Zentrum für Entwicklungsforschung
Center for Development Research

University of Bonn

A Strategy for the Future of ZEF

The Next Decade 2007 – 2017

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Foreword

Established in 1995 and operational since 1997, the Center for Development Research (ZEF) is an academic institute within the Rheinische Friedrich-Wilhelms University of Bonn dedicated to research, teaching, and policy advice on international development.

The decision to set up ZEF was closely connected to the German Federal Government's effort to reinvent Bonn as an internationally renowned center for development research and policy. In the process of establishing ZEF, the Senate of Bonn University took into consideration the establishment of the UN climate and desertification secretariats and organized the Center's departments to address issues of development and their effect on people's well-being and cultural and natural environment. It approved a broadly-designed research and teaching strategy, giving the Center's directors and International Advisory Board considerable freedom to develop the program in detail.

This paper represents an updated version of the original strategy paper and incorporates lessons learned since 1997. It sets strategic directions and long-term goals for the Center over the next ten years and shows how research, teaching, and advisory activities will be linked to those goals. ZEF's future annual reports will use this framework to monitor progress made.

For ZEF's three departments, this new strategy represents an important convergence of thinking and approach. It was discussed at several senior staff meetings, and substantially revised thereafter. The Advisory Board reviewed the strategy in October 2006. The Board commented upon the progress achieved and declared the current version a "living document" which will continue to be revised as the Center evolves. Thus, the strategy remains open for debate among ZEF's partners, staff, and stakeholders.

Klaus Frohberg

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1. ZEF and the Development Context

As a research institution which became operational in 1997, the Center for Development Research was faced with both an opportunity and a challenge. The opportunity was the chance to create a structure and goals that were immediately relevant to the development context of the late 1990s and beyond. The challenge was to capture and move beyond the best current research and teaching on development, which in many cases meant thinking more holistically about development and cutting across traditional academic disciplines.

ZEF has seized the opportunity and accepted the challenge. From the beginning research activities have focused on the notion of "sustainable development" which emphasizes the importance of promoting growth that does not undermine the long-term productivity of natural resources and the environment. As the development concept evolved, it also broadened into a more comprehensive, integrated, systemic approach. Today it encompasses issues such as the role of governments, the private sector, and civil society; poverty reduction and equity; technology; and political, institutional, and legal frameworks.

The increasing complexity of the development task has been acknowledged by international leaders in recent years. The "Millennium Declaration" (2000) laid out a plan to fight poverty in all its dimensions (income, education, health, environment) with well specified targets until 2015.

In the Monterrey Consensus of the International Conference on Financing for Development (2002), private trade and capital flows were recognized as engines for development in addition to Official Development Assistance (ODA). And, the Johannesburg World Summit on Sustainable Development (2002) adopted concrete steps toward improving people's lives while conserving natural resources in a world that is growing in population, with ever increasing demands for food, water, shelter, sanitation, energy, health services and economic security.

The new international political consensus embraces three important aspects of the development challenge. First, it highlights the betterment of living conditions, especially for the world's poor, as the ultimate objective of international cooperation. Second, it acknowledges that there may be trade-offs between fighting poverty and the conservation of natural resources in the short term, but such trade-offs have to be overcome in the interest of future generations. And third, it is emphasized that policies need to be results-oriented and to achieve pre-determined objectives in a given timeframe.

To live up to the challenge, ZEF has designed its research program around crosscutting themes of central importance for the developing world and of high relevance to the international community that has been attracted to Bonn. Crosscutting projects require the knowledge and input of the three disciplines at the core of ZEF's research:

- Political and Cultural Change;
- Economic Development and Technological Change; and
- Ecology and Natural Resource Management.

The focus on human development, natural resource management and appropriate policymaking provides the context for the strategic orientations of ZEF's research program over the next ten years. Key questions are: How can economic policies be structured so as to foster growth, poverty reduction, and the

sustainable use of natural resources? How can natural resources be allocated so as to accommodate rural, urban, and industrial requirements, while at the same time not jeopardizing resource quality and regeneration? And, how can the implementation of policies be improved so as to ensure the achievement of the desired goals?

For the research community, the multiple aspects of development and the rapidly changing context in which development is occurring pose several difficult challenges, including:

- How to bring together knowledge and combine methodologies and methods from different disciplines.
- How to make reasonable estimates about changes in living and environmental conditions over time and about what trends are to be considered robust.
- How to bring externalities such as the impact of climate change on agriculture, or of upstream water use on downstream users into the framework of development models.
- How to find a proper balance between short-term and longer-term aspects of development processes.
- How to ensure participation of all stakeholders in policy formulation and implementation to create ownership and improve the chances of success.

2. ZEF's Strategic Approach

The goal of ZEF's core research and doctoral programs remains basically unchanged from that of the first strategy paper. It is to produce and disseminate sound development research that will help reduce poverty and enhance sustainable development; to improve development policymaking and support collaborative research with scholars in developing nations; to use doctoral studies to build greater capacity for improved policy analysis and policymaking in developed and developing countries; and to disseminate its research results beyond the research community through policy dialogue and advice, workshops, seminars, and a variety of other strategies.

In light of the new international policy orientations discussed above adjustments have, however, been made with regard to the approach chosen for the research program and its central themes.

The current state and dynamics of the world's natural resources and the fact that we are facing an unprecedented increase of knowledge about social, economic, and ecological systems and their interaction requires science to adapt its approaches. This becomes an even more important imperative when studying social, economic, and ecological change in the so-called developing countries, where, despite globalization, it is crucial to be able to view problems from different cultural and scientific perspectives in a participatory and communicative way.

The increasing number of scientific disciplines and sub-disciplines could lead us to a modern "Science-Tower of Babel" with countless scientific languages only understood within the narrow boundaries of specialist and expert thinking. Therefore, if development research wants to make a difference in terms of contributing to the Millennium Development Goals, it inevitably needs to cross intra- and inter-scientific boundaries. One way of dealing with this challenge is to adopt a trans-disciplinary approach. Trans-disciplinarity in development research takes a perspective that goes beyond specific disciplines and bridges the gaps between science, politics and practice in order to make research more relevant to building a better world in the 21st century.

ZEF's research work so far has highlighted the importance of modeling environmental change and societal response as co-evolutionary processes. However, modeling is not an end in itself and must be of utility to the stakeholder, be it the farmer, the landowner, or the mayor of a village. Therefore, interaction with all relevant stakeholder groups is required during the model development. Models that do not take local knowledge, local ecosystem expertise, and local interests into account are likely to be of little relevance. Interaction with local actors not only leads to better scientific results, but helps to understand in which way the knowledge exchange with different types of stakeholders has to be organized in order to cater to their knowledge needs and capacities. Trans-disciplinary research of long-term ZEF projects aims at creating innovative approaches towards the sustainable use and management of terrestrial resources to better serve human-environment systems.

Trans-disciplinarity encompasses the interdisciplinary approach pursued by ZEF over the last ten years, but also puts emphasis on policy lessons learned and stakeholder dialogue. The trans-disciplinary approach now favored by ZEF consists of the following key elements:

- Bridging between scientific disciplines
- Bridging between research and policy
- Bridging between research and practice

Bridging between scientific disciplines

Recognizing that today there are hundreds of scientific (sub-)disciplines, how can scientists communicate beyond mouthing more or less trivial generalities? Disciplinary language is often an insurmountable barrier for a neophyte, which we all are to some degree in some area of science. Science without bridging between its disciplines results in an ever increasing amount of information and an under-proportional success in understanding the meaning and relevance of the knowledge produced. Whereas multidisciplinary and interdisciplinary research is necessary, but always remains within the framework of disciplinary research, trans-disciplinarity aims at the more holistic understanding of the state of the present world. Confronted with complex problems in developing countries, ZEF applies trans-disciplinarity by communicating research approaches and results among scientists, politicians, and practitioners in order to achieve its goals in development research. Trans-disciplinarity concerns several levels of reality at once. It is not a new discipline, rather the innovative organization of science in a manner that disciplinary research is clarified by trans-disciplinary knowledge to contribute to sustainable development. As sustainable development is primarily a normative concept, trans-disciplinary research ultimately needs to supporting the shift from a sheer understanding of "what is" to the understanding of "what ought to be". This can be done by bridging research and policy.

Bridging research and policy

Using scientific evidence in making decisions and policies will considerably improve social and environmental conditions. In order to do so it is necessary, but not sufficient, to transport research to the policy sphere. It is important to understand the interplay of those factors that determine whether research-based evidence is likely to be adopted by policymakers. These are: 1) the political context, because the production of research is also a political process, 2) the quality of research, especially its relevance and operational usefulness, 3) communication and mediation of research and the way research findings are

"packaged" and delivered to policymakers. The media and campaigning groups play an important role in effecting public awareness and policy change. Intermediary institutions are key to transmitting research results to policy and practice. 4) A large amount of research in developing countries is funded by international donors. Trends in international politics and donor activities substantially influence the type of development research.

Bridging research and practice

Understanding and solving problems at hand often requires an understanding of local knowledge, but also making scientific knowledge understandable for local resource users. In addition, scientific insights need to be implemented to make change toward sustainability happen. ZEF applies trans-disciplinarity by engaging in participatory research, investigating local knowledge systems and communicating research and its results to local resource users. Ideally, local resource managers would be part of the decision-making, and thereby the policy process. However, the socio-political conditions in many developing countries do not always allow for such a degree of participation, so that ZEF researchers, by making local resource users part of the production process of knowledge, become important messengers between policymakers and local resource users. In this sense, ZEF researchers are agents of change.

3. ZEF's Research Program: Global Environmental Change and Human Development

Reflecting the recent international policy consensus, the general theme of the program is "Global Environmental Change and Human Development". Global environmental change is likely to be the most significant of all the factors connecting economic and political development, natural and social sciences, as well as human health. Global environmental change, as the biophysical phenomena reflecting societal and economic choices, does not only refer to the impacts of increases in CO_2 and other greenhouse gasses in the atmosphere, but also to broad-scale changes in land cover and land surface processes that accompany increasing human population, patterns of human settlement and economic activities. The interaction of these factors as well as the different velocities of change in environmental and human development will lead to emergent phenomena that may lie outside historical experience, and as a consequence will pose extraordinary challenges to trans-disciplinary development research. Dealing with global environmental change is rarely a technical issue alone. A thorough understanding of global environmental change phenomena and its drivers will be of little consequence if ways are not found to have local communities and policymakers act to mitigate or adapt their behavior. ZEF's cross-cutting research aims at establishing this link.

