A framework to diagnose barriers to climate change adaptation

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This article presents a systematic framework to identify barriers that may impede the process of adaptation to climate change. The framework targets the process of *planned* adaptation and focuses on potentially challenging but malleable barriers. Three key sets of components create the architecture for the framework. First, a staged depiction of an idealized, rational approach to adaptation decision-making makes up the process component. Second, a set of interconnected structural elements includes the actors, the larger context in which they function (e.g., governance), and the object on which they act (the system of concern that is exposed to climate change). At each of these stages, we ask (*i*) what could impede the adaptation process and (*ii*) how do the actors, context, and system of concern contribute to the barrier. To facilitate the identification of barriers, we provide a series of diagnostic questions. Third, the framework is completed by a simple matrix to help locate points of intervention to overcome a given barrier. It provides a systematic starting point for answering critical questions about how to support climate change adaptation at all levels of decision-making.

adapting | social-ecological system | decision process

In the first decade of the 21st century, adaptation to climate change has risen sharply as a topic of scientific inquiry, in local to international policy and planning, in the media, and in public awareness (1–3). Adaptation researchers have generally assumed lower vulnerability and greater adaptive capacity in developed countries than in developing countries and thus have focused more research in the latter (1, 4). Yet climatic events in Europe, the United States, and Australia in recent years have also led to critical questioning of richer nations' ability to adapt to climate change (3, 5, 6).

The examination of developed nations' adaptive capacity, and the persistent "adaptation deficit" in developing nations (7), has led to focused research on barriers and limits to adaptation. This research develops a systematic framework to identify barriers to adaptation, which impact society's ability to deal with climate change impacts, an area of growing interest in the past few years (6, 8–13). Our primary goal is to advance the discussion and examination of these barriers by presenting a systematic framework to identify and organize barriers that can arise in the adaptation process in different contexts. Systematically identifying barriers to adaptation can serve to advance our understanding of the process and assist in decision-making. As such, we aim to be comprehensive but do not assume every real-world process will touch on all steps or barriers.

Defining Adaptation

Adaptation has a long and multidisciplinary history of investigation. As a result, meanings of the term differ by field and in practice (14). For the purposes of this article, we select a generic, but inclusive, definition reflecting common usage in the climate change field. We deviate from the Intergovernmental Panel on Climate Change (IPCC) definition of adaptation 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 nonclimatic windows of opportunity (e.g., land-use plan updates, infrastructure replacement, renovating a building). The IPCC definition also implicitly assumes effectiveness in outcome that we believe is premature. Whether harm will be moderated and beneficial opportunities exploited is contingent on many factors, not just on the adaptive action itself. Some adaptive actions may turn out maladaptive later. Finally, the IPCC distinguishes natural and human systems whereas we are most interested in social-ecological systems. Thus, we define adaption as follows:

> Adaptation involves changes in social-ecological systems in response to actual and expected impacts of climate change in the context of interacting nonclimatic 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.

Our primary focus here is on the *intentional*, *planned* adaptation process without presuming a particular set of actors, level of planning, or involvement of government; rather, we attempt to account for the complexity of a deliberate and more involved process. We are also not a priori normative about what the right scale or scope of adaptation should be, 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. We do suggest, 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 (Fig. 1).

Defining Barriers to Adaptation

Researchers often use the concepts of barriers and limits together, even interchangeably, whereas others distinguish between them. Here, as is consistent with the IPCC (1), we refer to *limits* as obstacles that tend to be absolute in a real sense: they constitute thresholds beyond which existing activities, land uses, ecosystems, species, sustenance, or system states cannot be maintained, not even in a modified fashion (19–21). Beyond such limits looms irreversible loss (and the adjustment to living with that loss) and/or radical system shifts, including innovation and novelty (22, 23). 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

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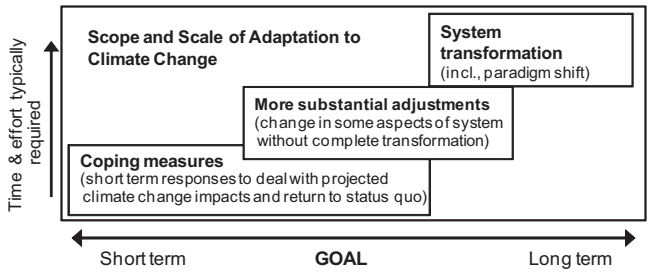

Fig. 1. Scope and scale of adaptation to climate change [based on an extensive literature review (ref. 14, especially refs. 15–18)].

