IDENTIFYING AND OVERCOMING BARRIERS TO CLIMATE CHANGE ADAPTATION IN SAN FRANCISCO BAY

Results from Case Studies

A White Paper from the California Energy Commission's California Climate Change Center

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ABSTRACT

The research goals of this project were threefold: (1) to systematically identify the adaptation barriers encountered by local government entities in San Francisco Bay; (2) to test empirically the robustness and usefulness of a diagnostic framework (previously developed by the authors) so as to modify or refine its components; and (3) to draw larger lessons about the adaptation process and the importance of adaptation barriers—even in highly developed nations—for the scientific community in terms of future research priorities and for policy-makers.

To fulfill these goals, an in-depth study of five California case studies in the San Francisco Bay region (Hayward, San Francisco, Santa Clara and Marin Counties, and the regional adaptation process) was undertaken. Relevant data were collected through key informant interviews, public documents, observation of and/or participation in public meetings, and a statewide survey.

The study found growing, but still very limited activities in the case studies. Institutional and attitudinal barriers dominate, but economic barriers are also important, even in wealthy locales. Leadership emerged as a critical factor in moving them forward on adaptation. Science mattered some, but policy and planning opportunities were more significant in motivating or launching the adaptation process. The study also found that communities have assets, aids, and advantages that can help them avoid barriers and that there is significant opportunity to affect and overcome the barriers that are being encountered in the "here and now." However, local communities need outside intervention to address "legacy" and "remote" barriers. With still very little visible adaptation activity "on the ground," the study concluded that a big portion of what communities are doing to date is working on overcoming the barriers to adaptation instead.

Keywords: barriers, adaptation to climate change, sea-level rise, coastal management, San Francisco Bay region, case studies

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Section 1: Introduction and Motivation for this Study

1.1 Scientific Interest in Adaptation Barriers

In recent years, adaptation to climate change has risen sharply on the scientific agenda (Adger et al. 2007; Moser 2009; Preston et al. 2009). Some of this literature has attempted to explain a widely observed "adaptation deficit" (Burton 2009), i.e., a gap between what might be considered a well-adapted society to the existing climate and the actual and inadequate adaptation achievements of that society. This deficit is not only common in poorer nations and communities of the developing world, but also evident in developed nations like the United States as inadequate preparedness for disasters, continued development in high-hazard areas, and growing losses from weather-related extreme events indicate (NRC 2010). To at least partially explain this adaptation deficit, some researchers have focused on the existence and nature of barriers to adaptation and about society's ability to overcome them (e.g., Adger et al. 2009; Adger, Lorenzoni, and O'Brien 2009; Burton 2009; Easterling, Hurd, and Smith 2004; Grothmann and Patt 2005; Jamieson and VanderWerf 1994; Lowe, Foster, and Winkelman 2009; Mitchell et al. 2006; Moser and Luers 2008; Moser et al. 2008; Nielsen and Reenberg 2010; Patt and Schröter 2008; Pielke et al. 2007).

This interest in barriers to adaptation is not unique as other researchers have focused, for example, on the barriers to, and "deficits" in implementing climate mitigation measures (e.g., Gifford 2011; Bazerman 2009), although much of that literature either focuses on individual behavioral barriers or the challenges of implementing effective international policy responses. By contrast, research on adaptation is more commonly focused on communities, organizations and those involved in the governance of adaptation responses. As this paper will show, many of the barriers identified here as impeding adaptive responses may be at work in mitigation as well.

Much of the existing literature on adaptation barriers has been empirically driven, conducted sporadically on individual projects or locations, and unsystematic in its approach. Predominantly, researchers have inductively identified whatever obstacles to adaptation emerged in a particular context. This has fostered both greater understanding of the impacts and importance of barriers and greater awareness of the fact that much adaptation is hampered by barriers, even in well-resourced entities with well functioning institutions. A meta-analysis of the existing body of research—previously funded by the California Energy Commission's Public Interest Energy Research (PIER) Program—has led to a theory-driven framework for systematically diagnosing adaptation barriers (Moser and Ekstrom 2010a; Ekstrom, Moser and Torn, 2011). Subsequently and independently, a Dutch research group reviewed some of the same and additional literature and produced almost identical results (Biesbroek, submitted). This suggests that the diagnostic framework is robust and well supported by existing theory and scientific literature. The present study is going a step further, however, in empirically testing the framework's robustness and practical usefulness in the context of the regional focus of the Vulnerability and Adaptation Study on San Francisco Bay.

1.2 Testing of a Diagnostic Framework for Adaptation Barriers

In a study preceding the current one, the researchers developed a theory-based framework for identifying and organizing barriers to adaptation based on a review of the relevant literature (Ekstrom, Moser and Torn, 2011). Rather than propose a normative approach to making "good" adaptation decisions, the authors offered a comprehensive, systematic approach to identifying specific barriers that occur in each stage of the adaptation process, along with diagnostic questions to ascertain how actors, context, and the system that is being managed in light of climate change (i.e., the system of concern) contribute to the existence of these barriers. The primary goal of that study then was to advance the discussion and examination of barriers to adaptation that can arise in different contexts by developing a framework and step-wide procedure to identify and organize potential barriers. This framework is summarized below, followed by the rationale for empirical testing.

1.2.1 Framework to Identify and Organize Adaptation Barriers

Before introducing the framework, it is important to define key terms. To be consistent with the previous study, this study defines *barriers* to adaptation as "obstacles that tend to delay, divert, or temporarily block the adaptation process, but which can be overcome with concerted effort, creative management, change of thinking, prioritization, and any related shifts in resources, land uses, or institutions" (Ekstrom, Moser, Torn, 2011, p.10).Barriers here are distinguished from *limits* to adaptation, which typically refer to physiological tolerance of species to changing climatic conditions that cannot be overcome (except with technology or some other physical intervention) (Moser and Ekstrom 2010a). Furthermore, *adaptation* is defined as "changes in social-ecological systems (i.e., in entities that involve both human and natural components interacting in complex ways) in response to actual and expected impacts of climate change in the context of interacting non-climatic changes" (Ekstrom, Moser, Torn, 2011, p.9). This definition is a modified version of that offered by the IPCC (2007), and thus also a modification of (but not fundamental deviation from) the one used in the California Adaptation Strategy (California Natural Resources Agency 2009).[1] Reasons for the modification are also given in Moser and Ekstrom (2010a). Adaptation strategies and actions can range from short-term coping to longer-term, deeper transformations; aim to meet more than climate change goals alone; be implemented proactively or reactively; and may or may not succeed in moderating harm or exploiting beneficial opportunities.

The design of the overall framework is guided by four principles, each reflecting a fundamental tension in adaptation research. It focuses primarily on human interactions without neglecting the physical and ecological constraints within which they work and make decisions. It is also focuses on the actors that make decisions, while fully recognizing that institutional, social, and cultural contexts within which they function constrain and/or enable their decisions and actions.

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[1] IPCC (2007) and CAS define adaptation as "… the adjustment in natural or human systems in response to actual or expected climatic stimuli or their effects, which moderates harm or exploits beneficial opportunities,"(IPCC 2007,p. 6; CAS 2009, p. 140).

The approach is most interested in the adaptation process but also action/outcome-oriented; and, finally, it recognizes that decision processes are iterative and messy, yet they are organized here in a logical, linear sequence for convenience.

The three basic components that make up the diagnostic framework are as follows: First, an idealized, conceptual model of the adaptation decision-making process makes up the process component and in the fundamental ordering device for grouping identified barriers (

Figure 1).

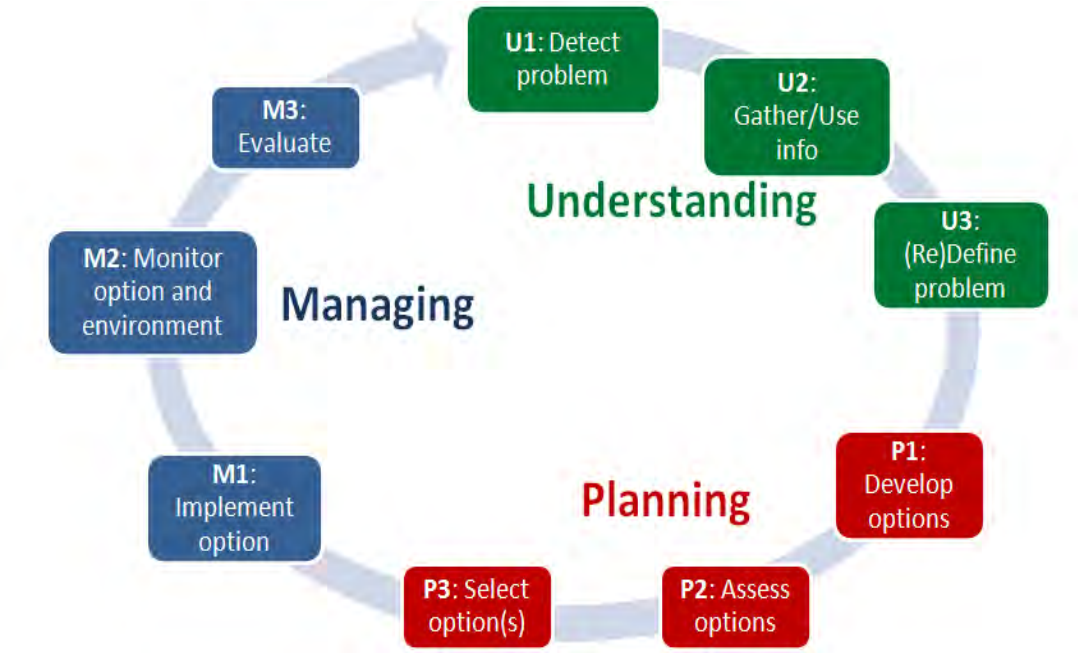

Figure 1: Ideal-type Stages of the Adaptation Decision-making Process

Source: Moser and Ekstrom (2010a, p.15)

Importantly, this idealized decision-making cycle is not a depiction of real-world decision-making but a useful ordering device or heuristic with which to organize the barriers along identifiable stages. While a real-world decision-making process typically would include many or all of these stages, it would rarely follow such a "clean" linear or cyclical trajectory (Mintzberg et al. 1976). Because of this deviation from the ideal-type depiction, many researchers have proposed alternative models of decision-making (see review in Moser and Ekstrom 2010a).In reality, some of these stages may be skipped or not clearly distinguishable, or actors may spend years in one phase, such as gathering information to define the problem, followed by quickly developing options, but then entirely skipping over any assessment of the options as they go onto implementation, maybe because of prevalent perceptions of what is politically feasible. In other instances, a pre-determined "solution" may become attached to problem opportunistically, with a skewed problem and options assessment to arrive at preferred outcomes. A process also can repeat stages, such as going from assessing options and

returning back to redefining the problem, after which the actors might follow with developing new adaptation options. In short, the idealized cycle of decision-making stages reflect a rational actor theory which is rarely if ever found in this sequence in practical reality. In Sections 4 and 5, the empirical results sections of this paper, the question of whether or not adaptation decisions follow this normatively preferable and idealized sequence will be taken up again.

The second basic component of the diagnostic framework consists of a set of interacting structural components. They include (1) the actors involved in the adaptation process (which typically changes over time), (2) the larger context in which they act (for example, the governance system and socio-economic conditions), and (3) the object upon which they act (here called the system of concern, which is the system that is exposed to climate change impacts and needs to be managed). Each component can play a role in creating the barriers encountered during the adaptation process (Figure 2).

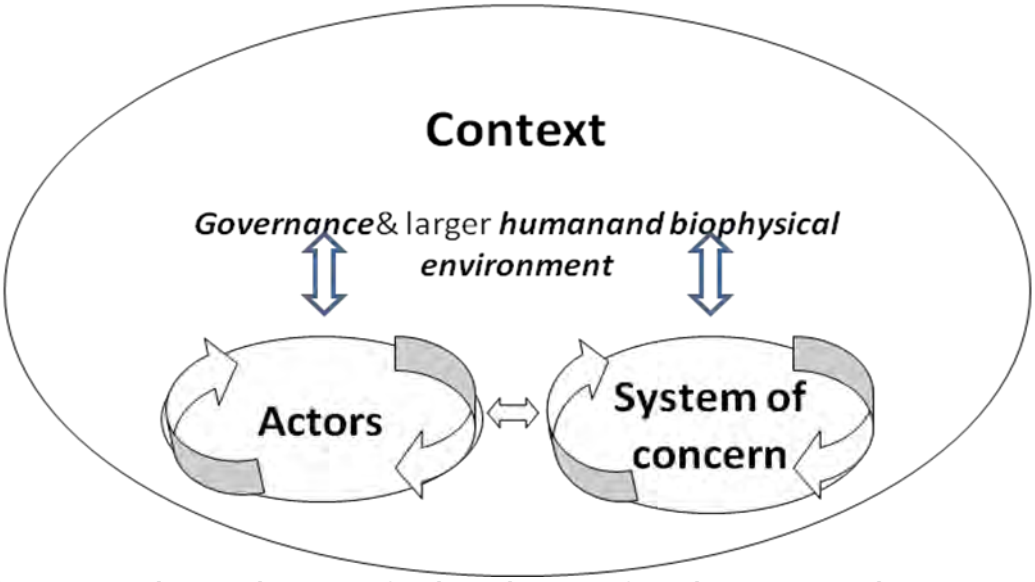

Figure 2: Fundamental Sources for the Existence of Barriers: Structural Components

Source: Moser and Ekstrom (2010a, p.16)

The first two components (process and structure) of the framework help answer two fundamental questions, namely: (1) What could thwart the process? And (2) how do the actor(s), context, and the system of concern contribute to the barrier? Moser and Ekstrom (2010a, Supplementary Materials) offered a series of stage-specific diagnostic questions about the actors, governance and larger context, as well as about the system of concern to help unearth possible barriers.

Finally, the third component of the diagnostic framework is a simple matrix that helps map the source of the barrier relative to the actor's influence over it for a given point in time and thus can be a first step in identifying interventions to overcome identified barriers (**Error! Reference source not found.**). The two axes of this matrix locate the sources of these barriers—and thus the locus of control over them—along a temporal and a spatial/jurisdictional axis.

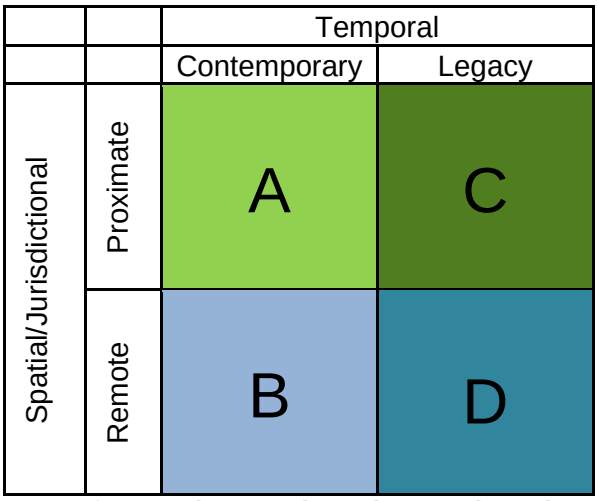

Figure 3: Locus of Control over Adaptation Barriers along Temporal and Spatial/Jurisdictional Scales
Source: Adapted from Moser and Ekstrom (2010a, p.54)

The need for such a matrix arose from the common observation that many barriers to adaptation currently experienced actually stem from decisions made, or institutions created, or strategies selected in the past. Such "legacy" barriers describe path dependencies that affect the current decision space for actors wishing to respond to climate change. As the methodology and analytical results sections will show, these legacies are often significant.

Together, the nature of the barrier, its source, and the location of influence over the barrier provide one "road map" to design strategies to circumvent, remove, or lower the barriers. Leadership, strategic thinking, resourcefulness, creativity, collaboration and effective communication have emerged from the literature as key resources for overcoming them. Past studies suggest that the effort of overcoming barriers is often, in fact, the primary target and focus of the initial adaptation effort.

1.2.2 Empirical Testing of the Diagnostic Framework

The research reported on here sought to contribute to an improved understanding of barriers to adaptation to climate change, both generally and specifically in California. Clearly, ongoing and projected impacts of climate change have created a need for societies to prepare for, respond to, and adapt to these impacts and the associated uncertainties. While scientific evidence supports the need to incorporate climate change projections in current planning and implementation, adaptation to anthropogenic climate change is only beginning to emerge (Adger et al. 2007; NRC 2010; Ford et al. 2011). What is delaying this process, and how, if at all, can it be accelerated so as to improve communities' readiness for climate change impacts?