In the crosscutting research activities, the various disciplines jointly analyze global environmental change issues and seek entry points to mitigate or cope with these phenomena in the course of pursuing sustainable development. They build on the experiences gathered since 1997 in areas such as land and water management as well as biodiversity, but also reach out to problems related to sustainable energy and health. The work on human security and vulnerability, jointly undertaken with the United

Nations University Institute for the Environment and Human Security (UNU/EHS), will also continue. The extension of ZEF's research program toward these new subjects of "energy“ and "health“ reflects the findings of previous research that an assured supply of energy as well as human health are essential components of an adequate management of natural resources.

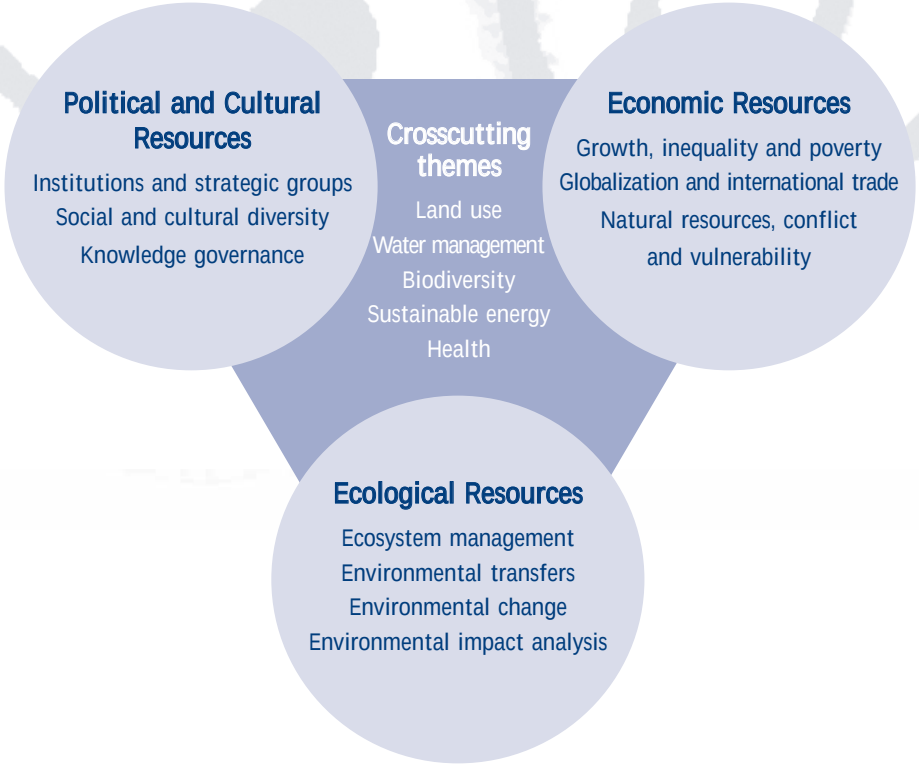
As demand for energy is growing on a worldwide scale and prices are skyrocketing, traditional energy supplies will increasingly need to be supplemented by new sources of energy. This is true particularly in sparsely populated rural areas and for poorer segments of the population in developing countries, if the management of natural resources is to achieve its goal of promoting human development. A similar conclusion holds for human health. With many infectious diseases (tuberculosis, malaria, HIV/AIDS) spreading rapidly across developing countries, resource management for human development cannot ignore the importance of the sustained health of the people it seeks to protect.

These new subjects will, of course, require additional expertise, which ZEF plans to obtain through cooperation and expansion. While research on sustainable energy can be accommodated within the existing organizational structure of ZEF, health-related research may not only require cooperation with medical science but also the establishment of a new department at ZEF.

Crosscutting research requires disciplinary strength. Conversely, disciplinary research will be inspired by the analytical challenges emerging from trans-disciplinary projects. This is graphically depicted in the diagram below.

ZEF's Research Areas

ZEF's research agenda is therefore driven by three sets of normative concerns that equally motivate development policy and research at the international level: environmental degradation and ecological sustainability; institutional analysis and knowledge governance; and growth, welfare, equity and poverty. These concerns and the technical and institutional constraints to sustainable development require a co-evolutionary process of technical and institutional innovation. Strictly technical approaches towards



the promotion of an ecologically sustainable human development tend to fail, particularly when investments follow a 'one-size-fits-all' approach. Thus, the objective of ZEF's research program is to arrive at integrated approaches, in partnership and collaboration with actors in the 'problem sheds' that are the subject of our investigations.

Crosscutting Themes

Land Use and Degradation

Background

The Millennium Ecosystem Assessment (MEA 2005) reports on an increasingly serious degradation of natural resources and the ecosystems that depend on them, threatening ecosystem goods and the services they provide. It is estimated by the United Nations Convention to Combat Desertification (UNCCD) that over 250 million people are directly affected by desertification, and up to one billion may be at risk. Some 40 percent of agricultural land has been degraded in the past half-century by erosion, salinization, compaction, nutrient depletion, pollution, and urbanization. The growth of population, expansion of croplands, and destruction of vegetation, global warming and the emergence of yield-enhancing technologies all seem to have played a role in accelerating this process. Land degradation in a context of continued population growth has also had far-reaching social consequences in some parts of the world, and consequences for food security worldwide.

Understanding land degradation and its drivers is not only a major challenge for science, but also a prerequisite for designing policies and actions to alter the course of events or temper their effects. Proper land management or reclamation is not a task for land managers or soil specialists alone. It also requires a policy environment that supports sustainable changes in land use, e.g. reliable tenure and property rights on land and water. These should provide incentives for farmers to invest in improving the productivity of land and water, thus allowing them to continue living off the land without destroying it. It is at this point that trans-disciplinarity, becomes a "must".

ZEF has gained first-hand experience with these problems in its research projects in South America, Central Asia, and sub-Saharan Africa. Evidence from these projects points out that the drivers of land degradation are both bio-physical and socio-economic in nature. Sound policies for mitigation or adaptation to land degradation are often lacking. Such measures, which should internalize the external costs caused by degradation, need to be adapted locally. In sub-Saharan Africa, combating land degradation means empowering the people by land tenure and knowledge generation for better resource use. In the transition economies of the former Soviet Union, it also entails carefully introducing market-oriented agricultural production schemes.

Research set-up: Proper land management requires sound ecological research...

ZEF's terrestrial ecosystem research program will give attention to land use change processes in two areas where the sustainability of the system is endangered:

- at the ecosystem edge where land conversion is taking place, such as forest margins, wetland margins, and desert margins (e.g. North Ethiopia, Sahel, and the Bragantina zone in NE Brazil where ZEF has worked for many years);
- in locations where intensive land-use practices are leading to land degradation and require new designs for sustainable land use (e.g. the Khorezm region in the Aral Sea Basin, and the highland rainforests of Ethiopia).

In such regions, ZEF will conduct integrated landscape analysis involving all components (soil, air, water, plants, animals and socio-economic conditions of human use) and a valuation of services provided by the natural and agro-ecosystem components. ZEF aims to understand the principles of ecosystem functioning at work in land-use systems—while some ecosystem functions are lost with the conversion of natural systems, some of them are regained with properly designed production systems. Service functions must be identified and flows measured. Understanding the drivers of land-use change and land degradation will help assess the possible implications of interventions.

...and integrating the disciplines: Land degradation in a development context

But the analysis does not stop here: economic, social, and cultural values must be determined because value determines use pattern, preservation, and regeneration potential. Ecosystem value must therefore be put in the context of agricultural productivity and trade (or substitution) options, particularly when societal resources are called upon to improve sustainability or preserve ecosystem function.

Land degradation problems and their cause-and-effect relationships are regional in character, and can be solved only at the level of the landscape. Thus the communities managing the landscape are crucial. Their economic interdependencies will be derived from analyzing the markets (regional, national and global); other interdependencies, such as pollution or loss of biodiversity caused by land degradation, will be studied through field research coupled with the appropriate modeling approaches. Hence, ZEF projects will seek to increase understanding of degradation processes and their social and economic consequences. This will allow us to develop management options that avoid or reverse them.

Most cases of land degradation have their origin in historical trajectories of political and economic drivers and processes. Understanding this path dependency of land-use change is a prerequisite for policy formulation to counteract the process of degradation and to foster resiliency. A major aim is to design institutions that steer this process to societies' advantage. The prevailing cultural, economic, social as well as political conditions will be considered as they provide the boundaries within which natural resource management can take place and technical innovations can be introduced.

Neither purely ecological studies nor pure administrative measures, such as land reform programs aiming at more equitable and secure land ownership, have led to sustainable and efficient land management. It is the judicious integration of these measures and the right mix of approaches that will make the difference.

Complexity and computer models

The emergent nature, as well as space, scale, and time dependency of the interactions between the bio-physical and human dimensions of land degradation call for appropriate tools to mimic, understand, and visualize these often long-term and off-site relationships. Social and natural scientists have gained substantial insights into processes affecting land degradation, and disciplinary models reflecting these insights have been developed, also at ZEF; however, these models "rarely speak to each other". Integrative models are needed, but have proven to be difficult to achieve. Recently, one promising approach was pioneered by ZEF in a research project in Vietnam, based on a Multi-Agent System (MAS) approach. The MAS provides a natural description of the human-environment system that can capture complexities of hierarchy, interdependence, and heterogeneity and is flexible in design as it is easily adjusted to changes. This approach, which is still in a development stage, is an ideal tool for the trans-disciplinary methods that ZEF pursues in its research. Nevertheless, MAS is but one tool in the toolbox of approaches, such as general linear models, that will be applied where deemed appropriate.

Water Management

Background

Access to water which is sufficient in quantity and quality for domestic, agricultural, economic and cultural requirements is a sine qua non for development in any meaningful sense of the word. Apart from its essential role in supporting healthy, productive and dignified domestic living conditions, water is the factor that determines agricultural productivity in many of the world's most densely populated regions, that directly influences the energy sector via hydropower generation and power demand for pumping; and that protects and promotes ecosystem health and biodiversity. Trans-disciplinary research on water in its physical, ecological, socio-economic, political, and legal contexts is thus integral to ZEF's research agenda.

