

Chapter 4

The Assessment of Adaptive Capacity

Abstract This chapter reviews the methods and challenges for the assessment of adaptive capacity. It presents and discusses the ranges of governance determinants of adaptive capacity as they have developed out of the different discourses such as good governance, adaptive governance, adaptive management, vulnerability and resilience. It concludes that the relative paucity of deep empirical examples exploring adaptive actions in periods that might be representative of a future warmer world remains a challenge in the operationalisation and characterisation of adaptive capacity as well as in the development in understanding how to mobilise it as climate change impacts take hold.

Keywords Adaptive capacity indicators • Governance determinants of adaptive capacity • Assessment of adaptive capacity • Analytical challenges to assessing adaptive capacity • Resilience based assessment of adaptation outcomes

4.1 Adaptive Capacity

In the preceding decade, adaptive capacity has become a more mainstream concept, yet significant challenges still remain in characterising and measuring it. To reiterate, climate change implies a speed and magnitude of change, which poses risks that are beyond the human experience and potentially at the boundaries of coping ranges (Adger et al. 2007). In order to better understand actions and means of expanding coping ranges, a growing body of literature has focused on identifying and developing determinants and indicators of adaptive capacity. Within this body of literature, indicators and determinants have tended to often be used without clear definition and sometimes interchangeably as can be seen in the discussion in the following section.

Determinants can be seen as a broad range of factors (technical, financial, institutional) that influence, affect or determine the outcome or nature of something. Indicators are seen as useful tools to interpret, monitor and provide information

on the levels of presence or absence of factors that comprise determinants of a particular condition and are vital in the simplification, quantification and communication of complex processes (OECD 1997). Such indicators could be comprised of quantitatively or qualitatively measurable criteria that are indicative of the presence of the particular condition and can be useful in its assessment (Slocombe 1998). The following discussion of determinants and indicators of adaptive capacity reflect the discourse in the body of literature, which has tended to not always clarify between these different definitions. However, at the end of this section and in the following methodology chapter, the means in which these terms are used within this book shall be clarified.

Yohe and Tol (2002) suggested that determinants of adaptive capacity have a key role in defining the potential boundaries of coping ranges and the ability of SES's to effectively prepare for and respond to stresses. Early determinants of adaptive capacity were defined as including a variety of system, sector, and location specific characteristics (IPCC 2001):

- The range of available technological options for adaptation,
- The availability of resources and their distribution across the population,
- The structure of critical institutions, the derivative allocation of decision-making authority, and the decision criteria that would be employed,
- The stock of human capital including education and personal security,
- The stock of social capital including the definition of property rights,
- The system's access to risk spreading processes,
- The ability of decision-makers to manage information, the processes by which these decision-makers determine which information is credible, and the credibility of the decision-makers, themselves, and
- The public's perceived attribution of the source of stress and the significance of exposure to its local manifestations.

These determinants drew heavily on the vulnerability literature, and while they represented quite a broad brush stroke attempt at characterising the components of adaptive capacity, they were an important starting point from which gradually a more nuanced range of governance and institutional indicators of adaptive capacity could be developed (Engle and Lemos 2010). Since 2001, there has been a growing body of literature focusing in particular on institutional and governance determinants of adaptive capacity (Brooks et al. 2005; Bussey et al. 2010; Eakin and Lemos 2006; Engle 2011; Engle and Lemos 2010; Folke et al. 2005; Gupta et al. 2010; Medema et al. 2008; Olsson et al. 2004a; Pelling and High 2005; Wilby and Vaughan 2011; Yohe and Tol 2002).

Different disciplinary fields have developed alternate interpretations and characterisations of adaptive capacity (Engle 2010), ranging from a focus on cooperation, resources and incentives in geography and political economy (Adger 2003), to an emphasis on poverty reduction and climate injustice in development studies (Dow et al. 2006). There is however, still a long way to go, and comparatively little work on creating a robust framework to measure, characterise and foster components of adaptive capacity so that operationalised indicators could be transformed into

meaningful and robust sets of choices for decision makers. This is a crucial step towards more tangible and applicable methods for improving the adaptive capacity of water institutions and governance regimes.

Building adaptive capacity, by cultivating or contributing to the presence of its determinants in an SES, improves the ability of systems to become resilient to surprises and longer term changes by shaping positive responses, even transformation or transition to a better state if this is required. The determinants of adaptive capacity listed above lay the foundations for a number of different features and principles, which are seen as useful indications of a systems' adaptive capacity. It is these indicators and principles that shall be discussed in this chapter. The following discussion builds on the body of research detailed earlier in this chapter, discussing the challenges in developing governance and institutional indicators to characterise and assess adaptive capacity, and thus presenting a synthesis of the current state of indicators and determinants of adaptive capacity.