The specific goals of this project are threefold:

1. **Systematically identify the adaptation barriers encountered by local communities (local government entities, i.e., municipalities and counties) in**

San Francisco Bay. The adaptation process of these local communities must be understood within the larger governance context, particularly regional governance entities (and, to the extent relevant, state and federal entities). Specific research question pursued in each case include:

a. How are communities adapting to climate change? What are local governments doing in terms of their adaptation to climate change? What goals are they pursuing with these efforts? How does their understanding/conceptualization of adaptation to climate change differ? (by case, degree of progress in adaptation planning, experience/training in climate change, educational level and discipline, level of government, perceived degree of risk from climate change impacts)

b. How does their progress differ by place and level of government?

c. What hurdles have they encountered in the past and which are they encountering at present? What are the causes of the barriers and how do they differ by locations, levels of government, stage in the adaptation process?

d. Which hurdles have they overcome and how? Which conditions, aids, assets or advantages helped communities avoid certain barriers in the first place?

2. **Empirically test the robustness and practical usefulness of the diagnostic framework so as to modify or refine its components.** This goal entails that the study of local-level adaptation be driven by the diagnostic framework developed in prior research.

3. **Draw larger lessons about the adaptation process and the importance of adaptation barriers—even in highly developed nations—for the scientific community in terms of future research priorities and for policy-makers.** A study of adaptation barriers in a developed context, such as California, can infuse a dose of pragmatic realism into scholars' heretofore rather simplistic assumptions about adaptive capacity and communities' and nations' ability to manage the impacts from climate change.

1.3 Policy and Practical Relevance of the Present Study

Atmospheric greenhouse gas concentrations are continuing to increase and evidence of changes in physical and ecological systems attributable to climate change is rapidly emerging the world over and in California (e.g., IPCC 2007; Moser et al. 2008; Karl et al. 2009; Franco et al. 2011). While mitigation policy and efforts to reduce greenhouse gas emissions are increasing at the local and state levels in the United States, mitigation policy is stalled both internationally and at the federal level in the United States, thus guaranteeing further delays in emission reductions and more challenging climate change impacts to deal with in the decades to come. At the same time, there already exists an adaptation deficit as previously noted in many regions of the world, including in the United States, where repeated extreme events cause enormous losses

and where a wide range of maladaptive policies place increasing numbers of people and assets at risk from sea-level rise (SLR), flooding, water shortages, droughts, and wildfires, to name a few. Meanwhile, a gap is opening between calls for and talk about preparedness and adaptation on the one hand, yet still very limited progress in actual policies and management changes on the ground, including implementation of adaptation plans, and actual advances in preparedness (NRC 2010; Blair 2009).

These observations place the present inquiry into an urgent policy context: while the need for adaptation is rapidly increasing, adaptation action is only slowly initiated and likely to take years to become widespread. What is delaying more ready engagement on adaptation and how can adaptation be facilitated are critical and highly policy-relevant questions.

In November 2008, then-Governor Arnold Schwarzenegger signed Executive Order S-13-08, which directed state agencies responsible for the management of natural resources, infrastructure and public health to identify potential adaptation measures for the state's at-risk assets and populations. In response, state agencies—under the leadership of the Natural Resources Agency—developed and published in December 2009 the first statewide climate adaptation strategy (CAS, CA Natural Resources Agency 2009). The present research is one of about 25 studies conducted in response to one of the CAS' overarching recommendations, namely to better understand the vulnerability and adaptation options of the state. Moreover, as part of the set of studies focused on the San Francisco Bay region, the study contributes to a regionally integrated understanding of the threats from climate change, vulnerabilities and adaptation options and barriers.

The study of several local communities in one region of California can provide comparative insights and useful examples for other communities in California and beyond, and help both the studied and other communities anticipate and strategize for where and why they may encounter future barriers. This provides practitioners with options to preemptively intervene or better manage the challenges that may arise in the adaptation process, and learn from the challenges and successful strategies of others. Study results may also inform State and federal policy-makers where their resources and other capacities (e.g., funding, research support, training and technical expertise) may be most useful in terms of assisting communities in their adaptation process.

1.4 Overview of Paper

The paper is structured as follows. Section 2 lays out in detail the research approach, methodology, data collection and analysis. Section 3 contextualizes the examination of barriers by a summary of the potential threats from climate change that the Bay Area faces, as well as a synthetic view at social vulnerability to these effects. Sections 4, 5, and 6 comprise the heart of the analysis. Section 4 provides integrated snapshots of the adaptation processes identified—and currently still ongoing—in the four local case studies as well as the regional adaptation policy development. Section 5 presents the barriers found in each, including what helped avoid certain barriers and what helped overcome those encountered. Section 6 then draws cross-cutting conclusions and circles back to the diagnostic framework to assess its robustness and

usefulness. It also concludes the study by suggesting future research directions and recommendations for local, regional, state and federal policy-makers.

Section 2: Methodology

To test the previously developed diagnostic framework, an in-depth, mixed-methods approach was chosen, focused on a series of five cases—four local jurisdictions and one regional adaptation process. Each of the methods is described in more detail below. First, to identify the cases a number of selection criteria were established. Second, information was gathered about each case in key informant interviews, a review of public documents, participant observation of regional stakeholder meetings, and observation of public meetings of pertinent governance institutions. Third, in collaboration with 15 other coastal organizations and agencies, a survey was developed and administered to >2,500 coastal professionals about current coastal zone management priorities, climate change adaptation actions and barriers, and related information and decision support needs. Results from this survey (preliminary results available in October 2011, final results to be published in April 2012) help contextualize the findings from the Bay Area case studies within the larger picture of coastal adaptation in the rest of the Bay Area and other parts of coastal California. Each of the employed methods is described in more detail below.

2.1 Selection of Case Studies

For a comparative case study approach as used in this study, it is essential that the selected cases vary along theoretically driven and potentially significant dimensions. As this study aimed to test a previously developed diagnostic framework of adaptation barriers, one clear requirement for the selection was to identify cases that varied in how far each had advanced already in the adaptation process, i.e., in the number of phases and stages completed to date. Relatively few local jurisdictions of the nine counties and 101 cities and towns around the San Francisco Bay have started deliberate or comprehensive adaptation processes, thus significantly narrowing the universe of potential entities. For those entities potentially available for closer examination, it was not entirely obvious prior to in-depth study how far along in the process each had come. Thus, the selection aimed to ensure that a concerted adaptation effort was under way, and to the extent possible, at least some variation in how far along each entity was said to have come already so as to ensure something could be learned about barriers at different stages in the process. This selection framework enabled investigation of barriers in communities that had entered certain stages of the adaptation process, but by default excluded communities that had not yet begun any formal effort, possibly because they face the greatest number or most difficult barriers, or simply had not yet overcome those barriers that prevent or delay initiation of such a process (see Measham et al. 2011 for a case examining barriers preventing initiation of adaptation in Sydney, Australia). While the empirical basis is not available to state this conclusively, it is quite possible that at least the initiation challenges identified through this study are either more daunting or have simply not yet been overcome in other communities.

A second distinction centered on the governance context. Because governance systems differ and thus can help or hinder different barriers to arise, inclusion of municipalities, counties, and a regional governance entity was desirable.

Another relevant distinction derived from the diagnostic framework was that actors needed to be exposed to signals indicating the need for adaptation, whether those signals emerged from the physical threat (frequently in this study, the threat of sea-level rise) or from the system of concern (e.g., the communities and natural systems in coastal areas exposed to the threat). Because global climate change and sea-level rise have been in the news for many years—potentially exposing anyone to signals about the need for adaptation, this criterion alone was not sufficient to ensure variation among cases. Thus, a narrower focus on locally or regionally-specific signals, i.e., from studies, projections, and/or experiences of local exposure to the threat of sea-level rise and associated impacts was expected to be a more useful distinction. Theoretically, signals could also derive from differences in social vulnerability to climate change risks. Thus, in the preliminary work to the in-depth case study work, a social vulnerability index (based on Cutter et al. 2003) was estimated to ensure potential cases also varied in their social vulnerability.

Finally, a pragmatic criterion of willingness to participate in the study further distinguished potential cases. Thus, the ultimate choice of case studies was based on a variation in two key variables and three additional criteria. The criteria represent features that are required for making a case practical to be studied, whereas variables are those factors that range across cases.

Variables

- Exposure to signals about local risks from climate change and sea-level rise
- Social vulnerability index (based on Cutter et al. 2003, see below)

Criteria

- An adaptation process had been initiated within the governance entity
- Inclusion of cities, counties, and a regional governance entity
- Willingness to participate in study

Preliminary screening of Bay Area communities thus involved collection of information as to different communities' and counties' efforts in adaptation with the help of informal informants (e.g., staff at the San Francisco Bay Development and Conservation Commission, Coastal Conservancy, and National Oceanic and Atmospheric Administration (NOAA) Coastal Services Center's Pacific Office). It was first determined roughly at what stage in the adaptation process prospective cities and counties were at the time (Fall 2010), based on (1) a review of local government planning and assessment documents, and city and county websites; (2) observations during public meetings and a regional climate change-focused conference for local governments, and (3) informal conversations with local government personnel, consultants, and other experts involved in local adaptation processes. Appendix A provides an overview of the results of the screening of potential local case studies in Fall 2010.

In addition, to provide an objective snapshot of relative social vulnerability to sea-level rise in the region, a geographic information system (GIS)-based social vulnerability analysis was conducted. It used the well-established index method applied in natural disaster research developed by Cutter et al. (2003) (and previously used in studies of the greater Sacramento area

[Burton and Cutter 2008], San Luis Obispo County [Moser and Ekstrom 2010b] and Fresno County [Moser and Ekstrom 2010c]). The social vulnerability index (SoVI) uses 32 variables of Census data to capture generic indicators of sensitivity, adaptive capacity, and social exposure. The 2000 Census was used for this study as results of the 2010 Census were not yet available at the time of case selection, and many variables previously available and used in the SoVI analysis are no longer collected by the Census Bureau. Social vulnerability was then mapped for the nine-county Bay Area revealing significant variation in differential vulnerability across the region (Figure 7). This map was then overlain by a 100-year flooding layer after 1.4 meter (m) of sea-level rise developed by the U.S. Geological Survey (USGS) (Knowles 2010). The flood risk area (as a proportion of each jurisdiction) was calculated for each city and county in the region (further details in Section 3). Because some local entities may not only respond to the risks from climate-driven sea-level rise but also to other types of climate change impacts, a synthesis of potential regional climate change impacts was developed as background information so that awareness of, and preparing for other than coastal climate change impacts could also be explored in the interviews (see Section 3).

Based on the collected insights on the presence and stage in the adaptation process, variation in social vulnerability and physical exposure to the threats from sea-level rise (and other climate change impacts), and meeting of the pragmatic criteria, the following local entities were selected (Figure 4):

- City of Hayward (and particularly the activities of its Hayward Area Shoreline Planning Agency, HASPA)
- City and County of San Francisco
- County of Marin
- County of Santa Clara

Figure 4: Map of San Francisco Bay Showing Location of Case Studies

The selection provides coverage of entities from the North and South Bay, as well as from the West and East Bay, and reveals variability in social vulnerability and physical exposure to flood-related risks (Section 3). Most importantly, however, with respect to the testing of the diagnostic frameworks, the selected cases display distinct patterns and degrees of progress in the adaptation process (Section 4).

In addition to the focus on four local government entities, the San Francisco Bay Area also offered an opportunity to study regional entities engaged in adaptation planning, and consequently the interaction between local and higher-level governance institutions (a potential source of barriers and ways to overcome them). Not only is the State of California already engaged in adaptation planning, including through its regionally and coastal-sector focused San Francisco Bay Development and Conservation Commission (BCDC), but a consortium of Bay-area focused regional agencies officially launched an adaptation and resilience effort in May 2011. This consortium, the Joint Policy Committee (JPC), is made up of four organizations—BCDC, the Metropolitan Transportation Authority (MTA), the Association of Bay Area Governments (ABAG), and the Bay Area Air Quality Management District (BAAQMD)—and its efforts to initiate a region-wide adaptation process became the fifth case for this study. The timing of this study allowed the researchers to observe how the consortium launched a joint regional adaptation planning process. In all cases, the adaptation processes continue, thus the results presented here provide a snapshot in time and an historical perspective up until the Summer of 2011.

2.2 Data Collection

A common trait and primary strength of case studies is that they allow for a "thick analysis," i.e., in-depth exploration of an issue through information gathering and triangulation using multiple sources and techniques. Data collection for the cases in this study involved (1) interviews with key actors involved in the adaptation planning and implementation process in each case (an emphasis consistent with the actor-centric diagnostic framework being tested here); (2) review of publicly available documents; (3) observation in public meetings occurring over the course of the study period (Summer 2010–Summer 2011); and (4) a California-wide adaptation needs assessment survey. Each is described in more detail below.

2.2.1 Key Informant Interviews

The purpose of the key informant interviews was to gather in-depth information about each community's or county's efforts to date in climate change adaptation (Appendix B lists the names and affiliations of the interviewees; none of their comments are cited in any identifiable way in this paper). The primary interest was in learning whether and in what ways the city/county had begun planning or managing for climate change (and, particularly, sea-level rise related) impacts, what challenges they had encountered in doing so, and what they needed, or had done, to overcome them. Interviews provided background on the institution(s) involved and on the interviewees, including their roles and positions, experience, attitudes, mental models/thinking about climate change and adaptation, and detailed background information about the adaptation process they were involved in. Particular emphasis in the questions on that process was placed on the adaptation phase and stage, the barriers, enablers, and strategies to overcome encountered obstacles.

Much of the obtained detail and insider knowledge and perspectives cannot be gathered from document analysis, meeting observations, and survey methods. In the interviews, in addition to learning about each entity's adaptation process and barriers, an attempt was made to establish the informant's concept domain of what he or she meant by adaptation to climate change. As opportunities arose during the interview, perceptions of interagency interactions (within local government, among independent agencies, and across levels of government), the political atmosphere surrounding adaptation, and the role of key players were also assessed. The interview protocol (full version included in Appendix C) was adapted depending on the state of affairs in each case study and on the particular role of each informant.

Key informants for this study were all those who were directly involved in the adaptation efforts (i.e., initiators, leaders, consultants, planners, and other agency officials involved in motivating the effort, developing, analyzing, selecting and/or implementing options; as well as elected officials, stakeholders, and close observers). Interviewees were identified through recommendations by BCDC staff (who are well-connected to, and closely work with, each of the local governments), a review of adaptation-related documents (i.e., authors of planning documents and scientific assessments, attendees of council meetings and lead officials in participating agencies), city and county websites, and a snowball sampling technique (i.e., recommendations by already-interviewed informants about others they viewed as key actors in the process). Table 1 lists the number of interviewees per case study.

Table 1: Key Informant Interviews in Case Studies

Case study	Full interviews (*)
City of Hayward	7
Marin County	6
City/County of San Francisco	10
Santa Clara County	6
JPC and Region	13
State	1
TOTAL	**43**

(*) In addition to full interviews, the researchers engaged in countless informal and follow-up conversations with already-interviewed and additional individuals on an ongoing basis. These are not individually counted here.

Prior to the interviews, the interview protocol and procedures were approved by the University of California-Berkeley Human Subjects Committee (approval on file).The protocol required that interviewees be informed of the purpose of the study and give written consent to being interviewed and being taped (for transcription purposes only; signed consent forms are on file with Ekstrom). Almost all interviews (98 percent) were conducted in person, either at the informant's office or in a mutually agreeable location. The remainder was undertaken by phone due to scheduling constraints or the preference of the interviewee. Most interviews were conducted by only one of the investigators (80 percent, Ekstrom), with the remaining being conducted by both investigators. Length of the interviews ranged between 31 and 123 minutes. All interviews were transcribed and coded to aid the analysis (see below).

2.2.2 Public Document Review

Public documents helped the researchers in becoming familiar with the technical details of each of the cases. The documents were identified by suggestion from a key informant to the researchers upon initial contact or in interviews or through an internet search through the entity's website. Reading of relevant documents served to both prepare the researchers for the interviews (to become knowledgeable about the adaptation efforts already undertaken, if any were documented) and for following up after the interviews to gather more technical details about the local government and/or departments efforts relating to climate adaptation and other related topics discussed in the interview.

2.2.3 Observation of Public Meetings

In addition to interviews and document review to understand local and regional adaptation processes, the study afforded numerous opportunities for the investigators to observe adaptation-related public meetings in real time. Two fundamentally different modes of observation were used in this research: Non-participatory observation and participatory observation. Observational research not only provides additional data (e.g., tracking of policy developments, actor behavior and interactions), but also allows researchers to complement, contextualize, and triangulate otherwise obtained information (Kearns 2005). Adaptation planning processes are still actively under way at present, and attending ongoing meetings

allowed the researchers to immerse themselves in these policy developments and more fully understand a complex policy setting.

Non-participatory observation. One of the investigators (Ekstrom) attended the majority of public meetings of BCDC and JPC over the course of the study period (i.e., all those that had adaptation-related policy developments on the agenda). Ekstrom also observed several of the meetings of a regional adaptation pilot project (the Adapting to Rising Tides [ART] Project, see Section 4 for more details).

