important thing to have is a suitable seed drill. It must achieve very good emergence despite a high proportion of stubble and organic material on the surface, be able to seed various crops, and be able to apply fertilizer along with seeding. Within the context of the project, the “Condor” seed drill was used and adapted. Trials were also conducted on the required row spacings for the crops rapeseed and spring wheat. In the dry steppe regions, row spacings of around 30 cm can be used, improving the straw throughput and further reducing the fuel costs.

The strip-till method before planting row crops, such as sunflowers and maize, is very well suited for reducing costs and applying fertilizer. For this purpose, a new aggregate was developed and tested within the project.

To improve the efficacy of crop protection measures, a completely new variation for herbicide application was developed within the context of the Kulunda project. The implements are equipped with sensors that detect weeds and only spray where they are actually located. This allows 50-80 % savings of the agent, which provides both ecological and economical benefits. During WP3, it was found that the nutrient supply to the crops is deficient in virtually all of the fields in the Kulunda steppe. A system has been developed that allows specific fertilization recommendations to be made. The technical requirements for applying large amounts of fertilizer in liquid form have been met.

In summary, it can be stated that the agronomic and technical requirements for increasing yields in the Kulunda steppe while preserving soil resources are provided. The most significant obstacles for conversion to sustainable agriculture are mainly a lack of knowledge and lack of access to adequate financing options for new agricultural technology.

Approaches for sustainable agriculture in Western Siberia: land-use history, farming practices and nutrient management

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After the dissolution of the Soviet Union in 1991 and the collapse of the state farm system, massive land-use changes took place across Western Siberia. Decreasing land-use intensity was observed on grassland due to declining livestock numbers. More than 40% of the arable land was abandoned after 1989, but has increasingly been recultivated since the early 2000s. Both, recultivation of abandoned cropland as well as increasing fertilizer inputs and narrowing crop rotations led to intensification on cropland during the last two decades. Sustainable management strategies for future land use have to consider these historical impacts as well as the current situation and climate change predictions. In an interdisciplinary approach, we compile results from plant diversity investigations, agronomical field trials and nutrient flow calculations to derive a framework for sustainable agricultural management strategies.

Post-Soviet transition processes positively affected phytodiversity. Large scale abandonment of arable land has resulted in the recovery of valuable grassland vegetation on formerly cultivated land (ex-arable land). Ex-arable grasslands were rich in species and contained an increasing number of plant species typical for ancient grasslands over time. In contrast, plant species richness of arable land was only moderate and species composition of the arable weed flora was of low conservational value. Most of the registered species were common throughout the temperate zone. On the contrary, the vegetation of ancient grasslands contained many specialized meadow steppe species, which have their distribution center in Eastern Europe and Western Asia. We conclude that strategies for the conservation of diversity should aim on preventing the reclamation of ex-arable land and focus on sustainable intensification of existing arable land.

Participatory developed agronomical field trials revealed a potential for enhanced water-use efficiency by direct seeding ("no-till"). Results from three years on-farm research with the most dominant field crop, spring wheat, showed significantly higher soil water storage under direct seeding conditions compared to conventional tillage. In conjunction with climate change predictions, reduced tillage intensity seems suitable to improve resource use efficiency and stabilize yields while minimizing environmental damage at the same time.

Analyses of nutrient flows from organic manure showed potential for optimization. At peasant farms and small farms the nutrients from manure are being recycled through grazing on pastures and manure application on arable fields. At some very large farms manure is oversupplied on fields in the close proximity of the confinement buildings, is stored in open slurry lagoons or is disposed in the landscape in an uncontrolled way. This handling imposes several environmental and agricultural risks. Full exploitation of the manure fertilization potential could minimize environmental hazards, reduce costs for mineral fertilizers, and contribute to higher yields and soil fertility on the mega farms.

Sustainable agricultural management should implement all these findings. Sustainable intensification of arable land by using no-till technology and optimized nutrient cycles would help to preserve biodiversity both on abandoned land and in near-natural ecosystems of Western Siberia.

Role of yam species and medicinal plants for food self-sufficiency and farmers' livelihoods in SW Madagascar

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Throughout the year the rainfed, subsistence oriented agriculture in the Mahafaly region of semi-arid SW-Madagascar is limited by the harsh climatic conditions and the availability of plant nutrients. Consequently, food insecurity in this area is high and rural households strongly depend on the exploitation of natural resources for their basic needs and income regeneration. In the view of the increasing pressure on ecosystem services and functions, we analysed the availability of important provisioning services from forest habitats, and their importance for farmers' livelihoods in the Mahafaly region. Wild yams and medicinal plants were selected as key provisioning services that are frequently collected from forest habitats and used in various ways by the local people to improve food security and health care.

An ethnobotanical survey was conducted to study the diversity, local use and knowledge of wild yams and medicinal plants in five villages in the Mahafaly region. To predict yam species distribution along environmental gradients, yam species abundance and environmental variables were inventoried in the field using a systematic plot design within a yams collection area of four villages.

Six endemic species of wild yam were identified as potential food resources on the plateau. All the interviewed households (n=250) consumed wild yam tubers and 70 % of them collected wild yam. Yam is mostly consumed additionally to the daily quantity of staple food (cassava and maize), but also as main food, especially in the villages near forest areas, where daily collection is possible. A generalized linear model indicated the importance of economic factors, which significantly affected the collection intensity of wild yams, whereas the usage of medicinal plants depended to a higher degree on socio-cultural factors (Andriamparany et al., 2014).

