8

Climate Change and Sea-Level Rise in Maine and Hawai'i: The Changing Tides of an Issue Domain

Susanne C. Moser

Introduction

Sea-level rise (SLR) is evident at a variety of scales. Those producing and using information about it exist along the spectrum from the global to the local. Scientific assessments demonstrate a remarkable consensus on the potential for accelerating SLR due to anthropogenic climate change (Gregory et al. 2001; Intergovernmental Panel on Climate Change 2001a, 2001b; Nicholls and Lowe 2004; Oppenheimer and Alley 2004; Stive 2004; Zhang, Douglas, and Leatherman 2004; Meehl et al. 2005; Wigley 2005). Yet SLR is already occurring along much of the U.S. coastline—in some places at barely perceptible, in others at alarming rates (e.g., Boesch, Field, and Scavia 2000).

A rise in sea level and potential changes in storm climatology are of the utmost relevance to coastal zone policymaking, development, and management. Human welfare, high investments, and significant environmental resources intimately linked to human activities along the coast are at stake. Thus, it is all the more surprising that concern with global climatic and related environmental changes among U.S. coastal managers, especially at subnational levels, continues to be rather scant. Until the late 1990s, only a few U.S. coastal states had conducted assessments of SLR, and even fewer had made changes in their coastal policies or regulations. This suggests that coastal management exists largely separate from climate change and its impacts, including SLR.

The question arises then whether scientific assessments of global environmental risks—such as SLR—influence local decision making and management. If so, under what circumstances are different assessment

designs and processes effective in supporting the management of cross-scale environmental risks? If salience, legitimacy, and credibility determine the influence scientific information has on decision making, then the question of how they are balanced in the context of cross-scale risk management should help us better understand effective information-decision-support systems.

I draw on case studies in Maine and Hawai'i to address these questions. At the heart of the case-study choice was an interesting conundrum: the island state Hawai'i is arguably more vulnerable to SLR and may have a greater need for useful SLR information, but as yet has not established any SLR-specific policy response. By contrast, the relatively less vulnerable Maine already has in place SLR-specific legislation. In examining the paradoxical relationship between these two states' vulnerability to SLR vis-à-vis their policy responses, I examined whether the quality and flow of information between scientists and decision makers influenced current local concern and policymaking on SLR. The study revealed two answers: one about the lack of immediate, or easily apparent, influence of assessments on policymaking and another about the much slower, more subtle, but no less important influences that alter the policy landscape and larger issue domain. In the latter case, how assessments are designed and conducted appears to make a difference.

In short, in single-level assessments, the challenge for assessors is to make the issue salient with nonparticipating audiences at other levels. The core challenge lies in forming connections between heretofore-separate issue domains where participant interests, frames, resources, and capacities differ radically. Once this connection is made, the issue domain of concern (e.g., climate change–induced SLR) has been altered to include participants from other issue domains (e.g., coastal hazards). In assessments that include participants from multiple levels, salience is more easily established. Here assessors must place more emphasis on legitimacy and credibility to ensure that participants feel their input matters and produces a desirable, fair, and defensible outcome. Once these basic procedural needs are met, participants may be more open to changing their beliefs, ways of framing an issue, and possibly their policy goals. Balancing credibility and legitimacy within the formal assessment

process and beyond, as participants carry assessment inputs and outputs between their respective communities, becomes essential.

Multilevel Assessment Designs and Influence—the Research Approach

Assessment Outcomes

To ascertain the influence of assessment efforts on policymaking and issue domains, it is useful to recall the definition of *assessments*. The GEA Project defines them as more or less formalized efforts to assemble selected (e.g., expert) knowledge and to make it publicly available for use in policymaking and decision making (see chapter 1 and Global Environmental Assessment Project 1997). This broad definition views assessments as products and processes, and defies identifying a single measure of influence or effectiveness (see Cash, chapter 10, this volume, for examples of partial measures). In this study, I judge influence subjectively on the basis of empirically observed outcomes of assessments, not just in the narrow sense of producing policy changes, but also in the broader sense of contributing to a range of issue domain changes, including participation, awareness, understanding, framing, goals, and the attributed qualities—salience, credibility, and legitimacy—of information itself.

Assessments as Communicative Interactive Processes

The transfer of information and its application in practice is—while much facilitated and influenced by institutions and technology—fundamentally a communicative, interactive process between individuals. A better understanding of the role of assessments begs for an analysis of the information being transferred and transformed into active knowledge, the motivations behind information transfer, the actual and potential linkages among actors, and the quality and frequency of interactions among them and their institutions (Miller et al. 1997). These interactions are examined here in the context of institutions and formal and informal networks. Likewise, decision making at various scales most commonly occurs within the context of existing management structures, government programs, and established decision-making procedures

(Moser 1997). This assumption does not preclude the possibility of launching new initiatives or programs. They become embedded in or go beyond ongoing management efforts and institutions but must be legally consistent with existing programs.

This comparative case study investigated the role of perceived vulnerability and information need, the links among information producers and users, as well as political closeness between local, state, and federal institutions in affecting assessments and their influence on information exchange and decision making. Maine and Hawai'i share several similarities and differences, and thus make for a strong comparative research design.

The critical elements examined included

- The *players*: information producers, gatherers, disseminators, brokers, and users (including the quality of interaction among them)
- The *information transfer process*: "one-time" versus iterative exchange among new or repeatedly involved individuals and institutions
- The *degree of integration of the information* (or assessment) *in the decision-making process*
- The *degree of integration* of information and decision-making systems *across scales* and other boundaries

My research did not involve an explicit analysis of political-economic interests, but clearly these dynamics shape the context, motivations, behaviors, and interactions among issue-domain participants. Concerns over power and interests are thus implicitly examined in the context of information exchange and use in controversial policy- and decision-making settings.[1]

Information Sources

The analysis was largely based on interview and documentary evidence. Specifically, I drew on documents available at local to international levels, including assessments, coastal-management documents, and other information on climate change and variability, SLR, and its more visible manifestations—erosion and coastal storm impacts. These materials document some of the formal and informal bridges between scientists, interested individuals, and decision makers. In addition, I conducted

Table 8.1
Interviews conducted for study

Type of Interviewee	Hawai'i	Maine	Federal/ National	TOTAL
Researchers	7	6	6	19
Program directors	2	2	2	6
Planners	7	10	0	17
Hazard managers	2	1	1	4
Environmental specialists, engineers	3	5	2	10
Extension agents	5	1	0	6
Outreach specialists/ coordinators	1	4	0	5
NGO representatives	3	3	1	7
TOTALS	30	32	12	74

seventy-four face-to-face interviews with key informants in state and federal offices, environmental NGOs, and research institutions (see table 8.1). Finally, I was a participant observer in state and federal assessment efforts.[2] The information obtained from these sources was validated through triangulation, then submitted to a qualitative, comparative analysis of the two states.

Contrasting Different Assessment Designs

There are two basic types of assessment designs for cross-scale information exchange. In one, assessments are conducted at one level, without involving participants from other levels. Assessors make no explicit attempt to directly capture the concerns, needs, and capacities of actors at other levels, but may assume that information coming out of the assessment affects decision makers at those levels. The IPCC climate change assessments are a good example. Research and experience consistently show that such expectations remain unfulfilled (e.g., Easterling 1997; Moser 2005), unless special efforts are made to downscale from global assessments to local decision-maker needs (see Patt's notion of "decision matching" in chapter 9 of this volume), and to involve players

from those regions and subnational areas (see Biermann, chapter 4, this volume).

In the second type of assessments, assessors make an explicit effort to include participants from all levels deemed relevant to the issue, and thus to directly capture the concerns, capacities, and opportunities at those levels. The first *U.S. National Assessment of the Potential Consequences of Climate Variability and Change* (1997–2001) (hereafter *National Assessment*; see National Assessment Synthesis Team 2001) is an example of this design. Lessons from this unprecedented effort in designing and conducting an inclusive, participatory process are still being drawn (e.g., a study conducted by Carnegie Mellon University; see also MacCracken 2000; Fisher 2001; Moser, forthcoming), but several federal agencies and individuals are committed to finessing this approach (U.S. Global Change Research Program 2001).

In this study, examples of both assessment designs are examined. This allows me to examine the respective challenges and lessons for developing more effective assessment processes and information-decision-support systems.

Sea-Level Rise Concerns in Maine and Hawai'i

Maine and Hawai'i—while vastly different in geology and geography—stand to lose much from accelerated SLR. Both states already experience significant rates of SLR along their coastlines (figures 8.1 and 8.2). Both are at risk from severe storms and most of their populations, development, and economic activities are located in the coastal zone. By any measure, however, the island state is the more vulnerable: Hawai'i has a longer coastline exposed to more intense storms; over 90 percent of its population (versus ~70 percent in Maine) lives in a narrow coastal zone with inland areas too steep to retreat to; most resources must be imported across long distances or are limited to what can be captured, produced, and stored on the islands (e.g., water); and its tourism sector, predominantly dependent on the state's beaches, is to a larger degree than Maine's *the* driver of the state economy.

