Chapter 14
Adapting and Transforming: Governance for Navigating Change

Derek Armitage and Ryan Plummer

14.1 Introduction

A transformation of earth's systems is under way. Many of the provisioning, regulating, and cultural services upon which national and global economies depend are on the decline (MA 2005; Carpenter et al. 2009), with uncertain consequences for human well-being. To navigate these changes, individuals and societies must develop the capacity to adapt and transform their interactions with ecosystems and ecosystem services (Berkes et al. 2003; Carpenter et al. 2009). Adapting and transforming are linked, but reflect some important differences. Adaptations can be reactive or anticipatory, autonomous, or part of a suite of responses to change. In the context of lock-in traps or unsustainable path dependencies, however, such responses may be inadequate. In systems where the ecological, social, and economic conditions are untenable (Walker et al. 2004), there will be limits to adaptation and a need for more fundamental shifts in strategy that require new ideas and practices (Olsson et al. this volume).

Institutions and multilevel governance arrangements are particularly important in this regard because they can support knowledge building, learning, and conflict resolution, which help to reduce vulnerability, build resilience, and increase adaptive capacity (Berkes 2009). The chapters in this volume highlight these linkages and improve our understanding of their connections. Insights are offered from diverse settings using a variety of analytical approaches (Plummer and Armitage

D. Armitage
Department of Geography and Environmental Studies, Wilfrid Laurier University, Waterloo, ON, Canada N2L 3C5
e-mail: darmitag@wlu.ca
R. Plummer
Department of Tourism and Environment, Brock University, 500 Glenridge Avenue, St. Catharines, ON, Canada L2S 3A1
Stockholm Resilience Centre, Stockholm University, Stockholm, SE-106 91, Sweden
e-mail: rplummer@brocku.ca

D. Armitage and R. Plummer (eds.), *Adaptive Capacity and Environmental Governance*, Springer Series on Environmental Management,
DOI 10.1007/978-3-642-12194-4_14,

this volume). Attributes and practices that can confer greater capacity to adapt and transform are emphasized, and we begin to see in the various chapters how governance can steer societies along pathways that sustain ecosystem services and human well-being.

This volume represents an interdisciplinary perspective on adaptive capacity in the context of environmental governance. In combination, the chapters contribute to (1) a synthesis of current knowledge and understanding of adaptive capacity in a wide range of environment and natural resource contexts, (2) theory development based on the synthesis of experiences from a variety of perspectives, and (3) better understanding of the implications of theory and experience for policy and governance for navigating change. In summarizing these contributions – both conceptual and applied – we make the argument that adaptive capacity and effective governance for navigating change should be seen as closely related. Adaptive capacity is central to effective governance, but building multilevel governance can contribute increased capacity to respond to change. To explore this relationship, we reflect upon the lessons learned from this volume and frame an agenda for practice and research (Fig. 14.1).

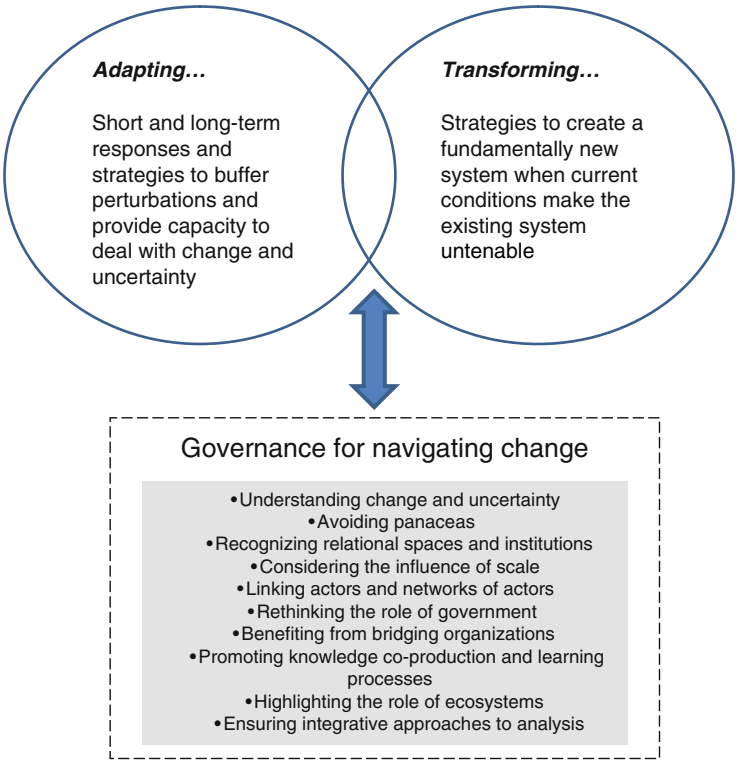

Fig. 14.1 Adaptive capacity and governance for navigating change

14.2 Governance for Navigating Change

Increased vulnerability of people and ecosystems to change, societal lock-in traps, and unsustainable path dependencies present a difficult milieu for environmental governance. Institutions and governance processes are required that match complex social–ecological systems (SESs), adapt as these systems change over time, and help steer these systems along sustainable pathways (Galaz et al. 2008; Pahl-Wostl 2009). Such arrangements must further support strategies to restore, maintain, and enhance the capacity of ecosystems to generate critical ecosystem services (Carpenter et al. 2009; Scheffer 2009). A growing body of environmental governance scholarship is pointing to the importance of multilevel arrangements, interactive networks, and partnerships among state and nonstate actors, in which diverse perspectives and knowledge are shared and social learning processes provide opportunities for adaptability (Folke et al. 2005; Brondizio et al. 2009; Newig and Fritsch 2009).