Our species distribution models highlighted the importance of human interventions, vegetation structure, and soil characteristics to determine the distribution of wild yam species. Predicted distribution maps showed a scarce occurrence of wild yam species, which were mostly located in restricted areas of open spiny forests and dry spiny forest thickets (Andriamparany et al., 2015).

An overuse of wild yams threatens the natural environment and people's livelihood and we, therefore, recommend to raise awareness on sustainable use of forest products in the villages near forests. Wild yam collectors should be encouraged to replant the corm part of the tubers in the soil after harvesting wild yam tubers. Domestication of wild germplasm and *in situ* conservation of wild populations may contribute to counteract the devastating effects of high harvesting intensity on the existing wild yam populations in this region. We, therefore, investigated the relative regeneration abilities of six wild yam species as well as the agronomic performance of the wild yam species *Dioscorea alatipes* and a local variety of *D. alata*.

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Integrating agricultural and water policies for more sustainable crop production in arid Northwestern China

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Massive expansion of irrigation agriculture and consecutive overuse of water resources leads to aggravating ecological and economic problems in the extremely arid Aksu-Tarim Region (ATR) in northwestern China (FEIKE ET AL. 2015).

Therefore the evaluation of policy instruments aiming at a more sustainable water management in crop production is of high relevance for research and regional decision makers (CHEN ET AL. 2014). Building on a primary crop production data set of more than 250 farm households, a regional farm model was developed applying a positive mathematical programming approach (RÖHM 2001; RÖHM & DABBERT 2003).

The tested water policies (taxation, pricing and quota) differ significantly in their effectiveness and efficiency, with water pricing constituting the most promising policy option. However, the scenario simulations revealed a strongly negative effect of water policy implementation on crop production and agricultural incomes. Therefore, the water policies are applied in an integrated approach together with agricultural policies, namely subsidisation of advanced irrigation technology for cotton production as well as a subsidisation of cereal production. With this integrated approach water saving could be realised with much less negative impact on crop production. Aiming at water saving rates of 10 % and 20 % decreased cotton production by 7 % and 15 %, increased cereal production by 17 % and 4 %, and caused an overall agricultural income deficit by 6 % and 13 %, respectively.

The study complements existing literature by the assessment of multiple policy instruments and presents a useful model framework to address further research questions of crop production and agricultural water management in water scarce regions of China.

“Processes and management of soil fertility in smallholder production systems”

Authors: Gröngroft, Eschenbach, Gwatidzo, Huber, Kowalski, Landschreiber, Luther-Mosebich, Masamba, Overmann, Reinhold, Simfukwe, Weinzierl, Zimmermann

Abstract

Within the Okavango Basin only small areas with comparatively high natural soil fertility are traditionally used for agricultural production. Analysis of soil characteristics and estimation of potential yields revealed that the old floodplains in the central part of the catchment, the dry river beds in the Namibian Kavango regions, and the Mopane veld in NW Botswana are the preferred landscape units for crop production. Here, potential yields of 800 to 1,200 kg maize ha⁻¹ can be realized, based on the natural fertility. However, these units cover only small parts of the landscape. The predominant landscape units (slopes and summits in Angolan highlands and the Arenosol area of the Kalahari) exhibit only very low natural fertility with potential yields varying between 250 and 600 kg maize ha⁻¹. The estimation of the yield potential showed that especially nitrogen is deficient and at some places also phosphorous. Modelling of soil water dynamics indicated a high proportion of unproductive water losses through evaporation on dryland fields. At all TFO study sites, it is evident that yields could be substantially increased even with small amounts of nitrogen fertilization.

Mineralization in the inherently nutrient-limited savannah soils is driven by microbial mediated processes (i. e. exoenzyme activities, ammonification and nitrification). It could be shown that nutrient release dramatically decreases with increasing anthropogenic impact and with decreasing water and nutrient availability. High-throughput-sequencing, metagenomics and multivariate statistical analysis identified representatives of the *Proteobacteria*, *Firmicutes*, *Acidobacteria* and *Actinobacteria* as key organisms of nutrient recovery processes. Hence, the support of the microbial community by e.g. conservation agriculture might sustain the soil fertility in small-holder production systems. The nitrogen supply of crops can be improved by using plants of the family *Fabaceae*. Studies within TFO revealed that the success depends on the intensity of effective nodules. Pilot field experiments showed an 130 – 380% increased bean yield with rhizobial inoculant in comparison to plants not treated with phosphorous or bacteria.

Crop production by smallholders is and will likely remain the backbone of rural livelihoods within the Okavango Basin. However, cropping practices which are based on the soil's natural fertility, and which thus depend on the potential to shift and expand the arable land into pristine areas, produce insufficient yields. Growing populations and increasing demands for cash income are additional push factors for a spatially expansive agriculture that is encroaching upon natural habitats. A major aim for an agricultural intensification and awareness campaign should therefore be to increase yields on existing dryland plots with alternative technologies (e. g. conservation agriculture including (organic) fertilization, evaporation control, improved seeds, agro-forestry). Such a shift in development paradigms is necessary due to the need to improve livelihoods for the growing rural population facing the low fertility of the majority of soils, the harsh climatic situation, the restricted possibilities for extracting surface water or groundwater for irrigation, and in consideration of the high value of woodlands.

