IHDP UPDATE

NEWSLETTER OF THE INTERNATIONAL HUMAN DIMENSIONS PROGRAMME ON GLOBAL ENVIRONMENTAL CHANGE

ISSN 1727-155X

02/2003

BUILDING RESILIENCE TO PROMOTE SUSTAINABILITY

An agenda for coping with globalisation and promoting justice |

BY W. NEIL ADGER

Foto: N. Adger

WHAT IS RESILIENCE?

➤ **The speeches of Presidents and Prime Ministers at the World Summit on** Sustainable Development (WSSD) in Johannesburg make it clear that sustainability is a widely held social and political goal, but one which is often more a utopian aspiration than a defined set of social and ecological states. However, sustainability clearly captures the desire for persistent and equitable well-being in the long run. The unfocussed aspirations for sustainability are captured in the notion of *resilience* – the ability to persist and the ability to adapt. Both sustainability and resilience recognise the need for precautionary action on resource use and on emerging risks, the avoidance of vulnerability, and the promotion of ecological integrity into the future.

One important contribution to the WSSD promoted the synergies between the sustainability and resilience agendas. The report from ICSU and the Swedish Envi-

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IHDP Update is published by the International Human Dimensions Programme on Global Enviromental Change (IHDP), Walter-Flex-Str. 3, 53113 Bonn, Germany, V.i.S.d.P.: Elisabeth Dyck

EDITORIAL

During the past year, three major conferences addressed, amongst others, the issue of resilience. The Stockholm+30 Conference, the World Summit on Sustainable Development in Johannesburg and the General Assembly meeting of ICSU, one of IHDP's sponsoring organisations, had interesting reports and discussions on this topic. *Resilience* – the focus of this issue of UPDATE – is a theoretical concept related to vulnerability, one of IHDP's cross-cutting themes. A number of international researchers and young scientists discuss issues of resilience in their articles, including studies that range from the Circumpolar North to Asia to sub-Saharan Africa.

Some years ago, a group of international researchers formed the *Resilience Alliance*, a consortium of institutions that investigate issues of resilience in complex social-ecological systems. Allyson Quinlan discusses in her contribution some key concepts of resilience analysis. In his interview on p.12, Brian Walker, Chair of the Board of Directors of the Resilience Alliance, explains how this network was set up and how it is operating. There are links between research on the human dimensions and resilience research, as well as opportunities for closer cooperation in the future. Michael Bollig's presentation of ACACIA is a very good example of such an opportunity. IHDP Scientific Committee members Elinor Ostrom (Indiana University, USA) and Carl Folke (Stockholm University, Sweden) are both members of the Resilience Alliance's Board of Directors. Elinor Ostrom and her group are leaders in investigating the role of institutions in building adaptive capacity, which has strong links to the IHDP Project on Institutional Dimensions of Global Environmental Change. Resilience was also the topic of a special guest lecture, given by Carl Folke during the 10th Meeting of the IHDP Scientific Committee (SC) in Bonn in early March.

Issues of vulnerability, adaptation and resilience will be analysed in a more systematic way as part of the stock-taking and synthesis process that IHDP will undergo in the next years. The goal of this process is to link core projects as well as core and joint projects, to produce synthesis publications and thereby strengthen the social science perspective in global change research. In this context, the SC also decided to undertake an internal and external assessment of IHDP. In order to provide a management structure that will support the synthesis process, the SC appointed an Executive Committee, consisting of Coleen Vogel (Chair), Mohamed Salih (Vice-Chair), Roberto Sánchez-Rodríguez (Vice-Chair) and Barbara Göbel (Executive Director). UPDATE will keep our community informed about this process.

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BARBARA GÖBEL
IHDP Executive Director

ronmental Advisory Council outlined a comprehensive analysis of resilience and sustainable development and was subtitled 'building adaptive capacity in a world of transformations' [1]. The authors, from the Resilience Alliance, argue that resilience is a goal that should be promoted, not for ecosystems or for social institutions *per se*, but for social and ecological system interactions. In a previous IHDP UPDATE (2/2001), Sander van der Leeuw argued that the underlying problems of global change stem directly from the traditional separation of the social and the ecological [2]. Humans impose distance from nature in our views of the world – this 'conceptual opposition between society and nature that we bring to bear on all our dealings with our environment' is detrimental to sustainability. A first principle of resilience and sustainability is that the human and natural worlds are not simply interdependent. These two worlds are in fact one and the same, viewed through the eyes of the human species.

Resilience of social-ecological systems is determined by the magnitude of the perturbations that they can absorb and still retain their overall function; the degree to which the system is capable of self-organisation; and the degree to which capacity can be built for learning and adaptation. The message of resilience is more radical for policy-makers than that of sustainability. The agenda implied by resilience actually challenges some widely held tenets about stability and resistance to change that are implicit in how sustainability is formulated in environmental and social policy arenas around the world. Promoting resilience means changing, in particular the nature of decision-making to recognise the benefits of autonomy and new forms of governance in promoting social goals, self-organisation, and the capacity to adapt. In a policy world focussed on resilience there is less scope for global blueprints, which are high on central control but low on equity – such blueprints create their own vulnerabilities and render some problems and issues invisible [3]. Promoting resilience is concerned with the knowledge required to facilitate robust governance systems that can cope with environmental changes and social, demographic and democratic transitions.

GLOBAL CHANGE CHALLENGES RESILIENCE

Resilience and vulnerability are both shaped by global and local economic forces. Yet the ability to promote resilience goals within environmental policy is dependent on the ability to frame sustainability questions in these terms and the 'purchase' of them compared to those of free trade, economic choice, or growth. Economic growth is not inherently desirable or undesirable in itself – it is a means to an end. The presently observed uneven patterns of economic growth have negative consequences for the resilience of both human and ecological systems.

The geographical distribution of resources is a key parameter in economic development. Persistent and widespread poverty is concentrated in sub-Saharan Africa, in parts of Asia and in the Andean region of South America. A 'new economic geography' argues that location matters. Economic isolation in terms of transport costs, lower agricultural productivity, as well as high exposure to pathogens in the environment makes economic development fundamentally

more difficult in these regions. Such explanations of persistent poverty imply that economic integration into the world system is the solution. Clearly it is not. Coping with the vagaries of a variable and unpredictable physical environment requires resilience, but so does coping with the vagaries of market instability that inevitably come with globalisation.

Globalisation has occurred in waves at different times and with different manifestations since the industrial revolution. In a polemic and forceful article, Branko Milanovic has examined the evidence on the impact of two waves of economic globalisation in the late 19th and 20th century [4]. He shows that the earlier period of globalisation was primarily one of resource extraction based on colonialism, which resulted in a massive divergence between global regions. The resulting economic world order and the processes of globalisation at that time sowed the seeds of economic and political instability in the early 20th century. The same trends in income inequality are evident in the economic globalisation wave that has been surging forward since the 1970s – the ratio between average income of the world's richest five percent and the poorest five percent increased from 78 to one in 1988 to 114 to one in 1993.

Can globalisation be directed to promote resilience? The answer is an article of faith in the power of the market, and it is faith in the power of civil society to resist the market. Advocates of globalisation argue that the greatest vulnerabilities are to poverty. To reduce them, the 'globalising' faith holds that those locations, where the poor are located, need to be integrated into the world economy through massive investment in infrastructure, opening up of trade flows, and allowing the developing countries to meet the market-oriented economies of the world on an even playing field – an optimistic view that globalisation can be made to work for global social good. The discontents of globalisation point out that people are vulnerable to economic globalisation. Liberalising trade and integrating economies into world markets makes the incomes of the poor insecure, open to vagaries and price fluctuations, and ultimately more vulnerable when other shocks and stresses come along.

There are two solutions: promote autonomy, local reliance, diversity and risk aversion to diminish vulnerability; or promote integration, specialisation, and risk taking to encourage economic progress and diminish vulnerability. These solutions could not be more divergent. The solution does not lie in a compromise of taking the least undesirable parts of both strategies and seeking a middle way. Rather, we need a new way of valuing autonomy, local reliance and the contribution they make to sustainability and resilience.

Resilience is not about promoting growth or change for its own sake. It is about promoting the ability to absorb shocks and stresses and still maintain the functioning of society and the integrity of the ecological systems. However, resilience also requires communities and societies to have the ability to self-organise and to manage resources and make decisions in a manner that promotes stability. Most important of all, resilience requires societies to have the capacity to adapt to unforeseen circumstances and risks. These objectives give generic guidance on how to promote sustainability at different scales.

RESILIENCE AND JUSTICE

Sustainability, the promotion of resilience, and the avoidance of vulnerability are directly related to equity, autonomy, and freedom, arising from the entitlement and access to resources and to security. Thus, resilience and justice promote sustainability. They are both observed in and promoted through diversity in both social and environmental systems, and in diverse knowledge systems and ways of looking at the world [5].

Justice in resilience needs to account for the outcomes of resource allocations and policy decisions – how the beneficial and adverse effects of human action are distributed across society. This distributive justice has formed the primary focus of the environmental justice social movements around the world. These movements seek to redress, through law or other means, the inequity in who suffers from localised environmental pollution or inequitable access to land and other resources. Justice is also made up of fairness in representation – how can societies build the capacity to adapt when vulnerable groups are marginalized and excluded from decisions? Justice is also about fairness in procedures and institutions, recognition of difference, and participation in decision-making. Both procedural and distributive justice is central to the implied goals of social-ecological resilience.

WHAT NEEDS TO CHANGE?

The issues raised are grand challenges in the evolution of environmental governance. Resilience means moving away from simple limits on environmental resource use towards active promotion of dynamic evolutionary processes. Adopting resilience principles also entails a redistribution of power among actors to more multi-level governance systems. Much traditional resource management in effect promotes stability rather than resilience. Diverse evidence, such as riverine flooding or intensive agricultural systems, shows that locking systems into particular technologies can promote stability and reduce risk in the short term. However, such strategies may sow the seeds for chronic stress and non-linear systematic change. Dealing with chronic stress caused by global change ultimately may be the most difficult.

Adaptation to global environmental change is therefore likely to be punctuated by examples of system collapse unless resilience is recognised as a central goal of sustainable development. Success in environmental policy should be redefined by how it promotes and facilitates resilience, and by how it promotes legitimate, broad-based development that allows individuals and societies to cope with risk and adapt to changing circumstances over time.