Folke et al. (2005) outlined four general principles to enhance adaptive capacity and governance: (1) build knowledge of ecosystem dynamics; (2) integrate different forms of knowledge with a focus on learning through adaptive management; (3) support flexible institutions and multilevel governance; and (4) deal with the unpredictable. Such capacity to cope and adapt derives from dynamic and ongoing processes of social learning, facilitated by knowledge coproduction and the formation of vertical and horizontal linkages (Folke et al. 2005; Berkes 2009). Governance arrangements to accommodate these principles and processes typically involve multiple centers of decision making and require many mechanisms for coordinated action (Dietz et al. 2003; Duit and Galaz 2008). Such networked arrangements are presumed to confer stability and adaptability because of enhanced capacity to diffuse the negative effects of change and distribute the benefits (Lebel et al. 2006; Bodin and Crona 2009).

The contributions in this volume reflect on these themes and highlight the manner in which adaptive capacity and governance are linked. Each of the lessons identified below extends in some way the principles identified by Folke et al. (2005) and the interdisciplinary concepts outlined in Chap. 1.

14.3 Lessons Learned

Lessons from this volume are many. As the chapters reveal, identification of attributes and dynamics of adaptive capacity as they relate to governance are multifaceted and complex. It is challenging to isolate a specific social level at which to focus capacity-building efforts, identify a specific asset or process that guarantees the emergence of adaptive capacity for effective governance, or point to a single type of barrier (e.g., institution, political dynamic, resource). Rather, policy makers and practitioners are better served by recognizing the *bundles* of attributes,

processes, and practices that support and link capacity and governance. From the perspectives of both research and practice, greater attention is required on how those bundles interact in particular places and at particular times to support or constrain governance for navigating change. We offer below a summary of those insights and the main lessons for practice and research, and thus point to a need for careful assessment of the relationship between adaptive capacity and governance. We make no claim that this list is exhaustive, and recognize that others summarizing the wealth of insights from the chapters in this volume would likely generate a somewhat different list. Nevertheless, we do highlight here what we believe are a set of key lessons with which researchers and practitioners of adaptive capacity and governance can move forward.

14.3.1 Change and Uncertainty

Why are we concerned about building adaptive capacity? The short answer is to deal with change and uncertainty in SESs. Governance systems are required to deal with, individually or in some combination, change of different magnitudes and levels of predictability. For example, directional changes in key drivers of social–ecological processes (e.g., declining fish stocks; see Kalikoski and Allison this volume) or increasing interannual variation and frequency of extreme events (see Wandel and Marchildon this volume) produce a wide range of outcomes of different magnitudes and degrees of uncertainty. The emergence of critical transitions or regime shifts (see Steffen et al. 2004) draws attention to processes of change with outcomes that are becoming increasingly difficult to understand given that the drivers and effects of these changes are cross-scale. A growing body of evidence on critical transitions (Scheffer 2009) thus highlights the challenges for building adaptive capacity to deal with surprise as well as cascade and threshold effects (see Galaz et al. 2008). Cascade and threshold effects present situations in which institutions and governance systems are unable to avoid irreversible shifts in SESs, or where there is an inability to buffer the flow of crises across scales and systems.

The chapters in this volume illuminate these dilemmas as they relate to building adaptive capacity. For example, institutions and governance arrangements in certain resource sectors (e.g., water, wildlife) have been, and still largely are, organized around the assumption that natural systems fluctuate within a predictable envelope of variability (de Loë and Plummer this volume). However, the predictability of this envelope is increasingly less clear. Building adaptive capacity for the former situation is not the same as for the latter. de Loë and Plummer (this volume) raise the problem confronting water managers of how to cope and adapt in this new environment. This problem, as well as the solutions being proposed, extends well beyond the domain of water into other resource sectors. While some, such as Milly et al. (2008), argue that more sophisticated modeling capabilities are required to adapt to climate change impacts, others (e.g., Ivey et al. 2004; de Loë and Plummer

this volume) argue that it is necessary to strengthen the institutional capacity of communities, organizations, and societies to address increasing variability.

In contrast, a number of chapters highlight how intersecting system changes in one region can create significant barriers to adaptive capacity and governance. Bohensky et al. (this volume), for example, document the challenges of building adaptive capacity in the Great Barrier Reef system battered by interconnected changes in adjacent terrestrial watersheds, agricultural systems, climate, and the reef itself. Fabricius and Cundill (this volume) raise the more problematic scenario of how to build adaptive capacity in a system that has possibly already crossed a threshold. The highly impoverished and ecologically degraded Macubeni system creates far different adaptive capacity and governance needs, for example, than most other cases in this volume. The implications of ongoing change for adaptive capacity and governance are profound. Because the structure and conditions of complex, multivariate, nonlinear, and multiscale SESs are always in flux (Gunderson and Holling 2002), the task of building adaptive capacity and governance arrangements is forever incomplete.