Interestingly, however, the less vulnerable state already institutionalized its concern with anthropogenic climate change–driven SLR in its

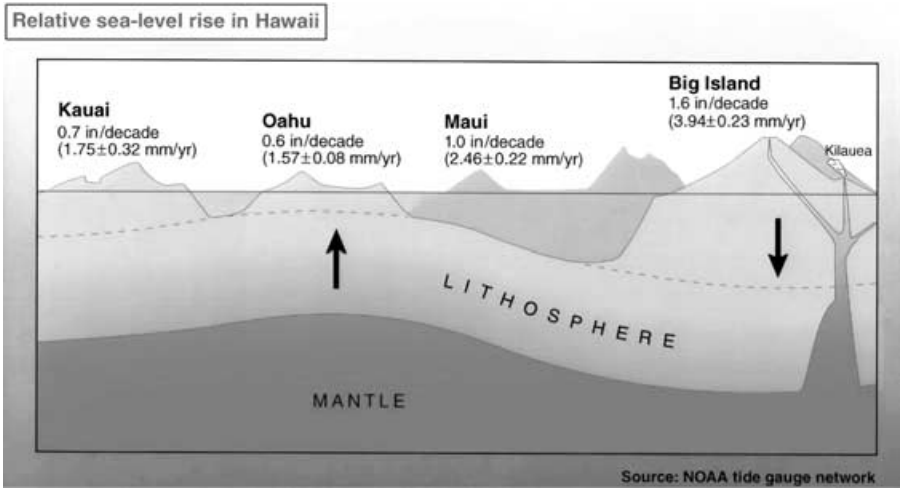

Figure 8.1
Sea-level rise rates of main Hawaiian islands. *Source:* Graph by Chip Fletcher. Reprinted with permission.

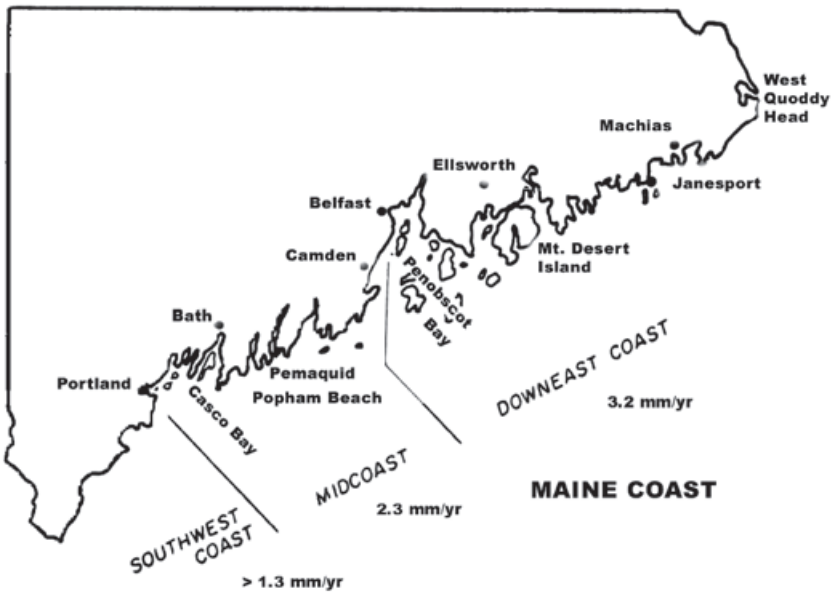

Figure 8.2
Sea-level rise rates along Maine's coastline. *Source:* Adapted from Kendall, David L. *Glaciers and Granite: A Guide to Maine's Landscape and Geology.* Unity, ME: North Country Press, 1987, p. 50. Reprinted with permission from North Country Press.

Table 8.2
Coastal zone management in Hawai'i and Maine

	Hawai'i	Maine
CZMP approved	1978	1978
Structure	Networked	Networked
Legal basis	Hawai'i Coastal Zone Management Act (1977)	13 different laws, especially Sand Dune Rules (SLR)
Home agency	State Planning Office	State Planning Office
Agencies involved	4 federal, 6 state (7 state NGOs)	4 federal, 7 state, 8 state NGOs officially integrated
Hazard priority?	Yes	Yes
SLR in law/regulations?	No	Yes (since 1988 even SLR due to global warming)

coastal laws in 1993, while there is no such policy in Hawai'i even now (table 8.2). One possible hypothesis holds that SLR assessments and cross-scale information exchange simply are more effective in Maine than in Hawai'i. If so, are there significant differences in design and process that can explain the paradox?

Sea-Level Rise Research and Assessments

National Context for Global Change Research and Assessments This analysis begins at the national level, which is central to investigating information flow and decision making across scales. Since 1990, the plethora of global change research initiated and funded by federal agencies has been found under the umbrella of the U.S. Global Change Research Program (USGCRP) (now Climate Change Science Program, CCSP), whose mission is defined in the U.S. Global Change Research Act of 1990 (hereafter GCRA, as amended) (U.S. Congress 1990b). The GCRA mandates that the "development of effective policies to abate, mitigate and cope with global change will rely on greatly improved scientific understanding of global environmental processes" and that "an effective federal research program will require efficient interagency coordination, and coordination with the research activities of state, private

and international entities." Coordinators of the USGCRP must "consult with actual and potential users of the results of the Program to ensure that such results are useful in developing national and international policy responses to global change" (Title I, secs. 101, 102).

The GCRA also requires that research results be made available to potential users through government dissemination services (Title I, sec. 104(d)). This has occurred since 1993 through the Global Change Research and Information Office (GCRIO). Interestingly, none of the subnational interviewees mentioned the GCRIO as a source for information on global change issues.[3] Interviews suggest that either the Office does not provide the kind of information its target audiences need and/or that there is insufficient effort by the GCRIO to consult with, and advertise its services to, potential users. So, while the GCRA establishes the framework for federal interagency cooperation, coordination, and communication of global change research across levels and constituencies, its success in reaching subnational information users is limited. One analyst predicted that "the program will likely produce 'good science' but fail to provide 'usable information' on which policy decisions relating to global change can be based" (Pielke 1994, 315) because no deliberate process was established to continuously assess "good science" and its usefulness in light of concrete policy problems and response options.[4]

Federally Sponsored, National and Regional Sea-Level Rise Assessments

Even before the passing of the GCRA, important SLR research and scientific assessments were conducted nationally (e.g., Hoffman, Keyes, and Titus 1983; Barth and Titus 1984; National Research Council 1987, 1990). Significant federal investments had been made in basic coastal science and SLR monitoring. Federal agencies also sponsored assessments and regional workshops on the potential impacts of SLR to raise awareness of the topic, educate subnational policymakers and coastal managers, and elicit input on information needs from the practitioner community (Mehta and Cushman 1989; Daniels et al. 1992; Gornitz et al. 1994; Rappa, Tomlinson, and Ziegler 1995).

Among the most visible federal SLR-related efforts is the research, assessment, and outreach conducted by the EPA since the early 1980s

(e.g., Hoffman, Keyes, and Titus 1983; Barth and Titus 1984).[5] As part of a 1989 multivolume climate change impact assessment for the United States, the volume on SLR served as *the* reference on the topic for much of the 1990s (Smith and Tirpak 1989). The EPA's Jim Titus was instrumental in compiling this scientific assessment and bringing SLR to the attention of state and local stakeholders (Moser 1997).[6] EPA and NOAA continue to sponsor and conduct their own SLR research (e.g., Titus and Narayanan 1995).

In the 1990s, the EPA also offered funds to states to assess state-level SLR impacts and response options. This process rarely included a broad range of stakeholders. Rather, these studies involved interdisciplinary teams of researchers and, to a lesser extent, representatives of state agencies involved with coastal management. Interviews revealed that participation in such studies was the strongest predictor of subnational actors' awareness of these federally sponsored efforts, and of their knowledge about climate change and SLR. No evidence was found, however, that suggested these reports had any impact on subnational policymaking, or on the broader public awareness of the problem.

The *National Assessment* was the most comprehensive effort to reengage the question of climate change impacts on various sectors and regions. It remains the most explicit, federally sponsored attempt to design a multilevel, multistakeholder assessment process. Both Maine and Hawai'i were active in their respective regional assessments (see below), but no representatives from the two states were involved in the coastal sectoral assessment (Boesch, Field, and Scavia 2000). Finally, under the auspices of the U.S. Geological Survey (USGS), an unrelated effort got underway to assess the U.S. coastline's physical vulnerability to SLR (Thieler, Williams, and Hammar-Klose 2001).

State-Based Sea-Level Rise Research and Assessments in Maine Maine has a well-established contingent of scientists, which for over three decades has investigated the sea-level history of the state, the ecological and economic impacts of SLR, and especially its most visible consequence—coastal erosion.

Maine's biggest assessment effort regarding climate change-induced SLR is a 1995 EPA-funded study conducted by the Maine State Planning

Office, the University of Maine's Marine Law Institute, and the Maine Geological Survey (Marine Law Institute/University of Maine School of Law, Maine State Planning Office, and Maine Geological Survey 1995). This study aimed to undertake "Maine's first systematic assessment of its vulnerability to a change in shoreline position as a result of accelerated SLR associated with global climate change" (p. S-1). The report, titled *Anticipatory Planning for Sea-Level Rise along the Coast of Maine*, is—in light of the general dearth of such studies at the subnational level—a remarkable document. It includes a physical-geographic analysis of SLR impacts (mainly based on past impacts of historical SLR in Maine and the development of scenarios), an economic vulnerability assessment and cost-benefit analysis of various response options, and a review of laws and regulations pertaining to the coastal zone that could be used to address SLR. The assessment uses low, medium, and high SLR projections and combines these with historical, locally measured rates of SLR.

