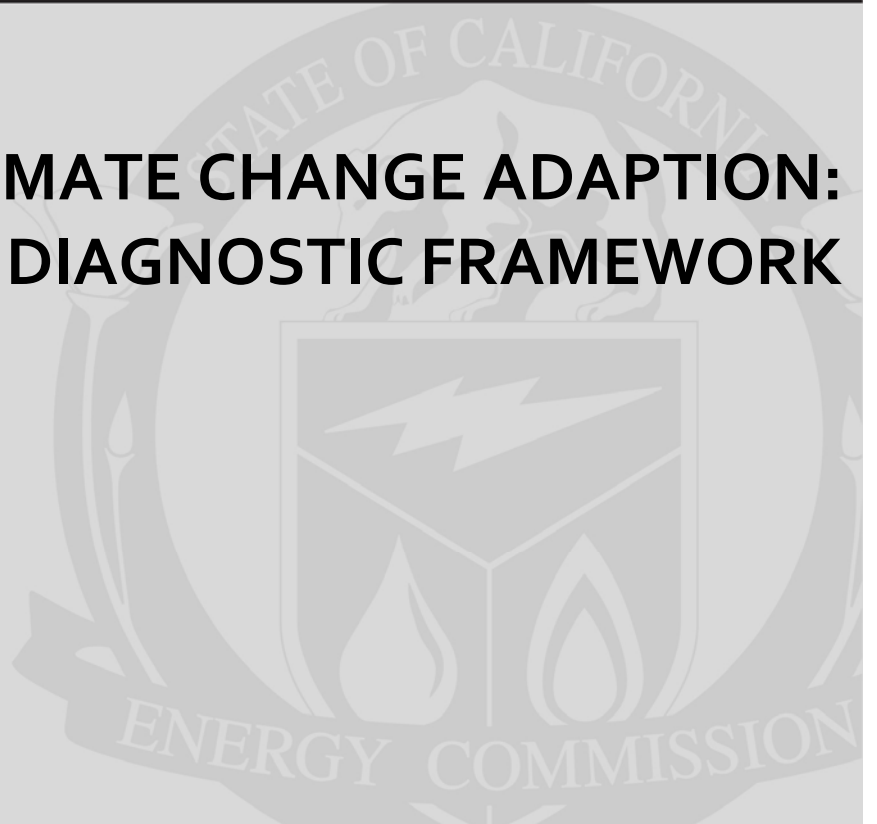


**Public Interest Energy Research (PIER) Program
FINAL PROJECT REPORT**

**BARRIERS TO CLIMATE CHANGE ADAPTION:
A DIAGNOSTIC FRAMEWORK**



Prepared for: California Energy Commission

Prepared by: Lawrence Berkeley National Laboratory



SEPTEMBER 2011
CEC-500-2011-004

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ACKNOWLEDGEMENTS

The authors would like to thank Oran Young and three anonymous reviewers for constructive feedback on a shorter version of this paper (published in the *Proceedings of the National Academy of Sciences*), and the California Energy Commission for financial support of Julia Ekstrom's time through California Energy Commission Contract 500-07-043. All errors, omissions, opinions, and interpretations remain the authors' alone.

PREFACE

The California Energy Commission Public Interest Energy Research (PIER) Program supports public interest energy research and development that will help improve the quality of life in California by bringing environmentally safe, affordable, and reliable energy services and products to the marketplace.

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Barriers to Climate Change Adaptation: A Diagnostic Framework is the final report for the Barriers to Adaptation project (Contract Number 500-07-043) conducted by Julie Ekstrom under supervision of Margaret Torn, and Susanne Moser. The information from this project contributes to PIER's Energy-Related Environmental Research Program.

For more information about the PIER Program, please visit the Energy Commission's website at www.energy.ca.gov/research/ or contact the Energy Commission at 916-327-1551.

ABSTRACT

This report presents a framework to systematically identify and organize barriers that may impede managing the risks and impacts resulting from climate change (such as those caused by sea level rise, shifts in seasons, changes in water supply availability, and others). The framework targets *planned* adaptation (that is, preparation for and management of impacts) and focuses on potentially challenging obstacles, but ones that can be overcome. The framework is made up of three key components. The first component is an idealized depiction of the adaptation decision-making process that provides the foundation for identifying and organizing the barriers into a logical framework, which helps to recognize when and why they occur. The second component consists of three core elements of any adaptation process: the actors involved, the larger context in which they act (for example, governance), and the system of concern that is exposed to climate change and that needs to be managed. These three elements are the principal sources for why a given barrier arises in the adaptation process. The third component of the framework serves as a guide for how to determine whether an encountered barrier is under the current and local influence of the actor. This component opens up options for policy or management interventions to overcome the barrier. Together, the nature of the barrier, its source, and the location of influence over the barrier provide a “road map” to design strategies to circumvent, remove, or lower the barriers. It provides a systematic starting point for answering critical questions about how to support climate change adaptation at all levels of decision-making (local, state, and federal government and in the private sector). This project is important because it created a testable framework that would allow decision makers to identify what barriers must be overcome to reduce environmental or economic damages of climate change.

Keywords: Climate change, climate change adaptation, barriers to adaptation, adaptation deficit, social-ecological systems

Please use the following citation for this report:

Ekstrom, Julia A., Susanne C. Moser, and Margaret Torn. 2011. *Barriers to Climate Change Adaptation: A Diagnostic Framework*. California Energy Commission. Publication Number: CEC-500-2011-004.

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EXECUTIVE SUMMARY

Introduction

In the first decade of the 21st century, adaptation to climate change has risen sharply as a topic of scientific inquiry in local and international policy and planning circles, in the media, and in public awareness. One of the critical research questions that has arisen is: *What barriers are preventing individuals, cities, regions, and states from adapting to climate change?* This report presents a systematic framework to identify barriers that may impede the process of adaptation to climate change. The framework focuses on deliberate, proactive (planned) adaptation and on the barriers that can arise in that process. The report defines barriers to adaptation as obstacles that delay, divert, or temporarily block the adaptation process, but which can be overcome with concerted effort, creative management, change of thinking, prioritization, and any related shifts in resources, land uses, or institutions.

This report uses a generic, but inclusive, definition of the term *adaptation* reflecting common usage in the climate change field. It deviates from the Intergovernmental Panel on Climate Change's definition of adaptation, however, in recognizing that adaptation must consider, but may not be justified by, climate change alone and may be initiated or undertaken in the context of non-climatic windows of opportunity (for example, land use plan updates, infrastructure replacement, renovating a building). The Intergovernmental Panel on Climate Change's definition also assumes effectiveness in outcome that the report believes is premature. Whether harm will be moderated and beneficial opportunities exploited are contingent upon many factors, not just the adaptation process or adaptive action itself. Some adaptive actions may turn out to be maladaptive later, for example if they fail to reduce the vulnerabilities to climate change impacts or if they have unanticipated negative consequences. For example, erecting seawalls along a stretch of eroding shoreline (increased due to sea level rise) may protect the land behind the seawall, but also cause loss of economically important beaches and ecologically important shoreline habitat. Lastly, the definition of climate change adaptation used here incorporates the notion of social-ecological systems while the Intergovernmental Panel on Climate Change refers to separate human and natural systems. The report's definition is as follows: Adaptation involves changes in social-ecological systems (for example, in entities that involve both human and natural components interacting in complex ways such as a coastal community or the agricultural industry of a region) in response to actual and expected impacts of climate change in the context of interacting non-climatic changes. Adaptation strategies and actions can range from short-term coping to longer-term, deeper transformations. They also aim to meet more than climate change goals alone; and may or may not succeed in moderating harm or exploiting beneficial opportunities.

Purpose

Although some studies mention barriers in broad sweeping terms (for example, lack of funding) while other studies have investigated specific barriers, there has been no attempt to synthesize or organize the barriers systematically to date. This research synthesizes previous work on adaptation and associated barriers and develops a framework that helps to identify and

organize barriers to climate change adaptation. Such an organizational framework can help researchers and decision-makers recognize certain barriers to arise in adaptation processes. This provides practitioners with options to preemptively intervene or better manage the challenges that may arise in the adaptation process.

The primary goal of this research, however, was to advance the discussion and examination of barriers to adaptation by presenting a systematic framework to identify and organize barriers that can arise in the adaptation process in different contexts into a theory-based ordering device. Systematically identifying barriers to adaptation can serve to advance scientific and in-practice understanding of the adaptation process and assist in decision-making. As such, the report aims to be comprehensive but does not assume every process will touch on all steps or barriers.

The diagnostic framework would systematize the identification of barriers that may impede the adaptation process and, thus, society's ability to deal with the impacts of climate change. The first two components (process and structure) of the framework help answer two fundamental questions:

- What could thwart the process?
- How do the actor(s), context, and the system of concern contribute to the barrier?

In the third component of the framework, a matrix helps locate the sources of these barriers along temporal and spatial/jurisdictional scales and thus identify the locus of control over them, which ultimately aims to guide possible interventions to overcome the barriers.

Results

Given the pervasive influence of climate change and the many climate-sensitive systems and decisions that will be made, a diagnostic framework that applies to a wide range of adaptation cases must be principled, but not overly confining. The design of the framework is guided by four principles. It aims to be focused on human interactions among them but aware of the physical and ecological constraints within which they work and make decisions. It is also focused on the actors that make decisions, while being aware of the institutional, social, and cultural contexts within which they function. The approach is most interested in the adaptation process but also action/outcome-oriented; and, finally, it recognizes that decision processes are iterative and messy, yet we organize them here in a logical, linear sequence for convenience.

Three key conceptual elements underlie the diagnostic framework. First, an idealized, conceptual model of the adaptation decision-making process makes up the process component. Second, a set of interconnected structural components includes the actors, the larger context in which they act (for example, governance), and the object upon which they act (the system of concern that is exposed to climate change). Each component can play a significant role in creating the barrier. Third, to overcome identified barriers, a simple matrix helps map the source of the barrier relative to the actor's influence over it.

The process of adaptation provides the foundation for identifying and organizing the barriers. Common phases of a rational decision-making process are used, including understanding the

problem, planning adaptation actions, and managing the implementation of the selected option. Each of these process phases includes a series of stages (a total of nine stages), within which certain barriers commonly arise. The report reviewed the extant scholarly literature on adaptation to identify barriers in each stage. The barriers may impede progress from one stage to another or – if stages and the issues that arise in each are skipped, as can be the case in real-world decision-making – can result in problems or unintended consequences later.

To understand why a given barrier arises in the adaptation process, the second component of the diagnostic framework uses three core structural elements of social-ecological systems. These include: the actors (not a static, but often wide-ranging and changing set of players over time), the larger context in which they act, and the object upon which they act (that is, the specific coupled human-natural system to be managed or altered such as a coastal community waterfront, a city's water resources, or a managed forest). For example, adaptation in coastal areas does not only require focus on the coastal waterfront (the system of concern) that has to be better managed in light of sea-level rise. Rather, it is also necessary to consider how the actors themselves who manage that waterfront have to change (for example, their perceptions of or thinking about the environment, use of information, decisions, and interactions with other levels of government). Finally, the greater context in which both the actor and the system of interest are embedded provides the enabling and constraining contextual conditions that shape adaptive actions. For example, the actors involved may make these changes only if the governance context in which they act also changes (for example, shaping what is legal or politically feasible, which decision protocols to use, or the timing of certain opportunities to make changes in budgeting, planning, or infrastructure replacement schedules). Barriers may arise from all three components. Sample diagnostic questions are provided in the Section 9 of this report to identify how each structural component contributes to the occurrence of a barrier.

The third and final step in the diagnostic framework uses a simple matrix to locate possible points of intervention to overcome a given barrier. An actor's ability to overcome a barrier depends not just on his or her capabilities and resources, but also on the source or origin of the barrier. Consequentially, the spatial/jurisdictional and temporal origins of the barrier relative to the location of the actor are important to identify. Along the temporal dimension, the approach proposed distinguishes between contemporary and legacy barriers, i.e., barriers that have arisen in the current context (contemporary) versus from decisions made in the past (legacy). Along the spatial/jurisdictional dimensions (which sometimes coincide; other times differ in scale), proximate barriers are distinguished from remote barriers, i.e., barriers that arise from decisions being made close-by, within the reach of the actor (proximate) versus barriers that arise from decisions made by a distant decision-maker.

Together, the nature of the barrier, its source, and the location of influence over the barrier provide a "road map" to design strategies to circumvent, remove, or lower the barriers. Leadership, strategic thinking, resourcefulness, creativity, collaboration and effective communication are required in overcoming them. Frequently, this effort of overcoming barriers is, in fact, the primary target and focus of the initial adaptation effort.

Conclusions

In this report a theory-based framework for identifying and organizing barriers to adaptation is introduced. The approach offered here is not normative (or prescriptive) about how to make “good” adaptation decisions. Rather, the framework offers a comprehensive, systematic approach to detecting barriers in each stage of the adaptation process, along with diagnostic questions that help ascertain how actors, context, and the system of concern contribute to the existence of the barriers.

This diagnostic framework requires testing and refinement if to be used to aid decision-making. Through this refinement, the framework can also advance the understanding of barriers to adaptation. For example, the framework could be used as a foundation to examine whether and how barriers differ by the type of system of concern, by sector, scale of governance, problem definition, and the depth of the adaptation or transformation sought. Patterns may emerge from such comparative investigations showing where the biggest barriers lie.

A refined ability to identify the most challenging barriers may allow governments, businesses, and non-governmental organizations to better allocate resources and strategically design processes to overcome them. Similarly, further research on barriers may improve understanding of adaptive capacity and what may constitute adaptation success. For example, what are the implications of actors skipping certain stages– and the associated barriers – in real-world decision-making? Thus, the framework presented here provides a starting point for answering critical questions that can ultimately inform and benefit climate change adaptation at all levels of decision-making. All of the data in this paper was provided by the author’s unless otherwise stated.

CHAPTER 1:

Motivation and Purpose

In the early years of the 21st century, adaptation to climate change has risen sharply as a topic of scientific inquiry, in local to international policy and planning circles, in the media, and in public awareness (Adger et al. 2007; Moser 2009a; Preston et al. 2009). Adaptation scholars have generally assumed lower vulnerability and greater adaptive capacity in developed countries and greater challenges in developing countries, and thus focused more research in developing countries (e.g., Smit, Pilifosova, et al. 2001; Adger et al. 2007). While this broad-brush wisdom may hold true in an absolute sense, catastrophic climatic events in Europe, the United States, and Australia in recent years have led to critical questioning of the common assumption that the US and other richer nations will be able to adapt to climate change with little problem (Moser 2009a, 2009c; Pielke et al. 2007; Schipper 2006; O'Brien et al. 2006).

One line of research that has grown out of this more critical examination of developed nations' adaptive capacity is the growing interest in barriers to adaptation: Are there any, and if so, what is the nature of these barriers, what is their impact on society's ability to deal with climate change impacts, and how, if at all, can they be overcome? This paper aims to contribute to this line of research by advancing the discussion and examination of barriers to adaptation by laying the foundations for a systematic framework that allows researchers and practitioners to identify and organize barriers that can arise in the adaptation process in different contexts into a theory-based ordering device. Systematically identifying barriers to adaptation can serve to advance our understanding of the process and assist in decision-making. As such, the discussion aims to be comprehensive but does not assume every process will touch on all steps or barriers. In subsequent papers the authors will build on this foundation to present the diagnostic approach and identify the range of barriers arising in the adaptation process.

Below, a brief overview is provided of the literature on adaptation barriers to provide a deeper rationale for the research and then define the authors' terms (Section 2). In Section 3 the authors offer some guiding principles to build the diagnostic framework. Section 4 then outlines the steps involved in planned adaptation and introduces the key process and structural elements of the framework. Section 5 – the major section of this report – describes in detail the barriers that may be encountered in each phase and stage of the adaptation process and how the actor, context and system of concern can contribute to their existence. Section 6 introduces the matrix to locate the temporal and spatial/jurisdictional source of each barrier and discusses in principle how to overcome barriers. The concluding Section 7 outlines steps to empirically test this framework of adaptation barriers. After the extensive reference list (Section 8), the appendix in Section 9 provides a list of diagnostic questions to help identify stage-specific barriers.

1.1 Synthesis of the State of Knowledge About Adaptation Barriers

A small but growing body of literature has emerged that specifically addresses questions about the existence and nature of barriers to adaptation and the society's ability to transcend them (e.g., Adger et al. 2009; Adger, Lorenzoni, and O'Brien 2009; Burton 2009; Easterling, Hurd, and

Smith 2004; Grothmann and Patt 2005; Jamieson and VanderWerf 1994; Lowe, Foster, and Winkelmann 2009; Mitchell et al. 2006; Moser and Luers 2008; Moser et al. 2008; Nielsen and Reenberg 2010; Patt and Schröter 2008; Pielke et al. 2007). This work can be augmented by insights on the challenges involved in social change and in management processes at all levels of aggregation and governance. Together this literature begins to explain the “adaptation deficit” (Burton 2009) and sheds light on the gap – quite frustrating to some (Blair 2009) – between the recent flurry of adaptation talk and planning and yet still limited progress in implementation and actual advance in preparedness. It infuses a welcome dose of pragmatic realism into scholars’ rather simplistic assumptions about adaptive capacity and communities’ and nations’ ability to manage the impacts from climate change. Indeed, a careful study of barriers and limits to adaptation can advance the understanding of adaptation processes and improve the predictive capacity, including the assessment of adaptation costs and the relative balance of mitigation and adaptation needs (Patt et al. 2009). Moreover, it could help society shake loose from the grips of complacency (O’Brien et al. 2006), enable decision-makers to prepare more efficiently, and increase the likelihood of effective and timely implementation of adaptation measures.

The societal obstacles identified in the literature to date predominantly focus on financial and technological ones, but psychological, social, political, cultural, organizational, and institutional ones have also been discussed. Much remains to be learned about all of them (National Research Council 2009a). To date, there has been no widely accepted definition of a barrier nor has there been a systematic identification of possible barriers in the adaptation process. While highly informative and illustrative, the empirical focus in barriers has varied widely (e.g., those faced by individuals, local governments, or private sector businesses) but has not been comprehensive. To advance the state of the science, it is important to carefully examine all aspects of the adaptation process, including the actors involved, the various stages of decision processes from start to finish, and the governance contexts in which actors undertake adaptation. The challenge is one of enormous complexity, and single disciplines or theoretical constructs are unlikely to suffice to capture it. The authors’ hope is to begin this interdisciplinary integration by laying the foundation for a diagnostic framework.

Chapter 2: Defining Adaptation and Barriers: Scope and Scale of Adaptive Interventions

2.1 Defining Adaptation

Scholars and practitioners use the term “adaptation” in a variety of ways (Adger et al. 2007; Head 2009; Schipper and Burton 2009; Smit et al. 2000; Smit and Wandel 2006). If the development of a diagnostic framework is to succeed at all, it is important to clarify what counts as “adaptation” in order to delineate the actions and contexts in which barriers may arise.

Early social science work on adaptation to environmental hazards and changes (Denevan 1983; Kates, Ausubel, and Berberian 1985; Rapport 1968; Vayda and McCay 1975) can be broadly described as falling into the human ecology tradition. Building on the classic literature on analyzing human response to environmental hazards (e.g., Burton, Kates, and White 1978), Kates, Ausubel, and Berberian (1985) distinguished between adjustment and adaptation. Adjustments are short-term, relatively small-scale or minor, whereas adaptations are longer-term and more systemic. They acknowledged that though these two concepts of adaptation and adjustments are theoretically distinct, they tend to be difficult to distinguish in practice. Some scholars maintain this distinction to this day (Berkes and Jolly 2001), but much recent scholarship no longer carefully distinguishes the shallower and deeper changes societies make in response to a stimulus. The units of analysis in the human ecology tradition vary from individuals (Vayda and McCay 1975) to entire cultures (Rapport 1968; Steward 1955), and earlier work was restricted to reactive adaptation given that the studied individuals and cultures did not have forward-looking capacity (e.g., models projecting environmental change).

