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Social and ecological resilience: are they related?

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Abstract: This article defines social resilience as the ability of groups or communities to cope with external stresses and disturbances as a result of social, political and environmental change. This definition highlights social resilience in relation to the concept of ecological resilience which is a characteristic of ecosystems to maintain themselves in the face of disturbance. There is a clear link between social and ecological resilience, particularly for social groups or communities that are dependent on ecological and environmental resources for their livelihoods. But it is not clear whether resilient ecosystems enable resilient communities in such situations. This article examines whether resilience is a useful characteristic for describing the social and economic situation of social groups and explores potential links between social resilience and ecological resilience. The origins of this interdisciplinary study in human ecology, ecological economics and rural sociology are reviewed, and a study of the impacts of ecological change on a resource-dependent community in contemporary coastal Vietnam in terms of the resilience of its institutions is outlined.

Key words: cultural geography, ecological resilience, human ecology, resource dependency, sustainable development.

I Introduction

The concept of resilience is widely used in ecology but its meaning and measurement are contested. This article argues that it is important to learn from this debate and to explore social resilience, both as an analogy of how societies work, drawing on the ecological concept, and through exploring the direct relationship between the two phenomena of social and ecological resilience. Social resilience is an important component of the circumstances under which individuals and social groups adapt to environmental change. Ecological and social resilience may be linked through the dependence on ecosystems of communities and their economic activities. The question is, then, whether societies dependent on resources and ecosystems are themselves less resilient. In addition, this analysis allows consideration of whether institutions

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themselves are resilient to change. Institutions in this case are defined in the broadest sense to include habitualized behaviour and rules and norms that govern society, as well as the more usual notion of formal institutions with memberships, constituencies and stakeholders. This broad definition is important because institutional structures such as property rights, govern the use of natural resources creating incentives for sustainable or unsustainable use. Hence they are a central component linking social and ecological resilience.

The article illustrates these themes through a review of the emerging ideas at the interface of ecology, ecological economics and rural sociology. It also presents an exploration of these themes by examining mangrove conversion in one site in northern Vietnam. Market liberalization and the privatization of mangroves in this case reduce ecosystem as well as social resilience. This loss of resilience is associated with negative impacts on livelihoods and, in the context of the institutions of common property management, collective institutional resilience is also undermined.

There is a long history of examining the resilience of ecological systems and their persistence in the face of human intervention. Evidence on the history of human use of ecosystems suggests an inevitable decline in ecosystem resilience with technological lock-in and reductions in diversity (Holling and Sanderson, 1996). Yet the concept of resilience has not effectively been brought across the disciplinary divide to examine the meaning of resilience of a community or a society as a whole. Is resilience a relevant term for describing communities? Is there a link between social resilience and ecological resilience? And do institutions exhibit resilience?

In addition to these issues, the concept of resilience is clearly related to other configurations of environment society relationships such as vulnerability and criticality, some of which have an explicit spatial dimension to these social processes. Analysis of vulnerability as a social phenomenon also has a long tradition within cultural geography and the critical questions of food security and famine (Watts and Bohle, 1993). It is related to the study of criticality (a concept applied spatially at different scales) and to security (Kasperson *et al.*, 1996).

Social vulnerability is the exposure of groups of people or individuals to stress as a result of the impacts of environmental change. Stress, in the social sense, encompasses disruption to groups' or individuals' livelihoods and forced adaptation to the changing physical environment. Social vulnerability in general encompasses disruption to livelihoods and loss of security. For vulnerable groups such stresses are often pervasive and related to the underlying economic and social situation, both of lack of income and resources, but also to war, civil strife and other factors (see Chambers, 1989). For natural ecosystems, vulnerability can occur when individuals or communities of species are stressed, and where thresholds of potentially irreversible changes are experienced through environmental changes. Social vulnerability to environmental change and other causes of vulnerability can be observed at different scales and in relation to a range of phenomena such as human-induced risks or natural hazards (Klein *et al.*, 1998; Adger, 1999). Resilience increases the capacity to cope with stress and is hence a loose antonym for vulnerability.

The concept of criticality is distinct from vulnerability. Environmental criticality 'refers to situations in which the extent or rate of environmental degradation precludes the continuation of current use systems or levels of human well being, given feasible adaptations and societal capabilities to respond' (Kasperson *et al.*, 1995: 25). Thus

criticality is a state of an area or region which incorporates various attributes including environmental degradation and some aspects of human adaptation (Kasperson *et al*., 1995: 8). The concept of environmental criticality is therefore applied to geographical areas or to resource systems. A region may exhibit criticality without the people living there necessarily being vulnerable to environmental change if, for example, the criticality is related to some other aspect of resource use such as ecosystem fragility.

