

Manuscript Number:

Title: Reconceptualising adaptation to climate change as part of pathways of change and response

Article Type: Special Issue:Climate Adaptation

Keywords: adaptation; climate change; global change; pathways; transformation; incremental; conceptual framework; decision making; framing

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Manuscript Region of Origin: Australasia

Abstract: Despite the growing intensity of calls for more decision-oriented approaches to adaptation research and practice, we found low rates of implementation of adaptation actions across a selection of case studies and reported in the literature. Moreover, implemented actions have been mostly incremental and focused on proximate causes with few reports of societal transformations. The framing of adaptation was found to be an important factor influencing the nature and effectiveness of response actions. Recent progressive decision-oriented approaches to adaptation research and practice draw upon a "pathways" metaphor to help emphasize the need for robust decision making within adaptive processes in the face of high uncertainty and inter-temporal complexity. These approaches are powerful for informing incremental adaptations to proximate causes of vulnerability but take prevailing governance regimes as given and assume these are conducive for adaptation. In this paper we propose and explore a broader conceptualisation of the adaptation pathways perspective that considers the implications of path dependency, interactions between adaptation plans, vested interests and global change, and situations where prevailing values, interests, or institutions constrain societal responses to change. This conceptualisation of adaptation as part of pathways of change and response is designed to inform decision makers about the need for and how to integrate incremental actions on proximate causes with the transformative aspects of societal change. The paper ends with a call for further exploration of the theory, methods and procedures to operationalise this broader conceptualisation of adaptation.

2 April, 2013

The Editor
Global Environmental Change

Dear Editors

Please accept our submission for the Climate Adaptation Special Issue of GEC:

“Reconceptualising adaptation to climate change as part of pathways of change and response” Authors: Wise, R.M., Fazey, I., Stafford Smith, M., Park, S.E., Eakin, H.C., Archer Van Garderen, E.R.M., and Campbell, B.

This paper is intended as the first paper of the special section on Climate Adaptation. It provides the justification for the special section and presents the overarching conceptual framework.

The work presented is the result of an international collaborative effort of researchers involve in adaptation to climate and global change. The research was initiated through funding provided by the CSIRO Climate Adaptation Flagship in Australia under the project “Enabling Adaptation Pathways”.

All authors contributed to the literature review and to the development of the broader conceptualisation of adaptation pathways. Each of the authors also contributed to one or more of the case study examples provided.

Please note that we have made references to many of the papers submitted to the special section and we are aware that these may need to change depending on whether these papers are accepted for publication or not. We will therefore update these cross-references as and when appropriate.

We declare that the research presented in the paper has neither been published elsewhere nor is being considered elsewhere for publication

Thank you.

Yours sincerely,

A handwritten signature in black ink, appearing to read 'R.M. Wise', is written over the typed name 'Wise'.

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Re-conceptualising adaptation to climate change as part of pathways of change and response

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Acknowledgements

Thanks to Andy Reisinger for discussions around Figure 1. Funding was provided by the CSIRO Climate Adaptation Flagship under the Enabling Adaptation Pathways project.

Highlights

- Adaptation has been mostly incremental and focused on proximate causes
- The framing of adaptation influences the nature and effectiveness of responses
- Adaptation pathways concepts help inform robust decision making under uncertainty
- Most pathways approaches assume a clear decision maker and enabling governance
- A broader pathways approach is proposed to inform societal transformation

Abstract

Despite the growing intensity of calls for more decision-oriented approaches to adaptation research and practice, we found low rates of implementation of adaptation actions across a selection of case studies and reported in the literature. Moreover, implemented actions have been mostly incremental and focused on proximate causes with few reports of societal transformations. The framing of adaptation was found to be an important factor influencing the nature and effectiveness of response actions. Recent progressive decision-oriented approaches to adaptation research and practice draw upon a “pathways” metaphor to help emphasize the need for robust decision making within adaptive processes in the face of high uncertainty and inter-temporal complexity. These approaches are powerful for informing incremental adaptations to proximate causes of vulnerability but take prevailing governance regimes as given and assume these are conducive for adaptation. In this paper we propose and explore a broader conceptualisation of the adaptation pathways perspective that considers the implications of path dependency, interactions between adaptation plans, vested interests and global change, and situations where prevailing values, interests, or institutions constrain societal responses to change. This conceptualisation of adaptation as part of pathways of change and response is designed to inform decision makers about the need for and how to integrate incremental actions on proximate causes with the transformative aspects of societal change. The paper ends with a call for further exploration of the theory, methods and procedures to operationalise this broader conceptualisation of adaptation.

Keywords: adaptation, climate change, global change, pathways, transformation, incremental, conceptual framework, decision making

Word count: 11539 excluding title page (3,362 words in the References)

1. Introduction

Over the last couple of decades, the climate adaptation community has made important contributions to improving understanding and awareness of climate-change related problems. These efforts have focused on: quantifying climate change (Hansen *et al.*, 2006) and the biophysical, social and economic consequences of climate hazards (Stern, 2006; Tol, 2010), developing and applying methods for assessing the vulnerability of communities and ecosystems (Turner *et al.*, 2003; Eakin and Luers, 2006; Adger *et al.*, 2007; Füssel, 2007), providing general principles and broad strategies for adaptation (Fankhauser *et al.*, 1999; Hallegatte, 2009) and identifying opportunities and barriers to adaptation (Burch, 2010; Moser and Ekstrom, 2010).

Of note, in recent years, has been the growing intensity of calls for more decision-oriented research as priorities have moved from estimating impacts and vulnerabilities in order to make the case for mitigation, to actual adaptation planning in a world that is looking less and less likely to stay within 2°C of global warming (e.g., World Bank, 2012). Such calls emphasise the need to focus on enabling decision makers to make the difficult and urgent choices between alternative policy and management options in interconnected social and natural systems (Sarewitz *et al.*, 2003; Pielke, 2007; Eakin and Patt, 2011). The factors behind calls for a more decision-oriented focus are varied but include: the perception of a limited usefulness of many assessments of impact, vulnerability and adaptive capacity for informing choices between adaptation options (Hinkel, 2011; Downing, 2012); adaptation plans not being implementable due to a diversity of limitations and barriers relating to human behaviour and governance (O'Brien and Wolf, 2010; Pelling, 2011); difficulties in planning for future uncertain consequences of changing and unpredictable values, preferences and vulnerabilities of at-risk populations (Fazey *et al.*, 2010b; O'Brien and Wolf, 2010); and the challenges of accommodating many of the confounding issues such as cross-scale effects over space and time and multiple forms of uncertainty (Funtowicz *et al.*, 1999; Dessai *et al.*, 2007; Stafford Smith *et al.*, 2011).