In sociological, psychological, and geographic work on hazards, the concern has traditionally been on short-term responses (coping) to hazardous events and a variety of “hazard mitigation” interventions. Despite deeper and theoretically differing causal analyses of hazard vulnerability and impacts (Hewitt 1983; Kates, Hohenemser, and Kasperson 1984; Wisner et al. 2004) and resulting calls for systemic interventions in human, natural, and technological systems, the predominant concern in applied hazards studies has been on the preparedness, response, and recovery processes immediately preceding and following a hazardous event. Until recently there has been little concern for longer-term trends in underlying environmental (or societal) drivers (Bruce 1999; Lever-Tracy 2008; Schipper and Pelling 2006). In scholarship and practice, these short-term concerns with individual hazardous events (disaster preparedness, hazard mitigation, and coping) now fall under the rubric of adaptation. The reverse approach has also been taken, namely grouping adaptive responses into common rubrics of hazard management intervention (Travis 2009).

Other social science theories attempt to describe and explain social change phenomena – from individual behavior change (Barr 2008; Gardner and Stern 2002; Halpern and Bates 2004) to organizational and institutional change (Argyris 1993; Breit et al. 2003; Collins 1998) to decision-

making and policy change (Jasanoff and Wynne 1998; Kingdon 2002) to technological innovation and change (Berkhout 2002; Rip and Kemp 1998; Rogers 2003) and to large-scale societal and cultural change (Inglehart and Welzel 2005; Raskin et al. 2002; Steward 1972). In particular, discussions of the “sustainability transition” or of “transition management” (Kemp and Rotmans 2004; Raskin et al. 1996; Rotmans, Kemp, and van Asselt 2001) speak to some of the deeper, lasting system changes that Kates et al. (1985) would have called “adaptation.” The degree of anticipation versus reactivity to stimuli from the social environment, the time-scales, the degree of intentionality and control, and the number of actors and the intensities and forms of their connectedness in bringing about change all vary widely.

While momentarily neglecting the theoretical contributions to adaptation in the field of ecology, the authors acknowledge its focus on resilience of ecological and social-ecological systems, a term that has come to absorb both short-term responses to disturbance (“bouncing back”) and the longer-term capacity to change and adapt in order to maintain essential system functions and features (Holling 1973, 1996; Walker et al. 2004). Out of this context the notion of “adaptive management” emerged, an iterative, deliberately learning-oriented strategy to assist in more flexible management of natural resources in light of uncertain knowledge, inadequate models and constantly changing contexts (Gunderson, Holling, and Light 1995; Lee 1993). With increasing attention to the institutional context and actor networks involved in ecosystem management, “adaptive governance” has become a central focus for resilience scholars (Folke et al. 2005; Olsson et al. 2006; Pahl-Wostl 2009).

In the climate change context, the now most commonly adopted definition of adaptation is that used by the Intergovernmental Panel on Climate Change (IPCC), where adaptation is an “adjustment in natural and human systems in response to actual and expected climatic stimuli or their effects, which moderates harm or exploits beneficial opportunities” (Intergovernmental Panel on Climate Change 2001, p.982). The types of adaptation included encompass anything from coping to deeper system changes. The actions are distinguished, however, by the timing of when they are undertaken (anticipatory or reactive), the actors undertaking them (private or public), and by the degree of conscious planning and intentionality (autonomous or planned). Planned adaptation can occur on any organizational level. Smit et al. (2000) also group actions into three broad temporal categories: those that deal with long-term trends, variability from the norm over relatively short periods, and extreme events. Pielke et al. (2007) have criticized the IPCC’s definition as restricted to actions that respond to “climate stimuli and their effects.” In fact, numerous researchers have found that many if not most adaptation actions are not taken for climate-related reasons alone (Adger et al. 2007; Tompkins et al. 2009). Thus, definitional purity may come at the expense of capturing the full range of actual adaptation experiences and processes.

Finally, it is important to examine how individuals who are engaged in planning and implementation of adaptive actions define what they do. Experience in the United States suggests that practitioners generally are less careful or systematic in their definition of adaptation (Moser 2009a). Many adopt the IPCC definition or a more intuitive derivative (e.g., “preparing for and managing the impacts of unavoidable climate change”). Importantly, as adaptation rises on the policy agenda and such definitions are put forth in public documents

(including its explicit climate rationale), countless actions previously undertaken without a climate change justification now find themselves under the “adaptation umbrella” (see de Bruin et al. 2009; Tompkins et al. 2009 ; Wilson 2006; National Research Council, forthcoming-a).

In light of the foregoing discussion, the authors adopt a definition here that deviates from the IPCC definition. The authors concur with it by recognizing that climate change will manifest at different time and spatial scales, and in social-ecological systems, as will the adaptive responses; some of these human responses will involve foresight, others reactivity; and they will occur at all levels of decision-making. The authors of this report deviate from it mainly in recognizing that adaptation must consider, but may not be initially justified by, climate change and may be initiated or undertaken in the context of non-climatic windows of opportunity (e.g. land use plan updates, infrastructure replacement, renovating a building). The IPCC definition also implicitly assumes effectiveness in outcome that the authors here believe is premature – whether or not harm will be moderated and beneficial opportunities exploited are contingent upon many factors, not just the adaptive action itself. Some adaptive actions may turn out to be maladaptive. Finally, IPCC distinguishes natural and human systems while the notion of social-ecological systems is used here. Thus, for the purposes of this report, the authors use the following definition:

Adaptation involves changes in social-ecological systems in response to actual and expected impacts of climate change in the context of interacting non-climatic changes. Adaptation strategies and actions can range from short-term coping to longer-term, deeper transformations, aim to meet more than climate change goals alone, and may or may not succeed in moderating harm or exploiting beneficial opportunities (Figure 1).

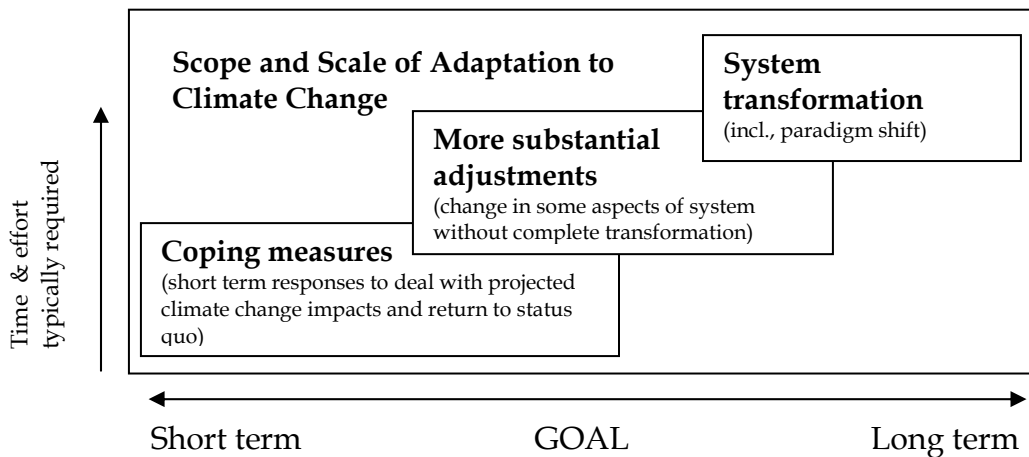


Figure 1. Scope and scale of adaptation to climate change (Based on the authors’ literature review, especially Dovers 2009; Kates et al. 1985; Olsson et al. 2006; Post and Altman 1994)

The primary focus in this report is on the intentional, planned adaptation process without presuming a particular set of actors, level of planning and decision-making, or involvement of government. However, the authors attempt to account for the complexity of a more involved process here. The approach is also not a priori normative about the right scale or scope of adaptation , i.e., assuming that actions taken in pursuit of shorter-term and maybe shallower

goals are necessarily less worthy. Success in the near-term may well turn out to be “maladaptive” in the long run, and vice versa. It should be expected, however, that choosing a particular scope and scale of adaptation has significant implications for the number and types of barriers activated and encountered by choosing different adaptation actions or pathways. System transformations will require different and likely more challenging barriers to be overcome than planning or implementing immediate measures to cope with a climate-driven disaster.

2.2 Defining Barriers to Adaptation

In addition to defining the scope of adaptation, a definition must be presented of what a barrier is. Researchers often use the concepts of barriers and limits together, even interchangeably, while others distinguish between them. Here, as is consistent with the IPCC (2007), “barriers” to adaptation are defined as distinct from “limits,” although the line between them may be blurry. *Limits* constitute thresholds beyond which existing activities, land uses, ecosystems, species, sustenance, or system states cannot be maintained, not even in a modified fashion. Beyond such limits looms irreversible loss (and the adjustment to living with that loss), radical system shifts, including – maybe – innovation and novelty. Limits are common in physical and ecological systems in their natural state, but in some instances physical and ecological limits have been stretched or overcome with technological innovations (e.g., genetic modification of crops to increase heat tolerance). These seeming limits would be viewed as barriers in this report.

Barriers are obstacles that can be overcome with concerted effort, creative management, change of thinking, prioritization and related shifts in resources, land uses, institutions, etc. As Adger et al. (2009) convincingly argue, many seeming social limits are, in fact, malleable barriers; they can be overcome with sufficient political will, social support, resources, and effort. However, many barriers will make adaptation less efficient or less effective, or require costly changes that lead to missed opportunities or higher costs. In many instances the barrier may *appear* to individuals participating in the adaptation process as *de facto* limits (e.g. a law). Not questioning the changeability of such barriers (however difficult to overcome) may itself be an obstacle to progressing in the adaptation process.

Importantly, the authors do not view or present these barriers through a normative lens, i.e., no value judgment is attached to an obstacle and declaring it as “good” or “bad”. Rather, the authors of this report take a descriptive approach where barriers are those thresholds or impediments that can stop, delay, or divert the adaptation process. By implication, the authors do not claim that overcoming all barriers leads necessarily to a successful outcome (however defined and by whom). Differently put, a hypothetical smooth, barrier-free process is not a sufficient condition to guarantee a positive outcome. In turn, not even the best run process should be expected to be free of barriers, and its outcomes may still require adjustments in the next iteration. Over an infinite number of such iterations through the adaptation process, however, one might find that ignoring certain best practices (such as effective stakeholder involvement, consensus or broad agreement if and when it is required, adequate information, considering both biophysical and social dimensions of the problems, adequate funding and so

on) could eventually lead to maladaptation. Having defined the focus of, and terms used in, this report, the next section lays out some principles that guide the development of the diagnostic framework.

Chapter 3: Principles Guiding the Development of a Diagnostic Framework

The diagnostic framework of adaptation barriers is guided by a number of basic recognitions or principles that are derived from the above-stated definition of adaptation and reflect the bodies of literature drawn on for this report. They represent inevitable dialectical tensions in the adaptation process, one which a diagnostic framework of adaptation barriers must be able to capture. The authors thus aim for a framework that is:

- Socially focused but ecologically-constrained.
- Actor-centric but context-aware.
- Process-focused but action/outcome-oriented.
- Realistically iterative and messy but linear for convenience.

Socially focused but ecologically-constrained. The researchers' primary focus is the social sphere because this report specifically concentrates on planned adaptation. This focus means the framework centers on actors who are not just autonomously reacting to a changing environment, but who are perceiving, thinking, feeling, planning, deciding, governing, guiding, facilitating, acting, authorizing, financing, implementing, making or changing policies and laws, leading, communicating, linking, blocking, rejecting, arguing, disagreeing etc. This social focus notwithstanding, the authors of this report recognize that all human systems are embedded in and interact with biophysical systems (i.e., social-ecological system, coupled human-natural systems), or else they would not require adaptation to a changing climate (Folke et al. 2002; Kasperson, Kasperson, and Turner 2009; Liu et al. 2007; Turner et al. 2003; Young et al. 2006).

Actor-centric but context-aware. The framework is explicitly actor-centric and assumes that the adaptation process typically involves multiple actors. Actors, however, are always embedded in a social, cultural, institutional, technological, natural, and economic context that enables and constrains the action space they have; in turn, actors are able to change the context in which they move (Giddens 1984). These contextual aspects will feature strongly in the diagnostic framework, but in what ways and how much they matter, to which actors, and for which adaptation strategies will be situation-specific. The presence of multiple actors involved in the adaptation planning and implementation process points to the notion of "governance," which implies that determining a course of action is no longer considered simply the purview of formal governments, but a multi-actor, multi-sectoral undertaking (Brown and Schmidt 2009; Moser 2009c). The delineation of what is the governance space and what is "larger context" is a matter of perspective and may itself be dynamic over the course of an adaptation process. The absence or presence of specific actors from multiple levels of governance can result in barriers or help overcome them; and what appears as a barrier to any one actor may differ depending on the top-down or bottom-up perspective taken (Urwin and Jordan 2008).

Process-focused, but action/outcome-oriented. The framework presented in this report emphasizes a variety of processes of interaction among the actors involved in adaptation, including processes of communication, analysis, decision-making, policy-making, resource allocation, implementation, etc. This focus on the dynamic nature of adaptation reflects the reality that adaptation to a continually changing situation (climatic, environmental, and/or social) is never just done once and then complete. It requires iteration. At the same time, the authors realize that actors make consequential decisions at some point, even if they have to return to them at a later point in time. Thus, the framework will need to balance attention to process with attention to decision, actions, and outcomes.

Iterative and messy but linear for convenience. Finally, the authors realize that a logically structured framework is always more static, simpler, and “cleaner” than the messy, iterative, partial or incomplete equivalents in reality they try to represent. Therein lies the perpetual tension between normative and descriptive models (incl. the inevitable reductionism involved in ideal representations of processes) (Mintzberg, Raisinghani, and Theoret 1976, Lindblom 1959). Few processes in reality ever follow a formulaic and complete sequence of steps. At the same time, and by necessity, the framework here must bring some semblance of order and recognition to an unwieldy and sometimes hidden reality. Thus, the authors are aware that a framework always imposes more order than exists in reality. Describing processes and the barriers that may arise in them thus is only linear for the convenience of writing.

Chapter 4:

Toward a Diagnostic Framework for Identifying Adaptation Barriers: Fundamental Architecture

Having defined the underlying concepts and principles, including some of the inevitable challenges in representing them in a comprehensive framework, the report next builds the fundamental architecture. The first basic component of the framework is procedural (Section 4.1), the second structural (Section 4.2).

4.1 The Process of Planned Adaptation

First, the process of adaptation provides the foundation for identifying and organizing the barriers. Planned adaptation, by definition, is a deliberate process that has an identifiable beginning and an end, if a temporary one. The process quite likely is ongoing and messy, but at various points, one should be able to distinguish different phases or stages. To avoid an overly linear conceptualization, some scholars have also referred to these “stages” as processes, routines, or tasks. In the decision, policy, organizational, and risk management sciences, various depictions of these stages or phases are common, and while different in detail, they resemble each other in fundamental ways (Bazerman and Moore 2009; Clark 2002; Frederickson 1986; Mintzberg, Raisinghani, and Theoret 1976; Mitchell et al. 2006; Renn 2008). Klein, Nicholls, and Mimura (1999) have adopted these stage depictions for the adaptation process, including: 1. Information collecting and awareness, 2. Planning and design, 3. Implementation, and 4. Monitoring and evaluation.

The framework presented here collapses Klein et al.’s four phases of the adaptation process into three major elements – understanding, planning, and managing – and identify distinct subprocesses within each (for a total of nine stages). This permits the systematic identification of potential barriers that may arise at different moments in the process. The barriers may impede progress from one stage to another or –if stages and the issues that arise in each are skipped (as can be the case in real-world decision-making) – may result in problems or unintended consequences later. The element of understanding involves (1) problem detection and awareness raising (the actor receives a signal and detects a problem, developing an initial framing of the problem); (2) information gathering; and (3) problem definition (characterizing it based on her or other participants’ pre-existing knowledge, values, beliefs, and experience). The element of planning involves (4) development of adaptation options; (5) assessment of options (to inform the selection process); and (6) selection of option(s). The element of management involves (7) implementation; (8) monitoring; and (9) evaluation. Monitoring and evaluation stages are critical to an adaptive management approach in that they can help support institutional and social learning (Lee 1993), which is necessary to deal with complex and uncertain problems (Gunderson and Holling 2002). The order of these steps may not be as linear and neat as this listing or Figure 2 suggests. Mintzberg et al. (1976) convincingly showed how reality differs from conventional, normative models of decision-making. For the purposes here, however, the process stages provide a useful ordering heuristic.

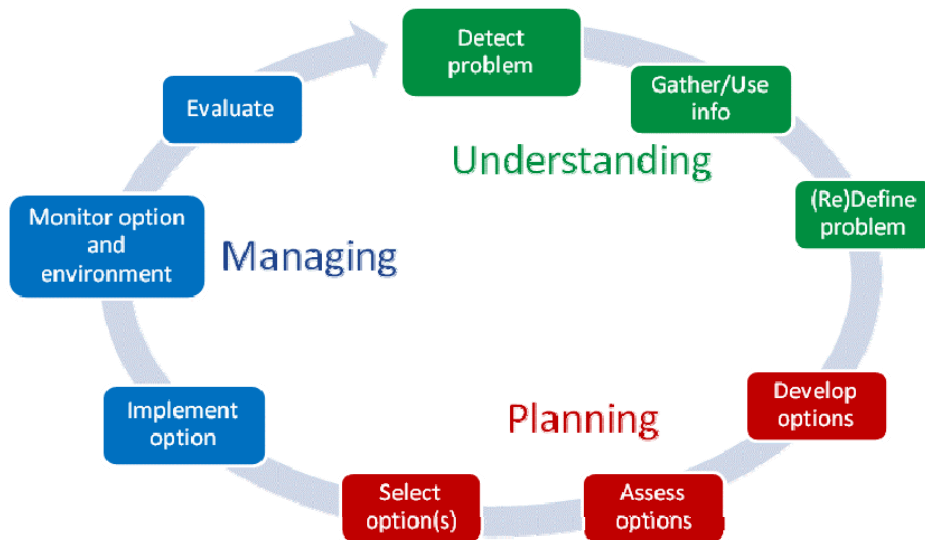


Figure 2. Schematic of phases and subprocesses common in the adaptation process

In the following section, the structural elements of adaptation are presented.

4.2 Structural Elements of Adaptation

Building on a framework proposed for the analysis of social-ecological systems (Anderies, Janssen, and Ostrom 2004; Ostrom 2007, 2009), the authors consider three interconnected pieces of the puzzle to fully understand an adaptation situation: the actors (not a static, but often wide-ranging and dynamic set over time), the larger context in which they act, and the object upon which they act (i.e., the specific coupled human-natural system of concern to be managed or altered). The authors are not only interested, say, in a coastal waterfront (the system of concern) that has to be better protected against sea-level rise. Rather, the framework is designed also to consider how the actors themselves who manage that waterfront have to change (e.g., their perceptions of or thinking about the environment or about coastal protection, their use of information, their decisions, and their interactions with other departments, agencies, and other levels of government). Finally, the greater context in which both the actor and the system of interest are embedded provides the enabling and constraining contextual conditions that shape adaptive actions (Figure 3). For example, the actors may only make these changes if the governance context in which they act also changes (e.g., shaping what is legal or politically feasible, which decision protocols to use, or the timing of certain opportunities to make changes in budgeting, planning, or infrastructure replacement schedules). Barriers may arise in any or all three of the components.