Participant observation. In the June 2011 ART Project meeting, Ekstrom had an opportunity to be actively involved by working with a breakout group to develop a list of assets used in measuring vulnerability in the selected subregion to sea-level rise and coastal flooding. Moser and Ekstrom co-led (with other Energy Commission staff and scientists) a meeting of PIER-funded researchers with Bay Area water utility representatives, in which adaptation actions by utilities and related informational barriers were discussed. All of the case studies were represented at that meeting. Both investigators regularly participated in Bay Area meetings of multi-sectoral adaptation stakeholders organized by a consultant to the JPC. Moser is a frequent advisor to that consultant. These meetings involved local government officials, consultants, and representatives of non-governmental organizations with interests in climate change impacts and adaptation, including several of the key informants interviewed for this study.

The information obtained through observation was recorded in notes to supplement interview and document data.

2.2.4 California-Wide Adaptation Needs Assessment Survey

Finally, an unanticipated opportunity arose midway through this study which allowed the findings from the case studies to be further augmented and contextualized. In December 2010 the University of Southern California (USC) and the two California Sea Grant Programs initiated a comprehensive coastal adaptation needs assessment survey. Moser became the scientific co-lead with Dr. Juliette Hart (USC) on this survey, a collaborative effort of 15 coastal organizations active in California. Ekstrom also became involved in survey design and in the collection of participant contact information. The survey instrument was adapted from one developed by Moser in 2005 for one of the first PIER-funded research projects on preparedness for the impacts of climate change in the coastal sector (Moser and Tribbia 2006/7; Tribbia and Moser 2008). While significantly expanded on information and decision support needs, as well as on barriers to adaptation to inform the present study, consistent questions between the 2005 and 2011 surveys allowed for a longitudinal assessment of adaptation progress in coastal California. Key results of the survey are reported on in forthcoming papers.

The purpose of the survey in the context of this study was to understand how the insights gained in the selected cases compared to other cities' and counties' efforts on adaptation, both in the wider Bay Area and across coastal California. The surveyed population included more than 2,500 California and Bay Area coastal professionals in local (municipal and county), regional, state, federal and tribal government agencies, non-governmental organizations,

consultants, and local elected officials. The survey was structured in four sections: (1) current coastal management challenges, (2) attitudes and responses to date to experienced or expected coastal impacts, including several questions addressing barriers to adaptation, (3) information, decision and planning support needs, and (4) demographic information.

The web-based survey was approved by the USC's Human Subjects Committee, which required Human Subjects Research certification of the investigators and a variety of measures to ensure confidentiality and data security. The survey in its extended 2011 form was pilot-tested by seven respondents (selected from different types of organizations) and revised based on the feedback received. At the conclusion of the survey in the late fall of 2011, the survey achieved a response rate of ~20 percent. The California-focused survey as a Sea Grant Program-initiated activity also informed a comparable survey administered in several other coastal states around the United States. A number of the questions in the California survey are also included in the other state surveys. This will allow for cross-state comparison once all results from all states are available.

2.3 Data Analysis

Data analysis proceeded through several steps. The first was to fully understand the adaptation process under way in each of the five cases based on an integration of insights gathered from the interviews, as well as document review and observations. The results can be considered the descriptive portion of the study. The second step was to examine the types, sources, origin, and ways to avoid or overcome the encountered barriers to adaptation in each case. The results can be considered the analytical portion of this study. Finally, in the third step, an attempt was made to understand and explain the internal and external influences on local and regional adaptation and to draw larger conclusions about barriers in the adaptation process. This is the interpretive portion of the study. The data obtained through the various collection techniques were integrated in each step, thus each is discussed in the sections below.

2.3.1 Adaptation Process Mapping

The adaptation process of each case was mapped onto the decision-making cycle produced in Moser and Ekstrom 2010a; see Figure 1 above), dividing efforts within each case into distinct 'periods'. The goal of this descriptive analysis was to capture in an integrative, chronological fashion what had occurred to date in each instance, i.e., to provide a case-specific snapshot that revealed both its historical trajectory and how the individual activities all fit together.

To complete this step, the researchers independently read through the group of transcripts for each case and then met to discuss how the information from the interviews (and other context information collected) charted on to the process stages. Cases clearly differed in how integrated they were across sectors, i.e., the local entity's agencies and departments); they also displayed very different storylines of how they began, what had been done to date, the players and governance system involved along the way, and the system of concern. Thus, Period 1 in one case study does not necessarily bear resemblance in character to Period 1 in another case; it is simply the first discernible time in which adaptation is being addressed in a particular location. Moreover, each case had several ongoing or isolated initiatives, making it particularly

challenging to map these as a single chronological process. While some activities were related, frequently the cases involved several different/unconnected processes. Therefore where participating actors, concerns of climate change, or bounds of the governance system were substantially different among efforts within a single case, the process of each effort was mapped as a distinct *period*. For each of these periods, the researchers then identified the relevant decision-making *phases* and *stages*.

Some cases have periods that are broken into several sub-periods—indicating independent parallel efforts, while others are described more linearly as a sequence of periods—indicating a single integrated adaptation effort albeit changing in distinct fashion over time. Several cases also show an anticipated future period, as interviewees projected forward what they anticipated or wished to see happen. When future periods are not described in any of the cases, it does not suggest that future steps (or any barriers therein) are not anticipated. It simply reflects that interviewees in that case did not discuss the future in sufficient detail to report on it here.

Using the delineation of major periods in chronological order, the researchers identified the set of players (involved actors), bounds of the system of concern, the governance system, and graphically depicted, reviewed and revised each case to reach consensus. Observational data and document information supplemented the interview-based information. The resulting process depictions for each case provide (a) a "10,000 foot perspective" on each case's adaptation efforts to date, and (b) more detailed insights into the extent of the adaptation decision-making process.

2.3.2 Barrier Analysis

In the second step of the analysis, interview transcripts were coded using the process summaries as a guide to identify barriers, strategies to overcome barriers, and any aids and advantages that helped avoid barriers in the first place. Rather than using a standard coding software such as NVivo, ATLASti or Dedoose (which was found to be too time consuming), the researchers took a more inductive approach to extracting relevant data from the transcripts, without, however sacrificing detail or rigor, resulting in carefully coded interview transcripts as well (Figure 5 depicts the coding and analysis process).

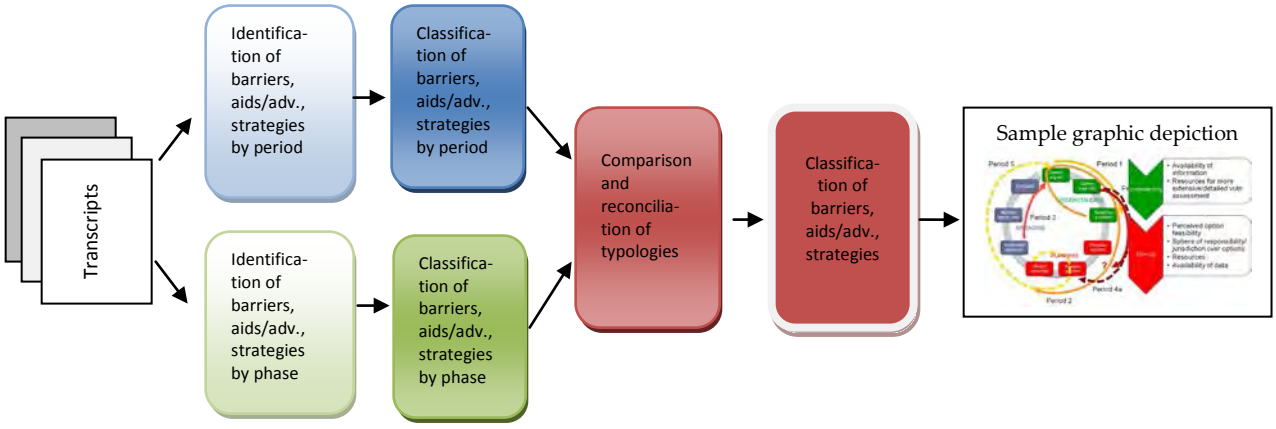

Figure 5: Barrier Analysis Process

Both researchers independently identified any barriers that the interviewees either mentioned explicitly (e.g., a law that prevents them from taking a certain adaptive action), including those they expect to encounter, or that emerged implicitly (e.g., actors in a single case that need to work together on adaptation don't get along with each other). The barriers informants anticipated to encounter in the future were also documented when actors provided sufficient detail about future plans to proceed with adaptation. Past, present, and future barriers were mapped onto the adaptation processes developed in Section 2.3.1 (i.e., onto each case's chronological process depiction by period and onto the phases and stages of the decision-making cycle). To the extent discussed by interviewees researchers also isolated the sources of the mentioned or observed barriers relating them to involved (or missing) actors, the governance system and wider socioeconomic context, and to the system of concern (i.e., the area being managed).Where data allowed, the researchers further extracted any information from the transcripts about what helped avoid barriers (aids and advantages) and what helped overcome those encountered (strategies).

Both researchers then developed a classification scheme for each set of raw data: (a) a typology of barriers, (b) a typology of aids and advantages, and (c) a typology of strategies to overcome the barriers encountered. The independently generated typologies were compared and—where necessary—reconciled. Importantly, the classification schemes were not restricted to the types of barriers previously identified in the diagnostic framework, but inductively derived from the interviews. This choice was obviously driven by the purpose of this study to test and critically evaluate the framework previously developed, i.e., to allow differences to emerge between the theoretical framework, the synthesis of previous studies, and the empirical cases studied here.

Finally, the independently generated raw data lists were then classified according to the agreed-upon typologies. Where differences occurred, the researchers discussed and reconciled them to finally arrive at an agreed-upon list of barriers, aids and advantages, and strategies—organized for each case by periods and by process phases and stages. The choice for both researchers to identify and classify barriers, aids/advantages, and strategies first independently, and then to reconcile them where necessary, was made to add rigor to the study. The careful discussions of

the details of each case significantly deepened the researchers' understanding of each locale's process, and aided the critical analysis and evaluation of the diagnostic framework.

Importantly, if a particular barrier (e.g., lack of money to conduct a certain study) was mentioned more than once per period, phase or stage, it was only counted once in that particular period, phase or stage. However, it was counted once in every period, phase or stage in which it was mentioned. If the exact same barrier was mentioned by more than one interviewee, it was also counted just once, but its prevalence was noted separately. If there are several mentions for a particular type of barrier (e.g., financial or institutional barriers), it means that several distinct barriers falling into those categories were encountered in a particular period, phase or stage. The logic underlying this particular accounting scheme is simple: in a qualitative study such as this, which relies predominantly on key informant interviews, the point is not to provide a quantitative analysis of how many times a particular barrier is mentioned (as that could be a simple reflection of the particular perspective or personality of the key informant interviewed rather than of the true importance of the barrier), but to discern and distinguish patterns of barriers that communities encounter over the course of the adaptation process, and to explain those pattern by way of integrating different data sets.

2.3.3 Comparison and Interpretation

Once coded, classified, and reconciled, each of the data sets was then summed and graphically displayed to identify patterns within each case, and to allow for a synthesis and comparison across cases and across stages in the adaptation process. As later sections will reveal, the cases differed in interesting and important ways in the number and types of barriers encountered, as well as in the advantages and strategies developed in each to avoid and overcome them.

The purpose of this comparative analysis among the five cases was to isolate key cross-cutting findings. The integrative view of adaptation process maps and the analysis of barriers, aids/advantages and strategies allowed for qualitative and quantitative representation of noticeable commonalities and differences. It also revealed which barriers dominated in different instances and times in the process and why. A number of possible explanations emerged for why the different communities are where they are at present in the adaptation process, and why some barriers mattered more than others, including differences in personal attitudes and worldviews, interpersonal dynamics, institutional and inter-institutional challenges, political dynamics and pressures, external opportunities and influences. These differences were examined for how they can create or help overcome barriers. Finally, a critical assessment of the validity, completeness, and usefulness of the diagnostic barrier framework was undertaken to conclude the analysis (Section 6).

2.3.4 Survey Analysis

Survey results did not become available until the very end of the detailed case study analysis. Only relevant elements of the 40-question survey were analyzed for the present study (a full analysis is forthcoming in future publications). Moreover, only responses from city, town, and county respondents were included in this analysis to provide the most applicable comparison to the data compiled through the case studies.

Relevant survey questions analyzed here—in addition to respondents' basic demographic information—included those related to respondents'

- attitudes toward climate change/global warming[2]
- level of concern about climate change
- knowledge about climate change
- consideration of climate change in their work
- attitudes toward preparedness for climate change impacts
- expectations of local impacts of climate change
- expectations of relevance of local impacts to their work
- rating of the importance of mitigation and adaptation in their work
- familiarity with different types of coastal adaptation options
- motivation to begin local adaptation planning
- assessment of the current phase and stage of the adaptation process
- perceptions of types and seriousness of barriers to adaptation

Simple descriptive statistical analysis was conducted for the purposes of this study, allowing for at least a qualitative comparison of the locally found patterns of barriers and those found statewide.

The following Section 3 provides a brief summary of potential climate change impacts on communities in the San Francisco Bay region, particularly, their exposure to flooding risks associated with sea-level rise and the social vulnerability analysis. While local communities will need to prepare for a wide range of climate change impacts, flood-related impacts from sea-level rise are emphasized especially in this summary as they are not only among the best studied impacts to date, but have been used to generate awareness in the general public and among decision-makers. Thus, Bay-area flood risks have a particular signaling value for the region and, consequently, potentially value as a motivator to undertake adaptation region. The analysis in Section 4 will show whether or not that is in fact so.

[2] To test whether there is a statistically significant difference in attitudes, concerns and opinion, half of the survey respondents (randomly chosen) filled out online surveys that used the term "global warming" while the other half answered the same survey questions using the term "climate change." In this report, all survey responses are combined and not discussed separately. For discussion of any differences observed, see the forthcoming detailed survey analysis.

Section 3: Vulnerability of San Francisco Bay Communities to the Impacts of Climate Change

The purpose of this section is twofold. First, it aims to summarize climate change-related threats to the San Francisco Bay region as a way of pointing to the types of impacts to which local communities may need to adapt. This brief summary of the available research literature points to the kinds of impacts the researchers could inquire about in the interviews, and thus also helps to assess how broad key informants' awareness of potential climate change impacts is at this time. Second, climate change-related threats and communities' social vulnerability to those climate change impacts provide two important but distinct sources of signals that could indicate to decision-makers that there is a need to initiate adaptation processes. Thus, awareness and understanding of potential future and/or already occurring climate change impacts—either through direct experience or through public communication about them—could serve as a motivating factor for adaptation, whereas lack of such awareness and understanding could be seen as a barrier to initiating an adaptation process.

3.1 Brief Summary of Projected Climate Change Impacts: The Threats

The San Francisco Bay Area region is located on the north central coast of California, encompassing nine counties, 101 cities, and encompassing a variety of geographic features (from mountain ranges, to inland valleys, the San Joaquin delta and bays). The regional geography creates several distinct climatic zones (BAAQMD 2011). As a result, the region's climate can vary dramatically based on topography and coastal exposure. For example, San Francisco tends to have cool foggy summers driven by the convergence of the Central Valley's hot dry inland areas and the cool ocean temperatures. Eastern portions of Alameda and Contra Costa Counties are more similar to the climate of the Central Valley with hot dry summers and cold winters. The southeastern portion of the Peninsula is sheltered from the coastal fog and wind by the Santa Cruz Mountains, allowing air pollutant emissions to build up, whereas San Francisco's high emissions quickly get swept away from the City by coastal winds (BAAQMD 2011). Micro-climates, together with topography, geology, availability of soil moisture and exposure to saltwater create w rich diversity of habitat types. These natural conditions are significantly affected and altered by human land uses, including intense urban and suburban land cover.

3.1.1 Overview

Several studies conducted for the State of California provide an indication of the potential climatic changes that the San Francisco Bay region may expect in the future. While these changes will vary across the sub-regions, the following provides a brief list of projected impacts, and thus of the types of threats that local communities might be aware of, and which might motivate them to begin adaptation planning (indicated in bold/italics below):

- ***Sea-level rise, related coastal hazards, and saltwater intrusion***: Sea-level rise along the outer coastal and bay shorelines (resulting in more coastal and bay-side flooding, shoreline erosion, and saltwater intrusion into coastal groundwater reserves (Cayan et

al. 2011; Bromirski et al. 2011; Knowles 2009, 2010; Heberger et al. 2009); the extent of lowland flooding along the Bay shoreline in part depends also on the height and stability of existing and future levees and other coastal protection structures, many of which are subsiding or in need of repair and maintenance (Brooks and Manjunath 2012; DWR 2009; Mount and Twiss 2005).

- ***Heat extremes***: Increases in inland temperature, affecting the number of extremely hot days and the frequency, length, and intensity of heat waves across a region not traditionally known for heat extremes (Cayan et al. 2011; Cordero et al. 2011; Pierce et al. 2011; Sheridan and Kalkstein 2011)
- ***Precipitation and runoff changes***: Changes in the timing and amount of water supplied by local precipitation and runoff, local recharge of groundwater supplies, and as runoff from snowmelt in the Sierra Nevada Mountain Range (Cayan et al. 2011; Pierce et al. 2011; Hayhoe et al. 2004)
- ***Change in fog occurrence***: Change in number of fog days along the coast (potential for decrease or increase) (Johnstone and Dawson 2010) with potential impacts on air temperatures and ecology.