The report builds on two basic premises: that "the state should protect and strengthen the ability of natural systems to adjust to changes in shoreline position, and that the state should prevent new development that is likely to interfere with the ability of natural systems to adjust to changes in shoreline position" (p. S-11). Assessors concluded that "meaningful preparations can take place now, despite scientific uncertainty, by carefully building upon what is already known" (p. S-2). The report also listed fifteen recommendations for planning and regulatory changes, research, and education.

Interview and documentary evidence suggests that no policy change resulted from that assessment. Experts continue to focus on the immediate (and growing) erosion problems without reference to future SLR. Interviewees reported little change in public awareness of SLR, and only few experts—either involved in it or close to the topic—even knew about the assessment. Neither finding is surprising since no significant outreach effort beyond a standard mailing and web announcement was undertaken. One private land trust used the findings to produce a video and attractive brochure for visitors to its land.

In 1997, Maine coastal experts were involved in a scoping workshop for the Northeast regional component of the *National Assessment*. In

that workshop, impacts of extreme weather events and climate change impacts on coastal ecosystems were discussed, but did not rise to the level of a key concern for New England in the final assessment. Hence, SLR was not assessed in any detail, and after the scoping workshop, Maine coastal experts were no longer involved in the effort (New England Regional Assessment Group 2001).

State-Based Sea-Level Rise Research and Assessments in Hawai'i SLR research on the Pacific islands dates back to the late 1940s, motivated by the desire to reconstruct the contested Holocene sea-level history of the Pacific Basin (Jones 1998; Nunn 1998). Other studies then and now focus on shorter-term sea-level variability associated with the El Niño–Southern Oscillation cycle because these variations are frequently larger, shorter in onset and duration, and thus more visible and of greater concern than the long-term changes expected with climate change (Lukas 1998). Mostly, however, coastal research was a stepchild of geology in Hawai'i in the face of the overriding interest in active volcanism.

Since the early 1990s, with coastal geologist Charles Fletcher joining the University of Hawai'i–Mānoa, geological research on Holocene sea-level changes took off with a more applied flavor. Studies on sediment deficiencies, shoreline change, erosion rates, and beach loss on each of the islands were intended "to make this knowledge available to governmental planners, decision-makers and the public to better manage the coastal zone and ensure sustainability for future generations" (Coastal Geology Group 1997, 2001). In an attempt to establish a "scientific basis for evaluating current land management practices" in Hawai'i (Fletcher, Mullane, and Richmond 1997, 209), Fletcher is not only producing pertinent information, but also training a growing number of coastal experts at the University of Hawai'i. Ad hoc, site-specific research on the impacts of development on shoreline dynamics and coastal erosion is conducted by private-sector coastal engineers. All these efforts are improving information availability and expertise but, as one county official put it, "a big dearth of scientific information" on coastal processes still exists.

To achieve greater salience for coastal hazards, Hawai'i's experts—like their counterparts in Maine—focus on the immediate, visible beach erosion rather than on long-term SLR. In both states, experts occasion-

ally use potentially accelerating SLR to augment arguments for changes in beach management (see also Fletcher and Hwang 1992b; Fletcher, Mullane, and Richmond 1997; Hawai'i Board of Land and Natural Resources 1998).

In 1998, a number of Hawai'ian experts and stakeholders participated in the scoping workshop and later in the full assessment for the Pacific Island Region—another part of the *National Assessment*. In the workshop, participants showed great concern for sea-level variation, accelerated SLR and its associated hazards, and for their impacts on critical island resources and economies. Thus, the assessment strongly emphasized coastal issues (Pacific Islands Regional Assessment Group 2001). Moreover, local organizers of that assessment made an exemplary effort to involve state agencies and key private-sector representatives to initiate communication, and have been building on this initial effort ever since.[7]

Interestingly, federally sponsored assessment and information exchange efforts in Hawai'i face a challenge not found as prominently in Maine. Interviewees referred to the frequently tense relationship between Hawai'i, the U.S. mainland, and federal agencies, unless they have local offices and are staffed by local residents ("local feds"). These tensions are rooted in the political history of Hawai'i, the historical treatment of Native Hawai'ians, the magnitude of the military's influence in local politics, and a basic distrust of "mainland" sources of information. Several interviewees spoke of the irrelevance of climate change information produced by mainland sources, because it does not account for special island challenges. Local information brokers and providers thus must present themselves as either independent of federal or mainland influences—even when such ties exist—or at least be unequivocal about their allegiances with Hawai'ian concerns.

Policy Action in Maine and Hawai'i

The Federalist Approach to U.S. Coastal Zone Management The federal Coastal Zone Management Act (CZMA) of 1972 is the umbrella legislation for all state-based coastal-management programs and implementation of national coastal-management goals. Federal authorities review and approve state programs, but states have the freedom to

achieve goals in ways they deem appropriate. In recent years, the CZMA has added mechanisms to increase state accountability to the federal sponsor.

In 1990, while global change figured high on the political agenda of the U.S. Congress, the CZMA was amended to include the following paragraph on global warming and its potential impacts on coastal areas:

> Global warming could result in significant global sea level rise by 2050 resulting from ocean expansion, the melting of snow and ice, and the gradual melting of the polar ice cap. Sea level rise will result in the loss of natural resources and will contribute to the salinization of drinking water supplies. Sea level rise will also result in damage to properties, infrastructures, and public works. There is a growing need to plan for sea level rise. (U.S. Congress 1990a, sect. 6202)

Although such changes are legally nonbinding on states, they can raise awareness among state policymakers. Inserting the threat of SLR into the federal law, however, has had no discernible impact on state programs. Interviews in both Maine and Hawai'i gave no indication that inserting climate change and SLR into the CZMA evoked any state policy response. Few coastal managers were even aware of this change. Even within the Office of Ocean and Coastal Resource Management—the implementing branch of the federal Coastal Zone Management Program within NOAA—no programmatic shift occurred toward aiding states in taking SLR into account in implementing their coastal programs. With the passing of the GCRA and the amended CZMA, however, state coastal programs became eligible for federal funds earmarked for investigating global change and SLR impacts and for examining potential responses (an opportunity Maine, but not Hawai'i, took advantage of in its 1995 assessment).

Policy and Issue-Domain Changes in Maine The case of Maine is peculiar in that a policy change occurred *before* the 1990 addition of SLR to the CZMA, before its comprehensive SLR assessment, and long before broader public awareness of the issue (Moser 1997). The policy history falls into three phases:

Late 1970s This period saw the establishment of the state coastal program, in which historic SLR without reference to climate change was

inserted in the legislative findings to justify the coastal-hazards focus of the program.

Late 1980s In a landmark regulatory change to the state's Sand Dune Rules,[8] accelerated SLR due to anthropogenic climate change was used to strengthen hazards management, a move motivated opportunistically to justify, and provide the specific basis for, directing the development boom of the period in a preferred direction.

Late 1990s–Present Slowly growing public awareness of global warming has expanded the climate change issue domain. While attention has primarily been focused on greenhouse gas emission reductions, a focus on adaptation has slowly emerged, opening the way to eventual integration of issue domains.

Recently, growing public concern about coastal erosion has led to the establishment of a multilevel, multisector Coastal Resources Stakeholder Task Force. Significant attention has gone to southern Maine's erosion problems and to regional beach-management schemes. Southern Maine's regional planning commission hired a "beach planner" to work with coastal communities on local beach-management plans that are integrated across municipal boundaries. The immediacy of erosion continues to dominate discussions, and local experts and key players in the debate see little value in focusing on the slow, imperceptible changes of SLR. At best, they use SLR as the "final nail in the coffin" to argue for improved coastal-management practices. For example, at the state level, the Sand Dune Rules were updated in 2004 (with a SLR projection over the next 100 years reduced from three to two feet), and outreach efforts are underway to strengthen stakeholder understanding of the value of restrictive regulations along beaches due to erosion (S.M. Dickson, personal communication, 2005). To date, key experts have rarely framed coastal hazards without reference to climate change.

Meanwhile, the combined impact of several regional conferences, increasing media attention, outreach efforts, research, and assessment activities by a variety of actors is changing discussions of climate change in Maine. In 2003, a state climate action plan, based entirely on voluntary measures, was replaced with one calling for an emission registry and

mandatory targets and timetables for CO_2 emission reductions. Moreover, the integration of climate change and coastal issues slowly continues from the older state Climate Change Action Plan (Maine State Planning Office 2000). Both acknowledge the vulnerability of coastal areas to the impacts of climate change and recall the state's 1995 SLR assessment. A second indication is the regional New England–Eastern Canadian Climate Change Action Plan (Conference of New England Governors and Eastern Canadian Premiers 2001), which concentrates on mitigation, but also includes references to coastal adaptation.

In summary, Maine (compared to other coastal states; see Moser 1997) is one of the most progressive U.S. states in addressing SLR in its regulations (University of New Hampshire/Institute for the Study of Earth Oceans and Space 1997, 45; Maine Environmental Priorities Project 1996). There is considerable local pressure to address coastal erosion problems but experts and stakeholders alike make the link to SLR only if it strengthens their position. SLR impact assessments have only occasionally and opportunistically supported coastal-management efforts. More importantly, the concerted and persistent outreach and educational efforts of key players in the coastal-management issue domain have raised awareness of erosion problems and related hazards among the coastal citizenry.