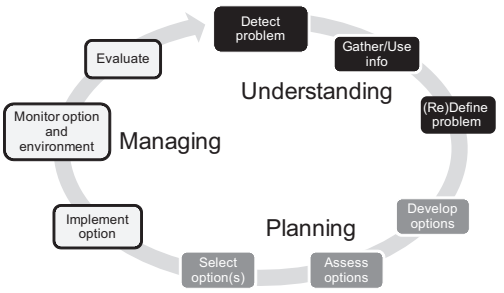

Fig. 2. Phases and subprocesses throughout the adaptation process.

heat tolerance). Those seeming limits that can be overcome, we would view as barriers.

Barriers are defined here as 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. (8) argue, many seeming limits, especially social ones, 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 may require costly changes that lead to missed opportunities or higher costs. In many instances, the barrier may *appear* 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, we take a descriptive rather than a normative approach in which barriers are simply impediments that can stop, delay, or divert the adaptation process. Overcoming all barriers does not necessarily lead to a successful outcome (however defined and by whom). Thus, a hypothetical smooth, barrier-free process is not a sufficient condition to guarantee adaptation success. 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. However, ignoring certain best practices throughout the process (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 problem, or adequate funding) could lead to maladaptation.

Results

Given the pervasive influence of climate change and the many climate-sensitive systems and decisions that will be made in regard to it, a diagnostic framework that is applicable to a wide range of adaptation cases must be principled but not overly confining. The "architecture" of our framework is guided by four principles. It aims to be (*i*) socially focused but ecologically constrained; (*ii*) actor-centric but context-aware; (*iii*) process-focused but action/outcome-oriented; and (*iv*) iterative and messy but linear for convenience (14).

Three key components underlie the diagnostic framework. First, an idealized depiction of a rational approach to adaptation decision-making makes up the process component. Second, a set of interconnected structural elements include the actors, the larger context in which they act (e.g., governance), and the object on which they act (the system of concern that is exposed to climate change). Third, to overcome identified barriers, a simple matrix helps map the source of the barrier relative to the actor's influence over it.

Process of Adaptation. The process of adaptation provides the foundation for identifying and organizing the barriers. We use common phases of a rational decision-making process, including understanding the problem, planning adaptation actions, and managing the implementation of the selected option(s). Each of these process phases includes a series of stages (for a total of nine stages) (Fig. 2). We systematically identify potential 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)—result in problems or unintended consequences later. *Understanding* involves the stages of (*i*) problem detection and awareness raising (resulting in an initial problem framing); (*ii*) information gathering and use to deepen problem understanding; and (*iii*) problem (re)definition (resulting in a framing that does or does not warrant further attention to the issue). *Planning* involves (*iv*) development of adaptation options; (*v*) assessment of options; and (*vi*) selection of option(s). Finally, the *management* phase involves (*vii*) implementation of the selected option(s); (*viii*) monitoring the environment and outcome of the realized option(s); and (*ix*) evaluation. Monitoring and evaluation stages are critical to an adaptive management approach because they help support institutional and social learning (24), which is commonly considered necessary to deal with complex and uncertain problems (25). The decision process typically is less linear and neat in practice. Several authors convincingly show (26–28) how reality typically differs from such ideal normative models of decision-making. For the purposes here, however, the process stages provide a useful ordering heuristic.

Structural Elements of Adaptation. To understand why a given barrier arises in the adaptation process, we build on a framework proposed for the analysis of social-ecological systems (29, 30). We consider three interconnected pieces of the puzzle: 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 to be managed or altered). For example, we are interested not just in a coastal waterfront (the system of concern) that has to be better managed in light of sea-level rise. Rather, we also consider how the actors themselves who manage that waterfront have to change (e.g., their perceptions of or thinking about the environment, use of information, decisions, and interactions with other levels of government). In turn, they 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). 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 (Fig. 3). Barriers may arise from all three components. Sample diagnostic questions are provided in Table S1 to identify how each structural component contributes to the occurrence of a barrier.