14.3.2 Blueprints and Panaceas

Ostrom (2007: 15181) has highlighted problems with the "perverse and extensive uses of policy panaceas in misguided efforts to make SESs. . .sustainable over time." As the chapters in this volume illustrate, efforts to build adaptive capacity and multilevel governance arrangements for complexity are no different. As one example, Diduck (this volume) identifies the recent proliferation of "learning" in relation to adaptive capacity and resource and environmental governance. He argues that it is necessary to untangle the definitions and explanations of learning, and uses five social units of analysis (individual, action group, organizational, network, and societal) to delve into the theoretical nuances and the implications for applied research and practice. de Loë and Plummer (this volume) provide an applied example of the need to "go beyond panaceas." In exploring the challenge of adapting to the impacts of climate change on water supply, they highlight the importance of considering the context of the water system, the anticipated outcomes of climate impacts, and the capability of the system's management to address current and future impacts. There is no simple or linear strategy to build adaptive capacity given the pace and scale of social–ecological change (Fabricius and Cundill this volume), the myriad constraints on the emergence of institutions that match biophysical systems (Matthews and Sydneysmith this volume), and the messy influences of power, ethics, culture, and even genes (Fennell and Plummer this volume).

A key lesson that emerges from the combined insights of this volume is that actors (e.g., resource users, department officials) engaged in collaborative governance processes in "messy social–ecological systems" (see Alessa et al. 2009) must build issue- and place-specific strategies. There is a need for further clarity on how

specific experiences and attributes that build adaptive capacity can be transferred across institutions and levels (Keskitalo this volume). Yet it is also clear that there are no panaceas when it comes to building adaptive capacity for governance.

14.3.3 Relational Spaces and Institutions

Pelling et al. (2008) suggested that relational spaces – the places and sites where actors engage in understanding and resolving challenges – are a result of the interplay of institutions and social learning. Such spaces may lead to a process of social transformation and are associated with adaptive capacity. Kalikoski and Allison's (this volume) review of cases from Africa and South America shows how learning and adaptive capacity are built within fishing communities through comanagement. As actors engage in these relational spaces, we can anticipate multilevel interactions. Advances are being made to trace relational spaces by concentrating on the interactions between individual learning, organizational contexts, and the pathways by which adaptive capacity and action are negotiated (Pelling and High 2005; Pelling et al. 2008; see also Bodin and Crona 2009). For example, Diduck (this volume) links learning outcomes at several levels to illuminate adaptive capacity in multilevel governance, and supports the suggestion that relational spaces enhance adaptive capacity. He reveals the importance of accounting for network and societal interactions, the institutions that link individuals and groups, and the power asymmetries that influence relational spaces. The challenge for understanding these spaces, however, stems from their inevitable diversity, and the very different institutional (formal, informal), organizational, and social variables with which they are associated (see Vatn 2005).

The notion of relational spaces highlights the role of institutions in shaping adaptive capacity. Matthews and Sydneysmith (this volume) in fact argue for an institutional perspective that links culture, organizations, and the actions of individual actors, highlighting the limitation of a perspective of institutions as simply normative constraints (see also Ostrom 2005). Emerging from these institutional relationships may be what are referred to as shadow networks (often informal linkages and connections among individuals and groups) because they remain largely hidden, difficult to delineate, and even more difficult to control (Stacey 1996; Pelling et al. 2008). As Matthews and Sydneysmith (this volume) point out, new institutionalists in sociology can offer a unique perspective that is fundamentally concerned with questions of power and authority. Institutions and adaptive capacity are recognized as embedded within a broader context of social structures and a result of particular social relationships that lend them legitimacy. The chapters in this volume illustrate the breath of this institutional perspective as it relates to adaptive capacity and governance. For example, Wesche and Armitage (this volume) emphasize the importance of culture and land-based traditions for adaptive capacity of the Dene in Fort Resolution, Northwest Territories. They also adopt a perspective "from the inside out" and focus on features of social organization

in relation to the wider Northern institutional context, highlighting the largely informal, multiscale shadow networks that play an important role in constraining or enabling adaptive capacity. Employing a similar lens, Bohensky et al. and de Loë and Plummer (this volume) provide commentaries on the formal "rules of the game" but also discuss how "the game" is actually being played out in the context of networks and social relationships shaped by asymmetries of power, authority, and legitimacy. Moreover, Kalikoski and Allison, as well as Fabricius and Cundill (both this volume), discuss institutional incentives, such as the importance of participation in comanagement of fisheries, or the role of property rights and economic benefits in building capacity to respond to systems beyond the threshold. As Young et al. (2008) have argued, institutional analysis is cutting-edge social science, and they pointed to the critical role of institutions in shaping "real world" environmental governance systems and policy advances. Understanding adaptive capacity, therefore, demands a careful tracing of formal and informal institutional connections or pathways across spatial and temporal domains.