Topic 8

Integrated landscape and land use management

Synthesizing place-based research across disciplines and scales: the GLUES approach

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Much of our knowledge about land use and ecosystem services is derived from place-based research. Local case studies, such as the regional projects of the Sustainable Land Management Programme, provide valuable insights into various aspects of land use, but it is often unclear how much their findings can be extrapolated beyond the study areas. In contrast, many land use drivers, such as population growth or climate change, are well captured at the global scale, but there are significant uncertainties how they interact with local conditions. The complex land systems thus must be studied through the lens of multiple disciplines and in the same time synergies and trade-offs occurring at various levels need to be considered in order to optimize land use and inform policy decisions. In this presentation, we give an overview of the GLUES approach we apply to synthesize research findings generated across various disciplines and spatial scales. The aim of the scientific synthesis is to bridge the gap between global challenges and local realities by providing a consistent methodological framework for assessing information from regional projects and producing new knowledge on general patterns of land-use intensity and ecosystem services. Using specific examples of the GLUES approach, we illustrate how large research projects can integrate information needed to identify sustainable development paths in social-ecological systems. These examples include: (i) integration of local and global drivers in ES assessments, (ii) synthesis of existing concepts for ES assessments, (iii) transferability of results from place-based studies, (iv) quantification of trade-offs between land use and biodiversity and (v) interactions between economic and biophysical processes in land-use studies.

The role of future LUC to reach aims of the National Climate Plan and ABC-program in Brazil (Southern Amazon)

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During the past decades Southern Amazonia (Brazil) has been recognized as a major global deforestation hotspot. Between 1996 and 2005 the CO₂ emissions related to land-use change made up almost 60% of total national emissions. One important driver of these processes has been the expansion of cropland and rangeland in response to a growing global demand for agricultural commodities. Only recently significant progress has been made in decoupling further increases of agricultural production from deforestation rates. Reasons for this development were the intensification of agriculture leading to higher crop productivity together with improvements in the enforcement of environmental law. In this context an important policy instrument is the Program for Reducing Greenhouse Gas Emissions in Agriculture (ABC program). Implemented in 2009 the program fosters the adoption of more sustainable agricultural practices with special emphasis on the reduction of greenhouse gas emission. It is seen as a cornerstone to fulfill the ambitious Brazilian emission reduction targets described in the National Plan of Climate Change.

In the light of an expected increase of global demands for food, bioenergy and biomaterials in the coming years it is uncertain whether the established policies and available technological potentials to further improve crop productivity are still sufficiently effective to prevent an expansion of agricultural area and to ultimately end deforestation. In order to explore future pathways of land-use change in Southern Amazonia we have developed a set of four scenarios consisting of storylines and simulated high-resolution land-use maps until the year 2030. The scenarios take into consideration changing agricultural production due to changing commodity demands from domestic and global markets as well as different assumptions regarding agricultural intensification and the effectiveness of policies targeted at the preservation of protected areas. Based on the generated maps greenhouse gas emissions (N₂O, CH₄ and CO₂) were calculated. The results indicate that further sustainable intensification of agriculture together with a strict protection policy are essential requirements to slow down the loss of natural ecosystems and at the same time to reduce greenhouse gas emissions as a prerequisite to fulfill the national climate targets. Alternatively a drastic change of consumption pattern towards a more sustainable diet could be identified as a suitable way to mitigate climate change impacts of agriculture.

Consequences of land use changes for ecosystem functions in Southern Amazon – status quo and future scenarios

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The Southern Amazon deforestation arc is one of the world most dynamically changing landscapes mainly to satisfy global demands on animal products. Already more than 50% of the Cerrado vegetation is converted to agricultural land and is basically continuing following the BR-163 highway to the north where former tropical rainforest is converted to pastures. Consequences of deforestation are discussed controversially in literature but expected to be negative and highly relevant concerning all ecosystem functions (ESF). Varying rainfall patterns with increased frequencies of droughts as well as floods are expected. Additionally, carbon and soil losses by forest disturbance and water erosion are likely to occur on a larger scale.

Within the Carbiocial project, the impact of land use changes (LUC) on ESF, as soil retention, SOC-stocks, greenhouse gas (GHG) emissions and water balance components, was measured and modelled in an interdisciplinary manner and at different scales. Based on Carbiocial scenarios multimodel simulations on the impact on ESF for future land use and climate scenarios were made in addition to present day effects.

Our measured results allow different predictions. LUC from natural vegetation to pasture lead to increased surface runoffs and soil losses. Due to predominantly no-tillage management, croplands do not reveal a similar behaviour; runoff and sediment yields are close to the initial level. Concerning GHG emissions and SOC-stocks, the land use signals do not show an unambiguous behaviour. SOC-stock changes are negligible compared to the removal of biomass during deforestation. Just older, unmanaged pastures have been shown to significantly loose SOC. Low N₂O emission levels could be interpreted as an indicator of unsustainable land use types, applied in the study region.

Compared to the land use signal more significant differences appear concerning the predominant soil types of the study region. Deterioration of ecosystem functions are less pronounced for Ferralsols with a stable microstructure than Acrisols. Additionally our data suggest, that the main collapses of ecosystem functions are related to the narrow time windows of natural land use conversion. Consequently to intensify production on existing agricultural land rather than creating new production area (deforestation) might be the most practical way of preserving globally relevant ecosystem functions of Southern Amazonia. Thereby on-farm carbon enrichment experiments and dissemination of integrated crop-livestock-forestry systems could be a useful measure.