The assessment of adaptive capacity is inextricably linked with that of adaptation. While the assessment of adaptation actions tend to be addressed within a framework of whether the outcome of such actions are equitable, effective and legitimate, there are also significant questions not just about *how we adapt*, but rather *whether we can adapt*. The concept of adaptive capacity is used as a point of departure to determine measurable indicators that 'could sustain comparable analyses of the relative vulnerabilities of different systems located across the globe and subject to a diverse set of stresses that lie beyond their control' (Yohe and Tol 2002, p 25). Such indices can be either qualitatively or quantitatively based, generated through formulaic or discursive data, but are critical for the management of risk in relation to climate change impacts.

Engle and Lemos (2010, p 3) note that 'decision makers are interested in identifying and nurturing specific system characteristics that will increase adaptive capacity and resilience'. The identification of determinants and indicators of adaptive capacity provide a broad suite of characteristics, among which governance and institutional processes are deemed particularly important for the development of adaptive capacity, reduction of vulnerability and prevention of overt and lasting damage from climate change (Brooks et al. 2005; Nelson et al. 2007). Previous studies of adaptation to climatic events have also highlighted the importance of institutional and governance aspects (Brooks et al. 2005; Engle and Lemos 2010; Hurlbert 2008).

As has been discussed in earlier sections of this chapter, a number of theoretical discourses have developed, such as adaptive management, adaptive co-management, and adaptive governance, in the quest for resilience in the face of uncertainty and climate change, and that take up the concept of adaptive capacity. Adaptive governance is seen to meet the call for dealing with increased uncertainty and change, arising from the 'growing number of failures among current approaches and increasing vulnerability of social-ecological systems' (Olsson et al. 2006, p 1). Along with the field of adaptive management, the concepts of learning by doing, social learning and scenario planning have become popular as a means of operationalising the need for flexibility and better integration of social and ecological factors. These approaches are seen as a response to the challenge of 'creating governance structures that are flexible and robust in the face of uncertainties and inevitable surprises' (Twin2Go 2010, p 3).

The adaptive co-management approach has also emerged from combining elements of adaptive management and collaborative management approaches, which also incorporate learning by doing and management flexibility, but emphasises collaboration and power-sharing within communities at the local level, as well as across regional and national levels (Resilience 2011). IWRM places more emphasis on collaborative governance and the recognition of the multiple values of water, and is seen as one means towards increasing capacity of water management in the face of climate change. Institutional capacity is also seen as a critical requirement in effective adaptation, particularly in the clarity of roles and responsibility of individual authorities, especially in extreme event situations (UNECE 2009). In the literature on good governance, and therefore in the governance assessment itself, adaptive capacity to climate change tends to be assumed if indicators of good governance are adequately met.

Tools and concepts used to measure the validity of outcomes of adaptive actions can also be employed to assess underlying states beneficial to the development of adaptive capacity. A number of determinants of adaptive capacity have been identified within the climate change impacts, adaptation and vulnerability literature. To recapitulate, common factors considered determinants can be categorised into the following groups; economic resources, technology, information and skills, infrastructure, institutions, equity, social capital, and collective action (Eakin and Lemos 2006; Engle and Lemos 2010; Yohe and Tol 2002). Yet, empirical verification of the merit of these norms for building adaptive capacity is sparse, particularly within the water sector (Engle and Lemos 2010; Wilbanks and Kates 1999).

4.2 Good Governance Determinants

4.2.1 *Accountability, Participation, Transparency*

As shall be discussed in the following chapter, the STRIVER governance assessment utilises three main indicators to assess good governance in the context of IWRM. These are accountability, participation, transparency (and IWRM is also employed). The indicators were not specifically designed to measure adaptive capacity, but were rather shaped in the context of good governance for IWRM. However, these indicators also play different roles in other adaptive capacity assessments (Engle and Lemos 2010; Hurlbert 2008; Iza and Stein 2009). Accountability, participation and transparency are often considered key principles in adaptive capacity. A recent IUCN report (Iza and Stein 2009) refers to different process principles in the discussion on reforming water governance, which are requisite to provide an enabling environment, including transparency, accountability and participation. Their definition of participation broadens out from more than just consultation in decision making to involvement in multi-stakeholder platforms and decision making at the lowest appropriate level. It is considered these elements of participation could effectively raise levels of awareness, co-management and citizen initiatives, all components deemed necessary for fostering effective water governance

capacity as well as sources of resilience in social-ecological systems. Furthermore, the rule of law and legal certainty are seen as crucial for legitimacy of decision making and access to justice on environmental matters (Ebbesson 2010).