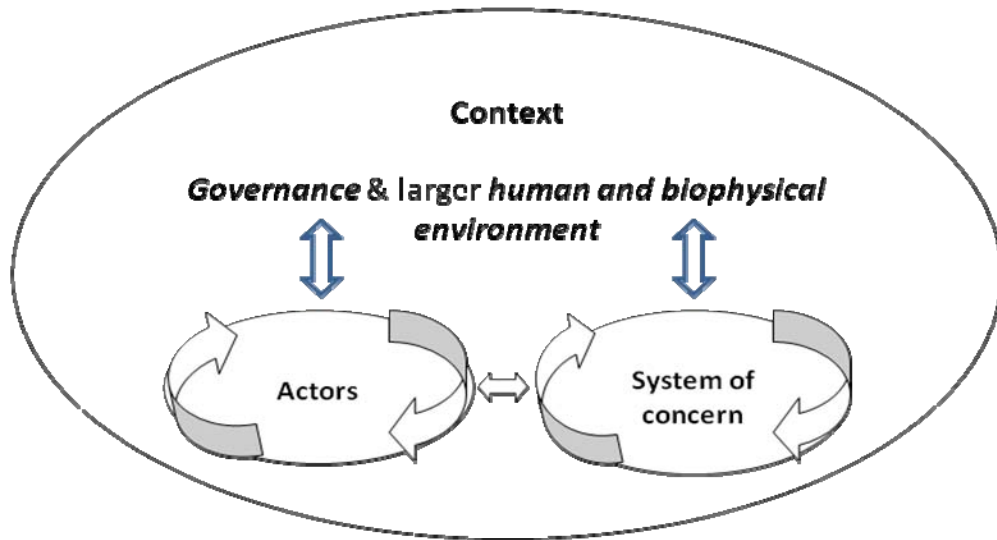


Figure 3. Interaction of actors, the governance and larger socio-economic context, and the system of concern that is to be managed.

In many instances it will be useful and necessary to distinguish the more immediate institutional, legal, social, political, or fiscal factors shaping the governance context of the actors from the larger economic, social, technological, or cultural context in which actors act and resources, sectors, or human systems get managed. There is no hard and fast rule, however, as to where to draw the line between the more immediate and the larger context. For example, the strong actor focus of the framework makes issues that are deeply culturally and socio-economically influenced—such as values, beliefs, perceptions, and attitudes—central. These issues are clearly part of the governance space but also stem from the larger context. Thus, drawing a clear line between governance and wider context may be less important than recognizing the importance of culture’s influence on the adaptation planning and implementation process.

Typically, the governance context already exists when an adaptation planning process is initiated, but one (interim) outcome of an adaptation process may be to change the governance system if it is viewed as too rigid or restrictive. It critically shapes the interactions among the actors, those between the actors and the system they manage and affect, and between them and the larger context (Berkes 2002; Cash et al. 2006; Gupta 2008; McCay 2002; North 1990; Ostrom 1990, 2005; Young 1999, 2002). Governance is defined here as the set of decisions, processes, institutional structures, and mechanisms, including the division of authority and underlying norms, involved in determining a course of action (adapted from Moser 2009c, p.315). Box 4.1 gives a simple, but illustrative (and entertaining) depiction of the architecture.

Box 4.1. *The Little Prince* and Adaptation on “Asteroid B-612”

A very simple case serves to illustrate the fundamental architecture just introduced: *The Little Prince*. Imagine the climate were expected to change on the Little Prince’s home “planet”, Asteroid B-612 (Saint-Exupéry 2000 [1943]). The sole *actor* having control over the question of how to adapt is the Little Prince. The *system of concern*, of course, is his beloved flower. Climate change may raise threats such as whether there will continue to be enough water to irrigate it, or whether the changed climate will favor “bad plants,” like the baobabs, or grasses that will allow the sheep to multiply and increase the grazing pressure. Aside from contextual issues like the active volcanoes that modify the local climate, the *governance system* guiding the Little Prince’s choices are solely the rules and norms he made up in his head about how to run his little planet.

Barriers may arise from all three components described above. The next section presents how to diagnose the barriers using both the stages of the process and the structural elements presented above.

Chapter 5: Diagnosing Barriers to Adaptation

To diagnose the barriers specific and relevant to each stage in the adaptation process, there are two fundamental questions to ask. The first pertains to the process component of the framework (See Figure 2), the second to the structural components of it (Figure 3):

- What can stop, delay, divert the process? (or: At every stage in the process, what can prevent the adaptation process from proceeding?)
- What causes the impediments? (or: How do the actors, context [governance and otherwise], and the system of concern contribute to those impediments?)

In the sections that follow (5.1 through 5.9), these questions are used to identify impediments repeatedly identified in the literature.

5.1 Understanding the Problem

The first major phase of the adaptation process involves various sub-processes that shape the understanding of the problem or change one has to deal with or adapt to Figure 4. They include (1) the detection of the potential problem and initial framing, (2) gathering more information about the potential problem to improve understanding, and (3) a refined (e.g., narrower or broader, deeper or more complex) problem definition. In each of these stages, barriers may arise that impede progression to the next stage of the adaptation process or – if stages and the issues that arise in each are skipped, this may cause problems later.

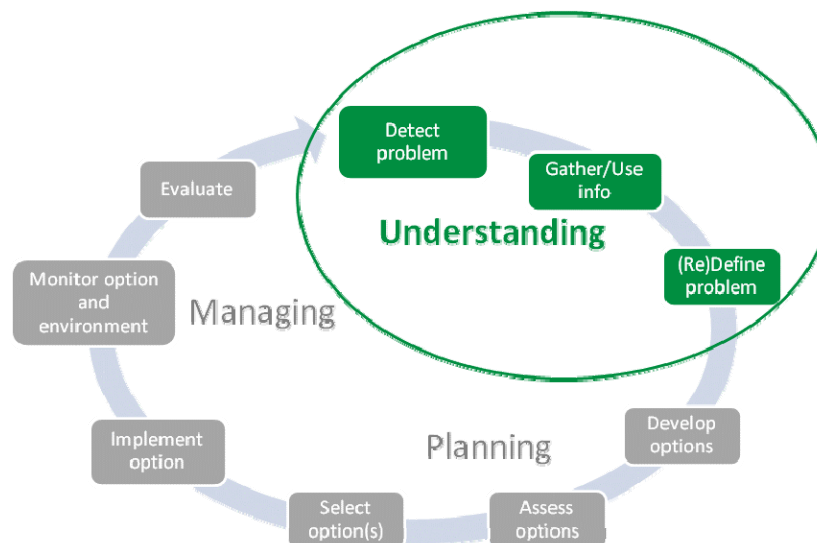


Figure 4. The first phase of the adaptation process is ‘Understanding,’ which includes three stages of detecting the problem, gathering and using information, and defining (or redefining) the problem.

5.1.1 Problem Detection and Initial Framing

Initiation of an adaptation process begins with the existence of a signal indicating some type of change and/or potential problem.¹ The signal could manifest in a variety of ways, such as through a disaster (e.g. Hurricane Katrina) where the media portrays the event as connected to climate change, through a public awareness campaign, scientific findings, or projections foretelling certain future conditions such as sea-level rise or snow pack decreases (or a synthesis of science, such as the IPCC), or a high-level political statement or even policy change. If a signal exists or is sent out, the next critical threshold to overcome is its detection or perception by individuals or a community of interest. Leaders tend to be critically important at this stage, or differently put, those who perceive the signal may take on leadership roles in initiating an adaptation process. Third, the signal must rise above a threshold of concern for recipients, i.e., they must come to an initial framing of the detected issue as a problem. And finally, recipients of the signal who interpret it as indicative of a problem must come to believe that a response is needed and – at least in principle – feasible, i.e., they must have at least a quick and intuitive response-framing that suggests action rather than inaction (Box 5.1).

Box 5.1: Key Barriers in the Problem Detection and Initial Framing Phase

- i. Existence of a signal
- ii. Detection (and perception) of a signal
- iii. Threshold of concern (initial framing as problem)
- iv. Threshold of response need and feasibility (initial framing of response)

The sources or causes for the existence of these thresholds can arise from the actor, the governance system and larger context affecting signals and their interpretation, and from the target system itself. Each is discussed in turn, and a succinct listing of diagnostic questions is provided in the Appendix to this paper (Section 9).

ACTOR

The first question to answer is “Does the actor receive and detect (recognize or perceive) a signal?” There is a variety of actor-specific reasons why the signal may not be received, for example that an actor’s mental model does not allow detection or filters out the signal; the individual is too busy or distracted to notice the signal, the actor is too distant from the signal, to notice it.

In cases where the signal reaches the actor, the actor may or may not act on it, which raises the question: “How does the actor interpret the signal and initially frame the issue?” Cognitive biases and pre-existing mental models of those receiving the signal shape how the problem is

¹ At this point in the process, the authors remain neutral and speak of something signaling a “change” or “potential problem,” as it is the endpoint of this subprocess to recognize something as potentially problematic, i.e., as worrisome enough to warrant further investigation. Over the course of the processes involved in the “Understanding” phase, a framing will emerge that defines the nature and extent of the “problem,” or alternatively dismisses the signal as insignificant.

initially perceived and interpreted (Kahan and Braman 2006; Kahan et al. 2007). Generally, direct personal experience will tend to give the signal greater weight, than mere cognitive processing of a communicated signal or risk (Weber 2006). If the signal is not viewed as a problem and something to be concerned about, then the process stops here until this threshold is surpassed.

Once this threshold of concern is overcome, the next actor-based question is: “Does the actor view responding to the problem of concern as necessary and feasible?” In cases in which the signal produces a severe sense of threat or fear but individuals don’t have a sense that they can do anything about that threat, actors are likely to deny or reject the signal (Moser 2007b; Norgaard 2006; O’Neill and Nicholson-Cole 2009). For example, an actor may interpret the signal as worthy of concern and feasible action, but not be in a position of power, authority, or have the capability to further investigate the signal. Alternatively, that actor may receive the signal, not feel like she is the right person to address the issue further, but choose to inform those in power about the need to add it to the organization’s priorities. If the actor does not transcend the need/feasibility threshold in any way, the process will not progress further.

GOVERNANCE AND CONTEXT

Institutions – both formal and informal and at all levels – tend to be path-dependent and “sticky,” meaning that they can be difficult to alter (North 1990). Therefore, it is critical to understand the governance landscape in which the actor and adaptation target exist and how it influences the detection of a problem and its initial framing. The larger context e.g., the communication means and networks that are fundamental to the detection and transmission of signals, can also create barriers at this stage. For example, to diagnose whether governance-related barriers to problem detection and framing exist, one may ask: “Does the governance system in any way prevent the signal from being detected and sent out to the public or certain stakeholders?” This could occur, for example, if research is not supported that could identify a problem. Similarly, signal detection by the public may not occur if the media and/or government fail to report on scientific discoveries or studies that could send a signal out to the wider public. Next, one may ask: “Does the governance system fail to transmit a signal or prevent it from reaching individuals?” Transmission could fail because of the absence of social or professional networks through which concerns may be shared, or because the social norms and relationships in those networks, institutional disconnects, or the degree and nature of science communication with the public or certain populations result in blocking further transmission (Pahl-Wostl 2009; Vogel et al. 2007, Wolf et al. 2010). Maybe public outreach programs are not tailored effectively to reach specific audiences (Dunwoody 2007; Moser and Dilling 2007; O’Neill and Hulme 2009).

Delivery (by whom and how) strongly affects how signals are received. One must investigate “how is the signal delivered and by whom?” The more direct transmission (i.e. face-to-face or through direct experience) tends to be more believable and impactful and create more opportunities for dialogue (e.g. Podestá et al. 2002; Moser 2006) By contrast, vicarious experience and indirect or mediated communication through other individuals or the mass media tend to have lower signaling strength (O’Neill and Hulme 2009). The source and the

recipient's trust in the source of the signal become crucial (National Research Council 2009a; Patt and Gwata 2002; Chess and Johnson 2007). When the signal comes from a trusted source, this can lead to engagement rather than dismissal of the signal (Dunwoody 2007, Moser and Dilling, forthcoming).

Another governance- and context-related question one may ask is: "Do leaders, norms, or institutions dismiss the issue as not a problem?" For example, lay audiences may dismiss a problem if they do not see their political leaders taking it seriously (Berkhout, Hertin, and Gann 2006; Stehr and Storch 1995). And finally, "Do laws, policies, and social norms (or the perception of these norms) support or prevent taking a problem seriously and responding to it?" For example, government staff may not have a mandate to take on certain novel problems, and so even though staff members detected a problem and think it is serious enough to warrant action, they don't have the authority (and related resources and time) to do so. Or, if an actor is surrounded by a conservative community in which innovation is not embraced, taking further steps to investigate a detected problem and initiating an adaptation process may be stifled.

SYSTEM OF CONCERN

Whether or not a signal is detected and how it is interpreted also depends on the target system. Here one must first establish "Does a signal exist and what does it mean?" The emergence of a clear signal may be hindered by the fact that there is significant variability in the system (e.g., interannual rainfall variability, multi decadal variability underlying hurricane frequency and intensity) and/or the degree of complexity driving the dynamics of a system (e.g., various causes underlying economic growth or decline, hunger, poverty, or land cover change). A slowly emerging problem ("creeping" problem) (Glantz, 1999), long time lags, and feedbacks may also prevent the emergence or detection of a signal (e.g., the rate of sea-level rise in response to thermal expansion of the oceans and ice sheet loss). Finally, uncertainty in or ignorance about what is actually happening (e.g., because of data gaps, stochasticity, or lack of fundamental understanding) may not allow researchers to say whether or not anything unusual is occurring. A good example is the search for indicators of when a system may be nearing (or have crossed) a tipping point (Brock, Carpenter, and Scheffer 2008; Dakos et al. 2008). Lack of understanding may also be a principal cause behind not being able to interpret a signal's meaning, to spell out its implications, and hence to establish the appropriate sense of urgency, caution, or ease. If there is no signal emerging from a system or data remain obscure and meaningless, there is no reason to begin worrying. An adaptation process will not be initiated.

A second system-specific diagnostic question should focus on the signal itself. "What is the nature of the signal?" Certain signal characteristics (severity, duration, intensity, pace of onset, or rate of change etc.) have led to well-established differences in lay and expert perceptions and assessments of which risks warrant attention and which do not (Dessai et al. 2004; Weber 2006). Next, "How is or can the signal be identified, seen or experienced?" The signal may be clearly visible and experienced by many, or it may be more obscure and accessible only via scientific research. Moreover, the signal may stem from an event or process occurring at present, it can be established empirically as having occurred in the past, or it may be based on an expectation about the future (e.g., a theory- or model-based projection of climate change impacts). A signal

thus may come in the form of extreme events associated with climate change (such as heat waves, droughts, flooding, or storms), as studies documenting ecological changes, or as scientific projections. Typically, these signals are amplified or attenuated through the media or intra- and inter community sharing of concerns (Hulme 2009; Pidgeon, Kasperson, and Slovic 2003; Wilson 1995). Thus, many climate change signals come to people's attention as news clips of scientific discoveries, assessment reports or high-level political conferences, as a neighbor's story, or a colleague's concern.

These differences affect the strength of the signal and its emotional and cognitive impact on actors who may perceive and need to make sense of them. For example, if the signal is the result of direct experience, those having experienced it directly (and their loved ones) will have the strongest reaction for wanting to take action (though, not necessarily the power); whereas if the signal is experienced only vicariously, the actors are likely to have less of a sense of urgency for the need to act (Marx et al. 2007). In the absence of already very powerfully apparent impacts of climate change in most mid-latitudinal regions, visualizations of potential futures have been shown to be powerful means of communication. They can bridge some of the distance between obscure scientific projections and lived experience, raise awareness, concern, and understanding of the issues, and enhance the desire to act, even prior to the actual experience of an impact (Sheppard 2005). Maps of projected sea-level rise impacts on specific regions (e.g., the San Francisco Bay area, New York, or Atlantic City) have also served as powerful signals to the public and decision-makers (Frumhoff et al. 2007; San Francisco Bay Conservation and Development Commission 2009a).

The target system and the signals it sends also influence the initial problem definition or framing. Thus one may ask: "Is the issue/problem novel or familiar?" If the signal indicates a disturbance or problem that is already known, familiar, or maybe a priority for actors, then its increasing severity may fit well within policies and action agendas, such as drought problems in Southern Australia (Lynch et al. 2009). If the questions "are there logical actors to take on the detected problem?" and "are there already agreed upon ways of dealing with the detected problem?" can be answered (even just intuitively) in the affirmative, then the adaptation process may proceed, as the response need and feasibility threshold has been crossed. By contrast, even in cases where actors believe in the severity of a detected problem and understand it intuitively or superficially, it still may be difficult to move forward with the adaptation process because of the lack of prior experience and lack of clear authority or institutional responsibility in dealing with the problem (Moser 2009c).

5.1.2 Information Gathering and Use

Assuming that the barriers in the first stage of problem detection and initial framing have been successfully overcome, the adaptation process can continue. In reality the next step could involve jumping to any of the stages in Figure 2. However, in the idealized rational decision-making model presented in Figure 2 (for purposes of organization) the next stage involves a deepening of the understanding through gathering more information about it. In the vast majority of cases, more detailed, more locally specific, and additional or different kinds of

information are needed than what first raised one's awareness of a potential problem. In this second stage, eight fundamental barriers are repeatedly mentioned in the literature that could derail, delay, or interrupt the adaptation process (Box 5.2). In some instances they are objectively about the information per se, whereas in other instances they represent interrelated characteristics of the information and the user. Below, the sources and reasons are discussed for each as they relate to the actor, governance and context, and target system.

Box 5.2: Key Barriers in the Information Gathering and Use Phase

- i. Interest and Focus (or consensus on these)
- ii. Availability
- iii. Accessibility
- iv. Salience/Relevance
- v. Credibility and Trust
- vi. Legitimacy
- vii. Receptivity to Information
- viii. Willingness and Ability to Use

ACTOR

The first overarching question in this process to help illuminate potential obstacles is: "What values, perceptions, and beliefs, direct what information should be collected?" The answers to this question make explicit why certain information is deemed interesting, important and sought after while other types are not, and also why subsequent stages go in the direction that they do. By itself, the answer to this question does not yield a barrier, but channels the actor's interest and focus. However, the selective choices made right at the outset of this stage may well produce barriers for subsequent stages of the process. Narrow interests may produce narrow problem definitions and thus influence the range of adaptation options assessed. As O'Brien et al. (2006, p.50) found in their analysis of Norwegian adaptation efforts, "a sectoral or narrow investigation of impacts perpetuates complacency by failing to capture critical aspects of climate change impacts and adaptation." In addition to causing complacency, a limited problem investigation can lead to ill-defined problems (e.g., too broad or too narrow), which might lead actors down a path of inadequate adaptation. If this is a multi-actor process, "Is there agreement about what information should be gathered and analyzed?" If there is no agreement, this indicates that a divergence or conflict in values exists between multiple actors within a single process. This lack of agreement can stall the current process or if not dealt with directly here will likely cause problems in later stages (that may arise in establishing criteria for developing, assessing, and selecting options) (van der Brugge and van Raak 2007). Given that the implications of these early choices may result in challenges much further down the path of adaptation, the impediments resulting from the chosen focus are particularly difficult to identify because it may require questioning long-established practices as well as paradigms of the actor(s) (Meadows 1999).

