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Social-Ecological Resilience and Behavioural Responses

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Introduction

A common thread of this volume is the analysis of behavioural responses to environmental issues and environmental change; how socially determined habits of thought and action, from the level of the individual to society as a whole, govern environmental behaviour. A key challenge is to unravel mechanisms behind the creation of habits of thought and action and how they are maintained and possibly reformed, recognizing that behavioural changes have multiple determinants. There is an overarching emphasis on the processes of behavioural change and their dynamic and non-linear nature.

The focus of the volume provides a refreshing contrast to the simplified view and application of individual rationality in for example social cost/benefit analysis, an analysis often promoted as an essential tool to capture the social significance of the environment and help make informed and rational decisions (e.g. Pearce et al. 1989). Such an analysis does not take into account the inherent complexities and resulting uncertainties associated with dynamic and interdependent human-environmental systems (Pritchard et al. 2001). Preferences and values of people are not necessarily invariable, nor do they exist in a social and cultural vacuum; rather, they are formed and re-formed as part of a social process, part deliberative, part historical (North 1990?). They co-evolve with a diversity of social and environmental variables over a diversity of temporal and spatial scales with processes that

seldom operate in a smooth fashion. Furthermore values and behaviours do not necessarily coincide. There are conflicts and mismatches between values for the environment and human behaviour and there is also inertia to behavioural change (Biel chapter 2; Mårtensson and Pettersson chapter 3). People may be well informed and concerned about environmental issues but the social and institutional context in which they are embedded may offset behavioural responses. For example, trajectories of large technical systems, or socially constructed infrasystems, are difficult to redirect. Infrasystems leave vast and long-lasting imprints on society and constrain behavioural change (Kaijser chapter 7).

But there are also contexts that stimulate behavioural responses such as the interplay between consumers and producers in creating green identities and products (Lindén and Klintman chapter 4), the environmental repositioning of large firms to fit the sustainability discourse in society (Wolff and Zaring chapter 5), the self-organizing responses of the global business community towards sustainable management practices and social responsibility (Hydén and Gillberg chapter 6), lurches of social learning (Lee 1993) and formation of norms and rules for collective action to cope with environmental change (Ostrom 1990, Berkes and Folke 1998). Thus, directing human behaviour towards improved environmental performance and sustainability is not just a simple matter of providing information and policy prescriptions but a complex socio-cultural process. It will require understanding of the contexts that form, shape and reshape habits of thought and action. As stated by Hansson (chapter 8) "the missing link between values and information and actual behaviour is an integrated and coherent understanding of the greater context in which they are imbedded".

The authors of the volume are confronted with "the greater context" from multiple perspectives and at different temporal and spatial scales. Some are faced with contexts that constrain behavioural change; other chapters concern contexts that support such change. Empirical interdisciplinary work crossing the boundaries of the natural and social sciences, inspired by the theories of C.S. Holling, suggest that change in environmental behaviour and resource management is less likely to take place during periods of growth and stable conditions. It is during periods of rapid change (or release in Holling's terminology), often perceived as periods of crisis, and in the following reorganization that renewal and redirection of social pattern and behaviour are most likely to happen (Holling 1986, Holling and Sanderson 1996, Holling 2001). Such periods open up space for transformations, from one behaviour to another, from one perspective to another. It is a time of crisis, but also of opportunity framed by previous experience and social memory of the system (McIntosh 2000;

Folke et al. 2003). Unexpected interactions can occur among previously separate properties that can nucleate an inherently novel and unexpected focus for future good or ill.

Understanding the contexts for how people respond to and shape periods of change and how society reorganizes following change seems to be a largely neglected and poorly understood issue in environmental science and management (Gunderson and Holling 2002). It will most likely require a stronger emphasis on thinking that moves from the perspective of a world in steady state or near-equilibrium to one of complex systems (Holland 1995, Kauffman 1993).