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References to this article are included on the IHDP website at www.ihdp.org/update0203/references.htm

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RESILIENCE AND ADAPTIVE CAPACITY

Key components of sustainable social-ecological systems | BY ALLYSON QUINLAN

➤ **Change can be desirable when viewed from an adaptive** perspective. Small changes that serve to enhance one's understanding of the properties of a system (i.e., its strengths, weaknesses, limits, and leverage points) contribute to a knowledge base, which can become a resource for managing the system. Minor crises or intentional probing of a system through structured experiments can provide valuable information about how the system self-organises and its capacity to cope with disturbance.

Ironically, change is one of the few reliable phenomena of integrated natural and social systems. In the past, policies have tended to attempt to control change in what were believed to be stable systems. From the perspective of system resilience, policies that are aimed at building the capacity of a system to cope with, adapt to, or even direct change can more effectively contribute to the long-term sustainability of the system. Understanding how to guide change may be advanced by a better understanding of the roles of resilience and adaptive capacity in complex dynamic systems.

A growing body of research and knowledge relating to resilience and adaptive capacity in social ecological systems has emerged in recent years, driven largely by a 5-year collaboration among an international group of ecologists, economists, social scientists, and mathematicians. These efforts have spawned much new collaboration, which continues to contribute toward the synthesis and application of this knowledge to challenges in sustainable development. As a conceptual framework, this body of knowledge aims to improve our understanding and management of complex adaptive systems. Fundamental to this approach is the awareness that human and natural systems act as strongly coupled, evolving systems, and that ecosystem response to human use is rarely linear, predictable, or controllable. This article provides a brief overview of some of the foundational concepts in resilience research.

STATE SHIFTS – THE ELEMENT OF SURPRISE

The existence of thresholds in ecological systems reveals how subtle, cumulative changes can have sudden catastrophic effects on the structure and function of ecosystems. A shift in shallow lakes from clear water with abundant submerged vegetation to turbid, eutrophic conditions, in response to increased nutrient levels is one such example [1]. In lake ecosystems, gradual increases in nutrient concentration appear to have little effect on water clarity until some threshold is reached, at which time the water suddenly becomes cloudy with algae, causing submerged plants to disappear and biotic diversity to decline. Restoration of eutrophic lakes requires more than simply returning nutrient concentrations to levels that preceded the shift. Evidence of catastrophic state shifts in various types of systems highlights that change in natural systems is often non-linear, surprising, and that interaction among a subset of system components across scales can have strong system feedbacks. Such dramatic state shifts are one characteristic of complex adaptive systems.

COMPLEX ADAPTIVE SYSTEMS

Integrated systems of people and ecosystems tend to be dynamic and complex. Not only do natural and social systems behave in non-linear ways, but evidence also suggests that they behave as strongly coupled social-ecological systems (SES). As our worldview changes from one where nature, and its goods and services that we rely upon, are considered in isolation of humans, to a worldview that recognises the union of people and nature, the need for multi-disciplinary approaches to address challenges in sustainability cannot be ignored. Integrating social and biophysical sciences presents its own set of challenges, which are compounded by issues of scale.

Linked SESs are influenced by structures and processes at multiple scales. Events or perturbations at one scale may influence processes that occur at other scales within the system. These cross-scale interactions increase levels of uncertainty within the system, yet also may provide a mechanism for reinforcing the system as a whole. It is postulated that only a small set of critical variables and processes actually create and maintain self-organisation within these systems [2]. The relative simplicity in a sub-set of variables holds great promise for better understanding and managing complex adaptive systems. By identifying the key components or processes that drive a system, we gain insight into what contributes to the resilience of the system and where the system is most vulnerable.

RESILIENCE

The resilience of SESs has three defining characteristics: i) the amount of change the system can undergo and still retain essentially the same structure, function, identity, and feedbacks on function and structure, ii) the degree to which the system is capable of self-organisation, and iii) the degree to which the system expresses capacity for learning and adaptation (**www.resalliance.org**).

More resilient systems are able to cope with a higher level of disturbance and have the adaptive capacity necessary to re-organise when change is unavoidable. Attributes of a system that enhance resilience include redundancy, diversity, modularity, spatial heterogeneity, rapid feedbacks, and ecological and social "memory".

Less resilient systems become increasingly vulnerable to disturbances that were previously within coping limits. Gradually changing conditions (e.g., nutrient loading, climate, habitat fragmentation, etc.) can lessen system resilience, causing thresholds to be surpassed and triggering an abrupt system response. When resilience is lost or significantly decreased, a system is at high risk of shifting into a qualitatively different state. The new state of the system may be undesirable, as in the case of a productive freshwa-

ter lake that becomes eutrophic and depleted of its biodiversity.

ADAPTIVE CAPACITY

If chance favours the prepared mind, then preparing SESs for inevitable, yet uncertain change, must involve building adaptive capacity. Building adaptive capacity is complementary to building resilience within social-ecological systems. Adaptive capacity relates to increased options for re-organisation following change. Systems with high adaptive capacity are more able to maintain resilience and avoid significant disruption of critical functions after a disturbance. Folke et al. (2003) [3] list four factors that confer adaptive capacity and appear to be indispensable when dealing with natural resource dynamics during periods of change and reorganisation:

- learning to live with change and uncertainty;
- nurturing diversity for resilience;
- combining different types of knowledge for learning; and
- creating opportunity for self-organisation towards social-ecological sustainability.

ADAPTIVE CYCLE AND PANARCHY

A discussion of the roles of resilience and adaptive capacity in SESs is aided by the adaptive cycle, which offers a compelling metaphor for the movement of managed systems through characteristic phases of change [4, 2]. The cycle describes an initial period of rapid growth and exploitation leading to accumulation and conservation of structure, during which time the system tends toward rigidity and declining resilience. Eventually the system suffers a rapid breakdown and release of accumulated potential which provides an opportunity for renewal and reorganisation. Complex SESs may well benefit, over the long term, by alternating through periods of relative stability with periods of rapid change. The challenges presented by crisis events can serve to strengthen the system through learning and reinforcing flexible, adaptive strategies.

An SES may be represented by an interlinked, hierarchical set of adaptive cycles, dubbed a "panarchy" [2]. When an SES is viewed from this perspective, a number of system dynamics emerge, including changes in resilience, at multiple scales, as components of a system move through the phases of the adaptive cycle; points of opportunity or vulnerability within the system; and cross-scale interactions among subsystems nested within the hierarchy. An important insight to emerge from this body of work lends support to the critical role that cross-scale interactions play within complex adaptive systems as catalytic agents. Trigger points for such cross-scale influences could potentially be used to guide the timing and type of management action.

MANAGING FOR RESILIENCE

How does one manage for resilience and build adaptive capacity in social-ecological systems? Elements of uncertainty and surprise are inherent in SESs, but insights from both the adaptive cycle and case studies suggest that the timing of intervention may be a critical factor when attempting to guide change along acceptable trajectories. Linked systems are most receptive to efforts at re-directing their development during phases of reorganisation. It is also critical to reinforce resilience immediately following crisis events.

One approach for analysing resilience in SESs involves a four-step process that requires the close involvement of stakeholders and builds upon a conceptual model of the system to develop a limited set of future scenarios and simple models used to explore the dynamics of the system, followed by a stakeholder evaluation of both the process and outcomes [5]. One of the first challenges encountered when attempting to analyse system resilience involves defining system boundaries by asking the question: resilience of what and to what? Describing perceived vulnerabilities and areas of significant and high uncertainty helps to lay the groundwork for exploring the dynamics of SESs and building structured scenarios.

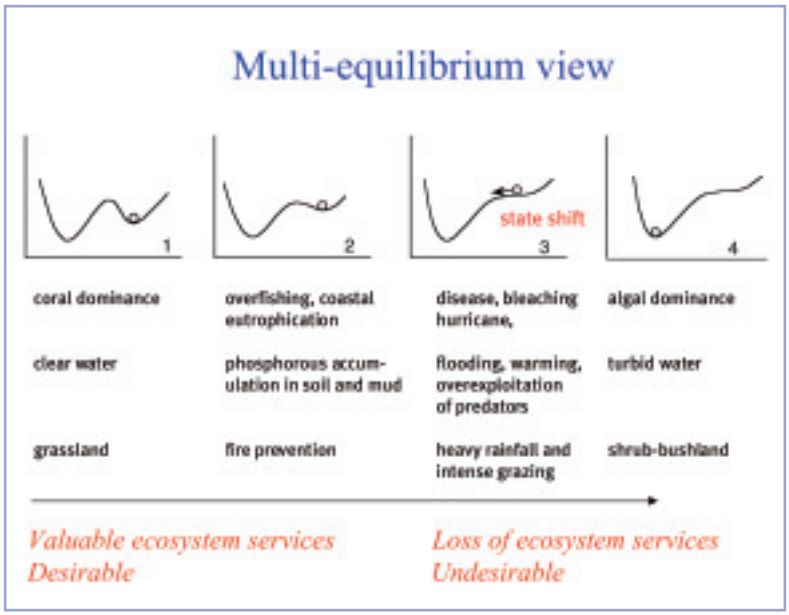

Fig. 1. Multi-equilibrium view of ecosystems (Source: Folke and Skånberg, 2003)

THE RESILIENCE ALLIANCE

A core group of scientists is presently co-ordinating their research on resilience through the Resilience Alliance. Some of the current areas of inquiry include thresholds, the evolution of rules and norms in SESs, envisioning resilience through structured scenarios, resilience from a long-term archaeological perspective, and the role of transformative capacity in relation to adaptive capacity. The synthesis of several case studies is underway and several collaborations with other research organisations have spurred a number of new projects. For more information visit **www.resalliance.org**.

REFERENCES to this article are included on the IHDP website at **www.ihdp.org/update0203/references.htm**

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RESILIENCE OF HUMAN-RANGIFER SYSTEMS

Frames of resilience help to inform studies of human dimensions of change and regional sustainability |

BY GARY KOFINAS

➤ **The resilience of human relations with *Rangifer tarandus*** (reindeer/caribou) is evident in the historical record of herding and hunting people of the Circumpolar North. In North America, wild *Rangifer* are called "caribou" and domestic *Rangifer* are called "reindeer", while in Greenland and Eurasia both wild and domestic forms are called "reindeer." Saami, Nenets, Dolgan, Evenk, Chukchi, Koryak, Dogrib, Sámi, Gwich'in, Dene, Cree, Chipewyan, Innu, Naskapi, Iñupiat, Inuvialuit, and Inuit are among the indigenous cultures of the Arctic. They have co-evolved with this resource for millennia by responding to changes in wildlife distribution and abundance, and have developed indigenous knowledge systems that ensured human survival.