A critical consequence of these challenges is that the resulting loose coalition of research and practice that represents 'adaptation science' has to date had a modest impact on the number of effective adaptation decisions influenced in policy, planning and management (Tompkins *et al.*, 2010; Berrang-Ford *et al.*, 2011; Ford *et al.*, 2011). Additionally, and despite long-standing calls for a focus on decision making (Willows and Connell, 2003), the adaptation actions that have been implemented have been mostly incremental and focused on proximate causes, with limited reports of transitions and transformational change (cf. Park *et al.*, 2012).

More recent efforts to address this situation have used "route maps" or "pathways" as a metaphor for helping visualise a decision-centred approach to adaptation, as classically represented in the Thames barrier study (Reeder and Ranger, 2011). The concept of pathways draws the focus onto the processes of decision making, rather than the outcome; emphasizing the adaptive nature of the decision-process itself in face of high uncertainty and inter-temporal complexity. Figure 1 (Andy Reisinger, pers. comm.) illustrates this 'classic' adaptation pathways metaphor for exploring and sequencing a set of possible actions based on alternative external, uncertain developments over time. This visualisation of the concept is complemented by Haasnoot *et al.* (in press) who instantiate the pathways metaphor with a proposal for a rigorous syntax for illustrating the implementation of adaptation plans and policy. Both of these efforts focus on the individual decision-making actor and

climate change with the intended outcome being more and improved decisions. Where the goals of adaptation are not ambivalent and the decision maker is in the 'adaptive space' (white area, Figure 1) with the power and agency to make decisions, these approaches are powerful tools for supporting decision makers explore and sequence a set of possible specific actions under deep uncertainty about the future.

[INSERT FIGURE 1]

Gorddard *et al.* (under review), Pelling (2011) and Voß *et al.* (2007) emphasise, however, the need to make explicit the tensions between policies and actions aimed at proximate causes of vulnerability (i.e., supporting decision making within prevailing governance arrangements) and those seeking broader and systemic change to social and political regimes. The growing likelihood of a >2°C warmer world will require proactive adaptation that continually cycles between incremental and transformative actions (Park *et al.*, 2012). Attention therefore now needs to be given to better understanding and informing the “when”, “where” and “how” of complementing incremental actions on proximate causes with the more challenging and long-lead time transformative aspects of societal change (Nelson, 2009; O'Brien *et al.*, 2009; Pelling, 2011).

The purpose of this paper is to propose a broader conceptualisation of the adaptation pathways perspective that allows decision makers to explore the need for and the implications of societal transitions and transformation. In particular, this broadened pathways perspective provides insights and guidance on diagnosing whether systemic change is needed and the role of incremental adaptation in achieving this. This broader conceptualisation draws on a pluralistic and systems perspective of adaptation and builds on existing contributions in climate adaptation, sustainable development and governing epidemics.

In broadening this conceptualisation we first canvassed the status and effectiveness of adaptation research and practice as documented in the literature over the past few years (Section 2). This review revealed key insights into the factors contributing to the limited on-ground adaptation and the predominance of incremental over transformational change. The role that framing plays in influencing the nature and effectiveness of adaptation was identified as critical and is discussed in Section 3. Section 3 also provides the justification for a broadening of the prevailing IPCC vulnerability-impacts framing which is largely based on predict-and-provide approaches (e.g., Adger *et al.*, 2007); drawing upon lessons reported in cognate areas of sustainable development (Voß *et al.*, 2007) and governing epidemics (Leach *et al.*, 2010). The Section also justifies the need for further developing decision-oriented approaches to adaptation. Our re-conceptualisation emphasises the perspective of adaptation as part of pathways of change and response, where the intent and outcome of adaptation are not risk reduction per se but rather addressing the systemic drivers of vulnerability in dynamic systems. We provide detailed examples to explain and justify why this pathways approach is a more productive and effective approach for facilitating adaptation. This is presented and discussed in Section 4. The paper concludes with a call for further exploration of this conceptualisation of adaptation and importantly, some initial considerations for its application to the task of enhancing ongoing and dynamic adaptation action (Section 5), noting the contribution of other papers in this special issue.

2. Literature review of the status of adaptation research and practice

To understand the current status of adaptation, we reviewed a selection of international literature that directly and indirectly assessed the status, barriers and opportunities to adaptation practice, and those that reported empirical studies of adaptation decisions and on-ground actions. These three groupings within the adaptation assessment literature were further supplemented with four case studies of adaptation experiences (Table 1). The case studies were done by the authors drawing on their practical experiences and were chosen to represent a diversity of adaptation contexts that: (a) cover developing and developed country contexts; (b) focus on different levels of decision-making, i.e. community adaptation to climate change (Solomon Islands), local government experiences (Australia and United States of America), national decision making (national adaptation plans in developing countries, and biodiversity planning in South Africa), and (c) cover a diversity of sectors/zones (biodiversity, agriculture, coastal zones).

2.1. The status of adaptation practice

There are three broad types of studies on adaptation practice. First, there have been recent direct assessments of adaptation practice, with a primary focus on adaptation initiatives in developed countries (Berrang-Ford *et al.*, 2011; Ford *et al.*, 2011). These found that, whilst there were considerable efforts and studies in assessing vulnerability, there was limited evidence of adaptation action. Where adaptation action had occurred, this was typically in sectors sensitive to climate impacts (e.g., coastal zones, utilities, infrastructure and transport) and action had most often been implemented at the local scale and facilitated by federal governments. Climate change was rarely the sole or primary motivator while extreme events were important catalysts for adaptation action. The primary “adaptation mechanisms” were institutional (i.e., guidelines and policies) and financial (e.g., provisioning of financial support) and there was limited reporting of adaptation efforts taking advantage of climate change or focusing on marginalised groups, such as women, the elderly, or children (Berrang-Ford *et al.*, 2011; Ford *et al.*, 2011).

Second, there are numerous studies that characterise the limits and barriers to, and opportunities from adaptation (e.g., Adger *et al.*, 2009; Burch, 2010; Moser and Ekstrom, 2010; Nielsen and Reenberg, 2010; Measham *et al.*, 2011; Sietz *et al.*, 2011; Marshall *et al.*, 2012). These, and others listed below, seek to develop the conceptual, theoretical and knowledge foundations for understanding adaptation, assessing the vulnerability of social and ecological systems to projected climate changes, and developing and implementing adaptation strategies. Many comment on how useful these efforts have been for building understanding and awareness, measuring vulnerability and adaptive capacity, identifying adaptation options, and creating opportunities for adaptation (Burch, 2010; Eakin and Patt, 2011; Measham *et al.*, 2011). Many also report that thorough and reliable evaluations of adaptation options have been undertaken and plans developed. Actual on-ground implementations are reported in very few of these papers. The detailed case studies presented in Table 1, for example, describe the status of adaptation practice to date to be limited or ‘in progress’; with few examples of what might be considered fully fledged implementation. These examples also clearly show limited scope and planning for transformational change. In the cases of the U.S. and Australian local governments, for example, the authors observe limited real reform. In the case of Least Developed Country National Adaptation Plans of Action (NAPAs), real translation to in-country planning and action remains limited; with NAPA’s arguably not being written in ways that

readily translate to real action. Some successes in incremental adaptation actions, are, however, evident and provide lessons and potential options for future direction.