COMTESS: Modelling the impact of changing environmental conditions on ecosystem service provision under different climate and land use scenarios

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The collaborative research project COMTESS (Sustainable coastal land management: Trade-offs in ecosystem services) investigates the impact of climate change, sea level rise and different management options (LMO) on ecosystem service (ESS) provision by coastal vegetation at the German North and Baltic sea coast until the end of this century. A chain of hydrological, ecological and socio-economic models predicts the impact of changing climatic and sea level conditions on the hydrology, the composition of plant communities and finally ecosystem service provision of the study regions. We consider services as vegetation-mediated (e.g. forage production) or directly depending on hydrology (e.g. reduced flood risk due to retention of excess water in polders or the reduction of global warming potential, which is directly related to groundwater levels and conductivity). Vegetation-mediated services are modelled depending on the distribution of single plant species (species distribution models which in turn depend on the varying hydrology of the study region). Plant traits, i.e. the community-weighted mean (CWM) of the resulting species composition on a site, are then related to ecosystem services (e.g. fodder marginal income is related to the CWM of species-specific grassland utilization indicator values). We have developed a tool for synthesis and visualisation in order to incorporate all steps of that modelling chain.

The resulting temporally and spatially explicit predictions (annual maps) of a range of providing, regulating and cultural ESS are then used to explore trade-offs and synergies between single ESS or ESS bundles. As the socio-economic valuation of ESS is done from different stakeholder perspectives (e.g. farmers, water board members, tourist managers), each scenario combination may yield different final values for each stakeholder group. We are thus able to follow either single ESS or the integrated value of all ESS for each land management option (assuming a certain combination of climate and sea level rise scenario) over time to identify important points in time, e.g. when a service becomes a disservice or when a whole LMO surpasses the value of another LMO. These potential shifts over the next 90 years are important information for local land managers and will be communicated along with the uncertainty of the modelling results during the implementation phase of the project.

Mission accomplished? – INNOVATE’s overall findings on sustainable land management in a semi-arid water basin in North-East Brazil

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Reservoirs and hydropower facilities of Brazil’s São Francisco river basin witness a respective development strategy in northeast Brazil since decades. Except providing electricity, rural development had been a major goal and since then land management schemes targeted primarily on irrigation schemes. Irrigated agriculture, however, suffered from poor soils, insufficient water management strategies and a disregard of integrating smallholders grazing based perspectives outside the irrigation schemes. The INNOVATE project studied the aquatic and terrestrial land use systems, with its underlying ecosystem functions and services. Management decisions on the allocation of scarce water resources proved as the major driver of land use discourses and practices. A major challenge involves a better interaction of more recent and regional (river basin committee) and established bodies (often federal agencies). The primarily hydroelectricity focused water management might not be maintained in the same size in the long run, as it has ever more become adverse towards competing water usages. Major initial concerns on the river and reservoir water quality and possible greenhouse gas emissions have not been confirmed in this semi-arid study region. Water quality matters primarily in off-stream reservoir bays. Water uptake should miss out such bays and low water levels; from a limnologic perspective the daily and seasonal water level amplitudes of the reservoir should be kept as limited as possible. The land-water nexus has further been addressed with the ‘green-liver’ approach, purifying effluents from land-based fish production. Further monitoring and subsequent approving might allow for substantial implementation efforts of this approach.

The major question for the non-irrigated Caatinga ecosystem had been to which degree the grazing intensity could get adjusted to still feasible socio-economic outcomes on the one hand and the well-being of ecosystem’s biodiversity, biomass allocation and carbon storage capacity on the other hand. INNOVATE researchers recommended limited grazing loads, and preserving natural habitats along irrigation schemes. Restoration measures for endemic trees were demonstrated, including studies on acceptance and implementation conditions. Much will depend whether such initiatives will actually be backed-up e.g. from the Brazilian rural development agency. Locally available and economically feasible substrates for soil melioration have been identified and tested to improve the productivity of the agro-ecosystems; such practices require further guidance from the Brazilian agricultural research agency. Other innovations, so far practiced by only few smallholders might be up-scaled (e.g. drought-tolerant livestock breeds and forages, pasture rotation). Major phenomena have been identified as driving forces or relevant barriers for a sustainable land and water management. This involves the multi-level governance challenges with manifold actors involved on different scales, often not sufficiently cooperating horizontally as well. The persistent drought crisis acts as a driver for change, initiating e.g. a discourse on payments for irrigation water. Strategic and participatory land use planning, including environmental and social impact assessments, remain a missing link so far in Brazil. The current making of a new ten year river-basin management plan serves as a focal point and a well-established communication process has been set up between INNOVATE and the responsible actors, including the river basin committee.

Agent-based modelling of subsistence agriculture and land cover changes in SW Madagascar

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The unique ecosystem in the Mahafaly region of SW Madagascar provides a range of services to local inhabitants, who mainly depend on subsistence agro-pastoralism for their livelihood. Food insecurity is a serious problem and most people partly rely on forest products to fulfil their daily needs. Due to the ongoing population growth, the highly variable and unpredictable climate and the low economic development, the pressure on natural resources increased drastically over the last decades and triggered land use and land cover changes (LULCC) with high rates of deforestation.

