

Social Resilience: A literature review on building resilience into human marine communities in and around MPA networks

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I. ABSTRACT

In many marine environments around the world, increased human pressure has caused long-term and irreversible ecological shifts and an overall reduction in ecosystem resilience. Establishing marine protected areas or MPA networks is one approach used to reverse these trends, but doing so entails the consideration of not only biophysical but also socio-economic concerns. Because MPAs have direct consequences on human resource use patterns, communities need to build their capacity to adapt to these consequences and manage themselves without losing critical social relations, economic options and political stability. This is the concept of building social resilience. This review examines current knowledge on social resilience and explains the concept as it relates to MPA network establishment and management. It also identifies principles, case studies and approaches for assessing and building social resilience in marine social-ecological systems. The review concludes by giving key recommendations on how to effectively incorporate social resilience into MPA network frameworks and management systems.

II. BACKGROUND/CONTEXT

There is clear consensus that the world's coastlines and oceans are of fundamental importance to human well-being, that these systems are increasingly threatened by economic change and environmental degradation, and that consequently, urgent attention is needed to address these problems. In recent years, marine scientists have been challenged to move towards large-scale marine conservation and begin scaling up their work from site to system or network level conservation. There is much to learn however on how to design, adaptively manage, monitor and finance marine protected area (MPA) networks. This requires increased collaboration and focused learning among institutions working across sites and countries around the world.

In 2005, four major non-government organizations and their partners implemented a learning partnership to accelerate knowledge building towards a framework for tropical marine conservation that emphasizes resilient and representative MPA networks. The partnership is working together to address specific learning areas affecting our collective marine conservation efforts, learn from each other's experience, and collaborate among ourselves and our partners at the scale of MPA networks.

A priority learning area identified by the partnership was the social, political, economic, and governance features that allow social-ecological systems (SES) to be more robust to disturbance and change. Over time, challenges such as conflicts with cultural groups residing in MPA boundaries, incongruence in political and conservation decisions, and weakened enforcement measures can wear down the structures put in place by officials to protect marine resources. The

combined experiences of partnership members from field trips last year in Mauritania, Ecuador, and Indonesia really produced the incentive and created the space for this to be a priority learning area. A working group began to outline a concept of “social resilience” to complement the current emphasis on biophysical resilience in MPA networks and associated emerging tools. Social resilience was initially defined as *the capacity of a social system, involving multiple levels of government, communities and users, to embrace uncertainty and change in the advent of political, social or economic disturbances by building knowledge and understanding of resource and ecosystem dynamics*. The working group plans to address this concept of social resilience through the following key questions: *What conditions or enabling factors are necessary to enhance social resilience in a community¹ where MPA networks exist or will be established? How can we best build the principles of social resilience into a community so that MPA networks are more robust?*

To accommodate the needs of the Social Resilience working group members, who are mostly biological and ecological experts by training, a literature review and consolidation of knowledge on social resilience was conducted. The specific objectives of the literature review were to:

- Research current knowledge in social resilience, clarify and define the concept of social resilience as it relates to MPA networks;
- Develop a set of criteria or questions for appraising the level of social resilience in a community;
- Identify best approaches for building social resilience into the design, implementation and management of MPA networks based on case studies.

Knowledge gathered from this review will be used by the working group members to build a framework that would allow for measuring the existence of social resilience in a social-ecological system and building and maintaining it in the face of large scale changes, such as the development of MPA networks.

III. REVIEW PROCESS

The review process involved identifying (a) publications that examine the scope of the social resilience concept, specifically marine as well as other areas that can provide pertinent data and background, (b) case studies that reveal aspects of building resilient human communities in marine environments, and (c) socio-economic and other tools with potential to measure social resilience or related aspects. It also involved communicating with experts to learn about past and current research in this field and exploring how social resilience affects and relates to marine protected areas.

Sixty-nine technical papers (90% published in journals, books or reports) related to the topic of social resilience and/or resilience in social-ecological systems (SESs) were examined. About a third of the papers were theoretical – providing a background on resilience theory, defining and explaining key concepts, and identifying the principles or elements important in building resilience in integrated systems of people and nature. More than a third discussed case studies

¹ Because of its institutional context, social resilience is defined at the community level rather than being a phenomenon pertaining to individuals. *Community* is used broadly in this review and may encompass a small island group or a larger urban area, province or region.

that explored principles contributing to resilience in various SESs and resource management mechanisms. The case studies covered terrestrial or marine ecosystems in the US, Caribbean, Europe, Africa, Southeast Asia and Melanesia. The latter two regions had the greatest number of studies with most of them looking at relationships between socio-economic conditions or factors and marine ecosystem management. Coral reef management was discussed most often among the case studies, although there were a few examples of linking social resilience with wetland and mangrove management. Only a few papers dealt with novel tools or frameworks that can be used specifically to assess resilience in complex social-ecological systems. In general, most of the research relied on common social science tools, research methods and approaches.

IV. RESULTS AND DISCUSSION

Understanding resilience in social-ecological systems (SESs)

Despite tremendous improvements in technological, economic and material well-being in parts of the world, development of human society still relies heavily on ecosystem services and goods. Throughout history, people have been strongly dependent on nature for support, and nature has in turn strongly shaped human development. Humanity and nature have been observed to co-evolve in a dynamic fashion, and consequently the term “social-ecological” system (SES) was used to emphasize this integrated concept (Berkes and Folke as cited in Folke et al. 2005). Accumulating evidence suggests that SESs exhibit marked thresholds in their dynamics, behave in non-linear ways, and act as strongly coupled, integrated systems (Folke et al. 2002 and 2003).

Human societies continuously impact ecosystems from local to global scales. Ecological systems are currently transformed by human use at a more rapid and unpredictable pace than previously in human history. This causes the environment to often shift into less productive or less desirable states and to have greater uncertainty in responding to inevitable increases in resource use. Its capacity to sustain societal development is reduced, leading to vulnerability in many places and regions with constrained options for livelihood and progress (Levin et al. 1998; Diamond 2005; Folke et al. 2004 and 2005). These shifts or changes reflect loss of resilience in the SES and pose new fundamental challenges to environment and resource management.

The challenge for management is to change perceptions and viewpoints, among actors and all sectors of society – (1) from the view that humanity and nature are independent of each other to one of humanity and nature intricately linked and co-evolving, and (2) from the existing paradigm of commanding optimal production and controlling disturbance and fluctuations (‘command-and-control’) to one of increasing adaptive capacity by addressing the gradual changes that affect social-ecological resilience (Adger 2000; Folke et al. 2004; Tompkins and Adger 2004). In Florida for example, social resilience from strong institutions, early warning systems, and a high capacity to deal with crisis among locals confined the impact of Hurricane Andrew to manageable proportions, whereas social vulnerability in areas of Bangladesh affected by an equivalent tropical typhoon caused a human disaster of a far greater scale (Adger et al. 2005).

The Resilience Alliance (www.resalliance.org) defines *resilience* as applied to SESs, as *the amount of change a system can undergo and still retain the same control on function and*

structure; degree to which the system is capable of self-organization; and the degree to which the system expresses capacity for learning and adaptation (Carpenter et al. 2001 as cited in Folke et al. 2002). Resilience provides SESs the capacity to buffer perturbations, self-organize, learn and adapt. Managing for resilience enhances the likelihood of sustainable development in ever changing environments where the future is unpredictable and surprise is likely (Holling 2001).

Social resilience and its relation to MPAs

The concept of resilience has been widely applied to ecological systems but it is not as developed for social systems. In 1975, Andrew Vayda and Bonnie McCay drew from the work of Holling (1973) and suggested that the concept of resilience may be more useful to understand human adaptation than stability and resistance (as cited in Davidson-Hunt and Berkes 2000). They concluded that the resilience concept abandons the equilibrium centered view and instead allows individuals and societies to adjust in response to environmental challenges. This thinking encouraged more investigations on processes of change through an examination of relationships between the environment, individuals and societies, and promoted studies that explored potential links between social resilience and ecological resilience.

Social resilience was defined by Adger (2000) 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 the fact that social resilience has economic, spatial and social dimensions and thus requires interdisciplinary understanding and analysis at various scales. It differs fundamentally from ecological resilience by having the added capacity of humans to anticipate and plan for the future (Moberg and Galaz 2005).

In many marine environments around the world, major stresses and changes have already caused dramatic phase or regime shifts which are often long-lasting and irreversible (Hughes et al. 2005). A most familiar example is the phase shift occurring in many coral reefs following the destruction of habitats and the collapse of many coastal and oceanic fisheries. These undesirable ecological shifts or changes – evidence that the system is losing its resilience – have profound effects on the development of human communities in and around these marine environments. Thus there has been a tremendous challenge globally to protect these habitats and conserve the remaining marine species that provide food, livelihood and well-being to many societies.

One popular tool for marine conservation and fisheries management, especially in developing countries, is the establishment of MPAs. In most cases, MPA design and its impacts are examined largely from a biological perspective. Research suggests, however, that social factors, not just biological or physical variables, are equally important determinants of MPA success or failure (Christie et al. 2003a; Mascia 2003; Wahle et al. 2003; Christie 2004). Because MPAs involve a degree of restriction on human resource uses, they can generate considerable stress and conflict among affected stakeholders. MPAs that fail to integrate social dimensions into their design and implementation downplay the evolved relations of human communities with their environment. This results in a poor understanding of social interactions operating on multiple levels, user conflicts, unreceptive stakeholders, unintended negative consequences, and missed opportunities for positive change and reallocation of resources (Christie et al. 2003a; Wahle et al. 2003).