Policy and Issue-Domain Changes in Hawai'i Although Hawai'i has not yet formulated a policy response to SLR, climate change has not gone unnoticed in policymaking circles. In 1985, the Hawai'i Coastal Zone Management Program (HCZMP) produced a short report on the potential "effects of a worldwide rise in sea level induced by the 'greenhouse effect'" (Hawai'i Coastal Zone Management Program 1985). This report—qualitative and typical for that time in its relatively simplistic approach—projected dire consequences under four different SLR scenarios for Honolulu. These scenarios were alarming, if not outright catastrophic, and should have—given their focus on the political and economic center of Hawai'i—produced loud outcries among the intended audience. Maps showed several critical shorefront installations to become inundated under those SLR scenarios, including the Honolulu International Airport, major traffic arteries, and significant high-value

properties in Honolulu's tourist center, Waikīkī. One nongovernmental but well-informed insider explained that for acute political reasons—the proposed expansion of the airport—this report vanished without receiving any publicity. It is unclear whether it was ever submitted to the state senate at all.

Unsurprisingly, the assessment had no discernible outcome, although it recommended (1) continuing to study SLR and its impacts on Hawai'i and revisiting the issue of SLR in 1989; and (2) developing a more comprehensive plan detailing how SLR should be addressed within planning, shoreline infrastructure development, existing regulations, and economic incentives to direct development away from hazardous areas (Hawai'i Coastal Zone Management Program 1985, 7–8).

The issue was not publicly revisited until the Regional Assessment (see below). Independently, the HCZMP has, however, financially supported the preparation of a Beach Management Plan (Fletcher and Hwang 1992a). The plan discusses current and projected rates of SLR for the major Hawaiian islands, taking island subsidence and accelerated SLR projections by the IPCC into account, and assesses available management options. No specific policy changes resulted from this plan, although proposals for planning and regulatory changes have been discussed. In the late 1990s, Fletcher's research group also conducted studies for each of the islands to provide shore-status baselines and identify beach-nourishment priorities. In a parallel effort, an interagency task force (MACZMAG, see below) is reviewing and streamlining beach-nourishment permitting procedures.

Other state-government publications occasionally mention SLR but have not resulted in any specific policy action.[9] Separately, several reports about climate change did not mention SLR—again a compartmentalization of issues that may have institutional and/or strategic motives, but that has resulted in independent framing of related issues.[10] In another instance—the state climate change action plan—SLR and climate change were mentioned simultanelously in one report, but the information had little local credibility. Initiated in 1997 through the EPA's State and Local Climate Change Partners Program the plan (State of Hawai'i 1997c), incorporated an EPA pamphlet on climate change impacts on Hawai'i, including coastal impacts, but the information is uninformed and

outdated—a good example of why Hawaiians frequently are skeptical of mainland information.

Over the past few years, several high-visibility climate change or coastal conferences in the region have addressed SLR, thus beginning to build a bridge between the climate and coastal-hazards issue domains.[11]

In the late 1990s, the HCZMP established a new statewide institution, the Marine and Coastal Zone Management Group (MACZMAG), to bring together a broad range of stakeholders to exchange views on, and discuss options for, coastal management. Interviewees considered this group critical to improving cross-agency, cross-scale, and cross-constituency information exchange and thus critical to improved decision making. One of its subcommittees—closely tied to the Coastal Geology Group—is exclusively focused on coastal erosion, but government interest in climate change–induced SLR remains low.

In short, while various state agencies have been involved in efforts to look at climate change and resulting impacts such as SLR, there is no indication yet that they have informed or led to specific policy or management changes. Those management changes that have been set in motion in recent years have been justified on the basis of tropical-storm and erosion-related hazards. However, these changes may be seen as fostering readiness to deal with SLR. According to interviewees, they contribute in a cumulative fashion to changes in awareness and policy changes over the long term. As in Maine, coastal managers return from such workshops to the daily pressures of more immediate erosion- and hazard-management challenges, pushing the long-term, less visible driving force again to the back burner. The strong strategic focus on beach erosion and replenishment that emerged in the late 1990s has resulted in research and outreach efforts. These have brought historical SLR to public and policymaker attention, although without any emphasis on future trends (Hawai'i Board of Land and Natural Resources 1998). Slowly, these efforts build a constituency "neighborhood association by neighborhood association" for alternative, regional and adaptive, learning-oriented approaches to beach management, according to a professor at the University of Hawai'i. They also slowly change the range of participants in the coastal-hazards issue domain and may be instrumental in integrating it with climate change–driven SLR.

Table 8.3
State responses to sea-level rise in comparison

	Hawai'i	Maine
Research	Some, accelerating in recent years	Significant research history
Assessments	1885, 1992 qualitative	1980–1990, 1995 quantitative
Programs/planning	1991–1992, 1997	1980–1990, 1995
Legislation	None for SLR Beach-management plans under development	Sand Dune Rules (1988, 1993) Beach-management plans instituted

Table 8.3 summarizes Maine and Hawai'i's scientific and policy responses to SLR. Below I examine in more detail the reasons behind these differences.

The Influence of Assessments in Issue-Domain Changes

The introduction to this volume argues that the qualities participants attribute to an assessment (salience, credibility, and legitimacy) largely determine its influence in an issue domain. Assessments influence the behaviors of actors and public policies by (1) changing the way people frame a problem, (2) mobilizing people to become participants in an issue domain, (3) altering people's knowledge about the issue and potential solutions, (4) affecting their goals, and (5) building their capacity to understand the science and/or deal with the problem (also see chapter 11).

The cases sketched above clearly suggest that there is no monolithic issue domain of climate change and (coastal) impacts linking the global with the local. Hence, achieving salience, credibility, and legitimacy across scales involves some interesting challenges. Experience in Hawai'i and Maine suggests that SLR assessments conducted at one level largely failed to become salient to scientists, policymakers, and decision makers at other levels. Coastal impact assessments by and large did not reach the broader coastal expert and management community. Interestingly,

multilevel assessments, as the example of the regional or sectoral components of the *National Assessment* show, have no guarantee of doing so either, even though participation of the relevant stakeholders is more likely. The fact that multilevel participatory assessments are undertaken, however, despite the enormous time and resources required, marks a growing recognition of the importance of stakeholder input.

These findings suggest three fundamental conclusions. First, assessments of cross-scale environmental risks can fail to have an easily discernible influence on policymaking because those involved fail to deal effectively with the salience/credibility/legitimacy challenges involved. They may make strategic choices around participation, framing, and outreach that prevent such influence (see also Deelstra et al. 2003), or the assessments are conducted at a time in the issue domain's evolution when the policy environment is not yet primed for policy change. Second, if an effort is made to consciously design assessments of cross-scale environmental risks, the quantity and quality of relationships constituting the assessment process are of utmost importance to its outcome in terms of salience, credibility, and legitimacy. And third, understanding the dynamics between separate issue domains may help produce assessments that do reach the intended audience. Important differences in the quality and quantity of relationships between Maine and Hawai'i are delineated in table 8.4 and discussed in detail below.

To assess the extent to which the conduct of the various state-based assessments influenced outcomes, it helps to first eliminate some nonassessment factors, which also appear to have affected the observed differences in the policies of Hawai'i versus Maine. These are largely contextual factors, which assessment designers cannot influence directly, but also must not ignore if assessments are to be influential. Among these nonassessment factors are the state of the economy (as reflected, for example, in state budgets or development pressures on the coast); historical relationships between federal, state, and local decision makers; and the preassessment status of coastal and climate research, including the quality and extensiveness of the network of involved researchers and decision makers. Together, these factors appear to have made Maine more receptive *earlier* than Hawai'i to the issue of climate change–induced SLR.

Table 8.4
Comparison of information-exchange networks in Hawai'i and Maine

	Hawai'i	Maine
Multiactor networks	In place	Elaborate, well established
Frequency of interaction, communication	Issue-specific	High
Interagency relations (at same level)	Highly varied, competitive	Mostly congenial
Cross-scale relations		
State-local	Antagonistic	Collaborative
State-federal	Antagonistic	Collaborative
Science/policy relations (info producers/users)	Some existing, emerging and getting better	Established, strong
Satisfaction with interaction (generally, across all informants)	Low	High

Several differences, however, are less readily explained by these nonassessment factors and seem better explained by differences in features of the assessments themselves. They apparently made Maine decision makers more concerned with SLR than Hawaiians. They also all involve strategic decisions by assessment participants around salience, credibility, and legitimacy in light of the specific context: (1) to reframe the climate change issue in ways that "speak to" local decision makers, or to link local coastal issues to global change when doing so bolsters local policy goals; (2) to build a contingent of credible researchers as messengers of a complex, controversial issue, and to develop a transparent process of credibility assurance; and (3) to carefully design information-decision-support processes that involve participants who can provide the needed expertise, representation, and decision-making power, but also to skillfully tend to the interaction opportunities and challenges within multiactor networks. Each of these points is discussed in more detail below.