To explore the drivers of LULCC and gain insight on the complex interactions and feedbacks between land use activities and ecosystem services, a spatially-explicit simulation model was developed by using an agent based modelling approach (ABM). Our aims were (i) to simulate possible future trends of the land use system and the effects of these trends on the environment, household economy and food security, (ii) to explore small holder farmers' coping strategies to food insecurity and (iii) to evaluate LULCC and landscape fragmentation in space and time.

The model consists of four different submodules (household and crop production, livestock, climate, landscape). For the parameterization of entities, a wide range of data was used incorporating social surveys, high-resolution remote sensing and field-based validation data. Households represent the individual farm households characterized by their state variables, which capture the livelihood capital and assets derived from socio-economic surveys. The landscape is depicted by congruent land pixels corresponding to GIS-layers of institutional and biophysical spatial state variables extracted from field surveys and mapping campaigns. Forest patches are additionally characterized by spatial state variables related to the forest use potential (e.g. biomass stock, growth rate), which are parameterized based on remote sensing and forest inventory data.

The household decision making process was mainly simulated using a heuristic approach, which takes inputs from the household profile, its perceived landscape information, and information from other household agents. Simulations are performed along discrete time steps, following a yearly cycle, which includes sequential steps with patch-based processes and ends after 30 years. For each time step households may use different adaptation mechanisms to avoid food insecurity and increase household income through land-use activities. The effect on forests varies between different land-use activities, ranging from forest degradation to deforestation.

Crop yields were simulated based on production functions, which take into account management activities, soil quality and climatic conditions. Global variables were defined as driving forces that directly affect the state variables and household activities such as population dynamics, climate conditions and management strategy. During model initialization, the user can change global variables in the user interface at will to simulate multiple scenarios. Simulation outputs are spatio-temporally explicit land-use and land cover maps, which were used to analyse habitat fragmentation, changes in forest area and biomass stocks and basic socio-economic indices such as food security (food-self sufficiency), crop yields, household income, availability of fuel and construction wood and coping strategies.

Integrated landscape and land use management for sustainable rubber cultivation in South-East Asia

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The rapid expansion of rubber (*Hevea brasiliensis*) in the Greater Mekong Subregion led to the conversion of over 2 million ha of other land use types from 2000 till 2010. Recent trends include rubber planting at higher altitudes and latitudes, i.e. in non-traditional and marginal cultivation areas. The shift from swidden agriculture to large-scale rubber monoculture has greatly improved the livelihoods of farmers, but it also resulted in a loss of ecosystem services (ESS), changes in ecological functions and socio-economic conditions. Rubber driven land use change and market price fluctuations have affected food security of local populations differently and led to trade-offs with ESS. In the framework of our project SURUMER we are able to simulate the impact of land use change on ESS with help of the Land Use Change Impact Assessment (LUCIA) model as well as using the INVEST modeling platform. These integrative modelling approaches allow quantitative estimations of yield, erosion processes, carbon storage, water supply and quality both at the plot and landscape level. In conjunction with economic models, they allow the monetary valuation of ecosystem services and trade-off analysis.

We tested management and landscape design options of sustainable rubber cultivation systems designed to: a) reduce run-off and erosion and increase carbon stocks compared to rubber monocultures by improved soil and intercrop management strategies; b) lower carbon emissions and strengthen climate change resilience; c) preserve agro-biodiversity and biodiversity-related ecosystem services such as supporting of non-timber forest products (medicinal plants), pollination and others; d) yield social acceptable economic returns and reduce vulnerability of farmers to market changes.

We found that intercropping and weed management were crucial in providing enhanced ESS. The reduction of herbicide applications to the understory in rubber plantations reduced soil erosion by 40-70%, decreased environmental pollution (sediment entry) into rivers, and increased plant biodiversity. The time averaged carbon stock of rubber plantations was larger than carbon sequestered in agricultural crops, bush and grassland but lower than those in forests. ESS may be increased by highland regeneration of forest from bush and grassland and by avoiding rubber planting at steep slopes and elevations above 900 m a.s.l. Rubber plantations have a lower CO₂ emission potential as forests, but on the other hand, they also have a lower methane uptake, which influences their C balance negatively. Turbidity and pesticides concentration in surface water used for drinking water are from time to time exceeding drinking water guideline values in rubber dominated landscapes. Intercropping and weed management may therefore further lead to improved raw water quality and reduce work and costs for drinking water purification.

The results of our integrated socio-economic and land use change modelling showed how trade-off's between rubber yield (income) and carbon sequestration could be solved by optimizing planting density of rubber trees. Comparison of biophysical and socio-economic land use scenarios indicated the necessity of regulation measures for limitation of rubber planting at marginal and highly vulnerable sites. At high elevations and steep slopes economic revenues and carbon sequestration strongly decreased, threatening farmers' welfare and enhancing risks particularly in the context of recently falling rubber prices. Proposed tools for integrated land use and landscape management can be easily adopted in all rubber planting regions and further developed for broader use in regions with rapid land use change.

Drivers, processes, and consequences of land use change in the Okavango Basin

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The Okavango Basin which extends over three countries is a composite of heterogeneous socio-ecological systems of high diversity facing significant challenges. Currently, it is still one of the most pristine river catchments in Africa. However, since the last decade it started to undergo increasing transformation. The Future Okavango project (TFO) aimed at understanding the processes and drivers of change, looking in detail at the social-ecological systems of four research sites in Angola, Namibia and Botswana and at the Basin as a whole. The project combined transdisciplinary field data sampling with earth observation imagery and spatial modelling.