14.3.4 Scaling Up, Scaling Down, Scaling Out

Scale is a central concern in most of the chapters in this volume. A useful definition as it pertains to adaptive capacity and governance is the notion of scale as the "... spatial, temporal, quantitative, or analytical dimensions used by scientists to measure and study objects and processes" (Gibson et al. 2000). In this regard, scale and level are distinct, with level the units of analysis that are located at different positions on a scale (Cash et al. 2006). Cross-scale dynamics and multilevel interactions are recognized as central to understanding and assessing the attributes and conditions of adaptive capacity in a governance context, and thus, there is inevitably a diversity of variables and processes to consider. For example, the review of experiences with the CAVIAR project (Sydneysmith et al. this volume) emphasizes how exposure sensitivities and adaptive capacity of communities in the Arctic are dynamic across both temporal and spatial scales. They point to an interplay among local leadership and knowledge, social networks, economic resources (e.g., human, financial, equipment), and local institutions with policy decisions and market fluctuations that originate from afar. In the context of global drivers of change, they illustrate how adaptive capacity at the community scale intersects in multiple ways with external events, resources, and higher order governance institutions.

Several insights for adaptive capacity and governance emerge from scale-sensitive analysis. For instance, it is clear that adaptive capacity is scale-dependent, or specific to place and context (Bohensky et al. this volume). This means that it is difficult to scale up from local experience or transfer (scale down) the adaptive capacity of regional bodies to the local level. A clear example of this are the constraints on building adaptive capacity in aboriginal drinking water systems where cross-scale issues like climate change, economic dislocation, and externally

driven socio-cultural pressures make coping and adapting particularly difficult. There are, moreover, inevitable trade-offs across scales when seeking to build adaptive capacity, as is the case in the examples from the Northwest Territories and northern Sweden (Wesche and Armitage this volume; Keskitalo this volume). Wesche and Armitage note how building capacity of one group (the Dene) may in fact lead to, or result from, conflict with other groups (the Metis), or how the claims of emerging regional groups through the Akaitcho Territory may paradoxically undermine local capacity-building efforts in the Deninu K'ue Traditional Territory. In contrast, several chapters illustrate how adaptive capacity of certain groups in one part of a system may compensate for a lack of capacity to adapt elsewhere in the system. This is an important relationship for governance indicated by Diduck (this volume), who focuses on the role of different levels and the need to document the relationships among different units of analysis (individual, organizational, etc.) with regard to adaptive capacity. Elsewhere, experiences in the Great Barrier Reef context (Bohensky et al. this volume), the Macubeni region (Fabricius and Cundill this volume), and Brazil fisheries context (Kalikoski and Allison this volume), all provide examples of certain actors or groups operating at different scales that have enabled adaptive capacity in a governance context by compensating for resource, economic, and or political capacity constraints of others (e.g., small-scale producers). As scaling adaptive capacity up, down, or out is not straightforward, strategies to build adaptive capacity in a multilevel governance setting must be carefully targeted to connect with the needs of a diverse range of governance actors.

14.3.5 Actors and Networks, Networks of Actors

Several chapters in this volume (i.e., de Loë and Plummer; Fabricius and Cundill; Olsson et al.; Wesche and Armitage) draw attention to the diverse roles and requirements of state and nonstate actors in building adaptive capacity and creating conditions for adaptive governance. As these contributions illustrate, the "State" is no longer alone in claiming the authority (although see below) or resources to deal with increasingly complex and multiscale problems (Stoker 1998; Sonnenfeld and Mol 2002; Pahl-Wostl 2009). Moreover, it is evident that no one actor can possess the knowledge, experience, resources, or legitimacy necessary to address complex and connected global environmental problems. These insights point to the increasing importance of networked arrangements in which a range of public and private actors coordinate to resolve environmental challenges by sharing information, speeding up the transfer of knowledge about ecosystem dynamics and feedback, and distributing equitably the costs and benefits of action (Bodin and Crona 2009; Berkes 2009; Schultz 2009; Plummer 2009). Networks may thus serve to increase adaptive capacity and build resilience (Tompkins and Adger 2004).

Kalikoski and Allison (this volume) highlight how networks for governance have formed out of comanagement arrangements to support efforts to deal with

cross-scale effects. However, their analysis also points out how networks have self-organized in one context but not in an adjacent area. They point to the role of power and legitimacy as key factors in the self-organization of networks prepared to build institutions and respond and adapt to change. Keskitalo's analysis, in contrast, shows what happens when networks are slow to form, creating the potential for conflict in sites of interaction and reducing the capacity to cope and adapt. These findings emphasize the importance of linkages and flexible networks of actors, or partnerships, in building adaptive capacity. However, legitimacy of the network is required to confer stability *and* adaptability, and to create capacity for diffusing the negative effects of change and distributing the benefits (Lebel et al. 2006; Bodin and Crona 2009). In the context of networked governance arrangements, responsibility and accountability are dispersed among a variety of actors (local, regional, private, public). The cases in this volume illustrate that legitimacy may be less a matter of formalized mandates than of the strength of bonds that build trust.

