Zentrum für Entwicklungsforschung
Center for Development Research
University of Bonn

Annual Report 2007/2008

Land degradation

Contents

1 Introduction

by ZEF's Directors

After celebrating our 10th anniversary with an international conference on "Global Change and Human Development: Research and Action", which took place in Bonn on 4 and 5 October 2007, and with an "open house" event at ZEF on 17 November 2007, the Center found it hard to return to business-as-usual. But 2008 has also been an eventful year for ZEF and its staff.

The WISDOM project (a multidisciplinary project in Vietnam with 19 partners in Germany and Vietnam), to which ZEF is contributing the social science background and perspective, opened a project office at the premises of the Mekong Delta Development Research Institute in Can Tho at the beginning of 2008. The office's main task is to conduct research and to coordinate our activities in the region, in particular the activities of the project's junior researchers working in the Delta.

The ninth Conference of the Parties (COP 9) of the UN Convention on Biological Diversity (CBD) was held in Bonn from 19 to 30 May. With more than 5,000 delegates, it was one of this year's major events in international environmental politics. At its center was the so-called "Plaza of Diversity", a fair which attracted 50,000 people to the tents of over 200 exhibitors. ZEF's project on the Conservation and Use of Wild Coffee in Ethiopia (CoCE) was chosen as one of a few model projects in biodiversity research to be presented at the stand of the German Federal Ministry of Education and Research (BMBF). The project was very well received and reactions from the visitors were overwhelmingly positive.

The project on the "Economic and Ecological Restructuring of Land and Water Use in Khorezm, Uzbekistan" organized a series of workshops and conferences this year in Bonn as well as in Tashkent and Urgench—among others the workshop on "Innovative Research for Sustainable Land and Water Use" in Uzbekistan from 27 to 29 May 2008.

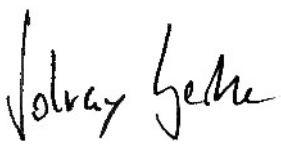
Another major event for ZEF was the International Conference on "Global Change and Water Resources in West Africa", which took place in Ouagadougou, Burkina Faso, from 25 to 28 August 2008. More than 200 researchers, politicians and stakeholders from all over the world attended the conference, which was organized by ZEF and funded by the German Federal Ministry of Education and Research (BMBF). The African projects of the Ministry's GLOWA program (Global Change in the Hydrological Cycle) took this opportunity to present their scientific results and findings. In advance of the conference, ZEF organized a trip through the Volta basin for representatives of the German and Burkinabé media. Coverage of the conference in the African as well as the German media was huge and positive.

These are only the major events which kept us busy. Some smaller projects were also approved, among others in connection with the GLOWA project. In addition to our well established publication series, ZEF also went online as co-publisher of the e-journal "Water Alternatives".

We must also mention the successful application submitted by ZEF and ISSER (Institute of Statistical Social and Economic Research in Ghana) to establish one of the five selected "Centers of Excellence" in Sub-Saharan Africa—an initiative by the German Academic Exchange Service (DAAD)/German Foreign Office. ZEF will be involved in the Center in Ghana.

We would like to express our gratitude to our main donors, who enable us to continue our trans-disciplinary development research efforts and our international capacity development, in particular through our Bonn International Graduate School for Development Research (BIGS-DR). Our special thanks go to the German Federal Ministry of Education and Research (BMBF), the German Federal Ministry for Economic Cooperation and Development (BMZ), German Technical Cooperation (gtz), the German Academic Exchange Service (DAAD), the Robert Bosch Foundation, as well as the Volkswagen Foundation.

We wish you an interesting read.



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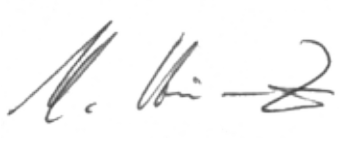

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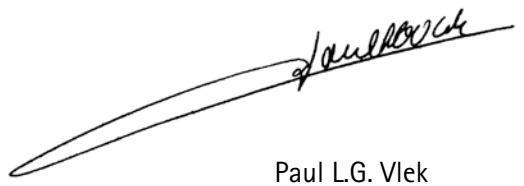

Paul L.G. Vlek

2 Preface

by Uwe Holtz

Land and in particular the topsoil are the skin of planet Earth. However, this skin is suffering from the "cancer" of land degradation and soil erosion. Land degradation does not generally represent a one-off catastrophe but a slowly unfolding disaster, a silent tsunami affecting above all the drylands. Drylands account for 41 percent of Earth's land area and are home to more than 2 billion people, at least 90 percent of whom live in developing countries.

Land potentials are shrinking due to the impact of climate change such as drought, flooding and other factors. Projections indicate greater land degradation and the loss of fertile land, less secure livelihoods, increased vulnerability to hunger and poverty, worsening social inequalities causing migrations and conflicts.

According to the United Nations Convention to Combat Desertification (UNCCD), desertification means land degradation in arid, semi-arid and dry sub-humid areas resulting from various factors, including climatic variations and human activities. Combating desertification includes activities aimed at preventing and/or reducing land degradation, rehabilitating partly degraded land and reclaiming desertified land.

The UNCCD with its five regional implementation annexes for Africa, Asia, Latin America and the Caribbean, the Northern Mediterranean as well as Central and Eastern Europe is the centrepiece of the international community's efforts to combat soil erosion, land degradation and desertification. Despite these efforts, land degradation is still an under-recognized threat to global well-being. It requires more public attention and a higher place on the international agenda for action. Topsoil should be ranked a global public good, and land issues should be made a priority on the agenda of decision makers, encouraging governments and parliaments to give them more attention. All relevant stakeholders at all levels should be involved, and, last but not least, a scientific International Panel on Desertification should be established. In particular, the involvement of the scientific community is required to support the transition from a state of land degradation to land health and improved living conditions in rural areas. ZEF's projects such as its project on "Sustainable Management of Land and Water Resources in Uzbekistan" give a good example of how science and implementation can go hand in hand.

Bringing agricultural land use into the realm of implementation mechanisms on climate change could also help to re-define the concept and the content of domestic efforts and international development cooperation. What we need is a policy shift from typical donor-driven individual projects to a more sectoral and cross-sectoral programme-based financing in the field of agriculture, poverty reduction and sustainable land management. It is the poor who suffer most from the degradation of land, soil, water and forestry resources, all of which are vital to their food security, their livelihood and the attainment of the Millennium Development Goals. By 2020, it is projected that between 75 and 250 million people will be exposed to an increase of water stress due to climate change. Relationships between water, vegetation cover and rural poverty should be given the most urgent attention within the framework of an integrative land and water management approach.

Land degradation, climate adaptation, migration and the prevention of conflicts are closely connected to questions of governance. Even the *Millennium Ecosystem Assessment* emphasized that when it comes to successfully combating degradation, much depends on the socio-economic resources available, the policies adopted and the quality of governance. Governance matters: Good governance in each country and at the international level is essential for sustainable human development. Bad governance, corruption and political repression in the most affected developing countries hamper efforts to combat land degradation.

Enhanced cooperation between the University of Bonn, including ZEF, and the Bonn-based UNCCD Secretariat could be very helpful in widening the bridge between research and action. First steps have been taken in this direction—but more must follow.

Uwe Holtz is a ZEF Senior Fellow and former chair of the Development Cooperation Committee of the German Parliament. He is currently a member of the UNCCD Panel of Eminent Personalities to consider the poverty-environment nexus.

3 Lead Article:

Sustainable access to food from dwindling land resources: a socio-technical challenge

by Paul L.G. Vlek

The concept of sustainability was developed in the context of economic development by the Report of the World Commission on Environment and Development chaired by Gro Brundtland. According to the so-called Brundtland Report, sustainable development is development that meets the needs of the present generation without compromising the ability of future generations to meet their own need. Needs in this definition can be flexibly interpreted, but the definition implies a degree of equity in the development process, both for the current generation and between current and future generations. Thus, the satisfaction of the future needs is as important as the satisfaction of present needs. In this sense, the concept of sustainability echoes the question posed by Henry Sidgwick as early as 1907: "How far are we to consider the interests of posterity when they seem to conflict with those of existing human beings?" If we accept the objective view that the period in which men happen to exist should not affect the value of their satisfaction with life *(Sidgwick equity principle)*, then the interests of posterity must concern them as much as those of contemporaries. Unfortunately, the effect of his actions on posterity—if the species manages to persist—is by necessity more uncertain.

Men's reluctance to share equitably often is seen as greed. However, time preference is another human infirmity (Harrod 1948) equivalent to greed. We underrate the advantage of satisfying our needs at a future date compared with that of having it now. In fact, we may be dead at the future date and not rate the welfare of our off-spring as highly as our own. A true challenge lies in defining these needs within the limitations imposed by the total resource endowment and the current and future state of technology and social organization to extract utility from these resources for current and future generations. The widespread practice of discounting later utilities (enjoyments) against earlier ones is a poor instrument to deal with inter-generational equity and has been declared ethically indefensible (Ramsey , 1928).

The Brundtlant Report does not talk about utilities or greed, but about needs. These needs should be seen as part of the *social primary goods* that should be universally shared on a sustained basis. The chief components are "rights, liberties, opportunities, and income and wealth" (Rawls 1971), and one of these rights would be access to food. Even for the present generation, there are huge geographic and social differences in resource endowments, the stage of economic development, and the political and social institutions that that constrain the universal right to food. The debate in this session is on the social and economic policies needed to ensure food rights now and in the future. The very nature of sustainability requires that policies should pay attention, not only to the elimination of such inequities among the present generation, but also to those with future generations.

For the current population of 6.5 billion, the right to food translates to the ability of their land to produce it or their ability to purchase from those that produced for a market. In the 60ies and 70ies a number of controversial studies projected a crisis due to the pressures exerted on the available resources with book titles such as Silent Spring (Carson, 1962), Limits to Growth (Meadows et al., 1972), and the Gaya Hypothesis (Lovelock, 1979). These concerns are now being echoed in books such as Out of the Earth (Hillel, 1992) and Collapse (Diamond, 2004) and gaining in credibility. In a most authorative study, the Millenium

Millet plantation in Ghana

Ecosystem Assessment, land degradation was ranked as one of the three major threads to habitat, economy and society, warning that inaction means a cumulative addition to a long historical legacy of degradation, from which recovery is difficult or impossible. However, even today the documented assessment of the degradation of land resources remains weak and is often anecdotal (Vlek et al, 2008, Diamond, 2006).

A recent study by Vlek et al. (2008) demonstrated that modern tools such as remote sensing (RS) are increasingly able to spot the regions that are under threat. Based on RS data collected between 1982 and 2003, around 2.13 million km^2 or 10% of the SSA land mass showed a consistent and significant decline in land productivity (NDVI). Over 60 million people live on land that is losing its ability to produce green biomass due to human actions. Within the degrading areas, the large majority of the affected areas are thinly populated, irrespective of the rainfall zone. Most likely these are marginal areas with limited carrying capacities to start with. These regions are bound to get worse and eventually may need to be taken out of cultivation or abandoned. However, this study also identified some degrading areas with high population densities. Often these are regions with high agricultural potential and in urgent need of remediation. Of the 1.46 million km^2 that are degrading but suitable for cultivation, 0.3 million km^2 are actually farmed (agriculture and forest/cropland) and are likely over-exploited or poorly managed. The remaining 0.67 million km^2 that are degrading are not suitable for agriculture, of which 105 thousand km^2 are actually being farmed and probably should not be. Means should be found to offer alternatives to these farmers so that land can be restored over time.

Manipulation and modification of the environment was a characteristic of many societies long before the advent of earth-moving machines and of toxic chemicals, even before the advent of agriculture. Humans seem to have always affected their environment in ways that tended to destabilize natural ecosystems, using clearing or fire to facilitate hunting or to promote the growth of plants that produced edible products for direct human consumption. The collection of such products and the trapping of grazing animals eventually led to domestication and to the advent of agriculture (Harlan, 1992). Agriculture then became the chief agent of environmental transformation as humans replaced natural ecosystems with artificial ones. Increasingly, prime land is being taken out of agriculture to accommodate urban expansion or, more recently, to provide biofuels. Agriculture has been sustainable for roughly 10.000 years, and it behooves us to think in such time frames when we consider the provision of food for future generations.

River catchment during dry season in Burkina Faso

Cultivation and crop harvesting depletes the organic-matter and the nutrient reserves of the soil by hastening its decomposition, reducing replenishment by plant and animal residues, and often causes erosion of topsoil. As long as agriculture was confined to small enclaves, degraded land could be abandoned and thus allowed to recover gradually, while new tracts were cleared, in succession. But, the growth of population, brought about by the advances in medicine, led to the spread and intensification of agriculture until extensive regions were put under continuous cultivation. As population pressures built up, farmers increasingly moved into areas of marginal productivity or resilience. To compensate for the loss of natural fertility and to achieve ever-higher

yields, farmers have applied chemical fertilizers and pesticides. In arid regions, irrigation has been introduced to overcome drought. Land degradation through erosion, fertility depletion, waterlogging, salinization, pollution, and the eradication of numerous species, such were the unforeseen but now global consequences of humanity's expansive and often injudicious management of soil and water resources (Science, 2004).

Inaction holds a dual risk to the sustained well-being of mankind. The first risk is the problem of persistent poverty. The competition for land resources has forced many farmers into regions where they can merely survive. Farmers caught in this poverty trap live in a situation far below what would be attainable if pre-emptive measures, based on our current state of knowledge of land use and management, were accessible to them. They will live in poverty on their land until they are forced by the failure of their land to migrate, increasingly to continue to live in poverty in urban environments. The damage done to their land does not recognize borders and often affects society through lost ecosystem services. Individually it is hard to deny poor farmers the right to mine their soil for their need of survival, but collectively, society acts penny wise pound foolish by sitting by idly. It has a stake in making technologies available that allow sustained cultivation, preserve ecosystem services and lift farmers out of poverty. However, when such technologies are technically or economically not feasible, farming such areas should be discouraged and other livelihoods need to be offered by society. Not doing so holds the second risk, which are the natural and social hazards associated with land degradation that can creep up on society and its economy without being anticipated, recognized or in some cases acknowledged (Vlek, 2005).