Social resilience for communities living in and around MPAs can therefore be defined as their *ability to cope with changes or stress brought about by MPA establishment and management without losing their critical functions as a community concerning social relations, economic prosperity and political stability*. The major changes brought about by MPAs are restricted resource use, reduced fishing grounds and increased resource protection and conservation. In a resilient community, these changes should have the potential to create opportunity for development, novelty and innovation among stakeholders (Folke et al. 2002; Olsson 2003).

Key principles for building resilience and contextual variables

Emerging insights from adaptive and community-based resource management suggest that building resilience into both human and ecological systems is an effective way to cope with environmental change characterized by unknowable surprises and risks. It essentially involves enhancing the adaptive capacity and self-organizing ability of SESs.

From a synthesis of several case studies, Folke et al. (2003) identified and developed four critical factors that interact across temporal and spatial scales and that seem to be required for dealing with the dynamics of SESs during periods of change. They proposed these factors as *principles for building resilience* and emphasized their interaction and interdependence. The principles are discussed below in more detail together with some contextual variables. Specific case studies in marine SESs are summarized in Table 1 to illustrate these variables. Definitions of key terms in the following text can be found in Appendix 1.

Principle 1. Learning to live with change and uncertainty (adaptability)

This factor emphasizes the necessity of accepting change or crisis and living with uncertainty and risks. To enhance resilience, strategies for social-ecological management should take advantage of change and crisis and turn it into an opportunity for development. This approach to ecosystem management is similar to the force behind adaptive management.

Leadership and vision

Leadership contributes to the social capital of a system and is an important aspect of adaptability. To build resilience, leadership needs to be a dynamic process, including change in leaders, that is responsive to prevailing social and biophysical conditions. A leader typically defines the visions and goals of an area, such as an MPA network, and may initiate management actions, but consolidation of the goals is best done by others. Therefore, a single, well defined leader is unlikely to be able to maintain a resilient system. Multiple leadership roles, vested in different individuals or groups, is usually required for a resilient community (Walker et al. 2006a). Leaders act as catalysts encouraging collective action and fostering effective public participation and deliberation among stakeholders during resource management (Olsson 2003; Folke et al. 2005; Lebel et al. 2006). In Kristianstad Sweden, a key leader played an instrumental role in directing change and transforming governance that ultimately led to the adaptive co-management of their local wetland landscape (Olsson et al. 2004b).

Multi-level social networks and building social capital

Multi-level social networks are also crucial for developing social capital (Adger et al. 2005). Social networks affect motivation and cooperation and are a basis for communication in communities (Davidson-Hunt and Berkes 2000; Walker et al. 2006a). Such communication provides a system of feedback among stakeholders and allows for appropriate adjustments in behavior. Two broad types of social networks are the bonding and bridging networks. Bonding networks are tightly connected relations based on family and kinship while bridging networks are weaker relations or ties external to the group (Adger 2001; Newman and Dale 2005). For resilience to be enhanced in a community affected by MPA networks, the aim should be to develop balanced social networks with a wide scope of actors that connect institutions and organizations across scales. These social networks are vital to build trust, facilitate information flows and create pools of expertise needed for problem solving and decision-making (Adger 2001; Olsson 2003; Tompkins and Adger 2004; Moberg and Galaz 2005). When linkages between civil society and the central government were strengthened in an MPA community in Tobago, novel institutional arrangements such as co-management emerged (Brown et al. 2001 as cited in Adger 2001).

Demographic changes (migration and population size)

The influence of migration and population size on social resilience was not clearly established from the literature reviewed. These variables however were still included here to highlight their importance in human marine communities and the need for further research in this area.

Migration has such diverse social, economic and demographic consequences and effects on social resilience. However studies have shown that resilience or changes in resilience cannot simply be inferred from the presence or absence of migrants in any area or community, the degree of labor mobility, or an increase or decrease in total population over time (Adger 2000; Adger et al. 2002). Significant population movement can be evidence of instability, or could be indicative of enhanced stability and resilience depending on the type of migration. In other words, the net effect of migration on social resilience is inevitably mixed.

Only a few case studies covered in this review looked at the relationship between population size and effective coastal resource management. Cinner et al. (2005a) and McClanahan et al. (2006) noted that villages in Indonesia and Papua New Guinea with relatively lower population sizes had stronger and more effective traditional marine resource management systems (customary marine tenure and periodic closures). This factor was believed to have promoted a high degree of group interaction and increased compliance with resource use regulations. Results from these studies however seem inconsistent with another work by Cinner (2005) that showed weak or insignificant relationships between the two factors.

Principle 2. Nurturing diversity for reorganization and renewal (diversity)

This factor explains the importance of nurturing diversity for resilience, recognizing that diversity is an insurance to uncertainty and surprise. Diversity of knowledge, institutions and human opportunity and diversity of economic options all contribute to sustainability and adaptive opportunity (Berkes et al. 2002 as cited in Folke et al. 2002). In relation to the dynamics of SESs diversity can be of two kinds: (1) functional diversity, i.e., the number of functionally different groups present in a system and their effect on its performance and (2) response diversity, i.e., the

diversity of types of responses to disturbance (Walker et al. 2006a). Diversity is also related to social memory, or the components of history that make development and innovation after a crisis or change possible. Social memory comes from the diversity of individuals and institutions and is important in linking past experiences with present and future policies. Functional and response diversity will allow a community to redevelop, innovate and spread risks brought about by management interventions, i.e. establishing an MPA network.

Diversity of livelihood

Because MPAs entail some degree of exclusion from marine habitats and a restriction on resource use by humans, their sources of income are reduced or affected significantly. Diversification provides a means of coping with this pressure by allowing community members to switch to other occupations when protected areas or restrictions are in place, during times of seasonality and fluctuating markets (Davidson-Hunt and Berkes 2000; Luttrell 2003; Adger et al. 2002 and 2005). During periods of resource decline in Kompong Phluk, Cambodia, fishing communities adapted by building a portfolio of livelihood options – diversifying their fishing activities (i.e. specialization in different gears) and operating small businesses (Marschke and Berkes 2006). Diversification likewise provides communities the added livelihood security of replenishing natural resources within those closures (Cinner et al. 2005a).

Resource dependency

Resource dependency is the reliance of a community on a narrow range of natural resources leading to social and economic stresses within livelihood systems (Adger 2000). It influences social resilience and the ability to cope with shock, particularly in the context of food security, income stability and coping with hazards. Resilience can be undermined by high variability in the market system or high disturbance in the environmental system. Resilience therefore depends on the diversity of the ecosystem as well as the institutional rules which govern the social systems. Governance and management frameworks can spread risk, and in effect build resilience, by diversifying patterns of resource use and by encouraging alternate activities and lifestyles (Adger et al. 2005). In Quang Ninh Province, Vietnam, high dependence of communities on mangroves for their livelihood led to low resilience at the household level: when the resource was converted to private mariculture areas, reduction in income was significant (Adger 2000). At the community level, loss of part of the mangrove resource also led to increased conflicts over remaining resources.

Principle 3. Combining different types of knowledge for learning (learning & knowledge)

This factor addresses the significance of people's knowledge, experience and understanding of complex ecosystems, their inclusion in management systems and their complementarity to conventional management. Scientific understanding of complex adaptive systems and ecosystem management can be enriched by experience and insights from local communities and traditional societies. Combining different ways of knowing and learning will allow different stakeholders to work together, even with much uncertainty and limited information. Much like in the second principle of resilience, social memory is critical for building knowledge and learning because it links past experiences with present and future policies.

Traditional and local knowledge systems

Local people inherently accumulate a knowledge base of how to relate and respond to environmental changes in their area. This traditional ecological knowledge is complex and represents decades of societal and institutional learning about species, environments, and their interactions accrued and passed down over multiple generations (Drew 2005). The traditional resource management systems (e.g. customary marine tenures, taboos and traditional fishing patterns) that evolve from this knowledge are not mere traditions but adaptive responses of the community that have evolved over time (Folke et al. 2005; Berkes 2004). These are known to be effective in certain areas because they are embedded in local institutions and value systems (Cinner et al. 2005b; McClanahan et al. 2006). Cree and Inuit communities in James Bay, Canada documented changes in their environment (e.g. changing sea-ice patterns, distribution of sea mammals, damage to eelgrass) based on traditional ecological knowledge, combined these into a regional picture and used it as baseline for management in the face of additional hydroelectric projects (Olsson et al. 2004a). The application of traditional ecological knowledge to customary ecological management plans can be useful for MPA networks or coastal resource management programs (see Figure 1).

Transformational learning

Transformational learning is a key ingredient for enhancing transformability, i.e. capacity of an SES to reinvent itself to become a different kind of system when ecological, economic, or social, including political, conditions make the existing system untenable (Olsson et al. 2004a&b; Walker et al. 2004). Successful transformational learning towards adaptive governance emphasizes the following attributes: learning as people use and manage resources, monitoring and accumulating knowledge on the way, and constantly adjusting the rules that shape their behavior to match the dynamics and uncertainty inherent in the system (Folke et al. 2002). People and institutions in resilient systems should be willing to take risks and to tolerate and learn from earlier management successes or failures. They should also focus on activities that lead to learning so that they maximize the impact of meager resources. (Tompkins and Adger 2004; Anderies et al. 2006). In Sweden, the change of policy of the Municipality of Kristianstad initiated transformational learning and collective action among stakeholders for the management of their wetlands (Olsson et al. 2004b).