The nexus between the three sets of normative concerns previously identified—environmental degradation/ecological sustainability; democratic governance; growth, equity and poverty—is nowhere more visible than with respect to the development of water resources, and of irrigation in particular. The livelihoods of roughly 70% of the world's poor are closely tied to agriculture, and irrigation development has been demonstrated to clearly increase employment and income and to reduce the price of food. The negative impacts of irrigation development on the physical environment are equally well documented, and it has been estimated that reductions in irrigation water use relative to present levels will be required to maintain the health of ecosystems globally. Efforts to reconcile poverty alleviation and ecological sustainability objectives will require protocols for the management of water resources that take full account of the value of water in supporting ecosystem function, which in turn must acknowledge the complex system of rights and entitlements that underlies the water governance process. Finally, existing technological options represent an additional framework of constraints that will have to be negotiated in the process. The broad objective of ZEF's water management research agenda is to arrive at inte-

grated approaches, in partnership and collaboration with actors in the "problem sheds" that are the subject of our investigations.

Focus on water in the context of integrated environmental—social systems

The role of water in contributing to sustainable livelihoods cannot be evaluated without considering the environmental and social conditions. As the hydrological cycle itself imposes a fundamental set of physical constraints to the management, allocation and governance of water resources, the river basin is being increasingly identified as the appropriate spatial framework within which water resources research is conducted. The current GLOWA Volta Project in West Africa and the Khorezm Project in Central Asia are examples of this approach.

In designing and conducting development research on integrated water resources management, the established engineering approach to multi-objective water resources planning must be expanded to encompass ecosystems dynamics; similarly, classical concepts of efficiency must be enlarged to acknowledge the multifunctionality of water resource systems and the ecosystem services they provide. Evolution of the Integrated Water Resources Management (IWRM) concept can be viewed as recapitulating the chronology of development itself: societies naturally focus first on developing the technologies and the institutional arrangements required to secure domestic water supply and to store and control water to support irrigated agriculture; and subsequently on hydropower and industrial development. Only when basic needs are perceived as threatened, or when ecological crisis ensues, does the scope of water governance protocols begin to acknowledge the claims of non-human communities as well as human needs. The inevitability of this process, however—whether or not developing countries necessarily have to go through the same sequence of steps, or whether environmental water needs can be addressed as part of agricultural and industrial production-oriented resources development—is both a research and policy question within ZEF's purview.

Development and environment—conflict or opportunity?

The task of reconciling societal and environmental requirements for water is central to ZEF's research agenda. The approach is based on the integration of physical simulation models of climate, surface and subsurface hydrology and biophysical processes with socio-economic models providing estimates of the demand for freshwater and simulating the mechanisms of governance. Within this integrated approach, an outstanding task of high priority is the development and application of credible methodologies to value ecosystems services, and to estimate environmental flow requirements in ways that allow "trade-offs" between societal and environmental concerns. The prevailing belief, largely unchallenged and rarely examined, is that the trade-off between agricultural productivity and ecological sustainability is inherent. ZEF is well positioned to contribute to policy-relevant research on agricultural systems that generate positive environmental externalities.

Water, governance, and decentralization

The *No Water No Future* preparatory document for the Johannesburg World Summit on Sustainable Development states that: "The water crisis is a crisis of governance—not one of scarcity." The advent of the governance concept reflects an expanded scope of the understanding of water resources *management*, notably in the field of agricultural water management. This is because, in contrast to manage-

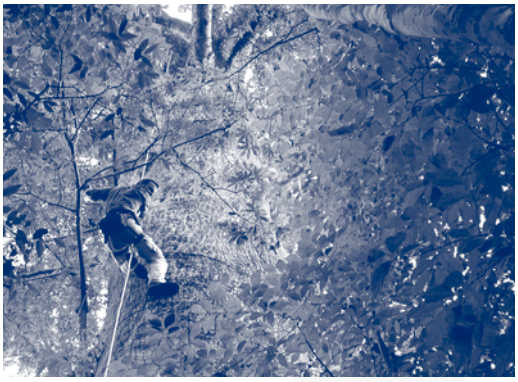
ment, the governance concept raises questions of allocation, rights, interest groups, and decision-making process in combination—how the rules of the management game are made. As a result of the acceptance of the governance concept, a series of policy instruments for enhancing democratic, effective, and efficient development and resources management have been put forward. ZEF engages in these debates through research on actual management and governance practices under different water policy regimes, from a combined socio-political/social justice and performance/impact perspective, and through practical engagement with water policy processes at different levels in its long-term research projects. The main emphasis lies on the comparative analysis of the connections between global, national, and local/everyday water politics and governance across different state and policy regimes.

A new research focus that ZEF seeks to develop in the domain of water governance is the co-evolution of governance arrangements and the physical infrastructure for water use and management. The relationship between governance principles and technological characteristics is intimate, as can be seen in the issue of decentralization. For example, decentralized urban water supply based on water harvesting and conservation employs different technologies than centralized supply systems. Once the technological and/or institutional choices have been made, path dependencies spanning decades have been created. There are thus strong implications for sustainable development options in the strategic choices regarding governance/technology regimes. A preliminary classification of the socio-technical connections that will be investigated in this research deals with infrastructure and its linkage with property rights, management relations, distribution among resource users, participatory design, knowledge generation, and political control.

Water use and poverty

The social-technical nexus also encompasses questions of linkage between issues of water governance and poverty. Current debate within the international water resources community seeks consensus as to who should secure the provision of water and related services, and by what mechanisms (volumetric tariffs, user fees, quotas, payment in kind ...). Arguments range from the desirability of full cost recovery to the need for explicit cross-subsidy based on ability to pay. Framing this debate are technical questions concerning the distribution of benefits from investments within the water sector and political questions concerning the degree to which public investments in water resources should serve efficiency "more crop per drop" as distinct from equity (redistribution) objectives. Some evidence suggests that scarcity itself is sufficient to motivate efficient water use. Local governments and other institutions, such as water user associations, play an important role in creating an institutional environment that encourages farmers to adopt improved technologies. For smallholder irrigators, the capacity to invest in improved irrigation technology and management is limited by knowledge and training as well as financial resources and the structure of incentives. ZEF research will continue to explore the impacts of alternative incentive structures on the willingness of farmers to include water-saving technologies in their production systems.

Biodiversity and its Conservation



Background

Initially, biodiversity is a measure of the abundance and variety of life at different scales. It is defined by the diversity of genes, species, and ecosystems. But apart from quantitative attributes, it also includes functional attributes and humans who attach various values and rules to it in order to protect and use biodiversity for human development or for its own sake. As noted in the United Nations Convention on Biological Diversity (CBD), biodiversity "...is the fruit of billions of years of evolution, shaped by natural processes and, increasingly, by the influence of humans. It forms the web of life of which we are an integral part and upon which we so fully depend." The short time scale of human society has come into collision with the long time scale of biological diversity. In the face of accelerating global losses of biodiversity, the international community has committed itself in the CBD to conserve and sustainably use biodiversity, to grant access to genetic resources, to fair and equitable benefit sharing, and to the transfer of relevant technologies. Today, it is recognized that biodiversity loss can undermine the chances of future generations to adequately respond to environmental changes, diseases, changing consumer trends and other challenges which we currently cannot foresee or predict. Human population growth, policy and institutional failures, and poverty have been frequently identified as causes of biodiversity loss which need to be dealt with to achieve sustainable development.

In the context of "Global Environmental Change and Human Development", biodiversity needs to be seen as a "state" and "resource". The former refers to the entire extent of biodiversity in a given section of nature, and has the potential to provide the basic conditions for and drive the processes that ensure human survival. The latter refers to the use of its functions and components as consumables in ecological and social processes. Using and protecting biodiversity should go hand-in-hand in sustainable development. Economic as well as political and societal developments are required to reduce the dependency and pressure on biodiversity, but often this can only be achieved by the sustainable use of biodiversity, be it through the judicious exploitation of its resources (e.g. logging), the use of its functions (e.g. water and soil retention), or the protection of its state (e.g. wildlife and nature protection). The institutions we establish to organize interactions between social and ecological systems are the human web of life.

Biodiversity goods and services, and their governance

Biodiversity stands for goods and services that make life on earth possible and satisfy the needs of human societies now and in the future. Accordingly, species diversity can supply a multitude of different foods and raw materials, while ecosystem diversity provides habitats, recreation, and ecosystem services. Biodiversity goods and services can be private goods (e.g. fruit, wood), common pool resources, (e.g. fisheries, forests) or functions with public good features (e.g. clean water and air). Markets, hierarchies, cooperatives, strategic alliances and other governance structures have varying capacities to deal with the organization and allocation of biodiversity goods and services. Because of the differences in the physical nature of these goods and services, policy analysts grapple with the governance of biodi-

versity as some of these do not lend themselves to the preferred instrument of market regulation. The task of biodiversity conservation is frequently viewed as one requiring global collective action, which has given birth to facilities such as the Global Environmental Facility (GEF) and various other organizations operating internationally. Such initiatives have not stopped the erosion of biodiversity and the question of interlinking global initiatives and local action remains unresolved.

However, especially on a global scale and in developing countries, we often lack effective institutions to reward the stewards of biodiversity or punish those who cause the loss. Whereas money works well as the payment vehicle in market exchange for private goods, the proper management of common pool resources often requires different kinds of exchange mechanisms and/or different incentives. In many cases strict regulation (e.g. protected areas) is successfully used to achieve biodiversity protection. Payments for environmental services, participation in decision-making, access to infrastructure and development, information (e.g. by certification) or investment security with appropriately designed property rights can be very effective incentives in different socio-political contexts and when markets alone fail. ZEF aims to analyze the limits of market functioning and the need for innovative incentives through the design of institutions at the level of local resource managers, national-level institutions and organizations as well as international alliances and partnerships.

Values of biodiversity

Various groups of actors are equipped with different attributes and abilities to deal with the governance of biodiversity, such as knowledge, education, power, or reputation. They also perceive biodiversity differently and attach different values to it. The economic values of biodiversity focus on direct, indirect and even non-use values, in the sense that present use is "saved" for the benefit of future generations. As such its value is defined by the willingness of people to pay for its immediate use or to refrain from using it. From an ecological viewpoint, however, the values of biodiversity also consider the fact that we do not know in how far biodiversity is a non-negotiable "need", regardless of how much we are willing to give for it in exchange. On the other hand, ecosystems comprise a diverse web of seemingly unnecessary or redundant species that provide it with stability and resilience, which has a value in its own right. Research at ZEF aims to better understand the composition and functioning of ecosystems and to define their negotiable and non-negotiable components.