Salience: The Challenge of Separate Issue Domains

Salience refers to the level of interest and relevance information garners among potentially interested parties. In the cases presented here, there is ample evidence of separate issue domains that vary in salience: climate change and SLR apart from coastal-hazards management. Scientists and decision makers often fail to connect across the boundaries of these issue domains, even when logical, physical, and social connections exist. That such boundaries exist is precisely the power of framing and of the social networks and institutional arrangements involved in defining and maintaining them (Ancona and Caldwell 1992, 1990; Cash and Moser 2000; Fennell and Alexander 1987; Gieryn 1999, 1995; Guston 1999; Leifer and Delbecq 1978). In Maine and Hawai'i coastal management, there is a prevailing focus on present and near-term problems obvious to all stakeholders, especially after disasters. To address these issues, scientists—in Maine longer than in Hawai'i—have been working closely with coastal zone managers to fill critical information needs (e.g., on erosion and cliff recession rates, quantity and quality of sediment supplies for beach nourishment). The links between scientists and decision makers are now well established and information exchange within the coastal-management issue domain works reasonably well,[12] despite downsizing and fiscal constraints due to the cycles in state and national economies.

Outreach and stakeholder processes involving the larger public are a growing component of coastal management, but still often unsophisticated or only sporadic. Moreover, as coastal managers in both states contended, even the most pressing management challenges today continue to be addressed against a backdrop of little appreciation of coastal resources and a lack of understanding of shoreline dynamics.

In Hawai'i more so than in Maine, the climate change issue domain is still perceived as largely external to the concerns of coastal managers. Interviewees suggested that climate change–induced SLR—as framed—falls victim to everyone's limited attention span and burden of responsibilities. This lack of time and attention limits people's ability to educate themselves or others about it. Thus, they fail to examine the importance of the issue to their daily spheres of concern and responsibility. Moreover, doing so is typically not rewarded by a system of more narrowly

defined agency missions and professional duties. Thus, if salience is the gateway to connect two previously separate issue domains, more than flashy information packages are needed to achieve resonance for SLR among potential information users. The challenge is to iteratively (re)frame and negotiate the meanings of an issue such that both sides can relate to it. In that way, frames become the doors through which previously uninvolved people step to become participants in a joint issue domain (see Gupta, chapter 3, this volume). Specifically, an effective frame would help people understand how day-to-day coastal management is affected by SLR; mobilize actors from one domain to become part of the other, too; and affect participants' understanding of management options and goals. Because existing issue frames often maintain issue-domain separation, additional resources and possibly new institutional structures could encourage communication among members of different domains, and in turn facilitate their eventual merging.

The study illustrates how in the United States, the federal government plays an important role in coastal management as well as in initiating and funding global change research and assessments. Through incentives (e.g., funding, program reviews) it can bring attention to otherwise-neglected issues at the state and local level. (By the same token, cessation of funding can bring the end to local efforts as well.)[13] Federal funds could also buy staff capacity to provide the human link between issue domains.

The two case studies also point to the importance of local, bottom-up interest in creating connections across issue domains. Both states' assessment and policy histories illustrate a mix of *strategic* choices among participants in one or both issue domains about when to link the climate/SLR issue with the more immediate erosion problems. Clearly, local actors understand how information can be used to connect issues, mobilize actors (or keep them at bay), and affect other parties' options and goals. Connecting issue domains is useful when it helps unite participants around decisions. It is counterproductive when such links would weaken an argument, invite additional (e.g., legal) challenges into the debate,[14] or draw resources and attention away from the other issue domain.

Because climate change is still scientifically uncertain and politically contentious, it adds elements to local decision making that require high skills of communication, discernment, and brokerage. Hard trade-offs between policy choices frequently weigh against adding the challenge of such vast, unwieldy problems perceived to be beyond local control. However, the fact that both states have witnessed bottom-up efforts to connect with the global problem also attests to the willingness, leadership, and commitment of individuals to overcome boundaries between issue domains. Structures and capacities can be used or created to foster a desire for the results of an assessment, thereby increasing its perceived usefulness (see Patt, chapter 9, this volume).

To create a desire or need for information points to a dimension of salience that interviewees alluded to repeatedly, one for which the issue of scale is particularly relevant. For local decision makers, the question is not only whether the issue of SLR is salient, but whether the information is actually relevant to the decisions a manager controls. Can that information be directly inserted into the decision-making process at his or her level? For example, accepting the reality of a rising sea level, a coastal planner will need to know how the accelerating SLR will change historical erosion rates in order to adjust setback requirements to provide adequate protection against future chronic and episodic erosion. Clearly, if assessors hold an expectation that local decision makers *should* respond to SLR, the assessment must produce information that is directly applicable to the decision they have control over. This typically only happens in the later stages of issue-domain development, yet it is essential to help a remote issue evolve into a routine, locally resonant one. In both states, decision-relevant information (erosion rates, cliff recession rates, sediment supplies, and so on) is now being produced, but in neither state do decision makers currently receive information about accelerated erosion rates due to climate change.

Credibility: The Interplay of Message and Messenger

In the two case studies, people rarely scrutinized the credibility of information as a means to decide about the fundamental validity of the climate change issue *before* they entered the issue domain. Rather, the lack of salience or the contentiousness of the issue—only in part based

on scientific uncertainty—deterred them from entering the issue domain. On the other hand, once people entered the issue domain and thus became participants, their interest in relevant information shifted beyond mere content and relevancy to matters of credibility. Interviewees did afford scientific knowledge a privileged, if not exclusive, status over other kinds of information. Thus, having such knowledge on one's side, and ensuring that it is produced in a credible, scientifically sound manner, is a strategic goal.

To the technical community (or communities), credibility means that the information is "true" or at least better than competing information and that it was derived via standard scientific methods and procedures (Steel et al. 2001). Participants in an issue domain without such technical expertise use "proxies" to assess "truth"—such as assurances about the scientific method, the source of information, or past performance, credentials and expertise of assessors, and so on (Steel et al. 2001). Of course, some communities (e.g., Native Hawaiians) may not afford science a privileged access to "truth," and standard scientific methods and procedures would thus not lead to greater credibility for them.

Interestingly, at subnational levels, where the number of involved players gets smaller—that is, where there is a fairly constant and limited pool of actors—the interplay between message and messengers (and their affiliations), or between truth and the trustworthiness of the information provider, becomes very important. The small pool of actors makes it possible to build familiar, trustful relationships with the messengers and habitually used information channels over time, unless personal conflicts create breakdowns in the communication (observed in both case studies).

The relationship between message and messenger is quite complex, especially when the information is uncertain or its implications are politically loaded and legally binding. For such information to be taken seriously, the information provider must build trust by offering credible, high-quality, and useful scientific information; follow through on contracts and promises; and serve as a noncondescending, accessible, and patient advisor. Equally important is the provider's willingness to work directly with communities and government agencies, and to hear managers' and coastal residents' concerns. Information users then express

satisfaction with the access to information and the institutions and channels through which they express their information needs. If they encounter responsiveness, professionalism, and useful advice, trust grows and information, even about contentious issues outside their immediate sphere of responsibility (such as climate change), have a chance to be examined and absorbed.

The need for highly credible information and trustworthy messengers was only partially met in the multilevel regional component of the *National Assessment*. Two lessons for assessment designers can be drawn here. First, multilevel assessments find more fruitful soil when they tap into well-established, well-functioning networks and high-quality relationships among information providers and users. A more conscious effort in doing so and strategically choosing participants placed in leadership positions or at critical nodes in the information-decision system can enhance an assessment's influence. For assessments conducted only at one level, the implication is slightly different. To affect an issue domain at other levels, associated outreach efforts need to make use of existing networks. Interviews revealed differences between and within states, among NGOs as well as state agencies, suggesting that these networks were not used well and that not all outreach was conducted with equal skill or effort.[15]

Second, in situations where there are no or only small networks among information providers and users, credibility and trust cannot be obtained quickly and are easily lost if disregarded. Depending on the contentiousness of the issue and the quality of preexisting relationships, building trust and credibility may be of foremost importance in a multilevel assessment. Assessments conducted at a single level rarely have significant influence at other levels if there are no strong established networks. The historically contentious relationship between Hawai'i and the federal government exemplified this well. Both case studies uncovered instances where information was withheld—sometimes strategically—to maintain competitive advantage or entrenched antagonistic positions. Thus, if in the course of an assessment process trusted relationships are built, the process could be called a success, even if no immediate policy changes occur. Building trustful relationships means creating

the precondition for effective information exchange (see Biermann, chapter 4, this volume).

Legitimacy: The Ultimate Obstacle to Moving Forward

Legitimacy in the context of an evolving issue domain refers to whether the assessment is perceived as fair, whether its participants or users believe that the assessment process respected the rules and norms of relevant institutions, whether it involved the right players, and whether their values and interests were adequately represented. The judgment over legitimacy and fairness has a different basis in a multilevel or single-level assessment. Evaluating legitimacy is also a function of personal involvement and—if available—the reading of the fine print on how and why the assessment was conducted in the first place.[16]

The case of Hawai'i illustrates vividly how the legitimacy of an assessment, or of technical information passing between levels of government, cannot be fully understood without considering the context of deeply engrained historical relationships between them and—at any one level—among the involved institutions and individuals. The greater distrust of the federal government in Hawai'i in part explains why that state is less responsive than Maine to SLR information. Apparently, legitimacy of any new assessment effort is judged against the background of such political "preexisting conditions." All too easily, it is the "politics that get in the way" of exchanging information and working collaboratively and effectively within assessment processes or with assessment outcomes in decision-support systems. While that is not a new finding, it is a fatal one to ignore.