Today, society is struggling to find answers to such a stealth threat, global climate change, where actions of the past two generations (and inaction of the past decade) have an environmental momentum that leaves few options other than coping with the consequences. Some time in the future, the world may recognized that meeting the need and greed of 6.5 billion inhabitants has over-taxed the capacity of our land and, in Lovelock's analogy has left the world a sick patient. In the affluent West, the awareness is growing rapidly that land stewardship can no longer be left to the individual alone, and priorities, policies, action plans and social safety nets are put in place to extend the life, if not heal the patient. The choices are hard but generally affect a small fraction of the population that today is active in the agricultural sector. Confounding policies such as the bio-fuel programs that increase the pressure on the land can easily off-set the progress made. In the poor parts of the world, where a large majority of the population have stewardship functions, the options are limited, even if ground-roots awareness of the problem is slowly emerging. In a globalized world, the risks of inaction extend well beyond the boundaries of these regions. Therefore, it behooves society as a whole to act, and to design and finance the implementation of action plans that target the regions that are under threat, based on sound land monitoring. Such plans should include social safety nets for those that will be asked to improve or forsake the use of their land. If we fail to act, the price of inaction will be paid by us all, if not by us, than by future generations.

Paul L.G. Vlek is director at ZEF. This article is based on a presentation held for the UN Commision on Sustainable Development in New York, May 2008.

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4 Focus Articles on Land Degradation

Afforestation as a means of mitigating land degradation and improving rural livelihoods in Uzbekistan

by Asia Khamzina

Salinization of irrigated cropland

Land degradation due to soil salinization is responsible for an annual withdrawal of 1.5 million ha of the world's irrigated cropland from agricultural production. The interdisciplinary ZEF project "Economic and Ecological Restructuring of Land and Water Use in the Region Khorezm" has conducted research on mitigating the causes of land salinization and adapting to its impacts in Central Asian Uzbekistan.

Conversion of degraded cropland to plantations

One study assessed afforestation as an alternative use of highly salinized land marginal for, or abandoned from, crop cultivation. Local salt-tolerant tree species, adapted to the harsh agro-ecological conditions and familiar to the farming population, were assessed for suitability on degraded cropland. The most promising candidates included Russian olive (*Elaeagnus angustifolia* L.), Siberian elm (*Ulmus pumila* L.), and Euphrates poplar (*Populus euphratica Oliv.*) Experimental plantations of these species were successfully established on saline land under reduced irrigation input which, following the pre-planting event of salt leaching, only amounted to 80-160 mm per year. This is merely a fraction of the water demand of 800-1000 mm yr^{-1} required for cotton cultivation. Two years after planting, the trees were able to fully rely on the shallow, moderately saline groundwater table.

Contribution to soil fertility and land restoration

The impact of afforestation on soil fertility has already become evident in the 5th year following the conversion of the degraded cropland to tree plantations. The increase in soil organic Carbon, a major indicator of soil fertility, averaged 20%. Plantations of *E. angustifolia* contributed most to the replenishment of soil nutrient stocks, particularly Nitrogen (a primary macronutrient). This is due to the ability of this species to fix atmospheric Nitrogen, which can then be added to the soil via litter decomposition.

The afforestation did not remedy the soil salinity which, in the absence of irrigation, tended to rise. The increased productive capacity of land in terms of fuelwood, fodder, fruit, honey and eventually timber

Tree plantations established on degraded cropland in Yangibazar, Khorezm, Uzbekistan

Farmers cutting trees in Khorezm

production, however, suggests that afforestation is a promising alternative land use option in degraded agricultural areas. Abandoned croplands are otherwise taken over by fallow vegetation, mostly low value halophytic plants. The amenities provided by trees such as habitat for wildlife, shadow, and shelter for livestock further support the option of afforestation.

Fuelwood and fodder supply

Annual recurring benefits from non-timber products should increase the motivation to plant trees among farmers, who are seldom willing to invest in ecological services alone. Findings showed that the tree-based systems in degraded agricultural areas can provide such returns after a relatively short period.

A gradual thinning of the plantations in order to sustain an optimal density of the growing stands generated an energy value equivalent to 6-10 tons of oil per hectare in the 5th year of afforestation. This energy value exceeds the amount gained from cotton stalks, which are traditionally used for cooking, by 400%. Given the annual per capita energy consumption in Uzbekistan, 1 ha of trees could cover the annual energy needs of about 50-100 people. This shows the potential for supplementary energy supply in those rural areas where the provision of natural gas is frequently interrupted or absent. The opportunities for ethanol extraction from trees could be further explored given the growing interest in cellulosic biofuels.

Tree fodder may also benefit livestock keepers who struggle to obtain quality feed, particularly in the deteriorated cropping areas. The protein rich leaves of *E. angustifolia* and *U. pumila* can supplement livestock diets, now mainly based on low quality roughages such as winter wheat and rice straw.

Carbon sequestration

The Clean Development Mechanism (CDM) under the Kyoto Protocol links the efforts of combating land degradation and reducing emissions via re- and afforestation projects and provides an opportunity for developing countries to participate in, and benefit from, the C trade. The study in Khorezm showed the potential of tree planting on degraded cropland to contribute to the C sequestration efforts. The C stocks in the woody biomass reached 10-20 t per hectare in the 5th year of afforestation. At this impressive sequestration rate, about 1000-2000 ha of land would potentially be sufficient to apply for a small-scale afforestation project under the CDM for obtaining C credits.

Promoting local development

The financial assessment of capital investments in afforestation on marginal land showed the profitability of this land use option given the low opportunity costs for land and reduced water input, as well as the value of the products, particularly timber. In the case of afforestation projects considered for C sequestration, it must be determined whether the revenues from certified emissions reduction are sufficient to cover the cost of plantation establishment, i.e. to make this option financially attractive as a CDM project for financiers.

Providing incentives for farmers to participate in afforestation is a challenge which requires support from the local administration. The recent ZEF research findings can help motivate policy makers to create a transparent legal framework for setting aside degraded cropland for afforestation. Incentives such as (degraded) land tax exemption and water allocation for plantations would further encourage farmers' participation in afforestation projects, increase the productive capacity of degraded lands, improve soil fertility and provide the co-benefits of C sequestration.

Asia Khamzina is a senior researcher at ZEF.

Multi-scale assessments of land degradation in West Africa

by Quang Bao Le, Lulseged Tamene, Paul L.G. Vlek

Abstract

Land degradation is a serious environmental problem that threatens ecosystem health and food security. It is caused by a combination of natural (e.g., climate change) and human (e.g., population pressure and resource mismanagement) factors. The role of each factor varies across biomes and spatial scale. Efforts to combat land degradation therefore require different types of measures specific to the spatial scales under consideration. As it would not be suitable to prescribe one single approach to problems occurring and observed at different scales, a multi-scale approach is required to assess land degradation processes.

This study was conducted to identify human-induced land degradation hotspots at basin, sub-basin and catchment scales. First, long-term remote sensing and rainfall data along with terrain, soils, population and land cover were used to identify human-induced land degradation hotspot areas in the Volta basin. Second, a spatially distributed soil erosion and sediment yield model was used in the White Volta sub-basin to pinpoint critical areas of soil loss and estimate its magnitude. Finally, a landscape management and planning tool was designed to simulate different land-use and management measures at two selected catchments of the areas that experience high net soil loss. The study demonstrates a multi-scale approach to targeting land degradation issues in West Africa and in similar environments elsewhere.

Climate station in Boudtenga, Burkina Faso

Introduction

Land is central to development in Africa since the livelihoods of about 60 per cent of the population are dependent on agriculture. With increasing population pressure and low investments in land conservation, the future health of land in Africa is in question. Degradation of this terrestrial ecosystem sets in when the terrestrial ecosystem services, notably the primary production services, are persistently reduced or lost. The loss of land services in turn influences not only the water cycle, but also the livelihoods of millions of people. Assessing land degradation based on this definition in its spatial and temporal extent continues to pose a challenge. Separating human-induced land degradation from that caused by natural processes adds complexity to the assessment, but is important for developing mitigation strategies. It is essential to identify the underlying processes leading to anthropogenic land degradation such as soil degradation, land conversion or overgrazing.

Climate change or other natural events are responsible for land degradation too, but the main cause of this phenomenon are human actions. There is thus a need to identify areas showing high levels of productivity decline in order to differentiate those lands where human pressure needs to be alleviated from those that are at minimum risk.

Figure 1. Volta Basin and neighboring countries

Because of the close relationship with soil resources, land degradation assessment should be based on studies on soil loss resulting from land-use activities under different natural constraints. Spatially distributed soil erosion models can be applied to estimate the magnitude of soil loss and identify areas that experience a high rate of soil loss.

The complexity and data demand of models could hinder an efficient utilization of existing, calibrated and

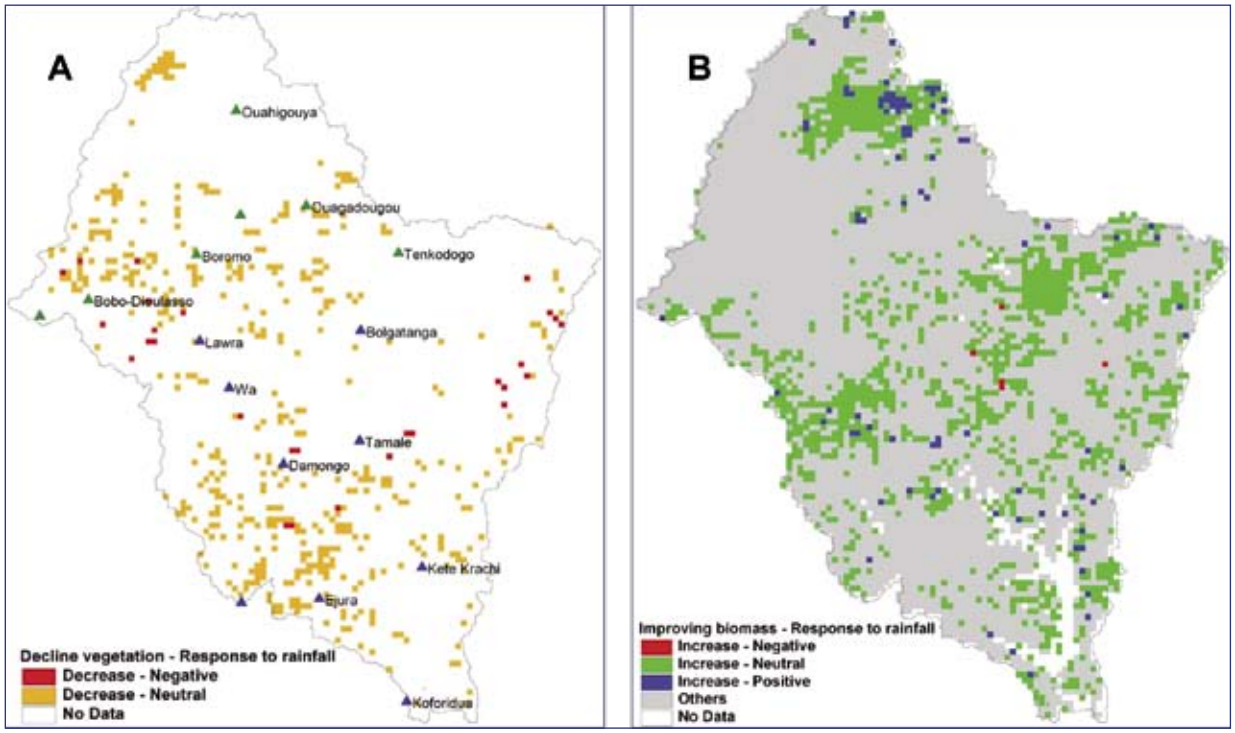

Figure 2. Areas with human-induced biomass degradation (A) and improving biomass (B) in the Volta River basin over the period 1982–2002

validated models. It may therefore be necessary to choose a suitable model that, with a reasonable input of data, can be applied in developing regions.

Strategies to mitigate land degradation require a proactive approach to land management: land-use planning has to minimize the costs of land-use adjustments and maximize ecological services of the land for local communities. Land-use planning with such objectives requires a planning decision support tool that enables land management stakeholders to participate actively in the planning, development and implementation phase. This decision support tool should be designed in such a way that it is scientifically rigorous but also simple enough to be effectively used and updated by local planners and decision makers. It should also incorporate options for ranges of possible factors and co-efficients as well as of different models so that users have the freedom to choose those suitable for their localities and conditions.

Land degradation assessment approaches and landscape planning tools developed so far are specific to one scale or a limited geographical extent. In this study, we have developed a multi-scale approach to assess land degradation and design a landscape management and planning tool. Long-term remote sensing and rainfall data were principally used to identify human-induced land degradation hotspots in the White Volta basin. This approach is generally based on the long-term trend in vegetation productivity and the role of rainfall in determining the observed trend.

A spatially distributed soil erosion and sediment yield model with a more detailed dataset was used to estimate the magnitude of net soil loss in the White Volta basin. Principally, data on vegetation cover, rainfall, terrain, soils, and management practices were used to estimate the rate of net soil loss and identify critical areas of high soil erosion. Finally, a proactive spatial decision support tool was designed to simulate the impacts of land-use change and land management on land and soil degradation. The tool was applied in two selected catchments in the White Volta basin that experience high net soil losses.

Methodological Approaches

Remote sensing based assessment of long-term land degradation at basin level

We used a step-wise approach to map the areas of human-induced land degradation across the Volta River basin, which covers about 400 thousand km^2 of six riparian countries. This research first of all analyzed time-series (1982-2003) of normalized difference vegetation index (NDVI) to delineate the extents of areas with significant biomass decline or improvement in the Volta basin. Subsequently, the correlation between NDVI and rainfall for the period 1982–2002 was used to analyze the extent of human-induced land degradation in the basin. The response of green biomass to rainfall (Fig. 3) was used to separate areas of human-induced biomass decline from that driven by climate change. Areas with no or a negative correlation between rainfall and green biomass are considered to experience land degradation due to non-climatic factors.

In a next step the areas of biomass decline were differentiated according to terrain and soil constraints. Pixels in the declining areas with very severe soil or terrain constraint (e.g. areas of laterite crusts, sand pans, high salinity or very steep terrain) were not considered the subject of human activities. These sites were therefore excluded from our human-induced land degradation assessment. Finally, the degraded areas detected were interpreted in terms of population densities (1980–2000) and land-use data acquired for the region.