14.3.6 From Governance to Government?

In most environmental governance scholarship, government is no longer considered the sole or even main source of environmental decision-making authority. This shift in thinking is characterized as a transition from government to governance, and reflects an understanding that multiple actors from corporations to nongovernment organizations, public–private partnerships, and quasigovernmental boards are central players in environmental decision making.

The need to consider the adaptive capacity of a broad range of stakeholders and governance actors is well recognized in the literature (e.g., Folke et al. 2005; Boyd 2008; Himley 2008; Armitage et al. 2009). Paradoxically, many case examples in this volume point to a central role for *government* in fostering adaptive capacity. There appear to be a number of reasons for this. For example, state policies and regulations create a very real external limit to the ability of subnational or local actors to adapt and transform (Keskitalo this volume; Wandel and Marchildon this volume). Where states lack legitimacy or functional capacity, prospects for building adaptive capacity at other levels appear to be eroded or at least undermined. This is illustrated to a certain degree by Keskitalo (this volume) as local-level adaptive capacity in the Swedish case is constrained by broader policy interactions between reindeer herders and forestry sectors, and in the case from South Africa (Fabricius and Cundill this volume). In contrast, the case from the Northwest Territories in Canada highlights how government support programs to local harvesters and the emerging land claims agreements (federal-First Nation agreements) may in fact enhance the ability of local communities in the North to proactively respond to change. However, in the case from Alberta Wandel and Marchildon (this volume), note that the "state" is not monolithic, and as a result, it is essential to determine which levels and branches of government are critical to build adaptive capacity in the broader governance process. That chapter related how federal policies, historically,

undermined adaptive governance, while provincial policies created opportunities for novel responses to difficult biophysical circumstances.

Recognizing the critical role of the state raises some obvious questions. Are the conventional policy measures of the state – legislation, taxes, and subsidies – up to the task of promoting adaptation and transformation in the face of profound social–ecological change? If not, what types of new and innovative public policy tools do we need to build adaptive capacity and facilitate systemic transformation? How might such tools interact with private-sector-led and community-based governance initiatives? Answering these and other public policy questions will shed further light on suitable roles for the state in adaptive governance. However, a lesson from this volume is that government still has an essential role to play as a leader in seeing that experiences from one setting can be transmitted across scales in an effort to build adaptive capacity.

14.3.7 Organizations on the Edge

Government clearly has a central role to play in providing leadership and creating the enabling conditions for adaptive capacity. However, one interesting theme that has emerged in several chapters is the influence of bridging organizations in helping to build adaptive capacity. Bridging organizations by definition operate on the edges of different domains of practice and in so doing create arenas for social processes and trust-building that support shared capacity for adapting, coping, and transforming. Bridging organizations can thus foster and sustain the relational spaces and governance networks which engender adaptive capacity. Evidence of this appears in several chapters in the volume (notably in the cases from Brazil, South Africa, and Sweden) where the strength of specific organizations that bridge local and higher level interests plays a significant role in the adaptiveness and effectiveness of governance processes. Schultz (2009) has documented the role of bridging organizations specifically in terms of their contributions to knowledge generation, collaborative learning, preference formation, sense making, and conflict resolution among actors in relation to specific environmental issues. Also identified is the role bridging organizations play in supporting the vertical and horizontal linkages that improve information and resource flows and support adaptive capacity (see also Berkes 2009).

Bridging organizations may be particularly important where government capacity is constrained. This appears to be the case in the example from South Africa (Fabricius and Cundill this volume) where the Macubeni Project Advisory and Steering Committee (MPASC) provided critical linkages among community representatives, donor organizations, and government actors. This coordination, enabled at least initially by the MPASC, was necessary to deal with the fragile linkages that existed among these groups in a very challenging context. In the Swedish case examined by Keskitalo (this volume), the lack of an effective bridging organization may have constrained efforts to bring together different groups (reindeer herders,

forestry interests, tourism operators) to collaborate more formally, and to build shared capacity to deal with vulnerability and adapt to change. However, bridging organizations also appear to have an important role where the scope of government has been purposefully constrained through decentralization processes. Many of the more recent governance processes in Canada's North provide just such an example as comanagement bodies are emerging as key sites of interaction for different kinds of knowledge sharing (local, scientific), the coordination of tasks enabling cooperation and networking, and learning that promotes adaptive capacity (Armitage et al. 2009; Berkes 2009). Kalikoski and Allison (this volume) document a similar process and set of conditions in the cases they assess, although with variable outcomes. One clear example they cite is the formation of the Forum of Patos Lagoon in Brazil by nongovernmental (i.e., church), community, and government actors. As the Forum itself evolves and learns through experience, it may yet become an important mechanism to bring groups together to deal with the crisis in small-scale fisheries in the lagoon system.