Analysis of vulnerability of different social groups and the institutional architecture which determines resilience in the context of environmental change is an emerging research issue (Adger and Kelly, 1999). There is a critical need that such a concept of social resilience is sensitive to the institutional context, yet is able to be observed in a meaningful manner. Social resilience has economic, spatial and social dimensions and hence its observation and appraisal require interdisciplinary understanding and analysis at various scales. But it is important to note that, because of its institutional context, social resilience is defined at the community level rather than being a phenomenon pertaining to individuals. Hence it is related to the social capital of societies and communities.

II Defining resilience

The resilience of an ecological system relates to the functioning of the system, rather than the stability of its component populations, or even the ability to maintain a steady ecological state (Pimm, 1984; Holling *et al*., 1995; Perrings 1996; Gunderson *et al*., 1997). Resilience in ecological systems is not easily observed, and there seems at present to be no agreed relationship, for example, between the diversity of ecosystems and their resilience (Pimm, 1984; Naemm *et al*., 1994; Tilman, 1997). Thus many tropical terrestrial ecosystems have stable and diverse populations but are relatively low in resilience, while similar ecosystems in temperate regions with apparently low diversity can exhibit greater resilience. Coastal and estuarine ecosystems are typically of low species diversity since they experience periodic physical changes and have a high degree of organism mobility. Yet Costanza *et al*., (1995) argue that such ecosystems are highly resilient because of their high levels of functional diversity.

Resilience can be defined in many ways. It is the buffer capacity or the ability of a system to absorb perturbations, or the magnitude of disturbance that can be absorbed before a system changes its structure by changing the variables and processes that control behaviour (Holling *et al*., 1995). By contrast other definitions of resilience emphasize the speed of recovery from a disturbance, highlighting the difference between resilience and resistance, where the latter is the extent to which disturbance is actually translated into impact (see Figure 1). It is important to note that these definitions, shown for a population in the graphical representations in Figure 1, are most relevant at the ecosystem scale. It is argued by many ecologists that resilience is the key to biodiversity conservation and that diversity itself enhances resilience, stability and ecosystem functioning (Schulze and Mooney, 1993; Mooney and Ehrlich, 1997; Tilman 1997). Ecological economists also argue that resilience is the key to sustainability in the wider sense (e.g., Common, 1995). Certainly resilience is related to stability, but it is not clear whether this characteristic is always desirable, for example, in evolutionary terms.

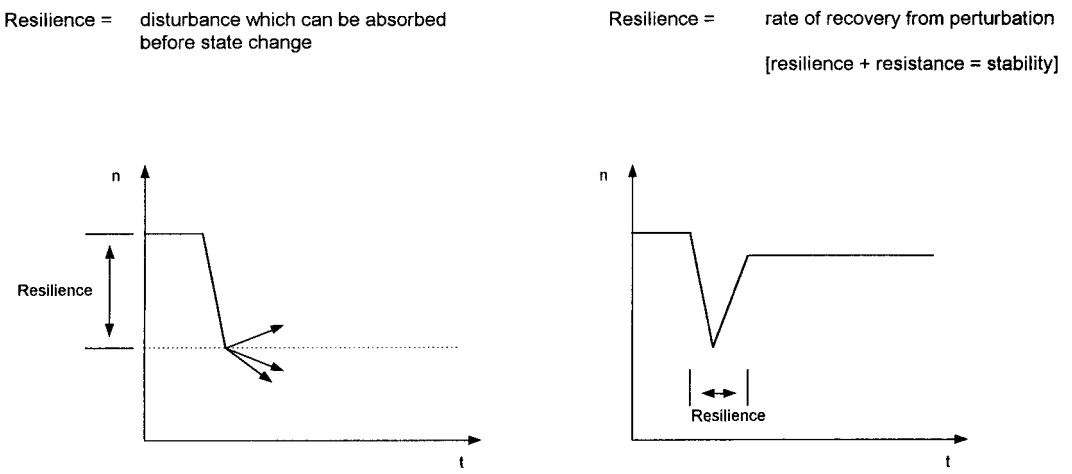

Figure 1 Ecological resilience. There is no precise definition of resilience. Two alternatives appear to be (left) the disturbance which can be absorbed before the dynamic equilibrium is change completely (following Holling) and (right) the rate of recovery from a disturbance

Variability in ecological systems is in some ways inherently predictable, but in other ways is always surprising (Holling, 1986). Holling's 'theory of surprise' is based on the notion of discontinuities and on the nature of ecological systems. More recently Holling (1995) has intimated that the philosophical basis of managing the environment is determined by the world-views of nature where people managing resources conceive of the environment as either benign, balanced or, indeed, resilient and able to reorganize itself (also Gunderson *et al.*, 1997). Whichever view is adopted of how ecological systems work, surprises are still inherent in the system. Kates and Clark (1996) have suggested that human intervention inevitably leads to surprises which confound social expectations while not being unpredictable from a scientific viewpoint; which are generally harmful to social resilience and human welfare but also create windows of opportunity in environmental management.