What can stop, delay, or divert the adaptation decision-making process? This question, applied to every stage in the process, identifies the stage-specific barriers. The structural model establishes the source of the barriers by asking: What causes the impediments? How do the actors, context, and the system of concern contribute to the barriers? We discuss the third step of the framework after the initial diagnosis as it addresses how to overcome the barriers.

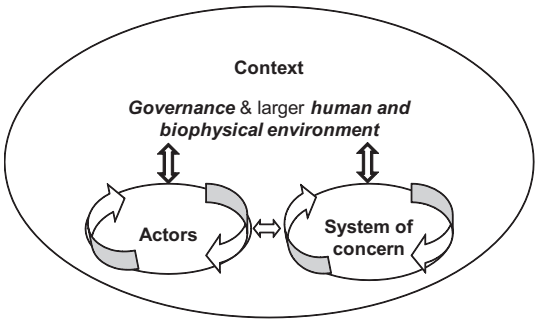

Fig. 3. The structural elements of the diagnostic framework: interacting actors, the governance and larger socio-economic context, and the system of concern that is to be managed for climate change.

Identifying Barriers Throughout the Adaptation Process. Based on our reading of the adaptation literature, certain barriers are repeatedly encountered during the Understanding phase. We have organized them in Table 1 according to the stages in which they arise.

Although the system of concern may produce signals of change, the actors, governance system, and larger context affect whether they are noticed and how they are interpreted. In terms of detecting the problem (the first stage of the Understanding phase), the existence of the signal may not be detected if, for example, the actor's mental model filters out the signal, if the individual is too busy or distracted to notice it or if the actor is too distant from the signal to take note. In turn, the governance system or media may fail to transmit a signal or prevent it from reaching individuals. A study on the needs of coastal managers revealed that a lack of high-level leadership and guidance (governance) can undermine the capacity and willingness to make adaptation decisions (31). Transmission could also fail because of the absence of social or professional networks or because of the presence of dysfunctional ones (32–34). Similarly, the nature of the system of concern and its interaction with climate change may involve so much uncertainty or variability that a signal does not clearly emerge from the background noise.

In the same way, other barriers can arise from one or all three sources in our framework. If the actors do not reach a minimum threshold of concern over the detected issue or do not see a need for, or a feasible, response (at least in principle), the adaptation process will not enter stage *ii*. (Alternatively, if actors have a solution in search of a problem, as is often the case in practical decision-making (28), the climate problem must have registered sufficiently on the actors' radar to fit the bill.) Actors may not proceed carefully through each of the subsequent stages (and thus encounter the associated barriers), but those who do may encounter the barriers listed in Table 1. Systematic discussion of each barrier, its sources, and examples from the published literature are provided in Ekstrom, Moser, and Torn (14).

In the rational decision-making model, actors next go through the adaptation planning phase. Research on existing adaptation processes reveals that they commonly encounter the barriers listed in Table 2.

In an ideal-case process, the initial stage of the Planning phase produces a larger set of potential options that are then assessed according to agreed-upon criteria and goals; one or several options that meet the goals and are deemed feasible are selected in the end. During the first stage in this phase, where adaptation options are being brainstormed and developed, leadership, authority, and skill to guide the process can be critical. Actor(s) may focus their deliberations only on options they perceive to be under their control or may be open to generating options beyond their immediate control (32, 35, 36). The inability to identify and agree upon goals and criteria can become a significant barrier at this point. A survey of U.S. government officials showed that >55% of respondents indicated the challenge of defining adaptation goals as very to extremely challenging (37). Because the brainstorm is rarely cleanly separated from the careful evaluation, many of the barriers identified in the option development stage reemerge, as do those encountered in stage *ii* (information gathering) given the potential reliance on science, information, and existing knowledge to assess options.