Once an interest in certain kinds of information has been established, the next logical questions are “Does the desired information exist?” and “Is it accessible?” To the extent the answers depend on the actor’s level of education and training, these questions are actor-dependent. In many instances to date, decision-makers come up wanting in search of what they need or wish to have, especially for highly spatially resolved data and information for their sectors or locations of interest (National Research Council 2009a). Next, those seeking to learn more about the issue of interest may ask: “Is the information salient or relevant to better understanding and solving the problem?” “Is it reliable, credible and from trusted sources?” And “Has it been produced and vetted in a legitimate manner?” (Cash et al. 2003; Mitchell et al. 2006). These views are not inherent to the information, but attributions made of the information by the actor. As such they are shaped by the recipient’s values (Lorenzoni, Nicholson-Cole, and Whitmarsh 2007), attitudes (Post and Altman 1994), pre-existing beliefs, experiences, initial perception of the problem, and degree of trust in information sources (National Research Council 2009a; Lorenzoni, Nicholson-Cole, and Whitmarsh 2007; Mitchell et al. 2006)

In cases where information exists and is accessible, one may also ask: “Are the recipients of information receptive to the information?” For example, if actors do not view the information as credible or do not trust the source, they are less likely to be willing to use it. Or: even if it is salient, recipients may question the legitimacy and thus justify not using certain information. Particular pre determined outcomes or political leanings may result in a lack of willingness to accept and use information, even if the actor admits to the information’s salience, credibility and legitimacy. Finally, the available information may vary in sophistication. High sophistication may contribute to its inaccessibility to different users. Thus, one should also ask: “Do potential recipients have the understanding and ability to make sense and appropriate use of the information?”

GOVERNANCE AND CONTEXT

The governance and larger context can equally contribute to the eight identified barriers in this stage. First, particular organizations (including government agencies) may have a legally or mission-defined focus and familiarity with certain types of questions and information but lack interest in, familiarity with, or a charge to explore relevant other types. Thus actors within these organizations may not see the need or have the capacity to ask for, understand, or critically analyze, question, and evaluate other, less familiar types of information. This is the oft-deplored “lack of a mail box” problem, for example, for the social sciences in the federal government, especially in agencies involved in the U.S. Global Change Research Program (NRC 2009a, 2009b). One must therefore ask: “In what ways does the governance system restrict interest and focus in the issue to be explored?” A related question, but one more relevant to the barrier of willingness and ability to use certain types of information, is: “What kind of information can be used in existing policy and decision-making processes?” An answer to this question can help expose whether there are existing institutions (common practices to formal laws) that prefer or exclude certain types of information from being used in decision-making and management. Both laws and common practices (and actors’ preferences) can dictate the source and type of information that may be included in deepening problem understanding and – later on – in decision making. For example, traditional and other experienced-based environmental

knowledge has only recently begun to be incorporated in science-based management, and still this is not commonly accepted (Berkes 2008; Stevens 1996; Moller et al. 2004; Bergmann et al. 2004; Mackinson 2001; Johannes, Freeman, and Hamilton 2008; St. Martin et al. 2007). Even when the needed information is acceptable for decision-making processes, “Is the information compatible with existing decision-making (e.g. policy, mental/individual) processes and models?” (Jones, Fischhoff, and Lach 1999). In some cases, the delivery format of information can be distributed in a way that is compatible with existing decision-making models (See Patt 2006 for examples of formats useful at individual and community levels.); in other cases the extant processes and models themselves need to be changed so they can receive these new types of information (Rayner, Lach, Ingram 2005).

The next question is: “How does the governance system influence whether information is salient, credible, and legitimate?” For example, does the government or other funding institutions support research that produces information relevant to the problem and community at hand- such as model projections produced at the appropriate resolution or social data relating to the vulnerability of the region, sector, or community of interest at a fine enough scale? If the information is produced as part of a regional or national assessment, is the process conducted in a manner that potential information users find legitimately represents all relevant interests? (Moser 2005a). Or, has the available information been adequately peer-reviewed? If information must be produced (rather than gathered from an established source), how was the creation of information overseen to make sure it is credible? All these issues – typically determined by the rules and procedures that govern research and assessments – can affect how potential users of the resulting information perceive it (Mitchell et al. 2006). If stakeholders find fault with them, they may consider the information inadequate or illegitimate and thus discredit it.

The governance system may also constrict the accessibility of the information: “In what ways do formal or informal institutions (e.g., laws and/or property rights) prevent actors from accessing needed information?” (Clark et al. 2002). Some types of information are not publicly accessible (such as information collected and maintained by private businesses); others may be generally available but not accessible at the resolution needed (e.g. high-resolution data from the Census may be protected by law for privacy protections) (National Research Council 2009a). Recognizing the importance and challenge of accessing information for climate change adaptation, the European Union plans to establish the Clearing House Mechanism as an information technology tool to help link climate impact, socioeconomic, and other necessary data across countries to make it more accessible for the region (European Commission 2009). In cases where information is accessible, “Is there sufficient time and expertise available to access, become familiar with, analyze, evaluate, and use it?” If not, even the most relevant information may not be used for the purposes at hand.

SYSTEM OF CONCERN

The first question one can ask to identify potential information-related barriers arising from the system of concern is: “Has the system been a problem or the focus of research previously?” If the system of concern has experienced a problem previously (e.g. flooding from storm surge in

a low-lying coastal community), then some relevant experience and maybe documented information exists. Some systems may not have experienced the same problem before but have been the target of research (e.g., pristine conservation areas), which may be useful for the new purposes at hand. If the system is not understood and or the problem is completely novel, there may be no knowledge to gather and synthesize.

If data and information about the system of concern do exist, one might ask next: “How well is the system understood?” or “How much uncertainty is there about how climate change will affect the system?” There are different ways that uncertainty can interfere with an adaptation process (Edwards et al. 2007; Hallegate 2009; Moser 2005a). In some cases, the perceived need for more certain data about exactly which effects climate change will bring may serve as a barrier to adaptation (Dessai et al. 2009), while other initiatives have overcome this obstacle by recognizing the need to manage for an uncertain future (Lempert, Popper, and Bankes 2003; West et al. 2009). In other words, uncertainty about the system of concern can undermine the issue’s saliency and ultimately reduce actors’ receptivity of and willingness to use information. When the desired information about the system cannot be attained, actors tend to choose one of several tactics: (1) inaction until information with greater certainty exists; (2) shift in the initial problem framing as one about the lack of information (therefore requiring investment in further research); (3) focus on just that aspect of the problem that is better understood; or (4) developing robust options based on a (range of) agreed-upon scenarios.

5.1.3 Problem (Re)definition

In an ideal-case process, if the barriers in the second stage of information gathering and use have been successfully overcome, the adaptation process proceeds to the point where the problem is more fully defined or redefined and reframed. The issue first discovered and named in Stage 1 has become more fully understood through the processes of gathering information, analyzing, and synthesizing in Stage 2. The information gathering in Stage 2 has revealed more or deeper dimensions of the problem and has helped to clarify what part of the problem the actor is willing and able to address. Thus the problem redefinition and reframing are strategic problems to position the actor appropriately to begin the exploration of responses. Not surprisingly, some of the barriers that can delay or interfere with the adaptation process at this third stage are similar to those encountered in Stage 1, albeit after considerably more deliberation (Box 5.3).

Box 5.3: Key Barriers in the Problem (Re)Definition Phase

- i. Threshold of concern (reframing of the problem)
- ii. Threshold of response need
- iii. Threshold of response feasibility
- iv. Level of agreement or consensus

ACTOR

The first actor-centric question one may ask about what may prevent this stage from transcending the barriers is: “How do actors now interpret and assess the issue?” As with the initial problem framing, cognitive, psychological, social and other factors shape all aspects of this process, including what information is used to redefine the issue and what pre-existing beliefs, values, and norms set the foundation for whether and how the risk is interpreted and the problem gets reframed. Examples of such problem framings may include adaptation as climate-resilient disaster preparedness (e.g., Allen 2006; Collier et al. 2008; Keim 2008) or as “climate-proofing” development (e.g., Boer 2008; Bouwer and Aerts 2006; Kabat et al. 2005), or as a more fundamental transformation of human-environment interactions. This information and how it is interpreted largely direct whether the actor (i.e., the one who is accountable for the adaptation process) surpasses a threshold of concern for taking action. These cognitive factors can stall or stop a process but are surmountable if the participants are willing to question the nature of these influences through an evaluation of perceptions of the stakeholders (and wider public, if needed). Another aspect that may influence both the level of concern and the perceived need or feasibility of a response concerns the actors involved in this redefinition process: “Are there any new players involved in this stage of the process?” Players who have not participated previously in this or related processes can provide fresh insights and innovative ideas for defining the problem (van der Brugge and van Raak 2007). At the same time, including new players can create obstacles to defining the problem if they are not trusted by prior participants or if the new ideas and considerations are introduced suddenly or in disenfranchising ways.

A shared definition of the problem is important for planning and management stages, serving as foundation for coordinated, collaborative planning, decision-making, and action (Young 2008). This raises the question: “Is an agreement reached on the problem (re)definition?” If there is no agreement on the problem understanding, then the process ideally must focus (with more time and resources) on achieving agreement about goals and priorities (Daft 2008). How important it is to achieve such agreement or even a consensus or what level of consensus and among which parties is deeply context specific, but may be essential in politically charged or complex-situations. Polarization of attitudes due to different values and interests among groups can prevent agreement for developing a shared problem definition in a way that bridges across the diversity of stakeholder interests (Olsson et al. 2006; National Research Council 2009a). Oftentimes what influences the difficulty of finding a shared problem understanding is that participants already anticipate its impact on developing options (See Stage 4) (e.g., Adger et al. 2009). If they intuit or surmise that their preferred options are not feasible given the problem definition (based on any given factors, i.e. resources, political will, public support, etc.), actors are likely to reject either the entire adaptation process or the problem definition. In such instances one may ask: “How much negotiation or mediation skill is there among participants?” The most constructive and skilled participants in such a discussion negotiate the problem definition until and in such a way that it leads to a broader range of viable options.

GOVERNANCE & CONTEXT

As in Stage 1, the governance system can help or hinder the problem (re)definition from occurring and from leading to the continuation of the adaptation process. “Do leaders, social norms, or institutions dismiss the issue as a problem or support that it is taken seriously?” (Moser 2009c). One of the ways in which governments or other responsible institutions can signal their willingness to take an issue seriously and to develop responses at this stage is by the emergence of a clear leader, someone who makes the adaptation process and its success his or her responsibility. Thus one may ask at this stage, “How do institutions signal (lack of) support for the process?” Allocating resources, providing technical assistance and staff time, and promoting a vision for success (of the process and/or the outcome) can all build momentum needed for later stages. As an outcome of the previous information gathering stage, actors may have determined that the governance system(s) in which the adaptation is embedded have not helped gather or create sufficient needed information. As this lack can severely hinder the process as it continues, support to develop the necessary information is another way in which the governance system can signal the recognition of the problem and the need and feasibility of response.

SYSTEM OF CONCERN

The system of concern is in many ways the main focus of this stage. Compared to the initial concern or problem identified, after the deepening of its understanding in Stage 2, actors may have come to the conclusion that the problem is bigger, smaller, or different than previously thought. Thus the problem identified in the beginning may now be a different one, resulting in the need to involve a different, narrower, or broader set of actors and components of the governance system. Thus the questions are now: “What is included or excluded in the system of concern?” “How broad or narrow is the system that actors will focus on?” and consequently, “What is the nature of the problem to be addressed?” Either too broad or too narrow a problem definition can create impediments that surface in later stages and stall or divert the process (e.g., a problem without a responsible agency) or drive it down a potentially maladaptive pathway. For example, if adaptation is driven exclusively by climate model and impacts projections without adequate consideration of on-the-ground vulnerabilities, scientific uncertainties about climate change may unduly dominate later discussions, intervention options may be missed, and surprises resulting from unanticipated interactions between climate, the environment, and society may undermine effective preparation and contingency planning (Füssel 2008).

The system of concern may vary along several different scales. In terms of the temporal scale, one may ask: “Are the impacts of concern on the target long term and (de facto) irreversible?” And if so, “are there any near-term indications of the problem?” Examples may include indications of a system nearing a tipping point, near- and medium-term projections of sea-level rise (not just for 100 years from now) and so on. The time scale of concern at which the problem is defined has clear implications for problem management: If the problem is defined as one of concern for the next 10 years, versus as one of concern in 30 years, there are clear implications for urgency, and when to begin acting and so on (The Heinz Center 2007; GAO 2009; Stehr 1995). If there is no short-term action implication in the problem definition, it may be difficult

for the actor to exceed the threshold of response need. The spatial scale also requires consideration given that the problem target may span over one or more jurisdictional boundaries. Finally, as in Stage 1, where the question was asked, whether a problem can be seen or experienced directly, the visibility matters in the redefinition stage as well. Whether or not the system (problem) can be directly seen or experienced (e.g., the hydrologic cycle isn't easily seen, subtle ecological changes are not apparent to the lay eye) can be a contributing factor as to why people become concerned, whether resources are allocated to fixing the problem, and whether the political will arises to tackle an issue (Duhigg 2010).

5.2 Planning

In the idealized rational decision-making model, the adaptation process proceeds now to the point where actors enter the adaptation planning phase. This phase proceeds through a stage of developing options, followed by one focused on assessing the options, and finally selecting one (Figure 5).

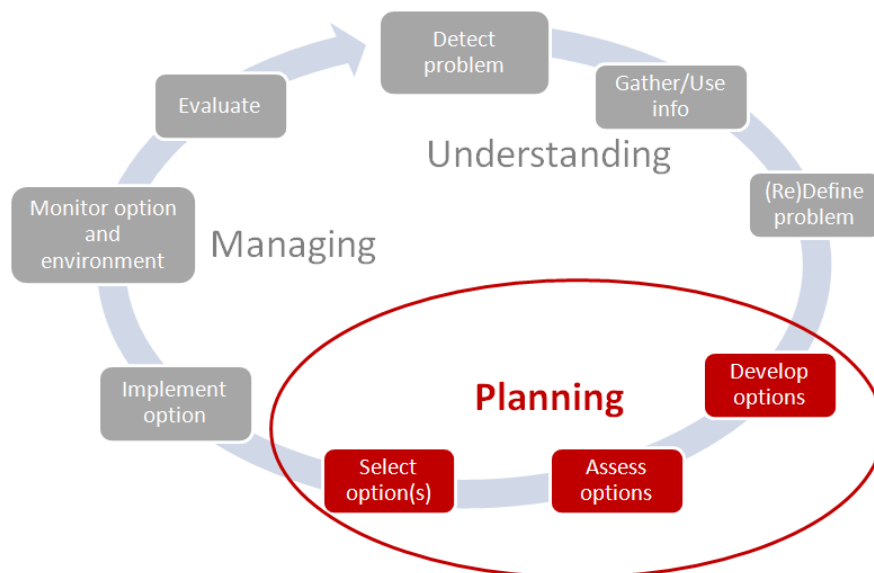


Figure 5. The second phase of the adaptation process is 'Planning,' which involves stages of developing options, assessing the options, and selecting one or more.

5.2.1 Developing Adaptation Options

In this fourth stage in the adaptation process, actors begin to brainstorm response options. In an ideal case process, this initial phase produces a larger set of potential options that are then assessed according to agreed-upon criteria and goals in Stage 5. (See Section 5.2.2 below.) At this stage, the literature on existing adaptation processes reveals six common barriers that can stall, stop, or divert the adaptation process including (1) existence of leadership, authority and skill to guide the process; (2) the ability to identify an appropriate set of goals, (3) the ability and willingness to identify a range of criteria (incl. physical feasibility, environmental soundness,

economic feasibility, and socially, culturally, politically, and legally acceptability etc.); (4) the willingness to develop a range of options that fit the identified goals and criteria, (5) the level of consensus/agreement on goals, evaluation criteria, options; (6) control over the process; and (7) control over the identified options (Box 5.4).

Box 5.4: Key Barriers in the Option Development Phase

- i. Leadership, authority and skill in guiding the process
- ii. Ability to identify and agree on goals
- iii. Ability to identify and agree on a range of criteria
- iv. Ability to develop and agree on a range of options that meet identified goals and criteria
- v. Control over process
- vi. Control over options

ACTOR

In order for actors to be able to brainstorm and develop a range of potential adaptation options (actions and strategies), they first must agree on a particular (set of) goal(s). A goal may emerge rather naturally from the problem definition (e.g., the researchers don't have enough information to understand the problem.... thus, the most immediate goal is to fill the knowledge gaps); in other instances, more explicit attention must be paid to articulating exactly what the adaptation process is meant to achieve. The authors put this important step here under the stage of developing options because options so directly depend on what it is actors want to achieve with them. As is found repeatedly, poorly defined goals can give the false impression of adaptation progress but in reality wasting time and resources (Adger, Arnell, and Tompkins 2005; Davies 1993).

The ability to identify the goals and facilitate the option-development process often hinges critically on leadership. Thus, a first diagnostic question to raise is, "Who is leading the process?" Importantly, the issue with leadership is not merely whether someone has the formal authority, or a designated role, but the skills and ability to lead a process. Other considerations include personal or institutional "baggage" that may make it easier or harder for a person to take a leadership role. This is all the more important, the more novel the problem is, the more complex and politically contentious the process is, and the more actors with different interests are involved. Depending on the leader (personality, credibility, expertise, role in the community and organization, how he/she views the problem, etc.), he or she may serve to facilitate the process and help bring the involved to agreement on the range of goals and options, broaden the scope of options, constrain the process (e.g. by ending it or ranking it as a minimal priority) or prematurely narrow the set of options. The leader and other actors involved must also have the ability and willingness to develop and agree on a set of criteria (at least an initial set, potentially to be refined in Stage 5) by which they will eventually judge the "goodness" of the options they generate. Similarly, they must have the ability to develop and agree on the options that address the defined problem and might meet at least some of the identified criteria (e.g.

cost-effectiveness, fairness, degree of risk or vulnerability). Setting forth a vision and being open to others' visions, the leader here plays a critical role in the process of developing options and achieving agreement over the initial basket of options.

Even when the leader is visionary and connected and the process is transparent, control and authority issues must be considered. Control can imply legislative, decision-making, or behavioral authority, but it can also mean simply influence. For example, even if the public doesn't make policy, the public does have varying levels of influence over policy and decisions by voting, expressing their opinions, actively helping to shape policy by providing stakeholder input and so on (Bachrach and Baratz 1970; Huitema and Meijerink 2010; National Research Council 2008; Few 2007). Similar distinctions can be made between people in formal positions of power and authority (e.g., to approve budgets, make permitting decisions, pass laws) versus people having opportunities to influence and help shape what those decisions may be. Diagnostically, it is important to distinguish control over the process of developing options from control over the options themselves.

Control over the process is important to create transparency, legitimacy, an atmosphere of trust, and sense of empowerment and buy-in (Moser 2009c). Again, an open style of leadership plays an important role in setting the tone and providing meaningful opportunities for participating actors to shape the process. For example, one may ask: "Are the goals made explicit to those involved in developing the options?" This transparency in the process allows for dialogue on adjusting these goals, if necessary, to meet the needs and values of stakeholders, which is especially important for gaining and maintaining trust (Cash et al 2003; Mitchell et al 2006).