The observed patterns of land use change expose underlying processes and important driving forces at different scales and levels of decision making. At community level the expansion of agricultural land into natural ecosystems is mostly driven by low-yield smallholder agriculture. In many areas land allocation is governed by traditional authorities.

Major road infrastructure facilitates the commodification of collective ecosystem goods like timber, thatch grass, charcoal, honey, or bush meat. Thus, road axes predefine long belts of transformation and degradation. The reach of resources depletion penetrates differently far into the hinterland (e.g. hunting of bushmeat extends farther than charcoal production). While planning decisions on key infrastructure are taken at government level, the underlying driver of the resource commodification and the associated ecosystem transformations is the poverty of rural communities aiming to improve their livelihoods and to get access to modernity. Simultaneously, large infrastructure projects also pave the way for (agro-)industrial projects, promoted by national elites and international investors. Large irrigation projects develop on formerly collective lands, relocate communities, causing serious social externalities and complete ecosystem alterations. Generally, megaprojects are accompanied by narratives on national self-sufficiency, food security or socio-economic progress.

Global discourses (e.g. on nature conservation, progress symbolized by consumerist lifestyles) and associated consumption patterns (e.g. ecotourism, the emergence of a retail industry) also influence national decision making. National parks and game reserves protect vast surfaces of natural ecosystems from resource exploitation, while especially the urban areas and their surroundings rapidly transform. The interests of local communities and traditional users are not always taken into account and conservation projects or urban sprawl may redirect land use pressure to neighbouring areas.

Results show that resource governance, decision making and economic interests at different levels shape landscapes and enhance dynamics of their persistence, degradation and transformation. While processes at local level tend to be patchy and diffusely degrading, at higher levels they amount to large scale transformations. The spheres of different social-ecological (sub-)systems overlap spatially and in hierarchy, with multiple interconnections and trade-offs between them.

There is an increasing spatial and hierarchical imbalance between local socio-ecological systems, governance systems and actors at local, national and international level. This mismatch obstructs long term oriented sustainable management and inherently encourages short term oriented exploitation of natural resources. Thus, new strategies for sustainable land management should focus on strengthening the resilience of the socio-ecological systems (e.g. local resource governance, improved smallholder agriculture, adapted fire management, holistic land use planning).

Topic 9

Human wellbeing, social and cultural issues linked to ESS

Assessing and valuing Ecosystem Services: from global to local

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Growing global and local demand for resources increases pressure on ecosystem services (ES) and biodiversity. Monetary valuation of ES is frequently seen as a decision-support tool by providing explicit values for unconsidered, non-market goods and services. Here we present global value transfer functions by using a meta-analytic framework for the synthesis of 194 case studies capturing 839 monetary values of ES. For 12 ES the variance of monetary values could be explained with a subset of 93 study and site specific variables by utilizing boosted regression trees. This provides the first global quantification of uncertainties and transferability of monetary valuations (Schmidt et al. 2016).

ES values depend on the ecological and socio-economic context. Hence ES assessments and valuation need to be targeted at the local context in order to provide meaningful information for decision support. Within the Sustainable Land Management Programme, GLUES together with the projects INNOVATE, LEGATO, SuLaMa and SuMaRiO developed a problem-oriented approach toward assessing ES for informing land-use decisions (Förster et al. 2015). In a comparative analysis of existing approaches to ES assessments shortcomings in current approaches are identified and addressed by building on the experience of the projects of the Sustainable Land Management Programme.

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Life histories of pioneers at the Amazonian highway BR 163 as key to the understanding of LandUseChange (LUC)

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The perception of land use change as basis for land use planning is shaped by economic demand, political scopes and available data on the respective region. Very rarely the perspectives and necessities of local land users are taken into account. In the case of highway BR 163, although a consultation-process was conducted, in the end local voices were not included in public policies. Regarding the official aim to stimulate migrants to stay at a given location and refrain from on-migration in order to stop deforestation, we state that a bottom-up learning-process would offer the necessary inputs.

On the basis of our biographic project at the Amazonian highway BR 163 analysing the leitmotifs of pioneers' life histories, we came to the following insights:

- Primary land use is aligned to land use forms at the previous location;
- Exchange with traditional and/or indigenous populations at the new location is only rarely perceived as an orientation for own decisions;
- Knowledge transfer regarding local ESS that could happen by peer-learning does not fit into known learning formats and is not being supported by official policies;
- Demands for agricultural know-how are directed towards official consulting services such as EMATER and EMBRAPA, whose local presence is scarce, consequently, private firms such as Monsanto and Cargill step in;
- When eventually the use of local resources as additional income come into view, credit lines would hardly fit;
- The decision to stay at a certain location is composed by a variety of different factors, including security and access to health and education – hence, urban development.

Our thesis is, that many misconceptions could be avoided by serious stakeholder participation when planners and land-use-managers listened to local land use and life conceptions and their origins, respected the mind-sets of local land users, provided adequate agricultural consultation and informed at the same time on the respective legislations in place.

