

Chapter 2

Adaptive Capacity in Theory and Reality: Implications for Governance in the Great Barrier Reef Region

Erin Bohensky, Samantha Stone-Jovicich, Silva Larson, and Nadine Marshall

2.1 The Great Barrier Reef Region: A Complex Governance Challenge

The Great Barrier Reef (GBR) is among the world's iconic ecosystems. Extending some 2,300 km along the coast of Queensland, Australia, the GBR was listed as a World Heritage Area in 1981 in recognition of its outstanding universal ecological and cultural values. The direct economic value of the Great Barrier Reef Marine Park to the Australian economy, in terms of marine tourism, commercial fishing and recreational use, was estimated at \$5.4 billion Australian dollars in 2006–2007 (Access Economics 2008).

As in many marine ecosystems, three major processes pose threats to the GBR: overharvesting of marine resources, water quality decline from land use in the adjacent catchment, and climate change (Hughes et al. 2007). Each threat operates at a particular scale, but is itself a manifestation of cross-scale processes. For example, overharvesting reflects pressures not only from local fishers but also international demand for marine resources (Hughes et al. 2003). Changes in water quality are influenced by national and international demand for agricultural and mineral commodities produced in the catchment, national and state environmental policy, the regional economy and farm-scale management. The impacts of climate change are the result of actions, including mitigation and adaptation, from global to local scales. The multiple-scale nature of the processes influencing the GBR argues for the importance of incorporating scale into any analyses, monitoring systems, and management strategies to address these processes.

Although governance of the GBR clearly needs to span multiple scales, this presents a highly complex challenge. First, adopting a multiple-scale approach to governance has implications for multiple actors who have different objectives and

E. Bohensky, S. Stone-Jovicich, S. Larson, and N. Marshall
CSIRO Sustainable Ecosystems, Davies Laboratory, PMB Aitkenvale QLD 4814, Australia
e-mail: erin.bohensky@csiro.au

values associated with the GBR. Furthermore, each of the three major threats is managed by different organizations and addressed by largely separate policies, some of them relatively new. For example, land and natural resource management (NRM), including fisheries, are managed at state level, while national marine waters and reef tourism fall under the jurisdiction of the Great Barrier Reef Marine Park Authority (GBRMPA), a federal government agency responsible for the management of the reef. Climate change affecting the marine park is also managed by the GBRMPA, as well as the Australian Department of Climate Change, created in 2007. Water quality is addressed by the Reef Water Quality Protection Plan (Reef Plan), an initiative started in 2003 involving all levels of government, industry organizations, community, and Indigenous groups and scientists.

The ways in which the various changes noted above will play out depends in part on the region's capacity to adapt. Adaptive capacity, by most definitions and measures, is considered relatively high for this region (Nelson et al. 2007) and for Australia as a whole (Haddad 2005). Yet, these definitions and measures may have limited utility for management in reality because a greater understanding is needed of the sources and determinants of adaptive capacity that appreciates the complex dynamics of the region. Our aim in this chapter is to draw on a combination of theory and empirical data to examine where regional adaptive capacity for environmental governance in the GBR region lies. Our main questions are: (1) how is adaptive capacity defined in theory? (2) how is adaptive capacity defined in "reality," as illustrated by empirical research on perceptions held by resource users, managers, and other decision-makers in the GBR? and (3) to what extent do the theoretically-derived and empirically-derived definitions differ? We first review theoretical definitions of adaptive capacity, and compare and contrast these to individual and organizational perceptions of adaptive capacity elicited through four separate research efforts that were recently carried out in the GBR region. We then discuss key messages emerging from this comparison of definitions and implications for the future governance of this region.

2.2 Adaptive Capacity in Theory

2.2.1 Review of Definitions

Below we identify major contributions in the last 10 years to the theory of adaptive capacity as it relates to environmental governance. Significant contributions have been made prior to this, but as many of these are acknowledged in the current literature as the basis for contemporary thinking on adaptive capacity, we did not include these earlier papers in our analysis. We also note that these "theoretical" definitions may in fact be derived from or supported with empirical data to varying degrees.

The literature we discuss falls into one of two broad and often overlapping domains: vulnerability and adaptation, and resilience (Janssen et al. 2006).

We focus on these because they deal with adaptive capacity at multiple scales and multiple aspects of environmental change, and as such are most relevant to the GBR. We acknowledge, but do not review, a growing body of literature dealing with specific aspects of adaptive capacity at specific scales, such as community-level vulnerability to climate change, natural disasters, or other disturbances (see Day and Dwyer 2003; Norris et al. 2008; Cinner et al. 2009; Ford et al. 2009).