4.2.2 IWRM & Integration

IWRM is currently held up as the ideal framework for managing water in an integrated and sustainable way that would enhance the system's resilience to cope with the impacts of climate change on water resources. However, despite the concept's use in addressing the need for water governance processes to effectively and equitably manage the fair distribution and protection of the resource, it has weaknesses in terms of complexity, uncertainty and adaptive capacity (Timmerman et al. 2008). Timmerman et al. (2008) suggest that in addition to recognising multiple uses of water, that multiple sources of knowledge and information should also be integrated into management systems.

Olsson et al. (2006) explore the different features that contribute to the resilience of social-ecological systems in the face of change (in the context of adaptive co-management). Their criteria do not follow the neat normative categories of many of the other studies into adaptive capacity, but provide some useful insights into governance related criteria which can provide an enabling environment for enhanced resilience to environmental shocks and stresses. They suggest an 'enabling legislation that creates social space for ecosystem management' is requisite for the building of resilience. As vague as this may be, it deems that in order for resilience to be fostered, the institution of law should ensure that ecosystems and the environment are factored in as a relevant stakeholder. Not only should sectoral actors be integrated into legislation relating to resources (water in this case) but institutions also need to take account of ecosystem needs. This concept finds resonance with the element of integration and recognition for the non-economic uses of water within an IWRM context.

4.3 Resilience, Adaptive Governance and Adaptive Management Determinants

The following section reviews the common governance factors for adaptive capacity from the discourses relating to resilience and related concepts of adaptive governance and adaptive management.

4.3.1 Leadership, Trust, Commitment

Olsson et al. (2006) use the criteria of 'vision, leadership, and trust', which share some normative properties with accountability, in that an unaccountable system will not generate trust amongst its citizens. However, there is no reason to equate vision

or leadership with the same norm, but both could be seen as requirements for the necessary political will requisite to foster proactive responses to climate change and develop relations across different networks and levels of decision making. Folke et al. (2005) also suggest that vision, trust and innovative leadership can provide key functions for adaptive governance, e.g. 'building trust, making sense, managing conflict, linking actors, initiating partnerships, compiling and generating knowledge, mobilizing broad support for change'. Other studies have reinforced the willingness to adjust to change from an individual (as well as societal) and this perspective is also seen as a key determinant in social ability to adapt to new pressures (Tompkins and Adger 2005).

The importance of these elements of leadership in building collaboration and resolving conflicts is underlined by their role as key components in bridging interests and stakeholders and to a certain extent driving realisation of other principles of adaptive governance. Leadership can be seen as an abstract concept, which can be highly subjective to personal opinion. Additionally, strong leadership may not always have a positive correlation with principles of adaptive governance, but it may be inferred that meeting the other principles of adaptive governance may not be as easily reached without the presence of leadership. Linkages may also exist with accountability, resources, networks, transparency and participation. Engle and Lemos (2010) also discuss the indicator 'commitment', which refers to the belief held by the different stakeholders that the institutional and governance structures in place are adequate for management of the resource as effectively and efficiently as possible.

4.3.2 Experience

Engle and Lemos (2010) note that more experience would correlate with a greater ability to deal with everyday events, as well as extremes, in an effective and efficient way. While experience can broadly be deemed as relevant, just as with the concept of leadership, precise measurement of this principle is very abstract. Yet, though an actor may have many years of experience, preconditioned ideals or values may subject his/her decisions to preconceived notions, which may or may not still be relevant for changing conditions. UNECE (2009) highlight the importance not just of career experience, but also fostering experience through training and simulation exercises on a regular basis.

4.3.3 Resources

Olsson et al. (2006) propose 'funds for responding to environmental change and for remedial action; capacity for monitoring and responding to environmental feedback' as indicators which both relate to the importance of human and financial resources for ensuring effective capacity for monitoring systems, enforcing laws and responding to extremes or feedbacks. The importance of information and knowledge sharing, not just in itself, but across different levels of stakeholder and decision makers is

touched upon through criteria relating to information flow through social networks as well as the combination of various sources of information and knowledge. These criteria are also relevant for the creation of the appropriate level of public perception (Yohe and Tol 2002) for adaptation through sense making and collaborative learning (Olsson et al. 2006). Engle and Lemos (2010) also comment that levels of financial and human capital are critical for overall success of an organisation or governance structure. Yet, while more resources (financial and human) may increase the capacity of the system, it is how these resources are applied and organised that may be more important. Less could mean more. Therefore it is not just the presence of adequate resources, but perhaps the deployment of a suitable mix of financial and human resources across different scales that may be of relevance, emphasising the linkages with experience, networks, accountability, transparency and decentralisation.