Collaborative planning & participation

Collaborative planning and participation of stakeholders at all stages of MPA management (i.e., design, implementation, monitoring and evaluation) are critical for its effectiveness. Public participation builds trust, enhances legitimacy of rules and regulations and ensures the sustainability of MPA implementation plans by giving stakeholders a sense of ownership or responsibility for the MPA and its management arrangements (Christie et al. 2003b; Mascia 2003; Tompkins and Adger 2004). Moreover a collaborative approach to protected area management encourages continuous social learning. Participation and deliberation broadens the range of interests and knowledge that inform decision-making or management. These decisions may then be adjusted according to context-specific problems and needs of the community (Olsson 2003; Moberg and Galaz 2005; Lebel et al. 2006). In Mohéli, Comoros Islands, community members were included in the processes of park boundary delineation and guideline creation, and they were responsible for coordinating monitoring and enforcement within the marine park (Granek and Brown 2005).

Principle 4. Creating opportunity for self-organization (self-organization)

The ability to self-organize is important in systems of adaptive co-management and is an essential element of adaptive capacity. Folke et al. (2002) defines adaptive co-management as a process by which institutional arrangements and ecological knowledge are tested and revised in a dynamic, ongoing self-organized process of learning-by-doing. In the social domain, adaptive co-management is a way to operationalize adaptive governance. Adaptive governance of ecosystems generally involves polycentric or multi-layered institutions (Lebet et al. 2006; Moberg and Galaz 2005; Olsson 2003). This makes governance less rigid, less vulnerable and more capable of self-organization. It also allows for improved decision-making and problem solving among individuals and organizations. Overall adaptive management and governance builds resilience by increasing the likelihood of flexible and adaptive responses or behavior among stakeholders during periods of crisis, reorganization or uncertainty (environmental, social, political, or economic).

Multilevel polycentric governance and accountability

Polycentric or multi-level governance systems are institutions that have multiple centers or authorities (Lebet et al. 2006; see Figure 2). It involves local as well as higher levels of governance and aims to find a balance between decentralized and centralized control (Adger 2003; Olsson 2003). This builds social resilience by sharing and distributing power and by encouraging cross-level interactions and cooperation among stakeholders or institutions. An advantage of polycentric arrangements for MPA network management is that it provides an institutionally rich environment that improves the prospects of resolving complex problems; it can encourage innovation and experimentation by allowing individuals and organizations to explore different ideas about solving problems; creates a variety of feedback loops at different scales and contributes to scale matching of social ecological dynamics (Olsson 2003). Management of Bunaken National Park, for example, improved with the creation of the Multistakeholder Management Advisory Board that involved villagers, private tourism sector, environmental NGOs, academe and government officials at the city, district and province levels (Toengkagie 2002).

Accountable authorities who pursue just distributions of benefits and involuntary risks enhance the adaptive capacity of vulnerable groups and society as a whole. Accountability reduces destabilizing conflicts and strengthens weak links in the community (Lebet et al. 2006; see Figure 2). Accountability also ensures that decision-makers further the interests of constituents rather than personal interests and it fosters fair and active enforcement of MPAs (Mascia 2003).

Conflict resolution mechanisms

Conflicts are inevitable but essential elements of governance. But conflicts need to be bounded – disputes should be conducted within the boundaries of a social process that the disputing parties perceive as legitimate. Unbounded conflict can tear apart social capital and consequently impede learning (Lee 1999). Societies should ensure that channels of expressing dissent and disagreement are always open (Olsson et al. 2006). For a community to be resilient to interpersonal and inter-stakeholder conflicts, these should not be addressed on an ad-hoc basis or ignored until they reach a crisis stage. As observed by Christie (2004) in the Philippines, MPAs

need to have formal conflict resolution mechanisms that operate impartially and represent stakeholder interests equally.

Capacity

It is important to build both human and financial capacity in a community to ensure the sustainability of MPAs or networks in the area. Institutions should equip stakeholders with knowledge and skills for managing local, regional or global marine ecosystems in the face of complexity and change (Folke et al. 2002; Christie et al. 2003b). Focus of capacity-building activities can range from broad environmental education, MPA planning and management, monitoring and research, enforcement and surveillance, conflict resolution, evaluation and feedback, sustainable tourism and financial management. Developing the capacity of individuals to learn effectively from their experiences is also an important part of building knowledge and skills into organizations and institutions to permit good adaptive management (Folke et al. 2005). Needless to say it is equally important to build funds for these and many other activities involved with MPA management, especially for developing countries that rely on external support (e.g., donor support) at the onset of MPA planning and implementation.

Monitoring and feedback loops

Monitoring and feedback loops are essential elements of adaptive management (Folke et al. 2002; Olsson 2003). Accumulation of knowledge on the state of the environment and society and the communication of this knowledge back to the community are important in building capacity and trust among stakeholders (Mascia 2003). Sharing of information and feedback also allow appropriate adjustments in human behavior and management actions to match current environmental or social changes. This consequently expands networks of dependence and engagement among people and contributes to community resilience (Tompkins and Adger 2000). An example of a comprehensive monitoring and feedback program that has broad stakeholder involvement is that for the Great Barrier Reef Marine Park (see Figure 3). The goals of the program were to ensure public participation, establish mechanisms for data exchange, and encourage stakeholders to review the efficiency and effectiveness of management (Great Barrier Reef Marine Park Authority 1994).

Table 1. Principles, contextual variables and case studies related to building resilience in social-ecological systems.

RESILIENCE PRINCIPLE	VARIABLE	REFERENCE	CASE STUDY
Learning to live with change and uncertainty (adaptability)	Vision and leadership	Christie et al. 2003b	Supportive and committed local leadership enhanced the community-based coastal resources management in San Salvador Island, Philippines Over reliance on a small group of leaders can however result in “burn-out” and the narrowing of community participation
		Olsson et al. 2004b	A key leader played an instrumental role in directing change and transforming governance in southern Sweden that led to the adaptive co-management of a wetland landscape
		Adger et al. 2005	Strong leadership confined the impact of Hurricane Andrew to manageable portions in Florida
		Cinner et al. 2005a; McClanahan et al. 2006	Village leaders in Papua New Guinea had the authority and autonomy to develop and adapt harvesting rules in MPAs to reflect ecological and social conditions
	Multi-level social networks and building social capital	Brown et al. 2001 as cited in Adger 2001	When linkages between civil society and the central government were strengthened in an MPA community in Tobago, novel institutional arrangements such as co-management emerged
		Olsson et al. 2004b	A broad social network was assembled from several key organizations at different levels in society to support the management of wetland ecosystems in Kristianstad, Sweden
		Cinner et al. 2005a	For communities in Indonesia and Papua New Guinea, high social capital brought about by a high degree of group interaction likely facilitated the high compliance with periodic closures (<i>taboos</i>)
		Harkes and Novaczek (manuscript)	Strong bonds between traditional and formal institutions in Indonesia make traditional fisheries management and seasonal closures (<i>sasi laut</i>) highly resilient
	Demographic changes	Adger et al. 2002	In Nam Dinh Province, Vietnam, migration and its associated remittance income to the communities increased investments in

			<p>business and new enterprises and reduced pressure on the coastal resources, e.g. mangroves</p> <p>However remittance income also increased economic inequality among households, limiting access of poorer members of the community to coastal resources and encouraging greater risk of unsustainable exploitation</p>
		Cinner 2005; Cinner et al. 2005a	Low or negligible migration contributed to the effectiveness of customary marine tenures and periodic closures in certain villages in Indonesia and Papua New Guinea
		Cinner et al. 2005a; McClanahan et al. 2006	Relatively small population size was related to strong and effective traditional management systems (customary marine tenure and taboos) in Indonesia and Papua New Guinea
Nurturing diversity for reorganization and renewal (diversity)	Diversity of livelihood	Luttrell 2003	Livelihood diversification was a form of adaptation for people in Nam Hai and Da Rang Communes, Vietnam in response to changes in property rights and tenure over mangrove forests
		Adger et al. 2005	Reduced livelihood options and loss of traditional income sources due to already degraded ecosystems in parts of Indonesia reduced the potential for rapid economic recovery after the 2004 Asian tsunami
		Marschke and Berkes 2006	Fishing communities in Kompong Phluk, Cambodia adapted during periods of resource decline by building a portfolio of livelihood options – diversifying their fishing activities (specialization in different gears) and operating small businesses
	Resource use and dependency	Adger 2000	<p>In Quang Ninh Province, Vietnam, high dependence of communities on mangroves for their livelihood led to low resilience at the household level: when the resource was converted to private mariculture areas, reduction in income was significant</p> <p>At the community level, loss of part of the mangrove resource also led to increased conflicts over remaining resources</p>
Combining different types of knowledge for learning (learning & knowledge)	Traditional and local knowledge systems	McCay 1978 as cited in Davidson-Hunt and Berkes	In Fogo Island, Newfoundland, fisherfolk perceptions of codfish population cycles across time and space provided them with the means to formulate adaptive strategies, e.g. maintaining several