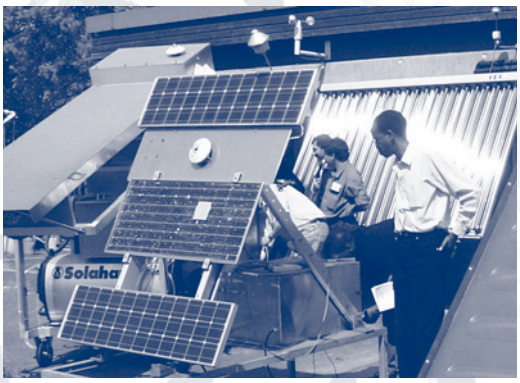
Cultural diversity

Values and attitudes towards nature evolve from human culture and reflect the condition of the socio-political environment, which has an immediate impact on governance and people's behavior towards nature. The cultural diversity in attitudes towards nature is enormous and reflects the differences in norms and values. These values can be viewed as preferences expressed in the marketplace or as norms and principles, or even as feelings about what is the right thing to do. This cultural diversity is a direct result of how diverse environments are conceived, managed and understood. Loss in biodiversity and cultural homogenization as a consequence of globalization as well as rapid development have often resulted in a reduction or even loss of local knowledge, the marginalization of ethnic groups, and the gradual disappearance of languages and dialects. This leads to a diminishing scope in the range of approaches towards the coexistence between humans and nature and limits the possibility of imaginative new solutions. One of ZEF's foci closely linked with cultural diversity is the role of biodiversity *sensu lato* in human-transformed landscapes.

From knowledge to action

ZEF recognizes that driving forces and measures for the conservation and use of biodiversity vary within and between cultures and depend on a multitude of factors, such as resource availability, social norms and cohesion, skills for exploitation, education, availability of information or market access. The combination of the different features and functions of biodiversity with the attributes of the users of biodiversity and their abilities to respond to environmental change by adaptive social organization yields a complex research domain. Exploring and understanding this complexity requires trans-disciplinary approaches. ZEF, therefore, works on biodiversity conservation and management concepts that equally consider ecological, economic, and cultural factors. Simultaneously, ZEF is searching for innovative approaches to implement its research findings in practice. A passable way might be the establishment of researcher-driven NGOs on the ground, which bridge the gap between the scientific community and local stakeholders, integrate newly generated knowledge into existing biodiversity conservation and management concepts and, all in all, make research sustainable.

Sustainable Energy



Background

Research on sustainable energy (that is renewable energy (RE) plus energy efficiency (EE)) will be a new item on ZEF's trans-disciplinary agenda. This extension is largely in recognition of lessons learned in the crosscutting projects, which have shown that the need for energy is often met at the expense of conserving land, water, as well as biodiversity. A sound sustainable energy policy is thus a key element of any strategy for sustainable development. Without it, the environmental damage caused by energy consumption will affect the productivity of agriculture and industry, human health, and education. Similar arguments have made sustainable energy one of the thematic pillars of the international development agenda for achieving poverty reduction and sustainable development goals. The 1st World Conference on Renewables (Bonn 2004) resulted in the adoption of an international "Programme of Action". The goal by 2015: one billion more people are to have access to clean energy from renewable sources. Currently, 1.6 billion people lack access to modern energy services and 2.3 billion people rely on biomass for their basic energy needs (UNEP). Conservative forecasts see the demand for energy in developing countries doubling over the next 20 years. If this demand is primarily satisfied by fossil fuels, the result will be grave environmental damage.

The energy problem: challenges and responses

The main challenge from the perspective of poverty reduction is energy provision to the poor. An enormous number of decentralized energy supply systems must be installed and operated to improve the living conditions of people in rural areas. The most sensible solution to decentralized supply would be to rely on locally produced renewable resources that are efficiently transformed using modern technologies and know-how. For this purpose, close cooperation between the public and private sectors is necessary.

Efficient use of energy is an effective strategy for avoiding current and expected shortfalls in energy supply. Additional benefits and opportunities are cost reductions for the consumer, reduction of harmful emissions, and conservation of domestic or imported energy resources for the national economy. Financial resources previously used to import energy can be invested in more labor-intensive, energy-efficient technologies, thereby creating additional jobs. Moreover, efficient use of energy is the most economical and effective way of reducing the global effects caused by CO_2 emissions.

As a first step towards a future with sustainable energy supplies, environment-friendly technologies need to be integrated into energy policies. International cooperation will be needed to find instruments to finance sustainable energy as well as to develop financing mechanisms to reach the grass roots and to engage the poor as active partners in changing to sustainable energy. Ways need to be found to improve knowledge exchange, learning and analytics, e.g. the exchange and transfer of know-how on clean energy technology, promoting rural energy services, providing consultancy services for the local communities and the private sector.

Few studies so far have attempted to assess the impact of energy reforms on the poor or provide the requisite empirical evidence that sustainable energy policies can benefit them.

ZEF's sustainable energy research approach

Supporting sustainable energy involves the coordinated deployment of several interventions including: channeling services and capital resources for investment in small and medium energy enterprises; supporting research and knowledge about the environmental and sustainability benefits as well as trade-offs of investments in renewable energy markets and industries; building capacity in the design and deployment of renewables-friendly policies. ZEF's trans-disciplinary research agenda cannot span the full range of sectors, applications, and technologies of RE and EE. ZEF will concentrate on selected sectors and regions which fit into the portfolio of its research experience and research capacity: (1) study policy and regulatory measures that encourage the production of renewables through private sector investment and lending, (2) analyze the options, and the constraints and the technologies to produce sustainable energy, and (3) develop alternative energy strategies and integrate environmental externalities into the energy sector analysis. As always, the ZEF focus will be on developing countries.

ZEF has considerable potential for formulating renewable energy policies and regulatory frameworks derived from its experience in resource and technology assessment. This includes market analysis, market forecasts, statistical analysis, and environmental assessment strategies for energy technologies. ZEF will develop solid research experience in developing rural energy systems. These could include electricity for homes, schools, and health centers, as well as mechanical power for water pumping and agro-processing applications. A crosscutting project will be developed to study the technological, economic, and institutional constraints and requirements for the successful introduction of renewables in rural settings. Eventually, ZEF staff should be able to provide expert advice on implementing energy projects to, amongst others, government ministries, development agencies, and commercial clients.

Health

Background

Health concerns take a prominent position among the Millennium Development Goals (MDGs). With many infectious diseases (tuberculosis, malaria, HIV/Aids) spreading rapidly across developing countries, resource management cannot ignore the importance of the sustained health of the people it seeks to protect. Therefore, trans-disciplinary research on human health should be an integral component of ZEF's research program on Global Environmental Change and Human Development. Prerequisites for launching this program will be the necessary expertise, in particular with respect to medical science, financial support, and the appropriate organizational structures. The general research agenda can be divided into two major areas: first, the link between infectious diseases and changes in environmental conditions, and second, the political economy of access to health care and medical treatment in the light of the acute spread of tuberculosis and HIV/AIDS.

Changes in environmental conditions, specifically ambient temperature and moisture regimes, can alter the suitability of habitats for bacteria, viruses and their vectors, including insects and rodents. Higher temperatures are particularly favorable for carriers of many tropical diseases, including malaria and dengue fever. In addition, changing hydrologic conditions can exacerbate diarrheal diseases when torrential rains lead to contaminated water supplies, or when drought conditions result in insufficient water supply for preparing food and bathing. Climate changes also affect the risk associated with rain-fed agriculture. Responding to that, farmers turn more and more to irrigation to reduce the risk of crop failure. However, irrigation reservoirs, flooded fields (paddies), channels, drains, and seepage ponds all harbor potential intermediate hosts for malaria and bilharzia.

A further link between change in the hydrologic cycle and adverse health effects relates to the contamination of surface- and groundwater by agrochemicals. The use of irrigation water and shallow groundwater in irrigation systems and for domestic purposes is being increasingly well documented. This shows that health risks from surface and groundwater contamination by pathogens and agrochemicals are highest for the rural poor, who are closest to points of application and who have low access to treated water. Women in particular are subject to elevated risks due to multiple modes of exposure (drinking, cooking, washing, bathing), and children are more physically vulnerable, both to pathogens and to developmental damage from biocides.

Changing environmental conditions are hardest on poor people with few options to adjust their livelihoods, while vulnerable households may not be able to cope with these changes at all. It is obvious that richer people face fewer difficulties in securing a minimum level of health care. Poor people tend to be excluded from health care either because facilities are not available or because treatment cannot be afforded. Reducing poverty is thus an important response in order to reduce vulnerability to illness. These differences are likely to be more pronounced between rural and urban areas, as well as for women and girls, and different ethnic groups. So far, it is unclear to what extent societies are able to cope with an increased demand for health care due to environmental depletion.

The risks to health induced by a decrease of environmental 'quality' impose further difficulties for the

development prospects of poor countries. The lack of access to health care, already not equal across different income groups, implies economic costs for the country. To what extent is still unknown. Furthermore, while a poor health condition of the population can be expected to put a brake on economic development, there are recursive effects. Empirical evidence suggests a connection between the general health conditions of the population and economic growth rates. The question which determines what and to what extent is still puzzling and unresolved.

ZEF's approach to trans-disciplinary health research

While health and development are closely related, important research questions to be addressed are: What are the social costs of increasing vulnerability to diseases? How do individuals, households, and communities manage health risks? What kinds of coping strategies exist? Also, how important is the nature of the disease itself, (its duration, severity, and repetition), who is affected (child, adult) and what impact does the affected person's role have within the household (dependant, productive, reproductive)? Sickness influences individuals and households in many different ways. People are less able to work productively; they may have to pay for medical care and sell assets to cope with illness. This reduces their future ability to deal with crises and can seriously affect whole households and wider communities. In cases of highly infectious diseases, quarantine measures may stop all economic activity with huge economic implications.

In focusing on the connection between anthropogenic impacts on the natural environment and how they affect human health, ZEF aims to identify particularly vulnerable segments of the population and to formulate policies that ameliorate their situation. While doing so, ZEF explicitly acknowledges the significance of socio-economic factors and cultural values within local contexts, as the causes of disease often lie, at least partially, in the social, economic, cultural, and spiritual context of the patients. ZEF will therefore take such social factors regarding health and diseases into consideration. Issues to be addressed further include risk assessments, existing coping strategies, and risk management to reduce the poverty-illness linkage and improve resilience.