Keywords: local knowledge, survival strategies, learning pattern, stakeholder participation

Carbiocial Book: <http://www.editoraolhares.com.br/livros/sempr-para-frente-historias-de-vida-na-br-163-59?locale=en>

Measuring the costs and benefits of land use changes– an ecosystem services approach

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Within the project CC-LandStraD, different strategies for sustainable land-use changes and management focusing on climate change mitigation, biomass production and nature conservation have been developed. In order to provide effective decision support for a sustainable land management based on these strategies, a holistic perspective on their costs and benefits is required. In this presentation, we provide an extended framework for cost-benefit analyses, and exemplify it with the estimated costs and benefits for the strategies developed in CC-LandStraD. The framework is based on the Ecosystem Services approach as a tool to categorize forestry and agricultural land use related costs and benefits into provisioning, regulating and cultural ecosystem services.¹ Provisioning ecosystem services relate to products which are traded at markets (e.g. the agricultural outputs), and can be valued with market based methods. To approximate the effects in monetary units, we used results from the agricultural and environmental information model RAUMIS in terms of differences in profit margins to agricultural firms. Regulating (e.g. carbon sequestration and nutrient retention) and cultural ecosystem services (e.g. landscape scenery) require non-market valuation approaches like the assessment of abatement or damage costs and elicitation of willingness to pay values. For provisioning services, the other CC-LandStraD subprojects provided the implied changes in CO₂ emissions and nutrient abatement, which we then monetarized with data from secondary literature. The values of cultural ecosystem services were elicited through a stated preferences survey, conducted in March 2013 with nearly 10,000 randomly sampled respondents in Germany.

The results show that the highest net-benefits could be achieved with a strategy that (besides the climate change mitigation goal that all strategies had in common) focused on extensification of agricultural production and on an enhancement of nature protection. The strategy focused on an increase in biomass production is the least effective one, which is mainly due to large societal costs for a deterioration of landscape scenery. As such analyses inherit a high degree of uncertainty, we also provide results of a sensitivity analysis, which revealed that the net-benefits and thereby the ranking of strategies strongly depend on normative assumptions, e.g., on the costs of CO₂ emissions. In extreme cases, this can lead to a shift from net-benefits to net-costs.

¹ In this presentation, we focus on the analysis of agricultural land use.

Sustainable land use in the rice terraces of Northern-Luzon, Philippines - stakeholder impressions and experiences from LEGATO activities

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The province of Ifugao, Northern-Luzon, Philippines is one of the 7 regions dealt with in the LEGATO project (SETTELE et al., 2015). It is characterised by large areas of irrigated rice terraces, which to quite some extent are inscribed in the UNESCO list of cultural world heritage sites. A variety of changes affected the region throughout the recent decades. A very important component are demographic changes and changing behaviour of the local inhabitants. Contrary to earlier times, rice production has the role of an insurance crop, while other income creating activities increasingly dominate the work structure in the region. Tourism, which is based on the scenery of the rice terrace landscape, is a major source of cash income. But as it heavily depends on the maintenance of the terraces, ways have to be found to combine agriculture with tourism and to guarantee income for rice farmers for managing the terraces while providing cultural services (TILLIGER et al., 2015). The presentation will shed some light on the view of local inhabitants and their expectations, where J. Cabbigat represents the view of local farmers and J.V. & M. Bustamante the one of a tourism based income source (provision of accommodation). They will highlight what they have gained from LEGATO and what they would expect from future research activities in the region.

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Surviving in a fragile environment – Livelihood challenges and strategies of households in semi-arid south-western Madagascar

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In south-western Madagascar, local households manage their livelihoods under extremely difficult environmental and socio-economic conditions. The semi-arid, strongly seasonal and variable climate sustains a dry spiny forest ecosystem with a high share of endemic species. At the same time, government and utility services as well as rural infrastructure (the road network, education and health facilities, supply with clean drinking water) are highly deficient. In this contribution, we analyse the different livelihood portfolios of local households and explore their strategies to cope with the highly seasonal and variable environmental conditions. The results are part of the SuLaMa research project.

The extremely poor local population builds their livelihoods primarily on subsistence agriculture, livestock keeping, and several off-farm activities. Six livelihood types were identified based on survey data from 934 households using cluster analysis of revenue shares. The livelihood types show also differences in the level of revenue generated and the self-perceived wellbeing of households. The data indicates considerable variation in the livelihood strategies, revealing diversification as well as specialisation of livelihoods.

Given the absence of bank accounts and social security systems beyond family and clan, households work hard to ensure subsistence under a strongly seasonal climate. In arable farming, harvest periods with high food availability are in April/May (harvest mainly of cereals and legumes) as well as in July/August (harvest of Cassava). Households often sell a substantial share of their harvest at low prices in order to buy market goods for basic subsistence, for cultural festivities, or to cover debts. Already beginning in November and steadily increasing until the next harvest of cereals and legumes, a majority of households suffer from – partly very severe – food shortage (*lean season*) after stored staple food (mainly Cassava) is consumed. If livestock can be sold, the proceeds are used to purchase staple food – at much higher prices.

The situation is worsened by strong interannual variation in precipitation resulting in major variation in food production between years. Climate change is predicted to result in lower mean precipitation with even higher variability. Households react to food shortages by increasing the collection of alimentary plants in the forest or of ocean products, increasing charcoal production, and temporal outmigration for work. However, coping strategies prove insufficiently effective and leave many households deprived of assets (in human, financial and natural capital terms) after a drought period.

In order to improve the situation of local households and preserve natural resources, development measures reducing the risk of agricultural production and enhancing access to non-farm income sources are required. Especially, improvements in infrastructure and education would allow better access to high-return non-farm activities for a broad range of households.