4.3.4 Networks & Connectivity

Folke et al. (2005) explore the social elements of adaptive governance, which can enable adaptive ecosystem based management in the context of abrupt change. ‘Connectivity across Networks’ refers to connectivity across individuals, organisations, agencies and institutions through bridging organisations. Networks capture the various institutional levels and relationships involved with river basin management. Folke et al. (2005) also suggest that adaptive co-management requires more flexible social networks, which may be more innovative and responsive than bureaucracies in times of rapid change. Additionally, bridging and boundary organisations and networks (e.g. management councils, communities of practice, learning networks, associations, cross-sectoral partnerships, political coalitions and social movements) are seen as important central nodes of cross-scale interactions (Kofinas 2009). Challenges are, however, recognised in fostering adaptive learning between such bridging organisations and larger society as a whole (Kofinas 2009). It is assumed that the greater the networking and connectivity between groups and stakeholders involved in the management processes, the greater the adaptive capacity (Engle and Lemos 2010). While networks enable individuals to engage in the wider decision making environment, gain access to information and resources (technical or financial), the usefulness of such networks are determined by both social and institutional factors (Tompkins and Adger 2004). Hence, just as in the critique of participation, connectivity and networks alone may not imply a willingness to cooperate, which is requisite for systems to be adaptive (UNECE 2009).

4.3.5 Predictability – Flexibility

Flexibility is to be taken as the antithesis of irreversibility. This indicator is repeated across a number of the studies on adaptive capacity. The UNECE comments that ‘the capacity to adapt requires flexibility. As a result, measures that are highly

inflexible or where reversibility is difficult should be avoided' (UNECE 2009, p 78). In institutional terms, it refers to an ability to bend, but not break, and to learn iteratively, incorporating lessons learnt through experience efficiently and effectively (Engle and Lemos 2010). This concept of *iterative adaptive governance/learning by doing* is a key element of adaptive management and governance (Olsson et al. 2004b; Pahl-Wostl et al. 2007a). Tompkins and Adger (2004) also note that flexible management systems that incorporate learning-based processes (i.e. allow for modifications based on new information) are important for building resilience. Assumptions proposed are that the greater the flexibility of rules (legislation, institutions), the greater the adaptive capacity (Engle and Lemos 2010).

However, there is a struggle here between flexibility for adaptive management, and the need for certainty (Iza and Stein 2009; Tarlock 2009) or predictability (Hurlbert 2009; Engle et al. 2011) within the law, as emphasised in IWRM. Predictability suggests that all laws and regulations should be applied fairly and consistently. The assumption is that consistency in application of the law will enhance adaptive capacity. However, the discussion concerning the role and rule of law in adaptive governance (see Sect. 2.2.2) highlights the on-going challenge and discourse related to balancing predictability sought in the law, with flexibility requisite for adaptive behaviour. The IUCN (Iza and Stein 2009) use a similar concept in the process principle of 'certainty', rests upon the rule of law in terms of both predictability and enforceability. This would of course be dependent upon laws also reflecting principles of ecological integrity, equitable access for all and linkages between land and water resources. Otherwise, rigidity in the application of 'bad' laws and policies would diminish adaptive capacity.

4.3.6 Knowledge & Information

The UNECE (2009) cite the importance of supporting training and response systems with climate and hydrological information systems which are 'capable of delivering early warnings in a timely and efficient manner' (UNECE 2009, p 42). Folke et al. (2005) relate the idea of knowledge with the creation of an iterative learning environment. There are therefore important links with *flexibility* through the process of learning by doing. The goal here relates to an improved understanding of the dynamics of the whole system so that an understanding is established for how to manage periods of rapid change. The interpretation of knowledge is also highly linked with how to effectively deploy scientific information across different networks or levels of decision making for the management of resource issues in the context of change. Engle and Lemos (2010) also refer to the linkage of using scientific knowledge and information with the building of adaptive capacity, but add to the concept the importance of equality of decision making and knowledge use (in terms of power distribution among stakeholders and access to technical knowledge).

Nelson et al. (2007) also suggests that the ability to maintain a response capacity is predicated in part on the capacity for learning. Recent studies by Huntjens et al. (2011)

emphasise that in their study of eight different water governance regimes, positive correlations between knowledge indicators (information production, consideration of uncertainties, communication) and cooperation indicators (vertical, transboundary, joint/participation information) suggested that consensual knowledge is an important element in adaptive approaches when attempting to foster cooperation for managing uncertainty and change. This conclusion is also mirrored in studies by Tompkins and Adger (2004) and Olsson et al. (2006). Huntjens et al. (2011) go on to recognise the importance of socio-cognitive theory of information systems when recognising the interdependence of information management and social cooperation structures towards understanding the related challenges in developing adaptive water management regimes (Hemingway 1998, in Huntjens et al. 2011).