In its research program on development issues related to health, ZEF will investigate the necessity and capacity of the public sector to address the higher demand for health care. The design of health programs as well as public spending will face tremendous challenges in the future as the anticipated costs of the infectious diseases to the economy, and their impact on human welfare and development are enormous. These questions also relate to issues of the efficiency of allocating governmental resources. ZEF will analyze whether public expenditure on health care is targeted efficiently and reaches those who need it most. The question is which factors drive public programs and investments in health care and how to design efficient public programs that reduce the danger of supply bottlenecks, e.g. when granting mosquito nets only to mothers with a new born baby in order to reduce the impact of malaria as opposed to freely distributing mosquito nets. A major contribution of the research conducted at ZEF will aim at designing policies and strategies to develop efficient public health care schemes that improve access to health care.

Given its institutional environment, ZEF is well prepared to embed a Health and Development research unit in its overall research framework. As the unifying theme is public health, ZEF combines methods and concepts from all branches of natural and social sciences that mutually add to existing approaches. A crucial precondition, however, is that the existing institutional structure is enriched with

expertise from the medical sciences in order to conduct up-to-date research. This expertise includes not only pure medical knowledge, but also new methods and approaches pursued in the context of public health.

Disciplinary Research Programs

Research on Political and Cultural Change (ZEFa)

Background

The department's research in the field of political and cultural change is concentrating on the analysis of cultural, political, and social aspects of Global Environmental Change and Human Development. The disciplinary research is focusing on the governance of social resources and resource transfer. The production, access and control of social resources (or of social capital) play a crucial role in every society. By social resources, we understand knowledge, institutions (rules, norms), and networks of a society. The production, access and control of social resources—in combination with economic and natural resources—are the driving forces for inclusion and exclusion processes—the guiding principle of every society. They shape the emergence of identities, power structures, or disparities and vice versa. However, social resources shape not only the communal life, but also the bio-physical environment that enables people to survive. Thus, our research embraces topics such as 'social security', 'livelihood strategies', and 'social resilience'.

Additionally, research in the department is focused on the transfer of social resources, which includes a vertical as well as a horizontal dimension. Horizontal transfer of social resources involves all kinds of population movements. Besides migration, forced by natural disasters or wars, there are networks of labor migration, networks enabling the flow of goods (trade) or of ideas (knowledge). In this context, ZEF's research addresses cross-boundary networks and migration which takes place in ecologically and politically vulnerable border regions. The vertical transfer of social resources deals with social stratification and opportunities for social mobility, e.g. in which context what kind of social resources enable people to improve their livelihoods.

Following this understanding of social resources, ZEFa concentrates on three core research areas:

- Institutions and Strategic Groups;
- Social and Cultural Diversity;
- Knowledge Governance.

Institutions and strategic groups

Apart from patterns of power, authority, and collaboration, which are fundamental to governance, a special focus is on the generation, proliferation, evolution, and decay of institutions. Institutions include

the dynamics of laws, rules, regulations, norms and values, as well as organizations in which they are implemented. The making, implementation, supervision and enforcing of rules and norms are social processes constituting societies and organizations. Institutions have the potential to reduce or increase the transaction costs of social interaction and define the distributional outcomes of social interaction and resource exploitation.

Institutional regimes are often diversified, especially in developing nation-states, which are often characterized by a great degree of social, political and cultural diversity as well as a limited degree of state hegemony. Here the lack of power, resources and at times political will leads to a situation in which state laws and regulations are paralleled by (neo-) traditional, religious or customary rules, norms and values, remnants of colonial laws and project regulations, which people may equally refer to. On the one hand, this legal pluralism may lead to competition between institutional representatives and create behavioral uncertainty, which has the potential to increase conflicts. On the other hand, it creates flexibility and grants local actors more room for maneuver. Given the institutional complexity in the developing world, it becomes clear that careful institutional mapping and institutional analysis is crucial to understanding patterns of societal control regarding resource use and resource transfers.

Institutions as the core of governance, defining socially accepted behavior as well as access to resources, are frequently debated and contested. Social actors that create, change or ignore institutions directly affect power structures and the distribution of benefits. The key is to identify and analyze the way in which different actors are involved in these processes. Institutional and strategic group analysis, therefore, unravels the ways in which various actors invest their respective bargaining power to shape or ignore institutions in ways that suit their interests.

The focus on institutions as a boundary concept will foster meaningful trans-disciplinary research cooperation. Actor-oriented approaches that focus on the interests of strategic groups and the underlying power structures would enable ZEF to understand the distributional outcomes and social impact of respective institutional arrangements. This would generate narratives for realistic resource management scenarios and would allow cross-checking the likely social and political impacts of different policy options. Qualitative research is combined with quantitative methods that enable the social scientists at ZEF to deliver parameters for a formalized analysis of resource management options that can be combined with the economic and physical modeling approaches developed by colleagues in other departments, as quantified socio-science results provide crucial inputs for the calibration of rule-based multiple agent and economic optimization models.

Social and cultural diversity

In governing social resources, one is directly confronted with the complexity of diverse social and cultural patterns. Any attempts to regulate or even control communal or societal entities have to cope with diverging social and cultural norms, values, and identities. Over the last two centuries, efforts to establish governance structures while maintaining a balance between diversity and homogenization have been based on two meta-narratives: the establishment and spread of the nation state and globalization.

Many nation states endeavor to diminish the cultural and social diversity on their own territory by political and economic integration and homogenization. The definition of 'national' cultural and social categories has become an effective means to simplify governance and to exercise power. Additionally, by imposing certain cultural and social norms, governments have not only created effective instruments

for resource allocation, but have established certain cultural icons or even fetishes for the nation-building process. However, the forced imposition of cultural norms and values has caused some of the most protracted and violent wars during the last hundred years from the Second World War up to recent wars in the Balkans, Caucasus, or Darfur.

The current move towards globalization seems to be a governance strategy which also leads to the homogenization of cultural and social norms and values. While globalization—in competition with the nation-state—opens a new avenue for cultural and social diversity on the one hand, cultural and social patterns, which hamper the integration of global markets are homogenized on the other hand. Thus the global development of the metropolitan city and its uniform cultural and social codes has led to a retreat of diversity that stands in the way of global markets, worldwide conglomerates and the need for effective governance. Furthermore, industrialization and the extension of global markets may have led to a loss of diversity with regard to locally available livelihood strategies.

Cultural and social homogenization attempts may ease governmental control but could lead to the suppression of various parts of the population that do not meet national or global standards. However, the great potential of cultural and social diversity is rarely taken into consideration. Sustainable livelihood and resilience strategies in particular often depend on cultural and socio-economic structures, which are threatened by globalization. The imposition of national or global standards and policies often leads to a loss of highly adapted socio-economic strategies and therefore increases the vulnerability of the respective population.

ZEFa research focuses on the impacts which development policies and globalization have on cultural and social diversity and the livelihood strategies, social resilience, and vulnerability of local populations. It also aims to assess the importance of diversity, and to develop ideas on how governance of diversity can work and under which conditions it is possible to maintain cultural and social diversity in today's world.

Knowledge governance

Knowledge is a major factor of development. Many governments have embarked on a development strategy oriented towards creating a knowledge-based economy and a knowledge society. Although more and more attention is being given to this topic the contours of a knowledge-based strategy for development are still hazy. In particular, we still need to investigate which policies are most suitable for developing regions with divergent endowment of natural and human resources. The creation of a knowledge system requires not only a backbone of ICT (information and communication technology) but also an appropriate institutional framework and a vibrant epistemic culture of knowledge creation.

The increased value of knowledge for development may also induce the appropriation, monopolization, and control of knowledge production through strategic groups. Knowledge is increasingly becoming a strategic resource for development, but also for the accumulation of private wealth. Development knowledge is becoming a valuable source of power, which raises the necessity to examine its impact on social mobility and social stratification. A polycentric competitive system of knowledge creation, utilization, and dissemination requires coordination between public administration, private companies, and civil society organizations.

The field of knowledge governance increasingly requires the attention of ZEF researchers. Knowledge on natural and human resources is created through research, including ZEF's own trans-disciplinary

projects. The transfer of this knowledge has to be embedded in the social structural, cultural, and institutional environment in order to achieve effective dissemination and the adoption of research results ("Bridging research and practice"). The typical adopters are government agencies, private firms, civil society organizations, and the population at large. Channels of knowledge dissemination have to be researched, demand for specific pieces of information has to be ascertained and the local adaptation of global expert knowledge has to be studied. Decision support systems aiming to use knowledge for development, including poverty reduction, health care and improved livelihood strategies will have to take local knowledge into account.

Research on Economic Development and Technological Change (ZEFb)

Background

Development from an economic perspective is mainly about setting the right incentives to overcome poverty and improve natural resource management. Technological change is often the driving force behind improved efficiency, a more sustainable development, and the reduction of poverty. Sustainable development, poverty reduction and development-enhancing technology utilization require appropriate institutional frameworks. The international trade agenda and emerging global and regional integration set part of this institutional framework. Against this background, the disciplinary research of ZEFb addresses the following issues:

- Growth, Inequality and Poverty;
- Globalization and International Trade; and
- Natural Resources, Conflict, and Vulnerability.

All three research topics are interlinked with the crosscutting themes. They derive from the notion that sustainable development and poverty reduction face two major types of constraint. The first one relates to the natural environment and available technologies, and the second type of constraint is of an economic and political nature, including formal institutions such as policies and legal frameworks at the international, regional, national, and local levels, but also informal ones. Moreover, an overall framework for the research agenda has to build on a comprehensive methodological base of competence covering economic theory, modeling, empirical testing of relationships, policy evaluation, and forecasting.

Growth, inequality and poverty

ZEFb's research program in this area is dedicated to the investigation of reasons for and ways out of persistent poverty. The major goal is to identify the factors that hinder poor people from escaping poverty, and to find sets of policies that effectively help to overcome long-term poverty. The issues comprising the program can be broadly distinguished according to the investigation of the relationship between growth, inequality, and poverty on the one hand and the political economy of poverty reduction on the

other. The major question which arises is: Why do some countries and/or regions within countries achieve economic growth and simultaneously alleviate poverty, while others are less successful in reducing poverty rates despite positive economic growth rates?

A number of theories consider the distribution of physical capital and the functioning of credit markets as important determinants for a country's degree of inequality. This view, however, is too narrow and needs to be broadened with respect to access to resources, understood to encompass material items, such as land, as well as human capital, such as knowledge and health. This access provides opportunities to participate more successfully in economic activities and to achieve higher levels of personal welfare. Despite the positive effects that can be ascribed to improved access to resources, it is yet not clear how large the net gains are and under what circumstances they are to be expected, if at all.