Today *Rangifer* continues to be the most important terrestrial resource for indigenous peoples of the Arctic. While the relationship between northern indigenous peoples and caribou/reindeer remains vibrant in many regions, novel forces for change in the form of industrial development, expanding human infrastructure, climate change, globalisation of economies, local culture change, and political transformation indicate a need to assess carefully the resilience of Human-*Rangifer* Systems in a modern-day context.

DRAMATIC CHANGE

Several observations highlight this need. Large-scale, non-renewable resource development projects are occurring or planned in many regions of the Arctic and sub-Arctic at an unprecedented rate, with many intended for habitat deemed important to *Rangifer* herd sustainability (e.g., herd calving grounds). On the Yamal Peninsula in Russia, for example, there has been significant loss of grazing habitat due to gas development and an overall reduction in the capacity of rangelands to support traditional herding. Climate change, which is likely to be greatest in polar regions, raises additional questions regarding its effects on the growth and distribution of forage plants, the distribution and movements of *Rangifer*, its implications for insects which affect *Rangifer* energy reserves, and users' access to and movement with caribou at important times of the annual cycle. Fundamental changes in political and legal structures also have been dramatic and varied, affecting indigenous groups and their relationship with reindeer/caribou resources. In some regions, increased access to Human-*Rangifer* Systems by southern populations, enclave developments, and culturally inappropriate management policies have spurred northern peoples to seek clarification of their rights and reassert their role in resource management. In Canada these changes have resulted in widespread implementation of institutions for caribou co-management, which in some respects is contributing to the overall resilience of those Human-*Rangifer* Systems. The political developments in Canada, however, contrast with those in Russia where the collapse of the former Soviet Union has led to the demise of many state farms, which for decades supported reindeer herding lifestyles and the rise of the market economy and privatisation. As a result there has been a ten-year reduction in the total stock of domesticated reindeer in Russia from 2,000,000 to 1,000,000 animals and a concurrent increase in wild reindeer populations. In several cases, reindeer herders are abandoning their traditional way of life or they are adapting to change through a shift from herding to the hunting of wild reindeer for subsistence uses and commercial market.

Given this complex array of regional changes, how can research assess resilience in a manner that contributes to our understanding of sustainability? Researchers and resource users of the Human Role in Reindeer/Caribou Systems Project, an initiative of the International Arctic Science Committee (IASC), have been grappling with this question through efforts to undertake a circumpolar study of past and potential future changes in the Human-*Rangifer* Systems. The initial work of our group points to the value of focusing on resilience as a central organising theme. Our efforts highlight the challenges associated with making operational the concept of resilience in an empirically based study of coupled human-ecological systems.

FRAMES FOR ASSESSING RESILIENCE

The focus on resilience (and adaptation) in the study of the human dimensions of change has been important in thinking beyond the idea of ecosystems in equilibrium and sustainability as a set of static objectives. As a consequence, there is greater interest in the development of new models of Human-*Rangifer* Systems that account for uncertainty, emergent properties, regional heterogeneity, human agency, and surprise. In the context of Human-*Rangifer* Systems, this focus on resilience translates directly to questions focused on thresholds of change (e.g., critical changes in *Rangifer* population that result in herd-wide shifts in migration patterns), vulnerability (e.g., local communities at the margin of a herd's range that loose opportunities for harvesting with a population decrease) and bottlenecks that constrain recovery from disturbance (e.g., limited access for cash that reduce participation in a herder's or hunter's traditional way of life). In our effort to make operational an analysis of resilience at the circumpolar scale, the Human Role in Reindeer/Caribou Systems initiative has defined four coupled frames of resilience that scale from individual animals to human societal-level learning.

➤ *At the individual animal level, resilience is defined as the amount of change in winter/spring conditions and summer/fall conditions* (or the amount of displacement or disturbance) that can be buffered by increasing back fat or decreasing calf size within a season. Fat levels of cow *Rangifer* are considered a good integrator of seasonal environmental conditions that relate closely to pregnancy success and calf survival. The assessment of body condition provides measurable indica-

tors for ecological monitoring and serves as a central variable when modelling caribou/reindeer energetics.

➤ *The intrinsic rate of increase of a herd's population is an index of herd resilience,* which is dictated by herd-specific adult mortality rates, age of first reproduction, harvest rates, etc. Herds with the capability to buffer range conditions or human disturbance energetically (by reducing calf size) may not have the demographic capacity to absorb the associated productivity costs (e.g., lower pregnancy rate, higher calf mortality) without suffering population declines. For example, a comparison of rates of change for the populations of four barren ground herd populations of western North America suggests that the Porcupine Herd, a internationally migratory herd of Canada and the USA, is less resilient than other herds (Fig. 1).

➤ *The capacity of a Human-Rangifer System to sustain preferred modes of economic activity* (i.e., traditional caribou hunting, nomadic reindeer husbandry) represents a third type of resilience. It is best measured by a suite of variables including the availability of wild reindeer for hunting, the adequacy of markets to support reindeer product exchange, and property rights for access to animals, exclusion of non-local resource harvesters or those with competing interests in grazing lands. The recent abandonment of traditional herding in some areas of Russia, such as Chukotka, suggests that there are critical thresholds that are important in understanding such transformations.

➤ *A social system's capacity to facilitate human efforts to deduce the trends of change, reduce vulnerabilities, and facilitate adaptation* is a forth type of resilience. As with economic resilience described above, social resilience is often related to the effectiveness of social institutions to serve society in adapting and innovating in the face of novel conditions. Detecting, understanding, and responding to change are key elements of such a process. The establishment of community-agency partnerships, implementation of co-management arrangements in ecological monitoring and research, and participation of stakeholders in an adaptive co-management process are examples of social learning.

These frames suggest that the resilience of any single Human-*Rangifer* System is an integrated function of social, ecological, and economic conditions, requiring interdisciplinary approaches. As well, these frames underscore that both social and economic resilience can be cultivated, whereas individual animal and herd-level resilience are tightly bound to the properties of an ecosystem.

Photo: Y. Konstantinov

Reindeer herders on the Kola Peninsula in the former Soviet Union.

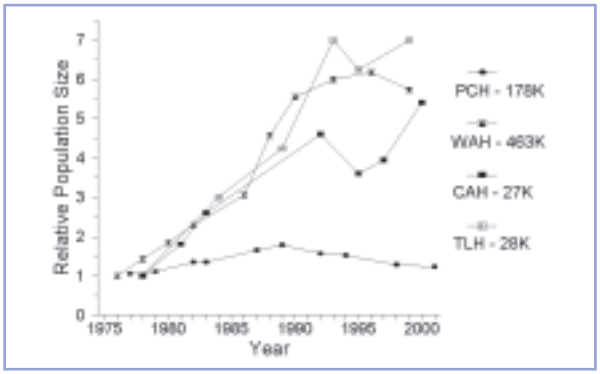

Fig. 1. Changes in Four North American Caribou Populations as a Measure of Herd Resilience. (Source: Griffith et al., 2002)

CULTIVATING RESILIENCE THROUGH PARTICIPATORY RESEARCH

Several projects associated with the IASC Human Role in Reindeer/Caribou Systems Project have included intentional efforts to cultivate social resilience. One example is the National Science Foundation's Sustainability of Arctic Communities Project, which has collaborated with caribou co-management boards in Yukon, Northwest Territories, and Alaska to establish a regional ecological monitoring programme based on science and local knowledge indicators (see **www.taiga.net/ coop/index.html**). The Sustainability of Arctic Communities Project has also developed simulation models that are used with local leaders and researchers as discussion tools to explore the implications of various policy alternatives (see **www.taiga.net/sustain/index.html**). Another example is the work of the European Union-funded project, Challenges of Modernity to Reindeer Management, which is working with traditional reindeer herders to integrate local knowledge with the findings of remote sensing analysis of habitat quality (see **www.urova.fi/home/renman/**). In each of these cases, questions of sustainability are being pursued through a diverse set of cultural perspectives.

The focus on resilience in the study of Human-*Rangifer* Systems is helping to inform the study of human dimensions of change and reframe the study of regional sustainability. While there are several approaches to understanding resilience in our work, there are significant opportunities to integrate these frames to provide meaningful results that advance the state of knowledge, as well as improve the *Rangifer* users' ability to respond to change.

REFERENCES to this article are included on the IHDP website at **www.ihdp.org/update0203/references.htm**

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VULNERABILITY AND RESILIENCE IN AFRICA

The creation of resilience in two African herder societies | BY MICHAEL BOLLIG

➤ **Demographic growth, environmental degradation and** entitlement decline are hazards that increase the vulnerability of pastoral communities. Droughts, violent conflicts and livestock epidemics are shock events, which turn a community from a state of vulnerability into a state of famine and disaster. This article highlights how resilience is created in two African herder societies – the Himba of northern Namibia and the Pokot of Kenya. The data are based on several years of ethnographic fieldwork with both communities [1] within the multidisciplinary programme on Arid Climate, Adaptation and Cultural Innovation in Africa (ACACIA) funded by the German Research Council at the University of Cologne since 1995. Vulnerability and resilience of societies and ecosystems in arid Africa across time is a key interest of this programme.

DEMOGRAPHIC GROWTH, ENVIRONMENTAL CHANGE AND ENTITLEMENT DECLINE

If demographic growth is not accompanied by a growing sustainable production or a territorial expansion, any population becomes more vulnerable. The Himba and the Pokot showed very different population growth rates (<1% vs. 2.4%). Compared to other pastoral societies the fertility rate for the Himba population (3.2) is extremely low, while the Pokot rate (4.7) is not exceptionally high. The population density of the Pokot is unusually high for pastoral nomadic societies, i.e.10 people per km^2, a figure typical for agro-pastoral systems.

The sustainable use of pastures is essential for the viability of pastoral communities. Degradation means decreased productivity and increased vulnerability. The natural potential for livestock husbandry in Kenya's Northern Baringo plains has declined throughout the last century. Degradation correlated with heavy overgrazing and the demise of communal resource management. In contrast, environmental changes were not so dramatic in Namibia's Kaokoland. A gradual replacement of perennial by annual grasses and a decline in biodiversity were noticeable in most areas, but the productivity of grassland remained stable [2].

Entitlement decline is another major factor contributing to increased vulnerability in pastoral societies. Especially in settler colonies like Kenya and Namibia, pastoralists were kept away from the markets to protect the interest of white farmers specialising in beef production. Exclusion from markets by strict regulation of livestock sales and newly invented boundaries meant a drastic loss in exchange entitlements. Today, all African herder communities are dependent on livestock markets to obtain cereals. These markets, however, are highly unstable. During droughts, market prices for livestock plummet and herders are forced to sell more animals than usual. Soon their preferred item of exchange, adult male livestock, is sold off, and they have to embark on sub-optimal selling strategies which seriously endanger their capacity to rebuilt herds after a disaster.