4.3.7 Decentralisation

Decentralisation and subsidiarity (Hurlbert 2008) refers to the delegation of responsibility and authority of water management to the lowest feasible level. Devolved decision making means that a system would be ‘presumably, better able to recognize and respond to unforeseen circumstances’ (IISD 2006, p 119). There is a theoretical link here to the IWRM component ‘Basin/Watershed Approach’, as well as to Olsson et al.’s (2004a) concept of enabling legislation that creates social space for ecosystem management. Yet, while a system may be highly decentralised, this does not imply that there are ecological based units of decision making. Nor does it always imply that sustainable solutions can be found in complex systems that contain multiple uses of water (i.e. river basins), where a measure of central top down control and guidance may provide some balance. Huntjens et al. (2011) concluded that in large scale complex systems, a centralised governance structure can help to facilitate participatory processes, set standards, build capacity and assist in building of cooperation across boundaries, conflict resolution and the provision of information not available to local level actors or institutions.

4.4 Analytical Challenges

This list of indicators captures the development in the analytical field of adaptation and vulnerability in the preceding decade. However, it is equally recognised that there has been fairly minimal empirical verification of the correlation between different principles and adaptive outcomes, particularly at local and regional scales, and more so within the water sector (Engle and Lemos 2010; Wilbanks and Kates 1999). There are a number of analytical challenges relating to the different principles and indicators of adaptive capacity listed above, five of which are discussed below. Firstly, much of the discussion around governance issues in adaptation and adaptive capacity has a strong normative edge. Normative principles such as accountability and participation tend to denote a stronger bias towards the researcher’s analytical

framework. More open indicators such as knowledge and levels of decision making are less prescriptive and therefore predisposed to be more iteratively developed through the research process, both theoretical and empirical exploration. While this distinction should be recognised, and normative bias to the analytical framework should be avoided where possible, it should not be seen as a major impediment to the development of more robust indicators.

Secondly, there is a difference between the process indicators as described in many of the studies, and the more outcome associated determinants in others. Requirements such as ‘enabling legislation that creates social space for ecosystem management’ (Olsson et al. 2004a) and institutional capacity (UNECE 2009), can be seen as requisite for both an enabling environment for adaptive capacity, but also as an outcome of sufficient adaptive capacity. A key issue is therefore how questions relating to enabling legislation and institutional capacity could be integrated into more open indicators. Or, are such concepts in fact outcomes of indicators such as ‘levels of decision making’ and ‘networks’, and therefore should not be separately tackled within the adaptive capacity assessment per se? More specifically regarding institutional capacity, one could perhaps infer that if indicators such as transparency, knowledge, networks, resources, decentralisation and subsidiarity as well as experience are met, then institutional capacity should be strengthened, and therefore it could be taken as an output.

Similarly, the issue of ‘process vs. outcome’ is pertinent to IWRM. While IWRM is not considered an indicator, its component parts could be seen as useful determinants of adaptive capacity. An indicator for ‘integration’ could encapsulate a key element of IWRM. Normative prescriptions could be avoided by not suggesting that an ideal level or type of integration pre-exists, but that different levels and types may enable adaptive capacity in varying sectors or geographies. Additionally, considering that numerous studies have shown that ‘a substantial gap exists between promise and practice’ (Ingram 2011, p 2) in IWRM, it would be make more sense to focus on how different types of integration rather than IWRM per se contribute adaptive capacity, rather than testing normative assumptions based on the criteria of IWRM.

The concept of environmental integrity or ecological system resilience (Nelson et al. 2007) appears regularly as a key determinant for adaptive capacity in the adaptive management discourse. Since the capacity of aquatic ecosystems to produce many of the goods and services on which societies depend is rapidly declining, the provision of water for nature or nature as a buffer can be seen as a key indicator of adaptive capacity in a system under stress. If the biological component of the system is already under stress, then adaption to more extreme conditions may be limited. Principles purported within the adaptive governance literature are linked with achieving these outputs, but again the question arises of how to define the relationship between ecological integrity and resilience with adaptive capacity.

Thirdly, preferences concerning the right mix of modes of governance (hierarchy/state, market/private and decentralisation/civil society) are rife within the literature on adaptation and vulnerability, despite the recognition by many that what matters is that prescriptions fit contexts (Ingram 2011). The focus on full participation and decentralisation in water management as desirable norms is reflected across a broad swath of the literature (Hurlbert 2009; Nelson et al. 2007; UNDP 1997; UNECE 2009;

WB 2002). However, other studies note the fact that decentralisation and participation per se are not *a priori* requirements for better management and enhanced resilience. Berkes in Nelson et al. (2007, p 409) suggests that ‘the balance of evidence shows that neither purely local level management nor purely higher level management works well by itself’, and Lemos and Agrawal (2006) highlight the development of emerging hybrid, multilevel and cross-sector forms of environmental governance.