Human Well-being and Urban Green: An Institutional Approach

MARTIN WELP, ABDULLA ABLIZ, SIEGMUND MISSALL, ÜMÜT HALIK

Urban and peri-urban green provides various ecosystem services (ESS) which directly or indirectly contribute to well-being of city dwellers. Public parks, urban gardens, peri-urban shelterbelts, and other green elements of urban environments provide *regulating services* such as reducing heat and dust stress. Additionally, they work as points of identification, give a feeling of continuity and they can provide spaces for community action. The presentation seeks to explore which institutions govern the establishment and maintenance of urban green. Cases from both China and Germany are used to illustrate the variety of management approaches initiated either as a top-down process or initiated by local people and communities.

At one end of the continuum we find public authority driven approaches, which rely on mass mobilisation of people. The city of Aksu, situated at the northern fringe of the Taklamakan Desert in the northwest of China, is exposed to periodic severe dust and sand storms. In 1986, local authorities decided to establish a peri-urban shelterbelt plantation, the so-called Kökyar Protection Forest. It was realised as a patchwork of poplar shelterbelts and orchards while the maintenance of the plantation is facilitated by a leasing system. At the other end of the continuum of management approaches we find citizen initiatives and community gardening, for instance in Berlin and Eberswalde. These are based on principles of common pool resources management, without strong interference of public authorities.

The case studies show that ecosystem services can be delivered through different institutional arrangements. Urban planners can increase awareness, commitment, and ownership regarding urban green through encouraging people's initiatives and by learning more about the preferences and expectations of citizens (e.g. through surveys). Public participation and stakeholder dialogues give individuals, communities and households possibilities to have a say in issues related to urban green. Local knowledge about important places and historical structures should be integrated into visions of city development. Finally providing space, support and incentives for urban dwellers for community based arrangement has the potential of improving living conditions in cities through voluntary action.

“Land use, agrobiodiversity and risk perception: an economic analysis of rubber cultivation”

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The study on the socio economic aspects of land use, agrobiodiversity and ecosystems services of rubber land use systems in Xishuangbanna, China includes three components.

In the first study, contingent valuation methods were applied with inhabitants of Shanghai and Jinghong and with tourists visiting Xishuangbanna. They were asked for their willingness to pay to halt deterioration of ecosystems. Results showed that the average monthly WTP in Shanghai was 130 RMB, tourists in Xishuangbanna 62 RMB, and Jinghong residents pay 28 RMB. Using benefits transfer techniques the results are extrapolated to all big cities in China in order to assess the total value of reforestation in Xishuangbanna.

In the second study the relationship between farmers' risk perception, their land use choice and resulting agrobiodiversity was assessed by using cross-section data from 612 rubber farmers in Xishuangbanna. Results confirmed that risk perception is important for farmer's land use strategy which influences agrobiodiversity. Risk-averse farmers plant other crops in addition to rubber. Other factors that can influence crop diversification and thus agrobiodiversity are land tenure status, household wealth ethnicity, off-farm employment, altitude, and rubber farming experience.

The third study was using qualitative methods, i.e. in-depth interviews with about 40 farmers and 2 expert workshops in order to explore whether and to what extent farmers are aware of ecological problems in connection with rubber monoculture and are willing to accept innovations which are more environmentally-friendly than current practices. Results revealed that farmers are open to new technologies. This attitude is nurtured by the recently declining rubber prices which in some cases prompted farmers to stop tapping rubber trees and seek non-farm wage employment.

The three studies allow deriving some important policy conclusions. First, awareness of the environmental implications of rubber monoculture is high in China. Urban people reveal a considerable willingness to pay for improving the landscape in the region. Second, there is a challenge for policy makers and agricultural research and extension services in the region. What is needed are technologies that can reduce negative externalities of rubber monoculture and at the same time offer location-specific environmentally-friendly cropping systems in order to reduce dependence from rubber. Third, the decline in rubber prices is an economic shock that can make farmers become more risk averse and therefore more open to changes in land use systems. Hence, in developing and promoting alternative measures it is important to take behavioural factors of small holder farmers into account.

Based on our findings we predict that smallholder rubber farming expansion in Xishuangbanna will slow down. We recommend that local policymakers enhance programs like the Environmentally-friendly Rubber Plantation (EFRP), provide extension information and training and improve the institutional environment to facilitate transition towards a more diversified land use systems in the region.

Sustainable consumerist modernities?

Anthropological findings on ambivalent cultural valuation, individual lifestyles and nature in Namibia and Angola (TFO)

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In northeastern Namibia and Southern Angola landusers live deeply intertwined with the natural environment. Recently they have become caught between traditional modes of production, modern cash-based lifestyles, and new consumerist incentives for the commodification of nature. In this presentation I will introduce some core findings from the LAMA project The Future Okavango (TFO) on the processuality and culturality of landusers valuation of nature in Namibia and Angola. Moreover I will deal with the question what ambivalences these people experience between natural resource consumption and the ambiguous goods of modern consumerism. I will thus approach some core challenges for sustainable consumption and moralistic consumer responsabilization in a non-western, less affluent society. My data show that the ambivalences between attraction and disaffirmation pose obstacles to loading responsibility for sustainability onto consumer's shoulders by taking the responsibility from political or corporate ones. In a process of governed responsabilization a key role is still being played by valued practices and practiced values. The fact that local people also hold to traditional, religious, or other absolute values and practices is of importance for the reorientation of consumer-oriented environmental governance.