What, then, is meant by social resilience? First, social and ecological systems are themselves linked, in ways which Norgaard (1994) and others have likened to synergistic and coevolutionary relationships. Thus the resilience of social systems is related in some (still undefined) way to the resilience of the ecological systems on which social systems depend. This is most clearly exhibited within social systems that are dependent on a single ecosystem or single resource. Simply taking the concept of resilience from the ecological sciences and applying it to social systems assumes that there are no essential differences in behaviour and structure between socialized institutions and ecological systems. This is clearly contested in the social sciences. Rather, the parallels between ecosystem resilience and social resilience have been hinted at in several disciplines, including human geography, human ecology and ecological economics (Zimmerer, 1994; Gunderson *et al.*, 1997; Levin *et al.*, 1998). They have been tested empirically in the context of land degradation (Blaikie and Brookfield, 1987), in the context of agricultural systems (Bayliss-Smith, 1991; Cuc and Rambo, 1993) and coastal livelihood systems (Peluso *et al.*, 1994).

In reality, seeking to analyse the resilience of social systems by using analogies from the ecological systems is akin to endogenizing the role of social institutions in the wider environment (Pritchard *et al*., 1998). There are two elements in examining the applicability of social resilience in terms of the physical environment. First there is the issue of dependency of social systems on the environment itself – are communities and institutions which are directly dependent on natural resources themselves linked to the resilience of the ecosystem? In other words, are there direct linkages between ecological and social resilience? In this sphere research in the areas of human ecology is relevant.

The second issue concerns the resilience of institutions. As already stated, institutions are taken here in the widest sense to incorporate both modes of socialized behaviour as well as more formal structures of governance or law. Institutions it would appear can be persistent, sustainable and resilient depending on a range of parameters, including legitimacy (O'Riordan *et al*., 1998); agenda setting and the selecting of environmental risks which resonate with the institutions' agenda (Cantor and Rayner, 1994); and the maintenance of social capital. Thus the resilience of institutions is based on their historical evolution and their inclusivity or exclusivity, and hence how effective they are in oiling the wheels of society. Indeed the social capital of communities is taken here to mean the existence of integrating features of social organization such as trust norms and networks (e.g., Pelling, 1998). The cultural context of institutional adaptation, and indeed the differing conceptions of human–environment interactions within different knowledge systems, are central to the resilience of institutions. These cultural contexts and local technical knowledge tend to be overlooked in considering equity and economic efficiency of sustainable use of natural resources, as argued by Gadgil *et al*., (1993), Blaikie *et al*., (1997) and Brown (1997), for example. Hence the resilience of institutions is not simply a matter of the economic relations between them but is determined, as with social capital, by their inclusivity and degree of trust (reviewed in Harriss and de Renzio, 1997).

In determining the parallels between social and ecological resilience, potential indicators for the concept are discussed below, focusing on the links between social stability (of populations within social systems) and resource dependency. Resource dependency is defined by the reliance on a narrow range of resources leading to social and economic stresses within livelihood systems. So, for example, the dependence of certain economies on mineral resources is defined by the extent to which they are reliant on their mineral production; are open to vagaries of world markets in these commodities; and are inclined to experience boom and bust cycles because of the nature of the commodity markets they are locked into. For example, Auty (1997; 1998) argues that resource endowment and dependency explain some of the constraints on social capital development and the ultimate destiny of resource-dependent societies such as those heavily dependent on oil revenues. The preoccupation with capturing the benefits of resource endowments during boom times in such countries impedes the creation of economic linkages, land reform and diverse development. In other words, dependency brings with it its own set of problems in the economic and social sphere.

Stresses and variability associated with resource dependency are manifest in instability and increased variance in income and risk of failure of particular sources. Social instability is manifest through various social indicators such as the impacts of population displacement. Resource dependency, in this sense, demonstrates the coevolutionary nature of the social and natural systems being examined, with social and

economic systems themselves being more or less 'resilient' to external physical as well as social stresses.

An example of the resilience of institutions can be found in the ability of institutions of common property management to cope with external pressures and stress. Social capital, ecological resilience and social resilience are all tested when upheaval and stress are placed on institutions. Commonly managed coastal resources are being degraded throughout the world through the breakdown of property rights or inappropriate privatization (see Berkes and Folke, 1998). Nowhere is this clearer than in coastal resources, such as fisheries, coastal communities and agriculture, or forest-dependent communities, as discussed in the examples below.

III Resource dependency and social resilience

The concept of dependency stems from a rural sociological perspective on communities and their interaction with risky resources, primarily in a north American context (e.g., Machlis and Force, 1988; Machlis *et al*., 1990; Freudenburg, 1992), but also increasingly in the context of coastal communities (e.g., Peluso *et al*., 1994; Bailey and Pomeroy, 1996). Under this concept of dependency, the promotion of specialization in economic activities has negative consequences in terms of risk for individuals within communities and for communities themselves. Social resilience is therefore observed by examining positive and negative aspects of social exclusion, marginalization and social capital.