Our recent study showed a profound improvement in vegetation productivity in sub-Saharan Africa (24 % of the subcontinent landmass) compared to a decline of about 5%. This agrees with many recent studies demonstrating a global increase in terrestrial primary production during the past 30 years. Studies on the relationship between vegetation productivity and atmospheric chemistry suggest that the observed increasing trend in biomass is likely to have been caused by atmospheric fertilization such as rising levels of atmospheric CO_2. We estimated the biomass improvement due to atmospheric fertilization (CO_2+NO_x) for different biomes by focusing on the areas without human disturbance and with no significant correlation to annual rainfall in Sub-Saharan Africa. These values were then applied for correcting the assessment of land degradation in the Volta basin.

Model-based soil erosion assessment for sub-basin level

We used a distributed soil erosion and sediment delivery model to assess the spatial patterns of soil loss and sediment yield in the White Volta sub-basin. The rates and spatial patterns of potential sediment sources areas were mapped using the Revised Universal Soil Loss Equation (RUSLE). A distributed sediment delivery model was used to estimate the Sediment Delivery Efficiency (SDE) of each spatial unit. The models used account for the major drivers of soil erosion and deposition processes including climate, vegetation cover, terrain, soils and land management. Integration of those drivers in a Geographic Information System (GIS) enabled us to assess the critical areas where soil loss is high and thus prior conservation measures are needed.

Spatial decision support tool for landscape management and planning

Although many landscape studies on soil and water have been published in the last two decades, progress in developing operational tools for supporting landscape planning to minimize land and water degradation in developing regions is still modest. Some of the existing tools are very data demanding and/or too complicated to be useful to data-scarce regions. We developed the **Landscape Management and Planning Tool (LAMPT)** to facilitate land management decision making and landscape planning through optimization. LAMPT is designed based on commonly applied soil erosion and deposition models, including the RUSLE model, and has been programmed in NetLogo. To make the tool applicable to data-scarce regions, data were selected that can easily be acquired from common sources. In order to facilitate the use of the tool, options are provided for most of the physical variables. These are based on literature relevant to the study region. This allows users from different disciplines (or different management levels) to select a set of parameters that fits their objectives and locations. A pilot implementation of the tool was carried out in selected catchments of Ghana and Burkina Faso.

Major Findings

Long-term land degradation hotspots in the Volta River basin

The results of the study show that about 8% of the basin area, which is the living space of over 1.3 million people, is losing its ability to produce green biomass due to human actions (Fig. 2A). The degradation areas for the various land cover types are 12.2 thousand km² for woodland,

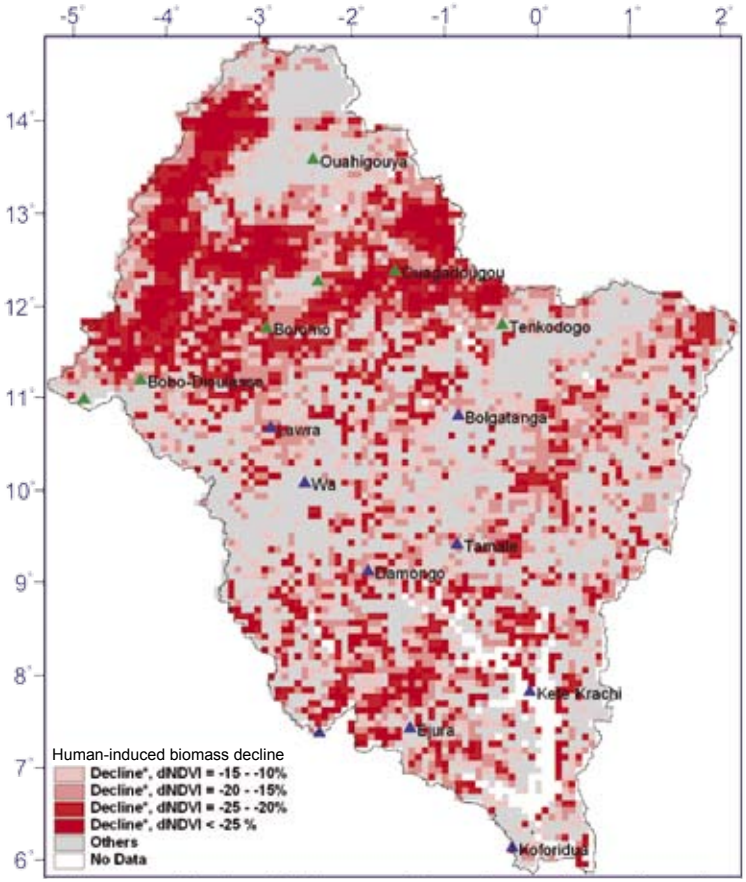

Figure 3. Areas with human-induced biomass degradation in the Volta River basin over the period 1982–2002 after the correction of atmospheric fertilization

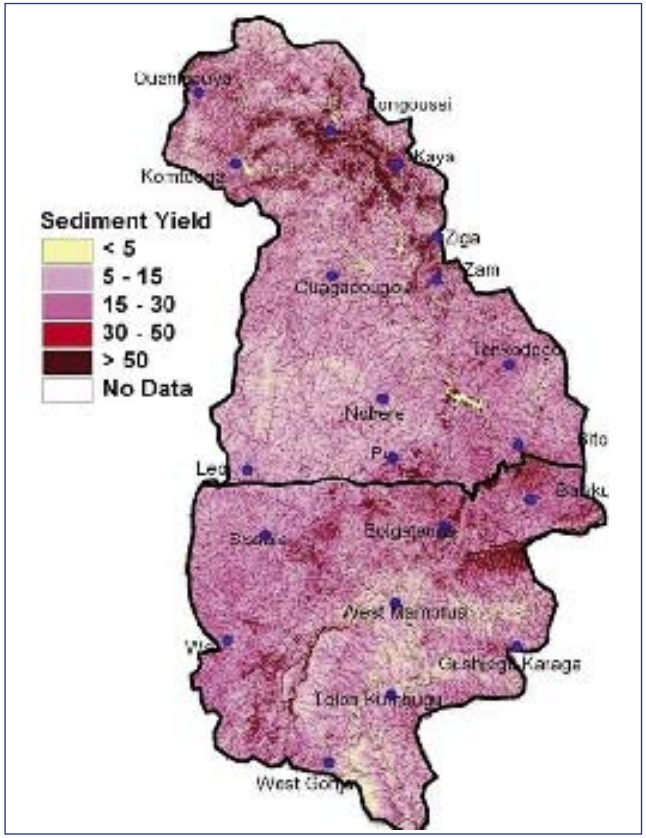

Figure 4. Spatial pattern of sediment yield (t ha-1 y-1) in the White Volta sub-basin, predicted using RUSLE model (with adjustment for sediment delivery ratio)

8.3 thousand km^2 for agriculture, 7.3 thousand km^2 for shrubland, and 1.6 thousand km^2 for evergreen forest. Most of the degraded areas are associated with areas of low population density (average of 43 persons/km^2), indicating that the affected areas are marginal lands with low carrying capacity. This means that slight population pressure could induce degradation in these fragile areas.

The fraction of degraded areas is modest in relation to the land showing significant improvement in green biomass, which covers 87.4 thousand km^2 (22% of the basin's land mass) (Fig. 2B). Global atmospheric fertilization is probably responsible for the observed increase in biomass. Correcting this fertilization effect provides an insight into the extent to which productivity decline would occur without atmospheric fertilization (65% instead of 8%) (Fig. 3). This suggests a decline in the soil resource base over wide parts of the basin. The masked degradation areas for the various land-cover types are 106,000 km^2 for agriculture, 55,500 km^2 for shrubland, 52,500 km^2 for woodland and 10,400 km^2 for arid grassland. The result suggests that our current information on the actual proportion of degraded areas might be an underestimate due to the masking effect of atmospheric fertilization.

Soil loss in the White Volta sub-basin

Our research shows that about 50% of the soil eroded upslope is deposited within the sub-basin. The spatial pattern of sediment yield (SY) in the White Volta sub-basin (Fig. 4) shows that the north-eastern parts of the basin show SY of over 15 t ha^{-1} yr^{-1} , (which is the threshold volume of the region) while the central and western parts show SY of less than 5 t ha^{-1} yr^{-1}. In addition, the Upper East region of Ghana and most places bordering Ghana/ Burkina Faso experience SY of more than 15 t ha^{-1} yr^{-1} while the southern parts of the basin show SY of less than 5 t ha^{-1} yr^{-1}. The areas associated with net soil loss greater than the threshold in the region are characterized by steep slopes, poor surface cover and/or high population pressure. These are the hotspots that require prior management intervention. The modeling procedure was then used for the development of an operational tool to support landscape management and planning to minimize land and water degradation, focusing on areas of high soil erosion risk (e.g., the Upper East Region of Ghana).

An operational spatial decision support tool to aid landscape management decisions

We developed an operational model that both scientists and planners can use to allocate and evaluate the potentials of best management practices that are intended to reduce land and water degradation. The tool incorporates options for users to (1) select and set different physical parameters, (2) choose and set different factor constants, (3) choose different sets of land-use and cover design options, (4) choose different types of landscape management options, and (5) perform robust sensitivity analysis. As the tool allows front-end users to handle the selection of management and planning options, and provide fast and responsive outputs (in terms of both maps and graphs), it can assist in effective multi-stakeholder negotiations over land-use planning where minimizing the degradation of land and water resources is the ultimate goal. The tool can easily be coupled with other dynamic land-use change models to simulate environment-community interactions.

Pilot implementations of LAMPT were done for the Atankwidi catchment (the Upper East of Ghana and southeast Burkina Faso) and another small catchment in Dano (southwest Burkina Faso). In Atankwidi, sensitivity analyses of soil erosion responses to different land management practices revealed that the introduction of conservation measures does not lead to significant changes in total soil loss over the catchment due to the flat topography of the area. However, the tool detected spots where conservation interventions are more effective in reducing soil loss.

Conclusions

We demonstrate that land degradation is a complex problem that requires a multi-scale approach. At a large geographical level (i.e. at regional and/or basin scale),

the combination of remote sensing, climate, terrain, soil, population and land-use data can enable to identify areas showing high levels of productivity decline to differentiate those lands where human pressure needs to be alleviated from those that are under minimum risk. As atmospheric fertilization shows a profound trend and its effect on vegetation productivity is significant, land degradation assessment must take this global change factor into account. Our findings show that land degradation in the Volta River basin has increased from 8% of the basin landmass without accounting for atmospheric deposition to 65% when the effect of atmospheric fertilization is taken into consideration.

At a sub-basin scale, our soil loss and sediment yield assessment shows that areas characterized by poor surface cover and higher population density are associated with a high rate of soil loss. This means that population pressure and increasing demand for agricultural land is likely to lead to more deforestation and land clearing for cultivation which will further accelerate land degradation.

The landscape management and planning tool developed for catchment and community scale demonstrated the significance of an operational tool to aid land management-related decision making, mainly focused on hotspot areas of significant concern. The tool is designed in such a way that important parameters affecting land degradation are incorporated, and it is easy to use and applicable for data-scarce regions.

The way forward

The land degradation assessment made in this study can be considered as a first good approximation. The results can be used to identify areas that appear to be threatened by human-induced land degradation. This could help to design sustainable land management options that will maximize social benefits from the use of the land. However, the analysis, in essence, is only as good as the underlying databases. This means that the maps and assessments made here need further verification in the field. The analytical framework proposed here can easily be updated as more new data become available. Our next target will be to design a systematic research effort in order to verify the validity of the findings reported here and to refine the analytical tool and interpretation of the results.

The sub-basin scale soil loss assessment shows the hotpot areas with significant soil loss. The modeling framework can be used to simulate the impacts on sediment yield of different land-use and management approaches. However, there is no existing work that explicitly captures the interactive loop between soil loss and land productivity. So, modeling approaches that capture the feedback between land degradation and agricultural productivity need to be designed.

The catchment scale landscape management and planning tool enables an assessment of the significance of best management practices and land-use processes on soil and water degradation. In a future development, it will be interesting to extend the approach so that detailed cost-benefit analyses could be implemented. The effort should detail the optimum land-use planning that can deliver the maximum return with a minimum cost of intervention. Future developments will also include incorporating more complex hydrological models and calibrating the models for the environmental conditions of sub-Saharan Africa.

River catchment during dry season in Northern Ghana

Quang Bao Le and Lulseged Tamene are senior researchers and Paul L.G. Vlek is director at ZEF.

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5 ZEF's Interdisciplinary Research

Land and Water Use

Sustainable solutions for the disaster struck Aral Sea Region:
The ZEF/UNESCO project on improved natural resource management in Uzbekistan

The ZEF/UNESCO project in Uzbekistan addresses the environmental, social and economic problems in Khorezm, one of the three provinces located within the so-called Aral Sea Zone in Uzbekistan. During the Soviet era, extensive irrigation systems were constructed throughout the region for the production of cotton or 'white gold'—the region's most strategic crop. The Aral Sea's two main feeder rivers were diverted to such an extent that today only less than two-thirds of the Aral Sea's surface area is left. Unsustainable water management and the associated land degradation have caused a decline in economic productivity and ecological sustainability throughout the region, with grave consequences for the region's predominately rural population.

The project aims to provide sustainable solutions to the Aral Sea region through a holistic approach, combining technology, policy and institutional options developed in cooperation with local and international stakeholders.

Target region and problem setting

Khorezm is located in the northwest of Uzbekistan in the lower reaches of the Amu Darya River—the largest former tributary of the Aral Sea. The Khorezm region accounts for only a small fraction of the over eight million hectares of irrigated land in the Aral Sea Basin (approximately 275,000 ha), but is critical in the water budget of the Amu Darya river delta, and is representative of lowland agricultural production systems throughout the Basin. The region serves as a model case in Uzbekistan for developing new technologies and concepts that will improve the management of irrigated lowlands throughout the Basin.

Project goals

The overall goal of this project is to provide a comprehensive, science-based concept for restructuring water use and agricultural production systems in the Khorezm region. To achieve this goal, research has been conducted on the following key system components: natural resources, production systems, economy and society and institutions. Simulation modelling is an essential component of the project for integrating the disciplinary scientific findings, up-scaling the results, and predicting the long-term impacts of current and alternative land and water use and management options and policies. The overall restructuring concept will thus be based on (i) recommendations developed with simulation tools for improved land, water and agricultural policies on the national and regional levels; (ii) institutional restructuring for a more sustainable natural resource use; and (iii) developing innovative technologies for enhancing the productivity and ecological sustainability of agricultural systems.