Further indirect and second-order impacts can be expected, such as:

- ***Species, ecosystem services and habitat losses***: Ecological changes (including loss of vulnerable species, particularly endemic species; change in ecosystem assemblages; loss of ecosystem services [e.g., carbon storage]; introduction and establishment of invasive species) driven by changes in temperature, precipitation, coastal fog and sea-level rise; of particular concern is the permanent loss of available habitat [especially coastal wetland areas when inundated by sea-level rise without available migration corridors to upland areas]) (Ackerly et al. 2012; PRBO 2011; Loarie et al. 2008);
- ***Changing wildfire risk***: Increases or decreases in the area burned annually by wildfires with resulting variable risk of losing structures and homes built in fire-vulnerable regions (Bryant and Westerling 2012);
- ***Agricultural changes***: A variety of impacts on agriculture, including increases in the quantity of wine grapes but shift toward lower quality wine grapes (Chaplin-Kramer 2011); potentially increased forage production but reduced forage reliability and forage season length (Chaplin-Kramer 2011);
- ***Growing threats to human health***: Increasing threats to human health through increased occurrence of heat extremes, possible spread of diseases, changes in air pollution (all else being equal, higher temperatures increase the formation of ozone) (Sheridan and Kalkstein 2011; Ostro et al. 2010; Basu 2009; Basu and Ostro 2008; Delfino et al. 2008); these impacts are expected to disproportionately affect socially vulnerable groups (e.g., the poor, elderly, those already and otherwise socially disadvantaged) (Jerrett et al. 2012; Garzón et al. 2011);
- ***Increasing electricity use***: Increases in electricity consumption during hotter summers, unless offset by concurrent electricity price increases (Auffhammer and Aroonruengsawat 2011);

- ***Transportation disruption***: Critical transportation infrastructure (roads, rail, ports and airports) in the larger Bay area could be impacted either by permanent inundation due to sea-level rise or by increased episodic coastal flooding with profound consequences for regional traffic flows and the transportation of goods in and out of the region, unless such impacts are prevented (e.g., through protection, elevation or relocation of traffic arteries and vulnerable infrastructure) (Biging et al. 2012);
- ***Water supply uncertainties***: Water supplies will be varyingly impacted by changes in precipitation and increases in temperature depending on the water supply portfolios of different regional water utilities (Cayan et al. 2012; Viers et al. 2012; Sicke and Lund 2012; Hanemann 2012; Langridge et al. 2012).

Below coastal impacts are discussed in greater detail given its importance in the region and its historical prominence in public communication. Both factors can be hypothesized to send signals to decision-makers about the need for adaptation planning.

3.1.2 Projected Sea-level Rise and Its Impacts

Perhaps the best-studied and most widely publicized consequence of climate change in the San Francisco Bay region is the increase in the rate of sea-level rise. Sea-level rise as a result of warming ocean waters (thermal expansion) and melting ice caps (especially Greenland and the West Antarctic Ice Sheet) are among the most certain consequences of climate change. However, accurate projections are currently hampered by the limits in scientists' ability to model ice sheet dynamics (IPCC 2007). Using the best available science, statewide studies published in 2009 project that sea level could rise 12 to 16 inches by 2050 above 2000 levels (Cayan et al. 2009). This is double the amount of increase the California coastline on average, and the San Francisco Bay in particular, has experienced over the entire past century (Flick 2003; Knowles 2010). By the end of the century, sea level is projected to rise a total of 3.3–4.6 feet (40–55 inches, and—if model and climate uncertainties are taken into account—ranging from 31 to 69 inches) above 2000 levels (Cayan et al. 2009). These projections have been adopted by the State's Ocean Protection Council in a resolution adopted in March 2011 and an accompanying guidance document given to state and local agencies in assessing coastal risks for development in shoreline locations (OPC 2011). A study by the National Research Council is currently under way to assess newer global sea-level rise projections, as well as projections downscaled to California's coast, with results expected in early 2012. While projections of regionally specific sea-level rise are thus still come with considerable uncertainty, a more rapid increase than historically experienced is no longer questioned in the scientific community (Price et al. 2011; Cazenave and Llovel 2010; Nicholls and Cazenave 2010).

Knowles (2010) produced flood risk maps for the region, using a concatenation of the best high-resolution topographic data available at the time and Cayan et al.'s (2009) SLR projections. His analysis provided an estimate of different types of land covers and uses potentially inundated if they were not protected from inundation, including wetlands, grazing and other agricultural lands, and urban land uses. Figure 3 shows the 100-year (1 percent annual) flood risk zone with (red) and without (blue) an additional 150 centimeters (cm) (~55 inches) sea-level rise above

2000 levels in San Francisco Bay and the types of land covers/uses that would be affected by such unmitigated flooding.

Based on these2009 projections, sea-level rise in the San Francisco Bay could result in the following impacts:

- Bay flooding with higher storm surges and flood elevations during coastal storms, potentially inundating critical transportation, as well as valuable commercial and residential infrastructure in low-lying areas (especially fill areas)
- Increased pressure on aging flood protection systems (levees)
- Permanent inundation of coastal wetlands along the bay shoreline
- Saltwater intrusion during more frequent flooding events into wastewater treatment systems and near-shore wells
- Prevention of sanitation and flood prevention systems from draining to the Bay (and potentially flooding from backing up on land)
- Saltwater intrusion in coastal aquifers

Aerial extent of flooding as shown in Figure 6, of course, does not necessarily correlate with the value of the assets at risk. For example, San Francisco appears to have relatively little inundation from storm-related flooding even with substantial additional SLR; however, the areas that would be affected by it are of major value to the city and region in terms of infrastructure, business activity and public access. Impacts on even a small strip of land there would substantially affect the economy in terms of transportation, structural value at risk, economic activity, wastewater (sewage) release, and so on.

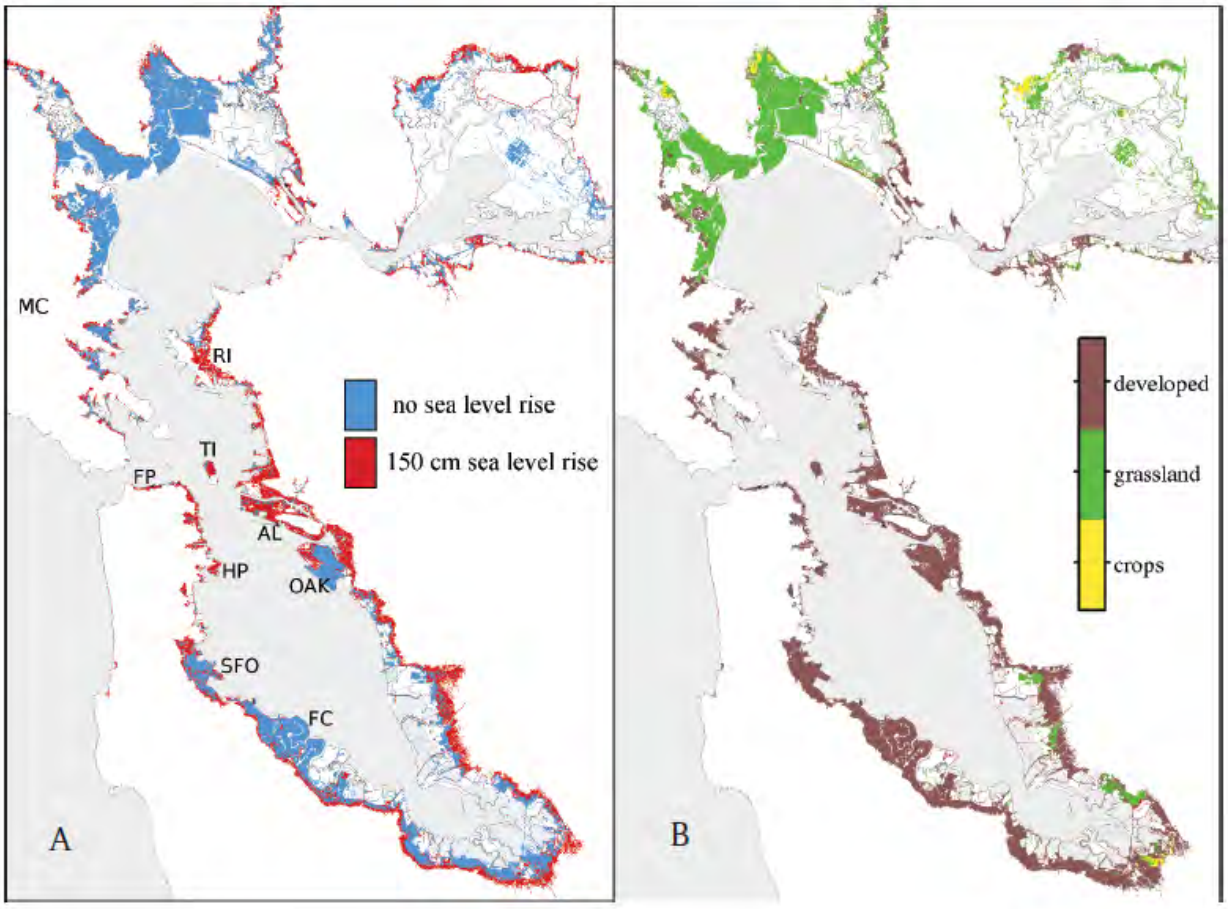

Figure 6: (A) 100-year (1 percent annual) Flood Risk With (red) and Without (blue) an Additional 150 cm (55 inches) Sea-level Rise Above 2000 Levels in San Francisco Bay and (B) Types of Affected Land Covers/uses

Source: Knowles 2010, his Figure 5

This rationale led the Pacific Institute to take a closer look at the assets and infrastructure at risk from such inundation. Heberger and colleagues (2009) used the present value of assets (infrastructure, business and residential buildings, including their contents) along the Bay shoreline to estimate the potential economic impacts of a 1.4 m SLR combined with a 100-year flood. Absent flood protection, the potential economic impact on the potentially affected areas would amount to $62 billion (in 2000 dollars). This absolute monetary value and the percent increase (compared to current risk) vary widely across the nine Bay Area counties (Table 2). For example, San Francisco is projected to see the most substantial increase in economic risk from 1.4 m SLR (3,400 percent). By contrast, San Mateo County is estimated to have the highest value at risk, but it increases by "only" 41 percent from the current assets at risk from a 100-year flood (Heberger et al. 2009).

Table 2: Replacement Value of Buildings and Contents at Risk of a 100-year Flood in San Francisco Bay, by County (in Millions of Year 2000 Dollars), at Present and with Different Sea-level Rise Scenarios

County	Current Risk	Risk with sea-level rise			Percent Increase (1.4 m)
		0.5 m	1.0 m	1.4 m	
Alameda	3,300	5,300	10,000	15,000	+ 370%
Contra Costa	190	330	620	980	+ 430%
Marin	4,700	5,900	7,400	8,500	+ 79%
Napa	220	260	320	410	+ 89%
San Francisco	110	370	1,400	4,000	+ 3400%
San Mateo	16,000	18,000	21,000	23,000	+ 41%
Santa Clara	3,700	4,700	6,400	7,800	+ 110%
Solano	620	940	1,400	1,900	+ 210%
Sonoma	150	180	240	280	+ 82%
Total	29,000	**36,000**	**49,000**	**62,000**	**+ 110%**

Note: Counties with borders on the Pacific coast and San Francisco Bay (e.g., San Mateo) were separated based on the shoreline affected.

Source: Heberger et al. (2009), p.79

Knowles (2009, 2010) and the Pacific Institute's SLR maps, as well as similar ones produced a couple of years earlier by BCDC (using inundation data produced by Knowles in 2008), have been widely distributed by regional organizations, scientists, environmental groups, and news outlets. Such communication has provided clear signals to regional residents and decision-makers about SLR-related threats and the need for planning ahead. At the same time, a number of data limitations, lack of integration of bathymetry, and inadequate treatment of flood protection infrastructure limit the reliability of these future flood risk maps. Research currently under way as part of the State's Vulnerability & Adaptation study (Biging et al. 2012) is improving on some of these aspects. In the mean time, the maps have stirred public awareness and created significant political attention, as subsequent sections will show.

3.2 Vulnerability

Vulnerability describes "a system's susceptibility to harm or change as a result of its exposure, sensitivity, and adaptive capacity" (V&A Study Guidance 2010).[3] Higher social vulnerability increases the likelihood that expected threats arising from climate change will be experienced as more severe by the exposed community, system, or sector (IPCC 2007; 2011). Higher vulnerability thus may serve as a motivation to launch efforts that are aimed at greater preparedness, protection, or reduction of the risks associated with climate change (e.g., by reducing exposure or sensitivity, and/or by increasing the capacity to respond and adapt).

The hypothesis that social vulnerability, not just climate change risk, has a signaling value to society, and thus may play a role in motivating adaptation efforts, affected the selection of cases

[3]This report is consistent with the State of California's Climate Change Adaptation Strategy and the PIER Program's Vulnerability Assessment Guidance in its use of the concept of *vulnerability*.

for this study (Section 2). Exposure of particularly vulnerable groups of society and/or of greater assets could result in greater concern, as could lack of adequate protection from SLR and related coastal impacts. Finally, inadequate capacity to prepare and adapt could delay the start of planning and adaptation efforts.

The results of the vulnerability assessment are presented briefly below. Importantly, not all combinations of physical climate change risks with social vulnerability are assessed here. Changes in temperature and precipitation from climate change may stress many portions of the Bay Area (through flooding, drought, heat waves, habitat changes, and others), and do so in different combinations. But given the prominence of sea-level rise in regional impacts research and public communication, it was used here as the primary indicator of physical risk and as a unifying threat across the Bay area.

3.2.1 Social Vulnerability

As described in Section 2, the Social Vulnerability Index (SoVI) developed by Cutter and colleagues (2003) was used to calculate an objective indicator of relative social vulnerability to climate change impacts in the Bay Area. This index provides a quantitative measure of exposure, sensitivity and adaptive capacity of differentially vulnerable segments of society to environmental hazards (Figure 7).

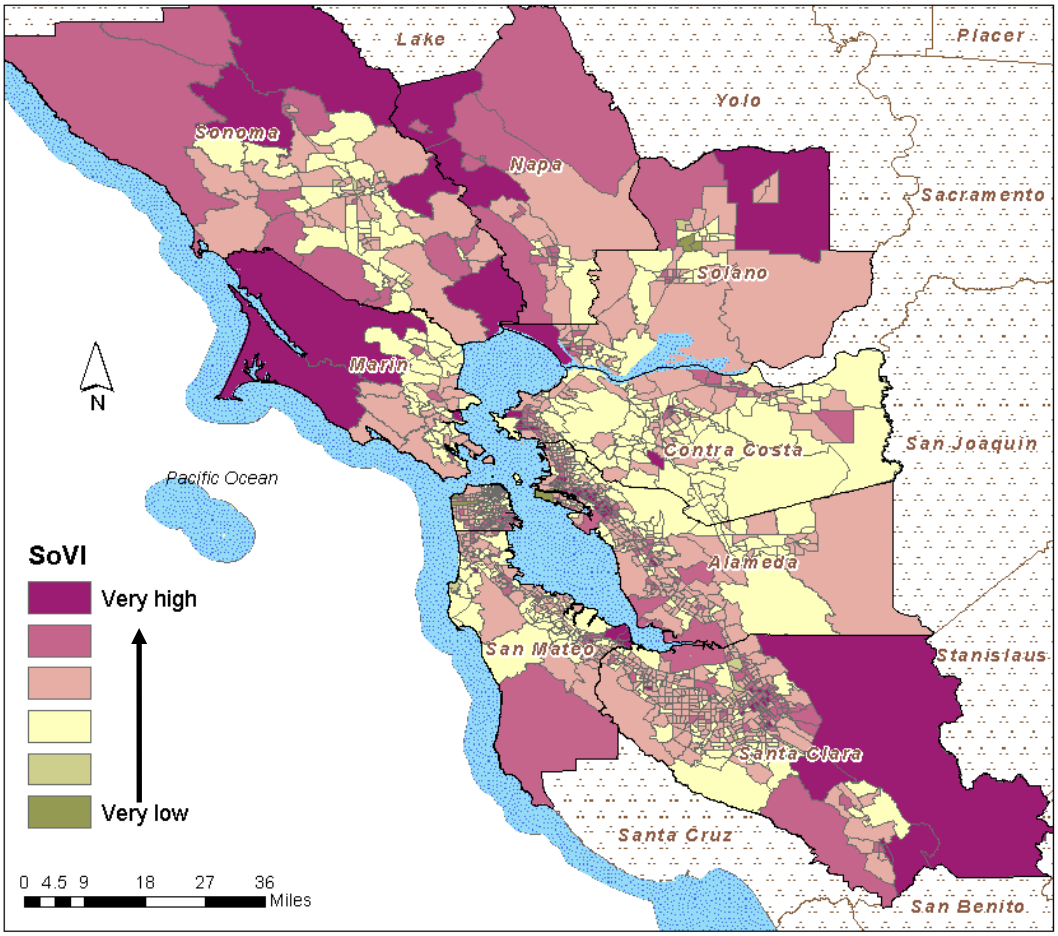

Figure 7: Social Vulnerability Index (SoVI) Results for the San Francisco Bay Area

The index, using Census 2000 data, indicates the general social vulnerability to disasters, including to the impacts from climate change. Differently colored census tracts represent summed factor scores divided by standard deviations. Areas in magenta indicate the highest vulnerability, yellow areas indicate medium-low vulnerability, and green areas indicate the lowest vulnerability.