Resource dependency relates to communities and individuals whose social order, livelihood and stability are a direct function of their resource production and localized economy (Machlis *et al*., 1990). There are a number of elements by which the consequences of dependency can be observed: income stability, and social stability and migration. The dependency of individuals within a resource system does not necessarily depend on reliance on a single crop or fish stock, but in some circumstances on dependence on an integrated ecosystem. This is particularly the case with coastal resources, as argued by Bailey and Pomeroy (1996: 195) in the context of coastal regions of Asia: 'fishing communities are best understood as dependent not on a single resource but on a whole ecosystem. This expanded understanding of tropical coastal resources is the key to stability for households and communities in South East Asia's coastal zones'.

As an example of the links between ecosystem and social resilience, the demand for diverse and resilient resources partially determines location for settlement. Differential concentrations of population across a landscape reflect the differing levels of comparative advantage in economic, political and social parameters of each site. Communities dependent on a single underground mineral resource are however severely constrained in their ability to adapt (Freudenburg, 1992), partly because subsoil resources appear to be randomly distributed across geographical areas. By contrast, coastal resources are attractive regions for economic growth and support an increasing proportion of the world's population because they are inherently diverse, allow multiple social and economic niches and hence are resilient compared to areas dependent on a single resource. Again in the context of southeast Asia, Bailey and Pomeroy (1996: 195) regard social systems dependent on coastal resources as inherently resilient, despite their dependency on a single ecosystem: 'coastal fishing communities

in southeast Asia are resource dependent, but not in the pathological sense of the term. The complexity of tropical coastal resource systems significantly reduces vulnerability to sudden economic misfortune and to community instability'.

Such complexity and vulnerability in the southeast Asian context depend on a host of complex institutional arrangements. Local level property rights associated with coastal resources, for example, are complex mixes of state, private and regulated and unregulated commons, often nested within each other and all changing and evolving over time (Walters, 1994; Adger and Luttrell, 2000). Vulnerability and resilience must then be contextualized by these social and institutional factors.

Coastal communities can be dependent to a greater or lesser degree on coastal resources for their livelihood. These resources in themselves may be diverse and incorporate tourism, fishing other extractive uses and transport. It is often argued that coastal ecosystems themselves are either more resilient or more stable, and therefore coastal communities are more resilient. But the economy is still reliant on a single coastal system. If an oil spill affects a tourism beach then it will also affect fishing stocks and have other ecological impacts. In the Straits of Malacca in peninsular Malaysia, research by Dow (1999) has shown that those parts of a coastal community directly and entirely dependent on fishing can experience major impacts from such extraordinary events as oil spills. If the pollution stress is frequent and severe the fishing communities have to cope with events which become 'normal' in their livelihood system (Dow, 1999). But as Costanza and colleagues (1995) point out, the resilience of coastal and estuarine systems may be high because of the diversity of functions which they perform, such as rapid self-regulating and regenerating functions. Both the speed of recovery and the buffer capacity of coastal seas following severe oil spills continually confound ecologists. The resilience of coastal communities to hazard may therefore be enhanced by the regenerating and absorptive capacity of the coastal ecosystems themselves.

Market variability is a key issue in the context of communities dependent on mineral resources. But many resource-dependent communities in both agricultural and coastal areas, particularly in the developing world, are partially buffered from such market variability by their persistent subsistence activities. The resilience of such communities can therefore be affected in both positive and negative ways by market integration. Bayliss-Smith (1991: 7) attempts to demonstrate systematically the importance of market integration, of the 'modern agricultural economy', in affecting the vulnerability of both the physical ecosystems and society in the New Guinea Highlands. He finds that vulnerability is socially differentiated. On the one hand market integration has provided some groups with the opportunity for diversification of crops and hence has contributed to drought-proofing their livelihoods. By contrast participants in rural settlement schemes are *more* vulnerable to food insecurity due to their reliance on cash crops, many of which are ecologically inappropriate and hence doubly insecure. At the same time in Papua New Guinea, the social trends associated with market integration are influencing the stability and resilience of mountainous and wetland ecosystems. Bayliss-Smith (1991: 10) concludes that 'the weakening of the connection [between food security and environment] is perhaps the most insidious and threatening effect of "development", even though so far in the New Guinea Highlands case the effects on food security at least have generally been positive'.

In contrast with this overall conclusion for the Papua New Guinea example, monoculture cash crops have been argued to contribute to the undermining of many

traditional systems of coping with natural hazards. For example, when the cash-integrated coconut economy has been decimated by hurricane in Samoa, the reciprocal institutions of the 'moral economy' become even further stressed (Paulson, 1993). For other forest-based communities in southeast Asia research demonstrates that commercial logging and other market activities can reduce the resilience of such communities (King, 1996), particularly when rapid market integration is exacerbated by low levels of social capital and infrastructure. The fate of transmigrants in Papua New Guinea alluded to above, as well as in Malaysia and Indonesia, demonstrates this vulnerability (Sage, 1996; Parnwell and King, 1998).