The disciplinary research will also focus on specific technologies and their potential for development in the context of the broader development of science and knowledge systems (see also ZEFa). The larger issues in this research program are to identify ways to overcome the technological divides between rich and poor countries, the scope for technologies that may facilitate "leapfrogging," and the role and optimal shape of science and knowledge systems for development in countries at different levels of income. The capacity of developing countries to borrow from advanced economic systems in order to build their own systems is critical for long-term innovation. The role of institutions favoring or hampering innovations will also be a topic of this program area.

Regarding the distribution of income, interaction between fertility and inequality has so far been neglected in applied research. High fertility is still a big problem in many poor countries where growing populations exert pressure on the availability of resources and induce severe environmental depletion. An example is Ethiopia, with 2.3% annual population growth. Decreased mortality has caused fertility rates to decline in almost all parts of the world, but at different rates. While in Asian countries, such as South Korea, the demographic transition has taken place at sometimes unprecedented speed, in Africa it is extremely slow. Fertility and available labor as well as the need to feed a large number of children are associated with options to generate income. In its inequality research component, ZEF looks at the different patterns of population growth and the distribution of income earning activities and relates it to the evolution of income distribution over time and in a cross-country comparison.

Globalization and international trade

Changes occurring throughout the world—such as regional integration, the development and opening of new markets, shifts towards more liberal trade regimes, or the increasing concern about food safety—are all having a major impact on economic development. In this large research area ZEFb focuses on two specific issues: first, the impact of globalization and international trade on the development of, in particular, low-income countries endowed with rich resources; and second, environmental and social standards as parts of global governance.

Too little is known about the impacts of increasing global market integration (globalization), global trade liberalization, as well as regionalism on human welfare, especially in poor, but resource-rich countries. The opening of new markets, the reduction of subsidies and lowering of trade barriers in the context of the World Trade Organization (WTO) as well as the increase in regional trade arrangements provides opportunities for increased export earnings through the exploitation of natural resources, but is expected to have different distributional effects in and among low-income countries. In addition, an

expansion of trade in natural resources can create new problems such as environmental damage and loss of biodiversity. ZEF's research will concentrate on examining these consequences of trade liberalization and regional trade agreements.

However, the impact of trade on the depletion of natural resources depends not only on trade policies but also on the domestic governance of these resources. Questions related to the political economy of natural resource management are for example: how to set economic incentives to achieve an efficient management of natural resources and to reduce its depletion? Who should govern natural resources: the state, communities, or the individuals? How do these institutional aspects differ with respect to different kinds of resources like land, water, nutrients, forest, climate, or biodiversity? ZEF's institutional research on these questions, as currently pursued in the Ethiopian coffee project, will be expanded to include trade aspects.

For many developing countries, the export of agricultural products is of immense importance. These products offer opportunities to many small- and medium-scale farmers, who often produce more than half the exports. However, there is the concern that decreasing trade barriers for food imports and exports as pursued by WTO will be replaced by new forms of non-tariff trade barriers, i.e. stringent product standards like quality and traceability of food as well as environmental or social standards in the production process. These are viewed by a great number of developing countries as substantial constraints on their ability to export agricultural and food products to the EU or other industrialized countries. In contrast to these concerns about the negative trade effects, there is also increasing concern about the safety of food products in the context of global trade. Numerous recent food safety incidents have worried consumers and affected producers in European countries. ZEF's research concentrates on both of these contradictory effects in order to assess the impact of standards and related mechanisms and to design trade policies that take into account both consumer and producer interests.

Vulnerability

The risks and impacts of conflicts and natural disasters are increasingly to be found on the development agenda. One of the most important elements in interdisciplinary research concerning these risks is the aspect of vulnerability. This field of research opens an array of questions that are directly related to the discipline of economics. Conflicts or a natural disaster like a tsunami can negatively affect vulnerable individuals, households, or communities. Many studies have shown that the poor population groups are the ones which are the most vulnerable. While in the past, scientists focused more on the hazard itself, research attention is shifting towards the analysis of the livelihood of affected households and ways and means to reduce their vulnerability to such hazards. This paradigm shift is based on the recognition that a natural hazard is not a disaster in itself, but rather turns into one if vulnerable people are around who have been affected by the hazard with severe consequences.

Diversification is seen as a strategy to reduce risks. For instance, diversification in agriculture and exports helps provide insurance against debt crises and natural disasters or unfavorable weather by spreading export earnings over a broader array of commodities. Countries diversify their exports to decrease their reliance on individual export commodities. This is especially important for some developing countries since lagging demand, increased competition or lower prices result in a decline of their traditional exports including coffee, cacao beans, or cotton. Diversification of exports can also mean that a country will move from one sector, such as agriculture, into another one, such as services. It can

help to overcome high variability of capital earnings. The more markets the industry establishes for a wide variety of products, the more protected it will be from a downturn in any particular area or for any particular product. Accordingly, high levels of economic diversification decrease vulnerability. Diversity can also provide long-term stability, as periodic weaknesses in some industries are balanced by strengths in others. Next to horizontal diversification into new niche markets, countries also try to promote vertical integration, which includes the processing of traditional exports. The research challenge is to analyze the relationship between progress with regard to diversification and reductions of vulnerability in different socio-economic contexts.

Research on Ecology and Natural Resources Management (ZEFc)

Background

Natural resources form the basis for human livelihoods and development. The depletion of natural resources, loss of biodiversity, landscape changes and shifts in material and energy flows are putting critical stress on the global environment. Understanding these changes is not only a major challenge for science, but also a prerequisite for designing policies and actions to alter the course of events or temper their effects. In many areas of environmental change, we have still not found solutions or adequate strategic responses, while in others there is a lack of public awareness and political will for corrective measures.

The visible components of ecosystems, land, water, as well as the diversity of plants, animals, and microbes, are linked by invisible relations and interactions. It is the whole of these components and their interactions that make ecosystems work. The ZEFc research program will focus on these resource components and their interrelationships in regions where development-driven change collides with the need to preserve natural ecosystems and their functions.

Ecosystem management

Deforestation, pollution, loss of natural habitats, loss of biodiversity, global warming, desertification, irrigation-induced soil salinity, and waterlogging have social and economic ramifications that are difficult to predict. By disturbing the (agro-)ecological balance, these problems lead to deterioration in human health and welfare. In seeking to enhance the management and development of the natural resource base, special attention must be given to improving the productivity and sustainability of agriculture, forestry, or fisheries given their weight in the economies of developing countries. However, it is imperative that ecosystem functions are not sacrificed in the pursuit of extracting utility from the natural resource base. ZEFc will seek to elucidate the state of the natural resource base as it is used for economic purposes and identify ways and means to use resources conservatively. Examples include buffer-zone management as a means to preserve critical habitats; complex cropping systems with eco-functional attributes as well as agro-biodiversity including conservation of the germplasm of crops and their wild relatives. ZEF will also be active in applying the principles of ecosystem functioning to agro-

ecosystem management. As some ecosystem functions are lost with the conversion of natural systems, other functions can be regained in production systems. ZEFc will focus on the following processes that may directly or indirectly affect ecosystem functioning and provisioning:

- Environmental transfers
- Environmental change
- Environmental impact

Environmental transfers

One important step in understanding the two types of vulnerable systems on which ZEFc places the focus of its research—the ecosystem margins and the intensively used ones—is to understand how they interact with their surroundings. The study of environmental flows—water, nutrients, air-borne transport of dusts, greenhouse gases, and diseases, but also the movement of organisms—is therefore imperative to the study of these systems. In times of globalization, environmental flows also gain more and more of a global dimension.

Water: Freshwater plays a central role as a nutrient, ecological medium and economic resource. Today, around 2 billion people lack access to clean water. Freshwater is the most important factor limiting food production. Land-cover changes affect infiltration, water storage capacity, and water purification. Excessive demands on freshwater for irrigation, industrial purposes, and human consumption lead to problems of allocation, distribution and conservation of water resources. Studies on water (re-) distribution, use efficiency, quality and re-use, as well as on the conservation of water resources are thus issues that will be watershed-based as both allocation and conservation have strong downstream effects.

ZEFc will tackle the issue at several entry points by assessing processes of water flow at a watershed level as affected by land cover, analyzing the ecological functions of water vis-à-vis its productive role, and monitoring the effect of water utilization on its quality and potential downstream re-use. Whereas such studies of "blue water" are controlled by physical processes such as evaporation (Millennium Ecosystem Assessment 2005), ZEFc also looks at "green water" as a way of analyzing "hidden" water transfers. "Green water" is influenced by biological processes such as transpiration by vegetation.

Nutrients: Human-induced changes to the flow of nutrients in terrestrial ecosystems significantly affect the sustainability of food production, the state of the natural resource base, and the health of the environment. Particularly, agricultural expansion and intensification to meet the needs of the expanding population have amplified human impacts on nutrient cycles and balances.

Negative nutrient balances due to inadequate external inputs, and the inequitable distribution of nutrients between and within countries, are exacerbated by the transport of nutrients in harvested products. The major nutrient movements between nutrient deficit and surplus countries have been caused by agricultural trade patterns often induced by subsidies. An estimated 230 million tons of plant nutrients are removed yearly from agricultural soils, whereas global fertilizer consumption of nitrogen, phosphorus, and potassium is only 130 million tons. Some of the key nutrients (e.g. phosphorus) are scarcer than oil and ways need to be sought to recycle more of what is used.

Environmental processes and impacts on waterways of nutrient outflows from agricultural lands are an increasing concern (erosion, sediment deposition in lowlands). Global net outflows of dissolved inorganic nitrogen to the oceans have been estimated at roughly 18,000 million tons. These flows of nutri-

ents are in turn affected by human diversions of surface water, such as dams that collect silt and reduce flows to natural wetlands. Other environmentally important human-induced perturbations of nutrient cycles include impacts on fluxes of nitrogen oxides that contribute to the greenhouse effect and ozone depletion and the accumulation in groundwater of nitrates and other nutrients that affect human health. ZEFc will continue to elucidate these bio-physical processes, and work on options for better management of local and global nutrient flows, particularly with regard to the relationship between nutrient surplus developed countries and nutrient deficient developing countries.

Organisms: Besides water and nutrient flows, there is also a huge "flow" of organisms. Globalization, tourism and international trade speeds up the movement of people and commodities, often accompanied by stowaways. These microbes, animals, and plants take on new modes of dispersion. Invasive species have long become a burden on many ecosystems, threatening native biodiversity, affecting ecosystem functioning and causing damage and control costs. On the other hand, new human-made barriers and borders impede the free movements of species that naturally travel, either over short or long distances. Short-term movement is impeded by ecosystem fragmentation, hampering the free flow of genes of even close-by pieces of the same environment. Consequently, ZEFc will address ecosystem and habitat invasion as well as fragmentation and its effects on biodiversity and ecosystem function.