[INSERT TABLE 1 ABOUT HERE]

Literature that characterises barriers and opportunities also explores the reasons for the limited conversion of assessments and plans into action. These include behavioural and cognitive aspects (O'Brien and Wolf, 2010; Nelson, 2011), uncondusive governance arrangements (Amundsen *et al.*, 2010; Storbjörk, 2010), lack of or self-interested leadership (Anguelovski and Carmin, 2011; Moser *et al.*, 2012), competing planning agendas and lack of institutional coordination (Moser and Ekstrom, 2010), insufficient financial and human capital and mechanisms for enabling these (Bryan *et al.*, 2009; Kabubo-Mariara, 2009), lack of information and data (Deressa *et al.*, 2009; Hammill and Tanner, 2011), historical determinacy and path-dependency (Chhetri *et al.*, 2010; Abel *et al.*, 2011), incorrect or incomplete diagnosis of problems (Gorddard *et al.*, 2012), the widening science-policy gap associated with wicked problems (Moser, 2010), and uncertainty and ambiguity (Sarewitz, 2004; Dessai *et al.*, 2007). While identifying potential problems is important, shopping lists are not helpful and a key challenge for adaptation research is to identify which barriers are likely to arise in which kinds of contexts to inform how to address them.

Third, there is a body of literature that reports actual and ongoing on-ground adaptation practices. The vast majority of these studies are in agricultural contexts and in community- or ecosystem-based initiatives in rural, resource-dependent communities of developing countries (WRI, 2011; Park *et al.*, 2012; Rodima-Taylor *et al.*, 2012). In the case of adaptation in agricultural settings, the actions reported are mostly either addressing proximate causes of problems through incremental, no-regrets actions, or building the resilience of desired system functions by facilitating social organisation and technological applications; some of the latter are building the potential to transition prevailing rules and decision processes. Examples include: the provisioning of information services (e.g., facilitating information flows such as seasonal forecasting to farmers and improved monitoring and feedback mechanisms); livelihoods management; trialling and replicating technical solutions (e.g., shifting to multi-species cropping, agroforestry systems, farming to deliver ecosystem services, conservation agriculture, water-use efficiency, and genetic research); promoting financial approaches (e.g., weather derivatives, micro-finance); land-use zoning; and changing organisational structures and the rules governing decision making processes (e.g., water markets, boundary organisations to provide extension services and disseminating information, creating community networks, and supporting the role of communities within public institutions) (Atwell *et al.*, 2008; Rickards and Howden, 2012).

Most of the ecosystem- and community-based adaptation examples have focused on rapidly realising improvements in quality of life of resource-dependent communities through changes to livelihoods and natural-resource management strategies (e.g., Acosta-Michlik *et al.*, 2008; World Bank, 2010; WRI, 2011). In essence, all of these are focused on building the specific resilience (as opposed to general resilience, cf Folke *et al.*, 2010) of existing urban or rural ecosystems and the capacity of communities to cope, acclimate and adapt through strategies that ensure the prevailing suite of ecosystem goods and services are sustained (Jones *et al.*, 2012). There is usually little recognition and acknowledgement that many of these ecosystems may transition to entirely

different states providing different goods and services as a result of climate change, and that adaptation will increasingly be needed to facilitate transitions of governance arrangements and transformations of societal processes, norms and values.

2.2. Recent developments in adaptation research

There are growing efforts by the research community to better understand and develop methods and processes to support and inform adaptation research and decision making. These efforts have focused on developing techniques and tools for dealing with uncertainty, long time horizons, distributed decision making, diverse knowledge types and contested values. Willows and Connell (2003), Dessai and van der Sluijs (2007), Ranger *et al.* (2010) and Weaver *et al.* (2013) have strongly argued for and developed decision-centred approaches that provide comprehensive and pragmatic guidance on scoping problems in complex settings, identifying relevant information, interpreting uncertain projections and selecting decision-making methods that are appropriate to the nature and level of uncertainty. Importantly, they also provide practical tools and procedures for incorporating adaptation principles and heuristics developed by Fankhauser *et al.* (1999), Hallegate (2009) and others when developing context-sensitive, 'no regrets', robust and flexible adaptation strategies.

The above decision-centred approaches have inspired the recent developments in adaptation planning and decision support mentioned earlier, which use 'pathways' as a metaphor to help visualise what adaptation is about (i.e., Leach *et al.*, 2010; Stafford Smith *et al.*, 2011; Haasnoot *et al.* (in press); Figure 1), and provide an analytical approach for exploring and sequencing a set of possible actions based on alternative external changes over time. These developments build on earlier contributions and experiences such as the application of the pathways approach to adaptation planning in New York and London (Yohe and Leichenko, 2010; Reeder and Ranger, 2011). These initiatives provide a powerful and flexible analytical approach for decision makers in relatively closed, high-reliability systems that are amenable to technical solutions (e.g., the Thames barrier: Reeder and Ranger, 2011). A key strength of this approach is that it explicitly considers the interdependencies between the uncertain timing and magnitude of climate-change impacts and the characteristics of responses in terms of their costs, lead and lag times, and reversibility. In this regard, the tool emphasises the need for flexibility and iterative management of immediate decisions, informed by a strategic vision of the future and a framework to inform future actions based on decision triggers and monitoring (Haasnoot *et al.*, in press). Haasnoot *et al.* (in press) also emphasise how social groupings with different values or worldviews may choose different decision pathways from the set of available options.