Commonly, actors will focus their deliberations on options that are under their control, but may be open in this stage to generating options beyond their immediate control: "Are the developed options within the actor's sphere of influence?" A local jurisdiction (or partnership of jurisdictions) may be limited in what measures it can carry out compared to what a higher level of government may be able to achieve (Moser 2009a; Naess et al. 2005). If the options are not within the actor's sphere of control, then the actor can choose to develop other types of options that are within his/her scope of control or initiate partnerships with other actors that have the more appropriate/fitting jurisdiction, such as with agencies at the same or different level of government representing different sectors or different regions, or agencies at lower or higher levels of government (Berkes 2002; Cash and Moser 2000; Pahl-Wostl 2009).

GOVERNANCE AND CONTEXT

In formal government contexts, in many instances there will already exist a set of rules and procedures for how to go about developing policy, regulatory or project-based options. But often, adaptation begins small and is just an internal and informal process. In the latter cases, formal rules and institutional procedures may be less important than social norms, organizational culture, and informal ad-hoc agreements on procedures. The critical issue here is to identify in what ways these formal and informal governance and larger context variables may affect the creation or transcendence of a barrier.

One relevant question to ask is: “What entity/organization has control over the process?” The answer to the question about responsibility, authority, and control over the process and options development can strongly influence what types of options are developed. If either a non-government organization or a government agency (both focused on public health) is in charge of the process, then the options developed will likely differ because of these organizations’ respective missions, jurisdictions, political interests, funding and so on (Renn 2008). Actual or perceived availability of funding of the leading institution may already influence the goals, criteria and range of options that may be developed. Thus, it is useful to ask: “Do resources to develop options and facilitate process exist?” Other than financial resources, especially time and expertise, within the institutions involved also influence the development of options. If these are not allocated to the process, then these will be major obstacles stalling or weakening the process. Obtaining such resources may require coordinated efforts across levels of organization, too, as well as strategically designed goals that meet the needs of adaptation and extant policy priorities. In cases where an institution's mandate diverges from other stakeholders' interests, this may form barriers to finding a workable level of agreement on the goals, evaluation criteria, and options developed (Cash et al. 2006; Lowe, Foster, and Winkelman 2009; Young 2002).

In terms of the broader governance issues, one may need to determine: “Do the options fit within the existing public or policy agenda?” or slightly differently put, “Do pre-existing policy agendas pre-determine the range of options being developed? Options that are perceived not to fit into existing agendas may quickly be dismissed, even if this selection criterion is not made explicit. Alternatively, options perceived to be preferable, but less familiar or more challenging, may be reframed to gain traction on existing policy agendas. In many instances, organizational culture, missions, policy histories and priorities, and institutional “stickiness” can create criteria – whether stated so explicitly or not – that affects “What is included in or excluded from the basket of options?” Acknowledging these influences can reveal why certain options are included and others are not, which may facilitate dialogue about priorities and values, but these issues are not always made explicit and can undermine trust, stakeholder engagement and buy-in later on.

SYSTEM OF CONCERN

Finally, the system of concern has its own influence on the range of options that can and will be developed. For example, one may ask: “Does the goal adequately address the complexity and source of the defined problem and target system?” If not, this could lead to inadequate or inappropriate adaptation later on. However, in the meantime, for developing options, one may ask: “At what level of intervention do the options focus?” Or “Do the identified options match or fit within the boundaries of the defined system?” If the system of concern extends across multiple jurisdictions, the problem requires coordination and collaboration across jurisdictions to implement options. Failing to develop such cross level relationships can cause major obstacles presenting and later (e.g. in implementation). Finally, actors may be interested in seeing that their options meet certain criteria, but sometimes these criteria may be difficult to measure or identify due to the nature of the system they are concerned with (Adger, Arnell, and Tompkins 2005; National Research Council 2009a).

5.2.2 Assessment of Options

The development and assessment of options – as the above discussion already indicated – is often hard to distinguish from the important step of critically and carefully assessing each option in light of identified goals and criteria. While decision analysts suggest this step be done separately, the brainstorm (Stage 4) is hardly ever as cleanly separated from the careful evaluation. Thus, many of the barriers identified in the previous stage also come into play here. Some of the barriers previously discussed in Stage 2 also apply here because of the potential reliance on science, information, and existing knowledge to assess options. Detailed discussion of these stages earlier is provided above, while the new and different nuances are discussed below (Box 5.5).

Box 5.5: Key Barriers in the Option Assessment Phase

- i. Availability of data/information to assess options
- ii. Accessibility/usability of data
- iii. Availability of methods to assess and compare options
- iv. Perceived credibility, salience and legitimacy of information and methods for option assessment
- v. Agreement on assessment approach
- vi. Level of agreement on goals, criteria, and options

ACTOR

One of the major challenges with conducting a systematic assessment of adaptation options is the lack of data, information, expertise and established and widely accepted methods on how to conduct such an assessment (Füssel 2007). As such, the first question geared toward the actor is “Is there expertise to do the assessment?” For some aspects (e.g., economic cost benefit analysis), expertise and methods may be more widely available than for others (e.g., assigning values to non-market ecosystem goods and services). Assessing options can be a complicated and complex process, which not only needs to be designed by those with relevant background to the challenges (Adger, Arnell, Tompkins 2005), but also may require stakeholder participation to conduct the assessment (Chapin et al. 2006; National Research Council 2008; Ogden and Innes 2009; Moser 2005b). If there is a well-connected and knowledgeable leader who can help identify and gather the necessary resources, expertise and information, the process is supported tremendously. But this is far from assured. A recent survey of people involved in adaptation planning in the United States showed that those involved in adaptation initiatives needed more training on how to conduct assessments, especially in assessing the costs and benefits of options (GAO 2009). Participants in and consumers of the options assessment, even if it is done by experts, must be able to understand and critically evaluate what the assessment means and what it implies for making adequate selection choices among them later on. As in the information gathering phase, information accessibility and perceived salience, credibility, and legitimacy, as well as willingness to use all come into play here again.

Because of differences in expertise but also values and interests, involved actors may differ significantly in what they believe an acceptable assessment approach is or should involve. In a well-structured and facilitated process, all these differences are made explicit and the assessment designed such that value differences, people's varying degrees in risk aversion and other preferences are systematically addressed. But this is often not the case. Differences in preferences and what is acceptable as a risk may lead to intense conflict among stakeholders (von Winterfeldt and Edwards 1984). Experience with well-structured and facilitated processes shows how many conflicts at this stage can be avoided or addressed, but when that does not occur, the process can be hindered or even permanently stop (Gregory 2002; Gregory et al. 2001, 2006; National Research Council 2008). In the course of discussing such differences, the involved actors may surface new, different. More or fewer goals and criteria that should guide the assessment and ultimate choice of options, thus it is good to review if anything changed in this regard from Stage 4.

GOVERNANCE AND CONTEXT

Expert and stakeholder assessments require allocation of adequate resources. While resources are an issue in almost every stage, those stages that require extensive scientific input and carefully conducted stakeholder engagement processes are more demanding in this regard than others. Thus, it is important to ask, "Are adequate resources made available to conduct an options assessment?" Similarly, it is critical that sufficient time is given for this process: "Are there time constraints or particular schedules that determine the available space for the assessment?" While time constraints and timing issues will always be at play, an unreasonable schedule may sufficiently undermine the perceived legitimacy of the process, such that participants will lose confidence in the entire effort.

As discussed previously in Stage 2, there are numerous ways in which governments, institutions, and other funding agencies can influence the availability of research funds (e.g., for the collection of data, development of assessment methods) and the development of the human resources (expertise) to support an adequate assessment of adaptation options. Reviews of U.S. federal government research R&D had shown that the investment in the area of vulnerability and adaptation research over the past 20 years has been inadequate to meet the quickly rising need for such expertise and information (Moser 2009a; National Research Council 2009a, forthcoming-a, forthcoming-b, forthcoming-c). But the challenge is common beyond the U.S. Due to the still limited experience with climate change adaptation and even less experience with assessing adaptation options, the lack of accepted methods in which the researchers analyze adaptation can be a barrier (Smit and Wandel 2006).

Finally, as discussed for Stage 4, the governance and larger context can – well ahead of actually selecting a particular set of options – already influence which adaptation options are assessed and by which criteria, including through issues like institutional mission, policy agendas, historical legacies, procedural rules, social and professional norms, or even the established information sources that leading entities customarily draw on.

SYSTEM OF CONCERN

The system of concern itself can make the assessment of adaptation options difficult in similar ways experienced in Stage 2 (Information gathering). These include the difficulty to understand how the system functions in the first place, how well its current (or future) condition is and can be understood, and what the problem is that people need to adapt to (Stage 2). Thus, issues previously discussed, including the level of understanding and information availability about a system, the degree of uncertainty in understanding, the novelty vs. familiarity with the problem, and the existence of data and methods that allow for an adequate assessment are all relevant here.

Maybe one of the most vexing and common challenges for climate change decision support at this stage is how to assess strategies in the face of uncertainty (National Research Council 2009a). This challenge has led to the development of methods to identify robust choices that can meet identified goals under a range of future climate scenarios. A parallel challenge is the desire to identify options that meet several criteria and goals simultaneously. Multi-criteria analysis can aid in identifying relevant options, but they all typically depend on data availability. Thus, one question that must be asked about the system of concern is, “Can the needed information be produced?” If the needed information cannot be produced through any means, then perhaps new angles (e.g., new indicators) need to be sought for the assessment. Alternatively, the adaptation effort may need to direct some resources to gathering such needed information for now or current assessments of options. If the system of concern has been a priority problem previously (e.g., water shortage) then information may already exist that could be used to help assess options (e.g., regarding the existing water infrastructure, laws, potential social inequalities).

5.2.3 Selection of Strategy or Option

If Stage 4 developed a wide range of options, Stage 5 typically leads to a narrower set of options. Sometimes only a very small (or no) subset of options is even carefully and systematically assessed due to the potentially substantial resources required to do so (e.g., legally required environmental impacts statements for major projects). What follows in Stage 6 now, is actually choosing one option, or a set of options (including strategies and actions), for implementation. As indicated before, the desired outcome of this stage may already – explicitly or implicitly, subtly or quite manipulatively – influence several of the stages before, from problem definition to the option assessment. But the following section identifies several stage-specific barriers that can stall or completely stop an adaptation process at this point (Box 5.6).

Box 5.6: Key Barriers in the Option Selection Phase

- i. Ability to reach consensus on selecting option(s)
- ii. Sphere of responsibility/influence/control over option
- iii. Threshold of concern over potential negative consequences
- iv. Threshold of perceived option feasibility
- v. Clarity of authority and responsibility over selected option

ACTOR

There are several critical questions one can ask about the actors in terms of their contributions to creating or transcending the barriers of this stage. The first question to ask is: “Who are all the people (and jurisdictions) that should or need to be consulted or involved in the selection process?” The answer may be influenced by their relationship with the leader, the roles and positions, the way the problem is viewed/perceived by different stakeholders, and the set of options now on the table. The set of actors may be different or the same than those involved in earlier phases. The selection process may also not occur with all individuals in the room at the same time, but occur in stages. The more actors are involved that have little history of working (well) together, the more likely it is that they will face challenges in coming to agreement. If a large number of stakeholders is involved in that process, it is important to examine: “Are there conflicting values and preferences that do not allow for consensus or agreement?” As much as leadership was important in the problem definition and options development and assessment phase (though not necessarily always involving the same individual), here again it plays an important role in the process of actually selecting one of the options or a set of options. Especially, if there are differences among participating actors, is there a leader that is able to facilitate the selection process and help mediate among different interests and agendas?

In addition to common barriers of finding agreement in any decision-making process, climate change adaptation brings additional difficulties because in most cases there is no widespread agreement yet on what climate change adaptation means or looks like (Adger et al. 2009; Doria et al. 2009). Unfamiliar adaptation options may raise questions about uncertain side effects – often negative social or environmental consequences, or other less easily studied, quantified, or projected effects. As such when values, preferences, concerns and mental models of participants differ widely, they will find it challenging to reach agreement on the set of options to select for implementation. One must also ask, “Is the highest ranked alternative viewed as feasible by those in charge of the selection process?” If not, a highly ranked alternative will probably not be selected if the leader does not view it as feasible. Reasons for doubt in feasibility may include availability of resources, expertise, degree of communication, collaboration, or cooperation with others, among others. Other issues that may influence an individual’s judgment are issues of clarity over who will be responsible for implementing an option once selected. Often, at the point of decision, the choice among even carefully vetted options may come down to the most dearly held beliefs and values or opportunistic reasons. Again leadership will be crucial to help take risky decisions if they would rather fall back to risk averse “business-as-usual.” Otherwise, satisficing (outright or not) may be the ultimate mode to make a selection (Bazerman and Moore 2009; Simon 1979).

GOVERNANCE & CONTEXT

The governance and larger social context can influence the selection process in important ways, and thus help or hinder or direct the selection process in certain ways. One of the questions to ask here is: “What are the laws that govern certain options and do they favor or inhibit the selection of certain options?” While this may be most relevant in later stages (the actual implementation), anticipation of those constraints may influence the selection process.

Similarly, conflicting mandates among involved entities may result in irreducible or hard to overcome selection choices. This will reveal legal obstacles that either can be worked around (e.g., for ideal options), challenged directly (e.g. by changing the law or the court's interpretation of the law), or viewed as insurmountable (for the current time). Furthermore, one must ask whether lines of authority over the selection process are clear. Along similar lines, the researchers ask, "What are the perceived institutional and legal constraints?" This may differ from the actual legal barriers, but distinguishing between perceived and actual barriers may be quite difficult (Kareiva et al. 2009). Even if obstacles are just perceived ones, they can direct actions just as much as actual barriers (Adger et al. 2009), but the former can be changed through strategic educational or outreach programs (i.e., agency staff training or public awareness campaigns). Next one may ask of the larger social, socioeconomic, and cultural context: "Is the favored option socially acceptable?" If the support of society is necessary to implement this strategy, then such acceptance is necessary, at least by the relevant segment or sufficient number of the population that will be needed to realize the option. This barrier can be addressed through awareness building or waiting until the time is right (or going with a different option).

SYSTEM OF CONCERN

While the selection process itself is in the hands of actors and institutions, and influenced by the governance and larger context, the system of concern can create ambiguities that make selection more difficult. For example, a system that crosses jurisdictional boundaries or that does not match jurisdictions will blur lines of authority and responsibility over the selected options (i.e., "scale discordance" in Cash and Moser 2000). Another challenge may arise if the (scientific) understanding of the system is so limited or uncertain that there is a high probability of unforeseen (particularly negative) consequences. The options available for selection may address some of these uncertainties, but not others, making the options more or less acceptable to different stakeholders. If the uncertainty is a product of the lack of information or insufficient research, then one logical (interim) strategy may be to obtain the necessary information and generate better understanding (if resources and expertise exist). However, in cases where the uncertainty is perceived to be difficult to reduce or irreducible in relevant timeframes, then the nature of the uncertainty itself may point toward strategies that are flexible to the uncertainty or regret-free and robust (Adger, Arnell, and Tompkins 2005).

In terms of reaching the threshold of consensus/agreement, one can ask: "Does the system target have attributes that are valued uniformly or differently by stakeholders?" Agreement is more easily built around the uniformly valued attributes while it may be more difficult to achieve or require challenging tradeoffs around the differently valued attributes (Renn 2008). For example, farmers value the water quantity that they are allocated, while fishermen value the water quality – and quantity – allocated to the streams where salmon spawn.

5.3 Managing Adaptation

Whether or not actors have proceeded through a sequential process of generating, assessing and selecting options (and overcoming the associated barriers), once an option has been selected, the process moves into the Management phase. It entails three stages, namely implementation, monitoring, and evaluation (Figure 6). These are each described in turn below.

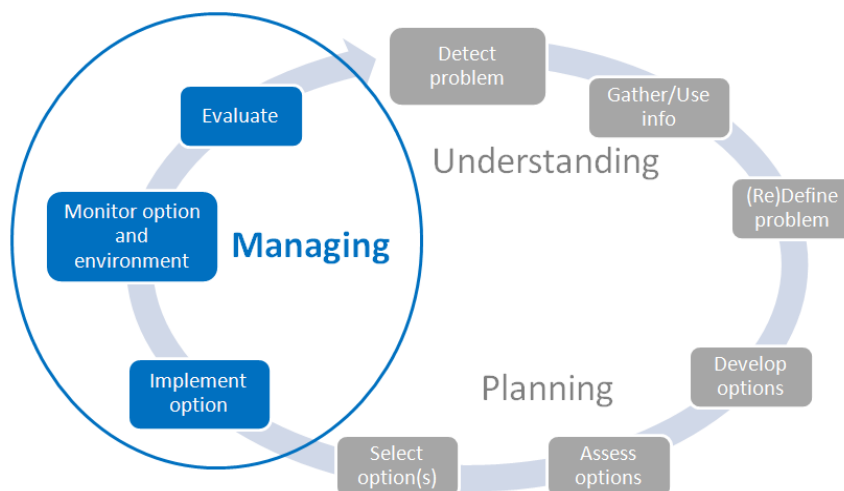


Figure 6. The third phase of the adaptation process is 'Managing', which involves implementing, monitoring, and evaluating.

5.3.1 Implementation

The stage referred to as “implementation” could itself be divided into many subprocesses, often involving many different actors (including some not involved in the process to date) and requiring varying amounts of time, resources, skills, and effort to fully accomplish. What and who exactly is involved in implementation depend on the option(s) selected in Stage 6. Thus, the authors’ discussion of thresholds is necessarily general. The literature on climate adaptation to date suggests that few adaptation processes have reached this phase (Adger et al. 2007; Adger et al. 2009; Dovers 2009; Berkhout, Hertin, and Gann 2006; GAO 2009), partly because the barriers prior to and in the implementation stage are so significant, and partly because how recent climate change adaptation has emerged as a policy concern. Thus, this section of the report draws more heavily on experience with other management and change processes. The stage-specific impediments include (1) a threshold of actual intent to implement a selected option; (2) obtaining necessary authorizations to do so; (3) securing sufficient resources to implement the option; (4) a threshold of accountability that may prevent or foster implementation; (5) clarity and specificity on what to do; (6) the legal and procedural feasibility to implement the option; and finally, (7) developing sufficient momentum to overcome institutional stickiness, path dependencies, and behavioral obstacles (Box 5.7).

Box 5.7: Key Barriers in the Implementation Phase

- i. Threshold of intent
- ii. Authorization
- iii. Sufficient resources (fiscal, technical, etc.) to implement
- iv. Accountability
- v. Clarity/specificity of option
- vi. Legality and procedural feasibility
- vi. Sufficient momentum to overcome institutional stickiness, path dependency, and behavioral obstacles

ACTOR

Actors critically contribute to whether or not a selected option is implemented and how. The literature suggests that even if options have been carefully assessed and one or several selected as the preferred ones for implementation, actual implementation does not automatically follow (Adger 2009; Adger et al. 2009; Berkhout, Hertin, and Gann 2006; Dovers 2009; GAO 2009). Thus, one of the first questions to ask that will reveal a potential barrier in this stage is: “Is there actual intent to implement the option?” Intent typically is influenced by several factors. Among the most important ones appear to be the actor’s perceived adaptive capacity and cognitive biases (Grothmann and Patt 2005) and the availability of sufficient financial resources to realize the selected option(s) – often a matter of prioritization. Actors may also perceive a lack of social acceptance or anticipate negative political ramifications, which may undermine their or responsible leaders’ political will to go ahead. Finally, actors may perceive or encounter physical or technical constraints on implementation and thus postpone or prevent implementation. If actors are not formally accountable to the people who were involved in adaptation planning or to a particular group of stakeholders, voters, or the public, these actors may feel less pressure to follow through with implementation. If instead, there are social, economic or political ramifications for not following through with a selected option, there is greater pressure to move to real action. On occasion, there may also be negative ramifications for implementing an agreed-upon option, if that leads to negative consequences. An actor may be averse to taking that risk and thus avoid implementation.