DROUGHTS AND VIOLENT CONFLICTS

Drought years result in massive under-supplies of fodder and increased rates of livestock mortality. In north-western Namibia and north-western Kenya, droughts occur during one out of four years. A minor drought with precipitation of 20% below the normal rate may result in a decline of 80% of biomass production in the grass/herb layer. In the wake of major droughts, the regional herd of Kaokoland declined by as much as 90% in the early 1980s, and by about 40% in the late 1950s. The high vulnerability of herds to climatic events is typical for all African herder communities. Reports show losses of 62% for cattle and 55% for small ruminants during Sahelian droughts [3], and livestock losses of 95% amongst the Sudanese Beja during the 1984 drought [4].

Violent conflicts had a detrimental effect on pastoralists in many African regions. A thorough militarisation of pastoral societies took place in much of eastern and north-eastern Africa [5] laying the ground for a permanent state of low intensity warfare. Violence does not only result in loss of land and livestock, it also hampers trade and other forms of development. Sustainable modes of resource exploitation can develop only under peaceful conditions.

FOUNDATIONS OF RESILIENCE

Both populations have developed a number of strategies to cope with shortfalls in food production. These include intensified sharing of food, reliance on food-aid, and extended spatial mobility and rituals. While the immediate management of disasters is necessary to prevent human mortality and excessive loss of livestock, institutionalised buffering mechanisms lower vulnerability. Immediate responses to a crisis are aimed at enhancing personal well-being. Buffering mechanisms take another approach: individual benefits are given up to create security as a common good. Pasture protection is a good case in point. Herders give up opportunities to exploit virgin grazing for the common good of a regulated and predictable range management.

Economic Diversification. The diversification of herds is a distinct and permanent strategy to minimise risks in herder economies. As droughts have a different impact on grass and bush land, a diversified herd with sheep, goats and cattle acts as a buffer against shortfalls. In many East African societies camels are an important asset to buffer the worst impacts of droughts, as they lactate even during very lean months. While diversification outside livestock husbandry is just beginning in the Pokot society, the Himba have combined pastoralism with agriculture and gathering for many decades. Recently, many Pokot men have tried to find additional income as self-employed livestock traders or merchants of veterinary drugs. Also, in recent years numerous households have planted small gardens.

In general, transaction costs of newly instituted strategies for income diversification are higher among the Pokot than

the Himba. Pokot livestock traders, for example, were frequently accused of envy and witchcraft. As the Pokot herding economy is highly specialised, any attempts to diversify beyond pastoralism demand a reorganisation of property rights and institutions of exchange. The comparative wealth of some Himba herders makes it easier for them to opt for self-determined forms of diversification. Among the Pokot, young traders, frequently poor and with little power in the gerontocratic system, have to bear the costs of changing institutions, while the 'big-men' of the Himba system are the change agents.

Photo: M. Bollig

Himba women at the ancestral fire

Networks of Livestock Exchange. Accumulating social capital during good times is a major device to lower vulnerability. Livestock loans and gifts are used to create networks of obligations. Exchange is strongly egalitarian among the Pokot, but has clear asymmetrical tendencies among the Himba. Pokot donors give up ownership rights in transferred animals; Himba donors give away animals mainly on a loan basis. Although livestock exchange establishes patron-client relations among the Himba, patrons are bound by a kinship morality, which inhibits excessive exploitation of clients. The way Pokot handle livestock transfer emphasises an egalitarian political system. The exchange system generates a dense, cohesive network. A structural analysis of the Himba network showed that it includes central and marginal positions, and the network was less cohesive than the Pokot network.

Institutionalised Resource Protection. The pastoralists' intimate knowledge of the vulnerability of savannah pastures has been noted in several ethnographic studies. A comparison of both societies, however, suggests that the "indigenous knowledge approach" is limited in its potential to explain sustainability. The knowledge of vegetation and pasture dynamics is extraordinary in both settings, but they proceed very differently when it comes to sustainable pasture management. The efficiency of communal resource-management institutions is the major fundament of sustainable range management [6]. Institutions of resource protection work effectively if the group responsible for protection is limited, i.e. its members are well-known, the resource to be protected is clearly defined, and rules and procedures on how to police and sanction 'free-riding' are specified.

The Pokot face problems in all three areas. There is some understanding of range protection, but concepts of responsibility are vague. Basically all livestock are entitled to graze everywhere in Pokot land, paving the way for open-access management. In spite of high human population densities coupled with a high degree of mobility, the Pokot still try to solve resource management problems in egalitarian, consensus-based neighbourhood councils. Sanctions for free-riding hardly exist. In contrast, the Himba combine access to resources with kinship and neighbourhood, and find it much easier to define the group of people entitled to use a resource. An 'owner' or 'guardian of the land' can be named for every locality, and his kin have primary rights of use. While decision-making among the Himba is also consensus based, influential elders and office holders (chiefs, councillors) influence discussions and guarantee that sanctions are carried out. There are rules for treating dry season and rainy season pastures in both economies, but the Himba's approach is more complex and detailed, which makes it much easier for them to identify transgressors. Pokot institutions for resource management lack clarity; this has many causes, including an increase in population. Furthermore, co-managing their resources has failed constantly. Since colonial times, the government's attempts to control resources have relied on external repression. In contrast, the repressive South African policy paradoxically contributed to a stable frame for 'traditional' resource management. The independent Namibian government continued this policy, although the recently introduced Communal Land Bill of 2002 includes chiefs in a land board dominated by administrative and political functionaries.

CONCLUSION

The concept of *resilience* is analytically useful but difficult to handle in complex socio-cultural, historically embedded settings. The Himba system is clearly more resilient than the Pokot system, but qualitative or quantitative measures to show this are lacking. There is no easy way to decide whether a specific institution contributes to resilience or prevents new adaptations. Pokot egalitarian networks of livestock loaning are a good case in point: the "double edge of dense networks" [7] ensures the supply of food and livestock at a low level. However, these highly cohesive networks also make collective resource-management difficult, since actors are "too close to each other" to effectively police and sanction communal goods. Finding convincing indicators for resilience in human systems, which allow a comparison of communities and of different time horizons within a given community, are needed. A key result of analysing buffering mechanisms is that resilience is a socially generated, collective good. It is exactly this social process – the creation of resilience – that should become a formidable field for comparative analysis.

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REFERENCES to this article are included on the IHDP website at www.ihdp.org/update0203/references.htm

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ENHANCING THE RESILIENCE OF CORAL REEF RESOURCES

Could genetic marking contribute to increasing the resilience of coral reef resources? | BY M.C.A. ABLAN, J.W. MCMANUS, C.A. CHEN, K.T. SHAO, J. BELL, A.S. CABANBAN, V.S. TUAN, P. JARAYABHAND, SUHARSONO, A. ALCALA AND I.W. ARTHANA

➤ **The issues relating to the management of the coastal zone** are multi-faceted and some issues are largely intertwined with policy and development goals in larger administrative units. The natural boundaries of reef resources, the processes that support reef ecosystems, and the local or national affiliation of the people who benefit from them may transcend the boundaries of the local management units. Thus, efforts to arrest the decline in fish catch from and loss of biodiversity in reefs require that management interventions and assessment activities are carried out at varying scales. Using genetic markers might provide a definition of management units for coral reef and reef-associated resources and thus contribute to the management of the resilience of this human-environment system at multiple scales.

Much of the biodiversity and reef fisheries resources in developing countries are unlikely to survive without active management. Coral reefs in Southeast Asia, for example, are greatly threatened with more than 80% at risk primarily from coastal development and fishing-related pressures [1]. Millions of coastal dwellers rely on reef resources for food and livelihood. As economies continue to grow and demands on the environment multiply, degradation and unsustainable use of this resource also increase. The management of reef resources depends on a more differentiated understanding of this human-environment system.

Coastal communities are heavily dependent on the reef fisheries. Catch from this fishery is estimated to comprise up to 20–25% of the total production from marine fisheries in countries like the Philippines and Indonesia [2]. The occurrence of over-fishing in east Malaysia, the Philippines, Vietnam and southern China has been documented [3]. Reports show that the maximum sustainable yield (MSY), the limit reference point beyond which immediate and substantial action should be taken to protect harvested stock [4], has been already exceeded for demersal [5], pelagic [6, 7] and reef fisheries [8] in the Philippines. Similar cases occur elsewhere in the region but are less documented. The situation is apparently the same in Vietnam (Long in press) and eastern Malaysia (Abu Talib et al. in press) where growing populations easily turn to fishing as a source of livelihood.

Aside from being unsustainable, over-fishing in the region has implications for species diversity and abundance for the pelagic fisheries [9] and reef fisheries [10]. Biodiversity loss due to harvest is apparent in the local-scale extinctions of reef-associated species such as the sea urchin [11] and the giant clam [12].

REEF CONNECTIVITY AND IMPLICATIONS FOR MANAGEMENT

Conceptually, rehabilitation and sustainability of a reef subject to intense fishing pressure hinge on the availability of new recruits and their success in replenishing resources removed from a reef. Eggs of most reef organisms are fertilized externally, and the majority has a larval phase when the larvae drift for several days through the ocean. Resource managers need information on the dynamics of the source and eventual sink of recruits to design marine reserves, estimate the potential contribution of restocking to rehabilitation efforts, understand mechanisms that maintain biodiversity and maximize gains from a fishery. An area, which is highly dependent on another area, has to be managed differently from one that is primarily self-recruiting [13]. Connectivity among reef systems may lead to situations where different local or national groups harvest the same stock of resources. Thus, management regimes in one area may be ineffective because of competing uses of the resource elsewhere. Such connectivity also has implications for the vulnerability of sink reefs, when the relative sources, which supply recruits, experience massive damage.

Scale effects are a challenge to understanding the resilience of the reef resources, since there may be a disparity between their boundaries and the jurisdictional limits of resource managers. The natural boundaries of reef resources, and the processes that support these ecosystems, are defined by the physical structure of the reef, the distribution of particular species of interest, and the variable scales at which processes and interactions that support the system operate. However, management boundaries usually correspond to existing political and administrative systems. There is always a possibility that management goals may be inconsistent among different areas and at different scales. This discrepancy between boundary definitions and management goals requires an approach where management interventions and assessment activities are carried out from the local to the regional scale.