2.2.1.1 Vulnerability and Adaptation

The concept of vulnerability is often discussed in relation to natural hazards and the ability of individuals or social groups to cope with these hazards (Adger and Vincent 2005). The study of adaptation of humans to environmental variability has its roots in anthropology (Janssen et al. 2006), but in recent decades has been applied to issues such as global climatic change and its impacts (IPCC 2001; Adger et al. 2005). Within the vulnerability and adaptation domain, adaptive capacity has been defined in several ways. The Intergovernmental Panel on Climate Change (IPCC) defines adaptive capacity as: “the general ability of institutions, systems, and individuals to adjust to potential damage, to take advantage of opportunities, or to cope with the consequences” (IPCC 2001). This definition has been adopted widely by other scholars and scientific assessments such as the Millennium Ecosystem Assessment (MA 2005).

Adaptive capacity, along with exposure and sensitivity, is considered a determinant of vulnerability (Adger and Vincent 2005). A region is thus more vulnerable if its adaptive capacity is low, but having high adaptive capacity in itself does not render it immune from disturbance; the nature of the disturbance and its impact also matter. However, adaptive capacity does represent “a vector of resources and assets that represents the asset base from which adaptation actions and investments can be made” (Adger and Vincent 2005). Adaptive capacity may be latent, realized only when sectors or systems are exposed to the actual or expected stimuli (Adger et al. 2005), and can only be observed when realized through some form of concrete adaptation (Lemos et al. 2007).

Adaptive capacity can be created by: “(1) investing in information and knowledge, both in their production and in the means of distributing and communicating them; (2) encouraging appropriate institutions that permit evolutionary change and learning to be incorporated; and (3) increasing the level of resources such as income and education to those in which they are presently lacking” (Lemos et al. 2007). Institutional arrangements are also important; adaptive capacity depends on the structure of institutions, the ability of decision-makers to manage information (Yohe and Tol 2002), and the potential of institutions to reduce impacts of risks (Smit et al. 2000).

Although vulnerability and adaptation are often discussed together, some authors make a distinction between the vulnerability and adaptation literature (Janssen et al. 2006). On the one hand, vulnerability studies may give more attention to the hazard itself, or to the risk of being detrimentally affected by the hazard

(Adger et al. 2004). Adaptation, on the other hand, may focus on actual management of the impact of and response to the hazard, and to do so successfully, by one account, requires heterogeneity of adaptive capacity across different stakeholders (Adger and Vincent 2005). Vulnerability may reflect “stocks” of adaptive capacity that are determined by a range of factors, whereas adaptation transfers adaptive capacity into action; we can assume that if one is adapting one has sufficient capacity to do so (although the converse is not necessarily true, having adaptive capacity does not necessarily imply adaptation).

2.2.1.2 Resilience

Resilience in ecological and social systems is the ability to undergo change and still retain the same controls on function and structure, the capability to self-organize, and the ability to build and increase the capacity for learning and adaptation (Gunderson and Holling 2002). The resilience literature discusses adaptive capacity in various contexts, including ecosystems (Carpenter et al. 2001), prehistoric societies (Redman and Kinzig 2003), organizations (Olsson et al. 2004), and governance (Lebel et al. 2006). A distinction is made between adaptive capacity in ecosystems and social systems. The former is thought to be related to genetic diversity, biological diversity, and the heterogeneity of landscape mosaics (Peterson et al. 1998; Carpenter et al. 2001; Bengtsson et al. 2003). In social systems, adaptive capacity is enhanced by institutions and networks that learn and store knowledge and experience, create flexibility in problem solving and balance power among interest groups (Scheffer et al. 2000; Berkes et al. 2002).

Much of the resilience literature is concerned with social–ecological systems (SES) (Walker et al. 2002); that is, coupled systems of humans and the environment (Westley et al. 2002) connected through a complex array of linkages and feedbacks (MA 2005). Central to social–ecological resilience theory is the concept of alternative regimes maintained by a small number of slow variables. Disturbance and change can result in abrupt, nonlinear shifts that move the system past a threshold and into a new regime. Such regimes manifest as “basins of attraction” that can be difficult to enter or escape when desired. The adaptive capacity of the SES is the collective ability of human actors in the system to manage these basins such that the system is kept within critical thresholds (Walker et al. 2004).