Assessing and evaluating sustainability in the context of complex systems is considered a frontier of interdisciplinary research (Ludwig et al. 2001). New perspectives, concepts and tools about the dynamics of complex systems and their implications for sustainability are now developing in parallel, influencing the natural sciences, the social sciences and the humanities through the work of many people and groups. Complex systems thinking is for example used to bridge social and biophysical sciences to understand climate, history and human action (McIntosh et al. 2000), assessments of regions at risk (Kasperson et al. 1995), syndromes of global change (Petschel-Held et al. 1999) and how to link social and ecological systems for sustainability (Berkes and Folke 1998, Gunderson and Holling 2002, Berkes et al. 2003). It underpins many of the new integrative approaches such as ecological economics (Costanza et al. 1993, Constanza et al. 2001, Arrow et al. 1995) and sustainability science (Kates et al. 2001, Clark et al. 2001). A long-term perspective suggests that stability in the management of complex systems is an illusion that disappears when one chooses a scale of perception commensurate with the phenomena under investigation (van der Leeuw 2000). A long view also highlights the importance of scale interactions across time and space in relation to adaptive renewal cycles of growth, conservation, release and reorganization in social and ecological systems (Gunderson and Holling 2002).

In the remaining part of the chapter I intend to address social responses to environmental change, and in particular to changes in resource and ecosystem dynamics. I will do this using the concept of resilience as a framework for the discussion. Resilience provides the capacity to absorb sudden change, cope with uncertainty and surprises while maintaining desirable functions. Resilience provides the components for renewal and reorganisation following change. Vulnerability is the flip side of resilience: when a social or ecological system loses resilience it becomes vulnerable to change that previously could be absorbed. In a resilient system, change has the potential to create opportunity for development, novelty and innovation. In a vulnerable system even small changes may be devastating. The concept of

resilience shifts perspective from the aspiration to control change in systems assumed to be stable, to sustain and enhance the capacity of social-ecological systems to cope with, adapt to, and shape change. The degree to which the social-ecological system can build and increase the capacity for learning, adaptation and responding in a manner that doesn't constrain or erode future opportunities is a central aspect of resilience (Carpenter et al. 2001, Berkes et al. 2003). The use of the resilience concept in the social sciences is reviewed by e.g. Davidson-Hunt and Berkes (2003), Scoones (1999) and King (1995). Social resilience is discussed in e.g Adger (2000).

The first part of the chapter gives a brief background of interactions and interdependencies between the life-supporting environment and societal development. This background provides an entry into a synthesis of a common pattern of response to environmental change and its implication for sustainability that has recently emerged from both contemporary and historical interdisciplinary studies of resource management systems. The synthesis exposes how socially determined habits of thought and action reinforced by short-term successes have led to ecological and social vulnerability in the longer term. It also highlights that if sustainability is the desirable direction for societal development it will not be sufficient to build an integrated and coherent understanding of only the social context in which environmental behaviours are embedded. The development of an integrated view of coupled social and ecological systems and a coherent understanding of social-ecological contexts need to be nurtured. A few modest attempts in this direction are presented.

The life-support environment and societal development

Earth's life-support systems do not develop in a smooth deterministic fashion. They are complex systems with non-linearities, thresholds and multiple stability domains (Levin 1999). A bundle of disturbances at different temporal and spatial scales – a disturbance regime - are part of ecosystem dynamics and development. The disturbance regime contributes to building healthy ecosystems. Disturbance opens up patches of opportunity for renewal and reorganisation of the ecosystem, for development and evolution. Several studies have shown how increasingly nested human activities in the biosphere are changing disturbance regimes by 1) actively suppressing or removing disturbance, 2) transforming pulse events into persistent disturbance or even chronic stress and 3) by introducing new disturbances. The intensity, severity, duration, spatial distribution, and frequency of disturbances are altered. Combinations of those changes lead to new synergistic effects termed compounded

perturbations that in many aspects are new to organisms and ecosystem dynamics (Paine et al. 1998, Nyström and Folke 2001).

Ecological resilience, the capacity to buffer or absorb disturbance, is required for reorganisation following change (Holling 1986). Ecological resilience contributes in time and space with the network of species, their dynamic interactions between each other and the environment, and the combination of structures that make reorganisation after disturbance possible. Hence, resilience is a key property of the life-support environment. It sustains a flow of essential ecosystem services on which social and economic development depends through the dynamic capacity to absorb disturbance and provides the components for reorganisation, opportunity and novelty.