Very little is known about the source and sink dynamics of organisms within reef areas. Undoubtedly reefs are demographically open to some extent because most reef organisms have dispersive larval stages. Furthermore, adult fish may travel large distances to spawn in aggregations. The scale and extent of connectivity among reef areas, however, remains largely inconclusive [14] though they have great implications for the ecological functioning and vulnerability of reef areas. Because management interventions are increasingly spatially explicit, information on resource boundaries and the extent of connectivity is urgently needed.

ESTABLISHING RESOURCE BOUNDARIES AND CONNECTIVITY USING GENETIC MARKERS

Genetic markers in conjunction with phenotypic characters may be a powerful means to identify spatial structures of reef populations. This is because the relationship between the marine ecosystem and the species that inhabit it is mediated

by the genetic variability contained in the component species and the interaction of this variability with the environment. Climatic and oceanic factors that affect marine ecosystems will also affect the nature and organisation of genetic information in species assemblages. Genetic changes within and between populations, in turn, can profoundly influence the distribution, abundance and persistence of marine species. Understanding of the complex interaction between the genetic material in marine species and the environment is rather rudimentary. Nevertheless, genes play an important and central role in shaping morphological phenotypes and behavior.

Genetics approaches have established their importance in fisheries management primarily as a tool to define stock boundaries, to identify the species of specimen obtained from traded fish [15], estimate effective population sizes, detect population bottlenecks and identify escapees from aquaculture facilities [14]. Examples of the use of the approach in stock identification, however, are less common. Genetic markers may be inadequate in situations where even low levels of adult or larval mixing occur. Thus, the management applications of molecular genetics to marine fisheries has been largely unfulfilled because of limited ability of the markers to detect differences among populations at scales relevant to managers. Statistical analyses to estimate gene flow have been limited by the assumption that populations are in mutation-drift equilibrium, a requirement unmet by newly established populations and those that are subject to very high levels of exploitation.

In recent years, however, the discovery of hypervariable microsatellite markers in nuclear DNA has ushered in renewed interest in the use of genetic markers for fisheries management. These markers have high mutation rates, are easy to score and relatively inexpensive to screen from a large number of individuals. The real advantage in the use of microsatellite markers, however, is in the statistical analysis methods. New methods have been developed to assign individuals to their populations of origin with a high degree of confidence. This will allow investigators to infer migration routes and estimate disperal rates among semi-discrete populations and assess parentage and relatedness [see 16, 17, 18 and 19]. There are not many published studies on the use of microsatellite markers to address marine fish species, thus the technique is still unproven in terms of its utility in fisheries management issues. The current challenge is to demonstrate empirically the use of these markers to fisheries management, particularly in a developing country.

AN EMPIRICAL STUDY AT DIFFERENT SCALES

Evidence from a large-scale genetic study of 16 sites in Malaysia, the Philippines, Indonesia, Vietnam, Taiwan and the Solomon Islands suggests the existence of four major subprovinces in the South China Sea and adjacent areas. This result is based on the observed genetic structure of populations of the unexploited coral reef fish species [20] (see Fig. 1). The number of sites surveyed and the use of slow mutating allozymes as genetic markers have limited the study. Patterns observed are most probably established at the ecological time scale because they are highly correlated with the general flow of present day surface currents in the South China Sea. This is a first step in testing the viability of using genetic markers to identify management relevant boundaries for coral reef resources in the developing countries in Southeast Asia.

The project is currently on its second phase using commercially important coral reef associated species (the damselfish, fusiliers and the sandfish) to establish the viability of

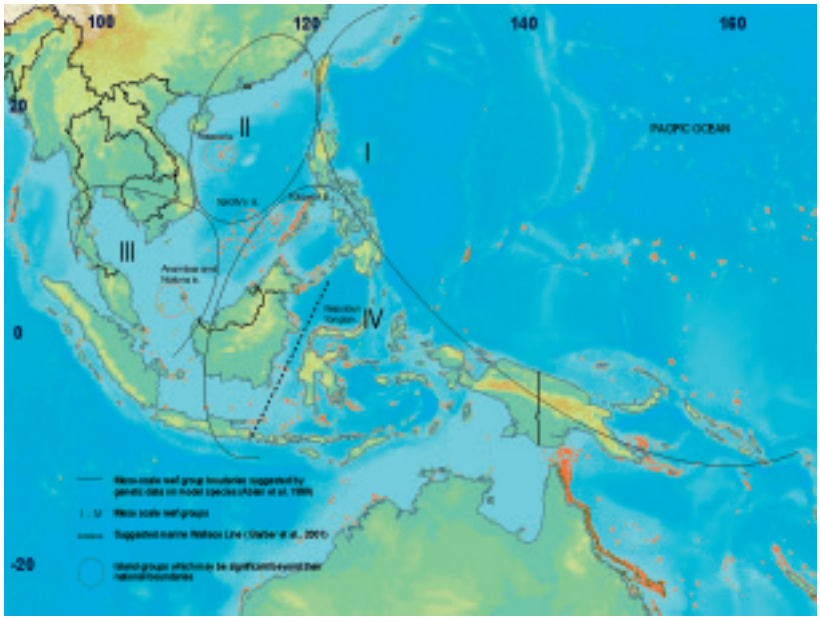

Fig. 1. Transboundary units for the management of coral reef resources based on genetic profiles of selected reef fish species.

using faster mutating DNA markers and new statistical analyses methods to establish resource boundaries and estimate connectivity among reef areas at the scale of tens to thousands of kilometers within the South China Sea, the Gulf of Thailand and the Mindanao Sea in the Central Philippines.

The project has heavily invested in consultation with resource managers and researchers in other disciplines to make sure the sites and species used in the study are relevant. The project also aims to identify cost-efficient techniques and establish a network of researchers and laboratories to ensure that the benefits far outweigh the cost of using molecular genetics approaches in managing fisheries.

ACKNOWLEDGEMENTS

The research project is supported by funds from the John D. and Catherine T. MacArthur Foundation, the United Nations Development Program (UNDP), the International Coral Reef Action Network (ICRAN) and the WorldFish Center.

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REFERENCES to this article are included on the IHDP website at **www.ihdp.org/update0203/references.htm**

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THE RESILIENCE ALLIANCE


Photo: B. Walker

➤ **The Resilience Alliance (RA) is a consortium of institutions that investigate issues of resilience in complex social-ecological systems. Brian H. Walker is Program Director and Chair of the Board of Members of the Resilience Alliance. He is also a research scientist at the Commonwealth Scientific and Industrial Research Organisation (CSIRO) in Canberra, Australia.**

***Q:** Dr. Walker, how do you define 'Resilience'?*

In general, resilient systems can absorb shocks without changing their essential structure and function. We define resilience as the amount of change a system can undergo and still retain the same control on function and structure; the degree to which the system is capable of self-organisation; and the degree to which the system expresses capacity for learning and adaptation.

The second and third parts of this definition are really corollaries of the first. The self-organising ability of a system, and its *adaptive capacity*, strongly influence the amount of disturbance the system can experience without changing to a different mode of operation. With regard to the notion of resilience, there is some misconception in the literature about the phrase "stable state", or "alternative stable states". The correct phrase is really "alternate configurations of states". There is seldom, if ever, just one particular state of a system that enables that system to function in the same way. In an alternate configuration the system functions in a different way. This is important to us humans, because we happen to like some particular configurations, for example, nice clean lakes, productive grassy rangelands, and don't like it when the system suddenly flips into an alternative one, such as eutrophic, smelly lakes or unproductive rangelands with shrub thickets.

***Q:** What do you mean by 'adaptive capacity'?*

Adaptive capacity means the ability of actors (humans and non-human species) in a social-ecological system to cope with novel situations without losing options for the future. Systems with high adaptive capacity are able to reconfigure themselves without significant declines in crucial functions in relation to primary production, hydrological cycles, social relations and economic prosperity.

***Q:** You are the Program Director and Chair of the Resilience Alliance. What is the history of this Alliance?*

It really began a couple of decades ago in the form of a loose and intermittent collaboration amongst a group of scientists who had worked or were working with Prof. C.S. (Buzz) Holling, at the University of British Columbia and later at the University of Florida. Buzz wrote the definitive paper on resilience in 1973, and it struck a chord with many like-minded ecologists. A small group of these people began collaborating and around 1995, Buzz formed the Resilience Network as a joint programme with Prof. Karl-Goran Maler, Director of the Beijer Institute of Ecological Economics. When that programme ended, the Resilience Alliance was formed as an incorporated body, thanks to a grant from the Rockefeller Foundation.

***Q:** How is the Resilience Alliance operating?*

We have 15 members of the Board of the RA, and an appointed Science Board to keep us scientifically honest and focussed. The Board of Members appoints an Executive Director, who is now Dr. Phil Taylor, and a half-time Program Director. Membership is by invitation to maintain complementarity across disciplines and problems/regions around the world. Membership fees maintain the running of the electronic journal Conservation Ecology; other work is supported through grants from foundations. We use the Internet extensively and are also developing a Portal system on our website (**www.resalliance.org**) for discussion sessions and working groups of members; a lot of information is open to anyone. The RA owns and runs Conservation Ecology and uses the Internet as a dynamic publishing medium and a means of holding dialogues.

***Q:** Could you give some examples of regional case studies?*

The case studies vary in their aims, the problems they are addressing and the scales involved, and they are in various stages of development. A few, e.g., the detailed analysis of the Everglades system with the policy implications of various 'mental models' of the system, were based on earlier research. Others, like the Mae-Ping valley study in Northern Thailand, are starting from scratch. In Mozambique, Tim Lynam has been working with local stakeholders in the region around Gorongoza National Park, using Bayesian Belief Networks, to examine their understanding and options for sustainable development in the region that will maintain and use the wildlife resource. We are now in the process of summarising what we know about the case studies for a comparative analysis meeting in September.

***Q:** In which areas would you encourage co-operation between the RA and the IHDP scientific community?*

A key area for IHDP interests is in regard to the role of institutions in building adaptive capacity. Elinor Ostrom and her group are our leaders in this area. It is important for us to be able to link the social dynamics with the ecosystem dynamics to address the resilience of the coupled system. Another area that I believe holds much promise is in how rules evolve in resource use systems. Elinor is completing a book that addresses the role of rules. It is clear that in social-ecological systems, the trajectory that the system follows through time is determined by the interacting set of rules, from government regulations through to agent decision rules. It is an area that needs a lot of attention. I hope that some collaboration might be possible in this area.