14.3.8 Knowledge Coproduction and Learning Processes

Knowledge is a key component of learning. A diversity of knowledge types and sources about complex SESs, explored through collaborative processes and efforts at sense making, is fundamental to building adaptive capacity for governance (Diduck this volume). Much effort to foster adaptive capacity thus depends on knowledge mobilization and knowledge coproduction. We use knowledge coproduction here to refer to the collaborative process where a plurality of knowledge sources and types are brought together to address a defined problem and to build a systems-oriented understanding of that problem. A willingness to integrate knowledge sources as a basis for testing assumptions and modifying worldviews is the basis for learning processes that enable adaptive capacity (Diduck this volume). With regard to climate change adaptation, for example, bridging science and indigenous knowledge has been shown to produce complementarities in temporal and spatial scales, and thus help understand impacts and adaptations and identify monitoring needs (see Riedlinger and Berkes 2001). Knowledge coproduction thus depends on the openness of actors to share and draw upon a plurality of knowledge in the search for solutions to pressing governance challenges (Berkes 2009).

In the cases examined by Olsson et al. (this volume), governance successes were linked to a large degree to the incorporation of improved understanding of ecosystem dynamics and the capacity to respond to ecosystem feedbacks more effectively as a result. This knowledge was not held by one group or actor, but coproduced. There is good evidence to suggest (Kalikoski and Allison this volume) that knowledge to facilitate adaptive governance and purposeful transformation emerges when a sufficient number of stakeholders agree that system conditions are untenable

(Olsson et al. this volume). Often, this recognition is precipitated by a crisis, and leads to a reevaluation of knowledge about the system and the assumptions and values framing that knowledge. Building adaptive capacity for governance means creating an arena for the coproduction of knowledge, with the assumption that knowledge itself is a dynamic process and contingent upon being formed, validated, and adapted to changing circumstances (Davidson-Hunt and O'Flaherty 2007: 293). At the same time, it is important to remember that changing perspectives, attitudes, and behaviors do not necessarily follow the accumulation of information or the increasing knowledge of individuals (Kollmuss and Agyeman 2002). Mindfulness is therefore required concerning basic questions about the who, what, how, and why of learning in such processes (Diduck this volume; Lundholm and Plummer in press).

14.3.9 The Importance of Ecosystems

A particular strength of this volume is the depth of insight into the institutional arrangements, social attributes and processes that influence adaptive capacity, and implications for flexible, networked governance. In summarizing the chapters, two insights emerge relating to ecosystems. First, it is clear that in the various sites and places where capacity has emerged to support adaptation, that capacity is not developed specifically for environmental change. The cases highlighted from the CAVAIR project (Sydneysmith et al. this volume), for example, show how vulnerability and adaptation emerge in response to the combined effects of environmental change and socioeconomic development. Untangling the relationship between vulnerabilities associated with large-scale resource development versus those associated with climate change is difficult. In fact, many of the cases in this volume point to how communities and other governance actors are dealing with a wide range of stresses and crises cast in terms of their social and economic consequences. Second, several contributions to this volume point out that connections to underlying ecosystem conditions and services which ultimately frame adaptive capacity are not always well articulated. Olsson et al. (this volume) are the most explicit in this regard. They note that significant attention to adapting and transforming can occur in the absence of improved capacity to learn from, respond to, and manage environmental feedback from dynamic ecosystems. This can lead in turn to further ecological degradation, a heightened need to cope, and reduced capacity for adapting and transforming in the longer term. As Newig and Fritsch (2009: 209) point out, "...the relation between public participation on the one hand and multilevel governance and rescaling on the other hand as well as its environmental effects have barely been treated." Ultimately, a focus on building adaptive capacity without adequate ecological knowledge or literacy serves to limit governance arrangements for navigating change.

14.3.10 It Takes Two to Tango!

Pomeroy and Berkes (1997) used the expression, "It takes two to tango", to describe the important interplay between community resources users and government actors in comanagement arrangements. We use the saying here in a different way – to emphasize the union of social–institutional and biophysical systems in relation to adaptive capacity. Complex systems thinking is integrative, and requires us to embrace an SESs perspective (Berkes et al. 2003). Correspondingly, this volume takes an interdisciplinary approach and integrative perspective to adaptive capacity. In so doing, the contributors weave together the bodies of literature and themes that inform our understanding of adaptive capacity (see Plummer and Armitage this volume). For example, Fennell and Plummer (this volume) highlight the connection between the natural and social sciences in regards to adaptive capacity. They unpack adaptive capacity as it has been interpreted by both ecological and social–institutional perspectives. In taking an integrative "nature-in-humans" view, they argue that evolutionary biology provides a metatheoretical basis for adaptive capacity. Both ecological and socio-institutional contexts are requisites for effective environmental governance, and environmental governance in turn shapes SESs. It takes two to tango!

Conducting research and/or engaging in practice at the nexus of social and natural sciences presents considerable challenges for understanding and building adaptive capacity into governance systems, and creating opportunities for transformation (Olsson et al. this volume). However, as Snow (1964:16) highlighted, "...the clashing points of two subjects, two disciplines, two cultures – of two galaxies, so far as that goes – ought to produce creative changes. In the history of mental activity that has been where some of the breakthroughs came." Efforts towards a common or general framework for analyzing SESs, such as that advanced by Ostrom (2009), are critical, as in their absence such knowledge does not cumulate. Persistent effort is required to ensure that (1) bridges are maintained between social and biophysical systems, (2) meaningful integration of the various perspectives occurs when examining adaptive capacity, and (3) insight gained from such endeavors accumulates to advance knowledge.