Barriers in the Planning phase that arise from traits of the governance system often have to do with who has control over the process. For example, if a nongovernmental organization and a government agency (both focused on public health) are developing adaptation plans, their respective options will likely differ because of these organizations' different missions, jurisdictions, political interests, funding, etc. (38). The system of concern has its own influence on the range of options. For example, to be effective, the level of intervention and the boundary of the system of concern may inherently limit the range of options (39). If the system of concern extends across multiple jurisdictions, the problem requires coordination and collaboration across jurisdictions to implement options. Failing to develop

Table 1. Common barriers in the stages of the Understanding phase

Phase and process stages: Understanding	Barriers
Detect problem	Existence of a signal
	Detection (and perception) of a signal
	Threshold of concern (initial framing as problem)
	Threshold of response need and feasibility (Initial framing of response)
Gather/use of information	Interest and focus (and consensus, if needed)
	Availability
	Accessibility
	Salience/relevance
	Credibility and trust
	Legitimacy
	Receptivity to information
	Willingness and ability to use
(Re)define problem	Threshold of concern (reframing of the problem)
	Threshold of response need
	Threshold of response feasibility
	Level of agreement or consensus, if needed

Table 2. Common barriers in the stages of the Planning phase

Phase and process stages: Planning	Barriers
Develop options	Leadership (authority and skill) in leading process
	Ability to identify and agree on goals
	Ability to identify and agree on a range of criteria
	Ability to develop and agree on a range of options that meet identified goals and criteria
	Control over process
	Control over options
Assess options	Availability of data/information to assess options
	Accessibility/usability of data
	Availability of methods to assess and compare options
	Perceived credibility, salience, and legitimacy of information and methods for option assessment
	Agreement on assessment approach, if needed
	Level of agreement on goals, criteria, and options
Select option(s)	Agreement on selecting option(s), if needed
	Sphere of responsibility/influence/control over option
	Threshold of concern over potential negative consequences
	Threshold of perceived option feasibility
	Clarity of authority and responsibility over selected option

such cross-level relationships may result in barriers in the Planning and Management phases (36, 40).

Whether or not actors have proceeded through a sequential process of generating, assessing, and selecting options [and overcoming the associated barriers (Table S1)], once an option has been selected, the process moves into the Management phase. Table 3 lists common barriers encountered in that phase.

Research on climate adaptation to date suggests that few adaptation processes have reached this phase (1, 9, 15, 37, 41), partly because the barriers before and in the implementation stage are so significant and partly because climate change adaptation has emerged as a concern only recently. Thus, we draw more heavily on experience with other management and change processes.

The first stage here, implementation, can involve multiple subprocesses, often many different actors (including some not involved in the process so far), and require varying amounts of time, resources, skills, and effort to fully accomplish. Actors critically influence whether and how a selected option is implemented. The actual intent to implement is a first barrier (42, 43). Grothmann and Patt (10) found farmers in Zimbabwe hesitant or even resistant to take adaptive actions because they had not learned how to correctly interpret climate-related probabilities and they preferred to plant (and eat) maize over millet (the proposed strategy for drought years). The same is often true in bigger interventions. Further, actors must have gathered and aligned knowledge, skill, and financial resources. As the "policy windows" literature has found repeatedly, preparations must be made before the opening of a policy window to be able to take advantage of it when it opens (44).

Moving from option selection to implementation also 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, authorization, permits, political climate, or social norms. For example, implementation of an 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. For example, hardening shorelines to protect them against the encroaching sea may not be permissible under existing law. Past practices of the implementer can present another powerful barrier. The nature of the system of concern also plays a significant role in that it will be physically changed in the course of implementation. Flexible and/or robust strategies may garner easier political will or behavioral intent than strategies that may have big or irreversible consequences (40). For example, building a dam or massive levee system may require a higher degree of public acceptance and stakeholder support and confidence in the science for implementation than those strategies that are more easily reversed.

For adaptive management, mechanisms have to be put in place to allow monitoring and periodic evaluation of the changing environment and the outcomes of the implemented option. A range of barriers have arisen in the past in various adaptive management experiments (45, 46). Lack of (agreement on) indicators, relevant data, methods, and expertise can undermine assessing outcomes and success as well as involve varying degrees of reception (i.e., legitimacy and credibility) by decision-makers and their constituents. The diagnostic questions in Table S1 suggest the actor-, context-, and system-specific reasons why this step so often is not taken.