Figure 8 shows a higher-resolution excerpt of a portion of the study area, illustrating how social vulnerability can vary considerably even within one city or county, including ones that are generally thought of as rather affluent. The least socially vulnerable areas in this portion of the Bay include park areas, Alameda's naval station, and affluent neighborhoods in San Francisco.

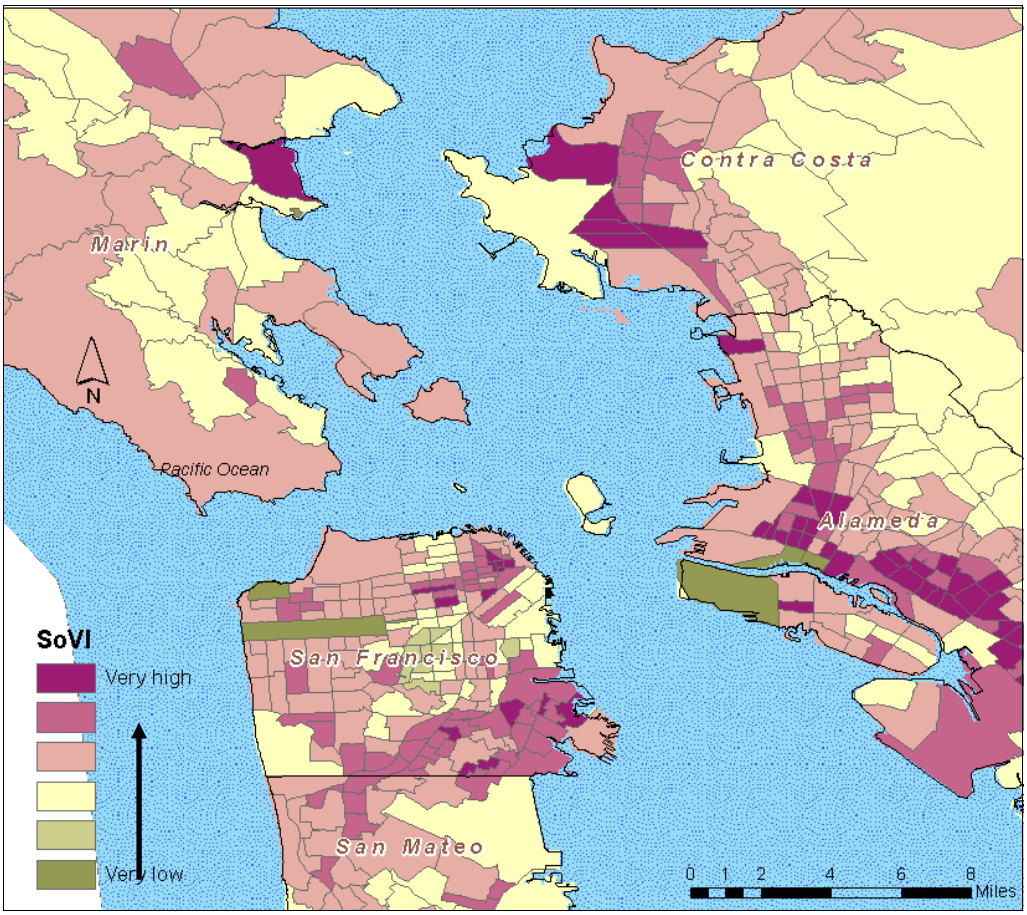

Figure 8: Social Vulnerability Index (SoVI) Results for a Portion of the Bay Area, Including the City/County of San Francisco, and Portions of Marin, San Mateo, Alameda, and Contra Costa Counties

Importantly, social vulnerability, as an indicator developed from population census data, does not include a representation of the value of physical assets at risk (for those, see the results presented above in Table 2 from Heberger et al. 2009). The SoVI is also not specific to the physical risk, in this case sea-level rise and related flooding risks. Rather, it is designed to give a first glimpse at the known social factors that can make some populations more vulnerable than others, based on common patterns observed across a wide range of disasters. While the fully integrated SoVI is thus useful in providing a single snapshot of social vulnerability, it is not recommended as the sole source of information for designing risk management interventions. The groupings of Census variables that cluster together to create a particular degree of vulnerability provide for a more thorough explanation of social vulnerability and for more useful insights in developing interventions to alleviate it. Appendix D describes in some detail the key steps in conducting a SoVI analysis, and how the Census variables were combined to arrive at the differential social vulnerability shown in the maps in Figures 7 and 8.

A careful review of Figure 7 shows the following areas as ranking high or very high in social vulnerability including:

- **Very high**: West Marin, Northern Sonoma, and Napa Counties, Mare Island and Sonoma Wildlife Refuge, Northern Richmond and other parts of Richmond (including Iron Triangle), West Oakland and adjacent cities/communities to the south, East Palo Alto, southeastern Santa Clara County, and eastern Solano County
- **High**: Shoreline of Santa Clara County, and portions of San Francisco (e.g., Hunters Point/Bayview)

High socio-economic status of a population generally is assumed to translate into high adaptive capacity (including in more resources available to the local government to take on planned adaptation). The grouping of Census variables related to socio-economic status explains more than 20 percent of the explained variance in the SoVI results. As a careful review of that factor in the SoVI analysis reveals, adaptive capacity as an indicator of greater readiness to begin adaptation planning varies considerably across the region. For example, Marin County has overall relatively high socio-economic status (the only county with no Census tracts in the lowest quantile). Most of its shoreline also ranks high in socio-economic status. By contrast, large portions of shorelines areas of Contra Costa, Alameda, and San Mateo Counties exhibit low socio-economic status.

3.2.2 Integrated Perspective on Social Vulnerability to Sea-Level Rise and Coastal Flooding

To explore the coexistence of social vulnerability and exposure to the physical risk of sea-level rise driven Bay area flooding, the results of the SoVI analysis were overlaid on a map showing exposure to a 100-year flood after 150 cm SLR based on Knowles (2010) (Figure 9).

The areas of greatest concern emerging from this simple correlation include San Rafael and part of Hamilton (south of Novato) in Marin County; the southern portion of Napa County; the Delta region and Mare Island in Solano County; Richmond in Contra Costa County; the Hayward shoreline in Alameda County; Alviso, the South Bay Salt pond Restoration Project, Sunnyvale and Mountain View in Santa Clara County; and East Palo Alto, eastern portions of Redwood City, as well as San Francisco Airport and portions of the surrounding cities of San Bruno and Millbrae in San Mateo County.

This preliminary analysis helped narrow the case study selection. Given the additional selection criteria (especially the presence of an adaptation effort, the willingness to participate in the study, and a mix of cities and counties), four cases were selected with different social/physical vulnerability profiles (Table 3).).

Table 3: Vulnerability Profile of Four Local Case Studies

Name	Type	SoVI (h, m, l)	Exposure to SLR (area and/or $)	Integrated vulnerability estimate
Hayward (w/HASPA)	City	Medium	High in area (for boundaries of HASPA)	Medium
Marin	County	Low-Medium	High in parts	Mixed/medium
San Francisco	City and County	Mixed	Low in area, very high in cost	Low-very high
Santa Clara	County	Mixed	Medium	Medium

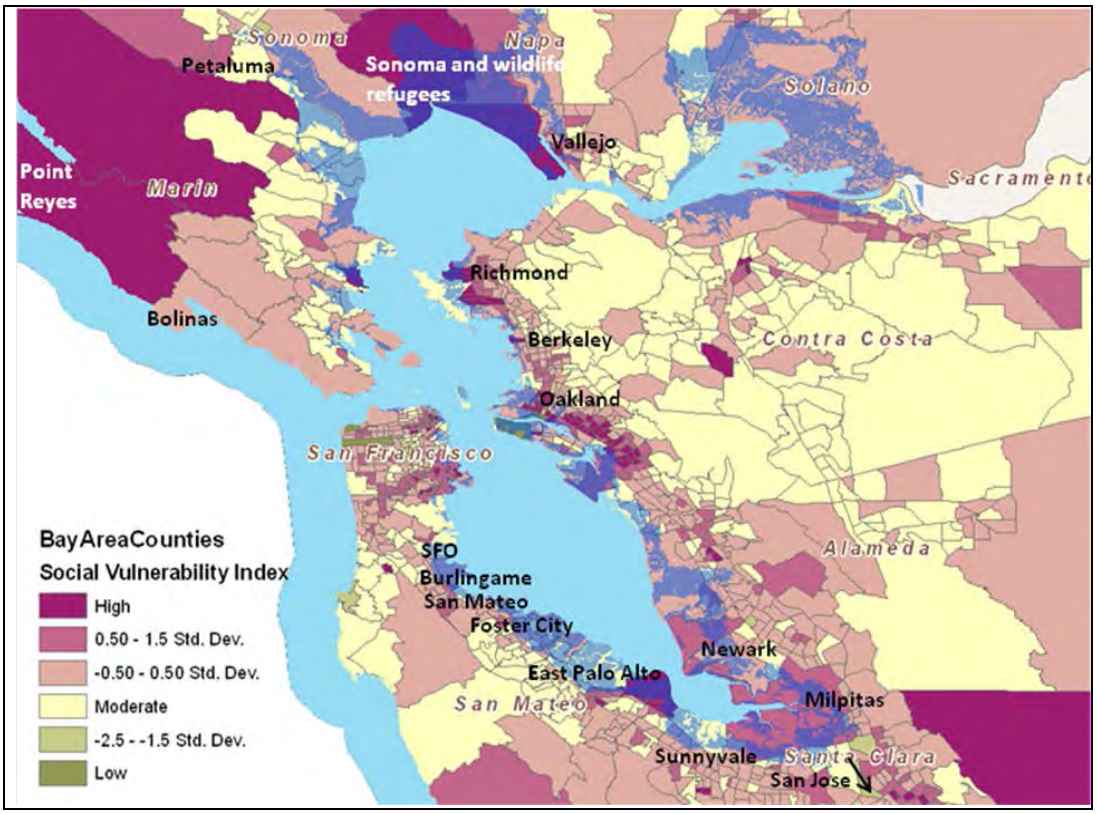

Figure 9: Bay Area Overlay of the Area Potentially Inundated by a 100-year Flood After 150 cm SLR and the Social Vulnerability Index

Source: SLR data from Knowles (2009), available at: http://cascade.wr.usgs.gov, and http://cascade.wr.usgs.gov/data/Task2b-SFBay/data.shtm) combined with theSoVI results presented in Figure 7

For San Francisco, the *area* of exposure is pretty low, but the estimated *economic impact* is very high (according to Heberger et al. 2009). Therefore, the exposure is considered high. This combines with a mix of social vulnerabilities—and corresponding mix in adaptive capacities—in affected areas. In Marin, the bayside portion of the county exhibits low to medium social vulnerability (largely because of the high socio-economic status), but combines with high exposure to SLR in several areas. The overall high socio-economic status of this county relative

to the other counties in the region, however, suggests that Marin has comparatively high adaptive capacity.

Santa Clara County's shoreline scores mixed but not extreme on either the social vulnerability or physical exposure, though some inland areas of the county are considered highly socially vulnerable. The socio-economic status of areas near the Santa Clara County shoreline rank in the two lowest quantiles, suggesting relatively low adaptive capacity there.

Finally, the City of Hayward's shoreline (in particular the jurisdictions falling under HASPA) is projected to be highly exposed to SLR-related flooding. The city itself shows a medium to medium-high social vulnerability index. When integrated, HASPA is considered to be a mixed/medium vulnerability area, especially because much of city's population does not reside within the projected flood zone with sea-level rise.

To what extent awareness of physical exposure of local risks from SLR and social vulnerability played into these communities' efforts in adaptation planning is revealed in the next section.

Section 4: Adaptation Activities Under Way in Four Local Case Studies and the San Francisco Bay Region

This section summarizes in a descriptive fashion what the four selected local cases and the regions as a whole are doing in terms of planning and preparing for the impacts of climate change and implementing any adaptation strategies. Communities have a wide variety of options to adapt to the range of impacts described in Section 3 above. For example to adapt to the impacts of sea-level rise, adaptation options are often broadly categorized into the three rubrics of "protection," "accommodation," and/or "retreat." But these broad categories obscure the specificity of strategies and actions (including policy and land use changes, economic or fiscal tools, technical solutions, behavioral changes and informational options) applied in different sectors of coastal communities. For example, what is needed or possible to address impacts on transportation or other major infrastructure is very different from the sorts of activities one may consider in water supply or wastewater management or in public health. Indeed the communities studied here—depending on the sectoral focus of their activities—are considering a wide spectrum of options although few are far enough along to have explored them in detail or settled on a specific set. Thus, it is too early to report on what adaptation options have been chosen in a comparative way. To the extent preferred solutions are emerging or actions are being taken, they are discussed in the process descriptions for each case below.

These process summaries have been compiled from information obtained during the interviews—mainly the key informants in each case, but also through informants elsewhere providing additional insights on a particular case—and triangulated with any document evidence obtained from websites or provided by the interviewees.

Each of the five cases below is summarized in a main subsection of this section (beginning with Hayward/HASPA, then describing San Francisco, Marin, Santa Clara, and the regional process), providing two different perspectives on each. The first is a chronological one (see Section 2.3.1 Adaptation Process Mapping), in that it aims to give a "10,000 foot" overview of what has occurred to date, what is currently under way, and— in most instances—an anticipatory preview of possible developments in the future. Efforts within each case studied are distinguished as *periods* where participating actors, concerns of climate change, or bounds of the governance system differed distinguishably.

The second perspective is that of the adaptation decision-making process introduced in Section 1 (see

Figure 1and Section 2.3.1 Adaptation Process Mapping). Along the chronological timeline presented, the decision process summaries describe in more detail the phases and stages that each case has gone through. In this section, the phase in the adaptation process to which individual efforts are mapped (e.g., U1 represents the stage called 'Detect Problem', U2 represents 'Information Gathering', etc.; see Figure 1) are referred to in parentheses where

relevant. The discussion will highlight key actors involved, the system(s) of concern, and the governance and larger socioeconomic context in which adaptation planning has occurred or currently is occurring. Finally, following the case descriptions, the section concludes with a discussion of similarities and differences among the cases.

4.1 Hayward and HASPA

4.1.1 Introduction and Overview of Climate Action in Hayward

Hayward is located near the southern end of the East Bay, in Alameda County (Figure 10A). The city, known as the "Heart of the Bay" due to its location just 25 miles southeast of San Francisco, 14 miles south of Oakland, and 26 miles north of San Jose, covers an area of more than 62 square miles and is home to nearly 146,000 residents, of whom nearly 41 percent are Hispanic or Latino, nearly 25 percent are Asian, nearly 19 percent are Anglo/White and more than 11 percent are African American (City of Hayward 2011). Having evolved from a trading post to a blooming agricultural "Eden" and today an ethnically diverse business community, Hayward is a bustling and growing city with three overarching governance goals: to be a safe, clean, and green community (Hayward City Council 2011).

Hayward began focusing on climate change in 2005, when the Mayor signed the U.S. Conference of Mayors Climate Protection Agreement. A year later, the City joined ten other local governments in Alameda County in the Alameda County Climate Protection Project (ACCPP) to coordinate regional greenhouse gas emission reduction efforts. ACCPP was itself an initiative of the Alameda County Waste Management Authority and Recycling Board (StopWaste.Org), the Alameda County Conference of Mayors, and *ICLEI—Local Governments for Sustainability* (ICLEI)—a nationally and internationally active membership organization supporting local communities in climate mitigation (and more recently also adaptation). With funding support from the Bay Area Air Quality Management District (BAAQMD), the City prepared and then adopted a Climate Action Plan (CAP) in 2009 "to make Hayward a more environmentally and socially sustainable community" (City of Hayward 2009). This plan dealt exclusively with greenhouse gas emission reductions, and followed the five milestones commonly seen in ICLEI-supported climate action plans.

While adaptation needs were not considered in the 2009 CAP, the city separately encourages water use efficiency and conservation, the benefits of which city staff interviewed for this study consider to have both mitigation and adaptation value. In the context of open space management, climate change is beginning to be considered, e.g., species migration and species invasion driven by climate change and growing wildfire risks. The city also has ongoing efforts in disaster preparedness, although climate change concerns are not explicitly addressed there. Only in one sector have there been concerted climate risk assessment and adaptation planning efforts: shoreline management.