Sustainable solutions can only be found through close cooperation among natural, social and economic scientists, as well as direct involvement of local stakeholders. An important aspect of the project's

Project title:
Economic and Ecological Restructuring of Land and Water Use in Khorezm, Uzbekistan

Project Period: 2001–2011

Donors: German Federal Ministry of Education and Research (BMBF) and the State of North Rhine-Wesphalia (NRW) (until 2004)

Project Team:
John Lamers, Ahmad M Manschadi, Christopher Martius

Capacity Building:
ZEF BIGS-DR (PhD), Uni Bonn (MSc) and in Uzbekistan (MSc, Bachelors): 15 PhDs completed out of 39

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activities is local capacity building and, to this end, a considerable amount of effort and resources have been invested in local training and infrastructure.

Highlights 2007–2008

Landscape segment

The project research activities in collaboration with national research and education institutes as well as international partners such as PFU/ICARDA, have resulted in the development of alternative allocation strategies for land and water whereby less productive, degraded land is dedicated to tree production systems. Innovations in crop diversification, conservation agriculture, judicious water and fertiliser use, livestock and fish production, if combined properly on the better land, can compensate for the rested land and increase the economic efficiency of the water and land use.

During the next four years, several of these innovations will be tested in preparation for a large-scale adoption on farmers' fields. To verify the interactions and synergies among these innovations applied in concert, a landscape development and restructuring program has been developed for implementation on the so-called landscape segment in Phase III. The intention of this landscape development study is to verify and quantify benefits derived from the synergetic effects of innovations, analyze the overall effects of improved land and water use, and develop the best management options. In this way, a complete cost-benefit analysis of farm restructuring in terms of direct and indirect monetary terms may also be estimated. The landscape study will thus mainly focus on the following components:

- Introduction of alternative land uses such as small-scale tree plantations, pastures, and aquaculture (ponds) depending on land suitability to optimize ecosystem services;
- A shift in the state order for cotton as mandated land use to setting the farm-gate delivery levels and allowing for farmers decisions on how to meet these demands;
- Judicious use of water, land and fertiliser resources;
- Production of annual crops under conservation agriculture for improved water, soil, and salinity management.

The entire area of the landscape segment (75 ha) is being surveyed for water quantity (field and farm-level) and quality (salinity), groundwater table, and soil quality (organic matter, salinity). The survey results will be used as a baseline resource inventory of the area prior to the implementation of any changes.

Drainage experiment

The groundwater table in Khorezm is generally shallow, fluctuating between 1.2 m during the peak irrigation season in July/August and 2.3 m in February at the end of the non-irrigation period. The shallow groundwater levels are mostly the result of high recharge through irrigation water losses and of low natural groundwater flow due to gentle slopes and deficiencies in the drainage system. Thus increasing the irrigation efficiency to reduce groundwater recharge and improving the drainage system are the key interventions for lowering the groundwater tables and reducing secondary soil salinization.

Following the advice of the project evaluation committee, we conduct a drainage experiment to (i) investigate the impact of lowering the groundwater table by drainage on the water and salt balance of the root-zone and the effectiveness of salt leaching, and (ii) demonstrate the scope of drainage solutions appropriate to the situation in Khorezm which is generally characterized by severe groundwater outlet problems.

Agricultural land in Khorezm, Uzbekistan

Follow the Innovation (FTI)

The research activities in Phase I and II have generated a number of 'innovation packages' that are promising for enhancing sustainable agriculture in the region, improving irrigation water management, and providing the necessary policy background for innovations to take a hold. In addition to further testing and refining of these innovative technologies and concepts in researcher managed settings (e.g. landscape segment), the third project phase will focus on facilitating the implementation of innovative land use and agricultural practices by the relevant stakeholders.

The project has, therefore, developed a truly consultative, participatory, and trans-disciplinary process that enhances the capacity of partners to innovate named 'follow the innovation'. The ultimate objective is to stimulate adoption of project innovations through an interactive process with the regional and farm-level decision makers. Through iteration, these innovations are adapted to address stakeholder

requirements and constraints. This process is seen as a prerequisite for up-scaling research findings to the whole Khorezm region as well as other similar environments in the Aral Sea Basin.

Researchers showing their results to stakeholders in Khorezm

Cotton Value Chain Analysis

To explore the economic, social and environmental gains possible by moving towards the production of value-added cotton products in Uzbekistan, economists in the ZEF/UNESCO project applied a Value Chain Analysis approach in the Khorezm region. This approach highlighted a number of scenarios that could reduce overall raw cotton production, while postulating a win-win scenario: maintaining income both for the state and the farmers, while increasing the environmental sustainability of production through more efficient resource use. Key results showed current revenues from cotton could be maintained while reducing the overall area sown to cotton. Land released from cotton production could then be diversified for alternative crops or land use.

Perspective

Phase III of the project is running from 2007 to 2011. During this phase, alternative policies, institutional arrangements, and integrated technologies will be explored and tested. The restructuring process in Khorezm will certainly exceed the lifetime of the project and will therefore require the long-term commitment of local stakeholders. In the final transition period, the local institutions such as the University of Urgench will take the lead in continuing with the implementation and adoption of technologies commenced during the project's lifetime. It is hoped this project will provide a successful framework for land and water restructuring in other irrigated agro-ecosystems in Central Asia.

Global Change and local climate adaptation: The GLOWA Project in the West African Volta Basin

Background

The Volta River Basin drains 400,000 km² of the sub-humid to sub-arid West African savanna zone, and is shared by six riparian countries. The most prominent hydrological structure is Akosombo Dam, which produces hydropower, and formed Lake Volta, the largest man-made lake in Africa. Average annual rainfall averages 1,000 mm, but less than 10% is utilizable due to evaporation losses. Agriculture is an important source of income for most of the region's population. Rainfed agriculture is jeopardized due to unreliable rainfall, and irrigation development is still low. Within the next decades, water demand, and vulnerability of the population are likely to increase due to climate change and population growth. Large development potential lies in the increase of irrigated agriculture, but also domestic and industrial water demand is expected to increase. The expansion of irrigated agriculture, and other upstream water use, however, stands in direct competition with hydropower generation at Akosombo Dam.

Village in Northern Ghana

Project goals

The central objective of the GLOWA Volta Project (GVP) is the analysis of the physical and socio-economic determinants of the hydrological cycle in the Volta Basin in the face of global climate change. The main challenges for research and water management are the climatic variability within the Basin, limited spatio-temporal data coverage for climate, hydrology, and land use data, as well as the heterogeneous institutional and socio-cultural environment. Key aspects of GVP research include sampling strategies and scaling techniques to bridge data gaps, and the development of models on land use and land cover change, water supply and demand, and to simulate human-environmental interactions. GVP provides an integrated assessment of environmental change and its impact. Through interdisciplinary research, the project aims at supporting sustainable water resource management in the Volta Basin. Main aim is the development of "Decision Support Resources" that will help the authorities in Ghana, Burkina Faso, and the other riparian countries to optimize water allocation. Capacity building and knowledge transfer have been pursued throughout the project by conducting much of the research with students and researchers from the Basin, and close collaboration with the GVP research network of Ghanaian and Burkinabe counterparts.

Project title:
The GLOWA Volta Project in the Volta Basin (Ghana and Burkina Faso)

Donor: German Federal Ministry of Education and Research (BMBF)

Project duration: 2001–2009

Capacity Building (as of mid 2008):
81 students participate(d) in the program: 57 PhD, 9 Dipl., 15 Masters 48 students finished their studies so far 34 students came from Ghana, 28 from Germany, 9 from other African countries, 5 from Burkina Faso, and 5 from other countries

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Main cooperation partners:
Germany: German Federal Ministry for Education and Research (BMBF), German Academic Exchange Service (DAAD), Institute for Meteorology and Climate Research (IMK-IFU), Forschungszentrum Karlsruhe, Remote Sensing Unit of the German Aerospace Center (DLR), University of Wuerzburg

The Netherlands: Delft University of Technology, Civil Engineering and Geosciences

West Africa: The Volta Basin Authority (VBA), based in Ouagadougou

Ghana: Water Resources Commission (WRC), International Water Management Institute (IWMI), Kofi Annan Centre of Excellence in ICT, United Nations University – Institute for Natural Resources in Africa (UNU-INRA)

Burkina Faso: Centre de Coopération Internationale en Recherche, Agronomique pour le Développement (CIRAD), Savanna Agricultural Research Institute (SARI), Direction Générale des Ressources en Eau (DGRE), Institut de l'Environment et de Recherches Agricoles (INERA)

Joint regional climate-hydrological simulations were performed for investigating the **impact of projected regional climate change on water availability in the Volta Basin.** This allows water managers to model river discharge, evapo-transpiration, soil moisture, groundwater recharge and other data critical to effective decision-making on water resources management under current and future climate conditions. The project has produced land use and land cover maps, using satellite observations, showing that population expansion and increase in agricultural land are responsible for land use and cover change processes in the region. Also, we can **project future development and pressure on land under various scenarios** and analyze the impact of policy decisions related to land and water management as well as population control measures.

A spatially explicit multi-agent simulation model, named GLOWA-Volta **Land-Use Dynamic Simulator (GVLUDAS)**, has been developed to simulate land and water se change and the interrelated socio-economic dynamics at the community scale for selected catchments in the Upper-East Region of Ghana and South-West Burkina Faso. Users can set development and policy options in land and water management (e.g. cotton cultivation, building small dams and reservoirs, and credit schemes for dry season farming) and evaluate as well as interpret the consequent land use and associated socio-economic changes on screen with dynamic maps and graphics.

A **Landscape Management and Planning Tool (LAMPT)** was developed to facilitate land management decision making and landscape planning by optimization. LAMPT can assist in effective multi-stakeholder negotiations over land-use planning, where the minimization of the degradation of land and water resources is the ultimate goal. One main objective is to develop a simple but robust land management and planning tool that can easily be applied in data scarce regions. LAMPT also allows users to choose different sets of land-use management and planning options designed to minimize soil and nutrient loss, as well as reservoir sedimentation or pollution.

Women washing clothes near Pwalugu, Northern Ghana

A water allocation system for the Volta basin (VB-WAS) is being developed supporting the planning, management and use of water resources in the transboundary river basin. The decision support tool simulates the impact of different policy alternatives, and infrastructure development like for hydropower reservoirs, agricultural, domestic, and industrial water usage on the water allocation within the Volta River basin.

International Conference in Ouagadougou

More than 200 researchers, politicians and stakeholders from all over the world attended the international conference on 'Global Change and Water Resources in West Africa', taking place in Ouagadougou, Burkina Faso, from August 25-28 2008. The conference offered a platform for researchers to meet with African politicians and stakeholders to discuss the outcome and options for a follow-up of research projects carried out in West Africa in the framework of the GLOWA (Global Change in the Hydrological Cycle) program.

Integrated Water Resources Management pilot project for the Middle Olifants sub-basin in South Africa

Background

South Africa is a water-scarce country. Located in the semi-arid part of the world, the annual average rainfall is only 450 mm, well below the world average of 860 mm per year. Consequently, the demand for water already far exceeds its natural availability in several basins, as is the case in the Olifants basin and especially its sub-basin Middle Olifants. Impact assessments of climate change such as those conducted by the IPCC 2007 predict a worsening of the natural conditions in this regard.

In its efforts to cope with water scarcity, the South African government is working on restructuring its entire water governance system. This is being done, among others, by shifting the focus from increasing water supply to a strategy of water demand management and introducing a compulsory water use licensing and registration scheme. In 1998, the National Water Act entered into force. It promotes integrated and decentralized water resources management.

Water management in the project area

Water use in the Middle Olifants is skewed. In Limpopo province, where the larger part of the Middle Olifants is located, only 15% of households receive piped (tap) water inside their dwelling. While another 28% receive piped (tap) water on site (in yard), the majority of the households collect their water at public taps (36%).

In South Africa, water service provision is the responsibility of water service authorities (WSAs), water boards, irrigation boards and community-based organizations (in rural areas). Water boards provide bulk water supply services and limited retail water. The WSAs, the bodies which are constitutionally responsible for water provision, sell water mainly to residents, while irrigation boards are responsible for the distribution of irrigation water.

Queuing for water in the Middle Olifants sub-basin, South Africa

Project goals and set-up

The overall project objective is to improve IWRM in South Africa and examine the applicability of technology transfer through a franchise concept. ZEF is responsible for looking at the economic part of IWRM in the Middle Olifants basin, where its research partner IEEM (Institute of Environmental Engineering and Management at the University of Witten/Herdecke in Germany) is investigating hydrological and other technical aspects. The overall aim is to design policies for improving the efficiency of water use and the services of those organizations providing water to users.

Our analysis of the economic conditions of an integrated water management strategy consists of two phases: In the first phase, the factors determining supply and demand of water as they currently prevail were analyzed and quantified. The results of these demand and supply analyses were presented at a workshop organized by ZEF/IEEM in Pretoria, South Africa on 18 and 19 September 2008. In the second phase, the quantification of water supply and demand will be used in a model for analyzing various policy scenarios

Project Title:
Integrated Water Resources Management (IWRM) pilot project for the Middle Olifants sub-basin in South Africa

Donor: German Federal Ministry of Education and Research (BMBF)

Project team: Klaus Frohberg, Ulrich Hiemenz, Daniel Tsegai, Teresa Linz, Julia Kloos and Melina Heinrich

Project period: August 2006–July 2009

Main cooperation partners:
Germany: Institute of Environmental Engineering and Management (IEEM) at the University of Witten / Herdecke.

South Africa: Water Research Commission (WRC), Department of Water Affairs and Forestry (DWAF), University of Limpopo

Contact/Project coordinator: Daniel Tsegai (dtsegai@uni-bonn.de)

Homepage: www.iwrm-southafrica.de

as referred to above. For this purpose, the economic module will be linked with the hydrological module.

Project findings

Household survey

A household survey on water demand was conducted in four villages and one town during the period of August to November 2007. The aim was to gather data about the attitude of households towards different alternatives and attributes of providing water services, including price variations. In total, 475 households were interviewed. Additionally, secondary data on households in the study area were collected from government authorities, the University of Limpopo and private consulting agencies.

The preferences of the households among alternative water sources as stated in the survey is being examined using an econometric model. The analysis is based on service attributes (quantity of water available, reliability of water provision, price charged for water, etc.) and socio-economic characteristics of the household (age, household income, gender, etc of the respondents[1]).