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INTERVIEW BY ELISABETH DYCK

SCENARIO DEVELOPMENT AND RESILIENCE

Local and global examples of resilience of social-ecological systems | BY ELENA BENNETT

➤ **Interest in sustainable development and conservation has** moved considerations of the future to the centre of many policy discussions [1]. Yet, we do not know most aspects of how the future will unfold. For example, is our current path sustainable? What actions would make it more sustainable? What surprises and critical uncertainties could deflect social-ecological systems in novel directions? How resilient is the global social-ecological system to such surprises? How do ecological, social and economic processes interact?

Prediction and forecasting, while well suited to thinking about the future of well-understood or deterministic systems, are not effective for understanding the far future of complex social-ecological systems. These systems are inherently uncertain, exhibit emergent properties, and change reflexively due to human choices. Scenario development has emerged as a key methodology for scanning alternative futures, identifying critical uncertainties, and guiding action [2, 3]. Scenarios are sets of plausible narratives about the future that can be used for decision-making and planning [4]. Developing scenarios is an iterative process, involving numerous storylines, quantification of driving forces and indicators, and revisions together with user groups. At the end of the process, the scenarios can be used to analyse policy alternatives [5].

Two current projects use scenarios to explore human actions that build or diminish resilience. One, in the Northern Highlands Lake District of Wisconsin, USA, is regional. The other, part of the Millennium Ecosystem Assessment, is global in scope.

In the Northern Highlands Lake District of Wisconsin (NHLD), a lake-rich area of 5,000 km^2, a small team of ecologists, ecosystem managers, property owners, business people and other stakeholders collaborated to explore the future of ecosystem services in the region [6]. The NHLD is becoming increasingly developed due to tourism and the construction of second homes. While some residents commend the economic growth stimulated by the development, others are worried about the effect development may have on the lakes. Stakeholders and scenario planners have worked together to develop scenarios to address resilience and sustainability of various development paths.

Three scenarios examined resilience and provision of ecosystem services along several development paths. In the first scenario, development decreases, leading to a decreased tax base and reduction in lake management. At the end of this scenario, water quality is fair, with occasional local disease and turbidity problems, and fish populations are robust but less valuable. In the second scenario, development increases and society focuses on protecting certain lakes while allowing others to be fully developed. Generally, rural lakes are protected and urban ones are exploited. By the end of the scenario, water quality and fishing near towns are of relatively poor quality while water and fish populations in rural lakes are high quality. However many rural residents feel that town residents have expropriated their ecosystems. In the final scenario, development increases and initial differences among lakes and their associated communities are amplified as new arrivals choose locations that match their interests. The focus on managing individual lakes leads to conflict over issues that involve connections among lakes, such as road-building, boating, fishing, and water quality. While many residents are unhappy with regional changes, most feel that their lakes are well managed.

The three scenarios illustrate the causal mechanisms and linkages between variables of the system. They also help residents and ecologists think about paths to the future, begin a process of evaluating policies in terms of how they shape the ability of the NHLD to respond to potential risks and benefit from possible opportunities. Participants identified several sources of resilience. The large undisturbed forests and lakes help the area absorb shocks, such as invasive species. The strong sense of place among residents leads to great concern about managing the area. Participants also identified an ability of residents to self-organise to solve problems in the region. If something goes wrong, it may be possible to isolate it, contain it, learn from it and protect the rest of the region.

At a global scale, the Millennium Ecosystem Assessment (MA) is a four-year process designed to improve the management of the world's ecosystems by meeting the needs of decision-makers and the public for peer-reviewed, policy-relevant scientific information on the condition of ecosystems, the consequences of ecosystem change, and the options for human responses (**www.millenniumassessment.org**). The focus is on provision of ecosystem services and human well-being.

The Scenarios Working Group of the MA is examining the future of ecosystems and society by developing scenarios that connect possible changes in unpredictable, uncontrollable drivers to human demands for ecosystem services, the services themselves, and the aspects of human welfare that depend on them. We will develop global scenarios that are linked explicitly to ecosystem services and the human consequences of ecosystem change. The MA will consider ecological feedbacks, particularly those that emerge from smaller scales to affect processes at larger scales. The MA scenarios will examine resilience and provision of ecosystem services along four development trajectories. The primary differences in the trajectories are whether global systems are highly linked or primarily regionalized, and whether the response to ecological problems is primarily proactive or reactive. The MA will use scenarios as a tool to help decision-makers think creatively about paths to the long-term future and to encourage discussions of ecological feedbacks and resilience.

REFERENCES to this article are included on the IHDP website at **www.ihdp.org/update0203/references.htm**

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LOCAL MANAGEMENT OF DYNAMICS AND DIVERSITY

How rural farmers in Northern Tanzania build social-ecological resilience | BY MARIA TENGÖ

➤ **On the escarpment rising above Lake Manyara in northern** Tanzania lies a settlement enclosed by a rim of higher mountains and two forest reserves. The area – known locally as *Iraqw'ar Da/aw* and in Kiswahili as *Mama Issara* – has been noted by early colonial observers and more recent researchers for its locally developed farming practices, which have sustained cropping on permanent fields for at least two centuries. Farming in Mama Issara, however, has not been static over this time. New crops and farm components, such as trees, have been incorporated, and land use has changed in response to demographic changes and other drivers. Moderate soil fertility and an adverse topography are major constraints for farming, which is performed primarily with hand hoes on slopes and valley bottoms. The climate is sub-humid, and a fair amount of rainfall allows for cropping almost all year round. However, rainfall is variable, both within and between years, and farmers in Mama Issara must cope with unpredictability in the onset, intensity, and amount of precipitation, as well as sudden outbreaks of pests and diseases of crops and livestock.

Photo: M. Tengö

A cattle herding farmer in Mama Issara, Tanzania

Dealing with change and unpredictability are central challenges for the sustainable management of ecosystems all over the world. This requires an understanding of the dynamic interactions between social and ecological processes. Resilience (*sensu* Holling, 1973) of linked social-ecological systems has been related to three characteristics: a) the capacity to absorb shock while maintaining function, b) components for renewal and reorganisation following change, and c) the capacity for adaptation and learning. Thus, resilient systems can cope, adapt or re-organise without sacrificing the provisioning of ecosystem services that the society depends on. Learning from cases of success and failure in local ecosystem management can teach us important lessons on how resilience can be built in linked social-ecological systems.

Using interviews and participatory mapping techniques, a multitude of management practices for dealing with ecosystem dynamics were found in Mama Issara. They were analysed according to a framework of ecosystem services important for human livelihoods. The study, which was carried out as part of the author's PhD-project, identified management practices directed towards the functioning of the ecosystem rather than merely resource output, including indirect processes provided, for example, by wild plant species and distant grasslands and forest areas. Practices of polyculture, mulching and ridge planting enhance ecosystem services such as biological control, nutrient re-cycling and erosion control. The farmers take advantage of a variety of crops and land use niches in time and space in their planning for food production. This diversification of management acts as an insurance against climate fluctuations and localised disturbances, such as pest outbreaks, thus limiting the decrease in overall production and allowing for rapid recovery. In addition, the response to a perceived decline in soil fertility is increased cropping in the more fertile valley bottoms and tree planting to generate income through selling of timber and fruits.

The study also found that the management practices are embedded in a nested set of institutions that structure human interaction with the environment. Certain resources, such as pastures and wetlands, are communal property that is subject to rules controlling extraction. Social networks for exchange of food and labour were found to be important components of rural livelihoods. These social mechanisms link individual farm households to ridge communities, the village and the region. Thus, resource dynamics can be monitored and responded to by individual farmers on a micro-scale, and on wider landscape scales through a set of nested institutions. Together, these features allow for risk-spreading and buffering of local disturbance, and for adaptive response to ecosystem dynamics at several levels.

It is suggested that management practices and social mechanisms in Mama Issara have developed in response to a set of disturbances that are irregular, but recognised and expected. Further, the ability of the local farmers to monitor and respond to changes at field and landscape levels can be crucial for keeping control of slow changing variables in the agro-ecosystem, such as soil degradation and fertility loss, preventing degradation that would drastically change the conditions for sustaining rural livelihoods. However, dealing with novel disturbances caused, for example, by climate change, and coping with globalisation, requires that local institutions be further nested in a regional and national setting.

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REFERENCES to this article are included on the IHDP website at **www.ihdp.org/update0203/references.htm**

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KNOWLEDGE AND INSTITUTIONS

BY SYMA A. EBBIN

➤ **At the Annual Meeting of the International Studies** Association, held in February 2003 in Portland, USA, the IHDP Project on Institutional Dimensions of Global Environmental Change (IDGEC) sponsored two panels examining the cross-cutting theme of knowledge and institutions. The panels were dedicated to the late Virginia Walsh, an IDGEC research fellow and former Executive Officer, who had spearheaded this theme. The German Political Science Association co-sponsored the panels.

➤ **Institutions and the production of knowledge for environmental governance.** In this panel, Oran Young, IDGEC's Project Leader, explored how regimes can influence the questions researchers ask, create expectations regarding answers considered useful, and dictate processes or procedures to be followed in the pursuit of knowledge. Sylvia Karlsson (IHDP) addressed the impacts of globalisation processes on environmental issues and the role of scientific knowledge in pesticides management in developing countries. Antonio Contreras, an IDGEC research fellow, examined the role of civil society in the production of knowledge used in forest governance in Thailand and the Philippines. He also co-authored a paper with Louis Lebel (SARC) and Suparb Pasong (IDGEC SSC), which examined a typology of different knowledge systems and management approaches to forest governance in Southeast Asian countries.

➤ **Knowledge and institutions: empirical evidence from marine systems** was the theme of the second panel. Leslie King (IDGEC SSC) evaluated the impacts of governance regimes on traditional knowledge and management systems of First Nations peoples in British Columbia, Canada, and the implications of emerging fisheries and forest co-management on sustainable environmental governance. IDGEC research fellow Frank Alcock examined the role of salience, credibility and legitimacy in shaping perceptions of scientific information and the implications of institutional structure in bridging stock assessments and fisheries management policies in the US, Canada and Australia. IDGEC Executive Officer Syma Ebbin explored the production and use of knowledge in the management of three US fisheries in New England, Alaska and Washington and implications for legitimacy and acceptance of knowledge. Merrilyn Wasson (IDGEC SSC) presented the legal framework protecting intellectual property and traditional fishers' knowledge of marine resources. Many of the panel papers[1] will form the basis for a special issue of the journal International Environmental Agreements, to be published in 2004.