Environmental change

Climate: Human-induced changes in natural systems or land use have a direct impact on the atmosphere. Processes such as emissions of methane and nitrous oxide from soils, or carbon dioxide emissions from biomass burning, remain poorly understood. Their consequences—including global warming, stratospheric ozone depletion, and acid rain—are serious environmental threats at both regional and global levels. In particular, the burning of fossil fuels as well as land conversion and the combustion of biomass boost worldwide emissions of carbon dioxide, which contributes to global warming.

In spite of some criticism in recent years, global environmental change has now been scientifically established as a fact. Productive land may be lost to the desert or to the sea as a result of climate change. Assessing the impact of climate change on the loss of land, agricultural output, and food security is a matter of concern to ZEF. The quantification of the effect of various development pathways on greenhouse gas emissions is undertaken by ZEFc in collaboration with various partners. Similarly, the potential consequences of climate change in terms of biological productivity and loss of ecosystems and their services will be a subject of study. Acceptable measures and policies to prevent such losses or adapt to them will have to be designed.

Land and Soil: Land is a complex of terrain, soil, vegetation, and climate. Soils are not just a nutrient-containing substrate for plant growth, but the living interface between the parent material, the atmosphere, and vegetation cover—an interface at which important ecological processes take place. They have formed over hundreds or thousands of years, and once lost they cannot regenerate within an acceptable period of time. In many parts of the world, land-use change and increasing population pressure have led to various levels of soil degradation, ranging from a decline in nutrient content due to over-utilization and irreversible destruction by erosion or salinization. It is estimated that 5 to 10 million hectares of soils are being lost annually through severe degradation. Moreover, incipient degradation through "nutrient mining" is affecting crop yields over large areas. Almost 2 billion hectares of land show signs of degradation. Soil degradation in turn causes migration and urbanization.

ZEFc's research will cover the global issues of soil degradation, soil erosion, and broken nutrient cycles linked to development processes. These problems and their cause-and-effect relationships are often regional in character and can be technically solved at the level of (agro-) ecosystems. However, regional and national policies often impede a "technically optimal" solution. The ways in which soil, nutrient, or organic matter losses occur, and the mechanisms involved in restoring these losses, need to be understood if sound policies are to be devised to conserve the soil or maintain its fertility. ZEF projects will seek to increase understanding of degradation processes and lead to management options that avoid or reverse them.

Functional Biodiversity: Biological diversity is the basis for human nutrition and plays an important role in the production of food, fuels, and fibers that agriculture supplies. Conversion to modern agriculture, land-use changes, internationalization of food markets, and changing food demands have caused rapid losses of agricultural diversity. With the emerging changes in biodiversity due to human impacts, the question arises of how much of it we need. As in the past, ZEFc will continue to have a close look at the role biodiversity plays at the land-use system and landscape level and seek ways to optimize its functionality.

Environmental impact analysis

A system analysis of many past development projects shows that an overly narrow sectoral orientation (e.g. the goal of increasing agricultural production by irrigation) produces partial solutions that do not address the complex and delayed system behavior of connective processes.

Modeling and particularly multi-agent modeling systems are one answer to addressing such problems as described in the trans-disciplinary section on land use. The development of integrated models for environmental impact assessments, such as multi-agent simulation models, requires the understanding of both bio-physical as well as socio-economic drivers of ecosystem structures and functions. At the same time, it requires environmental feedbacks, i.e. the effects of ecosystem change on human behavior and the vulnerability of communities. ZEFc will continue to refine the modeling approaches in a wide variety of environments in order to develop reliable indicators for advanced warning and methods for quantifying the environmental costs to future generations.

A major challenge of ZEF's research is to transform outcomes into recommendations that fit the actual demands of the envisaged target groups. Experience shows that even if the basic idea of researchers is ecologically sound, resource users may not adopt the newly developed technology. Constraints such as socio-economic and institutional framework conditions often play an important role in this context. Thus, research-based solutions have to pass a high measuring stick: they should be ecologically and economically superior to common practices. In addition, factors such as the management capacity or risk averseness of the resource user have to be considered. Therefore, adequate strategies for organizing the sustainable adoption of the innovation by the people that live in the vulnerable lands need to be developed and applied. ZEFc ecosystem research will put major emphasis on integrating research findings with change management into comprehensive development packages.

4. Capacity Building

Capacity building is a major component and goal of ZEF's research set-up and activities. The aim is to transfer an integrated view on development, which implies an intensive exchange of knowledge and exposure to the Center's research-for-development philosophy. Young academic professionals are an integral part of ZEF's research portfolio, which exposes them to trans-disciplinary concepts and the real life constraints of the local partners. In the process, ZEF's doctoral students contribute substantially to its research program and output. ZEF has institutionalized its Capacity Building component through its "Bonn International Graduate School for Development Research (BIGS-DR)".

The Bonn International Graduate School for Development Research (BIGS-DR) was founded in 1999 and primarily aims at building capacity in the field of development-related research for development and research organizations at international and European level and in the developing world. Target groups are scientists and future decision-makers from developing countries and Europe who are striving for a national or international career in the development sector. Since its inception, 323 PhD students from 67 countries have participated in the BIGS-DR. The program has become internationally renowned because it is unique in its size (an average of 140 PhD students are participating in the program at any one time) and in its trans-disciplinary approach in the field of development research. Two-thirds of the participants come from developing countries and one-third from Organization for Economic Cooperation and Development (OECD) countries, mainly from Germany.

The overall goal of BIGS-DR for the coming 10 years is to establish the program as a top candidate in graduate training in development research. To this end, ZEF will seek:

- to deepen trans-disciplinary training which is crucial to addressing the complex and interlinked problems of development research;
- to strengthen the research component of BIGS-DR in the framework of a structured, intensive course program;
- to intensify the system of tutoring and supervision by closer integration of doctoral students in ZEF's larger research projects;
- to expand cooperation with outstanding academic and non-academic institutions and researchers from industrialized and developing countries; and
- to intensify its relations and cooperation with the faculties of the University of Bonn in the framework of Bonn International Graduate Schools.

ZEF currently raises no tuition fees for BIGS-DR, but adequate research funds of up to 20,000 euros must also be secured. A stronger commercialization and new sponsors are envisaged and may be realized under the new legal frameworks in Germany and the state of North-Rhine Westphalia and the reputation of the program.

Based on experiences so far, special attention will be given to improved procedures for the selection of students, their regional mix, and closer collaboration with alumni.

The new concept of a Summer School

In order to attract and select top students, ZEF / BIGS-DR is striving to introduce a summer school in the form of an intensive interdisciplinary course on a yearly basis, where doctoral candidates are trained and screened for their suitability to enter the Doctoral program in consultation with their potential advisor from Bonn or any of our collaborating institutes.

The Summer School will offer interdisciplinary lectures and would partly substitute for the Interdisciplinary Course. Prominent guest academics will be invited to deliver lectures on selected frontier-level topics and address crosscutting subjects, such as governance, cultural diversity, sustainability, vulnerability, ecosystem services, conservation, etc. that will be used as a framework for an integrated analysis, where different pieces of knowledge are brought together in a 'workable' manner. Students will be engaged in regular debates on these issues and will be asked to write a term paper in which they contextualize the research proposal that they have written. The top students will be selected on the basis of this output and their ability to incorporate the material taught and to articulate their thoughts on this material and will be invited to join the BIGS-DR or other graduate programs at Bonn University.

Widening the geographical background of students

Currently, graduate students mainly originate from developing countries. Following the enlargement of the EU, many Central and Eastern European countries have become full members with the responsibility to engage in development programs. Students from these countries could benefit from participating in ZEF's graduate program as ZEF research is not country-specific, but rather aims at providing concepts and policy guidelines which can be applied in many countries. Hence, ZEF could make a contribution to strengthening the research capacity in the new Member States of the EU and prepare a generation of experts from these countries to fulfill their obligations in the future.

The Alumni Network

ZEF currently maintains an Alumni Network of development-oriented academics and policymakers who have been affiliated with ZEF. This network provides BIGS-DR with an increasing number of colleagues in key positions both in research and government institutions in all major developing countries (www.zef.de/alumni). Such a network enables Bonn University to plan future cooperative research; to initiate further projects in the educational field; and to disseminate its research results among those responsible for implementing development policies. Hitherto, the potential of an alumni network has not been fully exploited. ZEF is planning to intensify contacts with and among alumni by, among other things, initiating annual meetings, and integrating alumni in ZEF's policy advice activities. In doing so, ZEF is counting on the continued support of the Association of ZEF's Friends, a charitable association under German law.

5. Policy Advice

Since its establishment, ZEF has focused on policy-relevant research. This is expressed by the direct collaboration of ZEF researchers with institutions of development cooperation, the publication of policy-oriented recommendations as part of research studies, policy briefs, and public policy dialogue events. With the establishment of ZEFConsult in 2005, the Center aims to strengthen its efforts in effective research-policy linkages. Based on several years of research, teaching, and dialogue activities, ZEF has gained substantial experience and research knowledge in the field of development research and cooperation. Making use of these experiences, ZEFConsult is now developing capacity to cater to the needs of development cooperation and development political entities for evidence-based expertise and to work jointly with researchers at ZEF on solutions and concepts to be introduced into the political decision-making process.

As a new unit of ZEF, ZEFConsult aims at providing policy advice. Its target groups are governments, parliaments, their institutions of development politics, and private or non-governmental organizations in the field of development policy, politics, and cooperation. In the overall context of the Center, ZEFConsult will seek opportunities to introduce ZEF expertise into the policy debates and to add value to the research findings of ZEF by seeking and coordinating reimbursable projects in which such knowledge can be turned into practice. While ZEFConsult concentrates on the political dimensions of research done at ZEF and making such research application-oriented for decisions in development politics, policies and practice, it also aims to enrich ZEF's portfolio by introducing new subjects from the development policy agenda.