In some cases, typically involving fewer actors and simpler decisions, the implementer may be the same actor who selected the option, which makes implementation essentially an extension of the selection process, for example, farmers selecting responses to climate variability and change (Nielsen and Reenberg 2010; Öhlmér, Olson, and Brehmer 1998). In other cases the implementer is presented with an option or strategy developed by others (as in the case with international development projects providing alternative livelihood strategies, see Nielsen and Reenberg 2010). Especially if selection and implementation are done by different sets of actors, the ground for implementation may need to be prepared through necessary explanation, persuasion and/or education. For example, Grothmann and Patt (2005) found a lack of intention to take certain adaptive actions among farmers in Zimbabwe because they had not learned how to correctly interpret climate-related probabilities and they preferred to plant (and eat) maize

over the adaptive strategy of switching to millet in drought years. However, Patt (2001) found that farmers do have the skills to understand probabilities when taught through participatory practices. The same is often true in bigger interventions. As the “policy windows” literature has found repeatedly, preparations must be made prior to the opening of a policy window in order to be able to take advantage of a window when it opens (Kingdon 2002; Olsson et al. 2006).

A disconnect between those selecting the option from those who need to implement it can result in major barriers to successful implementation (see, e.g., Nielsen and Reenberg 2010). If the priorities of actors are inconsistent between stages (e.g., those who develop and select the strategy differ from those who have to implement it), the planned strategies may not line up with the situational context and mental models of the implementer, as exemplified in the just mentioned Zimbabwean farmer case (Grothmann and Patt 2005). When the intention is set, another question may arise: “Is implementing the option within the responsibility or authority of the actors?” For example, when incorporating climate change data or some other strategy is not in a government staff’s job description, there may be a legal obstacle to doing so. At the very least, there is no one accountable to implement the adaptation strategy (GAO 2009; Moser 2009a). Where implementing involves unfamiliar, novel approaches or skills, it is necessary to ask: “Does the human capital exist to implement the strategy?” (Füssel 2007). Without the relevant and necessary expertise, actors may lose important momentum in figuring out how to implement the option. Recognizing the importance of human capital in the adaptation process, agencies and organizations can provide training for staff to learn how to deal with climate change within their existing job descriptions, as the National Park Service has done (West et al. 2009). Finally, clarity of the strategy is also important for implementation: “Is the selected option or strategy clear and specific enough for actors to implement it?” If not, this leaves the interpretation up to individuals who may or may not have been involved in developing it (Huitema and Meijerink 2010).

GOVERNANCE & CONTEXT

Moving from option selection to implementation is influenced in important ways by the governance and larger social context, in part through its impact on the actor’s perception, freedom and capacity to do so, in part through its impact on the available resources. For example, existing social norms may help or hinder actual behavior change or implementation of a novel or simply uncommon option. Leaders may not have prepared their constituency to move from “talk” to “action.” The political context (e.g., an upcoming election) or economic situation (e.g., a budget crisis) may prevent or at least delay moving from planning to implementation of a preferred adaptation strategy. The institutional context may also influence intent, thus one may ask: “In what ways is the decision maker formally accountable for implementation?”

Ideally, the previous planning process clearly considered potential obstacles and requirements that might arise during the implementation process and thus developed a well-considered implementation strategy that appropriately addressed those needs. In smaller and less formal settings, however, this may not be the case, thus turning the implementation process into a problem solving process onto itself. Thus, even assuming the necessary intent has been set to

implement the strategy, implementation may be stalled due to governance-related barriers. First, implementation typically requires authorization, review, and oversight from various institutions, including authorization of necessary expenditures and permission to undertake certain interventions. This authorization preceding on-the-ground implementation may not happen through a single signature, but instead occur in stages and requiring approval from a variety of authorities. Much time can pass to get all the necessary signatures and approvals, if for example, previously uninvolved parties must review all the documentation pertaining to the selected option.

Formal authorization procedures aside, implementation of the selected option must be legal and feasible within existing policies, laws, rules, regulations, programs and mandates unless the selected strategy is to change a law or process. Moreover, more subtle norms and practices can affect implementation: “Are there common practices or policies within the actor’s institution that overlap with or contradict the adaptation strategy?” The administrative heritage (past practice) of the implementer can be just as powerful of a barrier as, but possibly more accessible to change than, the larger governance system (a matter of institutional rigidity) (Gunderson and Holling 2002; Post and Altman 1994). For those potential overlaps within the actor’s organization, the selected strategy needs to include how it fits with existing practices and policies. For example, if the agency’s policy does not include recognition of climate change, then the strategy can work within these policy boundaries by incorporating climate change into those processes that provide flexibility such as planning (West et al. 2009; Julius et al. 2008). Along the same vein, “Can the implementing agency acquire the necessary resources for implementation?” Long-standing practices (with people invested in them) and value-ridden institutional structures can make it difficult to allocate funding for new programs or shift it from existing programs to newer ones, including hiring new staff or training existing staff to increase the expertise to implement a selected adaptation strategy.

Once necessary financial and technical resources are in place, there are number of additional barriers that may arise in this stage, especially if they have not been adequately dealt with earlier or if the planners and implementers are not the same set of actors. For example: “Is there agreement on how the strategy will be implemented?” It is possible that not all parties agree or that previous value differences and stakes resurface now. For example, various involved parties may differ on whether or not the option is considered legitimate and as promoting equality, environmental benefits etc.? Furthermore: “Do necessary collaborations and lines of communication exist to accomplish an efficient and effective implementation?” If they do not yet exist, is establishing these lines of interaction part of the implementation strategy? “What is the role of other relevant agencies, institutions, or actors who have overlapping functional or jurisdictional authorities?” Cross jurisdictional conflicts within and between levels of organization can also be major barriers (Lowe, Foster, and Winkelmann 2009; Moser 2006). “Are the different roles and responsibilities of relevant actors clearly distinguished and clarified?” and “Does implementing an option interfere with the implementer’s other responsibilities?” Furthermore, “Are other responsibilities more pressing or does the strategy ‘fit’ with these issues?”

SYSTEM OF CONCERN

The nature of the system that will be changed in the course of implementation also matters for its success. For example, “How reversible or irreversible is the selected option or strategy?” Some strategies or actions are designed to be flexible, i.e. they can relatively easily be changed or corrected when changes in the system and/or undesirable, unanticipated outcomes emerge. Some strategies may also be more robust across a wide range of climatic changes and system configurations. Thus, flexible and/or robust strategies may garner easier political will or behavioral intent than strategies that may have big or irreversible consequences. For example, if the strategy is highly irreversible, such as building a dam or massive levee system, then it may require a higher degree of public acceptance and stakeholder support and lower uncertainty in the science for implementation than those strategies that are relatively reversible.

In addition, the magnitude and reversibility of impact depend in part on the sensitivity or fragility of the system. Actors may be more risk-averse in systems that are already under considerable amount of stress, or where large numbers of people, rare and threatened or particularly important ecosystems or species are at stake.

5.3.2 Monitoring

In an iterative, adaptive management process, monitoring is an absolutely essential aspect of the process (Holling 1978; Lee 1994; Walters 1986). Without it, deliberate learning from systematically obtained data cannot occur. Monitoring of the environment (in this case, the climate, relevant related environmental and societal changes) and of the effects that the adaptation strategy has on the environment and society provides the very basis from which actors can learn whether their selected strategy or adaptation option is working (i.e. whether it has the intended impact), whether it is and continues to enough in the face of ongoing climate and related changes, and what side effects it may entail (McLain and Lee 1996; Walters 1986). (For a Californian example, see the Salt Pond Restoration Project in South San Francisco Bay, Trulio et al. 2007). The common barriers that can arise in this stage include (1) whether or not there is a plan to monitor changes; (2) agreement on and clarity of monitoring targets and goals; (3) the availability and accessibility of established methods and variables to monitor; (4) the availability of appropriate monitoring technology; (5) the availability – and sustainability – of economic resources to support a long-term monitoring program; (6) the availability and sustainability of human capital; and (7) the ability to store, organize, analyze and retrieve monitored data when needed (Box 5.8).

Box 5.8: Key Barriers in the Monitoring Phase

- i. Existence of a monitoring plan
- ii. Agreement on and clarity of monitoring targets and goals
- iii. Availability and acceptability of established methods and variables
- iv. Availability of technology
- v. Availability and sustainability of economic resources
- vi. Availability and sustainability of human capital
- vii. Ability to store, organize, analyze and retrieve monitored data

ACTOR

One of the frequently bemoaned challenges for environmental management, especially adaptive management, is the lack of monitoring. There are many reasons why monitoring is not undertaken or unsuccessful, but often they are reduced to a money issue. A closer reading of the literature reveals a more diverse set of impediments. The first fundamental question to uncover potential barriers in this stage is: "Have the actors developed a monitoring plan?" The establishment of the monitoring plan may have already been considered at an earlier stage, or actors may decide on its necessity only now. Whatever the case, one must ask about its comprehensiveness: "Does the monitoring plan specify goals, design, targets, approaches, necessary resources, and the intent and schedule for analysis and assessment of the obtained data?"

Once such a monitoring plan exists and is agreed upon, the efficacy of the monitoring plan must be evaluated based on its potential utility. Clearly, deciphering what to monitor could be controversial, especially if resources are limited; nevertheless, it is important to recognize that a narrowly focused or too restricted monitoring plan will yield limited insights into the changing environment and effectiveness of the adaptive response. Gunderson and Holling (2002, p.7) report of a case, for example, where a narrow problem definition led to narrow monitoring of the environment, which in turn led to important changes being missed: "Because the problem was defined narrowly, [certain] changes were not perceived."

Another actor-specific barrier may be lack of expertise and/or insufficient human resources to carry out an extensive monitoring program. Observing changes in large regions may not be possible "in situ" or from the ground, but require remote monitoring platforms or, alternatively, a large cadre of observers. Thus, one must ask "Is additional capacity or expertise needed to design and implement the monitoring program?" If so, appropriate resources need to be sought to hire, train, or allocate staff time in order to operationalize the monitoring.

GOVERNANCE & CONTEXT

Because monitoring, especially over the long term, is a resource intensive activity, government and other entities are typically principally involved in funding monitoring activities, and/or in supplying necessary personnel and technologies. Thus, a logical question to ask about the governance context's contribution to barriers at this stage is: "Do institutions provide sufficient

resources (funding, technology) to implement the monitoring plan?” and “Do institutions invest in providing the necessary human capital (expertise, time allocated) to carry out the monitoring program?” The lack of such resources can create major barriers to implementing the monitoring. As with all other decisions made, to allocate such resources requires that the governance system and pertinent societal interests value this type of research or information gathering required by the plan. This includes resources to support the ability to store, organize, analyze, and retrieve monitored data, which requires expertise, institutional setup, software and hardware.

To the extent social data are being gathered, necessary protection may need to be in place or established to protect people’s interests and privacy. Importantly, monitoring climate change, related environmental and social changes, and the effectiveness of adaptation strategies requires long-term support, and that is often the biggest sticking point. While relatively short-term funding may be available, long-term funding (longer than 5 years) is often structurally constrained by funding rules, budget cycles, political turn over, and fickle societal support. The availability and sustainability of economic resources to undertake long-term monitoring are a major obstacle at all levels of governance.

Finally, the monitoring plan, or the adaptation strategy more generally, may or may not have built in the periodicity with which the data obtained through monitoring should be analyzed and assessed. This is a critical, governance-related trigger to ask about: “Is the monitoring system or plan set to trigger evaluations?” Alternatively, “Does the institution overseeing the implementation of adaptation options allow for unexpected/unplanned evaluations?”

SYSTEM OF CONCERN

Monitoring can have several different types of goals ranging from tracking the social-ecological landscape over which decisions were made (e.g., rainfall affecting farming, or sea-level rise affecting a specific shoreline area), to collecting information required in an evaluation to indicate whether the implemented adaptation strategy (or action) has achieved its goal and/or adequately addressed the problem. Without clarity of the goal, an adequate monitoring system cannot be established, thus it is important to clearly delineate the system and targets to be observed, and for what end: “What is the goal of the monitoring? Are the targets clear?” Developing goals and methods of the monitoring plan may require as rigorous of a process as developing the strategy (or will be included as part of the strategy).

Some types of systems or issues may be more difficult to monitor or gather information about than others (Ostrom 2007, 2009). Thus, the very nature of the system being monitored can create challenges for monitoring. These challenges are – in principle – similar to the system-related barriers encountered in Stage 2 (Information gathering process). A first question one may ask is: “What kind of baseline information exists about the system of concern, if any?” If no baseline exists, establishing one may be the first order of business to enable the tracking of change over time, much less attributing it to certain environmental influences or human interventions. Closely related is the question: “What type of monitoring does the system and implemented strategy require?” Some system properties or adaptation goals may be directly observable, while others are emergent properties arising from interacting proxy variables. Thus, the

adaptation goal may be achieved, but not be directly measured. Only the proxy variables may provide clues as to whether or not things are moving in the desired direction.

In many instances, it will be years before the success or failure, or even some of the positive or negative consequences of an adopted strategy or action, will become apparent, either because of time lags in the system that delay revelation of effects, or because an altered, redesigned system (e.g., an improved warning system) must await testing by an external stressor such as the next 500-year flood, or an extreme multi year drought. Thus, one should ask: “Does the monitoring plan include a strategy to deal with delayed outcomes?” Other system-inherent characteristics, such as uncertainty, may obscure observation of changes; thus one must ask: “Does system variability and uncertainty prevent clear detection and attribution of observed changes?”

In some cases, such as when permanent structures are built, adaptation strategies may need ongoing monitoring of the environmental changes to establish trends or to track whether they remain within the variability ranges to which the structure was designed. Other strategies, such as public awareness campaigns, may require more periodic data collection to gauge the impact of the intervention (and to garner continued support). To track certain indicators, well established scientific methods may already be available; in other instances novel, more creative methodologies need to be developed (and tested and refined over time). Thus, depending on the nature of the system and the issue to be monitored, it is important to ask: “Are there known and accepted indicators for monitoring the variable or goal?” Dynamic changes in vulnerability, for example, are more difficult to monitor, in part because researchers have not agreed on a common approach (Adger 2006). Additional challenges specifically for monitoring vulnerability include that many variables are exceedingly difficult to measure, some underlying variables are not regularly obtained or geocoded, and others are hazard-specific rather than generic, thus requiring special (resource-intensive) attention (e.g., Eakin and Luers 2006).

5.3.3 Evaluation

Periodic evaluation of how well the selected and implemented adaptation strategies are addressing the identified problem is the last step in the adaptation cycle; it may at once be the trigger that begins a new cycle. Such an evaluation may be concerned with the process and/or the outputs and outcomes of the adaptation effort. In addition, this step may specifically entail a scanning of the latest climate changes or insights from climate science (and maybe even more broadly, other relevant environmental and societal changes) to ascertain whether new or different challenges must be addressed. The stage addresses both scientific and policy-related matters, and thus involves barriers common to those activities (see previous discussions, e.g., in Stage 2, 3, and 5). The typical stage-specific barriers here include (1) a threshold indicating the need and feasibility of conducting an evaluation; (2) the availability of needed expertise, data, and evaluation methodologies; (3) a willingness to learn from the experience to date; (4) a willingness to revisit previous decisions; (5) legal limitations on reopening prior decisions; and (6) the social and political feasibility of revisiting previous decisions and/or initiate new actions or policies (Box 5.9).

Box 5.9: Key Barriers in the Evaluation Phase

- i. Threshold of need and feasibility of evaluation
- ii. Availability of needed expertise, data and evaluation methodology
- iii. Willingness to learn
- iv. Willingness to revisit previous decisions
- v. Legal limitations on reopening prior decisions
- vi. Social or political feasibility of revisiting previous decisions and/or initiate new actions or policies

ACTOR

Whether or not an evaluation takes place depends in part on the attitudes and motivations of actors to do so. Thus, one of the first questions to ask about the actors at this stage is: “Is anyone willing, charged or accountable to conduct an evaluation?” In order to perform an evaluation, there must be someone who is given and/or takes responsibility for conducting the evaluation. The person or entity to whom he or she is accountable must have surpassed the dual threshold of recognizing both the need and basic feasibility of conducting such an evaluation. Motivation to do so may come from the actor’s notion of principled leadership and good governance, a formal mandate, or because some perceived problem suggests that the previously adopted adaptation option may be inadequate or outdated.

In addition to establishing the basic need, feasibility, and accountability for an evaluation, one may also ask: “Are leaders, decision-makers, and other stakeholders willing to learn from an evaluation exercise?” Having to conduct an evaluation and sincerely wanting to learn from one are not necessarily the same. The willingness to learn from past successes and shortcomings are essential in adaptive management, but occasions to admit to past shortcomings can be personally, politically, professionally sensitive for those accountable for past decisions. Moreover, revisiting past decisions, especially if they were contentious, or if the current political situation is perceived as risky, requires considerable political courage. While elected officials may fear for their public position, mid-level agency staff may fear for their professional reputation, implications for their own performance evaluations, or even their job security. Thus, it is important to ask whether leader(s) are willing to revisiting previous decisions made in the adaptation process. For example, the leader(s) must be willing to redefine the problem from a different perspective, if the evaluation reveals the original understanding of the problem was too narrowly (or broadly) defined. Alternatively, the leader may have to face critique for having invested too little in a solution, or acknowledge that a selected option produced socially or environmentally unacceptable side effects. While these effects may have been unknowable and unanticipated at the time of decision-making, affected stakeholders may be unforgiving. The (anticipated) outcomes of an evaluation also will affect the social or political feasibility of reopening previous decisions and policies, and/or the feasibility of initiating and obtaining support (e.g., agency funding) for new, continued or different actions and policies (Moser 2009b).

Aside from potential barriers for initiating the evaluation process, other questions may help diagnose potential challenges that may undermine the credibility and legitimacy of the effort: “Was the actor evaluating the adaptation effort directly involved, or is the evaluator an outside observer?” Answers to these questions affect the evaluator’s prejudices, access to information, and knowledge of the process. Moreover, one may ask: “What interests does the evaluator (or planners of the evaluation) represent?” As with other stages in the adaptation process, past experience, educational background, and vested interests of the person designing and conducting the evaluation can steer it into a direction perceived as biased by others. Therefore, whose interests are represented can have a significant impact on the findings of the evaluation (Moser 2009b).

GOVERNANCE & CONTEXT

The governance and larger context factors can mandate or prevent, support or hinder an evaluation process, and help shape when and how it is being conducted. For example, one may ask: “Are there formal mandates to periodically evaluate the impacts of an adaptation policy or action?” With or without mandate, one may ask: “What is included and what excluded from evaluation?” The answer to the latter question in particular may raise legitimacy concerns for stakeholders or other observing parties.

Even when there is no formal mandate, one may ask: “Are feedback mechanisms in place to support (or prevent) social learning and adaptive governance?” Governance structures that allow and support social learning are associated with higher resilience, adaptive capacity, and even sustainability (Pahl-Wostl 2009).