		2000	fishing spots, using a variety of gear, and livelihood diversification
		Olsson et al. 2004a	Cree and Inuit communities of James Bay, Canada documented changes in their environment (changing sea-ice patterns, distribution of sea mammals, damage to eelgrass) based on tradition ecological knowledge, combined these into a regional picture and used it as baseline for management in the face of additional hydroelectric projects
		Cinner et al. 2005a	Local decision makers in Indonesian and PNG villages used their understanding of social-ecological systems to interpret threshold levels of social or ecological indicators used to implement reef closures
	Transformational learning	Olsson et al. 2004b	The change of policy of the Municipality of Kristianstad initiated transformational learning and collective action among stakeholders for the management of their wetlands
	Collaborative planning & participation	Tompkins and Adger 2004	In response to declining conditions of Buccoo Reef in Trinidad and Tobago, management enhanced ecological and social resilience by including stakeholders in a learning-driven and iterative decision-making process, with stakeholder preferences elicited and fed into a multi-criteria analysis model
		Granek and Brown 2005	Community members in Mohéli, Comoros Islands were included in the processes of park boundary delineation and guideline creation, and were responsible for coordinating monitoring and enforcement within the marine park
		Lebel et al. 2006	The Great Barrier Reef Marine Park Authority in Australia initiated an ambitious consultancy and public participation exercise with stakeholders to assist with plans for enhancing the level of protection of reef resources
Creating opportunity for self-organization (self-organization)	Multilevel polycentric governance and accountability	Toengkagie 2002	Management of Bunaken National Park improved with the creation of the Multistakeholder Management Advisory Board that included villagers, private tourism sector, environmental NGOs, academe and government officials at the city, district and province levels
		Christie 2004	Insertion of central government agency control over a community-based MPA in Balicasag Island, Philippines undermined

			community support (loss of social resilience)
		Alcala and Russ 2006	30 years of experience in community-based marine protected areas in the Philippines has shown that, at least for this country, one must initially devolve decision-making power to the community and then spend enormous amounts of effort, time and money in large-scale integrated coastal management programs that integrate up again at the national level
	Conflict resolution mechanisms	Christie 2004	For two MPAs in the Philippines, there were no formal conflict resolution mechanisms in place thus interpersonal and inter-stakeholder conflicts ensued. Initial successes of the MPAs and social networks in general were eroded by these conflicts.
		Marschke and Berkes 2006	A local resource management committee in Koh Sralao, Cambodia stopped local fishers from destroying confiscated fishing gear, and instead encouraged non-violent conflict resolution strategies such as negotiation and paint-marking crab traps to discourage gear theft
	Capacity	Christie et al. 2003b	Capacity-building of key community members on sustainable resource management supported the co-management regime setup in San Salvador Island, Philippines
	Monitoring and feedback loops	GBRMPA Strategic Plan	A comprehensive monitoring and evaluation program for the Great Barrier Reef Marine Park aims to ensure public participation, establish mechanisms for data exchange, and encourage stakeholders to review the efficiency and effectiveness of management

Tools and approaches used to observe resilience in SESs

There were very limited references that identified explicit tools or approaches to measure or assess resilience in SESs. Among the tools mentioned below, only the second one (scenario development) has been used empirically for ecological systems.

Bennett et al. (2005) presented a method in which simple systems models are used as a framework to identify resilience surrogates for case studies. They also summarized four basic existing systems models and gave examples of how each model may be used to identify resilience surrogates. Unfortunately, the method was explained using only ecological variables from terrestrial systems (e.g. water quality, forest composition, algal populations). It also relied heavily on integrative, formalized system models or ‘system archetypes’, which may be too simplistic to apply for marine social-ecological systems. It is possible to add extra complexity to systems archetypes when necessary but the authors argue that the addition of detail adds little to the insights into system function that the model generates.

Another methodology proposed by Bennett (2003) for determining resilience in SESs is the use of *scenario development*. This method is used to scan alternative futures, identify critical uncertainties and guide actions. Scenarios are sets of plausible narratives about the future that can be used for decision-making and planning. 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 analyze policy alternatives. Scenario development has been used in the northern highlands lake district in Wisconsin USA and for the global Millennium Ecosystem Assessment. This approach may be a useful tool for potential MPA networks or those in the planning/early development stage or areas with already established MPAs or MPA networks. Stakeholders and scientists may examine resilience together by developing scenarios that connect human demands for ecosystem services (e.g. fishing intensity), services themselves (e.g. food source), and aspects of human welfare (e.g. health).

Walker et al. (2002) proposed a framework for analyzing resilience in SESs, as a basis for managing resilience (see Figure 4). Their framework has four steps and includes close involvement of SES stakeholders. It begins with the development of a conceptual model of the system led by stakeholders and preliminary assessments of the drivers that supply key ecosystem goods and services. The next step identifies the range of unpredictable and uncontrollable drivers, stakeholder visions for the future, and possible future policies, and creates scenarios. The third step uses the outputs of steps 1 and 2 to develop a simple model of the system’s dynamics for exploring attributes that affect resilience. The last step is a stakeholder evaluation of the process and outcomes in terms of management implications. This framework or methodology seems to be an integration of the two previous methods explained above – system models and scenario development – with the addition of a social component in the process. This may be useful for the management of MPAs or MPA networks that have been established for some time or marine areas managed using traditional ecological knowledge, since knowledge of the system (ecological and social) will be critical in the resilience analysis.

Notwithstanding the broader tools mentioned above, most of the work related to socio-economic implications of MPAs and adaptive resource management rely on commonly used social science

tools. Wahle et al. (2003) summarized these tools and identified when each tool can be used in the development and management of MPAs (see Table 2).

Table 2. Social science tools for marine protected areas (Wahle et al. 2003).

COMMON RESEARCH METHODS AND APPROACHES	Planning	Management	Evaluation
	MPA PROCESSES		
Focus groups – interactive interview in which a small number of usually homogeneous respondents engage in a discussion of a set of questions on a particular topic	✓	✓	✓
Survey research – administration of a standardized questionnaire to a sample of respondents		✓	✓
Socio-economic impact assessment – systematic evaluation, in advance, of the social and economic consequences likely to follow specific policy actions; may be related to scenario development	✓		✓
Rapid assessment – intensive, team-based qualitative inquiry using triangulation, iterative data analysis and additional data collection to quickly develop a preliminary understanding of a situation from an insider's perspective	✓	✓	
Participatory coastal resource assessment – process of gathering and analyzing information involving the participation of local resource users in CRM planning and implementation	✓	✓	✓
Ethnography – study of people and culture using participant observation, interviews and examination of artifacts and records	✓	✓	
Contingent valuation – survey technique that assess respondents' willingness to pay to prevent a decline in environmental resources or to support an improvement in them	✓		✓
Predictive modeling – research in which data is collected, a statistical model is formulated, predictions are made and the model is validated (or revised) as additional data becomes available	✓		
Content analysis – method of data analysis for narrative data in which the segments of text are systematically categorized as similar to or different from segments in other categories		✓	✓
Cost benefit analysis – systematic identification, organization and evaluation of costs and benefits that are expected to result from proposed policy alternatives	✓	✓	
Comparative research – approach oriented towards identifying and unraveling complex patterns of similarities and differences across moderate number of cases		✓	✓

Historical research – qualitative research approach that entails the use of historical records including existing documents, artifacts and oral histories	✓		
Secondary data analysis – form of research in which data collected and processed by one researcher are reanalyzed by another researcher, often for a different purpose		✓	✓
Case study research – strategy for doing research that involves the empirical investigation of a particular contemporary phenomenon within a real life context using multiple sources of evidence	✓	✓	

Gaps in knowledge and constraints

A major gap in social resilience research is the lack of analysis on links between social resilience and demographic variables. Based on available literature, the effects of variables (e.g. population growth or size, level of education, mobility, migration, family size or economic status) on resilience of communities affected by MPAs or other resource management systems are unclear and have not been explored in detail. The few studies that attempted to look at relationships between population size and successful coral reef management, for instance, had conflicting conclusions. Cinner et al. (2005a) and McClanahan et al. (2006) noted that villages in Indonesia and Papua New Guinea with relatively lower population sizes had stronger and more effective traditional marine resource management systems. On the other hand, Cinner (2005) observed that marine tenure systems in some villages from the same two countries were relatively resilient to population growth. All three studies used household surveys and semi-structured interviews and the socio-economic data was analyzed qualitatively or correlated with biophysical data using simple statistical analyses (Mann-Whitney U test, Spearman’s rank correlation). The studies were mostly done however in remote island communities. More research is needed to describe possible relationships between demographics and social resilience, using multiple sites that have a wider array of social characteristics.

There is also a dearth of knowledge on actual assessments of social resilience in areas affected by MPAs or MPA networks. Most of the work that identified socio-economic factors in the context of resilience in communities were based on outcomes of broad coastal resource management programs, wetlands and fisheries management, or traditional management systems. Only a few studies specifically examined resilience principles and contextual variables contributing to successful MPA management in human marine communities. Moreover, studies that focused on socio-economic factors in marine SESs used sites from developing countries or island communities thus making conclusions site-specific. There is a need to broaden social resilience research to more diverse areas and to consider community profiles within these areas, i.e. rural/semi urbanized sites, high income/low income communities, etc.

Finally, the scale to which indicators should be used to assess resilience in a community have not been studied in detail. Developing appropriate scales for each indicator that reflect different levels are important for proper analysis and assessment of areas affected by MPAs or MPA networks.

V. CONCLUSIONS AND RECOMMENDATIONS

Based on the current review, it is clear that the concept of social resilience can easily be incorporated into an MPA network framework. The principles that build social resilience – adaptability, diversity, learning and self-organization – have been applied to resource management systems in the past and it can likewise be applied to MPA network management. As has been stressed by several authors, it is imperative to consider the social setting (culture, economy and politics) and improve the condition (social networks and social capital) of an area during the development and throughout the management of MPA networks. Enhancing the elements of social resilience in a community will help them adapt to the socio-economic impacts of MPA networks and will encourage them to support its long-term implementation.

Management can diminish or build resilience. Rigid control systems that seek stability, e.g. top-down approach to fisheries management, tend to erode resilience and facilitate the breakdown of SESs. Current MPA management practices around the world however appear to be building resilience elements into their areas, albeit unconsciously. The promotion of adaptive co-management regimes and community-based MPAs, the movement towards multi-level governance, the emphasis on stakeholder participation, education and capacity building, and the renewed respect for indigenous or traditional systems of ecosystem management are all significant steps towards enhancing resilience in human marine communities.