ZEFConsult provides research-based consulting expertise (short- and medium-term) and alternative forms of transferring academic know-how to political decision-makers (consulting seminars, lectures etc.). In addition, ZEFConsult monitors the needs for translating research results into practice and from this develops new approaches for work in practice. ZEFConsult operates within a network of national and international scientific and non-scientific development institutions. In the national context, it aims to initiate a forum for development research and development politics as a German platform for exchange between science and policymakers. Primarily, ZEFConsult works along ZEF's thematic portfolio. Additionally, ZEFConsult may respond to demands emanating from the agenda of the development arena. By developing and running a module on research-based consulting ZEFConsult may contribute to capacity building within ZEF's International Doctoral Studies Program.

6. Setting a Course for the Future

ZEF has come a long way since it took flight in 1997. Much of its original direction was set out by the Senate of Bonn University, which approved a broadly designed research and teaching program. Honoring this mandate remains an overriding priority over the next decade. However, the Senate left considerable leeway to the Center's directors and Advisory Board to elaborate and define ZEF's direction and goals. During the first decade of its existence ZEF has put this academic freedom to good use by establishing itself as an important trans-disciplinary research center undertaking policy-relevant, crosscutting research and contributing to academic capacity building in developing countries through its international doctoral studies program. The overriding objective for the next decade is to build on these achievements and to render ZEF research even more relevant for policymakers and other stakeholders in developed and developing countries. To meet this challenge ZEF will continue to strengthen its comparative advantages, to adjust its research program to the changing international development agenda, and increase the policy relevance of its research output.

ZEF's comparative advantage

Of the many lessons learned about development, one of the most significant is that development problems do not fit neatly into traditional academic disciplines. Cutting-edge development research requires coordinated thinking and an input across a wide variety of disciplines. ZEF has recognized this issue from the beginning. Its research programs are already trans-disciplinary, and it is placing increasing emphasis on designing broadly crosscutting research involving all three research programs. The goal is to combine methods and concepts from all branches of natural and social sciences, thus adding to existing approaches, and to make implementation problems an integral part of the analysis. Crosscutting research will be moving center-stage of ZEF's activities, in particular when the envisaged, new activities on sustainable energy and health are translated into projects and programs.

ZEF's embeddedness within Bonn University continues to provide important advantages. First, university affiliation coupled with support from the German government and elsewhere provides ZEF with the opportunity to undertake holistic and long-term research. Second, the university setting allows for considerable staff flexibility. In cases where ZEF lacks in-house expertise in a particular area, it can often borrow that expertise from elsewhere in the university. This aspect is of utmost importance for the evolution of ZEF's research program. Third, university affiliation provides ZEF's students with a powerful incentive: to obtain a doctoral degree from the faculties of Bonn University or collaborating universities. ZEF will continue to be a strong and integral part of Bonn University.

ZEF is part of Bonn's network of international centers of science, research, and development policy institutions. This network offers various possibilities for ZEF staff, e.g. to participate in joint conferences and workshops and to benefit from the exchange of staff, lecturers, and doctoral students. Network partners are, for example, the United Nations University Institute for the Environment and Human

Security (UNU/EHS), BICC (Bonn International Center for Conversion) and the German Development Institute (DIE). Other partners are: the Federal German Ministry for Economic Cooperation and Development (BMZ), the UN Secretariat for the Convention to Combat Desertification (UNCCD); the Secretariat of the UN Framework Convention on Climate Change (UNFCCC); the United Nations Volunteers (UNV); the Secretariat of the Convention on Migratory Species (UNEP/CMS). Finally, ZEF hosts the secretariat of the International Human Dimension Program (IHDP) of the International Council for Science/International Society for the Systems Sciences (ICSU/ISSS) and one of the joint projects dedicated to water resources, the Global Water System Project (GWSP). These networking relationships have increased the efficiency of ZEF research while promoting its visibility. ZEF will seek to intensify and expand its network of collaborating institutions.

Finally, ZEF's directors and fellows already serve on numerous boards and advisory committees, both in Germany, elsewhere in Europe, and at the international level. These interactions are an important opportunity for ZEF to integrate its research into the international flow of emerging development research themes. Further, they provide a sounding board for ZEF to ensure that its research is policy-oriented, timely, and relevant. ZEF expects to continue to engage in this kind of interaction and policy advice.

Defining ZEF's future program

There are four main criteria that have guided and will continue to guide the evolution of ZEF's research programs: research excellence, strategic relevance, thematic coherence and efficiency:

- *Research Excellence.* The project is innovative and original either in terms of its theory, methodology, or empirical outcomes. It promises to yield new knowledge and innovative answers to important development questions.
- *Strategic Relevance.* The project is relevant to policymakers and promises to have long-term significance and policy impact.
- *Thematic Coherence.* The project fits into the existing research agenda, contributes to a better understanding of the crosscutting research themes, and builds on the research priorities of ZEF's main stakeholders.
- *Efficiency.* The cost of the project is reasonable relative to its expected findings.

Two other issues, the availability of expertise and the availability of funding, are important considerations in project selection, but their absence should not necessarily preclude efforts to undertake a project. In many cases, ZEF can draw on experts from within the university or partner institutions. As for funding, ZEF operates on the assumption that it can find support for excellent research projects.

ZEF believes that the most efficient and creative way to explore new directions is to build on the exchange of ideas among ZEF's directors, its staff, its main stakeholders and research partners, and its International Advisory Board. This informal process has so far proven effective. It causes a relatively light administrative burden and is relatively inexpensive. The hallmark of this process is the interaction among ZEF directors and staff, in effect generating a marketplace of new ideas. At present, ZEF's directors closely collaborate in the development of the new crosscutting research programs mentioned above.

The research undertaken at ZEF is policy-oriented, but results do not necessarily lend themselves to immediate application in development cooperation or national policymaking. ZEF's goals are rather

- to provide, based on primary data and the most advanced methods, new concepts for finding solutions to complex problems related to the management of natural resources and human development;
- to generate support systems that allow the analysis of the interrelationships between ecological and human developments; and
- to contribute to capacity building in developing and other countries thus strengthening the base for rational policy formulation.

These goals imply that ZEF will usually not participate in individual development projects, but will rather engage in path-breaking fundamental research on such topics as land or water management or the conservation of biodiversity to find solutions that minimize the trade-offs between ecological concerns, economic objectives, and social acceptability. As such, solutions are empirically grounded so they are not readily transferable from one region to another. However, the concepts and support systems used to arrive at these solutions are transferable and can be replicated, with the necessary adjustment of parameters, to formulate appropriate policies in other countries and regions. ZEF thus acts as a pathfinder supplying the tools for dealing with crosscutting challenges. These tools are designed in a trans-disciplinary fashion; not only do they cut across traditional disciplines, but they also address all stakeholders from the individual household to the national government. By engaging all relevant stakeholders in finding solutions, ZEF supports the participatory approach to development because it believes that only this kind of approach that will ultimately lead to sustainability.

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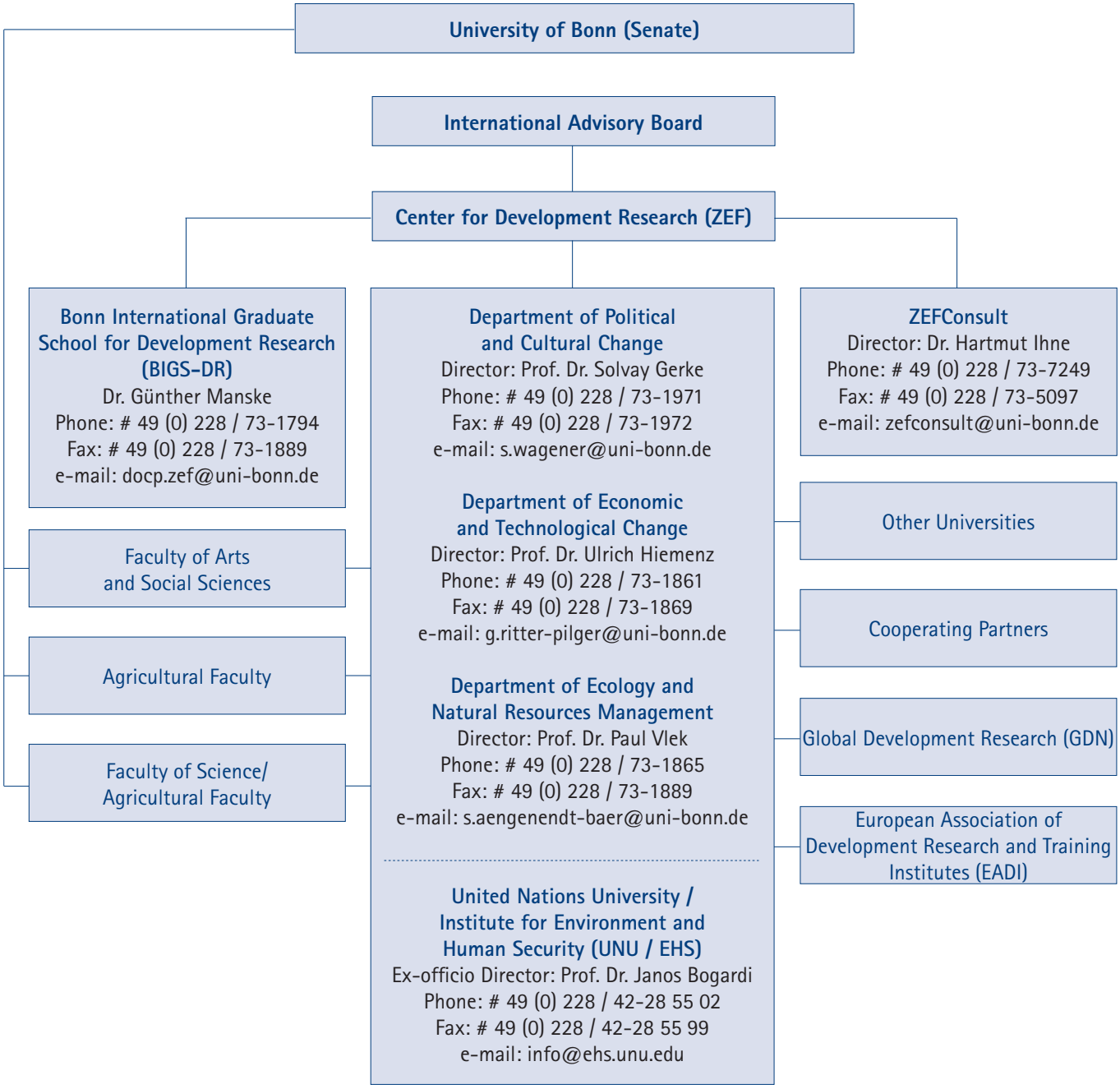
Organizational Structure of ZEF



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