In summary the direct dependence of communities on ecosystems is an influence on their social resilience and ability to cope with shocks, particularly in the context of food security and coping with hazards. Resilience can be undermined by high variability (or disturbance in ecological terms) in the market system or environmental system. Resilience therefore depends on the diversity of the ecosystem as well as the institutional rules which govern the social systems.

IV Observing social resilience

Given this complex relationship between social resilience and dependency on natural resources, a set of key parameters for observing social resilience can be developed. Social resilience is institutionally determined, in the sense that institutions permeate all social systems and institutions fundamentally determine the economic system in terms of its structure and distribution of assets. Social resilience can therefore be examined through proxy indicators, such as institutional change and economic structure, and through demographic change, each of which are discussed briefly below.

1 Economic factors, institutions and resilience indicators

One key factor of the economic aspects of resilience is in the nature of *economic growth and the stability and distribution of income* among populations. Dependency on a narrow range of natural resources can increase the variance of income and hence decreases its stability. This generally occurs for a number of reasons. First, resource dependency can be risky for commercialized activities due both to the *boom and bust nature of markets* for the outputs from resource use as well as to technological innovation threatening the sustainability of economic activity, particularly in an era of globalization. For example, Freudenburg (1992) shows that communities in the USA dependent on a single mineral resource are often encouraged to diversify and avoid cyclical swings in their economies associated with falling terms of trade for many minerals. But they are least able to undertake such action. As alluded to above, technology, the distribution of mineral resources across the landscape and labour mobility and training all contribute to this rigidity and dependency.

Secondly, *environmental variability* can increase the risk of being dependent on particular resources, through the incidence of extreme events in nature, such as drought or flood, or from the impact of pests and diseases on agricultural systems. The variability of global rice production, for example, has risen dramatically in the period

since the 'green revolution' which has decreased the genetic base of the world's planted rice crop, hence making production more reliant on a single variety and increasing variance (Hazell, 1985). The impact of such trends in agricultural-dependent communities is argued to be increasing vulnerability associated with this variability (Conway and Barbier, 1988).

A further aspect of social resilience is therefore *stability*, particularly of livelihoods. The insecurity of economic well-being, as measured through variance of income sources, for example, is often argued to be not as important as growth in these income sources when economies are stable. But much contemporary economic theory and policy is increasingly based on the premise that economic growth itself is dependent on institutions and social infrastructure (Ruttan, 1999). The stability of social systems in themselves can be a contributing factor to induced innovation and technological development. Further, it is argued that sustained economic growth is dependent on capturing positive externalities from investment in human capital (Hayami and Ruttan, 1985; Stern, 1995). Both these sources of economic growth (human capital and technological development) are encouraged by stable social and economic circumstances.

Further, there is increasing evidence that sustained economic growth is also promoted by the equitable distribution of assets within populations, due to various economic linkages. These linkages include the arguments made by Keynsian economists that equitable wealth enhances aggregate demand within the economy (Kim, 1997), and further evidence that the economic productivity of the workforce is jeopardized by the consequences of large-scale inequality (Persson and Tabellini, 1994).

Other elements of resilience at the community level can be observed through proxies, such as formal sector employment, recorded crime rates, and by demographic factors (Machlis *et al*., 1990) or other culturally defined variables. These indicators allow examination of links to changes in production of the resources on which communities are 'dependent'. But at the individual level, choices in livelihoods and social investments are more likely to be observed through income and other variables such as migration, which indicate stability at the household level. So, for example, Machlis and colleagues (1990) find correlations at the community level between social variables and resource production for forestry and mining resource-dependent communities in Idaho, as shown in Figure 2. Yet they conclude that it is equally important to examine 'coping strategies employed both by communities and individual members to mitigate the influence of production systems on the social order' (Machlis *et al*., 1990: 421).

2 Demographic change and resilience indicators

Mobility and migration are a further set of important indicators of resilience. However, resilience or changes in resilience cannot simply be inferred from the presence or absence of migrants in any area or community; the degree of labour mobility; or an increase or decrease in total population over time. Significant population movement can be evidence of instability, or could be a component of enhanced stability and resilience, depending on the *type* of migration. Migration and circular mobility occur for a plethora of reasons. Displacement migration may be caused by a deleterious state of affairs in the home locality (such as loss of assets) and often has negative impacts on social infrastructure in both sending and receiving areas.