The timing of the evaluation is also important, vis-à-vis both the adaptation strategy (or option) that is to be evaluated and contextual events. For example: “Does the period between implementation and evaluation give enough time for changes to take place?” The timing of the evaluation needs to be reasonable to allow the effects and effectiveness of the implemented option to be observable. Evaluations performed too soon after implementation may show no change when benefits would be expected after a much longer period of time (Ehler 2003; Pomeroy, Parks, and Watson 2004). On the other hand, if too much time has passed, much important institutional memory may be lost, and causal effects may be difficult to establish. The timing of the evaluation also must be strategic in order to garner necessary resources and be socially and politically feasible.

All too often, research and policy go forward without allocation of resources to evaluate their impact (Wondolleck and Yaffee 2000). This is particularly true for evaluation of processes, though evaluation of outcomes (as opposed to outputs) is notoriously difficult and underfunded (e.g., National Research Council 2008, Moser 2009b). Thus it is critical to ask: “Are necessary resources available?” As with all the other stages of the adaptation process, adequate resources (funding, expertise, technological tools, process facilitation etc.) are necessary to implement the evaluation process.

To the extent monitoring was part of the adaptation process up to this point, the necessary data may be available on which to base the evaluation, though often evaluators find themselves

without this foundation and have to “boot-strap” to construct post-hoc information. The evaluation is directly limited in this way by the quantity and quality of baseline and impact data available, i.e., by the monitoring and research-related choices made in previous stages.

SYSTEM OF CONCERN

Whether or not something can be evaluated, i.e. judged to be a success, failure or merely a deviation vis-à-vis previously set goals, targets, or baselines depends also on the system of concern. As discussed in Stage 2 and Stage 8, system-inherent characteristics may make such an assessment difficult. For example, even if the researchers assume that data are available, the signal may not yet emerge from the noise, or the system may be so complex that it is difficult to attribute with any level of confidence that an observed change is the result of a certain intervention (Berkhout, Hertin, and Gann 2006). For example, researchers disagree whether the National Flood Insurance Program has made coastal development less or more vulnerable, in part because implementation of that program has coincided with major socioeconomic and demographic changes along the coast (The Heinz Center 2000).

Depending on the selected focus of the evaluation, some aspects may be more easily evaluated than others (Adger, Arnell, and Tompkins 2005; Moser 2009b; Young 1999). In some cases the goal may be to determine effectiveness of an adaptation strategy that was geared toward increasing the ecosystem’s resilience to climate perturbations. This could be evaluated using biological indicators. With a slightly different adaptation goal, for example, one geared toward increasing the adaptive capacity of the local fishery, the challenge may be to evaluate the socioeconomic impacts of the marine protected area by looking at commercial and recreational fisheries in the area (Moser 2009b). While these indicators of effectiveness may not be mutually exclusive, there are significant differences in the type of data and expertise needed, the level of understanding, and how the evaluation may be received and perceived (in terms of legitimacy and credibility) by decision-makers and their constituents.

5.4 Cross-Cutting Issues and Emerging Priorities

A careful reading of the literature suggests that some issues appear to be of overarching importance throughout the process of adaptation, including leadership, the need for supporting resources, information (including its generation and exchange through communication), participation, and values and beliefs (as the basis of cultural cognition). These issues take on special significance or “flavors” in each stage, and specific context features may make them rise to greater or lesser significance; yet there is probably not a single case of adaptation to date, where these cross-cutting issues have not caused significant challenges to the process.

In addition to these in and of themselves complex cross-cutting issues, events external to the adaptation planning process, such as disasters, economic crises, or some other societal shock, can impede or temporarily suspend continuation in any stage in the process. Certainly, such events can distract attention, resources, and staff time. Likewise, novel opportunities may arise from within or without the adaptation process previously not foreseen or anticipated that may

radically shift or alter the adaptation planning process. Because the cross-cutting issues play a role at any stage of the adaptation process, but have situation-specific relevance for the process depending on when and how they unfold, the cross-cutting issues are summarized in terms of their significance as a form of conclusion to the diagnostic portion of this report.

5.4.1 Leadership

Leadership can be critical at any stage in the adaptation process, but maybe most importantly so in the process of initiating the first step(s). When there is no mandate, law, job description, or public demand yet for adaptation planning, leaders are not required to get the process started at all. Importantly, this function is not restricted to formal leadership positions and certainly not to just one individual, as some adaptation processes will go on for a long period of time; rather leadership is a role that can be taken on by individuals in any position a person holds in the adaptation process. Leadership can help overcome barriers, but lack of or ineffective leadership can also create some.

Leaders can present a barrier in two ways: when they are absent from the process or when they limit or derail or block the process. By contrast, an effective leader takes on a series of critical tasks that facilitate, support and guide the adaptation process. The presence of an active leader is especially important when an issue is new and unfamiliar and there is no requirement or decision and management routine yet to take it on. In those instances, leaders can help maintain momentum of the adaptation process.

Clearly, not every leader provides the same quality of guidance, motivation, and vision. Those who demonstrate high skill (e.g., in communication, facilitation, and elicitation) and strong qualities of integrity (e.g., dedication and openness to the issue, the process and the solution options, self-reflexivity, humility, creativity, transparency, honesty) tend to be trusted more by process participants, and perceived as legitimate (Podsakoff et al. 1990; Zand 1997).

5.4.2 Resources

Resources prove to be important in almost any stage, but certainly in the science-heavy planning and management phases of the process. Resources here refer to financial means, but also technical resources, technology, and staff expertise and time.

Lack of resources is typically the, or among the, first responses most practitioners give when asked why they have not yet begun adaptation planning (e.g., Tribbia and Moser 2007). But different types and amounts of resources – as the laid out in Sections 5.1-5.3 – are critical throughout. While resource scarcity can motivate tremendous creativity, efficiency, and flexibility among the involved actors, there are very real limitations to what is possible without resources. Competition among sectors and regions that require supporting resources, but also competition between resources for climate change adaptation versus other policy priorities is a persistent challenge already, and likely to become even more difficult of a barrier in the future, even in developed nations (Adger et al. 2009).

5.4.3 Information and Communication

Throughout the adaptation process, communication – information exchange and dialogue about the meaning of information and knowledge – is a perpetually occurring and critical process. Information-related barriers have to do with whether and how information is created (based on what goals, perceived needs, by what discipline and on the basis of what paradigm), how it is communicated (by whom and in what way – one way information transfer or two-way dialogue to co-create knowledge and understanding), and who receives it. Much information produced and used for adaptation to climate change has been through the lenses of the hazards-based approach and to a lesser extent the vulnerability-based approach. The impacts information produced from the hazards approach is especially useful as a signal about a potential threat and to increase awareness that a problem exists because the focus is typically on disasters over the long term (Füssel 2007). The vulnerability approach, on the other hand, provides information about the existing vulnerabilities and risks from climate-variability and other non-climate stressors, which are necessary to define the problem, develop and assess adaptation options, and implement a strategy. Ideally, adaptation planning should rely on both hazards and vulnerability approaches to create the most comprehensive understanding of the threats to a particular locale.

The delivery and reception of knowledge are also common themes throughout each stage. Misunderstood information, unintended interpretation of conveyed information, complete lack or insufficient frequency or content of communication can severely interrupt or derail social interactions among those involved in the adaptation process. This holds true about the communication within or among government agencies or private sector enterprises, between such entities and the wider public, or among various stakeholders. A growing body of literature highlights the importance of effective communication of climate change information in order to increase awareness and understanding, and to actively engage policy-makers, other stakeholders, and the public (Center for Research on Environmental Decisions 2009; Kahan 2010; Moser and Dilling 2007; O'Neill and Hulme 2009; O'Neill and Nicholson-Cole 2009; Ogunseitan 2003; Shackley and Wynne 1996). Mass media messages based on the assumption that “one size fits all” do not effectively promote awareness or inspire engagement, nor do messages designed to invoke fear (Lorenzoni, Nicholson-Cole and Whitmarsh 2007; Moser and Dilling, forthcoming; O'Neill and Nicholson-Cole 2009). Instead, communication of information (whether it is getting climate science into decision models or promoting public awareness about projected impacts) must be tailored specifically to the target audience (Maibach, Roser-Renouf, and Leiserowitz 2009; Moser and Dilling 2007; O'Neill and Hulme 2009; Patchen 2010). This involves consideration of pre-existing beliefs, values, cognitive biases of the recipients as well as credibility, salience, transparency, historical relationships between messenger and recipient, among other factors that may prevent the target audience from receiving the information and/or intended message (Cash et al. 2006; Cash et al. 2003).

5.4.4 Participation

Who and in what way individuals participate in the adaptation processes will differ by governance level, origin of the process, the nature of the signal or issue, and the style of decision-making (Gunderson, Holling, and Light 1995). In turn, the type, degree, intensity, frequency, and outcome of participation will strongly influence what occurs at every step in the process (Moser 2007a). There is no set prescription as to who should participate at what stage and in what ways (Moser 2007a; National Research Council 2008; Stringer et al. 2006). Moreover, who participates will likely differ not only from one sub-process to another, but also from one adaptive cycle to another. An early adaptation process may be composed entirely of managers and scientists to initiate thinking about the issue and gain some fundamental understanding of the challenges (Walters et al. 2000), while a subsequent cycle may include broader set of resource users, community leaders and non-governmental organizations. Another adaptation process may include community leaders, representatives of interest groups, and managers from the beginning.

Who participates is determined not only by the organizers, but also which of those invited elect to participate. Thus, participatory processes frequently require careful assessment of the constraints on participation and supporting resources of time, funding, energy, and expertise to enable effective participation (Moser 2007a). The form of participation also must fit the intended outcome (Rowe and Frewer 2005). While the inclusion of stakeholders in decision-making processes has become increasingly accepted (and sometimes mandated) in the design of management decisions, facilitating meaningful participatory processes is quite challenging, and if done badly, can present significant barriers to progress (National Research Council 2008). One recent review has shown that, “stakeholder engagement processes can in some situations actually cost more, take more time, increase distrust and conflict, and at a minimum, not bring any professional benefits to those involved” (Moser 2007a: p.21).

On the other hand, exclusion of (potentially) affected parties from a planning and decision-making process can undermine the prospects of congenial working relationships, implementation and acceptance or create lasting distrust that can severely hinder subsequent decision processes (National Research Council 2008). Within limits (as discussed in Renn and Walker 2008; National Research Council 2008), the benefits outweigh the costs for inclusion of multiple stakeholders (National Research Council 2008).

Importantly, formal public participatory processes are just one dimension to consider under the rubric of participation. In an adaptation process entirely within a government agency or corporate entity, questions of participation also arise – regarding which departments, which staff, which superiors need to be involved or consulted. Thus the scale and scope of participation matter in any process involving more than one individual. The formality of the process, however, may differ.

5.4.5 Cultural Cognition

Finally, there is the issue of how people think – a foundational influence on the adaptation process. Individuals always look at new problems, tasks, and solutions through the lens of their preexisting values, beliefs, norms and experiences. As research in risk perception, cognitive psychology, and people’s values and beliefs suggests, this “cultural” lens colors people’s general beliefs about society and the environment. According to Kahan and Braman, "culture is prior to facts in the cognitive sense that what citizens believe about the empirical consequences of [certain actions or] policies *derives* from their cultural worldviews" (2006, p.148). In addition, certain heuristics, mental shortcuts, lead to the tendency to underestimate risks arising from climate change (Kahan 2010; Kollmuss and Agyeman 2002). Together these cognitive filters shape people’s perceptions, constrain their attitudes about options, and influence decision-making processes, e.g., what and how information is used in defining a problem (Luers and Moser 2006; Renn 2008). Ideologies based on the dominating pattern of values thus can act as barriers or drivers to the process (Bachrach and Baratz 1970). For example, Blennow and Persson (2009) found that the strength of belief in climate change was a crucial factor for explaining differences in adaptation actions among Swedish forest owners.

Cultural cognition not only has direct impacts on the process, but also indirect impacts, such as what information is valued and is therefore produced. In addition, people frame time and resources (including seemingly farther reaching constraints such as budget allocations and intellectual capacity) under the issue of values and beliefs because these are a product of choices people have made, which were guided by their values and beliefs.

Having diagnosed several dozen of stage-specific barriers to adaptation, and identifying overwhelmingly important, cross-cutting categories of barriers, the report now turns to a brief discussion of how to overcome these impediments. Clearly, this question cannot be answered in specific terms here, as solutions to the identified impediments must be context-sensitive and should be owned by the stakeholders involved. Instead the authors structure the identification of solutions.

Chapter 6: Overcoming Barriers

6.1 Scales of Influence Over Barriers

Before presenting the third component of the framework, it is important to reiterate that overcoming barriers is not viewed as a normative “must.” Rather, barriers are approached descriptively as thresholds or impediments that simply can stop, delay, or divert the adaptation process. Thus, transcending a threshold can be viewed (by different actors) as a good or bad thing, depending on their perspective. For example, a particular problem definition or framing may serve some interests but not others, thus, whether it is desirable to move on with that framing or not is in the eye of the beholder. Similarly, not having the financial resources to implement a selected adaptation option may be deemed a terrible impediment to those in favor, but a lucky break to those opposed.

If one is interested, however, in overcoming the barriers – and in many cases decision-makers and stakeholders will see that as a desirable goal – then it is important to know where to intervene in the “adaptation architecture.” The guidance for where to intervene in the system to overcome a barrier makes up the third component of the framework. At any one moment in the adaptation process, an actor’s ability to overcome a barrier depends not just on his or her capabilities, but also on the source or origin of the barrier. The authors distinguish here the spatial and temporal source or origin of the barrier relative to the place and instance in which the actor finds him or herself. Along the temporal dimension contemporary vs. legacy barriers are distinguished, and along the spatial or jurisdictional dimension (where sometimes these two coincide, other times they differ in scale) proximate vs. remote barriers.

Each barrier varies along both dimensions (Figure 7), and while there tends to be overlap between legacy/remote barriers and contemporary/proximate barriers, respectively, they are not necessarily identical. For example, a local official is trying to find scientific information on vulnerability but can’t locate anything relevant to her community. The fact that federal agencies in years past have not provided funding to conduct such research has created a barrier that is a legacy of past science policy decisions by remote actors (D in Figure 7). The local official can’t easily overcome this obstacle by addressing it at its source – that is through changes in federal R&D funding, and through her actions only with significant resources, time, and expertise (i.e. by hiring a local researcher or consultant to do this research). By contrast, a barrier that is both proximate and contemporary (A in Figure 7) would be something over which the actor has direct control here and now. For example, the official finds that not all participants are at the table that should be and decides to extend invitations to those additional people for the next meeting. The same official may find that a local law prevents taking a certain adaptation action – a proximate legacy barrier (C in Figure 7). While still challenging, the local official actually has control over initiating changes in this regulation. The local official may also be faced with a remote contemporary barrier, which is an obstacle that occurs at the present time but is beyond the official’s direct control (B in Figure 7). For example, in the case that a state budget crisis

occurs, the state agency that was providing important technical assistance to the local process now has insufficient staff to provide information and expertise.

For clarity purposes, these two dimensions are described in more detail below. Although they are described separated they inevitably both define the nature of the barrier.

		Temporal	
		Contemporary	Legacy
Spatial/Jurisdictional	Proximate	A	C
	Remote	B	D

Figure 7. Opportunities for influence and intervention. The more remote in space and time the barrier is from the actor's sphere of influence, the less opportunity does the actor have to intervene and overcome the barrier.

6.1.1 Proximate vs. Remote Barriers

In terms of the spatial and/or jurisdictional dimension, barriers can arise close to the actor, while other barriers may originate in places that are out of reach to the actor. A proximate barrier is a barrier that is within reach of the actor's sphere of influence and thus can be directly affected by the actor. The bounds of this sphere of influence are largely defined by the actor's formal role or position and the perception of his/her capacity and influence (which can be bigger or (typically) smaller than objective bounds of influence or authority) (Grothmann and Patt 2005). Those barriers closest to the actor (such as the internal processes of cognition and perception) are certainly difficult to overcome, but still easier than those barriers that come from far beyond the actor's scope of control. An example of a proximate barrier is illustrated in Blennow and Persson's (2009) study on Swedish forest owners, which showed that a forest owner's lack of knowledge of adaptation options prevents him or her from adapting forest management. Actors can overcome such proximate barriers if they seek and gather information from outside sources. For example, in the San Francisco Bay region government agencies have formed an alliance with the Netherlands to get experienced-based ideas on adaptation strategies in the face of sea-level rise (San Francisco Bay Conservation and Development Commission 2009b).

On the other extreme of this spatial scale are barriers that are remote from the actor's control space. For example, a remote barrier may have emerged from a non-climate related market shift. Adger, Eakin and Winkels (2009) present a case where the expansion of a commodity in

one region (coffee in Vietnam) inadvertently affected the global market, making small farmers of the same commodity in Central America more vulnerable via market “teleconnections.” In this situation, the farmers in Central America encounter barriers to climate change adaptation that are driven by political and economic factors and international markets that are far beyond the farmers’ sphere of influence. This remoteness can result from an actor not participating in a multi-level social network, or could be the result of multiple levels of governance (in this case, market-related policy- and decision-making) between the actor and the origin of the barrier.

6.1.2 Contemporary vs. Legacy Barriers

Along the temporal dimension, a similar challenge arises from the fact that some barriers arise from sources in the past, others from the present situation. Legacy barriers are those barriers that occur as a product of a decision made in the past, either an earlier (separate) process or an earlier stage in the adaptation process. Sometimes the outcomes of these earlier choices will reveal themselves as barriers only at later stages (Nelson, Adger, and Brown 2007, p.408).

By contrast, contemporary barriers are those that arise in the current stage and clearly interfere with the progress of the current stage or process (e.g., stakeholders oppose taking a certain action because of strong cultural beliefs and values; inadequate resources do not permit implementation of a preferred choice). The difference between the legacy and contemporary barriers can be hard to pinpoint at any one point in time, and the two types are often interconnected (e.g., in the case when information does not exist for an assessment it is both a contemporary barrier and legacy barrier in that it impedes existing progress, but may also have been the result of earlier decisions made about what science to invest in. This prior decision, in turn, was influenced by priorities and pre-existing belief systems and mental models). A distinct difference between legacy and contemporary barriers, however, is that contemporary ones can be affected by the individuals involved at present, whereas legacy ones can no longer be changed. They may compel actors in the present situation to temporarily abandon the adaptation planning process to remedy the situation that has arisen from the past decision (e.g., conduct scientific research to fill information gaps, spend time building trust, work to remove institutional obstacles).

6.2 Interventions to Overcome Barriers

The purpose of the diagnostic framework presented here was to systematize the identification of barriers that may impede the adaptation process. Section 5 addressed two fundamental questions: (1) what could stop the process? And (2) how do the actor, context, and system of concern contribute to the barrier? Section 6.1 presented how the sources of these barriers vary across temporal and spatial/jurisdictional scales, and by doing so, illustrate how to determine whether an encountered barrier is under the current and local influence of the actor or not.

Together, the nature of the barrier, its source(s), and the location of influence over the barrier provide a “road map” to design strategies to circumvent, remove, or lower the barriers. Leadership, strategic thinking, resourcefulness, creativity, collaboration and effective communication will all be required in designing the most appropriate interventions for

overcoming them. Frequently, this effort of overcoming barriers is in fact the primary target or at least initial focus of the adaptation effort. At least, this is the overwhelming experience to date, where most actors and institutions are still in the understanding and planning phases (GAO 2009; Moser 2009a; The Heinz Center 2007).