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[1] The titles of the papers presented are included on the IHDP Website at **www.ihdp.org/update0203/references.htm**

ENVIRONMENTAL FACTORS OF CIVIL WAR

BY MAUREEN WOODROW

➤ **Nils Petter Gleditsch, a member of the Scientific Steering** Committee of the IHDP Project on Global Environmental Change and Human Security (GECHS), is the leader of a working group on the **Environmental Factors in Civil War**. This working group is one of seven in the new Center for the Study of Civil War (CSCW) opened by the Norwegian Minister of International Development at the Norwegian Academy of Science and Letters in Oslo on 6 January 2003. The new Center is within the already established International Peace Research Institute (PRIO) in Oslo and is a long-term multidisciplinary initiative that aims to consider why civil wars break out, how they are sustained and what it takes to end them. The Center has seven working groups including:

1. International Dimensions of Civil War
2. Micro-foundations of Civil War
3. Environmental Factors in Civil War
4. Governance and Peace
5. Global Economic Change and Civil War
6. Values and Violence
7. Conflict Resolution and Peace Building.

The Project on Environmental Factors in Civil War, led by Nils Petter Gleditsch, seeks to understand

➤ the environmental factors in civil war by integrating the traditional literature on environment and resources to that of the geography of conflict;
➤ the relationship between population and demographic growth, natural resource scarcity and/or abundance and armed conflict by contrasting the neo-Malthusian theories of conflict to the cornucopian view;
➤ the ethnic, religious and linguistic distinctions as causes of civil war;
➤ how political and economic factors influence the relationship between the environment and conflicts, by working in collaboration with the working groups on governance and peace and on global environmental change and civil war.

The researchers will develop general theories of environmental conflict and test them empirically and though case studies, the first of which will be Yugoslavia and combine factors of demography, ethnic fears and governance in precipitating civil war. For more information visit **www.prio.no/cscw**

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THE CARIBBEAN FOOD SYSTEMS PROJECT

An Update on GECAFS Research Planning | BY THE GECAFS CARIBBEAN FOOD SYSTEMS PROJECT INTERIM STEERING GROUP

➤ **The IGBP/IHDP/WCRP Joint Project "Global Environmental Change and Food Systems"** has made considerable progress in planning its implementation phase. Regional projects are now starting in the Indo-Gangetic Plain, the Caribbean, Southern Africa and the Eastern Pacific Fisheries. They will be underpinned by cross-cutting research on "Food System Vulnerability" and "Comprehensive Scenarios". This article builds on an earlier UPDATE article (No. 3/2001), summarising progress on the Caribbean Food Systems project to exemplify research questions and approaches GECAFS is taking (see **www.gecafs.org**).

PROJECT BACKGROUND

The food systems of the Caribbean are highly dependent on imports, amounting to about US$ 3 billion in 1999. Revenue for these imports comes primarily from export earnings from banana and sugar, and from tourism, all of which are highly vulnerable to Global Environmental Change (GEC). Of particular concern are potential changes in the frequency, intensity and tracking of tropical storms and hurricanes, and the environmental consequences of adapting the local food provision systems in response to reduced export earnings.

Regional policy priorities include enhanced food security and self sufficiency through increased productivity and diversification of agricultural and fisheries production; improved trade policies and competitiveness through greater export of high quality produce and processed products; enhanced sustainability of the food and agricultural sector and poverty alleviation in rural communities through greater opportunities for rural employment. The question for the GECAFS Caribbean Food Systems project is how will GEC interact with these policy goals?

GECAFS RESEARCH ISSUES

The Caribbean region is characterised by many small island states with diverse cultures, environments and food provision systems; a great dependence on food imports and hence reliance on export crops, tourism and other non-food sectors to provide revenue; considerable susceptibility to weather extremes and changes in preferential export markets; and weak regional-level institutional connectivity.

Against this background, and working under the oversight of an Interim Steering Group, Phase I of the project (April 2002 – March 2003) established a set of overarching questions relating to the three GECAFS Science Themes of "Vulnerability and Impacts", "Adaptations" and "Feedbacks".

➤ **Theme 1:** How will GEC (especially land degradation, variability in rainfall distribution, sea surface temperature, tropical storms and sea-level rise) affect vulnerability of food systems in the Caribbean?
➤ **Theme 2:** What combinations of policy and technical diversification in food harvested and traded for local consumption, in export commodities and in tourism would best provide effective adaptation strategies?
➤ **Theme 3:** What would be the consequences of these combinations on national and regional food provision, local livelihoods and natural resource degradation?

These overarching questions were then refined as "Story Lines" at regional and local levels (see Box).

Phase II will assess and synthesise existing information to build a strong platform for the subsequent main research phase. Phase II output will include an overview report on stresses on food systems (including country reports) and prototype models of Caribbean food provision systems. This phase will also consolidate links between national and regional policymakers, scientists and potential donors, between regional research communities and the international GEC programmes, and produce a Science/Implementation Plan based on the Phase III proposal to attract broader international scientific collaboration.

In the short-term, climate variability and changes in extreme weather events are the most important GEC aspects for the region. While research therefore needs to consider the disruptive effects of hurricanes and tropical storms on key revenue generating industries, it must also consider GEC impacts on land and water resources and availability, and on the vulnerabilities of different sections of societies and countries. These factors offer the opportunity to develop new GEC research agendas of interest to both science and development, and forge new regional and international research partnerships to address them. The project will also demonstrate how GEC research issues are related to regional development needs and how GEC research can help address current, near-term and longer-term issues.

Regional characteristics of political and trading arrangements and alternatives for income generation, issues of social vulnerability and land use change relate to ongoing research in GECHS, IDGEC, IT and LUCC. The IHDP community will have an important role to play in further developing and implementing this research agenda.

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THE GECAFS CARIBBEAN FOOD SYSTEMS PROJECT INTERIM STEERING GROUP includes representatives from Caribbean Agriculture Research and Development Institute; Caribbean Regional Fisheries Mechanism; Caribbean Institute for Meteorology and Hydrology; UN Economic Commission for Latin America and the Caribbean; UN Food and Agriculture Organisation; University of the West Indies; and the GECAFS Executive Committee; **www.gecafs.org**

GECAFS CARIBBEAN PROJECT: LOCAL-LEVEL STORY LINE

Target:	Food systems in resource-poor communities based on fishing and locally produced food crops.
Aim:	To reduce food system vulnerability, especially in relation to changes in climate variability.
Theme 1	How would changes in climate variability and water availability affect food systems of communities on different islands?
Theme 2	How would current national and regional policy instruments (e.g., access to markets, insurance schemes, EEZs) best be adjusted to enhance the effectiveness of technical options for diversifying cropping systems and fisheries so as to reduce vulnerability to GEC?
Theme 3	To what extent would these strategies affect food provision by altering the proportional reliance on local vs. imported commodities, and how would changed land management and associated changes in runoff affect coastal fisheries and other aspects of coastal zone ecology and tourism income based on this?

CHILE'S HUMAN DIMENSIONS COMMUNITY

An IHDP grant supports efforts to establish a national human dimensions committee in Chile |

BY ALEJANDRO LEON STEWART

➤ **Research on the human dimensions of global environ**mental change is an issue of increasing importance in many countries. Since its establishment in 1996, IHDP has played a key role in promoting the creation of National Human Dimensions Committees in over 40 countries. The National Committees bring together interested scientists to work on human dimensions issues related to global environmental change in their countries. They help to identify researchers who could participate in the IHDP science projects as well as identify research themes for the Programme as a whole.

Such is the case in Chile where, thanks to a 'seed grant' from IHDP, a directory of Chilean human dimensions research is currently being compiled. Since Chile is a relatively small country, we presumed that most global change-related research addresses non-human dimensions issues. Thus, a questionnaire was sent to all scientists registered by the national science-funding agency CONICYT, which deals with environmental issues. Preliminary responses indicated that the majority of national researchers focus on biophysical topics, such as climate, biodiversity, forests, soil management, biogeochemical cycles and marine ecosystems.

Most of the research is being conducted by a few leading research centres, including the Universities of Chile, Concepción, Valparaíso and Austral. The University of Magallanes, which hosted a recent meeting of the IGBP Scientific Committee and a related Symposium, and the University of La Serena, have recently opened the Center for Quaternary Studies (CEQUA) and the Center for Advanced Studies in Arid Zones (CEAZA), respectively. These centres have been funded by CONICYT in an attempt to promote research in geographical areas where, so far, science has been poorly funded. It is expected that these centres will encourage interdisciplinary research in the future, and thus also represent an opportunity for developing a human dimensions research agenda in Chile.

Preliminary results of our survey show that most of the ongoing human dimensions research covers issues such as human security, institutions, poverty and population; this represents only about 15% of the bulk of the projects. In many cases, scientists are working in isolation and not as part of a team. Also, some researchers may not even be aware that they are dealing with human dimension issues, but it will be difficult to identify them within the limited time scale of this seed grant.

An example will serve to illustrate the current situation in Chile. A small group of young, highly motivated scientists took advantage of the opportunity of the recent IGBP Scientific Committee meeting, held in January 2003 in Punta Arenas, Chile. These scientists, with valuable collaboration from CONICYT (which funded several graduate students), organised a Symposium on "Global Change: Toward a Systemic Vision" that took place in Punta Arenas on 23-25 January 2003, back-to-back with the IGBP meeting.

The 67 papers presented at the Symposium were related to such topics as the evolution of observations of the climate system, biogeochemical cycles, ocean-atmosphere and other interactions, modelling of processes and impacts of climatic change, and climate and society. The symposium illustrated that there are some well-developed research areas in Chile, such as paleo-climate, atmospheric chemistry, and climate change and glaciers.. The national scientific community working in these areas is well developed and enjoys good international contacts as well as foreign funding. On the human dimensions side, however, much is yet to be done, since there were only a few oral presentations and posters covering human dimensions research topics.

Thus, organising a human dimensions community in Chile poses several challenges for the future. We need to encourage a dialogue between the natural scientists and the few social scientists engaged in human dimensions research. There is an unfortunate tendency to overlook the benefits of this collaboration – which seems to follow the path of what happens internationally – as many Chilean scientists tend to work in isolation, given the competitive nature of the Chilean research funding system. Above all, we have to increase awareness, even among social scientists, to attain a critical mass and the ability to attract the attention of decision- and policy-makers and thus funding for human dimensions research.

There is no doubt that we are at a starting point. We hope that the directory on human dimensions research in Chile will help us to identify the target community for a planned workshop and, at the same time, increase awareness about the urgent need to include human dimensions aspects in our future research.

▼

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➤ The IHDP **UPDATE** newsletter features the activities of the International Human Dimensions Programme on Global Environmental Change and its research community.