Table 3. Common barriers in the stages of the Managing phase

Phase and process stages: Managing	Barriers
Implement option(s)	Threshold of intent
	Authorization
	Sufficient resources (fiscal, technical, etc.)
	Accountability
	Clarity/specificity of option
	Legality and procedural feasibility
	Sufficient momentum to overcome institutional stickiness, path dependency, and behavioral obstacles
Monitor outcomes & environment	Existence of a monitoring plan
	Agreement, if needed, and clarity on monitoring targets and goals
	Availability and acceptability of established methods and variables
	Availability of technology
	Availability and sustainability of economic resources
	Availability and sustainability of human capital
	Ability to store, organize, analyze, and retrieve data
Evaluate effectiveness of option	Threshold of need and feasibility of evaluation
	Availability of needed expertise, data, and evaluation methodology
	Willingness to learn
	Willingness to revisit previous decisions
	Legal limitations on reopening prior decisions
	Social or political feasibility of revisiting previous decisions

Crosscutting Issues. Research on climate change adaptation suggests that some barriers appear to be of repeated and crosscutting importance throughout the process. We describe each of these briefly below but suggest that more systematic empirical research must be undertaken to verify our observations.

Leadership can be critical at any stage in the adaptation process but maybe most important in initiating the process and sustaining momentum over time. When there is no mandate, law, job description, or public demand yet for adaptation planning, leaders are required to initiate the process. Importantly, we do not restrict this function to formal leadership and certainly not to just one individual, because some adaptation processes will go on for a long period; rather, we view it as a role that can be taken on by individuals in any position. Leadership can help overcome barriers, but lack of or ineffective leadership can also create some.

Leaders vary in the quality of guidance, motivation, and vision they provide. Those who demonstrate high skill levels (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 participants and perceived as legitimate (47, 48).

Resources also prove to be important in almost every stage, but certainly in the science-heavy planning and management (especially implementation and monitoring) phases of adaptation. Resources include financial means but also technical/information resources, technology, staff expertise, and time. Inadequate resources are often the first response practitioners give when asked why they have not yet begun adaptation planning (31, 49).

Throughout the adaptation process, *communication and information*—about the problem, solutions, and their implications—are perpetually needed aspects of the adaptation process. A growing body of literature highlights the importance of effective communication of climate change information to increase awareness and understanding, provide continuity, and constructively engage policy-makers, stakeholders, and the public (50–55). Information-related barriers have to do with whether, which, and how information is created, how it is communicated, and who delivers and receives it. 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 (56–58).

Finally, there is the issue of deeply held *values and beliefs* that influence how people perceive, interpret, and think about risks and their management, what information and knowledge they value, what concerns have standing and so on—in short, a foundational influence on the decisions and choices made during the adaptation process. Individuals look at new problems, tasks, and solutions through the lens of their preexisting values, preferences, beliefs,

norms, and experiences. In northern Burkina Faso, different cultural values allowed one and prevented another cultural group from adopting new livelihood strategies to reduce vulnerability to climate change (12). As research in risk perception, cognitive psychology, and people's values and beliefs suggests, this "cultural" lens colors our general beliefs about society and the environment (51, 59). In addition, certain heuristics, mental shortcuts, lead to the tendency to underestimate risks arising from climate change (60–63). Cognitive filters shape our perceptions, constrain our attitudes about options (and others involved in the process), and influence our decision-making processes (11, 38). For example, Blennow and Persson (64) found that the strength of belief in climate change was a crucial factor for explaining differences in adaptation actions among Swedish forest owners. Ideologies based on the dominating pattern of values thus can act as barriers or drivers to the process (59).

These crosscutting issues take on specific "flavors" in each stage, and context features may make them rise to greater or lesser significance, yet there is probably not a single case of adaptation to date where they have not posed significant barriers to the process.