Views differ regarding the relationship between adaptive capacity and resilience (Gallopín 2006). Folke et al. (2002) maintain that resilience is key to enhancing adaptive capacity, though Walker et al. (2002) remark that “adaptive capacity is an aspect of resilience,” which together suggest a mutually reinforcing relationship between these concepts. One view holds that resilience is about negotiating vulnerability and adaptation under different conditions; “true resilience will lie in knowing when to change course and when to forge ahead” (Redman and Kinzig 2003). In this vein, Folke et al. (2005) identify four dimensions of adaptive capacity in SES undergoing change and reorganization: (1) Learning to live with change and uncertainty; (2) Combining different types of knowledge for learning; (3) Creating

opportunity for self-organization toward social–ecological resilience; and (4) Nurturing sources of resilience for renewal and reorganization.

2.2.2 A Conceptual Lens for Assessing Adaptive Capacity

We note three themes that are common to the vulnerability and adaptation and resilience literatures, and together offer a lens through which our empirical research on adaptive capacity can be viewed. First, the context of adaptive capacity matters. Carpenter et al. (2001) argue for the importance of defining “of what” and “to what” in studies of resilience and adaptive capacity; that is, whom or what is resilient or adaptive, and to what change or disturbance is this individual, community, or system resilient or adaptive? Walker et al. (2009) distinguish between specified resilience, when the “to what” can be defined, and general resilience, when the threat is unknown. In the vulnerability literature, a similar concept is expressed in the terms of sensitivity and exposure (e.g., Adger and Vincent 2005), where sensitivity reflects the characteristics of a particular individual, community, or society, and exposure reflects the interaction of the individual, community, or society with a particular change or disturbance. Thus, adaptive capacity may vary depending on the specific change processes, and may also vary depending on the ecological characteristics of the system.

Second, the scale of adaptive capacity matters. Folke et al. (2005) observe that adaptive capacity results from critical factors that interact across spatial and temporal scales. Although the adaptive capacity of individuals may be linked to community, regional or even global adaptive capacity (Smit and Wandel 2006), specific attributes and determinants of adaptive capacity may be scale-dependent (Adger and Vincent 2005). They may also be culture- and place-specific, such that scaling up is not possible (Adger 2003). Furthermore, enhancing adaptive capacity at one scale may undermine adaptive capacity at other scales: a sector may benefit at the expense of a region (Allison and Hobbs 2004) or individual at the expense of a community (Pelling and High 2005). Similarly, short-term adaptive capacity may differ from long-term adaptive capacity (Folke et al. 2002; Pelling and High 2005), implying trade-offs between present and future outcomes. Thus, adaptive capacity is “the ability of a socio-ecological system to cope with novelty without losing options for the future” (Folke et al. 2002).

Third, information and knowledge to support adaptive capacity matter, as do the processes by which they are created and transmitted. Adaptive capacity requires communication and learning, and organizations and mechanisms for creating and maintaining knowledge (Lemos et al. 2007) and enabling flexible solutions (Scheffer et al. 2000; Berkes et al. 2002). Building and maintaining adaptive capacity requires a diversity of social groups with interacting networks (Pelling and High 2005), which can access a diversity of knowledge types (Folke et al. 2005) as well as shared knowledge (Redman and Kinzig 2003). Adaptive capacity also depends on a balance

of power (Scheffer et al. 2003) that gives all actors a voice in decision-making, and credible information-generation processes (Yohe and Tol 2002).

2.2.3 From Theoretical Definitions to Operational Measures

Increasingly, attempts are being made to move the discussion of adaptive capacity beyond theoretical definitions to operational measures that can support environmental governance on the ground. So far, operational definitions of adaptive capacity have been largely in the form of conceptual frameworks and indicators, often used in comparative assessments of adaptive capacity (e.g., Turton 1999; Adger et al. 2004; Nelson et al. 2007; McClanahan et al. 2008). An alternative approach is to elicit perceptions of individuals, communities or societies of their own capacity to adapt (e.g., Bryant et al. 2000; Hertin et al. 2003; Grothmann and Patt 2005; Ford et al. 2009). Such perceptual measures of adaptive capacity can feed into quantitative approaches; for example, Adger et al. (2004)'s indicators were informed by expert judgment and validation as well as literature review.

We believe the concepts that formed our conceptual lens above – context-dependence, scale-dependence, and information and knowledge creation and transmission – all argue for a perceptual approach to defining adaptive capacity. For adaptive capacity to have resonance and meaning in “reality,” it is pertinent if not imperative to consider how and by whom adaptive capacity is defined.