ISSN 1727-155X

UPDATE is published by the
IHDP Secretariat
Walter-Flex-Strasse 3
53113 Bonn, Germany.

EDITOR: Elisabeth Dyck, IHDP; elisabeth.dyck@chello.at

LAYOUT AND PRINT: Köllen Druck+Verlag GmbH, Bonn+Berlin, Germany

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IN BRIEF

➤➤➤ **UNFCCC officials visit IHDP Secretariat.** The Executive Secretary of the United Nations Framework Convention on Climate Change (UNFCCC), **Joke Waller-Hunter**, visited the IHDP Secretariat in early March 2003, accompanied by several senior members of the Convention Secretariat. The two Secretariats are almost neighbours, located only a couple of kilometres apart on the western bank of the River Rhine in Bonn. Held just prior to the annual meeting of the IHDP Scientific Committee, this visit offered an excellent opportunity for a meeting with our leading scientists and IHDP management. It intended to initiate an informal dialogue on the role of human dimensions research in the implementation of the UNFCCC. In October 2002, IHDP, together with its partner programmes IGBP and WCRP, was invited to present its activities at the 17th meeting of the UNFCCC Subsidiary Body on Scientific and Technological Advice (SBSTA) in Delhi, India. Following a decision by SBSTA, a regular dialogue between the UNFCCC and the international global environmental change research programmes is envisaged, to which IHDP would be pleased to make contributions.

Photo: E. Dyck

Joke Waller-Hunter, Executive Secretary of the UNFCCC

➤➤➤ **IHDP Scientific Committee Meeting.** On 5-7 March 2003 the IHDP Scientific Committee (SC) held its 10th meeting in Bonn, Germany. The extensive agenda included presentations by IHDP's core projects and by joint projects, and discussions of new initiatives (Urbanisation, Land, LOICZ and Health), cross-cutting themes, financial issues, future research, networking activities and capacity building. Strategic planning and visions for IHDP's future were at the centre of the discussions. The SC decided to undertake an internal and external evaluation of IHDP's research and prepare synthesis publications. **Roberto Sánchez-Rodríguez** was appointed unanimously as Vice-Chair of the IHDP SC, in addition to **M.A. Mohamed Salih**. An Executive Committee was formed, including SC Chair **Coleen Vogel**, the Vice-Chairs and Executive Director **Barbara Göbel**. The Committee will develop a consistent strategy for IHDP for the next years and set up mechanisms to put the plans into action. The next meeting of the IHDP Scientific Committee will be held on 22-24 March 2004.

Photo: E. Dyck

Roberto Sánchez-Rodríguez

➤➤➤ **IHDP Secretariat.** The composition of the Secretariat staff will undergo some changes in the months to come, as some of our colleagues will leave at the end of their contracts on 30 June. **Sylvia Karlsson** (International Science Project Co-ordinator) has been accepted for post-doctoral research at Yale University, USA. **Elisabeth Dyck** (Information Officer and Editor of UPDATE) has recently completed an MBA programme with the Open University, UK, and is now looking for new challenges. **Denise Butler** (Administrative Assistant) will leave the Secretariat for personal reasons and **Lisa Jibikilayi** (Administrative Assistant) will pursue her career in Berlin. The Secretariat is in the process of recruiting replacements for these positions. We wish our colleagues all the best for their future careers.

➤➤➤ **Award for IDGEC Researcher.** At the 2003 Annual Meeting of the International Studies Association (ISA), **Syma Ebbin**, Executive Officer of the IHDP Project on Institutional Dimensions of Global Environmental Change (IDGEC), was awarded the Lee Bennett Award for the best paper presented by a post-doctorate at the ISA Northeast Region Conference in Providence, Rhode Island, USA, in November 2002. Her paper was entitled, „Fish and Chips: Cross-cutting Issues and Actors in a Co-managed Fishery Regime in the Pacific Northwest".

➤➤➤ **IT Reference Manager.** The International Project Office of the IHDP Project on Industrial Transformation (IT) recently compiled a web-based reference manager on IT research. The manager is a tool for searching the IT database for papers, books and reports, which the IT Project and its Scientific Steering Committee considered interesting and relevant for understanding socio-technological transformations. The manager is not yet comprehensive; it represents only a first screening of literature relevant to IT. It includes all references that supported the generating of the IT Science Plan and the results of a number of IT endorsed workshops, projects and activities. The reference manager will be constantly improved to serve the IT community in its research on alternative development pathways that have a significantly smaller burden on the environment. Should you have any interesting literature for inclusion in the database, or comments on the reference manager, please contact **Anna.J.Wieczorek@ ivm.vu.nl**. The reference manager can be accessed on the IT website: **http://130.37.129.100/english/o_o/instituten/IVM/research/ihdp-it/reference.htm**

➤➤➤ **TERI.** The Tata Energy Research Institute in Delhi, India, has changed its name to TERI, The Energy and Resources Institute. The new name marks a new phase in the life of the institute, but also reaffirms the traditions, values, and work culture established over the years since TERI was founded in 1974 and began its own research activities at the end of 1982. It is an independent, non-profit institute engaged in research, training, information dissemination, and other activities focused on natural and human resources, with a special interest in sustainable energy and the environment. In February 2003, TERI was host of the "South Asia Conference on Transitions towards Sustainable Development", organised jointly with the IHDP Project on Industrial Transformation (IT) to discuss strategies for industrial transformation in South Asia (**www.teriin.org**).

MEETING CALENDAR

➤➤➤ *4-13 June 2003 – Bonn, Germany*

18th Sessions of the UNFCCC Subsidiary Bodies
Subsidiary Body for Implementation (SBI) and Subsidiary Body for Scientific and Technological Advice (SBSTA)
Contact: www.unfccc.org

➤➤➤ *16-18 July – Geneva, Switzerland*

International Conference on the Impact of Global Environmental Problems on Continental and Coastal Marine Waters
Organised by NEAR, CESNE, University of Geneva, co-sponsored by WHO
Contact: www.unige.ch/sciences/near/welcome.html

➤➤➤ *10-14 August – Stockholm, Sweden*

World Water Week In Stockholm
including the 2003 Stockholm Water Symposium
Contact: www.siwi.org

➤➤➤ *30 August- 6 September – Grindelwald, Switzerland*

2nd International Swiss NCCR Climate Summer School
Climate Change: Impacts of Terrestrial Ecosystems
Contact: nccr-climate@giub.unibe.ch
www.nccr-cFlimate.unibe.ch

➤➤➤ *23-25 August 2003 – Change Islands, Newfoundland, Canada*

Vulnerability in Coastal Zones: Adapting to a Decade of Change and Planning for the Future
Organised by IHDP-GECHS and the Ocean Management Research Network (www.omrn.ca)
Contact: Maureen Woodrow, GECHS IPO
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➤➤➤ *4-9 September – Norwich, UK*

The 3rd Sustainability Days: Connecting environmental research ... with the transition to sustainability
Organised by the Potsdam Institute for Climate Impact Research; hosted by the University of East Anglia, UK
Contact: www.pik-potsdam.de

➤➤➤ *16 -18 October – Montreal, Canada*

2003 Open Meeting of the Human Dimensions of Global Environmental Change Research Community
Co-sponsored by IHDP
Contact: http://sedac.ciesin.columbia.edu/openmeeting

➤➤➤ *1-4 December 2003 – Morelia, Mexico*

Open Science Conference: „Global Change and the Terrestrial Human-Environment System"
Convened by GCTE/IGBP/LUCC/IHDP
Contact: www.gcte.org
www.geo.ucl.ac.be/LUCC/lucc.html

PUBLICATIONS | NEW BOOKS

Navigating Social-Ecological Systems Building Resilience for Complexity and Change

By Fikret Berkes, Johan Colding, Carl Folke (eds)
Cambridge University Press,
Nov. 2002; 416 pages;
cloth ISBN 0521815924;
price: $85.00

Drawing on complex systems theory, this book investigates how human societies deal with change in linked social-ecological systems and build capacity to adapt to change. The concept of resilience is central in this context. Case studies and examples from several geographic areas, cultures and resource types are included. The book merges forefront research from natural sciences, social sciences and the humanities into an innovative framework for sustainable systems.

Public Participation in Sustainability Science. A Handbook

Bernd Kasemir, Jill Jäger, Carlo C. Jaeger, and Matthew T. Gardner (eds), Cambridge University Press; 2003;
cloth ISBN 0521818184; paper 0521521440

This book examines how citizens can participate more effectively in sustainability science and environmental policy debates. It discusses designs for participatory procedures, and experiences with their application to issues of global change, as well as specific stakeholders, such as water managers and venture capitalists. Focus group methods were combined with the interactive use of computer models into new forms of participation, tested with six hundred citizens. By combining the results with an examination of issues of interactive governance and developing country participation, the book provides state-of-the-art, practical insights for students, researchers and policy-makers.

Understanding the Dynamics of Technological Transitions: A co-evolutionary and socio-technical analysis

by Frank Geels; Twente University Press; 2002; price 30 €

Technological Transitions are major transformations of societal functions such as transportation, communication, housing and feeding. They do not only involve technological changes, but also changes in user practices, regulations, industrial networks, infrastructure and symbolic meaning. The author develops a conceptual perspective to understand technological transitions, of which technological substitution and co-evolution are two basic processes. This book is of interest to scholars in science and technology, evolutionary economics, innovation studies, policy science and business studies, as well as policy makers and groups working on sustainable transitions and system innovations (www.tup.utwente.nl)

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Building resilience to natural disasters and climate change. As cities grow, so does their exposure and vulnerability to natural disasters.Â Urban resilience goes hand in hand with environmental sustainability. The World Bankâ€™s Global Platform for Sustainable Cities (GPSC) works with mayors in developing countries to transform cities into inclusive and resilient hubs of growth, as part of the Global Environment Facility (GEF)â€™s Sustainable Cities program that is active in 27 cities and 11 countries, and will leverage $1.5 billion over five years. Learn about resilience, sustainability, how resilience complements sustainability, climate change and related trends for building operations success.Â Part 1 of a 2-part article on understanding the link between sustainability and resilience in energy and water efficiency, building envelope, stormwater, and other areas. By Greg Zimmerman, Executive Editor Emergency Preparedness. Other parts of this articlept. 1: This PagePt. 2: High-Performance Issues Link Building Resilience and Sustainability. For at least the last decade, scientists, economists, activists, and politicians have argued fiercely about how best to spend money to address climate change â€” should we admit substantial shifts in the climate are inevitable, and sink money into adap