In 1970, the Hayward Area Shoreline Planning Agency (HASPA) was established as a joint powers agency of representatives from the Hayward Area Recreation and Park District, East Bay Regional Park District, and the City of Hayward for the purpose of better coordinating

shoreline planning activities across jurisdictions so as to improve and preserve the shoreline for future generations (City of Hayward/HASPA 2011; Figure 10B). Through HASPA's efforts over the past four decades, over 3,150 acres of wetlands, marshes and adjacent upland areas between San Leandro Creek in the north and the Alameda Creek Flood Control Channel in the south have been purchased, preserved, and restored, or are in the process of being returned to wetlands, marshes, and protected uplands. This protected and restored land is in public ownership, open to the public for recreational purposes, and affords the city and its residential and industrial shoreline occupants a buffer against storm and tidal flooding. HASPA's Board of Trustees and a separate Citizen Advisory Committee meet quarterly to discuss emerging issues, development or restoration projects, and any relevant local or regional policy matters. HASPA's adaptation efforts are described in the next section.

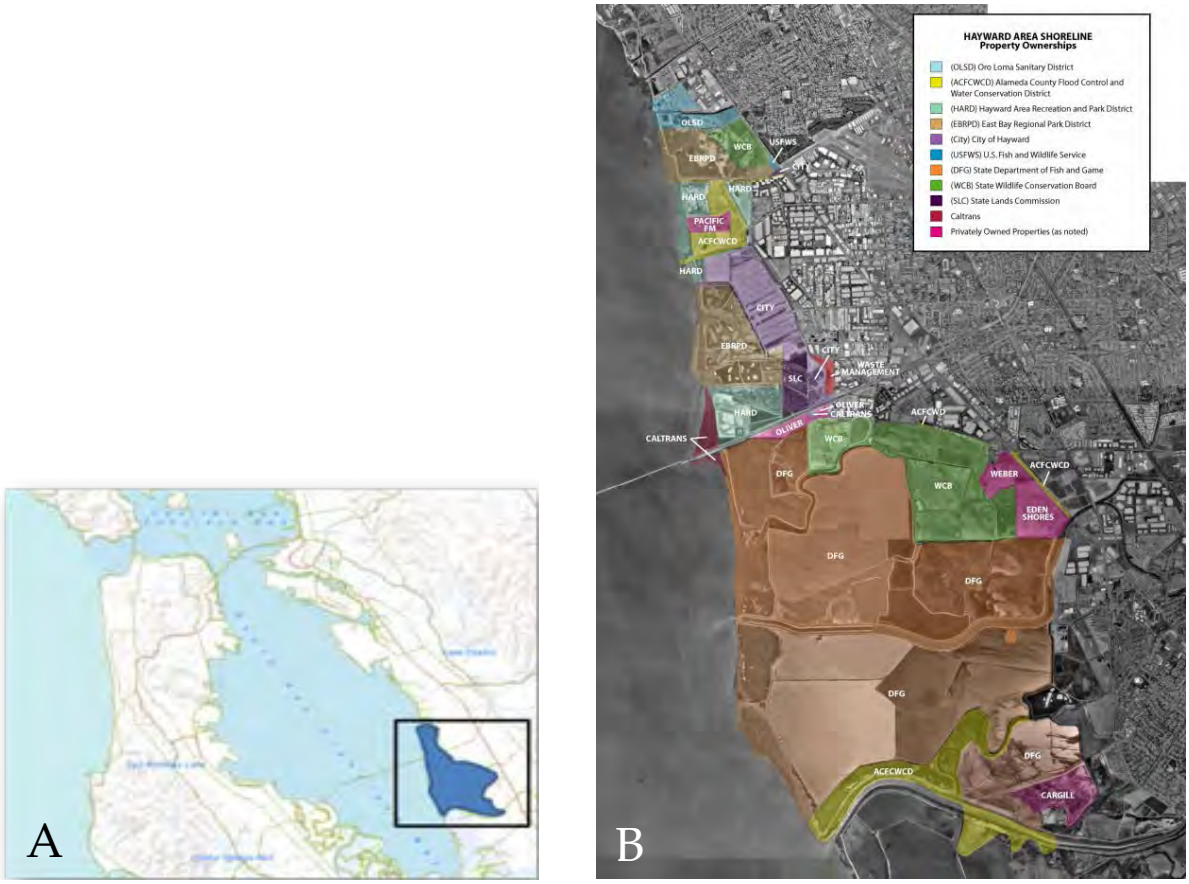

Figure 10: (A) Location of Hayward in San Francisco Bay, and (B) Complexity of Jurisdictions in the Hayward Area Shoreline Agency (HASPA)

Source: City of Hayward/HASPA 2011

4.1.2 HASPA and Coastal Adaptation Planning

Given the lack of citywide, comprehensive, cross-sector adaptation planning, this adaptation case study is one focused on a single sector, albeit one that crosses and integrates across a

variety of jurisdictions. This distinguishes the cases from all others. The timeline in Figure 11 represents the extent of the adaptation process studied here.

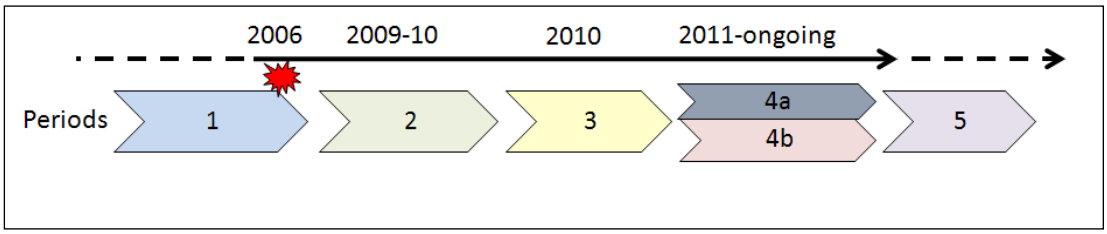

Figure 11: General Timeline of the Hayward/HASPA's Adaptation Process

The period of time included in this investigation begins prior to 2006 (Period 1) when a local elected official joined HASPA and began expressing the need to look at sea-level rise (SLR) and its potential impacts on the restored wetland areas under HASPA's jurisdictions. Then, in 2006, a winter storm led to levees along the Hayward shoreline being overtopped by Bay waters. This event triggered concern for future flood risks, and allowed for the connection to be made between single storm events and the underlying increasing rate of sea-level rise (Period 2). HASPA then initiated a first preliminary SLR risk and options assessment. Upon finalization of the assessment by the only consulting firm that responded to the call for proposals (Philip Williams and Associates, PWA), key individuals involved with HASPA continued the adaptation process with efforts to bring more stakeholders on board (Period 3). This coalition building period then entered a period in which HASPA's efforts got broadened and integrated into a regional effort along a larger portion of the East Bay shoreline (Period 4). Looking forward (Period 5), HASPA is planning to implement an innovative demonstration project that explores the feasibility of the currently preferred adaptation option, in particular focusing on the upland transitional wetlands that will be necessary to allow transgression of wetlands with SLR. Table 4 presents a summary of the case in terms of each period's principal actors, the system of concern, and the bounds of the governance system.

Table 4: Summary of the Hayward/HASPA's Adaptation Process by Period

Period	Summary	Key actors	System of concern	Governance system
1	A single actor trying to build awareness and concern for sea-level rise among peers, staff	Local elected official/ scientist	Shoreline N of Hwy 92, recently restored to marsh	HASPA Joint Powers Authority (JPA)
2	After major storm, a preliminary assessment of SLR risks and solutions options was agreed upon and conducted	HASPA, Phillip Williams and Associates (PWA)	Shoreline N of Hwy 92, to San Leandro Creek. Inland to the Union Pacific Railroad	HASPA JPA
3	Broadening the governance system (coalition building) to support a continued adaptation process	HASPA, PWA, neighboring cities, flood district	Extended shoreline – bounds undecided	Extended, but undecided
4A	Intention to conduct a more detailed vulnerability assessment and including at-risk shoreline infrastructure [not realized]	HASPA, many other jurisdictions	Extended shoreline – bounds undecided	Extended but undecided
4B	After being chosen as sub-regional pilot project, HASPA and neighboring jurisdictions receive fed and state resources, staff, and technical assistance to conduct a broader vulnerability assessment (social, ecological, infrastructure)	ART project leaders (BCDC, NOAA); HASPA, many other jurisdictions	Extended shoreline from Hwy 92 Bridge to Emeryville	Includes conservation, wastewater and flood districts, multiple cities, transportation agencies, more
5	Intended pilot project to test feasibility of marsh accretion option developed in Period 3 [not yet realized]	HASPA, City of Hayward (dominant), other coalition partners	Restored marsh shoreline	HASPA, extended, yet to be decided

Each of these periods is given a descriptive moniker (not used by interviewees, but the researchers' descriptors) and discussed in more detail below, highlighting the phases and stages of the adaptation decision-making cycle (and more specifics on the activities within each). Figure 12 at the end of this discussion shows the phases (U – Understanding, P – Planning, M – Managing) and stages within each (three stages per phase, e.g., U1, U2, U3) completed in each of distinct periods of the adaptation process.

Period 1: The Lone Voice

Period 1 is essentially embodied by a single actor trying to bring attention to climate change risks affecting the shoreline. With a background in climate science, this actor—a local elected official—had long been concerned about climate change, and vocalized this concern with the HASPA group over several years. This individual went through the three stages of the Understanding phase, but over the course of Period 1 never beyond it. He detected a signal (U1)

in his scientific training and gained understanding of climate change and SLR-related risks. After his initial education, he relied on information about climate change available more generally (U2) and had the problem essentially defined in his mind (U3).He repeatedly vocalized the concern and need to understand the local impacts of SLR on the restored marsh/shoreline more specifically, but did not find much of a receptive audience.

Both the governance and system of concern during this period were the shoreline bounded within the HASPA jurisdiction governed by the joint powers authority (JPA) of the City of Hayward, the Hayward Area Recreation and Park District (HARD), and the East Bay Regional Parks District (EBRPD). These agencies jointly oversee the management and restoration of wetlands along this segment of the Bay shoreline (Figure 4.1B).

Period 2: Preliminary Sea-Level Rise Assessment

A major storm in the winter of 2006 resulted in waves overtopping levees along the HASPA shoreline. These levees currently protect wetlands and other upland areas from the Bay. The event triggered concern among the JPA about adequate flood protection for their recently restored wetland habitat. Out of concern to avoid future flooding JPA members discussed how to deal with (i.e., avoid or minimize the risk of) such flooding in the future. Importantly, HASPA was set up to manage a stretch of the shoreline (cutting across jurisdictions), thus its response to the 2006 storms was, naturally, a regional one. The "lone voice" from Period 1 at this point in time found a receptive audience in HASPA when he made the link between a local extreme event and the long-term global problem. Moreover, having HARD and EBRPD involved (and providing staff) helped, as these agencies were well aligned with the goal of maintaining ecological services and had already undertaken significant restorations, so considering adaptation strategies that involved wetlands was not a big step for them.

Period 2 involved the call for and development of a preliminary SLR assessment for the HASPA shoreline. The boundaries of both the governance system and the system of concern (wetlands along the shoreline) still align with HASPA, similar to Period 1. The key actors in this period include a private consulting firm that HASPA contracted to conduct a preliminary SLR assessment. Because the South Bay Salt Pond Restoration Project in the southern part of HASPA's jurisdiction was already under way (with consideration of modest SLR scenarios), spearheaded by the California Department of Fish and Game, the preliminary SLR assessment was to focus only on the area north of Highway 92 to San Leandro Creek (PWA 2010).[4] The goal of this assessment was "to determine the impact of the anticipated sea level rise in San Francisco Bay, on the Hayward Shoreline and the actions that can be taken to protect both the wetlands and shoreline development in this area" (ibid., p.1).

The assessment, released in early 2010 in presentations to the Hayward City Council and to the HASPA Board, developed a better understanding of potential SLR impacts (U2, U3).

[4]Phase II of the South Bay Salt Pond Restoration Project, getting under wayat the time of this writing, looksto incorporate much higher SLR estimates.

Additionally, the consultant developed and assessed a set of adaptation options (P1, P2), and then recommended two interrelated strategies for HASPA to move forward on adapting to SLR (P3). One strategy, physical in nature, involved building up the marsh with the redirected sediment from a nearby marina (otherwise dredged and deposited offshore at considerable expense), allowing the marsh to accrete in elevation over time (see also Period 5). The second strategy, concerning the governance of the adaptation process, involved developing a broader coalition of relevant stakeholders in support of moving the physical adaptation strategy forward. Stakeholders not involved up until then included some that managed infrastructure along the shoreline which was also assessed to be at risk from SLR and coastal flooding. The consultant suggested that this broader coalition of stakeholders could develop and financially support a more detailed assessment of the problem and adaptation options (Period 3). Because the recommended strategies promised not only to solve the SLR impacts problem on the Hayward shoreline (at least for some time to come), protecting valuable habitat and built infrastructure, but also reuse treated wastewater on the shoreline, remove storm water channels, and address the sediment surplus problem of the nearby marina, interviewees unanimously considered the suggested approach a "win-win-win" solution. Each of the stakeholders bought a piece of the solution to the table (e.g., land, sediment, water), and thus the parties cooperated well in this period.

Period 3: Broadening the governance system (coalition building)

This period involved implementing one of the two recommended strategies suggested in the consultant report (M1), namely to build a broader coalition of partners that could help realize the more ambitious physical solution (also recommended there). Actors involved in the preliminary SLR assessment (City staff and the consultant) gave numerous presentations to potential collaborators in neighboring cities and jurisdictions about the assessment conducted in Period 2 (thus stimulating awareness of the SLR problem and the creative solutions they had crafted among the heretofore uninvolved actors, U1). The additional purpose was to garner support from all the relevant jurisdictions to engage in joint adaptation planning and solution finding for the long term. The ultimate purpose for creating this larger coalition was to amass sufficient support to conduct a more in-depth assessment of the infrastructure exposed to SLR-related risks and to carry out an environmental impacts assessment of the marsh accretion project as a necessary precursor to actually implementing it in the future.

The governance institutions (in this situation represented by the interests and institutional structures of several jurisdictions involved) and actors involved in this period extended beyond the original HASPA area of influence. The coalition built during this period remained informal (city partners, for example, were asked to pass resolutions acknowledging the SLR threat and stating their support for a joint process, but didn't ask for any further commitments). It included surrounding cities, a flood district, the East Bay Dischargers Authority (EBDA), and other relevant stakeholders. The system of concern was expanded beyond HASPA but continued to focus on coastal wetlands and critical shoreline infrastructure. This expanded system of concern influenced decisions as to who should be brought into the coalition of

stakeholders and a future (potentially more formal) governance structure that could support a long-term adaptation process.

Actors intended to continue—with a broader coalition in place—with generating the necessary funds for an in-depth infrastructure vulnerability assessment (Period 4A below), but the process was redirected when a regional agency selected HASPA as a pilot project for a differently focused vulnerability assessment (Period 4B below).

Period 4A: Deepening understanding through infrastructure assessment (planned, but not realized)

In this period (not realized), actors had planned to conduct an in-depth vulnerability assessment for the exposed infrastructure along the southern East Bay shoreline. This was to be carried out under the expanded governance structure developed in Period 3 and with the financial support from all participating/affected jurisdictions. It was thought that sharing the financial burden among all participating jurisdictions would make this step more feasible. The system of concern (the shoreline) was going to be extended beyond HASPA limits, but the exact bounds of this extended area had yet to be decided by the partners brought on board during Period 3. Again, this sub-period was ultimately not realized because efforts making up Period 4B were implemented instead when outside (federal and state level) assistance chose the shoreline for a larger study.

Period 4B: Deepening understanding in the Adapting to Rising Tides (ART) Project (currently under way)

This period began in early 2011 when the San Francisco Bay Conservation and Development Commission (BCDC) selected a portion of Alameda County (including HASPA) as the subregion of the Bay that would be supported in a comprehensive vulnerability assessment and adaptation pilot project. From the perspective of this study—and this case in particular—this period is part of the HASPA process because the efforts initiated by HASPA (initial assessment and coalition building) were a big reason for why this area was selected by BCDC. (See also Section 4.5 for a discussion of the regional process and BCDC's efforts within it.)