Clearly, such "preexisting conditions" are outside the control of assessment designers or assessors. Assessors must be aware, however, that participants bring personal and institutional relationships—as well as cultural differences in some cases—to the issue domain. Moreover, contradictions in agency approaches and turf issues in cases of overlapping jurisdiction or expertise can help or hinder the assessment and information exchange. Similar issues of competition can arise across scale, such as local versus state authority in managing the immediate coastline. If the struggle for authority is aggravated by differences in goals—even

if both authorities adequately adhere to the regulations they each administer—the legitimacy of an assessment process will come into question.

Assessment designers can work constructively with existing institutional arrangements (and baggage) by examining and working with the comparative strengths of potential players (see Cash, chapter 10, this volume). Again, it is a *strategic* decision to involve particular individuals or institutions since their participation can ensure a perception of greater legitimacy, and their satisfaction with the process can eliminate both internal and external challenges to legitimacy (see Andonova, chapter 6, this volume). Assessment coordinators of the Pacific Regional Assessment, for example, consciously weighed whether (1) to broaden the involvement of actors from agencies, academia, and the public to create more support and understanding for difficult CZM policies and decisions, or (2) to strategically reduce the number of players and—as one interviewee framed it—to "use the right tools and people for the right job" and to ensure that "the skill level and enthusiasm is high."

This and other regional assessments illustrate that in order to ensure legitimacy, some potential participants need to be enabled to legitimately participate and bring their insights and assets to the assessment process. Ensuring legitimacy by way of strategic choices around participation can mobilize relevant actors, and thus design effectiveness into an assessment or decision-support process. Typically, one-time mobilization alone will not suffice. As interviewees claimed and observation of the *National Assessment* process repeatedly showed, capacity building and maintenance are critical ingredients in designing legitimacy into an assessment process. Just "showing up" is not enough to make participation successful. Enabling participation and building capacity ensure that new players effectively add their insights and skills. In turn, this begins to shift the relative political weight of participants, and the coalitions they form, to affect policy change (Fisher 2001b).

Conclusion

Viewing assessments as part and drivers of an issue domain is at once more fruitful and more challenging than previous approaches. The

research reported here privileges the bottom-up view. Consequently, the complexity of this view puts assessments "in their place," appreciating the challenges they face and delineating the opportunities they afford in moving issues forward. The discussion of salience, credibility, and legitimacy highlights how the influence of assessments can range from little to significant depending on the strategic choices made to deal with the specific circumstances and challenges at any one level. While the efforts studied here produced little direct change in state or local policies, I uncovered opportunistic reactions to scientific SLR information: in Maine, the threat of global SLR was used to protect against certain forms of coastal development and to strengthen coastal erosion management. By contrast in Hawai'i, an early SLR impacts study was not publicized to avoid obstructing certain development goals, and more recently, SLR arguments are used only if they aid in advancing erosion-management efforts at the local level. It appears that assessments of cross-scale environmental risks fail to influence policymaking or decision making more strongly because those involved fail to deal effectively with the salience/credibility/legitimacy challenges involved, or because they make strategic choices around participation, framing, and outreach that prevent such influence.

What these studies also showed, however, is that the more important, albeit indirect, influence of assessments on issue domains relates to the process as opposed to the product per se. In both cases, assessments slowly affected the range of issue-domain participants, as well as their awareness and understanding of SLR, and thus—over time—the broader political landscape.

Somewhat counterintuitively, this chapter suggests that assessments intended as "purely scientific" might be more influential if their designers thought more strategically about the broader issue domain, its current stage of evolution, and thus about assessment design. Such choices, however, require the involvement of well-positioned and informed representatives from different levels, even if it is not a multilevel assessment. Single-level and multilevel assessments—if they want to be influential at any level at all—must be conducted with a politically savvy eye toward the context into which they will fall, lest they contribute to the growing number of shelves of dust-gathering reports.

Acknowledgments

This chapter is based on research conducted in 1997–1998 and summarized in Moser 1998. State and federal assessment and policy efforts were updated in early 2003. I wish to thank all my interviewees and informants for their generosity with time and information; several collaborators who influenced the development of this research, including Eileen Shea, David Cash, William Easterling, Tom Wilbanks, William C. Clark, and Sheila Jasanoff; and the participants of the Scale Working Group during a Summer Study at Bar Harbor, Maine (June 17–14, 1998), for constructive criticism and stimulating discussions and insights.

Notes

1. For the full detail on the two case studies, see appendices B and D in Moser 1998.

2. For a detailed interview protocol see Moser and Cash 1998. Interviews ranged from half an hour to two hours; the average length was just above one hour. About a half dozen of the interviews covered only selected issues of information exchange and decision making—for example, to obtain more detailed background on a particular study or education campaign.

Interviewees in each state and at the federal level were selected through an iterative process and from a variety of sources, including prior contacts at the federal and state levels, institutional websites, scientific publications, and Coastlinks—a directory of Maine coastal organizations. Governmental interviewees included coastal program directors, planners, hazard managers, environmental specialists, engineers, extension agents, and outreach specialists and coordinators. Additional information and contacts for Hawai'i were obtained at the "Workshop on the Consequences of Climate Variability and Change for the Hawai'i-Pacific Region," held March 2–6, 1998, in Honolulu and at a public advisory committee (MACZMAG) meeting. At the national level, information was also gathered while participating at the "U.S. Climate Forum on the Consequences of Global Change for the Nation," held November 12–13, 1997 in Washington, D.C., as well as through continued access to information on the U.S. National Assessment process.

3. Some mused that they would search the Internet, which may open the door to this information clearinghouse.

4. The history of the Office of Technology Assessment (OTA) is instructive here. According to long-term observers of federal science policy, Congress abolished the OTA in 1995 because it was perceived to not produce enough "usable information" (although others believe there was significant political motivation

behind this judgment, if not the actual elimination of the OTA (see, e.g., Morgan, Houghton, and Gibbons 2001)). As a result, there is significant pressure on the USGCRP (and now the Climate Change Science Program) to produce policy-relevant science to keep the level of funding it has enjoyed in recent years ($1.742 billion requested in research in FY 2001) (Subcommittee on Global Change Research 2000). Researchers frequently interacting with federal agencies are acutely aware of the lack of cooperation within and across different divisions and agencies. In ongoing discussions about the Climate Change Science Program (the successor of the USGCRP), improvement of inter- and intraagency interaction is a central focus (U.S. Climate Change Science Program 2002).

5. Very shortly after the EPA published its first major global change assessment in 1993, the National Research Council brought forth its own assessment (National Research Council 1983). The two publications differed significantly in tone and assessment of the severity of the threat (with the NRC assessment being more skeptical of doomsday scenarios and more careful in pointing out the scientific uncertainties). Because of the differences and the odd timing of publication, the two reports received significant media attention at the time (Easterling, personal communication).

6. Neither of the two states considered here was the focus of any of these studies.

7. Publication of the regional assessment occurred well past this study. Thus examination of its impact, the ongoing outreach efforts following the assessment, and the influence on local policy and decision making require further follow-up.

8. The SDR are part of Maine's Coastal Wetlands Act, which—in 1988—was integrated with other legislation in the Natural Resources Protection Act. The SDR were not only remarkable in Maine but serve as a pioneering example to the nation. For details on the policy history, see Moser 1997. The SDR were updated in 2004 but are scheduled to "sunset" within two years, leaving Maine's coastal laws with no regulation at all for shorefront development (S. M. Dickson, personal communication, March 31, 2005).

9. See, for example, Hawai'i Board of Land and Natural Resources 1998; Hawai'i Ocean and Marine Resources Council 1991a, 1991b; State of Hawai'i, DLNR, 1998; State of Hawai'i, DBEDT, Office of Planning, HCZMP, 1997; University of Hawai'i Sea Grant Extension Service and County of Maui Planning Department 1997. Interestingly, reference in these documents is to historical relative SLR only, not future projections of SLR.

10. See, for example, State of Hawai'i, DBEDT, 1997; U.S. Army Corps of Engineers, Pacific Ocean Division, 1997; U.S. Department of Energy, Office of Emergency Management, 1996.

11. Examples include a workshop on Climate Change Implications and Adaptation Strategies for the Indo-Pacific Island Nations, held in September 1995 (Rappa, Tomlinson, and Ziegler 1995); or the 1998 scoping workshop that was part of the *National Assessment*). The HCZMP also cosponsored the First Regional Conference on Coastal Erosion Management in Hawai'i and Other

Pacific Islands held in April 1998, which addressed SLR and was attended by several state- and county-level government employees (University of Hawai'i Sea Grant 1998).

12. There are important exceptions to this general summary. For details see Moser and Cash 1998.

13. Examples in my case studies included EPA's funding for Maine's SLR impact assessment, Hawai'i's climate change action plan, and NOAA's cut of funding for Hawai'i's Sea Grant–based climate change education program.

14. In today's litigious climate surrounding coastal management, which frequently pits private property against public-domain rights, additional expensive legal challenges are a significant deterrent to local managers taking on complex issues.

15. The efforts in Hawai'i through coastal geologist Chip Fletcher and his group to produce relevant scientific information and spread it through a growing number of information users is a good example of building the necessary outreach network and capacity—one that simply was not available prior to his arrival. Similarly skillful efforts are underway in the Pacific region (essentially since the *Regional Assessment*) to build an information and decision-support network related to climate variability and change. It remains to be seen how these two networks get linked.

16. The move within EPA, NOAA, and other federal agencies toward greater stakeholder participation is at least in part a consequence of past information users questioning legitimacy (and issue salience) (U.S. Global Change Research Program 2001; U.S. Climate Change Science Program 2002).