Throughout history humanity has shaped nature and nature has shaped the development of human society. The main part of Earth's surface has been modified by human activities (Turner et al. 1990) and recently at a much faster pace than earlier in human history. There are neither natural or pristine systems, nor are there social systems without nature. Instead humanity and nature have been co-evolving within the biosphere in a dynamic fashion (Norgaard 1994) and will continue to do so. Human actions are a major structuring factor of the life-supporting environment, and despite tremendous improvements in technological, economic and material well being, in some parts of the world, development of human society in all parts of the world will continue to rely on the capacity of the biosphere to provide ecosystems services and support.

Throughout human history there has been a tendency to homogenize ecosystems for production of certain valuable resources (Redman 1999) a tendency that has escalated since the second World War (McNeill 2000). Homogenisation causes loss of resilience. Ecosystems with reduced resilience may still maintain function and generate services, i.e. may seem to be in good shape. But when faced with an additional disturbance a critical threshold may be reach as a consequence of loss of resilience, and the system may slide into an undesirable stability domain where a large-scale degradation may occur, a pattern observed in both terrestrial and aquatic ecosystems (Scheffer at al. 2001).

A disturbance that earlier triggered a dynamic development of the system may under circumstances of lowered resilience become an obstacle to development. Losses of resilience through impacts on the landscape and seascape will exacerbate the effects of changed disturbance regimes and compounded perturbations and increase the likelihood for shifts into socially undesirable stability domains (Nyström et al. 2000, Jackson et al. 2001). These shifts are sometimes irreversible and in other cases the costs (in time and resources) of reversal are

so large that reversal is impractical. Such shifts may narrow the potential for social and economic development, reduce options for livelihoods, and create environmental refugees as a consequence of the impact on ecosystem life-support.

Hence, the likelihood of rapid environmental transformations and ecological surprises increases with altered disturbance regimes and reduced resilience. Or put in other words – social vulnerability is likely to increase and opportunity for development is likely to be constrained if society erodes resilience (Folke et al. 2002). Such development patterns push society into social traps (Costanza 1987).

The regional pathology of resource management

Human simplification of landscapes and seascapes for production of particular target resources to be traded on markets has generated steady resource flows in the short term. But it has done so at the expense of reduced diversity and it has eroded resilience. Far too often managers seek to command-and-control processes of change for optimal production in simplified landscapes in an attempt to stabilize resource outputs and sustain consumption patterns. Short-term successes of increasing yield in homogenized environments seem to reinforce a social perception of humanity as superior to and independent of nature. Nature can be conquered, controlled and ruled. Further efforts are made to reduce environmental variability and remove disturbance. The life-supporting environment is transformed into an economic sector for production of social value. Short-term successes make managing ecosystem dynamics a marginal issue and as a consequence knowledge, incentives and institutions for monitoring and responding to environmental feedback erode. Short-term successes cause managers to shift their attention from the original purpose to efforts to increase organizational or economic efficiency (Gunderson et al. 1995).

Since disturbance is endogenous to the cyclic processes of ecosystem renewal, from local scales to the biosphere, this type of resource management tends to increase the potential for larger-scale disturbances and even less predictable and less manageable feedbacks, or surprises, from the environment (Gunderson and Holling 2002). Technological systems, or infrasystems, may further mask the feedback from the environment, thereby magnifying the accumulation of disturbance to larger spatial and longer temporal scales (Kaijser chapter 7). The behaviour unconsciously contributes to a modification of the important variables that structure and sustain desirable states (Carpenter et al. 2001). Society becomes more susceptible to surprise and crisis but is ignorant about it. Vulnerability is created without recognizing it (Kasperson et al. 1995).