The overall challenge is to actively strengthen the resilience of ecosystems and local marine communities – i.e. their capacity to cope with the changes and disturbances brought about by the establishment of MPAs and MPA networks. The key recommendations from this review are that:

- Management should be based on a recognition that coral reefs and other marine ecosystems, including their associated human communities, are complex and adaptive and seldom change in a structured or predictable way;
- Leadership should be developed across scales, allowing enough flexibility in institutions and politics and should encourage institutional and social memory at all levels (local to global);
- Social networks with a diverse set of actors (fishers, government agencies, religious groups, academic institutions, women, private sector, NGOs, tourism industry, etc.) should be developed aiming to connect institutions and organizations across local, regional and global scales;
- Policies should encourage stakeholder participation and incorporate their ecological knowledge structures in a multi-governance system;
- Management should promote learning and communication among individuals, groups and sectors of society to encourage collaboration and active participation;
- Evaluation, monitoring and deliberation of the outcomes of management actions should be encouraged followed by change in practices if necessary;
- Future social resilience research should aim to describe potential relationships between demographic variables and robustness of marine resource management systems, extend to a wider range of sites/areas and scenarios, and determine appropriate scales for social resilience indicators.

As a final point, strategies to build resilience in human marine communities affected by MPA networks will take many forms. There is no single prescription or approach that will guarantee the robustness of marine SESs in the future. Sometimes the SES is already in a desirable state, and the challenge is to ensure that the state is not diminished (e.g. protecting pristine coral reefs from degradation). Other times, a SES may already be in an undesirable state and the challenge is to reduce resilience temporarily and move towards a more desirable state (e.g. using MPAs or other forms of closures and restrictions to prevent and reverse the condition of already degraded coral reefs). In addition the principles for building resilience interact and are interdependent. Only one or the other will not lead to social-ecological resilience. It will require a dynamic interplay of the four principles and their contextual variables to direct society towards resilience. Strategies will have to be context- and scale-dependent, and will themselves have to change over time. The key is finding a strategy that balances these principles and variables and that works best for a particular marine SES.

Figure 1. Applicability of traditional ecological knowledge to various biological disciplines. (Drew 2005)

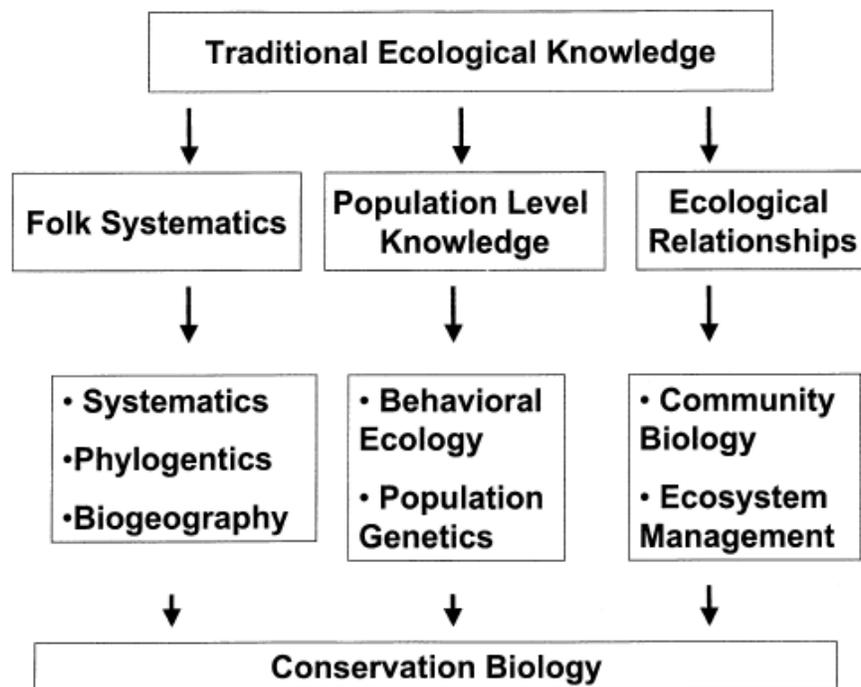


Figure 2. Associations between selected attributes of governance and the capacity to manage resilience. (Lebel et al. 2006)

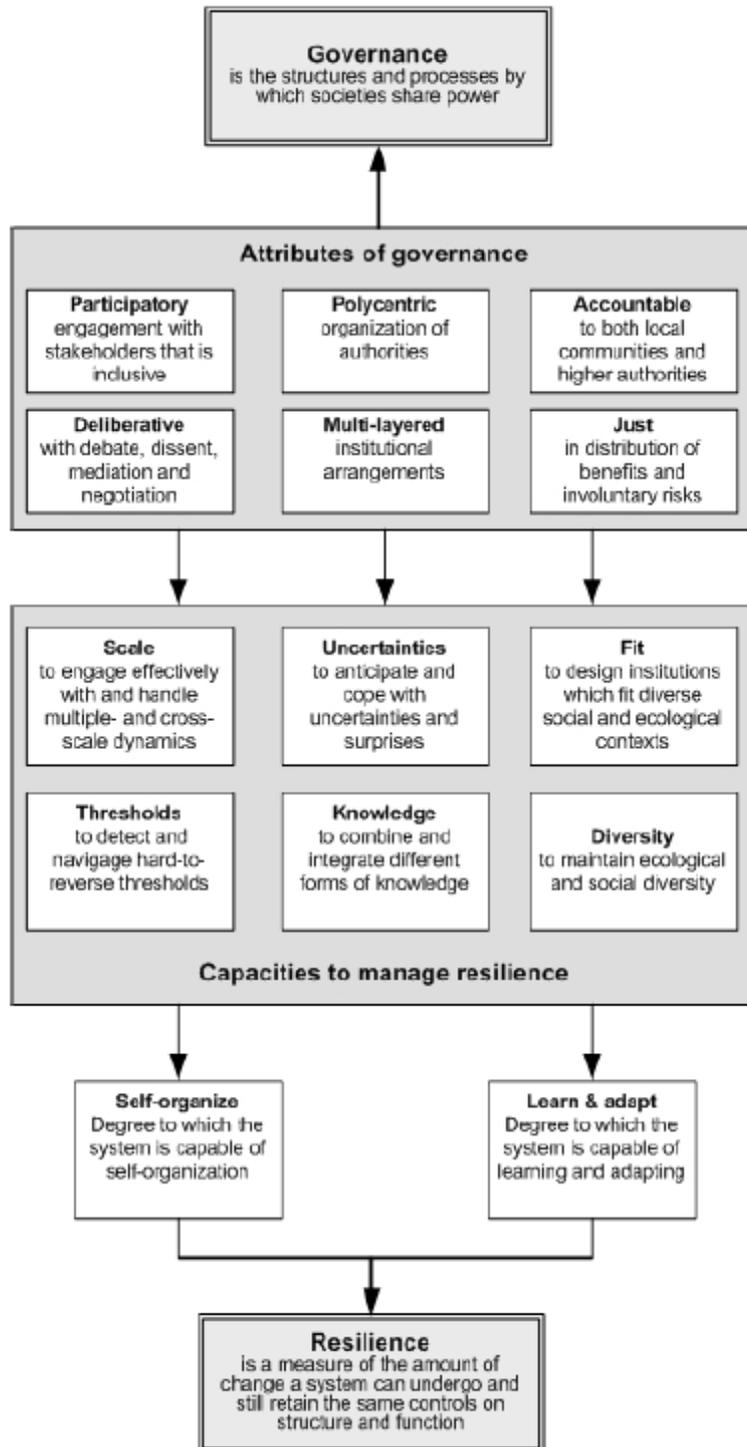


Figure 3. Annual evaluation cycle for the Great Barrier Reef Marine Park. (Great Barrier Reef Marine Park Authority 1994)

IMPLEMENTATION:

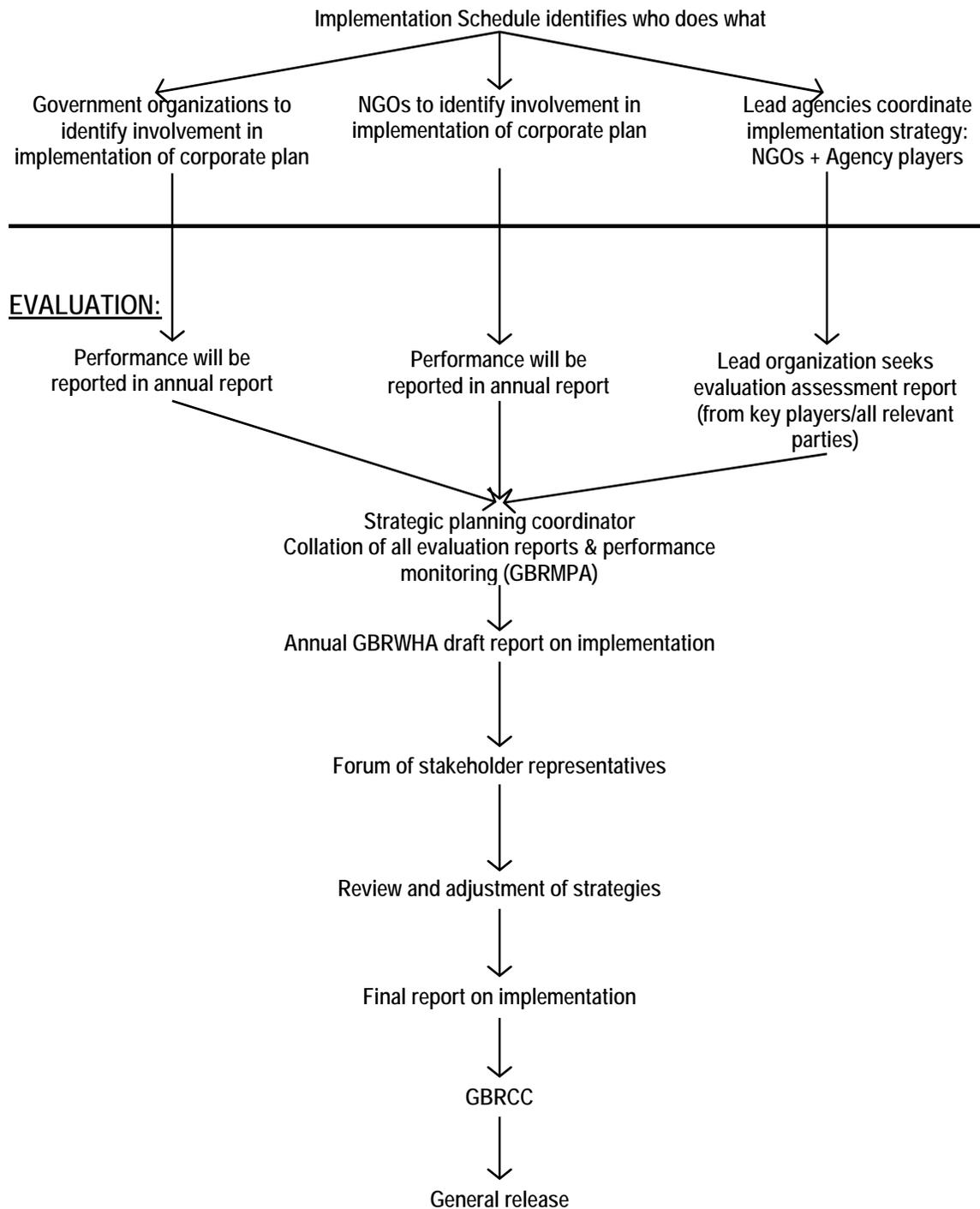
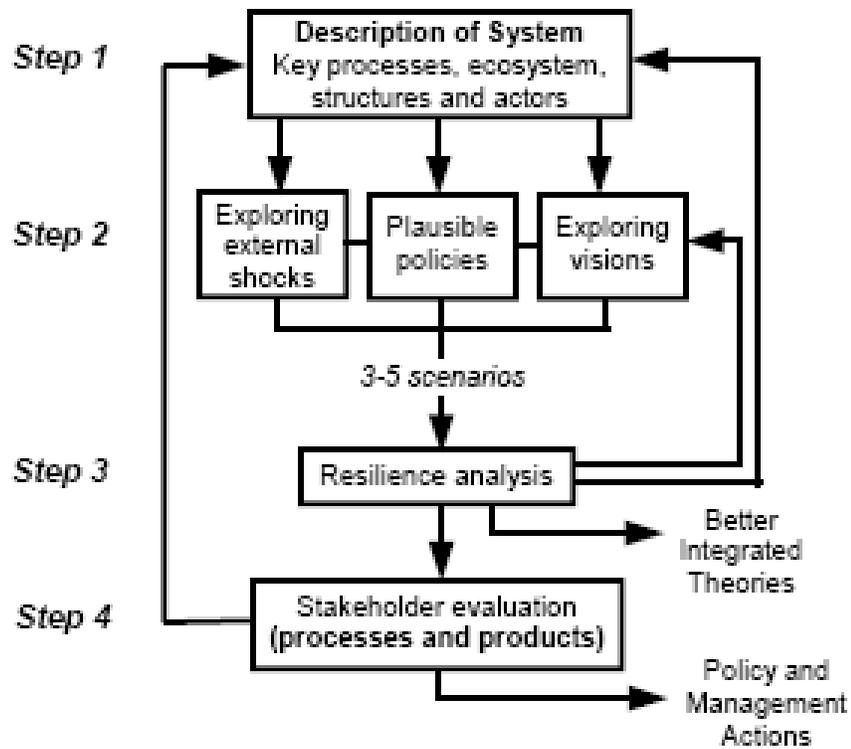


Figure 4. A framework for the analysis of resilience in social-ecological systems. (Walker et al. 2002)



VI. APPENDICES

APPENDIX 1: KEY DEFINITIONS

Accountability	Whether authorities are obliged to provide information and explain decisions and actions or inactions and whether they can be sanctioned when those answers are unsatisfactory
Adaptive capacity	Ability of humans in a social-ecological system to cope and respond to novel situations and change without losing options for the future; systems are able to re-configure themselves without significant declines in crucial functions in relation to social relations and economic prosperity
Adaptive management	Flexible management approach that allows for tests of different management policies and emphasizes learning as people use and manage resources, monitor and accumulate knowledge on the way, and constantly adjust the rules that shape their behavior to match the dynamics and uncertainty inherent in the environment
Co-management	Shared responsibility and collective action or the coordination of efforts among groups of individuals, i.e. between institutions of the state and of local resource users, to undertake some aspect of resource management
Adaptive co-management	Flexible systems of resource management tailored to specific places and situations, and supported by a diverse set of stakeholders and organizations operating at different levels
Deliberation	Process of open communication, discussion, and reflection among actors who have alternative political viewpoints and understandings that facilitates learning
Diversity	
Functional diversity	Diversity of functional actor groups in the social domain, i.e. the more different types of actors there are, the more functions are performed
Response diversity	Or functional redundancy; multiple distinct elements performing the same function capturing features of both redundancy and diversity
Governance	Structures and processes by which societies share power, shape individual and collective action; includes laws, regulations, discursive debates, negotiation, mediation, conflict resolution, elections, public consultations, protests and other decision-making processes
Polycentric governance	System of flexible decision-making shared by many different democratic sub-units, from national government to local villages, seeking a balance between decentralized and centralized control
Institutions	Rules and norms that structure human interaction, including their enforcement characteristics and sanctioning mechanisms

Formal institutions	Rules that human beings devise, such as written rules, laws and constitutions and are highly associated with the structural complexity of industrialized nations and their division of labor
Informal institutions	Norms of behavior, conventions, self-imposed codes of conduct and their enforcement characteristics; usually decentralized and self-enforced by a community
Memory	
Social memory	Reservoirs of experience, practice, adaptations, knowledge, values and world views crucial for preparing a system for change, building resilience and for coping with surprises
Institutional memory	Accumulation of experiences concerning management practices and rules-in-use particularly important during periods of change and crisis; subset of social memory
Resilience	Amount of change a system can undergo and still retain the same control on function and structure; degree to which the system is capable of self-organization; and the degree to which the system expresses capacity for learning and adaptation
Institutional resilience	Formal and informal rules or regulations that are in force to secure the right of resource exclusion and extraction
Social resilience	Capacity of a social system to embrace uncertainty and change by building knowledge and understanding of resource and ecosystem dynamics and to adapt to change without deteriorating in the advent of disturbance, whether it be political, social or economic
Resource dependency	Reliance on a narrow range of resources leading to social and economic stresses within livelihood systems
Scenario development	Key methodology for scanning alternative futures, identifying critical uncertainties, and guiding action
Self-organization	Ways by which a system buffers the impacts of other systems and maintains and re-creates its identity
Social capital	Features of social organization such as trust, norms and networks that can improve the efficiency of society by facilitating coordinated actions (collective action)
Bonding capital	Relations between family members, friends and neighbors that create closed, tightly connected networks and strong but localized trust
Bridging capital	Relations, based less on friendship and kinship but on the weaker bonds of trust and reciprocity made up by the economic and other ties external to the group, that give access to information, resources and opportunities outside the local network
Social learning	Sustained, i.e. decade-long, processes of attitudinal and behavioral

	change by individuals in social environments through interaction and deliberation
Social networks	Network of relationships among people
Social-ecological system	An ecological system intricately linked with and affected by one or more social systems; subset of social systems in which some of the interdependent relationships among humans are mediated through interactions with biophysical and non-human biological units
Transformability	Capacity to create a fundamentally new system when ecological, economic, or social, including political, conditions make the existing system untenable
Vulnerability	Exposure of groups or individuals to stress as a result of social and environmental change, where stress refers to unexpected changes and disruptions to livelihoods

APPENDIX 2: SUGGESTED QUESTIONS FOR ASSESSING THE LEVEL OF SOCIAL RESILIENCE IN A COMMUNITY

QUESTIONNAIRE [Using key social resilience principles and variables (adapted from Folke et al. 2003)]

1. Adaptability (Learning to live with change and uncertainty)

1.1. Vision and leadership

- Is there strong leadership capacity in the community that is responsive to prevailing ecological conditions and supportive of MPA networks?
- Are there multiple leadership roles or just a single well defined leader in the community?
- How would you define leadership?
 - a. Single leader
 - b. Multiple leaders
- How responsive is the community to ecological conditions?
 - a. Responsive (to ecological conditions)
 - b. Unresponsive (to ecological conditions)
- How supportive is the community of MPA networks?
 - a. Supportive (of MPA networks)
 - b. Unsupportive (of MPA networks)

1.2. Multi-level social networks and flexibility of social organization

- What type and how many stakeholder groups are present in the area affected by the MPA network? (List the stakeholder groups and the numbers individual in each of them)

Stakeholder	Numbers
Non-migratory small scale fishers	100
Large scale fishers	900
Seaweed farmers	34
Tourists	100
Traders	12
Government	
Church/Religious groups	

- What level of connectivity among stakeholders exists in terms of resources and opportunities outside their own networks? [*Connectivity* is defined as the level of connectedness or linkage between individuals or institutions that help build social capital]
 - a. Local
 - b. National
 - c. Regional
 - d. International
 - e. Combination of the above
- How much trust do local stakeholders have in their leaders in relation to marine resource management?
 - a. None
 - b. Moderate
 - c. High
- Using a scale of 1 to 5 (1=not a barrier and 5=major barrier), to what extent do stakeholders perceive corruption as a major barrier to development in the community?
- How close or connected are relationships among community members?
 - a. Strong bonds and tightly connected
 - b. Moderate and open to other actors or networks
 - c. Weak and with distrust
- What ethnic or indigenous groups are present in the area? What percentage of each ethnic group exists to make 100%?