The preliminary results show that households which obtain water from a tap inside their dwelling consume about 75 liters per person per day, while 19 liters per person per day is the average for households receiving water through yard connections, public taps and/or boreholes. Those households which obtain water from a tap inside their dwelling pay Rand[2] (R) 4.80 per m^3 in addition to a connection fee. A flat rate of R60 per month is charged in cases where water meters are absent or broken.

Households using other water sources, such as public taps are not charged for the water they consume. Yet, 17% of the households sampled rely on water vendors or a neighbor's tap as their main water source or additional water source, paying an average of R1 to R2 per 25 liter canister. The analysis also shows that households are willing to compensate water providers for better water services. The amount they are willing to pay for such improvements depends on the kind of service provided. For example, receiving water more often per week increases willingness to pay by R2 to R5.60 per m^3 depending on the number of days of supply per week and the model specification.

1 Respondent is the person who fetches water regularly and who knows about the household budget. Minimum age was required to be 17 years.

2 1 Rand (R)= 0,08774 Euro (Nov 2007)

Industrial and agricultural water use

As far as water consumption by mining and agriculture is concerned, data on input quantities and prices as well as output quantity were collected during the period of August to November 2007. Time series data for the period of January 2004 to September 2007 were collected from mining companies. The analysis aims at obtaining a relationship between the demand for water and output as well as the prices of all inputs, including water for these mining companies. The results show that water use only represents a small share of all costs in these companies. Estimation results also illustrate that the demand for water in the mining companies is price inelastic (-0.78 is computed).

Crop growing in the Middle Olifants is mostly possible by making use of irrigation. In general, only large-scale farmers irrigate. There are also some small-scale (subsistence) farmers and household gardeners

Household survey on water demand in the Olifants basin

who water their crops. But based on their land share, these are almost negligible. A total of 40 large-scale farmers were interviewed. The main crops grown are oranges, accounting for 34% of the land, followed by maize and wheat. These farmers employ modern types of irrigation systems. Various kinds of irrigation are used depending on the crop: center pivot on 48% of the land, micro and drip irrigation on a further 48%, and other types of sprinklers on the remaining 4% .

Service costs

The cost of providing water services is being analyzed with regard to water supply. Being able to provide water services in a sustainable and efficient way requires, among others, recovering the cost of the service. Tariffs for water in South Africa are often low and seldom reflect its actual value. The structure of the costs of supplying residential water in the Middle Olifants is being examined on the basis of data gathered by the National Treasury of South Africa (2004 and 2006) and its supply function estimated. WSAs purchase bulk water from water boards for distribution to residents. The volume of water purchased by the WSAs is equivalent to about 58 liters per person and day, which exceeds basic human needs (25 liters per person and day) according to the National Water Act. Furthermore, results show that the marginal cost of supplying water to the end user is R8.16 per m^3 while the average tariff for Limpopo and Mpumalanga provinces (major provinces constituting the study area) is R3.79 and R4.79 per m^3 respectively[3]. This shows that the WSAs are not recovering the costs involved in supplying water to the end user. Thus, raising tariffs to the level of marginal cost would be an option for improving the efficiency of water services (on the condition that the extra cash generated from raising tariffs would be invested in improving water supply infrastructure). According to the estimation results, increasing returns to scale prevail (1.16 was obtained), indicating that merging some WSAs would be advantageous. Thus, reversing the existing trend of supplying water at the local municipality level and up-scaling WSAs to the district level is an important policy option for water services efficiency.

Large scale irrigation in the Middle Olifants

Perspectives

The project team's next step will be to work on the integration of the supply and demand models. Once this is complete, these models will be integrated with the hydrological model and various simulations will be performed based on several policy scenarios. Final results will be presented to the South African water authorities, mainly the Water Research Commission and the Department of Water Affairs and Forestry.

[3] South Africa uses a block tariff scheme which means a specific price for a specific range of consumption or block (blocks could be in m^3 0-6, 6-12, 12-20, 20-60, etc.) and this tariff is for water consumption of 20-60 m^3.

Project on the conservation and use of *Coffea arabica* in Ethiopia (CoCE)

Introduction

The birthplace of *Coffea arabica* is Ethiopia. Here it is growing wild in the understory of the Afromontane rainforests. At current deforestation rates, however, there will be no wild coffee and no forests left within about 30 years. Researchers at ZEF are studying the ecological and economic value of the coffee forests and are developing methods for their conservation and sustainable use.

The place of origin of *Coffea arabica* lies in the highlands of southwest and southeast Ethiopia at altitudes between 1,000 and 2,000 meters. In these areas forests are being converted into agricultural land and settlements, driven by poverty and population growth. In addition, large-scale land development projects aim at curbing economic growth, providing income alternatives and increasing productivity. These interventions, if not carefully designed and regulated, can harm the forest habitat, irrecoverably leading to the loss of Ethiopia's cultural heritage for the world: The wild *Coffea arabica* populations.

Women sun-drying coffee beans in Ethiopia

ZEF project on the conservation and use of wild coffee in Ethiopia

ZEF's project on the use and conservation of *Coffea arabica* (CoCE) aims at developing solutions for the sustainable use and conservation of wild coffee populations in Ethiopia. The CoCE project is being funded by the German Federal Ministry of Education and Research (BMBF) and was initiated in August 2002. It is part of the BMBF's Biosphere research program—integrative and application-oriented model projects (BioTeam).

Coffea arabica has a unique value for the coffee sector and is well-suited as a model species in biodiversity research. This is because its wild populations can still be found in Ethiopia's natural rainforests and it is one of the few economically important crops whose origin is restricted to one country. However, the gene pool of wild *Coffea arabica* is highly endangered. An irreversible reduction in the gene pool could result in huge economic losses for coffee breeding and production. Breeding and selection measures for increasing the disease tolerance of *Coffea arabica* so far have focused on coffee leaf rust and coffee berry disease. In future, they will also have to focus on coffee wilt disease. Furthermore, coffee cultivation in many parts of the coffee-growing world is being moved to marginal land. Thus, coffee varieties have to be adapted to adverse ecological conditions, such as drought stress, in order to achieve production stability. To be able to adapt to these changing cultivation conditions, it is of utmost importance to have a diverse coffee gene pool for breeding. Ethiopian wild coffee populations provide highly diverse genetic material for future coffee breeding and selection.

The CoCE project covers six main research areas:

- Studies on the vegetation and floristic composition of the rainforests.
- Studies on the genetic diversity of wild coffee and genetic differences between wild coffee and land races as well as other coffee varieties.

Project title:
Conservation and Use of Wild Coffea Arabica in the Montane Rainforests of Ethiopia (CoCE)

Project period: 2002–2009

Main donor: German Federal Ministry of Education and Research (BMBF)

Project team: Manfred Denich, Franz Gatzweiler, Tadesse W. Gole

Contact/Project coordinators:
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Capacity building (as of September 2007):
In the CoCE project, nine students have finished their PhDs so far, among them five young Ethiopian and four German scientists. Four Ethiopian doctoral students and two Ethiopian master students are still involved in the project. Furthermore, the field research of ten Ethiopian MSc students was supported by the project.

- Investigations on site-specific tolerance of the wild coffee populations to drought.
- Investigations on tolerance of wild coffee populations to fungal diseases, coffee berry disease, and coffee leaf rust.
- The economic value of the coffee-genetic resource for international breeding programs and the economic value of forests with wild coffee occurrence.
- The institutional framework: investigations on how the conservation and use of wild coffee and forest resources are organized, regulated, and managed.

Main research issues during the ongoing second research phase:

- Practical measures are being developed to preserve the wild coffee gene pool in situ, i.e. in the species' habitat of origin. Different types of in situ gene banks are being set up. The advantage of conservation in the species' habitat of origin is that it maintains the plant's natural selection and adaptation mechanisms with regard to changing site and environmental conditions.
- The potential economic value of the wild coffee-genetic resource is being transformed into real economic benefits. Communication, education, and awareness raising are preconditions for that transformation. Certification, product development and marketing are examples currently developed. Various incentive measures will be evaluated against selected criteria in order to rank their appropriateness and suitability for the establishment of a biosphere reserve in the Yayu forest area.

Children in a village in southeast Ethiopia

- Communication and public awareness building, education as well as strengthening institutions for the conservation and sustainable use of coffee forest resources, is being carried out. To realize this, a non-governmental organization, the Ethiopian Coffee Forest Forum (ECFF), was founded at the end of 2005. ECFF provides education and training for schools and local stakeholders, mediates and initiates policy dialogue and, together with a network of interested national and international actors and groups, develops and carries out other projects to achieve the conservation and use of coffee forests in Ethiopia.

Main research highlights 2007–2008

The Coffee Forest Information System

The development of concepts for the conservation and use of wild coffee and its forest habitat requires information on the extent of forest cover and areas with wild coffee populations. To this end, forest areas are mapped on the basis of current satellite imagery. Satellite images from the 1960s are used as a reference for estimating long-term deforestation rates.

Suitable habitat areas for the occurrence of wild coffee populations are determined by means of ecological niche modelling, considering site factors and environmental gradients. This analysis provides guidance for locating wild coffee stands, particularly in less-known regions.

All spatial information is compiled in a Coffee Forest Atlas and in an online Coffee Forest Information System. Besides the coffee forest maps, the atlas includes further ecological and socio-economic information, e.g. population density, relevant to the location and design of coffee forest conservation areas. It thus facilitates the planning of a protected area for wild coffee in its forest habitat.

Certification as a marketing tool for biodiversity conservation

A group of researchers within the ZEF project on "Conservation and use of wild populations of *Coffea Arabica* in the montane rainforest of Ethiopia" (CoCE) is tackling the question whether certification can contribute to the conservation of biodiversity by assessing the prospects and challenges of the certification and marketing of Ethiopian forest coffee.

The current modes of forest coffee certification in Ethiopia face structural problems and do not offer sufficient incentives for the producers to preserve the forest ecosystem and biodiversity. In order to overcome these bottlenecks, the researchers recommend developing and implementing a consistent and distinctive certification concept for Ethiopian forest coffee.

Forest management guidelines that balance economic benefits and biodiversity conservation in the concrete ecological, socio-economic and institutional context thereby need to be linked to incentives for compliance. This is, of course, not an easy task. A public-private partnership with the "Ethiopian Forest Coffee Forum" NGO may provide the necessary capacity. Nevertheless, certification can only be one tool for conserving biodiversity. Participatory forest conservation programs as well as education and training measures are required in addition.

Ethiopian coffee ceremony delights visitors at UN biodiversity conference (COP9) in Bonn, May 19-30 2008

From May 19 to 30, the ninth Conference of the Parties (COP 9) of the UN Convention on Biological Diversity (CBD) was held in Bonn. With more than 5,000 delegates it was one of this year's major events in international environmental politics. To promote the knowledge about the importance of biodiversity and its conservation, Deutsche Bundesstiftung Umwelt (DBU)—one of Europe's largest environmental foundations—organized a fair which drew 50,000 people to the tents of over 200 exhibitors. At the center of the fair was the German Federal Government's tent with stands of all relevant ministries. ZEF's project on the Conservation and Use of Wild Coffee in Ethiopia (CoCE) was chosen as one of just a few model projects in biodiversity research to be presented at the stand of the German Federal Ministry of Education and Research (BMBF).

At the stand, CoCE presented an authentic Ethiopian coffee ceremony, where coffee was freshly roasted, ground and served by Ethiopian women wearing traditional dresses. This offering quickly became popular and attracted many delegates and visitors, one of whom was the Japanese Minister of the Environment. The stand was continuously staffed by project members to give background information or explain details to the visitors and to carry out a coffee quiz. A leaflet for children with an illustrated story about the discovery of coffee in Ethiopia was also handed out.

The project was received very well and reactions from the visitors were overwhelmingly positive. Apart from these PR activities, staff of ZEF/CoCE and its Ethiopian partner NGO "Ethiopian Coffee Forest Forum" (ECFF) actively participated in the conference and side events, e.g. by giving a presentation at the CEPA (Communication, Education and Public Awareness) fair.

Grain field in Ethiopia

Biodiversity Transect Analysis: BIOTA East Africa

BIOTA (BIOdiversity Monitoring Transect Analysis) is a research project carried out by 54 German and African universities and non-university institutions. There are project sites in East, Southern, West and North Africa. BIOTA's main goal is to provide scientific support for the conservation and sustainable use of biodiversity in Africa. ZEF has contributed to BIOTA East since the beginning of its second phase (2004-2007) in which the ZEF-led E13 subproject undertook a series of valuation studies to determine the monetary value of the ecosystem services of Kakamega Forest. The overall result showed that the conservation of Kakamega Forest makes economic sense since the value of the goods and services that it provides to the local and international community is larger than the cost of conservation.

In the ongoing third phase of BIOTA (2007-2010), we are examining how conservation can actually be implemented. The selection of conservation instruments was guided by four criteria: (i) the local population should benefit from the service flows (ii) the use of these benefits should be sustainable, (iii) the instrument should be politically feasible and (iv) research is required to determine the use of the instrument. Participatory forest management (PFM) and payments for ecosystem services (PES) are considered to best fulfil these criteria. Other instruments appear to be less applicable in the Kakamega context: Strictly enforced command-and-control mechanisms, for example, are likely to meet with strong resistance and may severely curtail the local population's livelihood. Integrated conservation and development programs have been reported to have had limited success in achieving their objectives and this would likely also be the case in Kakamega due to the multitude of existing problems.

Women carrying firewood in the Kakamega Forest, Kenya

By actively involving local communities in the management of the forest, PFM has the potential to gain the communities' support for conservation. On the other hand, it typically involves the risk of social dilemmas putting collective interests at stake. PFM also raises equity concerns with respect to the allocation of forest resources and benefits to community members, for example, by equitable sharing, preferential treatment of the poor or customary distribution.

Two PhD studies address these issues:

(1) In one study, we identify specific local behavioral patterns in economic experiments and feed the results as well as other survey data into a multi-agent model that simulates dynamic decision making processes under different regulatory scenarios. The model is expected to help determine the regulatory frameworks that are likely to lead to sustainable outcomes. Progress so far: A PhD student has been trained in the ZEF doctoral program, the concept has been developed and economic experiments have been designed and implemented.