We note that perceptions of adaptive capacity can both enhance adaptive capacity and constrain it. Adaptive capacity is enhanced by appropriate understanding of a problem and possible responses (Bohensky and Lynam 2005). By contrast, it is constrained when, for example, deep-rooted attitudes and behaviors of an individual or society undermine the ability to adapt to new situations (Scheffer and Westley 2007). For this reason, perceptual analyses of adaptive capacity benefit from the use of both deductive and inductive measures. The former are drawn from theory or conceptual frameworks of researchers, while the latter are defined by the actors themselves. There are trade-offs associated with each. Deductive approaches may fail to capture factors that are relevant on the ground. Inductive approaches run the risk of missing factors that are critically important to understanding adaptive capacity but not readily recognized by actors in the system. However, using both together enables a more complete picture of the factors, including perceptions that are likely to enhance or erode adaptive capacity.

2.3 Adaptive Capacity in “Reality”: Examples from the GBR

The adaptive capacity of the GBR is an issue that has attracted significant local and global interest (Olsson et al. 2008). However, to our knowledge, there have been no efforts to synthesize studies of adaptive capacity as it applies to the GBR across a range of contexts, scales, and methodologies.

In this chapter, we recognize the GBR as a regional SES, as defined above. However, we tend to agree with Walker et al. (2004) that “because human actions dominate in SESs, adaptability of the system is mainly a function of the social component – the individuals and groups acting to manage the system.” We recognize that the GBR SES comprises heterogeneous individuals, communities, and industries, and its adaptive capacity therefore needs to be addressed across different categories of social actors. We acknowledge the inherent complexities in trying to satisfy all actors in the GBR while meeting the objectives set for the GBR as a whole, and do not assume that enhancing the adaptive capacity of one type of actor results in enhanced adaptive capacity of another, nor of the whole. We also recognize that several change processes are affecting the GBR, such as overharvesting, water quality decline and climate change, and that all of these processes are linked in various ways to economic and policy change. In keeping with our point above about context, we do not assume that the adaptive capacity of the region to deal with each of these types of change is the same, but we acknowledge that these changes need to be addressed in an integrated way.

Below we discuss four separate research efforts and draw some lessons from the collective efforts on how adaptive capacity is perceived in the GBR region by different actors: resource users, natural resource managers, community residents, government bodies, and leaders from academia, government, and business working at the scale of the whole region. Each study was undertaken to address a specific research question related to one or more of the main threats to the GBR noted above (e.g., Hughes et al 2007). As such, aspects of adaptive capacity studied and the methodologies used differed. We have relied on both inductive and deductive approaches to define and understand adaptive capacity. In some cases, the research focused on the related concept of resilience.

2.3.1 Coping with Policy Change in the Fishing Industry

The commercial fishing industry in the GBR region and the sustainability of its activities has been at the center of public debate for many years and continues to experience changes in regulatory policies to minimize its impacts on the environment. Marshall and Marshall (2007) and Marshall et al. (2007) looked at how commercial fishers in the GBR respond and adapt to changes in these policies. Marshall and Marshall (2007) examined the capacity of commercial fishers to cope and adapt to changes in resource policy in a survey of more than 60 questions to elicit the likely response of commercial fishers and their families to changes in resource policy. The survey questions were based on the results of a literature review and scoping study and reflected concepts such as flexibility, strategic skills, coping mechanisms, capacity to reorganize and willingness to experiment and learn, as well as demographic characteristics. The survey was administered to 100 fishers and their families in their homes in five towns in northern Queensland, representing between 46 and 66% of the fishing population in each town.

Four main dimensions of the capacity to cope and adapt to policy change were identified by a Principal Components Analysis. These were, in order of importance:

- How fishers interpret risk associated with change?
- Fishers' capacity to plan, learn, and reorganize, which describes their level of financial preparedness and willingness to experiment.
- The capacity to cope, which reflects each fisher's perception of their ability to cope with changes required by a new policy, their level of financial stress, marital stress, and their ability to cope relative to other fishing families.
- Interest in adapting, which reflects the level of interest in learning new skills.

The combined effect of age, education, and attachment to occupation were important for fishers' understanding of risk and coping (Marshall et al 2007). For instance, younger, better educated fishers who were not as attached to their occupation were more optimistic about the risks associated with policy and their capacity to cope. Also, fishers with larger businesses and those that had business plans, were knowledgeable about their financial positions and had business skills, were more likely to perceive themselves as being able to cope and adapt. In addition, individuals' perceptions of risk and their capacity to cope were related to the combination of the level of involvement in the decision-making process, the perceived rate of implementation, and the interpretation of regulatory change.

Some fishers perceived themselves as lacking adaptive capacity because of a perceived lack of strategic skills, whereas others perceived a lack of options. This suggests that individual fishers may respond to change events quite differently. Policy implementers need to be cognizant of this heterogeneity and of the potential inequities that may result. Better understanding of differences between individuals can help with the design of solutions to assist resource users in adapting to change.