This pattern of environmental management, briefly summarized and simplified above, has been termed the “pathology of natural resource management” (Holling and Meffe 1996) and has been described for several sectors, in several regions of the world and over different temporal scales (e.g. Regier and Baskerville 1986, Gunderson et al. 1995, Redman 1999, Carpenter and Gunderson 2001). According to Holling (2003) the regional pathology has the following features:

1) The policies and development initially succeed in removing disturbance and enhancing growth,

2) Implementing agencies initially are responsive to the ecological, economic and social forces, but evolve to become narrow, rigid and myopic. They become captured by economic dependents and the perceived needs for their own survival.

3) Economic sectors affected by the resources grow and become increasingly dependent on perverse subsidies.

4) The relevant ecosystems gradually lose resilience to become fragile and vulnerable and more homogeneous as diversity and spatial variability is reduced.

5) Crises and vulnerabilities begin to become more likely and evident and the public begins to loose trust in governance.

In rich regions the resulting crises have led to spasmodic lurches of learning with expensive actions directed to reverse the worst of the consequences of past mistakes. In poor regions the result has been dislocation of people, increasing uncertainty, impoverishment and a poverty trap.

van der Leeuw (2000) characterizes land degradation and the creation of vulnerability as a socio-natural process that has occurred throughout history, a process that highlights the importance of the underlying perception of the socio-natural system. Human drivers of ecosystem change are deeply embedded in cultural values and underlying perceptions (Thompson et al. 1990), and economic production systems and lifestyles, mediated by institutional factors (Lambin et al. 2001). Urbanization and many aspects of globalization tend to distance people from their relation to ecosystem support by disconnecting production from consumption and production of knowledge from its application (Folke et al. 1998). People become alienated both physically and mentally from their dependence on access to resources and ecosystem functions outside the boundaries of their own jurisdiction.

Facing complex co-evolving social-ecological systems for sustainability requires ability to cope with, adapt to and shape change without losing options for future adaptability. It is not about controlling or removing change. The paradox is that the mental model of optimal

management of systems assumed to be stable and predictable has in many respects reduced the potential for development and altered the capacity of life-support ecosystems to buffer change. The less resilient the system, the lower is the capacity of institutions and societies to adapt to and shape change. Managing for resilience is therefore not only an issue of sustaining capacity and opportunity for development, now and in the future, but also an issue of environmental, social and economic security (Adger et al. 2001).

Behavioural responses for social-ecological resilience

Obviously, human environmental responses are more diverse and multiple than sketched above. There are places and societies that practiced sustainable resource use, not merely of resources but entire ecosystems, and even whole drainage basins, and some of their adaptations survive to date (Gadgil et al. 1993, Berkes and Folke 1998). In these societies a pattern of co-evolutionary adaptations between social systems and natural systems must have been the norm (Norgaard 1994), with the adaptations in many cases driven by crises, learning and redesign. Individual preferences seem to have acted in a social context that promoted sustainability of the combined and co-evolving social-ecological system, simply because behaving in a sustainable fashion was a necessity for survival. The co-evolutionary character reflects the fact that social-ecological systems can change qualitatively to generate and implement innovations that are truly creative, in the sense of opportunities for novel cooperation and feedback management.

Some of the most sophisticated co-evolving systems are common-property institutions that have developed over long periods of time (Ostrom et al. 1999). Examples include Spanish *huertas* for irrigation, Swiss grazing commons (Ostrom 1990) and marine resource tenure systems in Oceania (Ruddle et al. 1992). In other areas, such institutions have evolved over a short period of time (in the order of one decade) in response to a management crisis. Examples include the Turkish Mediterranean coastal fishery in Alanya (Berkes 1992) or the watershed-based resource management system in western Sweden (Olsson and Folke 2001). There seem to be social mechanisms in place that respond to ecological feedbacks instead of blocking them out (Berkes and Folke 1998).