These approaches, however, only partially consider (if at all) the dynamic interactions between the values, rules and knowledge that enable and constrain all decision-making processes (Gorddard *et al.*, under review). These underpinning elements of societal decision making are highly evolved, complex and difficult to change, yet in the context of climate and global change may rapidly become anachronistic. The task of enabling decision making and adaptation thus requires understanding the interdependencies between rules, values and knowledge and how to change these. There are consequently a growing number of studies attempting to better understand and address these systemic causes of vulnerability. These studies report on the specific approaches, difficulties and experiences involved in attempts to understand and inform transitions and transformations of the institutions and values that determine the distribution of rights and responsibilities and of the

processes of decision making. Important contributions here include: efforts focused on the wider societal processes and institutions that govern the interplay between actors and decision processes (van der Brugge *et al.*, 2005; Downing, 2012; Gorddard *et al.*, 2012; Rodima-Taylor *et al.*, 2012); shifting the focus of adaptation from viewing climate change risks as exogenous threats to development to accepting them as both products and drivers of development (Fazey *et al.*, 2010a); viewing climate adaptation “as a dynamic in social-ecological co-evolution” where the intent and outcomes of adaptation can span three levels – resilience, transition and transformation – and processes of social learning and self organisation are key (Ensor and Berger, 2009; Pelling, 2011: 169); and improved understanding and the development of approaches to bridge knowledge types and decision hierarchies, particularly deliberative participatory learning by stakeholders (e.g., Reid *et al.*, 2006; van Aalst *et al.*, 2008; Huntjens *et al.*, 2012). These limitations have a significant impact on current framings of adaptation.

3. Current framings of adaptation and how these influence action

A key challenge to achieving greater implementation of adaptation initiatives, especially in ways that are likely to lead to more transformative change, relates to how adaptation is framed. UNEP (2012) demonstrates the potential range in perspectives here by identifying seven different framings (Table 2). These reflect the diversity of contexts in which adaptation is required and the different world views, value systems, vested interests, and perspectives of adaptation researchers and decision makers (Chong and Druckman, 2007; Juhola *et al.*, 2011). Of particular relevance is how decision makers and researchers view and define the relationships between humans and nature, the role of knowledge in decision making, and how decision making can be enabled.

[INSERT TABLE 2 ABOUT HERE]

The importance of adaptation framing lies in the assumptions and goals that are, consciously or implicitly, adopted in the design and implementation of adaptation. For example, where vested interests benefit from the prevailing distributions of rights, funding and responsibilities, many climate-change related issues get framed as ‘simple’ knowledge problems by those benefiting from the status quo, rather than as complex and wicked problems (e.g., Stevenson, 2008). This leads to calls for more research to first resolve uncertainties, rather than to address the root causes of known problems. Leach *et al.* (2010), for example, show how amidst the complexity of viral–social–political–ecological interactions, different actors in the epidemics field produce particular narratives which frame systems and their dynamics in different ways, promote particular goals and values, and justify particular pathways of disease response.

An important component of the adaptation framing, related to whether responses should be directed at proximate or root causes of problems, is the degree of contextual complexity. The contexts within which adaptation is required are extremely diverse (Section 2). Voß *et al.*, (2007) presents a typology of contexts along a gradient of increasing complexity based on various combinations of the degrees to which a context has uncertainty in knowledge, ambivalent goals and distributed power. The simplest of these contexts is where knowledge of system functioning is relatively certain, a central decision maker exists and is easily identifiable, and goals are clearly defined. Problems in these contexts are ‘tame’ problems and are well-suited to the rationalist reductionist approach to decision making. Equally, in relatively closed systems with a central locus of

power and unambiguous goals (e.g., high reliability urban water supply systems) the problem is largely a ‘knowledge problem’ and can be tackled through capability building, learning approaches and tools for decision making under uncertainty (Ranger *et al.*, 2010). However, under climate change, many contexts have a high degree of uncertainty in knowledge, distributed power or ambivalent goals. In such systems (e.g., coastal communities along beach-dune systems and rural resource-dependent communities in developing countries) problems are best addressed through legitimate and fair processes of communication and engagement that reveal hidden or marginal-change narratives and challenge the dominant narrative that can lock decision-making into a reductionist or deterministic mode which reinforces inequities and power relations. Here it is important to provide a vision and create the networks between levels of government and across sectors that facilitate negotiation and encourage action at multiple levels (e.g., Tompkins *et al.*, 2008; Ostrom, 2010; Butler *et al.*, this issue). For the sake of balancing investment efficiency and effectiveness with fairness and legitimacy, it is essential to recognise contexts in which simpler, cheaper approaches are sufficient, as opposed to when these are likely to fail so that more complex approaches are required.

Most adaptation efforts to date have, to varying degrees, adopted the IPCC’s predict-and-provide or impact-analytical approaches to the design and implementation of adaptation (Downing, 2012; UNEP, 2012). These are largely based on a rationalist, linear, science-policy framework which focused on the *specific* risks identified (isolated) as ‘additional’ in the climate change context, rather than the *generic, complex* risks that characterize real-world decision-making. Consequently, adaptation efforts have been problem-oriented and reductionist in approach. Additionally, in most cases and particularly in developed-country contexts, research and planning efforts to support adaptation have adopted approaches based on the assumption that a clearly identifiable rational decision maker exists with the mandate to make decisions. The level of active participation of researchers and policy-makers in learning has varied depending on the framing; with the least participation in the ‘impact-analytical’ and ‘decision-making under uncertainty’ framings, increasing for the institutionally-oriented framings, and being prevalent in the ‘social process’ framings. The implications and consequences of such approaches to adaptation are listed in Table 3. Collectively, these favour adaptation responses that are more incremental than transformational in nature.

[INSERT TABLE 3 ABOUT HERE]

Despite their limitations, adaptation initiatives have helped build the awareness and understanding of adaptation researchers and decision makers of climate change, vulnerability, adaptive capacity and the barriers to making decisions in uncertain and complex contexts. Such initiatives are ill-equipped, however, to deal with multiple and deep uncertainties, dynamic and inter-dependent values and institutions, a diversity of perceptions and tolerances for global-change risks, positive feedbacks and path-dependency across space and time, and high levels of distributed power and decision making (Funtowicz and Ravetz 1993; Voß *et al.*, 2007). Proactive preparation for futures in a >+2°C world, will require responses that continually cycle between incremental and transformative actions (Park *et al.*, 2012). Attention now needs to turn from incremental actions on proximate causes, to more challenging and long-lead time transformative aspects (Nelson, 2009; O'Brien *et al.*, 2009; Pelling, 2011). This requires the social processes, institutions, organisations, skills and capabilities necessary to guide, facilitate, and manage the “when”, “where” and “how” of adaptation

for building the resilience of desirable system functions and for transforming values, decision-making processes and governance arrangements. Achieving this requires a paradigm shift in the framing of adaptation research and practice.

Recognition that different ways of understanding adaptation are needed is steadily entering science and practice discourses (Fazey *et al.*, 2010a; Fazey *et al.*, 2011; Pelling, 2011; Downing, 2012; Gorddard *et al.*, 2012). Such an evolution provides opportunities for a new coalescence of adaptation science and practice that is more effective and influential in helping decision making and the steering of complex social-ecological systems.