References

Ancona, D. G., and D. Caldwell. 1990. Beyond boundary spanning: Managing external dependence in product development teams. *Journal of High Technology Management Research* 1(2): 119–135.

Ancona, D. G., and D. Caldwell. 1992. Bridging the boundary: External activity and performance in organizational teams. *Administrative Science Quarterly* 37: 634–665.

Barth, M. C., and J. G. Titus. 1984. *Greenhouse Effect and Sea-Level Rise: A Challenge for This Generation*. New York: Van Nostrand Reinhold.

Boesch, D. F., J. C. Field, and D. Scavia, eds. 2000. *The Potential Consequences of Climate Variability and Change on Coastal Areas and Marine Resources*. Report of the Coastal Areas and Marine Resources Sector Team. U.S. National Assessment. Silver Spring, MD: NOAA, Coastal Oceans Program.

Cash, D. W., and S. C. Moser. 2000. Linking global and local scales: Designing dynamic assessment and management processes. *Global Environmental Change* 10(2): 109–120.

Coastal Geology Group. 1997. *Current Research Projects*. Honolulu: SOEST, University of Hawai'i.

Coastal Geology Group. 2001. *Is Hawai'i's Coastal Zone Sustainable?* Powerpoint presentations available at http://www.soest.hawaii.edu/coasts/presentations/Coastalsustain.html.

Coastal Geology Group. 2003. Relative sea-level rise in Hawai'i. Graphic 7 in *Sea-Level Changes: Rising Seas, Past, Present and Future*. http://www.soest.hawaii.edu/coasts/presentations/sealevchang.html.

Conference of New England Governors and Eastern Canadian Premiers. 2001. *New England/Eastern Canadian Provinces' Climate Change Action Plan 2001*. Moncton, New Brunswick: Conference of New England Governors and Eastern Canadian Premiers.

Daniels, R. C., V. M. Gornitz, A. Mehta, S.-C. Lee, and R. M. Cushman. 1992. *Adapting to Sea-Level Rise in the U.S. Southeast: The Influence of Built* Infrastructure and Biophysical Factors on the Inundation of Coastal Areas. Oak Ridge, TN: Oak Ridge National Laboratories.

Deelstra, Y., S. G. Nooteboom, H. R. Kohlmann, J. van den Berg, and S. Innanen. 2003. Using knowledge for decision-making purposes in the context of large projects in The Netherlands. *Environmental Impact Assessment Review* 23(5): 517–541.

Easterling, W. E. 1997. Why regional studies are needed in the development of full-scale integrated assessment modeling of global change processes. *Global Environmental Change* 7: 337–356.

Fennell, M. L., and J. A. Alexander. 1987. Organizational boundary spanning in institutionalized environments. *Academy of Management Journal* 30: 456–476.

Fisher, A. 2001, June 19. *Workshop Summary*. Mid-Atlantic Regional Assessment Evaluation Workshop. University Park: Pennsylvania State University.

Fletcher, C. H., and D. J. Hwang. 1992a. Beach management plan with beach management districts. In *Sea-Level Rise, Shoreline Hardening, and Beach Degradation in Hawai'i: Hearing Testimony, U.S. Senate Energy Committee*, 260–348. Honolulu: Hawai'i Coastal Zone Management Program, Office of State Planning.

Fletcher, C. H., and D. J. Hwang. 1992b. Sea-level rise, shoreline hardening, and beach degradation in Hawai'i. In C. H. Fletcher, ed., *Sea-Level Trends and Physical Consequences: Applications to the U.S. Shore*. Amsterdam: Elsevier Science.

Fletcher, C. H., R. A. Mullane, and B. M. Richmond. 1997. Beach loss along armored shorelines on O'ahu, Hawaiian Islands. *Journal of Coastal Research* 13: 209–215.

Gieryn, T. F. 1995. Boundaries of science. In S. Jasanoff, T. Pinch, J. C. Petersen, and G. E. Markle, eds., *Handbook of Science and Technology Studies*, 393–443. Thousand Oaks, CA: Sage.

Gieryn, T. F. 1999. *Cultural Boundaries of Science: Credibility on the Line*. Chicago: University of Chicago Press.

Global Environmental Assessment Project. 1997. A critical evaluation of global environmental assessment: The climate experience. A report of the First Workshop on Global Environmental Assessment and Public Policy. In *A Workshop Convened Jointly by the Committee on the Environment of Harvard University, the Center for the Application of Research on the Environment (CARE) of the Institute of Global Environment and Society, Inc., and the International Institute for Applied Systems Analysis*. Calverton, MD: CARE.

Gornitz, V. M., R. C. Daniels, T. W. White, and K. R. Birdwell. 1994. The development of a coastal risk assessment database: Vulnerability to SLR in the U.S. Southeast. *Journal of Coastal Research* (special issue: Coastal Hazards: Perception, Susceptibility, and Mitigation): 327–338.

Gregory, J. M., J. A. Church, G. J. Boer, K. W. Dixon, G. M. Flato, D. R. Jacket, J. A. Lowe, S. P. O'Farrell, E. Roeckner, G. L. Russell, R. J. Stouffer, and M. Winton. 2001. Comparison of results from several AOGCMs for global and regional sea-level change 1900–2100. *Climate Dynamics* 18: 225–240.

Guston, D. H. 1999. Stabilizing the boundary between politics and science: The role of the Office of Technology Transfer as a boundary organization. *Social Studies of Science* 29: 1–15.

Hawai'i Board of Land and Natural Resources. 1998. *Coastal Erosion Management Plan (COEMAP)*. Honolulu: Department of Land and National Resources.

Hawai'i Coastal Zone Management Program. 1985. *Effects on Hawai'i of a Worldwide Rise in Sea Level Induced by the "Greenhouse Effect": A Report in Response to Senate Resolution 137, 1984*. Honolulu: State of Hawai'i, Department of Planning and Economic Development.

Hawai'i Ocean and Marine Resources Council. 1991a. *Hawai'i Ocean Resources Management Plan*. Honolulu: State of Hawai'i, DBEDT, HCZMP.

Hawai'i Ocean and Marine Resources Council. 1991b. *Hawai'i Ocean Resources Management Plan*: *Technical Supplement*. Honolulu: State of Hawai'i, DBEDT, HCZMP.

Hoffman, J. S., D. Keyes, and J. G. Titus. 1983. *Projecting Future Sea-Level Rise*. Washington, DC: Environmental Protection Agency.

Intergovernmental Panel on Climate Change (IPCC). 2001a. *Climate Change 2001: Impacts, Adaptation, and Vulnerability*. Contribution of Working Group II to the Third Assessment Report of the Intergovernmental Panel on Climate Change. New York: Cambridge University Press.

Intergovernmental Panel on Climate Change (IPCC). 2001b. *Climate Change 2001: The Scientific Basis*. Contribution of Working Group I to the Third Assessment Report of the Intergovernmental Panel on Climate Change. New York: Cambridge University Press.

Jones, A. T. 1998. Late Holocene shoreline development in the Hawaiian Islands. *Journal of Coastal Research* 14: 3–9.

Kendall, D. L. 1987. *Glaciers and Granite: A Guide to Maine's Landscape and Geology*. Unity, ME: North Country Press.

Leifer, R., and A. Delbecq. 1978. Organizational/environmental interchange: A model of boundary spanning activity. *Academy of Management* Review 3(1): 40–50.

Lukas, R. 1998. El Niño: Seasonal-to-interannual climate variability. Paper presented at the Regional Workshop on the Consequences of Climate Variability and Change on the Hawai'i-Pacific Region. Honolulu, HI, March 2–6.

MacCracken, M. 2000, October 23–24. *Status Report and Some Initial Thoughts on Lessons Learned from the First Phase of the U.S. National Assessment on the Potential Consequences of Climate Variability and Change*. Prepared for discussion at a meeting of the Committee on Global Change Research, National Research Council, Washington, DC, Washington, DC: NACO, USGCRP.

Maine Environmental Priorities Project. 1996. *Report from the Steering Committee, Consensus Ranking of Environmental Risks Facing Maine*. Augusta: MEPP.

Marine State Planning Office. 2000. *State of Maine Climate Change Action Plan*. Augusta, ME: Maine State Planning Office, http://mainegov-images.informe.org/spo/pubs/origpdf/pdf/ClimateReport.pdf [last accessed November 9, 2005].

Marine Law Institute/University of Maine School of Law, Maine State Planning Office, and Maine Geological Survey. 1995. *Anticipatory Planning for Sea-Level Rise along the Coast of Maine*. Washington, DC, and Augusta: U.S. EPA and MSPO.

Meehl, G. A., W. M. Washington, W. D. Collins, J. M. Arblaster, A. B. Hu, E. Lawrence, W. G. Strand, and H. Teng. 2005. How much more global warming and sea level rise? *Science* 307: 1769–1772.

Mehta, A. J., and R. M. Cushman, eds. 1989. *Workshop on Sea Level Rise and Coastal Processes*. Washington: U.S. Department of Energy.

Miller, C., S. Jasanoff, M. Long, W. C. Clark, N. Dickson, A. Iles, and T. Parris. 1997. Shaping knowledge, defining uncertainty: The dynamic role of assessments. In W. C. Clark, J. McCarthy, and E. Shea, eds., *A Critical Evaluation of Global Environmental Assessments*, 79–113. Cambridge, MA: Harvard University.