As adaptation initiatives progress, accruing experience may reveal that understanding adaptation and its associated barriers will not lead to a fixed prescription for how to adapt, nor will there be a one-size-fits-all way to overcome barriers. Rather, one can expect the feasible strategies to be highly context-sensitive (i.e., actor, governance, and system-specific). This is the reason for developing this decision-support tool to diagnose barriers rather than offering a prescriptive list of necessary conditions, capacities, or steps to overcome them.

The generalized call for “building adaptive capacity” may be too simplistic an answer, however, to deal with the range of adaptation barriers. While the list of barriers developed here looks suspiciously similar to, or may be viewed as an elaboration on, the inverse qualities of adaptive capacity (e.g., leadership, resources, access to information, and many others), overcoming barriers is not as straightforward as building adaptive capacity. To truly understand the relevance of, say, “more resources” is to know (or ask) when these resources are available, to whom, and for what aspects of the adaptation process. Differently put, “more resources” just for science, but not for implementation or for monitoring does not result in a greater likelihood of adaptation actions being implemented on the ground. Thus one question for future research is whether “performance” in each of the stages could become a more useful and tangible measure of adaptive capacity. Different dimensions of adaptive capacity may also – to some extent (which needs empirical examination) – compensate for each other. For example, a good leader may be able to compensate to some extent for the lack of time and money because s/he has great connections or can facilitate potentially difficult processes efficiently and find creative financing solutions without additional resources. Similarly, strong social capital may compensate to some extent for lack of strong institutions. Future research must explore the range of pathways actors have found in their adaptation efforts to overcome the specific barriers they encountered.

Chapter 7: Empirical Testing of the Framework and Potential Broader Contributions

This report has introduced a theory-based framework for identifying and organizing barriers to adaptation. Rather than propose a normative approach to making “good” adaptation decision, the authors offer a comprehensive, systematic approach to identifying specific barriers that occur in each stage of the adaptation process, along with diagnostic questions that help ascertain how actors, context, and the system of concern contribute to the existence of these barriers.

This new diagnostic framework requires testing and refinement if it is to aid decision-making. The authors are currently planning a first such empirical test in the context of urban adaptation planning for increased flooding risks as a result of sea-level rise along the San Francisco Bay.² In the context of the State of California’s continued efforts to advance the science of climate change impacts, vulnerabilities and adaptation, a research agenda was recently developed that offers opportunities to test this framework in this region. Several municipalities and counties – in various stages of adaptation planning and implementation – will be selected to explore which barriers decision-makers have already encountered and are currently facing. The research will also examine how managers have overcome the barriers encountered and which barriers they perceive as more or less challenging.

Similar research should be conducted by others, in other regions, nations, sectors, at different scales, and in different contexts of economic development, and vulnerability to climate change. It is through such testing that the usefulness of a systematic diagnostic framework of adaptation barriers can be shown and improved. The researchers hope the diagnostic framework can become a decision support tool that helps decision-makers think in new ways about the systems that need to adapt to climate change, about the governance system that steers the adaptation process, and about their own role as actors in it. A refined ability to identify where the most challenging barriers may lie may allow actors to better allocate resources and strategically design processes to overcome them. In addition to serving as a decision support tool, this framework may usefully contribute to scholarly research questions about barriers to adaptation. This report provides a framing for investigating substantial questions that could help improve the understanding of the adaptation process, its associated barriers, how to overcome these, and potentially how to avoid maladaptation. For example, much could be learned about adaptive capacity and ultimate adaptation success by exploring the implications of actors skipping certain stages – including the associated barriers – in real-world decision-making. The framework could also be used as a foundation to examine whether and how barriers differ by one or more of the following variables:

² A second proposal for testing the framework’s utility at the federal level will be submitted by one of the co-authors (SM) to the Rockefeller Foundation.

- The type of system of concern (degree of complexity, uncertainty, and other features)
- The sector in which adaptation is planned and implemented
- The mandate of the agency or organization leading the process
- The scale of governance
- The way the problem is defined
- The depth of the adaptation or transformation sought-after, and many others.

Patterns may emerge from such comparative investigations showing where the biggest barriers lie – with the actor, the governance and larger context, or the system of concern. For example, the biggest barriers (i.e., those most difficult to overcome) might be based on the characteristics of the system of concern, such as its mobility (e.g., an eroding coastal bluff or an ecosystem where species may be able to migrate), its size, its horizontal or vertical connectivity (i.e., it crosses multiple jurisdictions or not), or its congruency with existing governance regimes. Alternatively, the biggest barriers might lie with deeply ingrained values, modes of thinking, and beliefs of actors, and how they are reflected in society's institutions (i.e., the governance structure). Findings about such patterns could match or contradict findings/principles derived from other areas of study, such as common pool resource theory (Ostrom 1990) or interventions in systems (Meadows 1999), and thus more broadly enable the study of adaptation to climate change to continue to learn from all disciplines of science.

Ultimately, the framework presented here may contribute to an improved understanding of the adaptation process and its barriers (and the linkages and feedbacks within coupled human-environmental systems). With further testing and refinement, it may allow actors to anticipate in a given set of conditions - which will be the greatest barriers and in what stage of the adaptation process they may occur. These types of predictions may improve the allocation of resources and the strategic design of processes that minimize and help overcome likely barriers. Therefore, the framework is not only as a decision support tool for current adaptation efforts. Perhaps more importantly it also provides a starting point for answering critical questions that can ultimately inform and benefit climate change adaptation at all levels of decision-making.

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9.0 Appendix: Diagnostic Questions by Barrier and Adaptation System Component

PHASE	Barriers	Actors	Governance & Context	System of Concern
<i>Understanding</i>				
<ul style="list-style-type: none"> • Problem Detection & Initial Framing 	<ul style="list-style-type: none"> i. Existence of a signal ii. Detection (perception) of a signal iii. Threshold of concern (initial framing as problem) iv. Threshold of response need and feasibility (initial framing of response) 	<ul style="list-style-type: none"> -Does the actor receive the signal? -Does the actor detect, perceive or recognize the signal? -How does the actor interpret the signal? -Does the actor perceive a need to respond and perceive a response to be feasible in principle? 	<ul style="list-style-type: none"> -Does the governance system somehow prevent sending out a signal? -How is the signal delivered and by whom? -Does the governance system fail to transmit a signal or prevent it from reaching individuals? -Do leaders, norms, or institutions dismiss the issue as a problem? -Do laws, policies and social norms support or prevent taking a problem seriously and responding to it? 	<ul style="list-style-type: none"> -Does a signal exist and what does it mean? -What is the nature of the signal? -How is or can the signal be identified, seen or experienced? -Is the issue/problem novel or familiar? -Are there logical actors to take on the detected problem? -Is there an already agreed upon way of dealing with the detected problem or not?
<ul style="list-style-type: none"> • Information Gathering & Use 	<ul style="list-style-type: none"> i. Interest and focus ii. Availability iii. Accessibility iv. Salience/Relevance v. Credibility and Trust vi. Legitimacy vii. Receptivity to information 	<ul style="list-style-type: none"> -What values, perceptions, and beliefs, direct what information should be collected? -Is there agreement about what information should be gathered and 	<ul style="list-style-type: none"> -In what ways does the governance system restrict interest and focus in the issue to be explored? -What kind of information can be used in existing policy and decision-making 	<ul style="list-style-type: none"> -Has the target system been a problem or the focus of research previously? -How well is the system understood? -How much uncertainty is there about how climate change will

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	iii. Willingness and ability to use	analyzed? -Does the desired information exist? -Is the information accessible? -Is the information salient or relevant to better understanding and solving the problem? -Is it reliable, credible and from trusted sources? -Has the information been produced and vetted in a legitimate manner? -Are the recipients of information receptive to the information? -Do potential recipients have the understanding and ability to make sense and appropriate use of the information?	processes? -Is the information compatible with existing decision-making (e.g. policy, mental/individual) processes and models? -How does the governance system influence whether information is salient, credible and legitimate? -In what ways do formal and informal institutions prevent actors from accessing needed information? -Is there sufficient time and expertise available to access, become familiar with, analyze, evaluate and use it?	affect the system?
<ul style="list-style-type: none"> • Problem (Re)Definition 	i. Threshold of concern (reframing of the problem) ii. Threshold of response need iii. Threshold of response	-How do actors now interpret and assess the issue? -How do actors now assess the need and feasibility of response?	-Do leaders, norms, or institutions dismiss the issue as a problem? -Do laws, policies and social norms support or prevent taking a problem	-What is included or excluded in the system of concern? -How broad or narrow is the system that actors will focus on?

PHASE	Barriers	Actors	Governance & Context	System of Concern
	feasibility iv. Level of agreement or consensus	-Are there any new players involved in this stage of the process? -Is agreement reached on the problem (re)definition? -How much negotiation or mediation skill is there among participants?	seriously and responding to it? -How do institutions signal (lack of) support for the process?	-What is the nature of the problem to be addressed? -Are the impacts of concern on the target long term and (de facto) irreversible? -Are there any near-term indications of the problem? -What is the temporal scale at which the problem is defined? -What is the spatial and jurisdictional scale at which the problem is defined? -Can the problem be seen or experienced?
Planning and Decision-Making				
<ul style="list-style-type: none"> • Development of Options 	i. Leadership (authority and skill) in leading process ii. Ability to identify and agree on goals iii. Ability to identify and agree on a range of criteria iv. Ability to develop and agree on a range of options that meet identified goals and	- Who is leading the process? - Do leaders have formal authority and/or the necessary skill and ability to facilitate the process? - Do leaders and others involved have the ability and willingness to develop a set of criteria to judge	- What entity/organization has responsibility, authority, and lead control over the process? - What formal procedures may exist to guide the process? - How do social norms, organizational culture, and informal ad-hoc agreements on	-Does the goal adequately address the complexity and source of the defined problem and target system? -At what level of intervention (e.g., local, state, national) do the options focus? -Do the identified options match or fit

PHASE	Barriers	Actors	Governance & Context	System of Concern
	criteria v. Control over process vi. Control over options	options? - Are the goals made explicit to those involved in developing the options? - Do actors have control over the process of developing options? - Are the developed options within the actor's sphere of influence?	procedures affect the process? - Which organizations/entities influence process? - Do resources (financial, technical, staff time) to develop options and facilitate the process exist (or are they perceived to exist)? - Do the mandate of the lead entity and stakeholder interests align or diverge? - Do the options fit within the existing public or policy agenda? - Do pre-existing policy agendas pre-determine the range of options being developed?	within the boundaries of the defined system? -Can defined criteria be measured and addressed?
<ul style="list-style-type: none"> • Option Assessment 	i. Availability of data/information to assess options ii. Accessibility/usability of data iii. Availability of methods to assess and compare options iv. Perceived credibility, salience and legitimacy	-Is there expertise to do the assessment? -Is there a well-connected and knowledgeable leader to identify and gather the necessary resources to adequately support an option assessment? -Are other participants	-Are adequate resources made available to conduct an options assessment? -Is sufficient time given to this process and what other timing issues affect the time available for the assessment? -Does the experience and	- What is the level of understanding and information availability about a system? - How much uncertainty is there in understanding the current and future state of the system?

PHASE	Barriers	Actors	Governance & Context	System of Concern
	<p>of information and methods for option assessment</p> <p>v. Agreement on assessment approach</p> <p>vi. Level of agreement on goals, criteria, and options</p>	<p>in the process adequately trained?</p> <p>-Are values, preferences, and differences in risk aversion among stakeholders adequately addressed in the assessment process?</p> <p>-Do the involved agree on the selected approach to assessing options?</p> <p>-Do actors agree on goals, criteria and resulting options?</p>	<p>expertise exist in participating organizations to conduct assessments?</p> <p>-How have governments, institutions, and other funding agencies influenced the availability of research funds and the development of human resources?</p> <p>-How do institutional mission, policy agendas, historical legacies, procedural rules, social and professional norms, or even customarily consulted information sources shape the assessment?</p>	<p>- Is the problem novel or familiar?</p> <p>- Can the needed information be produced?</p>
<p>• Selection of Options</p>	<p>i. Ability to reach agreement on selecting option(s)</p> <p>ii. Sphere of influence/responsibility/control over option</p> <p>iii. Threshold of concern over potential negative consequences</p> <p>iv. Threshold of perceived option feasibility</p>	<p>-Who are all the people (and jurisdictions) that should or need to be consulted and involved in the selection process?</p> <p>-Are there conflicting values and preferences that do not allow for consensus or agreement?</p> <p>-Do adaptation options</p>	<p>-What are the laws that govern certain options and do they favor or inhibit the selection of certain options?</p> <p>-What are the actual institutional and legal constraints of selecting certain options?</p> <p>-What are the perceived institutional and legal</p>	<p>-Does the system cross jurisdictional boundaries or not match jurisdictions?</p> <p>-Is understanding of the system so limited or uncertain that there is a high probability of unforeseen (particularly negative) consequences?</p>

PHASE	Barriers	Actors	Governance & Context	System of Concern
	v. Clarity of authority and responsibility over selected option	raise concerns over unintended negative consequences? -Is there a leader that can facilitate the selection process and help mediate among different interests and agendas? -Is the highest ranked alternative viewed as feasible by those in charge of the selection process? -How do responsibilities for implementation influence the selection? -Are people risk-averse or risk-seeking in their selection process?	constraints of selecting certain options? -Are there conflicting mandates among entities involved in the selection process? -Are the lines of authority over the selection process clear? -Is the favored option socially acceptable in a given context?	-What is the cause and nature of the uncertainty about the system? -Does the system of concern have attributes that are valued uniformly or differently by stakeholders?
Managing the Problem				
<ul style="list-style-type: none"> • Implementation 	i. Threshold of intent ii. Authorization iii. Sufficient resources (fiscal, technical, etc.) to implement iv. Accountability v. Clarity/specificity of option vi. Legality and procedural feasibility vi. Sufficient momentum	-Is there actual intent to implement the option? -Does the actor have the (perceived) adaptive capacity or any cognitive biases for or against implementing the option? -Are there sufficient financial resources to realize the selected	-Are there legal and institutional requirements or limitations that undermine the intent to implement? -Is the option to be implemented legal and feasible within existing policies, laws, rules, regulations, programs	-How reversible or irreversible is the selected option or strategy? -How sensitive or fragile is the system to human intervention? -How robust are the selected strategies to different climatic changes and system

PHASE	Barriers	Actors	Governance & Context	System of Concern
	<p>to overcome institutional stickiness, path dependency, and behavioral obstacles</p>	<p>option(s)?</p> <ul style="list-style-type: none"> -Does the actor perceive or anticipate lack of social acceptance, lack of political will, or negative political ramifications from implementation? -Do actors perceive themselves to be accountable to others for implementation? -Does implementation require explanation, education, and skill building? -Is implementing the option within the responsibility or authority of the actors? -Does the human capital exist to implement the strategy? -Is the selected option or strategy clear and specific enough for actors to implement? 	<p>and mandates?</p> <ul style="list-style-type: none"> -Do existing social norms help or hinder a needed behavior change or implementation of a novel or uncommon option? -In what ways is the decision maker formally accountable to others to implement? -Is there enough social and/or political support for the selected strategy? -Are there perceived and/or real negative consequences that may result from implementation? -Was an implementation strategy developed as part of the planning process? -Does implementation require authorization, review, and/or oversight from institutions? -Are there common practices or policies within the actor's institution that overlap with or contradict the 	<p>configurations?</p>

PHASE	Barriers	Actors	Governance & Context	System of Concern
			adaptation strategy? -Can the implementing agency acquire the necessary resources for implementation? -How do long-standing practices and vested interests prevent resource allocation? -Is there consistency in participants involved in the process? -Is there agreement on how the strategy will be implemented? -Do necessary collaborations and lines of communication exist to accomplish an efficient and effective implementation? -What is the role of other relevant agencies, institutions, or actors who have overlapping functional or jurisdictional authorities?	
<ul style="list-style-type: none"> • Monitoring 	<ul style="list-style-type: none"> i. Existence of a monitoring plan ii. Agreement and clarity on monitoring targets 	<ul style="list-style-type: none"> -Have the actors developed a monitoring plan? -Have the actors 	<ul style="list-style-type: none"> -Do institutions (typically, government agencies) provide sufficient resources (funding, 	<ul style="list-style-type: none"> - What is the goal of monitoring? -Are the targets clear? -What kind of baseline

PHASE	Barriers	Actors	Governance & Context	System of Concern
	<p>and goals</p> <p>iii. Availability and acceptability of established methods and variables</p> <p>iv. Availability of technology</p> <p>v. Availability and sustainability of economic resources</p> <p>vi. Availability and sustainability of human capital</p> <p>vii. Ability to store, organize, analyze and retrieve data</p>	<p>specified and do they agree on the monitoring goals, design, targets, approaches, needed resources, and the intent and schedule for analysis and assessment of the obtained data?</p> <p>-Is additional capacity or expertise needed to design and implement the monitoring program?</p>	<p>technology) to implement the monitoring plan?</p> <p>-Do institutions invest in providing the necessary human capital (expertise, time allocated) to carry out the monitoring program?</p> <p>-Do the governance system and societal interests value gathering the desired type of information?</p> <p>-Do protective measures need to be taken or put in place to protect people's interests and privacy?</p> <p>-In what ways do funding rules, budget cycles, political turn over, and societal support allow or constrain financial support for long-term monitoring?</p> <p>-Is the monitoring system or monitoring plan set to trigger evaluations?</p> <p>-Does the institution overseeing the implementation of</p>	<p>information exists about the system of concern, if any?</p> <p>-What type of monitoring does the system and implemented strategy require?</p> <p>-Are there time lags in the system that obscure or delay revelation of effects?</p> <p>-Does significant system variability and uncertainty prevent clear detection and attribution of observed changes?</p> <p>-Is monitoring needed continuously or periodically?</p> <p>-Are there known and accepted indicators for monitoring the variable or goal?</p>

PHASE	Barriers	Actors	Governance & Context	System of Concern
			adaptation options allow for unexpected/unplanned evaluations?	
<ul style="list-style-type: none"> • Evaluation 	<ul style="list-style-type: none"> i. Threshold of need and feasibility of evaluation ii. Availability of needed expertise, data and evaluation methodology iii. Willingness to learn iv. Willingness to revisit previous decisions v. Legal limitations on reopening prior decisions vi. Social or political feasibility of revisiting previous decisions and/or initiate new actions and policies 	<ul style="list-style-type: none"> -Is anyone willing, charged or accountable to conduct an evaluation? -What is the motivation for an actor to evaluate past performance of the adaptation strategy? -Are leaders, decision-makers, and other stakeholders willing to learn from an evaluation exercise? -Are leaders willing to revisit past decisions? -Was the actor evaluating the adaptation effort directly involved, or is the evaluator an outside observer? -What interests does the evaluator (or planners of the evaluation) represent? 	<ul style="list-style-type: none"> -Are there formal mandates to periodically evaluate the impacts of an adaptation policy or action? -Are (formal or informal) feedback mechanisms in place to support (or prevent) social learning and adaptive governance? -What is included and what excluded from evaluation? -Does the period between implementation and evaluation give enough time for changes to take place? -Does the evaluation occur too long after implementation? -Are there sufficient resources to conduct a proper evaluation? - Are necessary resources available? -Did the process produce 	<ul style="list-style-type: none"> -Does the system-inherent variability and uncertainty allow distinction of signal from noise? - Does the complexity of the system allow for confident attribution of cause and effect? -How well are different aspects of the system subject to evaluation currently understood?

PHASE	Barriers	Actors	Governance & Context	System of Concern
			and monitor data that can be used in the evaluation process?	