- What types historical information is available on cultural resources associated with MPAs and the protection of these cultural resources?

1.3. Demographic changes (population growth, migration)²

- How do migration rates impact the characteristics of the community?

2. Diversity (Nurturing diversity for reorganization and renewal)

2.1. Diversity of livelihood

- What are the primary sources of livelihood in the community where the MPA network exists?
 - Fishing
 - Agriculture/Farming
 - Seaweed farming
 - Tourism
 - Trade/Business
 - Labor-based employment (e.g. carpentry, helper, etc)
 - Others
- What is the estimated income from each occupation? (Put in order from lowest to highest)

2.2. Resource dependency

- What % of the community is primarily dependent on a particular marine-based activity within and around the MPA network?

Marine-based activity	% community dependent
Fishing	
Ornamental/aquarium trade	
Tourism (diving, snorkeling, boating)	
Aquaculture and seaweed farming	
Forest products (mangroves)	
Gleaning	
Etc...	

- Are there traditional mechanisms to control or regulate resource use/extraction?
 - Periodic closures
 - Seasonal fishing
 - Prohibition of gathering certain species
 - Open access
- Describe patterns of human use and resource management from past to present time
- What are the primary markets for marine-based products?

Marine-based product	Type of market (none, local, national, regional, international)
Fresh fish and shellfish	
Live fish	
Ornamental/aquarium fish	
Shells and by-products	
Seaweed	
Etc...	

3. Learning and Knowledge Systems (Combining different types of knowledge for learning)

3.1. Traditional and local knowledge systems

- What are the indigenous resource management systems present in the community which complement the MPA or MPA network?

² Demographic changes are mentioned in the SR literature as affecting social-ecological systems, however it is unclear whether their effect on resilience is positive, negative or neutral.

- Does MPA network management complement or contrast with any local cultural beliefs and traditions regarding resource management?
- Does the community have strong religious beliefs or social conventions that can help enforce environmental protection?
 - a. Sometimes
 - b. Never
 - c. Always
- Are customary marine tenure rights or concessions present among the communities covered by the MPA network?
- Do the communities have property or tenure rights or/and concessions in the area covered by the MPA network?
 - a. Yes, they have legal property rights with a strong organization and surveillance.
 - b. Yes, they have legal property rights, but there organization and surveillance is medium.
 - c. Yes, they have legal property rights, but there organization and surveillance is poor.
 - d. No, they do not have property rights.

3.2. Transformational learning

- What is the level of awareness of the community in terms of benefits of an MPA or MPA network?
 - a. None = Not aware of the benefits of MPAs or MPA networks
 - b. Moderate = Can identify 1 benefit of MPAs or MPA networks
 - c. High = Can identify >1 benefit of MPAs or MPA networks
- Are stakeholders willing to alter their use of or give up their rights to the marine resource and support MPAs or MPA networks?

Stakeholder	Yes or No
Non-migratory small scale fishers	
Large scale fishers	
Seaweed farmers	
Tourism sector	
Traders	
Government	
Church/Religious groups	

3.3. Collaborative planning & participation

- Which stakeholders participate in and support MPA network management?
 - a. Non-migratory small scale fishers
 - b. Large scale fishers
 - c. Seaweed farmers
 - d. Tourism sector
 - e. Traders
 - f. Government
 - g. Church/Religious groups
- What representation is this of the community as a whole?
- Are there instruments of collaboration among stakeholder groups for the management of the MPA or MPA network?
 - a. Memorandum of agreement or collaboration
 - b. Ordinances or other legal documents
 - c. Traditional collaborative agreements
 - d. Projects
 - e. Contracts
 - f. Others
- What activities are done to promote collaborative learning and MPA management?
 - a. Workshops
 - b. Consultations

- c. Public forums
- d. Meetings
- e. Field trips or study tours
- To what extent are stakeholders involved in MPA management?

Stakeholder	Extent (Only at the beginning, once in a while, regularly)
Non-migratory small scale fishers	
Large scale fishers	
Seaweed farmers	
Tourism sector	
Traders	
Government	
Church/Religious groups	

4. Self-Organization (Maintenance & re-creation of identity)

4.1. Multilevel polycentric governance and accountability

- What type of decision making arrangements are in the MPA or MPA network?
 - a. Legal arrangements
 - b. Verbal arrangements
 - c. Traditional arrangements
 - d. A combination of the above
- Do governance systems exist at multiple levels and share responsibility for management of the MPA network? List down and describe the different MPA decision-making and management bodies and their mandate.
- Are there partnerships between communities, government and other institutions that support the management of the MPA network?

	Nature of Linkage
Academe	
NGOs	
National gov't agencies	
Tourism industry	
Private sector	
Etc...	

- Do local organizations involved with MPA management interact with each other and organizations at other levels (national or regional)?
- Are mechanisms in place that monitor and ensure accountability of authorities for MPA management actions?
- Are the resource use rights of ethnic minorities or indigenous groups acknowledged and protected by authorities amidst the presence of the MPA or MPA network?
- Is there a mechanism for institutional continuity or memory in MPA management in the advent of political change or a major change in leadership?
 - a. Multi-sectoral body
 - b. Semi-autonomous committee or council
 - c. Advisory group
- What is the extent of staff turnover within the MPA management institution and government offices?

4.2. Conflict resolution mechanisms

- What are the predominant sources of conflict and issues related to MPAs or MPA networks?
 - a. Religion-based conflict
 - b. Socioeconomic
 - c. Political
 - d. Clan or family conflict

- e. Class conflict
- What mechanisms or institutions in the community help resolve conflicts emerging from the establishment or management of an MPA network?
 - a. None

Mechanisms:

- b. Formal legislation
- c. Community rules/regulations
- d. Traditional laws

Institutions:

- e. Government agency
- f. Multi-sectoral body
- g. NGOs or community organizations
- h. Tribal leader or chief
- i. Council of elders
- Are the vision, goals and objectives of the MPA network clear?
- What laws are in place that are compatible with the goals and objectives of the MPA or MPA network?
- Is there a legal framework to revise the MPA management plan?
- Are there provisions for sufficient and fair penalties for violators of MPA rules and regulations?

4.3. Capacity

- Do the stakeholders and management/government institutions have access to opportunities that equip them with knowledge and skills for sustainable resource management?
- What kind/level of training is provided to MPA management and staff?
 - a. Coastal resource management
 - b. Scientific monitoring
 - c. Environmental education
 - d. Sustainable tourism
 - e. Enforcement and surveillance
- Are there enough resources (human and financial) to support the capacity for MPA management?

4.4. Monitoring and feedback loops

- Are there institutions or groups that do monitoring and research (ecological and social) in the areas influenced by the MPA network? How extensive is the monitoring program?
- Are there institutions responsible for enforcement of the MPA or MPA network?
- Is there a strong and formal enforcement system for the MPA network?
 - a. None
 - b. Poor
 - c. Medium
 - d. High (effective)
- What type of enforcement system is employed in the MPA network?
 - a. Governmental
 - b. Community-based
 - c. Non-government organization
 - d. A combination of the above
- What are the regulations in the MPA network?
 - a. Zone restrictions (e.g. no-take)
 - b. Season restrictions
 - c. Gear restrictions
 - d. Combination of the above
- Are the rules and procedures on enforcement of the MPA network specific and clearly defined?
 - a. Rules are very complex and difficult to understand

- b. Rules are of average complexity
- c. Rules are very simple and easy to understand
- Are they socially acceptable to the stakeholders?
- Are the rules and procedures widely available and understood by stakeholders (multiple languages)?
- Are the boundaries of the MPA network clear and easily recognized by resource users and enforcement personnel?
- Are the stakeholders aware of information generated by the scientific community about their environment and MPA networks? Do resource users and decision-makers receive or have access to the same sets of information?

Stakeholder	Aware (Yes or No)	Source of Information
Non-migratory small scale fishers		
Large scale fishers		
Seaweed farmers		
Tourism sector		
Traders		
Government		
Church/Religious groups		

- Are stakeholders involved in the collection and analysis of research and monitoring data for the MPA network?
- Is MPA management evaluation facilitated by providing forums for deliberation, information sharing and providing feedback (e.g. workshops, public consultations, etc)?
- How well is the data managed and compiled so that it is consistent and comparable across the entire MPA network and the region?