As part of its Climate Program, BCDC launched the ART (Adapting to Rising Tides) Project in late 2010. The stated objective of the ART Project is "to field test vulnerability assessment and adaptation planning tools for the Bay region" and to do so at a fine-enough scale to be relevant to local decision-makers. "The goal is to develop a template for integrative planning that addresses both the built and natural environment, and takes into account local conditions and interests, and supports local community adaptation planning" (BCDC 2011b). With funding from NOAA's Coastal Services Center and the Federal Highway Administration (funneled through the regional Metropolitan Transportation Commission, MTC), and additional technical assistance from ICLEI, the selected pilot community was to showcase and test the use of these

planning tools to others in the Bay area. In the process, it would also become one of ICLEI's inaugural adaptation communities.[5]

Over the course of this study, while HASPA was in the midst of Period 3, building up its coalition of partners, BCDC announced its search for a pilot region. Local communities were invited to apply. The key actors in HASPA saw this as a valuable opportunity to get at least some of the more detailed vulnerability assessment (planned for Period 4A) conducted, and applied to become the pilot area. Given the preliminary SLR assessment already completed, the coalition building efforts under way, the obvious commitment to an ongoing adaptation process, and the opportunity to assess vulnerabilities of social and ecological systems as well as transportation and other build infrastructure, the ART project selected Alameda County, including HASPA, as its pilot area. The assessment of shoreline assets at risk from climate change impacts, in particular SLR, is under way at this time (summer/fall 2011). These assets were selected by stakeholders in a series of workshops that included representatives from wastewater treatment plants, utilities, water supply districts, NOAA, the flood district, transportation, public health departments, ports, cities, Alameda County, and others. Contrary to other Periods, HASPA representatives attend ART project meetings but are not a driver or leader of that work. Instead, BCDC holds the leadership role, including convening stakeholder workshops, developing asset indicators, and managing the vulnerability assessments. This period is also supporting and broadening significant stakeholder engagement.

The ART project includes a set of subcommittees that are loosely formed around transportation, airports and ports, technical issues (SLR maps, levees, and flood protection in region), and communication. These subcommittees were created on an ad-hoc basis (no formal structure) as the need arose to guide certain aspects of the larger project. The transportation subcommittee made up of agency partners in the region is advising and working on the vulnerability assessment funded by the Federal Housing Administration (FHA) and conducted by a consulting firm (AECOM). The BCDC is working with relevant stakeholders on airports and ports in-house. The technical sub-committee is an advisory committee made up of experts knowledgeable about technical aspects of flooding and flood protection (including levees) in the region, including the Flood District, the San Francisco Estuary Institute (SFEI), and other organizations. Lastly, the communications subcommittee is an ad-hoc group, meeting once a month, which includes representatives from the City of Oakland, City of Hayward, Hayward Area Recreational District, East Bay Recreation and Park District, ICLEI, BCDC, and others. It was set up to vet and discuss issues that could be politically sensitive and how to deal with

[5] ICLEI launched its Climate Resilient Communities Program, its concerted effort to support local communities in the U.S. in their adaptation planning, in 2010. The approach uses a five-step milestone approach akin to that used in its mitigation program. ICLEI has made available a number of online vulnerability assessment and adaptation planning tools and other resources to its member communities. Initially there were eight inaugural communities, BCDC, as a regional planning entity, being one. Moser is one of the twelve national adaptation expert advisors to ICLEI's program, but was not involved in either selecting BCDC as an inaugural community nor in BCDC's decision-process for selecting Alameda County as its pilot for the ART Project.

these through outreach and other measures. It also identified target audiences for particular outreach and worked with consultants on how to frame the metrics representing different assets for the vulnerability assessment.

At the time of this writing, the ART project is finalizing its list of assets exposed to sea-level rise and the vulnerability indicators that will be used for the analysis. The extent of the analysis and the plan following the analysis depends on available funding. Funds expected from NOAA were cut, such that the ART project can complete an existing conditions report but further assessment under different climate change projections and developing adaptation options (with continued stakeholder engagement) depends on future funding.

The ART project is unlikely to produce the specific engineering assessment needed to implement the pilot project (Period 5 below), but it builds awareness, stakeholder interest and engagement and thus lays the foundation for an even broader coalition needed to implement the HASPA adaptation option. Through its detailed assets inventory and broader vulnerability assessment, it also creates a broader understanding among previously uninvolved partners for the climate change challenges ahead. Thus, from HASPA's perspective Period 4B may be a small delay in getting to the specifics of its adaptation strategy, but otherwise a strategic advantage: they don't have to face the permitting and financing challenges alone and they are building broader understanding and support for moving ahead. Moreover, BCDC as a key regulatory agency and potential barrier is at the table. HASPA participants in this Period are not paid for participation, but are excited about and strongly committed to the process.

Period 5: Intended pilot project (not yet begun)

This period demarcates a future period, not yet begun, in which HASPA and its neighboring partners (brought together through the efforts in Periods 3 and 4B) will implement its pilot demonstration project intended to test the feasibility and effectiveness of the marsh accretion/sedimentation transfer option, as recommended in the preliminary SLR assessment by PWA (M1-M3). The pilot project will also serve to increase awareness of climate change risks and about adaptation options among the general public (U1-3), and help engage the public and other stakeholders on the issue of SLR and its impacts specifically for this area and more generally for the region and beyond.

To summarize the Hayward/HASPA adaptation process, Figure 12 gives a side-by-side depiction of the various stages completed (or intended) in the adaptation process in each of the five periods.

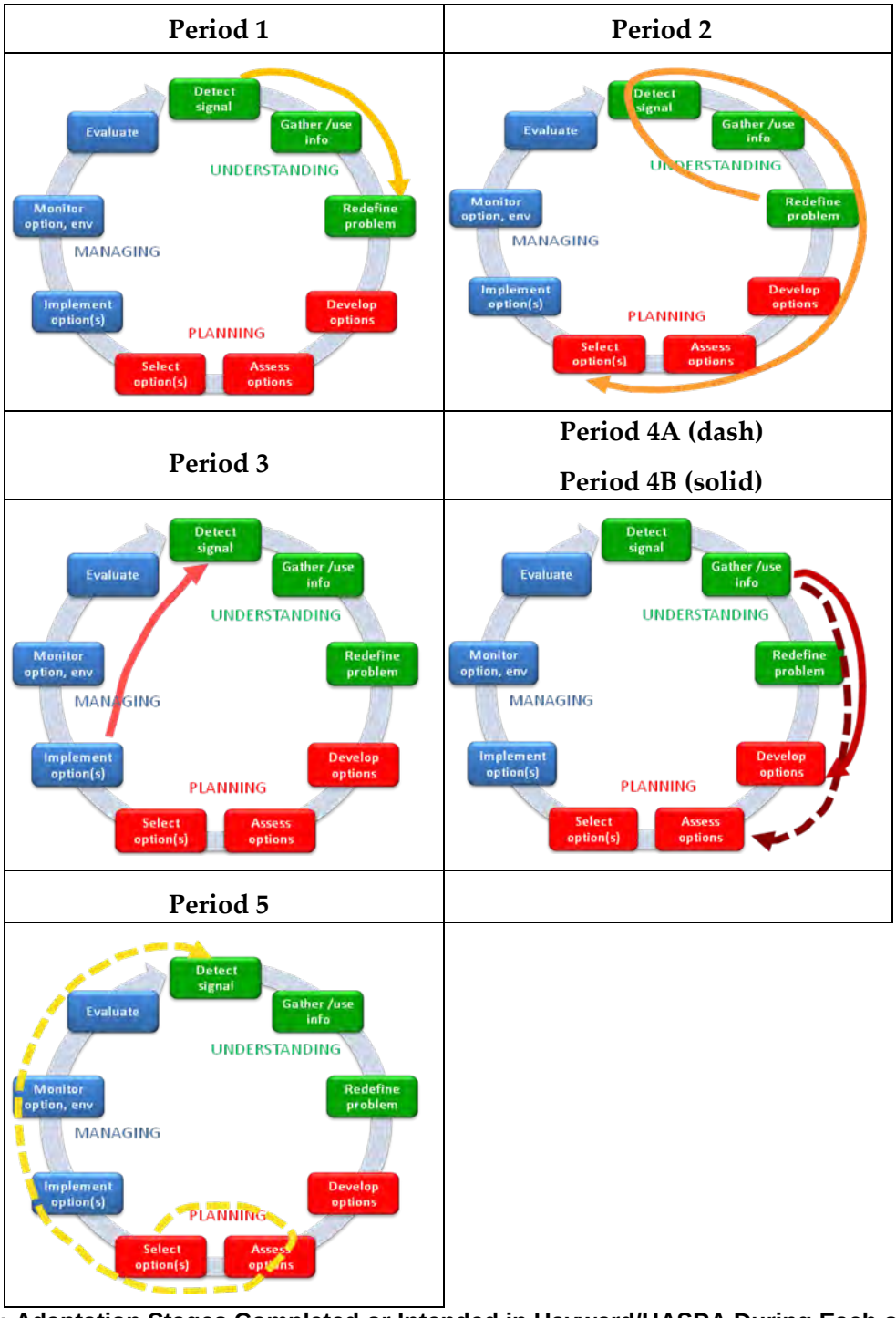

Figure 12: Adaptation Stages Completed or Intended in Hayward/HASPA During Each of the Five Periods of the Process. Arrows drawn over the conceptual model of an adaptation process (replicasof Figure 1) indicate which stages were included in individual periods. Dotted lines indicate anticipated or not yet realized (but planned) efforts.

While Table 4 above already showed that the key actors, the system of concern and the governance system and other aspects of the context vary over time, Figure 4 additionally

illustrates that the people involved in each period do not complete a full decision cycle in each period. In fact such a continuous flow through the process did not occur in the HASPA case (nor in any of the other cases described later on). Instead, actors typically go through a series of stages until they encounter a major barrier or set of barriers, which forces them to regroup, reorient and shift gears, bring in new actors and/or revisit an earlier stage of the adaptation process so as to create the conditions that would help them overcome the encountered barrier(s). The adaptation process phases and stages that occurred in each major period are summarized in Table 5.

Table 5: Adaptation Process Stages Observed in Each Period in the Hayward/HASPA Case

Period	Summary description	Stages included
1	Lone voice	U1, U2, U3*
2	Preliminary sea-level rise assessment	U1, U2*, U3, P1*, P2, P3
3	Broadening governance system/ coalition building	M1* U1
4A (intended but not realized)	Deepening understanding thru infrastructure assessment	U2*, U3 P1
4B (currently under way)	Deepening understanding thru ART Project	U1, U2*, U3 P1, P2, P3 (if funded)
5 (planned)	Pilot project (intended, not yet realized)	P2, P3 M1*, M2, M3 U1 (U2, U3?)

Asterisk (*) indicates the stage that was the main focus of a given period.

The case of Hayward and HASPA was unique among the cases studied in a number of ways. First, the principal focus (and thus its geographic and functional scope) of its adaptation efforts was primarily on one sector, shoreline management, albeit with multiple aspects of shoreline management (wetlands, wastewater, flood protection, etc.) involved and changing bounds of the governance system over time. Second, while thus more narrowly focused on just one sector, the case involved actors from a variety of jurisdictions (within and beyond the City of Hayward) that came together in this adaptation effort. And third, the set of periods observed representing its ongoing adaptation process were both sequential and clearly connected. The next case of San Francisco demonstrates a very different process that is primarily being pursued within a single city but involves multiple sectors (and thus systems of concern).

4.2 City and County of San Francisco

4.2.1 Introduction and Overview of Climate Action in San Francisco

The City and County of San Francisco is located on the northern tip of the San Francisco peninsula, which is bordered by the Pacific Ocean to the west, the Golden Gate (entrance between the Bay and the ocean) to the north, the San Francisco Bay to the east, and San Mateo

County to the south (Figure 13). San Francisco's city boundaries match those of the county's and therefore its government structures are administered in almost all functions (with minor exceptions) as one entity rather than treated as two separate governance structures. No further distinction is made in this section when the text simply refers to "San Francisco" or "the City of San Francisco."

Figure 13: Location of the City and County of San Francisco

In 2010, the U.S. Census Bureau counted just over 805,000 residents within the city's 46.7 square miles—a population that had grown by almost 4 percent over the preceding decade (US Census 2011b, all figures rounded). With almost 42 percent White/Not-Hispanic, 33 percent Asian, 15 percent Hispanic, and 6 percent African American, the city's population is rather distinct in its ethnic profile compared to the statewide average diversity. Average per capita and median household incomes are significantly higher than elsewhere in the state.

Despite high housing and population density, the city enjoys easy access to the wild and protected areas in the larger Bay Area but also has a remarkable amount of green space within its boundaries. The year-round moderate climate (and particularly cool, foggy summers) would not seem to raise concern about climate warming. Yet surrounded on three sides by the rising sea and enormous infrastructure, assets, and economic activity exposed to storms, flooding and inundation, as well as the city's dependence on water resources from the Sierra Nevada account at least partially for its early concerns about climate change.

4.2.2 Climate Protection Efforts in San Francisco

San Francisco is among the earlier cities in the US addressing climate change. In 2002, the city passed a resolution committing the city to an emissions reduction goal more stringent than that of the Kyoto Protocol (20 percent below 1990 levels by 2012). This resolution initiated the

development of a Climate Action Plan (City of San Francisco 2004) that laid out how such an ambitious goal could be achieved. As in Hayward, the city was supported in its efforts by ICLEI, and followed the common approach promoted by that organization. The plan's motivation was framed in terms of San Francisco having a responsibility to do its part in helping the state meet its emission reduction targets and in averting not just global problems, but reducing the city's vulnerability to local impacts. These potential local impacts and vulnerabilities were described at remarkable length in the plan (see pp.1–6 to 1–17), thus indicating considerable awareness among the plan's authors of the kinds of risks that would require adaptive actions. The citywide Climate Action Plan itself described a broad portfolio of strategies to reduce emissions from transportation, energy production and consumption, and solid waste but did not address adaptation at that time (SF Department of Environment 2011; SF Planning Department 2010). While early actions were largely directed toward reducing emissions from municipal operations, more recent efforts are oriented toward facilitating city-wide emissions reduction efforts.

Despite the recognition of local vulnerabilities to the impacts of climate change, the city, at the time of this writing, has yet to develop an integrated adaptation strategy. This is not to say, however, that there is a lack of awareness of the need for such a comprehensive strategy, nor a lack of separate adaptation planning efforts in different city departments and agencies. In fact, San Francisco has multiple ongoing efforts in different sectors to adapt to climate change impacts, yet recent attempts to integrate them have not yet led to fruition. Contrary to Hayward's efforts focused almost exclusively on shoreline management, adaptation efforts in San Francisco can be found in several sectors.

In this study, these diverse but separate efforts and the intentions discussed by interviewees of how to move forward are documented as two discrete periods. Period 1 (capturing largely the past, and possibly concluding at the time of this writing) is the time of isolated efforts, divided into seven sub-periods because they are all ongoing and conducted in different sectors without coordination (Figure 14). These include efforts in the transportation sector (with separate activities by the San Francisco Municipal Transportation Agency (SFMTA), the port, and the airport), the water supply sector, wastewater and flood management, public health, and planning. Period 2—initiated through discussions begun relatively recently and in the planning stage, but largely a preview of the future—represents a more integrated citywide climate adaptation process.

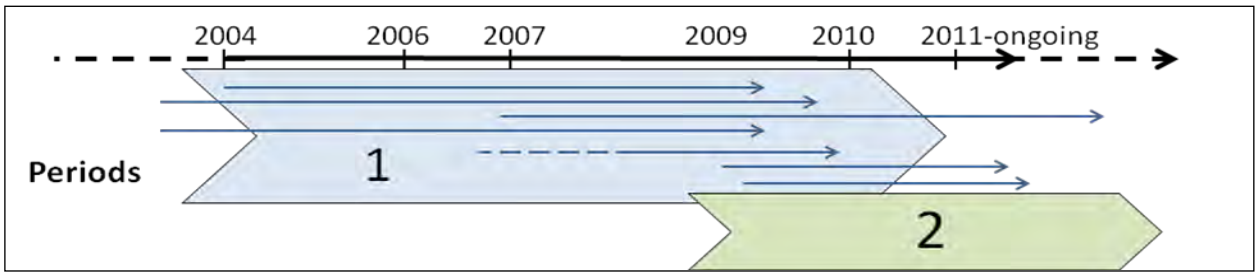

Figure 14: Timeline of Periods Observed in San Francisco

The adaptation planning and implementation activities completed to date and those planned for in the near future are described in more detail by period and sub-period below. A summary of each period is listed in Tabel 6 with its relevant actors, the system(s) of concern, and their respective governance systems.