Where migration is circular in nature and stimulated by the demand to move caused by attractive circumstances elsewhere, often in urban areas, the resource flows associated with remittances can often enhance resilience. Migration, whether circular or in the form of displacement, has both economic and social dimensions. Neoclassical economics generally models the migration decision as individual decisions or as intertemporal family contracts for risk spreading and adaptation (Ruitenbeek, 1996;

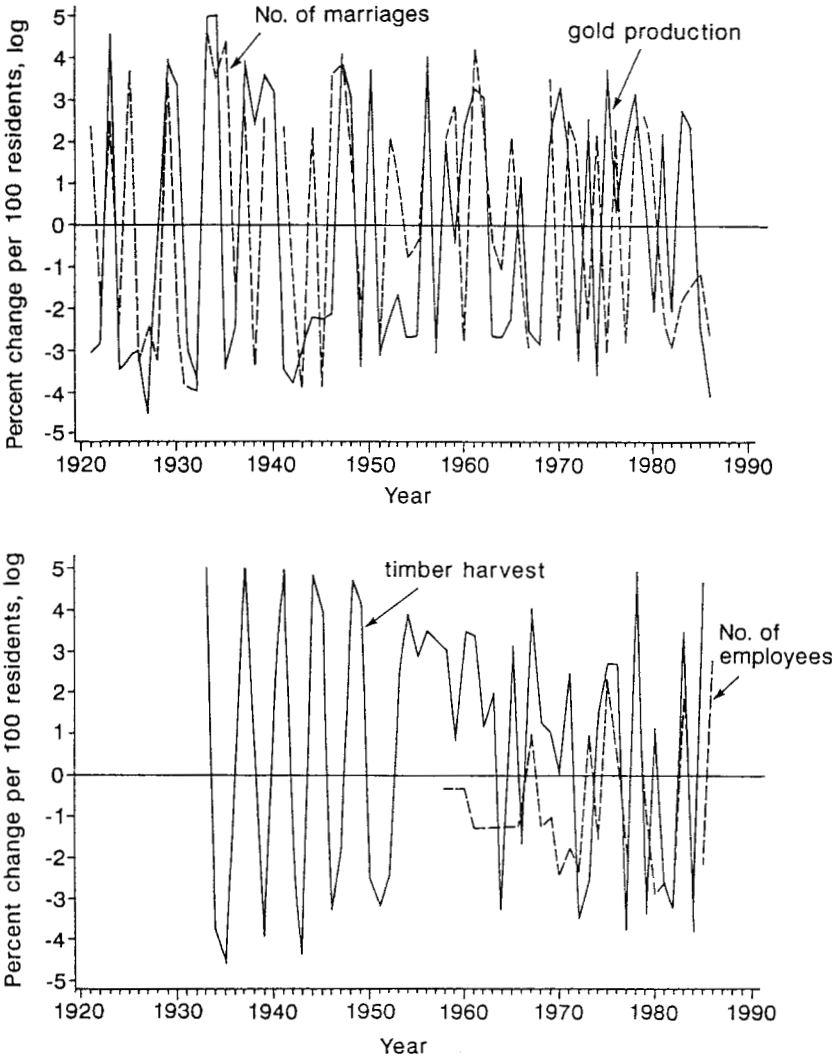

Figure 2 Resource dependency and social impacts in Wallace and Orinofo, Idaho. The fate of community resilience in Wallace (upper panel) would appear to be related to gold prices: the number of marriages in the town plotted against gold price. Similarly for Orinofo (lower panel), the volatile timber harvest directly affects the only major employment source in the town
Source: Machlis *et al.* 1990

Crook, 1997). The impacts of migration strategies on the use of natural resources, and environment, in both net immigration and net emigration areas have been highlighted as a major research not well documented to date (O'Lear, 1997; Pebley, 1998; Adger and O'Riordan, 2000). The most important aspect of population movement in the context of indicators of stability and resource dependency is that of migration as a strategy for risk spreading at the household level and the relationship of such migration to resource dependency.

Circular and seasonal migration are therefore important aspects of social stability. In many parts of the agrarian world seasonal migration contributes to livelihood security and resilience at the household level through remittances providing opportunities for diversification and reduction of resource dependency. There is evidence to suggest that remittance income tends to be invested in capital, both human and physical, rather than used for immediate consumption (Crook, 1997). In other words, remittance income is used to provide for long-term economic growth through investment in education or in agricultural capital. Thus much circular migration reinforces the asset and wealth distribution in agrarian societies, rather than being a redistributive mechanism (e.g., Stark *et al*., 1986).

But in the face of significant external stress population displacement is often an indicator of the breakdown of social resilience. In the literature on food security, for example, displacement and coping strategies represent an extreme manifestation of vulnerability (Watts and Bohle, 1993). Coping strategies are actions taken by households when faced with extreme food insecurity which might be caused by diverse factors, from climatic extremes to wars. They are, in effect, short-term adjustments and adaptations to extreme events, are usually involuntary and almost invariably lead to a different subsequent state of vulnerability to future famine situations.