4. Discussion - Towards a new framing of adaptation as part of pathways of change and response

We suggest the paradigmatic shift required in adaptation science and practice involves conceptualising adaptation as a part of pathways of interacting global changes and societal responses. This broadens the existing conceptualisation and instantiation of adaptation pathways documented by Figure 1 and Haasnoot *et al.* (in press), discussed in Section 2, to emphasise the societal change aspects of adaptation. In particular, this broader conceptualisation of ‘adaptation pathways’ emphasises five critical dimensions to the adaptation challenge which are currently poorly integrated in research and practice. The first is acknowledging that climate adaptation is not separable from the cultural, political, economic, environmental and developmental contexts in which it occurs and is therefore only part of a range of societal responses to change. Second, related to this first point or a result of it, is the prevalence of changes and responses that cross spatial scales, sectors and jurisdictional boundaries, which can lead to threshold effects and can be exacerbated if responses are not coordinated. A third dimension is the inter-temporal aspects due to positive feedback loops and system inertia. These intrinsic processes express themselves as historical determinism, path-dependency, and lock-in; they mean future pathways are contingent on historical pathways and difficult to change. A fourth dimension relates to the difficulty of determining (i.e., measuring and monitoring) and understanding where the system is and what its trajectory is due to the many emergent properties of social-ecological systems as they adaptively respond to change. The final dimension, which is related to those above, is that societal processes are enabled or constrained by the prevailing rules, values and knowledge cultures, and their interdependencies, making it important to recognise and understand the influences of these interdependencies and how to change them to better enable adaptation research and practice.

We return to more detail on these below, but their collective effect is to force researchers and decision makers to approach the adaptation challenge at two levels. The first of these involves continuing existing predominantly incremental actions (within prevailing governance arrangements) that address proximate causes of vulnerability or developmental needs but modifying these to ensure that they are informed by and inform systemic change. The second and more systemic level involves taking note of the intentions and outcomes of societal change; this level must put a particular focus on understanding the influence of existing rules and values on framing and decision making, and on how to change these to better enable society to anticipate and proactively steer systems onto more desirable pathways in the context of global change. Importantly, the perspective of adaptation as part of pathways of change and response emphasises that both levels are required,

are not mutually exclusive and need to be complementary. Making explicit this distinction in the levels of responses to change is important because each level implies different intentions, outcomes, and planning horizons and therefore requires different capabilities, tools, and processes for its design and implementation.

Figure 2 seeks to represent a broader conceptualisation of adaptation pathways as part of global change and response, by accommodating these complicating societal dimensions, with the goal of allowing their implications for adaptation research and practice to be more intuitively and explicitly considered. The relevant changes from the Figure 1 conceptualisation add to the 'classic' view of adaptation pathways (Box A, Figure 2), with an expanded, dynamic, and non-linear decision space, as well as adaptation contexts where the causes of vulnerability are systemic in nature (Boxes B, C, and D, Figure 2). Each of these is explored below, drawing on case-study examples from this special edition and the broader literature.

[INSERT FIGURE 2 ABOUT HERE]

The 'classic' view on adaptation pathways (Figure 1, and Box A in Figure 2) is clearly a limited and partial conceptualisation of the adaptation challenge. In particular it deals rather peripherally with the risk that a series of relatively incremental steps, whether well intentioned or motivated by narrow political and economic vested interests, may ultimately lead to maladaptation¹ (e.g., Fazey et al., 2011). This may result because of: the adaptive landscape drifting away from current conditions due to climate change, other global drivers of change, and the decisions of many distributed actors; the misdiagnosis of the location of the system within the 'adaptive space' or its proximity to thresholds; or the capturing and closing down of the framing of the issues by powerful actors and institutions to maintain the status quo. The possible implications of these issues are visualised and explored in Box B of Figure 2. For example, a series of incremental decisions along '*pathway 1*' in Figure 2 seems adaptive but ceases to be so due to a changing adaptive landscape, such that by point *e*, a cycle of transformative change is needed to recover (*pathway 7*). However, with deliberative, participatory, long-term visioning and scenario-planning (e.g., Butler *et al.*, this issue; Smajgl *et al.*, this issue; Vervoort *et al.*, this issue), consideration of transformative cycles (Park *et al.*, 2012), clear balancing of vulnerability reducing and resilience building responses (Maru *et al.*, this issue; Xu *et al.*, this issue), and decision-making forums that reveal and challenge dominant marginal-change narratives that lock decision-making into reductionist modes that lead to maladaptation (Leach *et al.*, 2010), this might be identified earlier (e.g. at decision point *d* or even *c*), thus necessitating less rapid re-direction. Additionally, this broader perspective lends itself to a wider consideration of the consequences of all responses to change (i.e., not only adaptation actions), particularly those with an insidious nature, which creates both awareness of the various sources of decision uncertainty and how to contextualise and manage these (Stafford Smith et al., 2011) and opportunities for more explicitly integrating adaptation with mitigation and development (van Vuuren et al., 2011).

¹ Here maladaptation describes situations where prevailing values, interests, or institutions promote reductionist, marginal-change framings that constrain options and reinforce existing inequities and power relations, fail to address underlying biophysical or behavioural drivers of change, and reduce the capacity to take up future response options (Barnett and O'Neill, 2010).

The 'classic' view on pathways also does not represent the decision contexts where the current status of the system and its future trajectory are heavily influenced by the past. The broader conceptualisation of pathways presented here acknowledges historical determinism and path-dependency (Abel *et al.*, 2011; Peters *et al.*, 2012) and allows users to visualise and consider the implications for adaptation planning (Box C, Figure 2). Here, although *pathways 1, 2, and 3* all seem open at decision point *a*, path contingencies may mean that antecedent *pathway 3* is more likely to result in the maladaptive decisions whereas antecedent *pathway 1* may pre-adapt decision making better for adaptive *pathways 1 and 2*. It is thus critical to recognise the importance of history (i.e., the positive feedbacks associated with social and cultural practices, technologies, and institutional arrangements (Dobusch and Schüßler, 2012)), and to have a reasonable idea of which pathway a social-ecological system is on, to understand existing vulnerabilities and capacities to adapt and to inform future planning and responses (see for e.g., Campeanu and Fazey, this issue).

Furthermore, we may not even be in the adaptive part of the decision space today. Governance arrangements and cultural values and practices evolve over time in response to the prevailing and predominant forces and dynamics of socio-economic, technological, biophysical, ecological and climatic conditions (Young *et al.*, 2008). In the context of climate and global change, however, the inertia in institutions and values means these can become anachronistic and fail to serve their purpose of enabling societal processes (such as research and decision-making) for realising fair, legitimate, and effective allocations and uses of resources. The broadened conceptualisation of adaptation proposed here allows for the implications of this to be visualised and explored (Box D, Figure 2). If decision-makers are not even currently in the adaptive space, as at decision point *b*, then all pathways may be maladaptive. In this case, transformations of the institutional arrangements or cultural values are needed, either through dramatic intervention (*pathway 5*) or through strongly directed incremental change (*pathway 6*) (Gorddard *et al.*, 2012; Butler *et al.*, this issue). In both cases intervention from higher levels of governance is likely to be needed but is often only forthcoming in response to disasters or catastrophic events due to vested interests in the status quo (Pelling, 2011).