Heterogeneity in individual behavior can be an important source of adaptive capacity and resilience at other scales. Research on the effects of policy change on individual enterprises may progress our understanding of how resource-dependent industries can increase their capacity to cope with future policy change (Smith 1995; Salz 1998; Smith et al. 2003; Bradley and Grainger 2004).

2.3.2 Natural Resource Managers' Perceptions of Social Resilience to Water Quality Change

Water quality change in the GBR region and the corrective actions of the Reef Plan both have potential to impact the region's social systems. In this context, research is being undertaken to understand the region's social resilience: will individuals, communities, industries, and organizations be able to absorb and withstand various environmental and policy changes without undergoing fundamental change themselves? This section briefly describes an approach to develop indicators of social

resilience to water quality change and management interventions to achieve water quality targets at a regional scale (Lynam et al. 2007).

The development of the indicators was informed by subjective understandings of social resilience and its determinants based on interviews with natural resource managers in key government and nongovernmental organizations (NGOs) operating in the GBR region. The main purpose of the interviews was to ensure that the indicators developed were appropriate, meaningful, and useful for NRM agencies. As such, the interviews focused specifically on capturing and incorporating managers' understanding, experiential knowledge and perceptions of (1) what social resilience means, specifically as it relates to water quality change at the catchment-to-reef scale, (2) what enhances or erodes social resilience to water quality change, and (3) the usefulness of social resilience indicators to inform and adapt water quality policy and planning strategies.

Semistructured interviews were carried out in May–July 2007 with 20 representatives of different stakeholder groups in the GBR region. Stakeholder groups were selected according to the following criteria: (1) had a prominent role in water quality policy and/or management, and/or have an economic stake in water quality issues in the GBR; (2) operated at either the catchment-to-reef scale or across multiple catchments within the GBR catchment area, and (3) had formal, established linkages (e.g., via participation in committees) to other key GBR stakeholders (e.g., community and industry). Within each stakeholder group selected, particular attention was paid to interviewing individuals who worked on water quality issues.

Participants were asked to explain their understanding of the concept of “social resilience.” The majority of interviewees viewed adaptive capacity as a core element of social resilience. In general, they perceived social resilience to consist of the capacity of the social system or different segments of the social system (e.g., society, communities) to respond, react, or adapt to changes and perturbations for the purpose of either creating and maintaining stability and the status quo, or enhancing quality of life or the economy. Some interviewees perceived the changes or perturbations to be of an unspecified or general nature, while others referred specifically to negative impacts and changes in water quality. They also differentiated between reactive and proactive adaptations.

Participants were also asked to reflect on “what would enhance social resilience to water quality change in the GBR?” They identified four broad categories of socio-cultural, economic, and ecological factors that were perceived as essential for developing, maintaining, or enhancing the GBR's social stability, status quo, quality of life or economy. These were social–cultural attributes; capacity building structures, processes, and tools; the economy, and the ecosystem. The greatest emphasis was given to socio-cultural attributes and capacity building structures, processes, and tools.

With regards to socio-cultural attributes, participants stated there was a need for:

- Values and attitudes emphasizing, for example, water protection and improvement, and desire to solve water quality problems
- Consensus and cohesion on how to approach and solve the problem

- Diversity of stakeholders, knowledge and expertise, and institutional responses to solve water quality problems, as well as the need for economic diversity
- Positive stories of successful examples and efforts underway disseminated by the media and NRM agencies and organizations

With regards to capacity building structures, processes, and tools, participants emphasized accessible, sound, “good and honest,” and diverse information and knowledge that is easily and appropriately communicated, exchanged, shared, and debated, and that contributes to reducing uncertainties and surprises. Other factors that were highlighted were the need for both informal and formal social networks and partnerships that are horizontally and vertically linked, bring together a mix of stakeholders and are characterized by flexibility and innovation.

Having a stable source of income, or economic stability, was mentioned repeatedly as key to enhancing social resilience to water quality change. Rural and urban communities that suffer from production booms and busts (such as graziers), or high unemployment rates, were seen as incapable of dealing with other issues, particularly issues such as water quality changes that are generally perceived as being secondary to meeting basic needs. While economic stability was mentioned mostly in terms of individual and family economic wellbeing and economic prosperity in towns, a stable global economy was also viewed as being key to enhancing social resilience of people in the GBR region. In addition, market-based instruments to promote the adoption of best management practices, and a diversity of economic activities at the scale of both individual landholdings and the catchment-to-reef system, were also highlighted.