Such coping strategies are postulated by Corbett (1988), in the context of African evidence, to be strategies primarily concerned with maintaining the future income-generating capacity of the household (as the decision-making unit) intact, rather than maintaining current consumption. Evidence from Rajasthan in India presented by Jodha (1975) confirms that the objectives of farmers' adjustment mechanisms in the face of food insecurity are to protect the assets and the sources of future income, rather than current consumption, thereby providing further evidence of the stages of coping. Interventions in such situations based on increasing consumption may 'prove self defeating and contribute to the process of pauperization initiated and accentuated by recurrent droughts' (Jodha, 1975: 1619).

In summary, resilience, in both its social and ecological manifestations, is an important aspect of the sustainability of development and resource utilization. Each of these social and ecological aspects has several empirical indicators, but no single indicator captures the totality of resilience. Social resilience can be examined, for example, by reference to economic, demographic and institutional variables in both temporal and spatial fashions. These themes are taken up in the following section in the context of coastal resources. The case study example also demonstrates the operationalization of the analysis of social resilience characteristics of ecosystem change, acknowledging the difficulty in analysing resilience at different scales.

V Mangrove conversion and the resilience of institutions in Vietnam

Throughout the tropics, mangroves are being converted to other uses, often at the expense of local users. These intertidal forests provide multiple benefits from fisheries through to coastal protection (see Barbier and Strand, 1998; Field *et al*., 1998; Tri *et al*., 1998) and hence the resilience of these coastal ecosystems and the communities which depend on them is directly intertwined. There are multiple causes of mangrove loss, from conversion for agriculture to human settlement as well as degradation through pollution (Farnsworth and Ellison, 1997), with each of these causes of mangrove conversion being related to property rights issues and the institutions of management.

Traditional management systems for common pool resources are often undermined by privatization and government policies, driven by the idea that private resources give increasing returns compared to open access. However, even in situations of rapid change, there are usually incipient property rights and rules which evolve to meet local resource user needs: hence all coastal resources have some type of common management, and the open access situation is very unusual (Ostrom *et al*., 1999). If social institutions are resilient, then is it possible to observe whether the impact of 'disturbance' on them results in a similar state or leads to a completely new situation?

In Vietnam the global trends in mangrove conversion outlined above are also observed. Vietnam has moved rapidly in the past decade from central planning to a market-orientated economy through divesting the state of responsibility for production and through privatizing much of its land, marine and other resources. Results from a study involving ecosystem changes from agriculture to aquaculture in one region in northern Vietnam (based on Adger *et al*., 2000) demonstrate that such decisions take place within the political economy of local resource use, specifically the changes to property rights and the imposition of external stress on local livelihood systems. Conversion affects the resilience of the livelihood system dependent on the mangrove resource: this can be investigated empirically through examination of property rights and the dynamics of inequality and income sources.

Given the complex set of state and collective institutions which manage mangroves, it would seem that some parts of this institutional system may be more resilient than others in the face of change. The major changes in Vietnam include a policy known historically as 'New Economic Zones' (Thrift and Forbes, 1986) combined with the present-day ascendancy of private property. These two policy contexts combined result in resettlement, aquaculture and agricultural conversion of mangroves in Quang Ninh Province in northern Vietnam (see also Sinh, 1998). The conversion of part of a mangrove forest for agriculture and aquaculture purposes in Quang Ninh demonstrates the potential impacts of conversion of mangroves when rights to the mangrove area are overturned by state decree and conversion takes place at the expense of local inhabitants.

Economic analysis of such a situation demonstrates one element of social resilience by examining the impacts on two distinct stakeholder groups: agricultural settlers and present extractive users. Adger *et al*., (2000) demonstrate that there is no economic case for conversion, based on the distribution of costs and benefits, since the poorer households are more dependent on mangroves and the richer households benefit from conversion.

But what of the impact of mangrove loss on social resilience? The resilience of the

communities dependent on the Quang Ninh mangroves is clearly affected by their loss. The ability of the community to maintain sustainable common property management of the remaining mangrove and fishing areas is undermined by the changes in property rights and changes in inequality brought about by externally driven enclosure and conversion. The prerequisites for common property management to be successful (e.g., Ostrom, 1990) include a reliance on the resource involved within the livelihood system and a relatively homogeneous distribution of benefits within the user group. Thus resilient common property management is enhanced through the users co-operating on the basis of relatively equitable share of the benefits of use and the critical role of the resource in their livelihood stability. The land converted to agriculture in Quang Ninh is allocated by central government to farmers from outside the province as part of the New Economic Zones strategy. In terms of the stability of income sources and the perceived legitimization of the imposed property rights changes, resilience of the existing local social systems would appear to be undermined.