(2) In field trials involving three communities, we are testing the auctioning of forest user rights as an intermediate step for the generation of benefits. Auctions potentially lead to the economically efficient allocation of resources and can maximize communal income. The auction income can be used to finance communal projects, the benefit of which is potentially higher than the direct use of forest products. Differences between the social structure of the communities, the use of forest products and the extent to which rules of the participatory process are imposed, as well as the continuous monitoring of the participatory process are

The Kakamega Forest in Kenya

expected to give important clues as to the potential benefit of auctions as an innovative allocation instrument in PFM and the conditions that facilitate the success of PFM. Progress so far: A PhD student has been trained in ZEF's doctoral program, the Kenyan Forest Service has been won as a close collaborator, communities have been identified and informed, forest plots identified and marked, user rights auctioned, and the participatory process is currently being monitored.

The rationale for the use of payments for ecosystem services (PES) in Kakamega is the forest's generation of national and global benefits (e.g. water, carbon and biodiversity services) that do not play any role in local land use decisions on the ground. A transfer of part of these benefits to the local population could provide the necessary incentives to tip the balance towards forest conservation. We are addressing the applicability of PES in Kakamega in a doctoral study and three master theses.

(3) At the Bali Conference of the Parties (COP) in December 2007, countries agreed to reconsider reductions of emissions through reducing deforestation and degradation (REDD) as a potential component of a post-2012 climate change regime. The potential and implications of REDD for Kakamega are investigated in a PhD study. Progress so far: A PhD student started training in the ZEF doctoral program in October 2008.

(4) The formal and informal carbon market offers potential income alternatives for the local population around Kakamega Forest. The feasibility of local involvement in the carbon market is examined in a master thesis. Progress so far: An MSc student trained at Kenyatta University, Kenya. A research proposal is currently being developed.

(5) One of the issues in PES is to determine payment amounts for services provided. Fixed payment levels and the lack of information about real provision costs potentially give high producer surpluses to the providers thus decreasing the cost-effectiveness of payments. Procurement auctions are a promising approach to determining real costs, but have hardly been applied in developing countries. In economic experiments in Kakamega, we found that procurement auctions are generally understood by the rural poor and that discriminative payments increase, communication decreases and repetitive bidding has no effect on cost-effectiveness. Progress so far: An MSc thesis completed.

(6) Finally, a master thesis is further investigating the possibility of providing on-farm biodiversity through the establishment of species-rich hedges, wood lots and fence lines as a complement in the agricultural landscape to forest conservation. Progress so far: An MSc student trained at Kenyatta University, Kenya. A research proposal is currently being developed.

Project title:
Conservation and Management of Biodiversity for Rural Livelihoods: Developing Sustainable Strategies for Reconciling Stakeholders' Interests in Kakamega Forest (BIOTA East subproject E13).

Project duration: BIOTA E13, 3rd phase: September 2007 – May 2010

Donors: German Federal Ministry of Education and Research (BMBF), Catholic Academic Exchange Service (KAAD)

Project team (BIOTA 3rd phase):
Ulrich Hiemenz, Tobias Wünscher, Mercelyne Khalumba, Julius Maithya, Stephen Mutie, Renata Saizaki, Levi Ouma, George Kariuki, Lucie Andeltova

Main cooperation partners:
Kenyan Forest Service, Kenyatta University, German BIOTA subprojects E01, E02, E03, E14a, E14b, E14c.

Country of research: Kenya

Objectives:
To develop scientific knowledge through original research for the successful application of conservation instruments for the preservation of Kakamega Forest.

Current activities / output:
Currently, 2 PhD students conducting field research, 1 PhD student being trained at ZEF, 1 MSc completed, 2 MSc students preparing proposal. Conference presentations since September 2007: Oral 12, posters 5. Publications since September 2007: peer reviewed 3, others 4.

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Biodiversity Transect Analysis: BIOTA West Africa
Biodiversity Patterns and Global Change in West Africa

Background

Achieving a better understanding of the causes of climate variability in West Africa is a major challenge for the international scientific community. In particular, researchers are still investigating the impact of the great Sahelian drought in the 70s and 80s on vast parts of the region in terms of ecological, economic and socio-cultural effects. Global circulation models (GCMs) are used in climate research in order to gain greater insight into the larger scale interrelationships of climate change. However, these models do not implicitly meet the requirements of biodiversity research on a regional and local scale. To meet these requirements, the BIOTA West project established joint structures of research sites within the Biophysical Observation Network (BON) in close cooperation with the GLOWA Volta project.

Scintillometer at a GLOWA climate station in Burkina Faso

Project goals

The main task of climatological and biophysical research in the BIOTA-West project is the continuous analytical monitoring of hydro-meteorological and biophysical variables that influence the local biocoenoses in the project area (Burkina Faso, Côte d'Ivoire, and Benin). These components are essential elements of the complex mechanisms contributing to the different stochastic and deterministic processes shaping and maintaining terrestrial biodiversity. With the support of collected field data, an extensive data base is being set up as a basis for the continued analysis of the spatio-temporal climate dynamics in West Africa.

Research highlights 2007–2008

New micrometeorological and climatological stations were installed in the course of several field campaigns in the main research area in Burkina Faso. The main selection criteria for the sites were their representativeness of and accordance with overall research questions of BIOTA – to achieve a maximum of synergetic effects with other BIOTA topics. The climatic data were part of a direct effort to monitor abiotic parameters.

The climate database set up within the first phase was extended with the data sets of the Biophysical Observation Network (BON) and data sets of the Institut de Recherche pour le Développement (IRD), national Meteorological Services of Burkina Faso and Ghana, the World Meteorological Organisation (WMO) and the Agrometeorology Group, Food and Agriculture Organization (FAO) of the United Nations.

This is an ongoing process. Based on time series analysis and geo-statistical interpolation, we have compiled geo-referenced maps of different climatic

Project title:
BIOTA West (BIOdiversity Monitoring Transect Analysis) in West Africa

Project duration: 2001–2010

Contact/Project coordinator:
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Homepage: www.biota-africa.org

Donor: German Federal Ministry of Education and Research (BMBF)

Main cooperation partners:
Germany: German Academic Exchange Service (DAAD), Institute for Meteorology and Climate Research (IMK-IFU), Forschungszentrum Karlsruhe, Remote Sensing Unit of the German Aerospace Center (DLR), University of Wuerzburg

West Africa: The Volta Basin Authority (VBA), based in Ouagadougou

Burkina Faso: Université de Ouagadougou, Institut de l'Environnement et de Recherches Agricoles (INERA), Service Nationale Météorologique de Burkina Faso, Direction Générale des Ressources en Eau (DGRE)

Benin: Université Abomey-Calavi

Côte d'Ivoire: Université d'Abobo Adjame, Université de Cocody, Station d'Ecologie Tropicale de Lamto, Institut de Géographie Tropicale (IGT)

Synoptic climate station in Burkina Faso

variables. A PhD student estimated the vegetation structure at the research sites by means of hemispherical photography and digital image analysis—which is available in ZEF's literature base.

Further experimental field work was carried out in Burkina Faso and Benin. A network of stations measuring precipitation, temperature and humidity was set up in the Pendjari National Park in Benin to gain an insight into the small-scale variability of meteorological surface boundary layer conditions. The project undertook capacity building measures by providing individual training in applied biophysical and micrometeorological measuring approaches. Automatization and remote access to the stations of the BON were tested and set up for sites of special interest.

International Conference in Cape Town, South Africa

More than 300 researchers, politicians and stakeholders from all over the world participated in the international conference on 'Biodiversity in Africa—Observation and Sustainable Management for our Future', which took place in Cape Town, South Africa from 29 September to 3 October 2008. The conference offered a platform for researchers to meet with African politicians and stakeholders to discuss the outcome and options for a follow-up of research projects carried out in Africa within the framework of the BIOTA (Biodiversity Transect Analysis in Africa) program.

Local governance and statehood in the Amu Darya borderlands (Uzbekistan, Tajikistan and Afghanistan)

Introduction

The ZEF project "Local governance and statehood in the Amu Darya border region" deals with local governance structures in Northern Afghanistan, Southern Tajikistan and Southern Uzbekistan. The aim of this project is to gain a better understanding of local political decision-making structures in a region which shares common historical trajectories, but has different political systems today.

Farmers in an Afghan village in the province of Takhar

Since the 1990s, the approach of "empowering the people" has become a trend in development politics. The core idea was to include local civil society in decision-making processes and to dismantle authoritarian state structures by generating processes of "decentralization" and "good local governance". At the same time, authoritarian governments all over the world endeavored to gain greater control of local level politics to bolster their power. A strong tendency toward establishing local governance structures could also be observed during the last decade in the three countries where ZEF conducts its research.

Country overview

Afghanistan

Nearly all state structures in Afghanistan became eroded as a result of the protracted (civil) war in the country. The reconstruction process in Afghanistan started following the international intervention in 2001. This process is funded largely by the international community. It soon became clear that administrative structures below the provincial level were completely lacking. A "good local governance program", called the National Solidarity Program, was launched to fill this gap and to establish local representative structures for the development agencies as well as for the Afghan government. The underlying notion of this program is that local communities should democratically elect their own representatives.

Tajikistan

Tajikistan also faced a civil war in the 1990s that eroded local administrative structures. Since the end of the war in 1997 and fostered by international programs for "good local governance", the Tajik government has established village organizations, sometimes building on traditional councils called *jamoats* that were influential in pre-Soviet times. However, the Tajik government has constantly simultaneously endeavored to strengthen the administrative vertical of power in an authoritarian manner which has had its impact on the democratic quality and inclusiveness of local governance.

Uzbekistan

Immediately after independence in 1991, the authoritarian government in Uzbekistan exploited traditional neighborhood councils, so-called *mahallas*, for local decision-making processes. Meanwhile, the *mahallas* have been officially incorporated into the state's structure as the smallest administrative units at local level. However, on occasion influential private interests easily capture state structures in both Uzbekistan and Tajikistan. Compared with the other two countries, international agencies are least active in devolution programs in Uzbekistan.

Project Title:
Local Governance and Statehood in the Amu Darya Borderlands (Uzbekistan, Tajikistan and Afghanistan)

Donors: Volkswagen Foundation and the German Academic Exchange Service (DAAD)

Project duration: 2005–2009

Project team: Hafiz Boboyorov, Bernd Kuzmits, Katja Mielke, Wolf Henrik Poos, Conrad Schetter, Andreas Wilde

Cooperation partners: State University of Termez, German Agro Action, Concern Worldwide

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ZEF's research approach

This overview shows the completely different ways in which development agencies and governments try to establish local decision-making structures in the area of research: In Afghanistan, the aim is primarily to fill the gap of non-existent state structures; in Uzbekistan, the *mahallas* strengthen the vertical power of the state on the local level. In Tajikistan, the central state and international development agencies often even follow opposite interests or compete with their own local governance programs.

However, ZEF's research approach goes beyond analyzing the way in which different local governance programs are installed. ZEF's focus is more on local social orders and the ways in which local people are coping with new political structures that were introduced from outside, be it top-down by the state or by international agencies.

ZEF's research findings

There is a general trend in all three countries towards the ruling local elites being able to consolidate their power by influencing or controlling the new decision-making bodies. In the case of elected governance structures—to be observed in Afghanistan and Tajikistan—elites are usually able to influence elections in their favor. However, often enough these new local decision-making bodies only attract the participation of local elites if they offer them access to resources or to power. This is why the new local governance bodies became especially attractive in regions with scarce resources or in regions which are highly dependent on central state structures—such as the cotton growing areas in Tajikistan and Uzbekistan.

The research also shows that, in all three countries, the new political structures rarely emerged as dominant institutions where political decisions are taken, but rather created artificial parallel structures. Thus different forms of traditional local institutions continue to exist in Afghanistan, for example the *shura*, due to the war and to the lack of official administrative structures. In fact, these traditional institutions are still the core political bodies for decision-making processes even today.

In the former Soviet republics of Uzbekistan and Tajikistan, the *mahallas* and *jamoats* of the rural borderland areas to Afghanistan have generally only become significant decision-making bodies if there has been continuity in staff and personal contacts with formally dismantled Soviet successor institutions such as kolkhozes. This warrants access to economic resources.

As a first recommendation from this ZEF project, we suggest that local governance programs—both those implemented by the governments as well as those implemented by foreign development agencies—should be adapted more to the highly varied landscape of local institutions. The project thus challenges the general assumption that so-called "failed states" such as Afghanistan and Tajikistan are characterized by chaos and anarchy and consequently do not have legitimate local governance institutions or even any at all. In our view, the opposite is true. A certain social order always exists, embracing a variety of institutions and expressing a particular mindset of its people.

Traversing a river in the Kunduz province

Water-related Information System for the Sustainable Development of the Mekong Delta (WISDOM) in Vietnam

Project set-up

WISDOM is a multidisciplinary project with 19 partners in Germany and Vietnam. Among the German partners, ZEF is contributing its social science background and perspective to the project. ZEF's core task is to implement one of the project's seven work packages, i.e. the work package on knowledge management (WP 2000). This entails:

- knowledge management systems governing the water sector
- water policy and planning and
- local politics of water management

Goals

The research aims at understanding the organisational structure and institutional plurality of the water sector as well as water governance at different societal and administrative levels. This includes analysing responsibilities, concurrent competencies and competing interests with regard to water resources. Another important dimension of the research is to find out how knowledge on water resources is generated, disseminated and put into action. Information gaps will be identified and the assessment of information flows and barriers will help to understand how policy development, planning and implementation work in practice.

Research at district and community levels will provide data on local knowledge and practices with regard to flood and dyke management. This is complementary to the research done at the provincial (regional) level, focussing on policy processes and the political economy of water resources management.

The results of the research will be integrated in the water information system and also guide the process of system design and project implementation .

Project track and achievements:

The first phase of the project started in April 2007. The start of the project was marked by the recruitment and training of five PhD students, the development of a research design and the establishment of a literature databank. Several field trips were undertaken, in particular to develop the partnership with the Mekong Delta Development Research Institute (MDI) in Can Tho and the Southern Institute of Sustainable Development (SISD) in Ho Chi Minh City. Both institutes are academic organisations with broad research experience and an in-depth knowledge of the Mekong Delta.

Mekong Delta, Vietnam

Information gathered from literature review and first data collection in Vietnam provided the basis for an organisational mapping of the water sector. This undertaking is still in process; results will be fed into a new databank currently being established. Further, the legal and policy framework of the water sector has been studied and the results examined. A few GIS maps have been produced; for example, one of these maps shows regional disparities in knowledge production.