Participants emphasized the need to have a healthy ecological system and the implementation of land use practices that minimized impact on the environment. Also mentioned was the need to have greater control over the environment, through technologies and predictive tools (e.g., models to predict climate change and its impacts).

An understanding of how natural resource managers conceive social resilience and how they would use the concept is critical for informing management of resilience and capacity to adapt at a regional scale. However, inductively-derived, subjective measurements of social resilience such as those elicited in this study are only as comprehensive as the depth and breadth of experiences and knowledge of those interviewed. As such, it is equally vital that subjective understandings of resilience and its determinants are balanced with empirical data and theory to ensure the reliability and validity of indicators.

2.3.3 Public Perceptions of Institutional Roles in Australian Water Management

Public engagement in water planning activities is a legislated requirement at all levels of policy making in Australia (McKay 2005). However, water management

involves a complex set of institutional arrangements, and catchments in the GBR region are currently regulated by a dozen statutory plans, based on various acts, as well as an equal number of relevant nonstatutory plans (Queensland Environmental Protection Agency 2006).

As Ostrom (2007) notes, multiple institutions and actors are required to create and enhance adaptive capacity, because “a mess of interactions forms the social raw material that shapes capacity to identify new information, learn and cope with change” (Pelling and High 2005). However, complex arrangements can create a confusing and thus disabling environment. Actors find it difficult to untangle complex webs of information and identify parties responsible for helping residents respond to impact. Ultimately, it is difficult for the general public to be meaningfully engaged in planning processes if the system is misunderstood. As Marshall (2008) observes, current regional-scale strategic processes and delivery models in Australia have considerably increased the complexity and the difficulty of the issues with which communities and individuals currently grapple.

A study was undertaken in the Whitsundays Shire, a local government area in the GBR region and a significant tourism destination, to explore the understanding of institutional arrangements of local residents who are expected to engage in water planning processes (Larson and Stone-Jovicich 2008). The principal goals were to investigate local residents’ perceptions of a range of water quality issues and institutional responses and responsibilities for these issues, and compare these to actual institutional responses and responsibilities. Interviews were conducted with community residents and secondary data collected on water management institutions at all relevant scales. The Driving forces-Pressure-State-Impact-Response (DPSIR) framework (OECD InterFutures Study Team 1979) was used as a guide for data collection and structuring of emerging themes and perceived linkages between sources of water quality deterioration and impacts on human wellbeing as identified by interviewees (Larson and Stone-Jovicich 2008). These themes and linkages were then compared with current institutional arrangements relevant to water management.

Significant gaps were found with respect to institutional responsibilities for water quality. Residents perceived their local government body (Shire Council) as accountable for responding to water-related pressures and impacts in their Shire, whereas the responsibility lies primarily with a range of government agencies and organizations at federal, regional, and state levels. In particular, in this case study, the local council is held responsible for several water quality problems for which it has either limited or no responsibility or ability to take action. Local governments in Australia are expected to deal with an increasing number of social, ecological, and economic issues and, given budgetary constraints, are continuously facing trade-offs between priorities for improvement (Larson 2009, Brown 2007). It is estimated that local governments receive only about 5% of total government expenditure, yet contribute some 53% of total government environmental spending (Dovers and Wild River 2008).

The findings of this study suggest the need for better communication between the various parties in water planning processes. In addition, there is a need for

more research on the roles of the following in limiting or supporting adaptive capacity:

- Capacity of local government to meet expectations of its expanding role (Dovers and Wild River 2008; Larson and Stone-Jovicich 2008)
- Knowledge and understanding of the institutional system by stakeholders (Measham et al. 2009; Larson and Stone-Jovicich 2008)

Other relevant research needs have been identified in the areas of:

- Devolution of centralized power and devolution of resources (Lane 2003, 2005; Lane and McDonald 2005; Lane et al. 2004)
- Ability to link and manage multiple sources of knowledge (Measham et al. 2009; Stafford Smith 2008)
- Levels of trust in institutions by stakeholders (Marshall 2008; Larson 2006)

The multi-layered institutional system emerging in Australia is revealing some opportunities for a more adaptive, participative, and deliberative regional style of governance. In particular, progress has been noted in areas such as broadening the scope and scale of institutional collaborations, emergence of new network configurations or arrangements, fostering of new forms of participation among regional communities and increased capacity of social actors to coordinate amongst themselves (Bellamy 2007).

Effective engagement and social learning are crucial for long-term improvement of adaptive capacity (Bellamy 2007; Larson and Williams 2009). In turn, capacity building and social learning that develop during engagement processes play a role in legitimizing new organizations or rules (Lemos and Oliveira 2004; Larson 2006; Ostrom 2007).