The mangrove resources are important in the overall livelihood system of the coastal communities, representing 11% of total consumption at the household level of marketed and nonmarketed economic activity (Adger *et al.*, 2000). This dependence on coastal resources demonstrates one aspect of resource dependency leading to low resilience at the household level: when the resource disappears the impact on household livelihood security can be significant. However, the resilience at the community level is also affected by such changes. Research among the households most affected by conversion shows that due to the loss of part of the mangrove resource, there is enhanced conflict over remaining resources (Table 1), leading to noncooperative exploitation of the mangrove fisheries. In addition, conversion to agriculture and aquaculture in this case increases income inequality within the population, thereby reducing the likelihood of co-operative action within a heterogeneous community.

This study of reduction in social resilience when mangroves are lost shows that the necessary conditions for the persistence of common property management are undermined by the process of conversion in this case. The 'disturbance' of the institution undermined the social capital of collective management and resulted in a breakdown of collective action for the remaining resource. This is demonstrated in this study in Vietnam but also elsewhere – commentators from Central America to the Philippines and Scandinavia have highlighted the negative social and ecological impacts of aquaculture and mariculture (Folke and Kautsky, 1992; Kelly, 1996).

Part of this story from Vietnam is related to the ecological resilience of the system. Aquaculture relies on a narrow range of commercial species prone to pests. In addition conversion of mangroves to aquaculture ponds actually increases the risk of inundation and coastal flooding. This means that its higher returns for a smaller number of users occur with less regularity and higher variance. In effect those entrepreneurs engaged in aquaculture act with implicit high discounting of the future: they often abandon their ponds after less than a decade.

Thus the links between ecological and social resilience can be demonstrated. Social institutions are subject to external pressures and shocks associated with both political and economic change. The ability to absorb these changes depends on social capital but also on the role of surprises and the characteristics of the resource system. In the case of the privatization of the Vietnam mangroves the returns to aquaculture are much greater than the alternatives of extraction of resources from the mangroves, mainly for

Table 1 A comparison of resource dependency and aspects of resilience of settlers and mangrove extractive users, Quang Ninh Province, Vietnam

	Present extractive users	Agricultural settlers
Mangrove dependency	> 13% of livelihood sources dependent on mangroves*	Low dependency on mangroves. Implementing mangrove conversion to aquaculture with higher risk
Assets	Leased agricultural holdings of 20–50 year leases under the 1993 Land Law (mean 0.42 ha)*	Leased agricultural land and aquaculture plots (> 5 ha for aquaculture). Also 20–50 year leases
Property rights and social institutions	Household land allocation has led to effective privatization of mangroves. Breakdown of common pool resource management in remaining mangrove since partial conversion	Exclusively private holdings. Isolated from existing social institutions of settlements

Note
* imputed income and land areas based on representative household survey (n = 141).
Source: Adger *et al*. (2000).

subsistence. The distribution of these high financial returns from nonresilient aquaculture has caused changes in the social organization for managing the remaining mangroves: the common management has broken down and there is increasing encroachment on to remaining mangrove areas as poorer households are squeezed out.

The interaction of the management of the coastal resources with the social system forms a direct coevolving link between ecological and social resilience. The external social driver, in this case land reclamation policy, directly results in ecosystem change which feeds back to the productivity of the economic activity and the institutional structures which manage them. The resilience of the management system governing extraction of fish from remaining mangroves is dependent on the resilience of the mangrove and fish stocks themselves to withstand increased fishing pressure. Further aspects of social resilience could be examined through the indirect impact on migration and changes in the livelihood system, and resulting disturbance to the natural resource system.

VI Conclusions

The examination of the resilience of institutions in the face of mangrove conversion in the section above has highlighted important constraints in observing social resilience. First, the study of interaction between mangroves and the communities dependent on them suggests that mangrove conversion and agricultural privatization have had

negative impacts on local-level social resilience through undermining common property institutions. Resilience is one of the most critical elements in the overall resource management issue, yet this aspect is not easily assessed.

This article argues that social resilience is defined as the ability of communities to withstand external shocks to their social infrastructure. This is particularly apposite for resource-dependent communities where they are subject to external stresses and shocks, both in the form of environmental variability (such as agricultural pests or the impacts of climatic extremes), as well as in the form of social, economic and political upheaval (associated with the variability of world markets for primary commodities, or with rapid changes in property laws or state interventions). It is indeterminate whether communities dependent on coastal resources, as have been discussed above, are themselves inherently more resilient, despite the undoubted diversity of these social and economic systems, and the ecological resilience of these areas. The centrality of social resilience to sustainable development remains a critical question.

The issues of resilience and vulnerability are likely to become more important in the framing of resource management questions in the future. They provide a bridge between the analysis of institutions and economies with the natural resources in which they ultimately depend. In policy terms these are also useful since both ecological stability and resilience are perceived as desirable social goals for many issues, from nature conservation through to climate change. It is argued by ecologists that resilience in natural systems provides the capacity to cope with surprises and large-scale changes – this is precisely what will allow innovation, coping with change and social learning in social institutions.

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