Fourth, Ingram (2011, p 8) adds that ‘participation is no panacea for water conflicts’. Other studies such as Iza and Stein (2009) elaborate that other factors such as coordination across levels, rather than pure participation and decentralisation hold significant importance. Thus, there is need to look beyond prescriptive norms such as participation and decentralisation and subsidiarity, to more exploratory indicators which allow examination of causal relationships between different indicators and adaptive capacity within different sectors as well as governance regimes.

Fifth and finally, in a number of studies the indicator of transparency is pinpointed as fundamental to good governance and adaptive capacity. However, drawing on studies and publications in the resilience framework and the wider climate dialogue, it might be worth broadening out from the normative prescription of transparency to a more thorough exploration of the contribution that different forms of knowledge and information play in enhancing resilience. By looking at knowledge as well, we therefore refer to not just scientific information and data (hydrological models, climate models, economic statistics etc.), but can also recognise the potential importance of local and indigenous knowledge. A recent report from Switzerland comments on the need to take into account and integrate traditional knowledge in climate data systems (Lugon 2010).

An awareness of the need for climate services also arose out of the 3rd World Climate Change Conference in Geneva (WCC-3 2009), which refers to the provision of climate information (both current climate variability and recent and future climate change) (Lugon 2010). It also calls for better management, communication and understanding of this information so that resource managers and the public alike can actually generate knowledge out of the wealth of data and information available. The HEID report comments that while today, people are likely to be inundated with information, often ‘the hurdles are not the hard science but the communication’ (Lugon 2010, p 64). It also notes that climate information per se is not enough; to be truly valuable it needs to be integrated with socio-economic and other environmental data. It is therefore important to investigate not just what kind of information decision makers are getting, but also how they use it, with whom do they share it and how relevant is it to the problem they need to resolve.

4.5 Developing the Approach

The understanding that past management approaches have led to a minimisation of choices through steady state resource management (Milly et al. 2008) and a focus on hard infrastructure and technical solutions (Gleick 2003), can be counter balanced

by suggesting that future approaches should enable systems to have more choices to draw from in times of uncertainty and crisis. Drawing from the resilience literature, the inference is that higher adaptive capacity should correlate incrementally with an ability to transform or adapt to new challenges or states (refer to Sect. 2.4). Therefore one would expect positive fulfilment of the adaptive capacity indicators to correspond with more transformative and adaptive actions and management approaches, and negative fulfilment of adaptive capacity indicators to correspond with passive approaches. One may also then infer that the more transformative the approach, the better and larger the future choices should be.

To reiterate, *transformation* is seen as the transition of a system to a fundamentally different, potentially more desirable state (Chapin et al. 2009), onto a trajectory that sustains and enhances ecosystem services, societal development (including economic security) and human well-being (Folke et al. 2010). The concept of triple loop learning (Pahl-Wostl 2009) is associated with transformation. *Adaptation* refers to adjustments in response to actual or expected climate impacts, that allows the SES to persist within the current state or basin of attraction (Folke et al. 2010). This can be associated with elements of double loop learning and single-loop learning (Pahl-Wostl 2009). *Passive change* refers to the degradation of a system to a less favourable state resulting from a failure to adapt or transform (Folke et al. 2010). *Passive change* can be seen as the inverse of transformation, so while transformation is determined to be a positive transition to a more favourable state, passive change should be seen as transition to a more negative state (i.e. unintended transformation). Deeper operationalisation of these categories will be developed and discussed in Chap. 6.

Creating adaptive capacity in water governance regimes should be about creating options now and in the future, rather than limiting them and allowing a system to bend rather than break in the face of new challenges, ensuring that change is navigated in a way that leads to transformative and adaptive responses, rather than passive forced transformations with negative outcomes. Thus, for the purposes of this piece of research, adaptive capacity is conceptualised through *its role in the transformation potential of a system to a more sustainable state as a means to absorb future shocks and uncertainty, thereby creating not limiting future adaptation choices*.