Are there behavioural responses that sustain social-ecological systems in a world that is constantly changing? Such issues are addressed through a case study approach in a recent volume (Berkes et al. 2003) focusing on periods of change caused by disturbance, surprise or crisis, followed by renewal and reorganization. Folke et al. (2003) identify and expand on four critical factors highlighted in many of the chapters of the volume, behavioural responses

that interact across temporal and spatial scales and that seem to be required for dealing with resource dynamics in social-ecological systems:

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

Learning to live with change and uncertainty

The first factor emphasizes the necessity of accepting change and living with uncertainty and surprise, and the volume provides examples of strategies of social-ecological management that takes advantage of change and crisis and turns it into opportunity for development. Management that actively behaves like disturbance is one of a sequence of practices - ecological and social - that seems to generate resilience (Berkes and Folke 2002). It appreciates the role of disturbance in development and includes monitoring and ecological knowledge and understanding of ecosystem condition and dynamics embedded in social institutions. Such management practices seem to have developed as a result of actual experience with change and crisis, realizing that not all possible outcomes can be predicted and planned for. Responding based on such experience depends on institutional learning incorporating previous crises, and may help avoid unwanted qualitative shifts in stability domains of resource systems. In this sense, institutions emerge as a response to crisis and are reshaped by crisis (Olsson and Folke 2001). Several of these local resource and ecosystem management strategies and associated institutions presented in the volume resemble risk spreading and insurance building within society, similar to portfolio management in financial markets (Costanza et al. 2000). As suggested by Low et al. (2003) diversity and redundancy of institutions and their overlapping functions may play a central role in absorbing disturbance and in spreading risks, just like diversity and redundancy of species and their function in ecosystem resilience.

Nurturing diversity for resilience

The second factor illuminates the importance of nurturing diversity for resilience, recognizing that diversity is more than insurance to uncertainty and surprise. It also provides the bundle of components, and their history, that makes development and innovation following disturbance and crisis possible, components that are embedded in the social-ecological memory (Folke et

al. 2003). Hence, diversity also plays an important role in the reorganization and renewal process following disturbance. It is in this context that the memory – ecological and social – becomes significant, because it provides a framework of accumulated experience for coping with change. It provides the frame for creativity and adaptive capacity. Social-ecological systems with uniform and static memory, with limited carriers of memory, or few structures for storing and developing memory, seem to be more vulnerable to change and surprise with lower adaptive capacity.

The results of the volume suggest that the experience of the role of disturbance, uncertainty and surprise, and the need to nurture biodiversity and conserve ecological memory for maintaining adaptive capacity, must be stored in the social memory of resource users and managers and be expressed in practices that build resilience. These include conflict resolution, negotiation, participation and other mechanisms for collaboration with rules aimed at maintaining the process of learning and adaptation in situations facing uncertainty and change. It also seems to require a social network with trust and respect and social nestedness for ecosystem management operating at multiple scales.

Combining knowledge systems into institutions

The third factor of environmental response addresses the significance of peoples' knowledge, experience and understanding about the dynamics of complex ecosystems, their inclusion in management institutions, and their complementarities to conventional management. An important aspects is that an adaptive learning process for managing ecosystems for social-ecological resilience should not dilute, homogenize, or diminish the diversity of experiential knowledge systems for ecosystem management, since they may embed lessons for how to respond to change and how to nurture diversity. Scientific understandings of complex adaptive systems and their change could be enriched by insights from local ecosystem management. There is also a need to expand knowledge from structure of nature to function of nature when dealing with complex systems. The potential for learning and building social-ecological resilience by making use of and combining different knowledge systems should be taken seriously.

Furthermore, the significance of incorporating knowledge of ecological processes and dynamics into institutions needs to be recognized. Knowledge acquisition is an ongoing dynamic learning process; perhaps most importantly, it seems to require social networks and an institutional framework to be effective. Flexible social networks and organizations that proceed through learning-by-doing are better adapted for long-term survival than are rigid

social systems that have set prescriptions for resource use. Such flexible institutional arrangements have been judged as inefficient since they look messy and are non-hierarchical in structure. A growing literature on polycentric institutions (McGinnis 2000) is demonstrating that dynamic efficiency is frequently thwarted by creating centralized institutions and enhanced by systems of governance that exist at multiple levels with some degree of autonomy complemented by modest overlaps in authority and capability. A diversified decision-making structure allows for testing of rules at different scales and contributes to the creation of an institutional dynamics important in resilience management.