APPENDIX 3: ANNOTATED BIBLIOGRAPHY

TOP 10 MORE RELEVANT PUBLICATIONS

- Folke, C., S. Carpenter, T. Elmqvist, L. Gunderson, C.S. Holling, B. Walker, J. Bengtsson, F. Berkes, J. Colding, K. Danell, M. Falkenmark, L. Gordon, R. Kasperson, N. Kautsky, A. Kinzing, S. Levin, K.G. Mäler, F. Moberg, L. Ohlsson, P. Olsson, E. Ostrom, W. Reid, J. Rockström, H. Savenije, and U. Svedin. 2002. *Resilience and Sustainable Development: Building Adaptive Capacity in a World of Transformations. Scientific Background Paper on Resilience for the process of the World Summit on Sustainable Development on behalf of The Environmental Advisory Council to the Swedish Government.*

This reference begins with a good background/context of how resilience theory came about. It stresses the point that humanity and nature should be viewed as co-evolving in a dynamic fashion, and that ecosystem response to human use is rarely linear, predictable or controllable. It then goes on to define the concept of resilience as used by the resilience alliance: the capacity of a system to buffer perturbations, self-organize, learn and adapt. The four elements of resilience are then explained in detail in the context of adaptive capacity and adaptive management. Finally, the paper discusses some social processes that tend to lead to a loss in system resilience, e.g. urbanization and aspects of globalization.

- Davidson-Hunt, I.J. and F. Berkes. 2000. *Environment and Society through the Lens of Resilience: Toward a Human-in-Ecosystem Perspective. Draft of paper presented at the 8th Biennial Conference of the International Association for the Study of Common Property (IACSP). Bloomington, Indiana USA.*

In this paper, resilience is discussed and described in terms of how it can be manifested in social systems. It explains elements of social resilience, such as diversity of livelihood, traditional societies, flexibility of social organization, decentralization of decision-making powers, communication and feedback loops, and working at multiple scales among others, and gives examples of case studies for some of these elements.

- Adger, W.N. 2000. *Social and Ecological Resilience: Are They Related? Progress in Human Geography 24, 347-364.*

This paper defines social resilience as ability of communities to withstand external shocks to their social infrastructure. It explains this definition in more detail throughout the narrative and discusses some parameters or indicators for social resilience, including social capital, cultural and local technical knowledge, resource dependency and livelihood stability.

- Tompkins, E.L. and W.N. Adger. 2004. *Does Adaptive Management of Natural Resources Enhance Resilience to Climate Change? Ecology and Society 9 (2): 10.*

This reference focuses on the role of networks and institutions in building resilience in both social and ecological systems, specifically the role of co-management in building community resilience. The authors suggest that adaptive management processes, informed by iterative learning about the ecosystem and earlier management successes and failures, increase present-day resilience, which can in turn increase the ability to respond to the threats of long-term climate change. It identifies several elements that build social resilience and highlights some of these elements in the successful management of Buccoo Reef Marine Park in Trinidad and Tobago.

- Lebel, L., J.M. Anderies, B. Campbell, C. Folke, S. Hatfield-Dodds, T.P. Hughes, and J. Wilson. 2006. *Governance and the Capacity to Manage Resilience in Regional Social-Ecological Systems. Ecology and Society 11, 19-.*

The aim of the paper was to answer the key question: how do certain attributes of governance function in society to enhance the capacity to manage resilience? The authors do this by initially defining the concept of governance and identifying attributes of good governance. They go on to describe attributes of governance that can enhance the capacity to manage resilience. These attributes include participation, deliberation, trust building, leadership, polycentric institutions and accountability. Some case studies were also mentioned to better explain some of the attributes.

- *Olsson, P. 2003. Building capacity for resilience in social-ecological systems. Doctoral dissertation submitted to the Department of Systems Ecology, Stockholm University, Sweden.*
The thesis analyzes social-ecological dynamics with the purpose of contributing to the understanding of adaptive capacity in social-ecological systems. It focuses on mechanisms for building social-ecological resilience in a world that is continuously changing. It summarizes four major research papers by the author and shows how his findings indicate that the adaptive co-management approach has the potential to build capacity for resilience in social-ecological systems. Some case studies from Asia, Africa, Europe and the Pacific were discussed throughout his study. Particularly in Paper II, the author describes in detail how a rural community in western Sweden manages their population of noble crayfish in the face of social and ecological change.
- *Wahle, C., S. Lyons, K. Barba, L. Bunce, P. Fricke, E. Nicholson, M. Orbach, C. Pomeroy, H. Recksiek and J. Uravitch. 2003. Social Science Research Strategy for Marine Protected Areas. National Marine Protected Areas Center, MPA Science Institute, Santa Cruz CA.*
This strategy document reflects the inputs of hundreds of scientists and other stakeholders and is intended to improve the incorporation of social science research into the planning, management and evaluation of marine protected areas. It identifies high priority needs for social science for social science information that are fundamental to MPAs and recommends practical ways to meet them through research, assessment, and capacity building. Although intended mainly for MPA development and implementation in the United States, the strategy can be applied widely to other countries or areas with MPAs as well.
- *Mascia, M.B. 2003. The Human Dimensions of Coral Reef Marine Protected Areas: Recent Social Science Research and Its Policy Implications. Conservation Biology 17, 630-632.*
This paper is a synthesis of findings from social science MPA research delivered at the 9th International Coral Reef Symposium in Bali, Indonesia in 2000. The author suggests several implications of these findings for coral reef MPA policy, i.e. decision-making arrangements, enforcement and compliance issues, and research and monitoring.
- *Anderies, J.M., M.A. Janssen, and E. Ostrom. 2004. A framework to analyze the robustness of social-ecological systems from an institutional perspective. Ecology and Society 9 (1): 18.*
The authors propose a framework that helps identify potential vulnerabilities of social-ecological systems to disturbances. Their challenge was to answer the question of: what makes social-ecological systems robust? A social-ecological system is defined and the types of disturbances experienced by these systems are discussed. Several case studies are also used to explain the complex interaction between components of an social-ecological system. Lastly, the authors identify and explain several principles for designing (or building) robustness in SESs.
- *Walker, B., L. Gunderson, A. Kinzig, C. Folke, S. Carpenter, and L. Schultz. 2006. A Handful of Heuristics and Some Propositions for Understanding Resilience in Social-Ecological Systems. Ecology and Society 11, 13.*
This reference is loaded with concepts and definitions needed to understand resilience in social-ecological systems. The authors begin by explaining five preliminary heuristics: adaptive cycle, panarchy, resilience, adaptability and transformability. Then they describe 14 propositions developed by experts in two workshops that represent the current understanding or knowledge of change in social-ecological systems. These propositions were based on comparative analysis of 15 case studies in a wide range of regions around the world. The propositions eventually led to several research questions which are presented at the end to encourage further resilience-related research.

CASE STUDIES OF PARTICULAR INTEREST OR RELEVANCE

- *Olsson, P., C. Folke and T. Hahn. 2004. Social-ecological transformation for ecosystem management: the development of adaptive co-management of a wetland landscape in southern Sweden. Ecology and Society 9(4): 2.*

Discussed essential features for self-organization and the emergence of adaptive co-management in a wetland ecosystem in Sweden

- *Marschke, M.J. and F. Berkes. 2006. Exploring strategies that build livelihood resilience: a case from Cambodia. Ecology and Society 11(1): 42.*
Highlighted resilience-building strategies employed by Cambodian fishing communities in response to changes in environmental and socio-economic conditions
- *Christie, P. 2004. Marine protected areas as biological successes and social failures in Southeast Asia. American Fisheries Society Symposium 42: 155-164.*
Examined social complexities associated to MPAs in the Philippines and Indonesia and their implications on management
- *Christie, P., D. Buhat, L.R. Garces, and A.T. White. 2003. The challenges and rewards of community-based coastal resources management: San Salvador Island, Philippines. In Contested Nature—Promoting International Biodiversity Conservation with Social Justice in the Twenty-first Century. Brechin, SR, PR Wilshusen, CL Fortwangler, and PC West (Eds.), pp. 231-249. Albany, NY: SUNY Press.*
Discussed social factors and lessons learned from building community-based coastal resources management in a Philippine MPA
- *Cinner, J., M.J. Marnane, T.R. McClanahan and G.R. Alamany. 2005. Periodic closures as adaptive coral reef management in the Indo-Pacific. Ecology and Society 11(1): 31.*
Determined socio-economic factors crucial to the effectiveness of adaptive coral reef management in Indonesia and PNG
- *Brown, K., W.N. Adger, E. Tompkins, P. Bacon, D. Shim, and K. Young. 1998. A Framework for Incorporating Stakeholder Participation in Marine Resource Management: A Case Study in Tobago. CSERGE Working Paper GEC 98-23.*
Identified key strategies that helped build social capital among communities affected by an MPA in Tobago, eastern Caribbean
- *McClanahan, T., M.J. Marnane, J.E. Cinner, and W.E. Kiene. 2006. A comparison of marine protected areas and alternative approaches to coral reef management. Current Biology 16: 1408-1413.*
Examined whether socioeconomic factors were related to outcomes of coral reef management strategies in several Indo-Pacific marine communities
- *Tompkins, E.L. and W.N. Adger. 2004. Does Adaptive Management of Natural Resources Enhance Resilience to Climate Change? Ecology and Society 9 (2): 10.*
Identified elements related to adaptive management that helped build social resilience in Buccoo Reef Marine Park in Trinidad and Tobago
- *Harkes, I., and I. Novaczek. 2000. Institutional resilience of sasi laut, a fisheries management system in Indonesia. Draft of paper presented at the 8th Biennial Conference of the International Association for the Study of Common Property (IACSP). Bloomington, Indiana USA.*
Identified elements important to the resilience of institutions in an Indonesian marine community
- *Lebel, L., J.M. Anderies, B. Campbell, C. Folke, S. Hatfield-Dodds, T.P. Hughes, and J. Wilson. 2006. Governance and the Capacity to Manage Resilience in Regional Social-Ecological Systems. Ecology and Society 11, 19*
Looks at attributes of governance and capacity to manage resilience as experienced in the management of the Great Barrier Reef in Australia

APPENDIX 4: REFERENCES

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