ZEF has been running a project office at the premises of MDI in Can Tho since the beginning of 2008. The office is run by a ZEF research fellow whose main task is to conduct research and coordinate our activities in the region. In April 2008, four junior researchers arrived in the Delta. The data collection concentrates on Can Tho City, one of the central provinces of the region. The research topics of the junior researchers are as follows:

- Managing and governing knowledge in the water sector of Vietnam
- Coping with floods: Local knowledge in the Mekong Delta
- Planning and implementation of dyke systems
- Rural water supply in the Mekong Delta
- Strategic groups in the water sector

Capacity development

In addition to its own research, ZEF is contributing to strengthening the existing knowledge management system in the region: In June 2008, ZEF and SISS

organised a first Knowledge Management Training Course in Ho Chi Minh City. Twenty participants, representing their respective Vietnamese WISDOM partner organisations, attended the three-day training course. Hans-Dieter Evers (ZEF) presented contemporary theory and concepts of Knowledge for Development to the Vietnamese research community. The training also included practical exercises and a field excursion.

Other capacity building activities will follow in 2009 and 2010. They include a training of trainers' component and aim at building local capacity in the field of knowledge management, which is still a nascent discipline in Vietnam.

Merchants heading to a market in Vietnam

Background information:

Vietnam has been on the upswing since the mid 80s: broad economic reforms, integration into regional and global markets and important political and legal changes have helped to overcome the poor performance of the old national economy. But despite many success stories, the one-party state is still facing huge challenges: Poverty is still widespread, environmental degradation has become a serious problem and state management is often weak and inefficient.

The Vietnamese water sector provides a good example of this: A complex set up of institutions as well as continuous changes within the system make informed decision-making and efficient water management very difficult. The WISDOM project aims at supporting existing local efforts in this field by developing a water-related information system. The information system is a tool for storing, processing and analysing water-related data and will be used by policy makers and other stakeholders from various disciplines and different administrative levels. Moreover, the platform will provide operational services in the fields of disaster prevention and mitigation as well as integrated water resources management.

The project region is the Mekong Delta in Southern Vietnam, a region characterized by a dense river network and a long history of water regulation. The Delta provides huge opportunities for agriculture and fishery and production in both sectors has experienced tremendous growth over the years. Other important development factors in the region are the trend towards urbanisation and demographic changes. In terms of water use, irrigation still dominates compared with domestic and industrial water use and surface water also serves for transport and hydropower projects.

Important and specific challenges to water management in the Mekong Delta are the region's vulnerability to natural hazards, seasonal floods and dry season saline intrusion. Man-made problems to tackle are water pollution, environmental degradation and low quality water supply in both rural and urban areas.

Project Title:
Water-related Information System for the Sustainable Development of the Mekong Delta (WISDOM)

Donor: German Federal Ministry of Education and Research (BMBF)

Project duration: 2007–2010 (Phase 1)

Project team: Solvay Gerke, Hans-Dieter Evers, Gabi Waibel, Simon Benedikter, Tatjana Bauer, Judith Huu Pham Cong, Nadine Reis

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Homepage: www.wisdom.caf.dlr.de

6 Further ZEF Research

Project Title	Duration	Donor	Team	Partners	Aims	Current Activities/Output
Improving water productivity of crop-livestock systems of sub-Saharan Africa	2007–2010	German Federal Ministry for Economic Cooperation and Development (BMZ)	Manfred Denich, Patricia Masikate, Tilaye Teklewold, Sewmehon Demissie, Sisay Demeku	IWMI, ILRI, ICRISAT	The project aims to optimize productive use of water to increase incomes and improve the environment within crop-livestock systems in the semi-arid areas of Zimbabwe and Ethiopia. The project is a collaborative activity that will contribute to the CGIAR System-wide Livestock Program.	The PhD students are in Ethiopia and Zimbabwe to carry out their field studies.
Genetic resources policy initiative – East Africa	2005–2008	BMZ/ German Technical Cooperation (GTZ)	Tobias Wünscher, Edilegnaw Wale		Strengthening the capacity of developing countries to design comprehensive policy frameworks for the conservation of genetic resources.	PhDs: none, MSc 1 Publications: Total published 10 (peer reviewed 9, in 2008: 4). In preparation: 2 monographs, 4 journal articles. Workshops and Conferences: contributions 5, organization 3.
Social management of water in Afghanistan	2005–2008	European Commission	Iskandar Abdullaev, Peter Mollinga, Conrad Schetter, Usman Shah, Saravanan Subramanian	German Agro Action, Balkh University (Afghanistan)	Understanding of institutional and socio-technical aspects of community water management in five selected canal command areas of Kunduz River Basin, Afghanistan. This is part of larger EU funded Kunduz River Basin project.	Amu Darya Series/ZEF Working Papers (http://www.zef.de/amudarya.0.html) • Journal Articles (2008 Südasien) • 2 MSc theses • XII World Congress of Rural Sociology, 6-11 July, 2008, Goyang, Korea.
Facilitating the widespread adoption of conservation agriculture in maize-based systems in Eastern and Southern Africa	2005–2007	GTZ	Christopher Martius	CIMMYT Harare, Zimbabwe	Studying the effects of conservation agriculture in smallholder farms of Zimbabwe on soil organisms (soil ecology)	1 PhD student.

Project Title	Duration	Donor	Team	Partners	Aims	Current Activities/Output
The importance of biological sources of polycyclic aromatic hydrocarbons (PAH) contents in tropical soils	2004–2008	German Research Foundation (DFG)	Christopher Martius, Wulf Amelung (INRES, Uni Bonn), Wolfgang Wilcke (Uni Mainz), Marcos Braganca (Universidade Federal de Tocantins, Palmas, Tocantins, Brazil)	Universidade Federal de Tocantins, Palmas, Tocantins, Brazil	Studying the role of termites as sources for polyaromatic hydrocarbons (=atmospheric pollutants); studying the effects of termites in the carbon cycles	
Strategy and methodology for improved IWRM— An integrated interdisciplinary assessment in four twinning river basins (STRIVER).	2006–2009	European Commission	Peter P. Mollinga, Saravanan.V.S. and Rahul Pillai.		• Differential treatment of irrigated and rainfed agriculture in integrated approaches • Technical and institutional innovations in rainfed and irrigated agriculture. • The interaction between rainfed and irrigated agriculture systems. Project area is the Tungabhadra river basin, India.	Research reports to EU and research articles in journals.
Water, Politics and Development	2007	ZEF Research group	Peter P. Mollinga, Saravanan.V.S. and Anjali Bhat.		Publication- focused project for sharing scholarly work on water, politics and development and design future research. The project has two components: (i) an international collection of conceptual papers; (ii) a collection with case studies.	• DFG sponsored roundtable March 2005 • Two workshops at ZEF (March 2007 and April 2007). • A seminar at Stockholm World Water Week 2007 (August 2007) • Submitted international collection of papers presented at Stockholm to an international development studies journal.

ZEF Consult

ZEFConsult has conducted and finished six policy advice-oriented projects between summer 2007 and summer 2008.

ZEFConsult members took actively part in conferences, workshops, published articles, gave interviews to the media and joined advisory groups.

Projects:

Introducing Information Systems for Water Sector Regulation: a Handbook for Practitioners based on Experiences in Kenya, Tanzania, and Zambia

- Analysis and evaluation of GTZ's experiences with the use of ICT in its water sector regulation projects in three African countries. Producing a handbook for future projects in the field of water management.
- Client: GTZ, Budget: 40,000 Euros
- Publication: Handbook for internal use of GTZ

Actor's analysis: African entrepeneurship in North Rhine-Westphalia (NRW)

- Identification of the potential of members of African diaspora in NRW for economic cooperation between SME in NRW and African countries.
- Client: InWEnt, Budget: 11,000 Euros
- Members: Stefan A. Haffner, Ruben Greiff, Hartmut Ihne

NRW-Ghana-Gateway

- Evaluation of potentials for economic cooperation to fill in the contract between the State of North Rhine-Westphalia (NRW) and Ghana under conditions of development cooperation. Development of a communication tool to link SME in NRW, partners in Ghana, members of Ghanaian diaspora in NRW and politics to improve economic cooperation at the SME level along the criteria described in the ZEFConsult study InfoTool NRW (April 2007).
- Client: Government of NRW (MGFFI), Budget: 33,000 Euros

Ghanean stakeholders discussing land issues

Background Paper on the Follow-up to 2001: The international Year of Volunteers

- Analysis and evaluation of the state of realization of the three UN resolutions on volunteering in the UN-system.
- Client: United Nations Volunteers, Budget: 30,000 Euros
- Members: Caleb Wall, Hartmut Ihne

Evaluation of development oriented research, teaching and consultancy in NRW

- Analysis, evaluation and recommandations on the state-of-the-art of development-related research, teaching, and advice in NRW (universities and non-university institutes).
- Client: Government of NRW (MGFFI), Budget: 33,000 Euros

7 Bonn International Graduate School for Development Research (BIGS DR)

Through its Bonn International Graduate School for Development Research, ZEF intends to strengthen the development research community in Germany, Europe, and worldwide. The program aims at educating future decision-makers from developing countries and Europe for international careers. It is an initiative to provide high qualifications for upcoming young scientists, academic staff, advisers, and managers in both the private and public sectors. The program offers training for doctoral degrees in social and natural sciences, economics, and agriculture at the University of Bonn and other universities.

Development is an expanding field of research and professional employment. Working in this field requires interdisciplinary skills and competences. The Bonn International Graduate School for Development Research safeguards disciplinary excellence while requiring an understanding of and an ability to work in other development-related fields. Combining theories, methods, and practical experience in the areas of social, economic, and ecological change enables students to explore new fields and be competitive on an international job market. The performance of field research in a developing country or a development-related institution is part of the BIGS-DR program in accordance with ZEF's philosophy of practice-oriented research.

The structure of the doctoral program is tailored to the individual academic needs of the students, in particular of those coming from developing countries. ZEF provides intense supervision and academic support services from tutors and mentors. The program has become internationally renowned since its inception in 1999. It is unique in Germany and Europe in its size (around 140 PhD students a year), internationality (students from 74 different countries) and interdisciplinarity.

Educational Concept and Timeframe

Although the structure of the doctoral program is tailored to individual needs, the timeframe is limited to three years in duration. Normally, students will qualify for entry to the research phase within six to 12 months, followed by a field research phase of one to two years. A final period of six to 12 months for synthesis and writing completes the program. Thesis writing is done in Bonn under the close supervision of a committee whose members are experts in the student's research field.

Alumni exchanging experiences at an alumni meeting in Bonn 2007

The PhD Course Program

The BIGS-DR course program consists of a set of block courses. These are conducted by professors, fellows, and senior researchers of ZEF as well as by professors of participating faculties at the University of Bonn and affiliated institutions and guest professors, mainly from Germany and Europe. The courses include the classical fields of environmental disciplines within natural sciences, and the economic, political, and social-cultural dimensions of development. They are offered in three modules, divided into periods of one to three months. Successful participation in the courses and passing an interim exam are a prerequisite for pursuing a doctoral degree supported by ZEF.

During the first 6–12 months of residence in Bonn, the students are also expected to work with their tutor and supervising professor on fi ne-tuning their proposals, working out the necessary budgets, and organizing the infrastructure as well as the institutional arrangements for their field research in the host-countries. The field research proposal is presented to the scholars in Bonn and to the interested faculty for comments and suggestions before clearance is given to travel abroad.

PhD Research Areas

The doctoral students of BIGS-DR are integrated in ZEF's cross-disciplinary research groups and often conduct their field research in one of ZEF´s large long-term research projects abroad. This gives the students an opportunity to work closely with experienced scientists and use the project's infrastructure. ZEF's doctoral research is closely aligned with ZEF's three core research programs: economic resources, ecological resources, and political and cultural resources.

Alumni attending ZEF's international advisory board meeting in Bonn, October 2007

Alumni Network

ZEF is especially proud of its alumni. 408 students from all over the world have participated in BIGS-DR which started in 1999. Thirty-three ZEF alumni from 22 countries attended ZEF's 10th year anniversary conference in October 2007. Twenty of them received financial support to travel to Bonn by DAAD. The alumni came to Bonn to meet old and new colleagues, and to support the up-and-coming generation of ZEF students by sharing their experiences and ideas. The alumni had also the idea to collect money and set up a ZEF Alumni Fund to support PhD students during their study at ZEF and field work. Many ZEF alumni believe that they found a good position due to their PhD study at ZEF, and it may now be time to pay back. ZEF is planning the next alumni meeting for 2009 at the occasion of BIGS-DR's 10th year anniversary.

Facts and Figures BIGS-DR (as of mid 2008)

- Since 1999, 408 students from 74 countries participated; 38% were women
- 180 received a doctoral degree (120 from the University of Bonn)
- Currently around 140 students participate in the program
- In the framework of PhD research, ZEF cooperates with around 100 organizations and universities worldwide

8 Events and Workshops—a selection

The GLOWA-Volta project held a **stakeholder and training needs assessment workshop in Ouagadougou, Burkina Faso** on 12 and 13 September 2007 in order to prepare the ground for the sound transfer of the GLOWA-Volta project in the Volta river basin region. Having defined the appropriate stakeholders for Burkina Faso together with their training needs, this workshop will be followed by four workshops in Burkina Faso, where our GLOWA-Volta experts will conduct stakeholder training on GLOWA-Volta products.

ZEFConsult co-organized and co-moderated the **"3rd Symposium Forum Media and Development: Measuring Change: Planning – Monitoring – Evaluation in Media Development"** of the Forum Media and Development (FoMe), which took place with 80 participants from 15 countries in Koenigswinter on 27 and 28 September 2007. FoMe is the German national platform for media development, of which ZEF is a founding member.

ZEF celebrated its **10th anniversary** on 4 and 5 October 2007 with the **International Conference on "Global Change and Human Development: Research and Action"**. Around 250 international and national experts from science, politics and practice attended the event at ZEF and the "Haus der Geschichte", where they listened to speeches by Per Pinstrup-Andersen and Klaus Töpfer and participated in panel discussions on land and water use, governance and biodiversity and in a plenary panel discussion on the interaction between development research, politics, and practice.

ZEF's first **Open House Day** took place on Saturday, 17 November 2007. Visitors had an opportunity to gain an overview of ZEF's research projects, among others the projects on water use in West Africa, land use in Uzbekistan and biodiversity in Ethiopia, as well as to learn about other research foci. In addition, talks were given on Coffee in Ethiopia and on the Center's work in Afghanistan, Uzbekistan and Tajikistan.