There are numerous additional implications of this broader conceptualisation for adaptation research and practice many of which are explored in the papers in this special section. For example, this broader framing ensures decision makers more readily recognise that various desirable and undesirable pathways can emerge from an intervention and that adopting a narrow focus on simple cause-effect relationships, as when adapting to proximate causes of vulnerability, can lead to unintended or mal-adaptive consequences (Sterner *et al.*, 2006). An often cited example of this is the response of building more flood defences which can affect perceptions of risk and lead to greater problems, or can reinforce existing tendencies for people to look towards external agencies for solutions thereby reducing some opportunities for more transformative changes (Newell and Wasson, 2002). Instead, by allowing both the root and proximate causes to be simultaneously considered, as this broader conceptualisation of adaptation pathways does, decision-makers can be open to direct and indirect pathways for achieving desirable outcomes (e.g., Butler *et al.*, this issue; Xu *et al.*, this issue). The pathways perspective also implies an iterative and ongoing approach, informed by a strategic vision, that enables experimentation and learning so that choices along pathways can be altered in response to predefined triggers. This conceptualisation also implies a deeper consideration of how adaptations can potentially reduce flexibility or limit opportunities

(e.g., by further commitment to a specific infrastructure design, power relations or distribution of rights, rather than complete reconsideration of it) and potentially lead to rigidity. It also implies the need for a shift to longer-term programmes of integrated research and practice (which existing institutions and organisations are not particularly well designed to do) that are solution oriented and comprise multiple complementary projects better designed to embed in the context and do the necessary monitoring and reflection (e.g., see Smajgl *et al.*, this issue). Key to delivery of such programmes is carefully designed processes of knowledge exchange, participation and negotiation that enhance ownership, fairness and responsibility while empowering participants to take action (Stringer *et al.*, 2006).

Coupled with the analysis presented here, the framing of Figure 2 highlights some key foci for adaptation research and practice efforts: building the capacity for critical consciousness and actor reflection on established institutions and power distributions; creating space and opportunities for new collaborations in innovation and experimentation of alternative values, ideas and practices within protected niches; providing legitimate, transparent and fair forums where actors with different levels of power and agency can actively negotiate changes to prevailing distributions of resources, rights and responsibilities; and supporting the creation of shadow networks of individuals and organisations in order to disseminate, popularise and mainstream successes from these niches (Leach *et al.*, 2010; Smith and Stirling, 2010; Pelling, 2011; Fischer *et al.*, 2012).

4. Conclusion

As the world seems increasingly likely to face a future with more than 2°C warming, it becomes increasingly important to move beyond impacts and vulnerabilities to adaptation action. Yet the uncertain and complex nature of future change poses significant challenges. We thus call for further exploration of the theoretical, methodological and procedural underpinnings of our proposed broader conceptualisation of adaptation, with an eye to more in-depth and previously ‘non-traditional’ considerations of adaptation’s complex role. For many of us working in the adaptation field, such approaches are likely to take us well out of our comfort zones; but further towards truly effective and meaningful intervention and change. The rest of this special edition comprises contributions spanning various areas of the required theory, as well as lessons from case study experiences.

The capacities required to develop and implement this broader conceptualisation of adaptation pathways will be heavily influenced by the extent to which stakeholders can learn from the experimentation of others via social and organizational networks. Hence, we also reiterate the calls of Fischer *et al.* (2012) and Nelson (2011) not only to consider the ‘technical fix’ type solutions for responding to social and environmental change, but also to conceptualise and use exposure and responses of people to the current impacts of climate change as a way to reflect on and reconsider the social norms and societal values that underlie existing problems. This should encourage greater responsiveness and reorganisation of institutional structures that are likely to lead to more sustainable trajectories. As Fischer *et al.* (2012) point out, focusing on such underlying issues is challenging and difficult and requires all sectors of society to reflect on their behaviours and practices, including the research community. Reconceptualising adaptation as part of pathways of change and response increases emphasis on such vital underlying issues.

5. References

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Table 1. Summary of the adaptation context, status of adaptation practice and key issues for five case studies, done by the authors drawing on their knowledge and experiences in these contexts.

Table 2. Summary of seven framings of adaptation (UNEP, 2012)

Table 3. Implications and consequences of the prevailing rationalist predict-provide and impact-analytical approaches to adaptation

Table 1.

Case study	Adaptation context	Status of adaptation practice to date	Key issues
Local governments in the US	<ul style="list-style-type: none"> • Lack of national leadership and policy framework to provide institutional coordination across sectors. Limited stakeholder participation. Absence of effective financing mechanisms (Poyar and Beller-Simms, 2010; Carmin <i>et al.</i>, 2012). 	<ul style="list-style-type: none"> • Cities and local governments are emerging as centres of action for climate change planning (Carmin <i>et al.</i>, 2012). • Currently in the domain of “early adopters” (Poyar and Beller-Simms, 2010). • Local champions, extreme events, and participation in national/international networks promote action (Anguelovski and Carmin, 2011). 	<ul style="list-style-type: none"> • Little evidence of reform of social issues relating to resource access and opportunity. • Broader structural concerns associated with urban design addressed in local planning.
Coastal local governments in Australia	<ul style="list-style-type: none"> • Coastal ecosystems and built infrastructure are at increasing threat of inundation due to sea level rise, storm surge and flooding. • Capacity- and budget- constrained local Governments are responsible for making choices between protection and retreat of private assets and ecosystems. • Higher levels of government are providing little leadership. 	<ul style="list-style-type: none"> • Many Councils have undertaken vulnerability assessments and evaluated adaptation options; • A few councils have taken action using land-use planning systems (Gibbs and Hill, 2011); largely to limit legal liability (Baker & MacKenzie, 2011) and protect public assets. • Responses have been incremental and focused on proximate causes (Herriman <i>et al.</i>, 2012; Webb <i>et al.</i>, under review). 	<ul style="list-style-type: none"> • Adaptation is hampered by the non-binding nature of state-wide policies (Gibbs and Hill, 2011) which are ambiguous in their intent and provide little guidance for determining ‘hazard zones’, weighting climatic and non-climatic risks, clarifying liability/compensation issues, and defining roles and responsibilities.
Least-developing-country (LDC) National Adaptation Programmes of Action (NAPA)	<ul style="list-style-type: none"> • 47 NAPAs completed by LDCs and lodged with the UNFCCC secretariat (June, 2012) (http://unfccc.int/resource/docs/2012/sbi/eng/15.pdf). • Despite a GEF-managed LDC Fund being established in 2002 to finance NAPAs, there remains a lack of clarity regarding who and how they will be implemented (Huq and Khan, 2006; Paavola and Adger, 2006; Saito, 2012). 	<ul style="list-style-type: none"> • NAPAs have involved the synthesis of information, participatory assessments of vulnerability, and evaluation and prioritized of activities. • Methods and processes have been systems-based, participatory and multi-disciplinary. • Few NAPAs have been implemented, but successes are due to effective inter-Ministerial mainstreaming of adaptation into development planning (Kalame <i>et al.</i>, 2011). 	<ul style="list-style-type: none"> • Urgency for adaptation has been balanced against the urgency of actions in many other areas; • Many NAPA processes were overly narrowly focused. Marginalised and more vulnerable groups (e.g. women) often excluded (Huq and Khan, 2006); • Progress hindered by failure to build in-country capacity to do integrated planning (Huq and Khan, 2006).
Adaptation in the Solomon Islands	<ul style="list-style-type: none"> • Challenges to governance exist due to chronic lack of infrastructure and financial capital, and a culturally and linguistically 	<ul style="list-style-type: none"> • The NAPA (completed in 2008) involved a broad assessment of climate change vulnerability at the national level and of the marine sector. 	<ul style="list-style-type: none"> • Multiple trajectories of change (e.g. erosion of social cohesion, natural disasters) and responses are often not