2.3.4 The Future Great Barrier Reef: Adaptive Capacity in the Eyes of the Region's Leaders

Adaptive capacity may be built through processes such as scenario planning that stimulate thinking about the future, how different institutions shape it, and how surprises, unexpected consequences, and possible responses may unfold (Peterson et al. 2003; Bohensky et al. 2006). As part of a scenario planning exercise for the GBR region conducted by Bohnet et al. (2008), 47 leaders representing Australian and Queensland government agencies, local government, regional NRM bodies, NGOs, industry and research organizations were interviewed about their perceptions and aspirations for the future of the region. Leaders were selected as individuals in influential positions, as they are often instrumental in making change processes happen (Olsson et al. 2004). Participants were selected on the basis of their past or present involvement in the whole GBR catchment-to-reef system rather than specific subregions, urban centers, or communities (see also Chap. 13).

In a semi-structured interview process, interviewees were asked to describe in their own words the adaptive capacity of the GBR's different subregions, communities, industries, and government in 2050, and the extent to which they would be prepared for change as opposed to being reactive. Interviewees were asked the following questions related to adaptive capacity of the GBR catchment in 2050: (1) How do you think communities, industries, and government will respond to environmental problems? Will they be prepared to respond to environmental problems or will they only react once they happen? How will they prepare or react to change? (2) Will there be differences between subregions within the GBR catchment in terms of their responses to environmental problems? Will some subregions be better prepared than others? (3) What capacity to adapt to change will exist in different regions, communities, industries, and government in the GBR by 2050?

The most frequently mentioned issues by interviewees relate to:

- Timing of change processes
- Comparative adaptive capacity in subregions, industries, communities, and government
- Scales of adaptive action and governance
- Determinants of and constraints on adaptive capacity

Several respondents noted the difficulty of evaluating adaptive capacity in the absence of actual adaptation. One interviewee stated that adaptive capacity needs to exist in sufficient amounts to be appropriately matched to the problem, but noted that it is difficult to define this in practice.

Most interviewees agreed that all sectors of society, apart from a few forward-thinking individuals, tend to be reactive rather than proactive in responding to change, and that crisis or catastrophic change is usually required to shift society to new ways of thinking and modes of operation (however, some noted that changes tend to be made incrementally). Most mentioned the importance of leaders or champions, the role of education and information, and economic, demographic, biophysical, and geographic factors as determinants of adaptive capacity and ability to effect change. Uncertainty of scientific information required to understand and guide action was noted as a constraint to adaptive capacity. Other constraints included the lack of extension officers and coordinated research.

Interviewees also agreed that adaptive capacity differs among industries, with most suggesting the sugar industry is least adaptable because it exports into a global market that it cannot control. Some argued that tourism is most adaptable and regularly demonstrates its ability to reinvent itself, while others observed that tourism is also vulnerable to global changes such as the economy and climate. It was also suggested that adaptive capacity differs between different types of tourism enterprises, depending on their mobility, resources, and other factors.

The scale or organizational level of adaptive capacity was a common theme throughout the interviews. Some suggested that adaptation occurs in parallel at each scale or level (individual, community, industry, government, and region), while others suggested that adaptation begins at the community level and triggers change

by the government, and still others suggested that government regulation is necessary to achieve change in communities.

Four future scenarios for the GBR region were developed from the interviews and refined in a workshop. The scenarios reflected two key uncertainties: (1) the nature and timing of climate change impacts, and responses to the impacts and (2) the type of governance in the region and the extent to which it is influenced by regional leadership or global economic forces. In effect, scenario building and exploring responses to change is a process of operationalizing adaptive capacity, intended to assist participants to deal proactively with the complexity and uncertainty of the region's future.

2.4 Adaptive Capacity in Theory and Reality: Matches, Mismatches, and Future Governance of the GBR

How well do adaptive capacity in theory and in “reality” match? In this section, we revisit our conceptual lens (the context of adaptive capacity, scale and information and knowledge), and use it to compare and contrast the definitions and measures of adaptive capacity that we have found in the literature and our empirical research. We conclude by remarking on implications for addressing the complex governance challenges in the GBR region.

The literature suggests that adaptive capacity is context-dependent. Our four studies analyzed adaptive capacity in the GBR in different contexts. Does adaptive capacity differ between different actors, or between actors confronted by different change processes? Although we did not design our research to address this question explicitly, our findings suggest that it often does. Regional leaders noted that adaptive capacity differs between industries and in response to different types of change, although their views diverged on determinants of adaptive capacity in industries such as tourism. In interpreting statements of interviewees, we note that perceptions of adaptive capacity can be influenced by the stage of the change process. Where policies are already in place, it is possible to observe adaptation that is already occurring, such as that of fishers to policy change. Perceptions of adaptive capacity to climate change are based more on inference, as there remains much uncertainty about specific adaptive behaviors and actions that may be undertaken.