14.4 Conclusions

The lessons and insights summarized above reflect a growing body of knowledge about adaptive capacity and the emergence of governance systems for navigating change. The chapters have identified, in particular places and contexts, the specific attributes of institutions that enhance learning opportunities and build adaptive capacity. They highlight the different roles participants in governance processes have in fostering the capacity to adapt and transform. And the chapters illustrate how the bundles of attributes and experiences that build capacity in one site can be

linked through networks to enhance opportunities for adapting and transforming in other places. In this regard, many of the chapters highlight the importance of vertical and horizontal linkages and interactions that build social capital and trust (Cash et al. 2006; Brondizio et al. 2009). We are provided with empirical examples of how flows of information, resources, and knowledge in emerging multilevel governance processes are linked to the capacity to adapt, and to transform SESs into alternative, sustainable trajectories. At the same time, many of the chapters illustrate how adaptive capacity and governance intersect with the political economy of particular sites and the inherent conflicts over resource access, control, and value systems. As reflected throughout the volume, no one group alone will have the power, resources, or skills to deal with increasing variability, nor provide the portfolio of tools to support adaptive capacity and environmental governance.

Still, further research is required. How institutional arrangements can best create the conditions for adaptive capacity is not yet fully articulated. More detailed studies are needed to examine how linkages in multilevel governance (vertical and horizontal) actually work. Greater clarity is urgently needed on how the attributes and experiences that build capacity in one area (e.g., wildlife management) can be transferred most effectively across institutions and scales to other areas, some of which, such as climate change, are exceedingly complex. Thus, in the context of global environmental change, how to enhance adaptiveness, foster learning, and improve fit between institutions and ecosystems is an area requiring significantly more research (Young et al. 2008; Biermann et al. 2009). If and how adaptive, multilevel governance generates outcomes that are not just socially positive but which also sustain the ecosystem services upon which we depend is one area that demands much more attention and better evaluative tools (Plummer and Armitage 2007; Olsson et al. this volume). Lastly, more effort is required to translate analytical understanding of the links between adaptive capacity and governance into accessible diagnostic tools enabling resource users, managers, and policy makers to identify key drivers of change, the strategies required to foster positive transformation (e.g., institutional mechanisms, leadership requirements), and opportunities to overcome path dependencies. The contributions of this volume are one step in that process, and help us find those windows of opportunity for positive change.

Acknowledgments We thank Alan Diduck, Carina Keskitalo, and Lisen Schultz for their valuable comments and feedback on an earlier version of this chapter. We thank as well the contributors to the volume for the insights and perspectives they have brought to the challenge of adaptive capacity and governance.

References

Alessa L, Kliskey A, Altaweel M (2009) Toward a typology for social–ecological systems. Sustainability Sci Pract Policy 5(1):31–41

Armitage D, Plummer R, Berkes F, Arthur R, Charles A, Davidson-Hunt I, Diduck A, Doubleday N, Johnson D, Marschke M, McConney P, Pinkerton E, Wollenberg L (2009) Adaptive co-management for social–ecological complexity. Front Ecol Environ 7(2):95–102