	<p>diverse population (Connell, 2010).</p> <ul style="list-style-type: none"> • National departments on disaster risk management and climate change to be amalgamated and climate change mainstreamed (NCCP, 2012). • Rural communities depend on natural resources (Allen <i>et al.</i>, 2006) which are being compromised due to increasing population and resource use. • Loss of social cohesion, increasing rates of alcoholism, disputes, and emphasis on cash crops are reducing adaptive capacity and increasing vulnerability (Fazey <i>et al.</i>, 2011). 	<p>(MECMH, 2008). More specific vulnerable locations were identified in the 2nd National Communication to UNFCCC.</p> <ul style="list-style-type: none"> • Community-based adaptation has been identified as a national strategy to improve well-being, and build adaptive capacity to climate change in the context of other pressures. • There is evidence of some effective community-based adaptation (Schwarz <i>et al.</i> 2011) but in general implementation of adaptation has been limited. Civil society organizations are building capacity to support communities adapt to climate change (NCCP 2012). 	<p>addressing root causes of vulnerability (Fazey <i>et al.</i>, 2011).</p> <ul style="list-style-type: none"> • While there may be greater recognition in government of the importance of adaptation measures actual on ground adaptation initiatives remain incremental, and the capacities to do anything significant are limited. • Current increasing population pressures and their impacts on food security and health are more urgent issues than climate change.
Adaptation planning in the biodiversity sector in South Africa	<ul style="list-style-type: none"> • Adaptation efforts have focused on biodiversity (e.g., National Biodiversity Assessment (Driver <i>et al.</i>, 2012)) and future direction is provided in the Climate Change Response White Paper (Department of Environmental Affairs, 2011)) • Ecosystem-based adaptation (EBA) is being promoted to conserve biodiversity and ecosystems, adapt to climate change, and generate socio-economic benefits. 	<ul style="list-style-type: none"> • Some longstanding experiences in EBA exist: vulnerability assessment processes informed a pilot EBA project in the Namakwa region; and in the Suid Bokkeveld area, civil society worked with local farmers to adapt to climate change and promote sustainable livelihoods, <i>in situ</i> conservation and ecosystem restoration (Archer <i>et al.</i>, 2008). • Successful adaptation initiatives have had local support from civil society and government. 	<ul style="list-style-type: none"> • Key weaknesses in support for adaptation exist at local and provincial government levels (on occasion, a support then provided by stakeholders such as civil society) • Significant, as yet inadequately realized opportunities exist to scale up successful approaches to provincial, national and regional concrete planning levels.

Table 2.

Framing	Focus and emphasis
Livelihoods-based	This approach emphasises the importance of existing social conditions, individual perceptions, local experiences and informal institutions as critical aspects for determining how communities cope with current climate conditions as a starting point for developing appropriate adaptation responses
Impact-analytical	This approach of the IPCC views adaptation as a single (or few) decision(s) that is (are) taken on the basis of projected future impacts, where it is assumed impacts and decisions can be singled out and formally quantified and evaluated using multi-criteria, cost-effectiveness or cost-benefit analyses.
Institution-analytical	This framing emphasises the need for horizontal integration of policy to mainstream climate change adaptation considerations into existing policy processes.
Decision making under uncertainty	In this framing, the analysis starts with a concrete decision (e.g., raise dikes) based upon all information on the range of possible impacts, rather than with climate scenarios and projections of impacts.
Social & institutional process	This framing emphasises how in linked social-ecological systems the outcomes of actions can usually not be predicted as they depend on actions of many agents as well as the social, cultural and natural context. The focal points of analyses thus are institutions (formal and informal rules) that shape the interplay between the actors.
Multi-level governance	This framing emphasises how the cross-scale and systemic nature of climate impacts requires understanding and creating multi-level institutions and organisations that promote vertical and horizontal integration.
Social learning & adaptive management	In this framing, the complexity and non-determinism of many resource management situations is recognised and adaptive processes of improving management goals, policies and practices through learning are adopted to help bridge the science-policy gap.

Table 3.