Different forms of adaptive outcome can therefore be seen as manifestations of the presence or absence of adaptive capacity. Drawing on the literature and discussion on governance determinants and indicators of adaptive capacity above, a list of broad determinants was developed for the exploration of adaptive capacity across the case areas. These were Knowledge; Networks; Levels of Decision Making; Integration, Predictability-Flexibility; Experience; Resources; Leadership. Table 4.1 presents both the determinants and sub-criteria, which draw on current understanding and the different determinants and indicators (as often used interchangeably in the literature) in the discipline of adaptive capacity, adaptive governance and adaptive management, as well as the discourse on Integrated Water Resources Management. The more prescriptive and normative indicators employed within the STRIVER/BRAHMATWINN assessment

Table 4.1 Initial operationalisation of tentative determinants to explore adaptive capacity across the case areas

Governance determinants of adaptive capacity	
Tentative Indicators	Sub-criteria
Knowledge	Right to Information; Communication/Public Perception; Spatial Planning; Access to scientific/environmental information; Exchange of data & information; Integration of scientific expertise; Quality of Scientific Information; Use of traditional & local knowledge
Networks	Access to participation; Selection of non-state actors; Level of influence; Type of participation; Stage in the political process; Social Networks; Professions Networks; Willingness to Cooperate
Levels of decision making	Ecological based units of decision making; Institutional arrangements
Integration	Geographical integration; Sectoral/Uses integration; Political integration
Flexibility-predictability	Consistency in rule of the law; Rigidity of legal provisions; Iterative elements of law/institutions
Resources	Financial resources; Quantity/quality of human resources; Organisation of resources; Independence/impartiality of experts
Experience	Training & development; Years of experience
Leadership	Political Commitment; Facilitating role; Initiation of partnerships; Support mobilisation; Linking of actors; Trust amongst stakeholders

were replaced by more open determinants to better complement the iterative development of indicators within this research.

These governance and institutional related determinants are the platform from which adaptive capacity may be explored across the case areas. These determinants have been discussed as being important to the nature of adaptive capacity and to affecting the outcome of adaptive actions. While climate change risks have been well addressed in the academic literature, adaptation to climate change is often initially experienced through adjustments to variability and extremes (Tompkins and Adger 2004), but adaptation rarely takes place purely in relation to climate change alone (Parry et al. 2007). The potential inconsistency between using past extreme events as a proxy, when simultaneously enforcing the notion that the past may no longer be a prologue for the future, is fully recognised.

However, the focus on extremes specifically pinpoints situations that while currently recognised as an outlier event, may in the future become situated within the normal frame of management reference (e.g. 100-year floods recurring three times within the space of a decade). In this case past adaptations to climatic or hydrological stresses are likely to provide some useful insight into incremental step changes in the future hydro-climatic reality that are to be expected over the next 10–20 years. If in the coming decades (20–50 years) massive shocks do occur, where certain tipping points are crossed in the

climate system, then one may insinuate that the learning generated through better understanding adaptive processes (rather than steady state resource management processes) should help decision makers better assess and develop responses to larger state changes. Therefore, concerning tensions and trade-offs across different scales, the assumption is that adaptations to current variability and experience of extremes should enable capacity to develop to longer term threats and challenges from climate change, but that inter-jurisdictional challenges and dynamics might hinder coherent adaptation.

Many studies have centered on theoretical development and in turn have been loaded with the assumption that these governance arrangements are desirable or key to increasing adaptive capacity. A common approach has been to define the key indicators and relevant policy or management prescriptions needed for adaptive capacity to be mobilised and then characterise how they are present within the system analysed (Adger et al. 2005; Brooks et al. 2005; Eakin and Lemos 2006; Smit and Wandel 2006; Yohe and Tol 2002; Pahl-Wostl et al. 2007c; Huntjens et al. 2010). It is a highly inductive approach that has partly led to a gap between theory and practice in establishing links between various water governance approaches and proven positive results in managing water resources in reality (Medema et al. 2008). Increasing the number of empirical studies in contrasting governance settings on the mobilisation and measurement of adaptive capacity can in part assist in addressing this gap. However, there are still few deep empirical examples exploring adaptive actions in periods that might be representative of a future warmer world, or even in attempting to measure the role of these approaches to support the theoretical assumptions. One aim of this book is to contribute to closing this gap.

4.6 Summary

The academic discourse on climate change adaptation in the water sector has seen a gradual realisation that hard path technical approaches (Gleick 2003) must be better balanced with soft path solutions, that also focus more on the enabling social infrastructure (governance, institutions, management) requisite for successful adaptive approaches (Pahl-Wostl 2007). Governance clearly plays a critical role in developing more adaptive and sustainable water management. Heightened vulnerability can erode resilience and so impede institutions from facilitating adaptation or resulting in maladaptation. Yet while the vulnerability, adaptation, and resilience frameworks are apt for defining the challenges that governance regimes face, their vulnerability in meeting those challenges, and the solutions to overcoming those challenges, they deal more with what those outcomes should look like than how they should be achieved; which is addressed by the concept of adaptive capacity.