The literature suggests adaptive capacity is scale-dependent. We were interested in identifying differences in perceptions between individuals and stakeholder groups operating at various scales. The analysis of resource users and organizations and their perceptions of rules identified gaps that may inhibit effective local participation in planning processes. However, there were also common perceptions across scales, in particular amongst natural resource managers working at different scales and leaders working at the broad regional scale. These commonalities may reflect the relatively high levels of education, knowledge, communication, and

networks in this region compared to other regions in which there are greater inequalities in access to information. Better understanding of similarities and differences in perceptions across scales would be valuable for future management and capacity building of managers. Ultimately, the effects of scale-specific perceptions in creating synergies or trade-offs in adaptive capacity across scales need further research: does individual adaptive capacity come at a cost to the adaptive capacity of the GBR region, and vice versa?

Information and knowledge is another theme common to the theoretical and empirical descriptions. While different types of knowledge are considered important for adaptive capacity in the literature (e.g., Folke et al. 2005), natural resource managers expressed a need for “honest” information about water quality change that is easily communicated. The significant barriers that exist between knowledge creators, holders, and users are noted in the institutional analysis, echoing challenges found elsewhere (Roux et al. 2006). We also note that differences in either the fundamental concepts or the language of theory and “reality” may prohibit effective communication between researchers, government agencies, and resource users. Clearly the language used in the theoretical and empirical definitions differs, and it is not always possible to discern the extent to which this reflects a mismatch in the underlying understanding.

The theory of adaptive capacity embodies ideas about complex SES, which requires great care to be conveyed successfully to nontechnical audiences. These concepts seem to be only partially comprehended in the GBR region. For example, some natural resource managers noted the need to have greater control over the environment, through technologies and predictive tools. This contradicts the theoretical views that acknowledge the need for governance to maintain the self-organizing capacities of ecological systems, and allow variation and adaptation, while seeking to keep the system within critical thresholds (Gunderson and Holling 2002). In addition, the managers’ view that a stable global economy is an important factor in enhancing adaptive capacity is in contrast to the view in the literature that adaptive capacity is itself part of an adapting and largely uncontrollable system. While the theory notes that taking advantage of opportunities and novelty are part of adaptive capacity, the perceptual definitions focus more on coping with consequences. In fact, most of the latter reflect a passive, reactive approach to adaptation, as was noted in the interviews with GBR leaders, and has also been found in other research (Olsson et al. 2004). Furthermore, most of the constraints to adaptive capacity mentioned in these interviews were related to information and understanding, yet interviewees also indicated a lack of will or responsibility to take adaptive action.

It is this point that we feel is noteworthy as a key message from this analysis. Overall, our findings indicate that the GBR region has high adaptive capacity, or high potential to develop it: despite the prospect of substantial change in the region, much of it uncertain, many of the individuals and organizations we interviewed remarked positively about forthcoming change, and some even welcome it. Yet they also indicated that this adaptive capacity may not be turned into active adaptation until a crisis occurs, and acknowledged the significant danger that this may come too late. Indeed, the theoretical definitions suggest that adaptive capacity

is latent and harnessed in response to stimuli. We wonder at which point the stimuli will be sufficient to provoke a response, and what this response might be. The prevailing belief among the GBR leaders who were interviewed that a catastrophe is the most likely pathway to change is unsettling. Reversing this *modus operandi* is probably the region's greatest, most complex governance challenge of all.

As a future applied research direction, we recommend that more emphasis be given to understanding motivations that underlie adaptive capacity and indeed adaptation, as argued by Haddad (2005). Empirical research requires analysts to observe adaptive capacity through adaptation processes, which is difficult to do in the absence of adaptation. The alternative approach of eliciting perceptions of adaptive capacity is also problematic as perceptions are couched in the unique views of each adapting actor, and importantly, he or she may not always act in accordance with stated perceptions. Combining inductive and deductive approaches to define and understand adaptive capacity as we have discussed in this chapter is therefore key to understand the motivational context of adaptive capacity.

Solving the complex governance challenges of the GBR requires nothing less than a multi-faceted, multi-perspective approach. It requires nothing less than a combination of theoretical and empirical analyses, at multiple scales, with heterogeneous social groups and through multiple methods, in order to confront disparities and improve both the theory and the development of practical and relevant operational measures of adaptive capacity. Governance that is based on theory or empirical analysis alone is not enough.

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