Morgan, M. G., A. Houghton, and J. H. Gibbons. 2001. Improving science and technology advice for Congress. *Science* 293: 1999–2000.

Moser, S. C. 1997. *Mapping the Territory of Uncertainty and Ignorance: Broadening Current Assessment and Policy Approaches to Sea-Level Rise*. Doctoral dissertation, Graduate School of Geography, Clark University.

Moser, S. C. 1998. *Talk Globally, Walk Locally: The Cross-Scale Influence of Global Change Information on Coastal Zone Management in Maine and Hawai'i*. Cambridge, MA: John F. Kennedy School of Government, Harvard University.

Moser, S. C. 2005. *Climate Scenarios and Projections: The Known, the Unknown, and the Unknowable as Applied to California*. Synthesis report of a workshop held at the Aspen Global Change Institute, March 11–14, 2004, in Aspen, Colorado. Aspen, CO: AGCI.

Moser, S. C. Forthcoming. *Stakeholder Involvement in the First U.S. National Assessment of the Potential Consequences of Climate Variability and Change: An Evaluation, Finally*. Draft report to the National Research Council, Human Dimensions of Global Change Committee's Study *Public Participation in Environmental Assessment and Decision-Making*. Boulder, CO: NCAR.

Moser, S. C., and D. W. Cash. 1998. Information and decision-making systems for the effective management of cross-scale environmental problems: A research protocol. Paper prepared for the workshop "Local Response to Global Change: Strategies of Information Transfer and Decision-Making for Cross-Scale Environmental Risks." Cambridge, MA: Belfer Center for Science and International Affairs, Harvard University.

National Assessment Synthesis Team. 2001. *Climate Change Impacts on the United States: The Potential Consequences of Climate Variability and Change*. Foundation report, USGCRP. New York: Cambridge University Press.

National Research Council. 1983. *Risk Assessment in the Federal Government: Managing the Process*. Washington, DC: National Academy Press.

National Research Council. 1987. *Responding to Changes in Sea Level: Engineering Implications*. Washington, DC: National Academy Press.

National Research Council. 1990. *Managing Coastal Erosion*. Washington, DC: National Academy Press.

New England Regional Assessment Group. 2001. *Preparing for a Changing Climate: The Potential Consequences of Climate Variability and Change—New England*. A report for the U.S. Global Change Research Program. Durham: Institute for the Study of Earth Oceans and Space, University of New Hampshire.

Nicholls, R. J., and J. A. Lowe. 2004. Benefits of mitigation of climate change for coastal areas. *Global Environmental Change* 14: 229–244.

Nunn, P. D. 1998. Consequences of sea-level change during the Holocene in the Pacific Basin: Introduction. *Journal of Coastal Research* 14: 1–2.

Oppenheimer, M., and R. B. Alley. 2004. The West Antarctic Ice Sheet and long term climate policy. *Climatic Change* 64: 1–10.

Pacific Islands Regional Assessment Group. 2001. *Preparing for a Changing Climate: The Potential Consequences of Climate Variability and Change—Pacific Islands*. A report for the U.S. Global Change Research Program. Honolulu: East-West Center.

Pielke, R. A. 1994. Scientific information and global change policy-making. Editorial essay. *Climatic Change* 28: 315–319.

Rappa, R., A. Tomlinson, and S. Ziegler, eds., 1995. Climate change implications and adaptation strategies for the Indo-Pacific island nations: Workshop proceedings, University of Hawai'i, Honolulu.

Smith, J. B., and D. Tirpak, eds. 1989. *The Potential Effects of Global Climate Change on the United States: Report to Congress.* Washington: USEPA.

State of Hawai'i, DBEDT. 1997a. *Hawai'i Greenhouse Gas Inventory.* Honolulu: DBEDT.

State of Hawai'i, DBEDT, Office of Planning, HCZMP. 1997b. *Hawai'i Coastal Zone Management Program: Section 309 Enhancement Area Grants Program: 1997 Assessment and Strategy.* Honolulu: HCZMP.

State of Hawai'i, DBEDT, Strategic Industries Division, 1997. *Hawai'i Climate Change Action Plan*. Honolulu, HI: DBEDT. http://www.state.hi.us/dbedt/ert/ccap-toc.html [last accessed November 9, 2005].

State of Hawai'i, DLNR. 1998. *Coastal Erosion and Beach Loss in Hawai'i.* Honolulu: State of Hawai'i, DLNR.

Steel, B. S., D. Lach, P. List, and B. Shindler. 2001. The role of scientists in the natural resource policy process: A comparison of Canadian and American publics. *Journal of Environmental Systems* 28(2001): 133–155.

Stive, M. J. F. 2004. How important is global warming for coastal erosion? *Climatic Change* 64: 27–39.

Subcommittee on Global Change Research. 2000. *Our Changing Planet: The FY 2001 US Global Change Research Program*. Washington, D.C.: Office of Science and Technology Policy. http://gcrio.org/ocp2001/ocp2001.pdf [last accessed November 9, 2005].

Thieler, E. R., J. Williams, and E. Hammar-Klose. 2001. *National Assessment of Coastal Vulnerability to Sea-Level Rise*. Woods Hole: Woods Hole Field Center. http://woodshole.er.usgs.gov/project-pages/cvi/.

Titus, J. G., and V. K. Narayanan. 1995. *The Probability of Sea-Level Rise.* Washington: USEPA.

University of Hawai'i Sea Grant. 1998. *First Regional Conference on Coastal Erosion Management in Hawai'i and Other Pacific Islands.* University of Hawai'i–Sea Grant, Maui, HI.

University of Hawai'i Sea Grant Extension Service and County of Maui Planning Department. 1997. *Beach Management Plan for Maui.* University of Hawai'i–Sea Grant, Maui, HI.

University of New Hampshire/Institute for the Study of Earth Oceans and Space. 1997. Workshop summary report. In *New England Regional Climate Change Impacts Workshop*. Durham: University of New Hampshire/Institute for the Study of Earth Oceans and Space.

U.S. Army Corps of Engineers, Pacific Ocean Division. 1997. *Coastal Hazard Mitigation Study for Energy and Lifeline Facilities: State of Hawai'i.* Ft. Shafter, HI: USACE.

U.S. Climate Change Science Program (CCSP). 2002. *Strategic Plan for the Climate Change Science Program, Review Draft, November 2002.* Washington, DC: CCSP. http://www.climatescience.gov/Library/stratplan2003/default.htm.

U.S. Congress. 1990a. *Coastal Zone Management Act of 1972.* 16 USC 1451–1464, Chapter 33; Public Law 92-583 (1972), as amended; Public Law 101-508 (1990). http://www.ocrm.nos.noaa.gov/czm/czm_act.html.

U.S. Congress. 1990b. *U.S. Global Change Research Act of 1990.* Public Law 101-606(11/16/90) 104 Stat. 3096–3104. http://www.gcrio.org/gcact1990.shtml.

U.S. Department of Energy, Office of Emergency Management. 1996. *Hawaiian Islands: Hazard Mitigation Report.* Honolulu: DOE, Office of Emergency Management for HI.

U.S. Global Change Research Program. 2001. *Draft Strategic Research Plan 2000–2010.* Washington, DC: USGCRP.

Wigley, T. M. L. 2005. The climate change commitment. *Science* 307: 1766–1769.

Zhang, K., B. Douglas, and S. Leatherman. 2004. Global warming and coastal erosion. *Climatic Change* 64: 41–58.

Selected Interviews

A. D. Challacombe, Chief, Environmental Review Branch, City and County of Honolulu, Department of Land Utilization, Honolulu, 1998.

S. M. Dickson, Marine Geologist, Certified Geologist, Department of Conservation, Maine Geological Survey, Augusta, 1998.

W. E. Easterling, The Penn State Institutes of the Environment, Pennsylvania State University, University Park, 1998. Personal communication.

A. Fisher, Department of Agricultural Economics and Rural Sociology, Pennsylvania State University, University Park, PA. Personal Communication, February, 2001.

C. Fletcher, Professor, Department of Geology and Geophysics, University of Hawai'i, Honolulu, March 12, 1998.

J. Kelley, Professor of Coastal Geology, Certified Geologist, Maine Geological Survey, University of Maine–Department of Geology, Orono, various dates, 1998–1999.

S. J. Lemmo, Planner, Hawai'i Department of Land and Natural Resources, Land Division, Planning Branch, Honolulu, 1998.

E. Shea, Associate, Global Environmental Assessment Project, e-mail interview, Center for the Application of Research on the Environment (CARE) of the Institute of Global Environment and Society, 1998.

J. Walters, Planning and Policy Analyst, Coastal Zone Management Program, Honolulu, 1998.

Acronyms

CZMA	Coastal Zone Management Act (federal act of 1972)
CZMP	Coastal Zone Management Program(s) (at federal or state levels)
EPA	Environmental Protection Agency
GCRA	Global Change Research Act (federal act of 1990)
GCRIO	Global Change Research and Information Office
GEA	Global Environmental Assessment (project at Harvard University)
IPCC	Intergovernmental Panel on Climate Change
MACZMAG	Marine and Coastal Zone Management Group (Hawai'i)
NOAA	National Oceanic and Atmospheric Administration
OCRM	Office of Ocean and Coastal Resource Management (within NOAA)
SLR	Sea-level rise
USGCRP	U.S. Global Change Research Program
USGS	U.S. Geological Survey