The first **WISDOM PhD scientific seminar** took place at the UNU-EHS in Bonn from 19 to 21 December 2007. The seminar was organized by UNU-EHS and focused on the WISDOM project's subtopics, ranging from a general project progress report to an introduction of the respective PhD research, and keynote talks on the Mekong Delta by experts from different fields.

On 24 January 2008, ZEF organized a **workshop on "Water Rights in Central Asia and South Asia"**, and on 15 February 2008 a **workshop on "Social Water Management in Afghanistan"**. The results of the joint ZEF-GAA project on "Social Management of Water in Afghanistan" were discussed during the latter event.

ZEF presented its project on "Conservation and Use of wild Coffea arabica in the montane rainforests of Ethiopia" at the **9th Conference of the Parties (COP9) of the UN Convention on Biological Diversity (CBD)**, which took place in Bonn from 19 to 30 May 2008. The project was one of the selected foci of the German Federal Ministry of Education and Research's (BMBF) tent in the center of the "Plaza of Diversity", a market place with more than 200 exhibitors, visited by more than 50,000 people. The daily Ethiopian coffee ceremonies were the attraction.

The ZEF project in Uzbekistan conducted a **workshop on "Innovative Research for Sustainable Land and Water Use"** in Uzbekistan from 27 to 29 May 2008. The overall objective was to share the project's innovative technologies and concepts for improved land and water use with policy makers, natural resources institutions, farmers, and the scientific community in Uzbekistan. The first workshop day was held in Tashkent and attended by around 70 people, including the Deputy Minister of Agriculture and Water Resources of Uzbekistan, Dr. Shavkat Hamraev, and other high-ranking guests. The following two days of the workshop took place in the project region of Khorezm,

ZEF 10 year anniversary conference

ZEF's stand at the 9th Conference of the Parties (COP9) in Bonn

where scientific presentations were combined with field visits to the project's experimental sites. The workshop was well received by the local stakeholders and the project was called upon to formulate concrete recommendations based on its scientific findings and present them directly to the Ministry of Agriculture and Water Resources of Uzbekistan.

More than 200 researchers, politicians and stakeholders from all over the world attended the international conference on "Global Change and Water Resources in West Africa", which took place in Burkina Faso from 25 to 28 August 2008. The conference was organized by ZEF and funded by the German Federal Ministry for Education and Research (BMBF). Many ZEF senior staff members working for the GLOWA Volta Project attended the conference and presented their research outcome in the context of the GLOWA program (Global Change in the Hydrological Cycle). In the run-up to the conference, ZEF organized a trip through the Volta basin for representatives of the German and Burkinabé media. The conference was covered broadly by African and German media.

ZEF organized a Workshop on Energy Modeling from 22 to 24 September 2008. Charlie Heaps of the Stockholm Environmental Institute in Cambridge, Massachusetts, USA, held this workshop, focusing on the LEAP modeling framework.

The German-African projects on biodiversity presented their research results at the International Congress on Biodiversity of Africa in Spier, South Africa, from 29 September to 3 October 2008. ZEF contributed the following projects to the event with talks, posters and presentations: BIOTA East, BIOTA West and the project on the Conservation and Use of Wild Coffee in Ethiopia (CoCE).

The "Water Lectures" are a series on water-related issues that ZEF has been organizing in cooperation with the United Nations University Institute for Environment and Human Security (UNU/EHS) and the Global Water System Project (GWSP). Six lectures by speakers with an academic, political, and non-governmental background took place last term. They included lectures on **"Food and Bioenergy in a Water Scarce World"** by **Jan Lundqvist** (Linköpping University, Scientific Head of Stockholm Water Week) and on the **"IPCC Water Chapter: Impacts of Climate Change"** by Petra Döll (Institut für Physische Geographie, Johann Wolfgang Goethe-Universität, Frankfurt am Main). With this variety of topics, the lecture series reached out to an expert community as well as to a more general audience and was well received.

International conference in Ouagadougou, Burkina Faso

ZEF organized the lecture series "Asiatische Grenzen? Wahrnehmungen, Identitäten und Interaktionen in den Grenzregionen Asiens" ("Asian Borders? Perceptions, Identities and Interaction in the Border Regions of Asia") in cooperation with the Institut für Orient- und Asienwissenschaften (IOA) of the University of Bonn. Thirteen lectures were held during the winter term 2007/2008. Among others, Stephan Conermann gave a lecture on "Mental Mapping – Das Beispiel, Asien" ("Mental-Mapping — the Asian Example"), and Eckart Ehlers talked about "Iran und Irak: Geopolitische Aspekte eines umstrittenen Grenzverlaufs" ("Iran and Iraq: Geopolitical Aspects of a Disputed Border").

Besides these lecture series, ZEF hosted numerous Public Lectures, such as "The 100 Dollar Laptop: Can high-tech serve the poor?" given by Peter Rave (GTZ) and Carsten Friedland (SAP Research) on 6 December 2007, "Global Environmental Change and Food Security: The Millennium Ecosystem Assessment and implications for food security" given by Monika Zurek (Economic and Social Department (ESAC), FAO, Rome) on 13 December 2007 and "Energy Crisis and Potential of Using Renewable Energy to Improve Rural Life" given by Jyotirmay Mathur (Mechanical Engineering Department, Malaviya National Institute of Technology, India) on 10 June 2008.

For a complete list of all ZEF events and activities see www.zef.de.

9 Budget 2008 / Funding Partners

Indirect Support**)	Project	in Euro	in %
Deutscher Akademischer Austauschdienst (DAAD) / Bundesministerium für wirtschaftliche Zusammenarbeit und Entwicklung (BMZ)		392,210	68.6
Deutscher Akademischer Austauschdienst (DAAD) Regional Referate/ Auswärtiges Amt (AA)		30,350	5.3
SAP (Software Provider) / Gesellschaft für technische Zusammenarbeit (GTZ)		25,000	4.4
Government of Lybia		20,000	3.5
Asian Development Bank		13,300	2.3
Studienstiftung		12,500	2.2
Fulbright Foundation		12,500	2.2
Friedrich-Ebert-Stiftung		12,500	2.2
Higher Education Commission Pakistan / Deutscher Akademischer Austauschdienst (HEC/ DAAD)		12,500	2.2
Nationaler Forschungs- und technologierat, Chile / Deutscher Akademischer Austauschdienst (CONICYT/DAAD)		12,500	2.2
Konrad-Adenauer-Stiftung (KAS)		10,600	1.9
Own funds		9,300	1.6
Nationaler Forschungs- und Technologierat, Mexiko / Deutscher Akademischer Austauschdienst (CONACYT/DAAD)		6,650	1.2
International Maize and Wheat Improvement Center (CIMMYT)-ZEF-Hohenheim		1,475	0.3
Total		571,385	100

External Funds***)	Project	in Euro	in %
Bundesministerium für Bildung und Forschung (BMBF) via		4,925,842	79.2
• Deutsches Zentrum für Luft- und Raumfahrt (DLR), or	Biota East Biota West		
• Forschungszentrum Jülich	Coffee in Ethiopia		
	Glowa Volta		
	Glowa Africa Conference		
	International Advanced Study Courses (IPSWaT)		
	International Project Office (IPO), Global Water System Project (GWSP)		
	IWRM Olifant, South Africa		
	Land Use in SouthEast Brazil		
	Uzbekistan		
	Wisdom, Vietnam		
Bundesministerium für wirtschaftliche Zusammenarbeit und Entwicklung (BMZ) via	Doctoral Program	310,322	5.0
• Deutscher Akademischer Austauschdienst (DAAD)			
• Gesellschaft für Technische Zusammenarbeit (GTZ)	Use of Media & ICT in Development Cooperation		
	Re-Thinking Water Storage		
State of North-Rhine Westfalia (NRW)	Glowa-Volta	252,820	4.1
	Infotool NRW		
	NRW Ghana Gateway		
	Survey on Scientific Development Studies		
Volkswagen Stiftung (VW)	Local Governance und fragile Staatlichkeit	195,723	3.1
	Workshop		
	Forest Resource & Livelihood Management in East Africa		
Europäische Union (EU)	Newater	125,204	2.0
	Striver		
Deutscher Akademischer Austauschdienst (DAAD) / Auswärtiges Amt (AA)	Establishment of an Expert Center at the University of Ghana	95,373	1.5

Deutsche Welthungerhilfe (DWWH)	Social Water Management in Afghanistan	66,157	1.1
Robert Bosch Stiftung	Doctoral Scholarships	60,000	1.0
International Water management Institute (IWMI)	Shallow Groundwater Project	37,905	0.6
United Nations Volunteers (UNV)	IYV Follow-up Paper	34,522	0.5
International Plant Genetic Resources Institute (IPGRI)	Genetic Resources Conservation in Ethiopia	32,247	0.5
Concern Worldwide		29,412	0.5
Kraft Foods Deutschland GmbH	Situation of Children and Adolescents in Ethiopia	27,136	0.4
Deutsche Forschungsgemeinschaft (DFG)	Importance of Biological Sources Stay of Guest Researcher Dr. Adinarayana at ZEF	17,290	0.3
Internationale Weiterbildung und Entwicklung gGmbH (InWEnt)	Africans and NRW Economy	4,200	0.1
Deutscher Bundestag	Importance of ICT	2,350	0.1
Total		6,216,503	100

Core Funds****)		in Euro	in %
Personnel Costs		1,178,743	77.4
Administrative Costs		290,000	19.0
University Bonus System*****)		54,360	3.6
Total		1,523,103	100
Indirect Support & External Funds & Core Funds		**8,310,991**	

***) Funds budgeted for 2008.**

****) Scholarships directly funded by the Donors.**

*****) Third-Party Projects of ZEF, funds budgeted i.a.w. Annual Financing Plans.**

******) University of Bonn, State of North-Rhine Westphalia Funds for ZEF.**

*******) Bonus of up to 5% of Annual External Funds of ZEF paid by the University of Bonn.**

ZEF's International Advisory Board

Mr. Frank Asbeck	Chairman of the Board of Solar World, Germany
Dr. Maritta von Bieberstein Koch-Weser	Founder and President of Earth 3000, former Director General of IUCN – The World Conservation Union; Chief Executive Officer of The Global Exchange for Social Investment (GEXSI - Global Headquarters), United Kingdom
Prof. Dr. Michael Bohnet	Former General Director, Federal Ministry for Economic Cooperation and Development (BMZ). Representative of BMZ for the new EU Member States, Germany
Mr. Gisbert Dreyer	G. Dreyer Planungsgesellschaft m.b.h.; founder of the Dreyer Foundation, Germany
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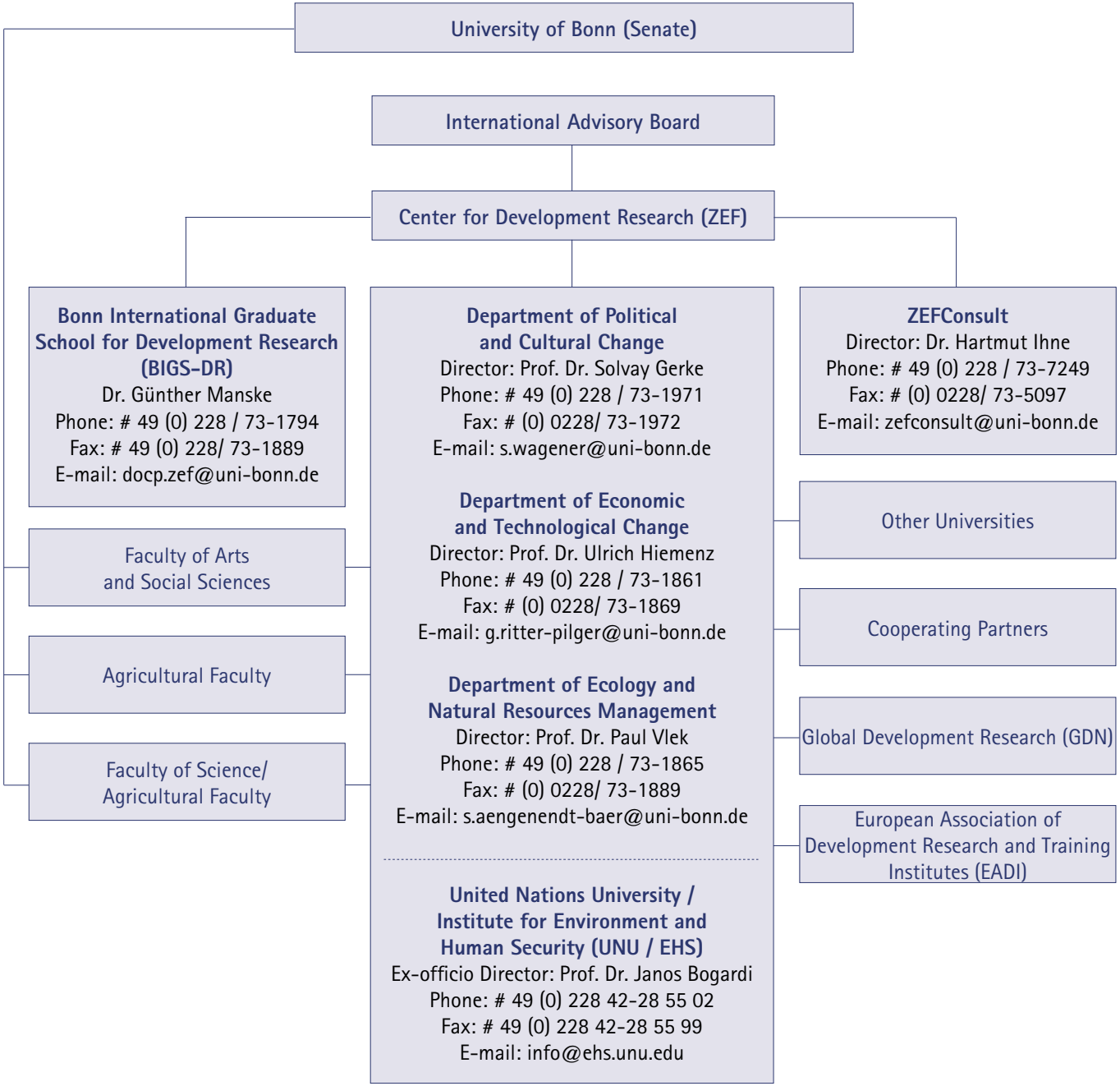
Prof. Dr. Matthias Winiger	Rector of the University of Bonn, Germany

ZEF's Organizational Structure



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