While there are increasingly numerous calls for water governance and associated management institutions to be resilient and robust towards future uncertainty and climate change impacts, there is room for deeper discussion on what desirable outcomes would look like. As adaptation responses are shaped, it is important to question

whether adaptation should lead to robust and resilient governance frameworks, or flexible and adaptive ones, or somewhere in between. Can an SES be both resilient and yet able to transform to be adaptable to new challenges and hydro-climatic realities? Where are the trade-offs implicit in the generation of institutional characteristics needed for climate resilient structures and adaptive elements. If we do presume that both robustness and transformative characteristics are desirable, then there is a need for cross case comparisons to show how these might be balanced and not mutually exclusive as well as to identify the means of negotiating and navigating these tensions within the governance framework.

There has been a set of incremental shifts in the focus on how to achieve better water management outcomes, from governance approaches that focus on the state, then the market, then decentralised role of user groups (Meinzen-Dick 2007). In the face of a number of converging disturbances in SESs, biodiversity loss, population growth and economic development, attention more recently turned to understanding governance approaches that fostered adaptability in water governance regimes. Generally, the bodies of research that have focussed on this issue have proposed that more flexible, participatory, collaborative, and learning-based designs and approaches will increase adaptive capacity and sustainability of water systems (Cromwell et al. 2007; Kallis et al. 2006; Pahl-Wostl et al. 2007b). Yet, scholars have also stressed the importance of acknowledging the difficulty in establishing links between concepts and management paradigms such as IWRM, adaptive management and adaptive governance with proven positive results in reality (Huitema et al. 2009; Medema et al. 2008).

In order to examine and define the underlying process that will enable governance regimes to respond to the challenges of the anthropocene, the concept of adaptive capacity has been used to refer to the latent conditions required for enabling successful and sustainable adaptation. The presence of adaptive capacity should allow a system to prepare for and adjust to the exposure of a stress, thereby reducing sensitivity and potentially embracing opportunities presented by that risk to not only adapt, but potentially transform to a new more sustainable pathway. In the field of resilience, adaptive capacity represents a more multi-faceted concept, both an ability to absorb shocks to maintain the system state, but also to facilitate transformations or transitions to a new, more desirable state.

For the purposes of this piece of research, adaptive capacity is conceptualised in relation to its role in the transformation potential of a system to a more stable and sustainable state as a means to absorb future shocks and uncertainty, thereby creating not limiting future adaptation choices. Thus, adaptive capacity should enable the system to prepare for, respond to and cope with challenges such as variability, uncertainty and surprise. The accommodation of uncertainty should enable the system to not constrain future options (creating choices), couching the understanding of adaptive capacity in the context of stationarity argument. Building adaptive capacity, by cultivating or contributing to the presence of its determinants in an SES, should therefore improve the ability of that SES to be resilient to surprises and larger scale changes, by proactive and reactively shaping positive responses, including transformations or transitions to a better state.

Conversely, the lack of adaptive capacity would lead to a narrowing of future choices (minimising choices), for example through a dominance of hard technical measures which are difficult to reverse when future hydrological or consumption patterns do not follow the decision maker's calculations. This lens of choice creation, posits adaptive capacity in the discourse on transformation and panarchy (Folke et al. 2010; Olsson et al. 2006; Walker et al. 2006; Schlüter and Herrfahrdt-Pähle 2011) and recognises the importance of ongoing dialogues within the policy sciences, such as path dependency, institutional inertia, and decision making under uncertainty (Lempert et al. 2004; North 1990).

Despite the growing body of evidence on adaptive capacity, governance and management, there is still significant scope for scientific validation and evaluation of many of the assumptions in the literature that has developed over the past decade, particularly in cases that cross both spatial and temporal scales (Chapin et al. 2009) rather than looking at single institutions in isolation (Meinzen-Dick 2007). Studies should therefore move beyond just assessing adaptation strategies and plans, to being able to investigating adaptive actions with a cross-scale lens. While a governance regime may not be a national plan or river basin plan for adaptation to climate change, local water users may already have techniques for coping with uncertainty that could provide valuable insights into the adaptive capacity of a particular sub-basin or even river basin system.

The current status of research into adaptive capacity and building of adaptive options is still in its infancy, despite an increase of interest in recent years (Engle 2011), and has only recently focussed more heavily on the practicalities of how to adapt (Dovers and Hezri 2010). Previous assessments and studies have focused on first showing that governance is important to adaptation and adaptive capacity, and then identifying certain approaches that are important in a system for being adaptable to change. The relative paucity of deep empirical examples exploring adaptive actions in periods that might be representative of a future warmer world remains a challenge in the operationalisation and characterisation of adaptive capacity as well as in the development in understanding how to mobilise it as climate change impacts take hold. The methodology employed for this research and described in the next chapter aims to address this gap, by drawing on the conceptualisation of adaptive capacity that draws from the multiple approaches described within this chapter.

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