Thus, it is not effective to separate ecological studies aimed at management from the institutional framework within which management takes place. Understanding ecosystem processes and managing them is a progression of social-ecological co-evolution, and it requires learning and accumulation of ecological knowledge and understanding in the social memory (McIntosh 2000). In that sense, a collective learning process, that builds knowledge and experience with ecosystem change, evolves as a part of the institutional and social memory, and it embeds practices that nurture ecological memory.

Creating opportunity for self-organization

The forth factor brings together the behavioural responses above in the context of self-organization, including scale, governance and external drivers, and emphasises the significance of the dynamic interplay between diversity and disturbance (Folke et al. 2003). Both diversity and disturbance are parts of sustainable development and resilience and their interaction needs to be explicitly accounted for in an increasingly globalized and human dominated biosphere (Gunderson and Holling 2002).

The learning process is of central importance for social-ecological capacity to build resilience. It is important that learning processes include operational monitoring and evaluation mechanisms in order to generate and refine ecological knowledge and understanding into management institutions. This is the focus of adaptive co-management in which institutional arrangements and ecological knowledge are tested in an ongoing trial-and-error process. Adaptive co-management draws on social-ecological memory and is informed by both practice and theory. It relies on the participation of a diverse set of interest groups operating at different scales. However, creating platforms for conflict resolution and participation by various interest groups for learning and knowledge creation will not be sufficient for sustainability. It requires the context of the dynamic interplay between diversity

and disturbance in resilience. Ecological knowledge and understanding of this interplay is a necessity and social-ecological memory frames the process.

It has been suggested that diversity in functions and in response among local level resource management systems, from the individual level to organizations and institutions (Burger et al. 2001, Westley 2002), enhances performance so long as there are overlapping units of government that can resolve conflicts, aggregate knowledge across scale, and insure that when problems occur in smaller units, a larger unit can temporarily step in (Low et al. 2003). Cash and Moser (2000) propose that governance for linking global and local scales should utilize boundary organizations, utilize scale-dependent comparative advantages, and employ adaptive assessment and management strategies. Governments should nurture the self-organizing ability of actors to voluntarily develop new norms and codes of conduct for sustainability (Hydén and Gillberg chapter 6) and create space for flexible and innovative collaboration towards sustainability (Folke et al. 2002).

Multi-level governance of complex ecosystems needs constant adjustment, which requires innovation and experimentation (Shannon and Antypas 1997, Imperial 1999). Olsson and Folke (2001) describe the development of watershed management by a local fishing association in a multi-level governance system faced with internal and external ecological and social change. The social change included devolution of management rights, which provided an arena for local users to self-organize and developed, refine, and implement rules for ecosystem management. Not only do these people respond to change but by doing so they learn, develop a social memory and build adaptive capacity to deal with future change in the multi-level governance system. A parallel Working with such ‘open institutions’ is essential for dealing with ambiguity of multiple objectives, uncertainty and the possibility of surprising outcomes (Shannon and Antypas 1997, Kasperson and Kasperson 2001). Such emergent governance (Shannon, SUNY Buffalo Law School, pers.comm.) that creates new institutional platforms for adaptive management is evolving in many places.

Concluding remarks

Not social, not economic, not ecological – a combination. The volume focus on the social context of environmental behaviour and discusses constraints and opportunities for behavioural change towards sustainability.

Concl, Human-nature scale and coevolution – från Resilience document. Koppla till Hydén/Gillberg artikeln. Lyft fram att the environment is not a sector. Old time view. Now it

is time to look for sustainable solutions over the social and natural sciences. Natural sciences have been mobilizing for a long time, e.g shift within the ESA, not the social first and than the natural, but together, not look for explanation and solutions only within the social systems – will not lead to societal-environmental sustainability. Need to have social mechanisms that respond to environmental feedback. Otherwise even the best social (in isolation) policy may lead to the pathology.

Building social-ecological resilience for sustainability requires a fundamental shift in thinking and perspective from assuming that the world is in steady-state and can be preserved as it is, by focusing on preventing and controlling change, to a recognition of change being the rule rather than the exception, and thereby concentrating on managing the capacity in complex adaptive social-ecological systems to live with change and shape change.

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