Implications and consequences	References
Considerable time and effort invested into explaining and justifying problem definitions in contexts where complexity, uncertainty or ambiguous goals make polarised world views legitimate and largely unavoidable. Leads to science being inappropriately used to try resolving contested problem definitions and solutions.	(Sarewitz, 2004)
The solution space being constrained to addressing symptoms and proximate causes (e.g. infrastructure planning, livelihoods management, legal liability) thus largely unsuited to informing and initiating innovative transformational changes to address root causes of problems.	(Pelling, 2011)
Focuses attention to static measures of vulnerability and adaptive capacity and on impacts at particular future dates, which has promoted once-off actions without due consideration for the temporal interdependencies between these variables and the general current and historical context in which adaptation is occurring.	(Fazey <i>et al.</i> , 2011; Hinkel, 2011)
Research, decision-making and values-deliberation processes being undertaken in relatively discrete stages of adaptation planning leading to limited opportunities for triple-loop learning by all stakeholders, which are a prerequisite to transformation.	(Gorddard <i>et al.</i> , 2012)
Emphasis on adaptation being about managing specific quantifiable or observable <i>risks</i> through increased control of the environment (i.e. assumed impacts and adaptation decisions can be singled out and formally quantified and evaluated using multi-criteria, cost-effectiveness or cost-benefit analyses). Results in lack of consideration of the wider social, political and normative elements of adaptation.	(Carter <i>et al.</i> , 2007)
Adaptation being promoted as a single or a few decisions to be made by the end of a project and largely unable to account for issues that play out over the long term such as cultural, institutional, political, technological and economic path-dependencies.	(Abel <i>et al.</i> , 2011)
Expectations and beliefs being created or reinforced that more research will reduce uncertainty and make choices easier leading to funds being allocated uncritically to scientific pursuits to 'reduce uncertainty'.	(Dessai <i>et al.</i> , 2009)
Insufficient integration of climatic drivers of change with other drivers of change and within broader development initiatives, particularly in developed nations.	(Fazey <i>et al.</i> , 2010a)
Tried-and-tested solutions (measured as the absence of the problem) are fitted to the status quo rather than novel solutions being generated to create desired conditions that may question or challenge the status quo.	(Swenson and Anstett, 1997)
Governments contributing as independent providers of information, capacity and funding without sufficiently exploring their own institutional limitations and partnering in learning and innovation.	(Gorddard <i>et al.</i> , 2012)
Focus on scientists as the key producers of knowledge with the learning being framed by and associated with external researchers rather than those who are supposed to be implementing adaptation or are supposed to benefit from it.	(Fazey <i>et al.</i> , 2010b)

Figure 1. The current ‘classic’ conceptualisation of adaptation pathways – as a series of adaptive learning decision cycles over time (top left, cf Willows and Connell, 2003; Haasnoot *et al.*, in press) with their decision lifetimes (top right - the sum of lead and consequence times, cf. Stafford Smith *et al.*, 2011), where some chains of decisions lead to maladaptive outcomes over time, but there may be other alternatives that are adaptive (bottom, cf. Reeder and Ranger 2011; Haasnoot *et al.*, in press). From the perspective of the current decision point at the left, a currently satisfactory pathway can be plotted through the future (strongest colour), but this must be re-visited at each decision point. (Figure developed by Andy Reisinger, pers. comm.)

Figure 2. One decision-making actor’s adaptation pathways through an adaptive landscape, building on the metaphor of Figure 1, where the boundaries between adaptive and maladaptive responses are changing over time, due to biophysical changes, but also to changes in social and institutional context, including the actions of other decision makers. Circle arrows represent decision points, dark blue arrows represent pathways that are contemporaneously adaptive, grey arrows lead to maladaptive dead-ends; dashed blue arrows represent more-or-less transformative pathway segments, and the green arrows show antecedent pathways prior to the current decision cycle (a) faced by the decision-maker of concern.

Figure 1

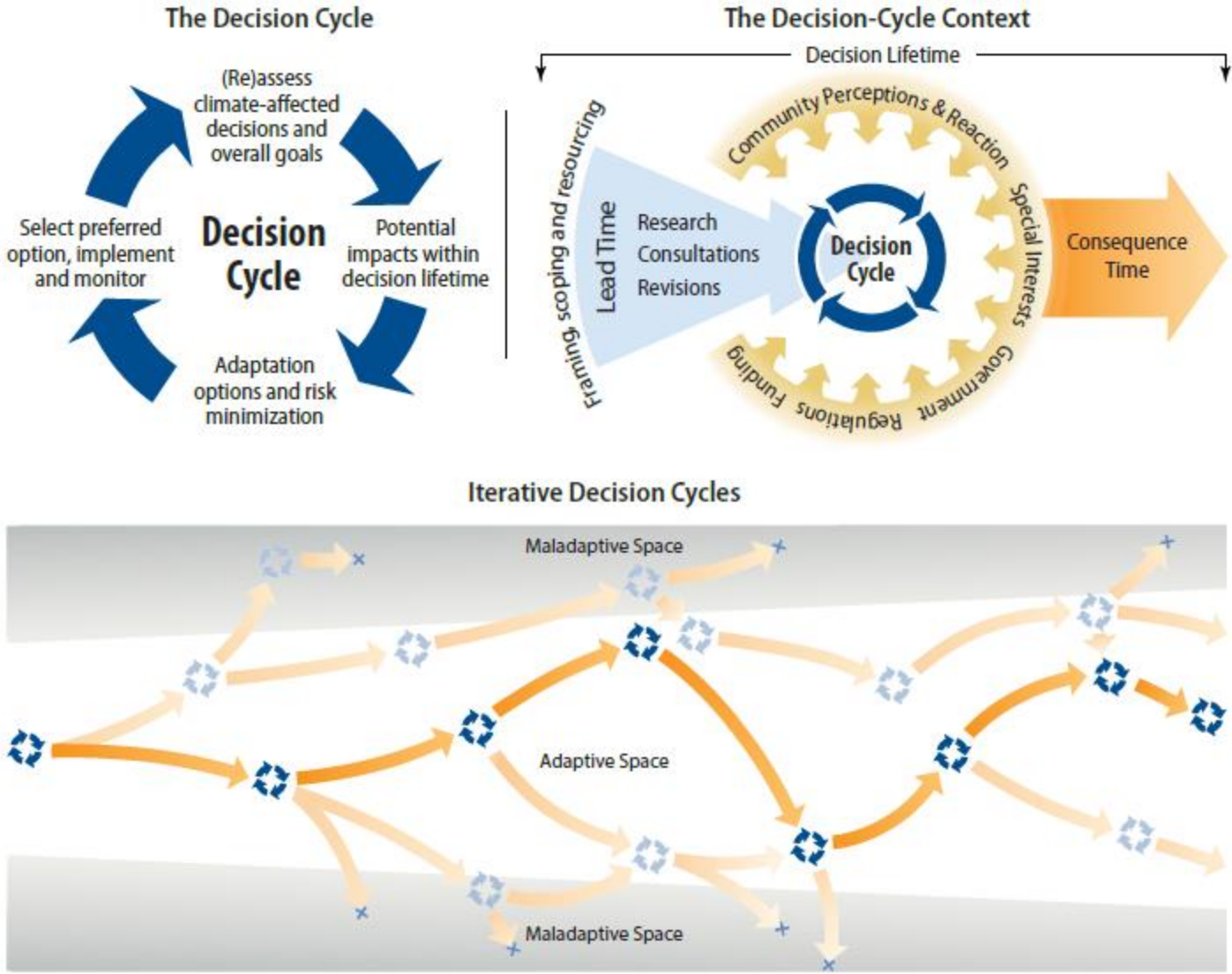


Figure 2