Overcoming Barriers: Scales of Influence. The third and final step in our diagnostic framework provides a simple matrix to help locate possible points of intervention to overcome a given barrier. Although we do not view overcoming barriers as a normative "must," actors involved in the adaptation process may be interested in overcoming them. In fact, we hypothesize that working through barriers, rather than skipping entire phases of the decision process, may prove beneficial for the decision outcome. At any rate, 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 spatial/jurisdictional and temporal origins of the barrier relative to the location of the actor are important. The temporal dimension includes contemporary versus legacy barriers, and along the spatial/jurisdictional dimensions (which sometimes coincide, other times differ in scale), proximate versus remote barriers.

Each barrier varies along both dimensions (Fig. 4), and, although there may be overlap between legacy/remote barriers and contemporary/proximate barriers, respectively, they are not necessarily identical. For example, a local official may want to find scientific information on vulnerability but cannot locate any relevant research 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 Fig. 4). The local official cannot easily overcome this barrier by addressing it at its source (i.e., through changes in federal research and development funding) and closer to home only with significant resources, time, and expertise (i.e., by hiring someone to do this research). By contrast, a barrier that is both proximate and contemporary (A in Fig. 4) is one 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 Fig. 4). Although the situation is still challenging, she has control over initiating changes in this regulation. She may also be faced with a remote contemporary barrier, i.e., one that occurs now but is beyond the official's direct control (B in Fig. 4). For example, a budget crisis results in an agency, charged with providing technical assistance to the local process, now having insufficient staff to do so.

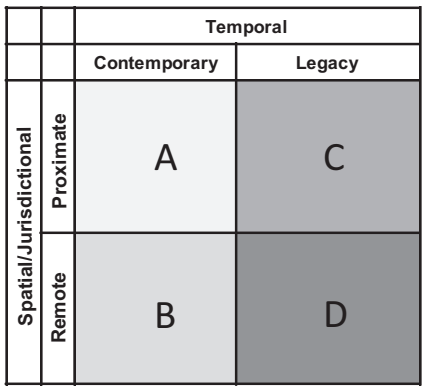

Fig. 4. Opportunities for influence and intervention to overcome barriers.

Discussion

The purpose of our diagnostic framework is to systematize the identification of barriers that may impede the adaptation process. In *Results*, we answered two fundamental questions: (*i*) what could thwart the process and (*ii*) how do the actor, context, and the system of concern contribute to the barrier. We also noted how the sources of these barriers vary across temporal and spatial/jurisdictional scales, and thus identified the locus of control over them.

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 will all be required in overcoming them. Frequently, this effort of overcoming barriers is in fact the primary target and focus of the initial adaptation effort (3, 37).

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 or to a one-size-fits-all way to overcome barriers. Rather, we expect feasible strategies to be highly context-sensitive (i.e., actor-, governance-, and system-specific), which is why a systematic diagnostic framework may be more useful than a prescriptive list of necessary conditions, capacities, or steps to overcome barriers. We do, however, suggest that the generalized call for "building adaptive capacity" may be too simplistic an answer to deal with the range of adaptation barriers. Although the list we developed here may be viewed as an elaboration on the inverse qualities of adaptive capacity, overcoming barriers is not as straightforward as building adaptive capacity. To truly understand the relevance of, say, "more resources" is to ask when these resources are needed, by 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" at each of the stages could become a more useful and tangible measure of adaptive capacity. Different dimensions of adaptive capacity may also partially compensate for each other. For example, a good leader may be able to compensate to some extent for inadequate time and money because she has great connections or can facilitate potentially difficult processes efficiently and find creative financing solutions without additional resources. Future research must explore the range of pathways actors have found to overcome the specific adaptation barriers they encountered.

Conclusions

In this article, we have introduced a framework for identifying and organizing barriers to adaptation. Rather than propose a normative approach to making "good" adaptation decisions, we offer a comprehensive, systematic approach to detecting barriers in each stage of an idealized adaptation process, along with diagnostic questions that help ascertain how actors, context, and the system of concern contribute to the existence of the barriers.

Our diagnostic framework requires testing and refinement if it is to aid decision-making. For example, the framework could be used as a foundation to examine whether and how barriers differ

by the type of system of concern, 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 where the most challenging barriers might lie affords the opportunity to better allocate resources and strategically design processes to overcome them. Similarly, we may learn much about adaptive capacity and ultimate adaptation success by exploring 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.

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