Berkes F (2009) Evolution of co-management: role of knowledge generation, bridging organizations and social learning. J Environ Manage 90(5):1692–1702
Berkes F, Colding J, Folke C (2003) Navigating social–ecological systems: building resilience for complexity and change. Cambridge University Press, Cambridge
Biermann F, Betsill MM, Gupta J, Kanie N, Lebel L, Liverman D, Schroeder H, Siebenhüner B, Conca K, da Costa Ferreira L, Desai B, Tay S, Zondervan R (2009) Earth system governance: people, places and the planet. Science and implementation plan of the earth system governance project, ESG report no. 1, Bonn, IHDP, The Earth System Governance Project
Bodin O, Crona B (2009) The role of social networks in natural resource governance: what relational patterns make a difference? Glob Environ Change 19(3):366–374
Boyd E (2008) Navigating Amazonia under uncertainty: past, present and future environmental governance. Philos Trans R Soc Lond B 363(1498):1911–1916
Brondizio ES, Ostrom E, Young O (2009) Connectivity and the governance of multilevel socio-ecological systems: the role of social capital. Annu Rev Environ Resour 34:253–278
Carpenter S, Mooney H, Agard J, Capistrano D et al (2009) Science for managing ecosystem services: beyond the millennium ecosystem assessment. Proc Natl Acad Sci USA 106(5): 1305–1312
Cash DW, Adger WN, Berkes F, Garden P, Lebel L, Olsson P, Pritchard L, Young O (2006) Scale and cross-scale dynamics: governance and information in a multilevel world. Ecol Soc 11(2):8
Davidson-Hunt I, O'Flaherty RM (2007) Researchers, indigenous peoples and place-based learning communities. Soc Nat Resour 20:291–305
Dietz T, Ostrom E, Stern PC (2003) The struggle to govern the commons. Science 302:1907–1912
Duit A, Galaz V (2008) Governing complexity: insights and emerging challenges. Governance 21:311–335
Folke C, Hahn T, Olsson P, Norberg J (2005) Adaptive governance of social–ecological knowledge. Annu Rev Environ Resour 30:441–473
Galaz V, Olsson P, Hahn T, Folke C, Svedin U (2008) The problem of fit among biophysical systems, environmental and resource regimes, and broader governance systems: insights and emerging challenges. In: Young OR, King LA, Schroeder H (eds) Institutions and environmental change. MIT, Cambridge, pp 147–186
Gibson CC, Ostrom E, Ahn TK (2000) The concept of scale and the human dimensions of global change: a survey. Ecol Econ 32:217–239
Gunderson LH, Holling CS (eds) (2002) Panarchy: understanding transformations in human and natural systems. Island, Washington
Himley M (2008) Geographies of environmental governance: the nexus of nature and neoliberalism. Geogr Compass 2(2):433–451
Ivey JL, Smithers J, de Loë RC, Kreutzwiser RD (2004) Community capacity for adaptation to climate-induced water shortages: linking institutional complexity and local actors. Environ Manage 33(1):36–47
Kollmuss A, Agyeman J (2002) Mind the gap: why do people act environmentally and what are the barriers to pro-environmental behaviour? Environ Educ Res 8(3):239–260
Lebel L, Anderies JM, Campbell B, Folke C, Hartfield-Dodds S, Hughes TP, Wilson J (2006) Governance and the capacity to manage resilience in regional social-ecological systems. Ecol Soc 11(1):19. (online). URL: http://www.ecologyandsociety.org/vol11/iss1/art19/
Lundholm C, Plummer R Learning and resilience: a conspectus for environmental education. Environ Educ Res (in press)
MA (Millenium Ecosystem Assessment) (2005) Ecosystems and human well-being: current state and trends. Island, Washington
Milly PCD, Betancourt J, Falkenmark M, Lettenmaier D, Stouffer RJ (2008) Stationarity is dead: whither water management. Science 319(5863):573–574
Newig J, Fritsch O (2009) Environmental governance: participatory, multi-level – and effective? Environ Policy Governance 19(3):197–214
Ostrom E (2005) Understanding institutional diversity. Princeton University Press, Princeton

Ostrom E (2007) A diagnostic approach for going beyond panaceas. Proc Natl Acad Sci USA 104(39):15181–15187
Ostrom E (2009) A general framework for analyzing sustainability of social–ecological systems. Science 325(24):419–422
Pahl-Wostl C (2009) A conceptual framework for analysing adaptive capacity and multi-level learning processes in resource governance regimes. Glob Environ Change 19(3):354–365
Pelling M, High C (2005) Understanding adaptation: what can social capital offer assessments of adaptive capacity? Glob Environ Change 15(4):308–319
Pelling M, High C, Dearing J, Smith D (2008) Shadow spaces for social learning: a relational understanding of adaptive capacity to climate change within organisations. Environ Plan A 40:867–884
Plummer R (2009) The adaptive co-management process: an initial synthesis of representative models and influential variables. Ecol Soc 14(2):24. (online). URL: http://www.ecologyandsociety.org/vol14/iss2/art24/
Plummer R, Armitage D (2007) A resilience-based framework for evaluating adaptive co-management: linking ecology, economy and society in a complex world. Ecol Econ 61(1):62–74
Pomeroy RS, Berkes F (1997) Two to tango: the role of government in fisheries co-management. Mar Policy 21:465–480
Riedlinger D, Berkes F (2001) Contributions of traditional knowledge to understanding climate change in the Canadian Arctic. Polar Rec 37:315–328
Scheffer M (2009) Critical transitions in nature and society. Princeton University Press, Princeton
Schultz L (2009) Nurturing resilience in social–ecological systems: lessons learned from bridging organizations. Stockholm University Press, Stockholm
Snow CP (1964) The two cultures. Cambridge University Press, London
Sonnenfeld DA, Mol APJ (2002) Globalization and the transformation of environmental governance. Am Behav Sci 45(9):1318–1339
Stacey R (1996) Complexity and creativity in organizations. Berrett-Koehler, San Francisco
Steffen W et al (2004) Global change and the earth system: a planet under pressure. Springer, Berlin
Stoker G (1998) Governance as theory: five propositions. Int Soc Sci J 50(155):17–28
Tompkins EL, Adger WN (2004) Does adaptive management of natural resources enhance resilience to climatic change? Ecol Soc 9(2). (online). URL: http://www.ecologyandsociety.org/vol9/iss2/art10/
Vatn A (2005) Institutions and the environment. Edward Elgar, Cheltenham
Walker BH, Holling CS, Carpenter SR, Kinzig A (2004) Resilience, adaptability and transformability in social–ecological systems. Ecol Soc 9(2): 5. (online). URL: http://www.ecologyandsociety.org/vol9/iss2/art5/
Young OR, King LA, Schroeder H (eds) (2008) Institutions and environmental change: principal findings, applications, and research frontiers. MIT, Cambridge