Table 6: Summary of San Francisco's Adaptation Activities by Period and Sub-period, Including Key Actors, System of Concern, and Bounds of the Governance System

Period		Summary	Key actors	System of concern	Bounds of governance system
1	A	Citywide climate action plan outlining climate impacts to the city (foundation)	Dept. of Env., SFPUC, SFMTA	Entire city/county (municipal operations initial focus)	City/county
	B	Airport: Observation and initial threat assessment	SFO	Airport flooding (from storms, aggravated by SLR)	SFO
	C	Water supply: national coalition building and regional threat assessment	SFPUC	Water supply from Sierra Nevada	SFPUC
	D	Wastewater: assessment and infrastructure updating	SFPUC, DPW	Wastewater treatment, release, and flooding	SFPUC, DPW
	E	Planning: sustainability plan, interest in SLR	SF Planning	Land use	Planning Dept
	F	Port: infrastructure vulnerability assessment	Port, consultant, peripherally other agencies in SF	Port property	Port of San Francisco (City/county level)
	G	Public health: vulnerability assessment of increased heat waves from climate change	DPH, UC Berkeley	Heat waves and temperature increases impacts on PH	DPH
2		Citywide adaptation planning	Mayor (City Administrator's)Office, Dept of, Planning, Dept of Environment, and all other relevant agencies and departments (previously and newly involved)	Entire city/county	City/county

Period 1A: Laying the foundation for citywide adaptation planning

This sub-period includes three main actors—the Mayor's Office, the Department of Environment (DE) and the Public Utilities Commission (SFPUC). The DE and SFPUC together prepared the previously mentioned Climate Action Plan in 2004, while the Mayor's Office was

instrumental in legislating and promoting it. It discussed the projected impacts of climate change to the city, including SLR and associated coastal impacts on flood protection, built infrastructure and wetlands; increased storm activity; a potential decrease in water supply availability from the Sierras; and regional ecological impacts on the Bay Area (City of San Francisco 2004). While this first CAP was primarily focused on mitigation activities, which are being implemented (and an update is being completed at the time of this writing), the CAP acknowledged a need for adaptation. It did not contain anything specific on the "how to" of adaptation; it raised initial awareness for potential local impacts (U1, U2) and thus can be considered a foundational effort.

Period 1B: Airport: Observation and initial threat assessment

The actors in this sub-period are various employees of the San Francisco Airport (SFO). Representatives from SFO have been invited to and participated in meetings with the citywide effort/discussions. At the policy level SFO staff is also regularly attending BCDC meetings to observe possible SLR/adaptation-related policy developments. Over the past couple of years (2009–present) there was discussion about SFO and other enterprise agencies (i.e., city departments that generate their own revenue) funding a citywide vulnerability assessment, but SFO did not do so, nor has such a vulnerability assessment been undertaken (though funding is currently being sought to undertake this in Period 2, see below). The airport, much as other city departments, decided to keep in communication with the citywide effort, but work independently on anything related to adaptation until Period 2.

As for assessing the threats to its own facilities and property (particularly from climate change-driven SLR and storm-related flooding), SFO has not yet undertaken a full or formal assessment. Instead, staff has done a preliminary informal assessment internally to establish that for the most part airport operations are protected for storm surges up to 36 inches higher than current mean sea level (U1-U3).[6](SFO has some existing concerns about a lack of adequate flood protection in an area occupied by the US Coast Guard on SFO property.) Otherwise, the overall level of protection currently meets the requirements by the Federal Emergency Management Agency (FEMA), but is not forward looking in the sense of accounting for an increase in sea level. As for planning ahead, interviewees expressed a level of temporary security due to the existing level of flood protection but reported interest in, and are observing, the efforts undertaken by the Port (see Period 1F). SFO is considering funding a SLR impacts assessment to ascertain adaptation needs and options, including any long-term strategies for flood protection and capital improvements as well as potentially more significant structural changes to maintain full functionality of the airport (U2, P1-2 when undertaken).

Period 1C: Threat assessment for city water supplies and regional/national coalition building

[6] FEMA requires protection of at least 36 inches in order for facilities to qualify for coverage under the National Flood Insurance Program.

SFPUC's water supply division is the key actor leading this sub-period. Through several efforts (e.g., a national conference, dedicated staff following and participating in relevant climate science, participation in state- and regional science advisory efforts), SFPUC has been working on assessing how climate change is or will impact water supplies for the city (U1-2). The system of concern is the water supplied to the city from the Sierra Nevada Mountains via the Hetch Hetchy Dam. An initial analysis completed by SFPUC (using a 3°F climate warming scenario by 2025) suggested that reasonable projections of supply changes with climate change are within the bounds of variability that the system was built to handle, thus lowering concern about the need for immediate managerial or structural interventions. But dissatisfaction with the inadequacy and limited usability of climate change science as well as concern over considerable scientific uncertainty keeps SFPUC involved in efforts to advance understanding and modeling capability. Thus, advancing the science and monitoring scientific advances can be considered one of its current adaptation strategies (U2, M1, M3).

Since 2007, SFPUC has also been active in helping to build a national coalition of large municipal water utilities to share and exchange ideas about how to deal with climate change (see the Water Utility Climate Alliance (WUCA) http://www.wucaonline.org/html/about_us.html). Together with WUCA partners, NOAA's Regional Integrated Sciences and Assessments (RISA) Program centers, and other research institutions, SFPUC has led the development of a WUCA program called PUMA (Piloting Utilities Modeling Application) that aims at building an end-to-end model integrating global climate model and downscaled climate projections with hydrology and operational utility models (U2). The resulting improved impacts projections are intended to be used to develop adaptation strategies as the need for management or infrastructure changes becomes clearer. The PUC's Citizen Advisory Committee requested in summer 2011 that more of SFPUC's research reports relevant to the city are made available and communicated to the public (SFPUC Citizens' Advisory Committee 2011).

Vis-à-vis city efforts, SFPUC plays an observing and advisory role among city departments and is contributing to the planning of a more integrated adaptation process for the city (Period 2), but continues its water supply-focused efforts independently. It also plays a somewhat unique role among city actors with its active involvement in "use-inspired fundamental research" (Stokes 1997) on the national scene.

Period 1D: Wastewater assessment and infrastructure updating

This parallel sub-period involves the SFPUC's wastewater division and the city's Department of Public Works (DPW) collaborating on issues related to the city's wastewater system. Relevant staff has long been concerned about SLR (especially prior to the early 2000s when ongoing monitoring showed a clear upward trend in sea level (U1). Over the past eight years or so, due to a shift in the Pacific Decadal Oscillation, regional sea level has not risen in a significant way, thus muting concerns about SLR but leading staff to expect considerable infrastructure changes

in the future when SLR resumes.[7] To date, the agencies have designed and allocated funds to alter particularly vulnerable parts of the storm drainage system to reduce flooding and overflow during extreme rain events (U2, U3, P1, P2, P3, M1-3). DPW is also involved in oceanfront erosion control projects and expects considerable adaptation needs in the future. Notably, in public communications about these efforts climate change and sea-level rise are not mentioned (see, e.g., http://www.sfdpw.org/index.aspx?page=718).

As with other departments, these efforts are so far occurring relatively independently. Design standards (e.g., SLR projections) are not yet fully coordinated with other city departments, but informal communication across key staff in different departments (facilitated through coordination efforts of the Mayor's Office) contributes to information exchange and awareness of each other's efforts.

Period 1E: Increasing concern for climate change and overall sustainability

The city's planning department with its responsibilities for all aspects of the city's general plan has interest in and concerns about flooding as a current problem and one that is expected to be magnified by climate change. It has been involved in a variety of planning projects where SLR considerations came up incidentally (e.g., in decisions to permit infill development of already developed land in areas believed to be protected against SLR in perpetuity due to the value of surrounding development).

The department is also engaged in efforts to increase the overall sustainability of the city (i.e., green infrastructure to reduce flooding). However, so far it has not undertaken a formal assessment of SLR- or other climate change-related risks nor included climate change adaptation as an explicit priority in its annual work program. Thus, the very limited attention to adaptation has been somewhat "under the radar" and more reactive than proactive (U1). Upon announcement of the BCDC ART project (see also Sections 4.1.2 and 4.5), staff was interested in applying to be considered as the pilot sub-region and so did find a way to do a small informal analysis using GIS on how projected SLR would impact two areas in the city (U2). This was to demonstrate the initial need for what types of work could be built on through the ART project. But BCDC selected Alameda County as its sub-region (see Section 4.1.2, Period 4B).

Period 1F: Port's infrastructure vulnerability assessment[8]

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[7] Recent observations indicate that a shift in the PDO and thus a resumption of SLR trends appears to be imminent (see Bromirski et al. 2011).

[8] In San Francisco, three agencies (the Port, the Airport, and the SF Municipal Transportation Agency) are responsible for different aspects of transportation. SFMTA released its climate action plan in 2011, and briefly recognizes that in future updates of its plan, not just the causes but also the impacts of climate change will need to be addressed. The 2011 strategy thus lists the development of an adaptation plan for the city's transportation system as a next step (see http://www.sfmta.com/cms/cmta/documents/4-19-11item13CAS-citywide.pdf). But it is not further listed in Period 1, as it has not yet undertaken any further steps. It is expected that SFMTA will be a participating agency in Period 2.

The SF Port is the lead actor in this sub-period. Port staff realized in recent years that SLR will be a problem for its infrastructure. The issue arose in considering future leases of their piers to local businesses (U1). Leases can last 60–70 years so the Port wanted to be able to inform future leasees about the risks involved with SLR and the need to add flood protection before new long-term leases are signed. Using internal funding, the Port paid a consultant to conduct an assessment of the state of the science, potential impacts of SLR on the infrastructure on and adjacent to Port property, and of adaptation options to deal with the projected impacts (U2, U3, P1-3). In addition to hiring the consultant, the Port also held meetings with representatives from a variety of city agencies and departments to discuss project scope, select relevant models and SLR projections, and obtain internal reviews of the draft consultant report of this assessment.

Period 1G: Public health climate change vulnerability assessment to heat waves

Finally, in the absence of a citywide, integrated assessment of climate change risks, the city's Department of Public Health is undertaking its own separate research regarding heat-related climate change risks. Department staff applied for and received a grant from the federal Center for Disease Control for a project that involves both research and outreach to the community. Working with graduate students and professors from UC Berkeley, the Department of Public Health (DPH)-led team—at the time of the interviews—was collecting data and running analysis on the city's differential social vulnerability to heat waves (U1, U2). In addition to developing adaptive strategies to reduce heat-related vulnerabilities, the department expects a considerable educational need, given the public's lack of awareness of and familiarity with heat risks in a region known for its cool summers (P1-3).

The Department has also been invited to meetings led by the Mayor's Office and the Department of the Environment in thinking about a citywide integrated adaptation planning effort (see Period 2), but has not had the funding or adaptation as a departmental priority to be involved more to date.

Period 2: Integrated citywide adaptation planning

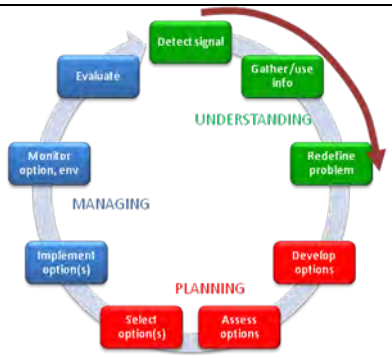
Period 2 began approximately in 2009 when the Mayor's Office first started pulling staff from different departments together to begin thinking about a comprehensive citywide approach to climate change adaptation. This period thus overlaps somewhat with the independent activities continuing in individual agencies and departments.

The Department of the Environment is also interested in developing a citywide, integrated adaptation plan or initiative and thus has helped to coordinate initial meetings with other relevant city agencies (U1). The Planning Department is supportive of this and trying to help but does not have the staff capacity or resources to contribute much at present. There is expressed interest in addressing adaptation once the CAP update is complete. Some initial attempts at assessing interest among various city players thus makes the current time a "coalition building" period, albeit one not yet fully successful, rather than a true assessment or planning period.

Several changes in leadership in 2009 and 2010 (change in mayors and change in the Director of the Department of the Environment) detracted attention from or created uncertainty regarding the adaptation focus. With the election of Mayor Ed Lee in November 2011, the emphasis on climate change adaptation is expected to take on a higher priority as part of his efforts to promote citywide resilience and disaster preparedness planning. The Mayor's Office and the Department of the Environment—at the time of this writing—were actively seeking funding to move forward with a citywide adaptation planning effort.

In addition to the change in leadership, competing priorities, budget constraints, and disagreements among potential agency collaborators about how to fund a joint effort—as well as disagreements about which climate projections to use as a common framework for the joint effort—have all hampered the attempt at cross-departmental integration.

To summarize San Francisco's adaptation process to date, Figure 15 offers snapshots of the extent of the process in each of the periods and sub-periods.

Period 1A	Period 1B
	
Period 1C	**Period 1D**
	

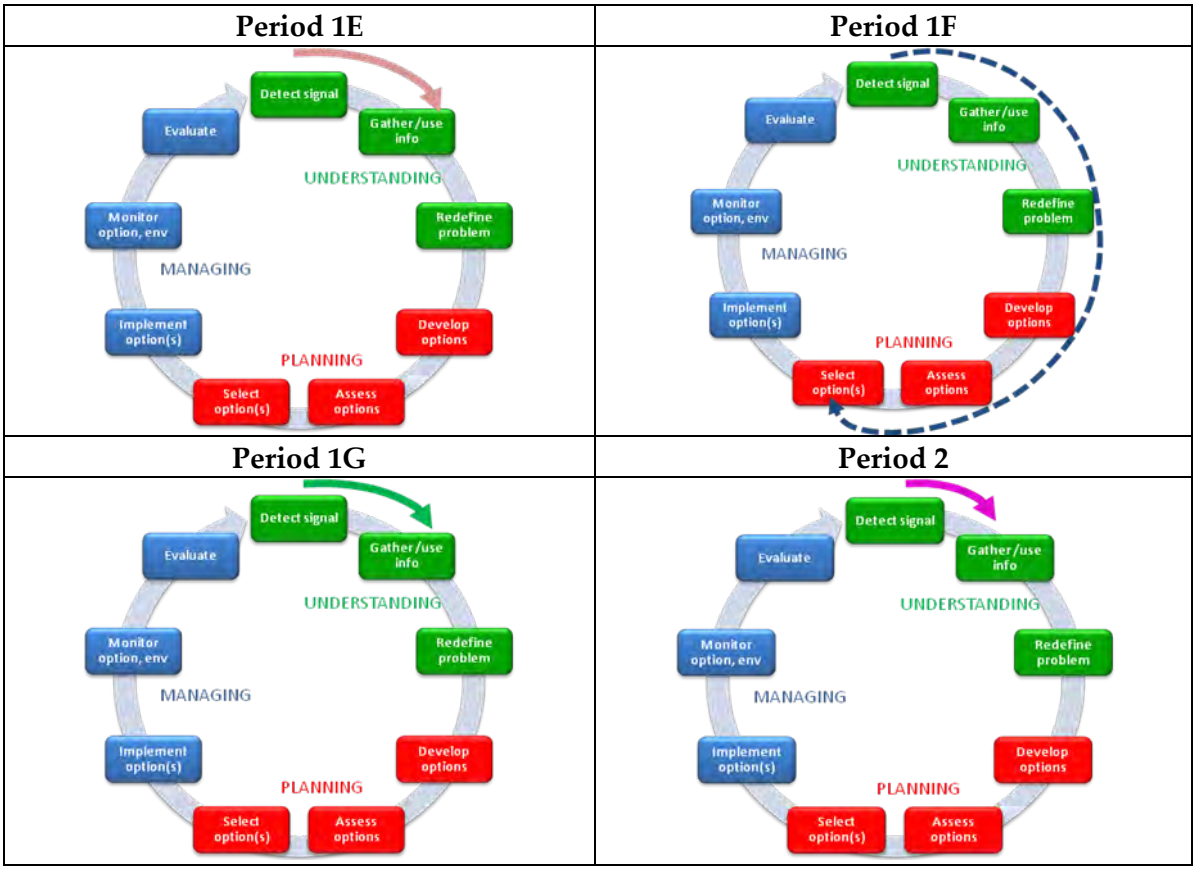


Figure 15: Adaptation Stages Completed or Intended in San Francisco During the Two Periods and Their Sub-periods. Arrows drawn over the conceptual model of an adaptation process (replicas of Figure 1) indicate which stages were included in individual periods. Dotted lines indicate anticipated or not yet realized (but planned) efforts.

As in the Hayward case, the actors, systems of concern, and the relevant governance system and context changes over the course of the adaptation process in this city. The difference to Hayward is that San Francisco has separate sectoral foci under way side by side, and is now seeking funding to support a comprehensive, citywide adaptation planning process. Despite the siloed departmental structure, magnified by separate work programs, different funding structures and revenue sources, and the highly experienced and professional staff in all city departments make considerable efforts at communicating and exchanging information, thus making greater integration likely in the future. As Table 7 shows, the process stages completed by key actors (i.e., in different sub-periods) vary considerably across city government, creating remarkable unevenness in the degree of understanding, readiness to act, and perspective as to what may be the most useful or prudent way forward.

Table 7: Process Stages Observed in Each Period of Adaptation Planning and Implementation in San Francisco

Period		Summary	Phase: Stages
1	A	Citywide climate action plan outlining climate impacts to the city (foundation)	U1, U2*
	B	Airport: Observation and initial threat assessment	U1*-U3
	C	Water supply: national coalition building and regional threat assessment	U1, U2* P1-3 M1, M3
	D	Wastewater: assessment and infrastructure updating	U1, U2*, U3 P1, P2, P3* M1, *M2, M3*
	E	Planning: sustainability plan, interest in SLR	U1*, U2 (P3)
	F	Port: infrastructure vulnerability assessment	U1, U2*, and *U3* P1-P3
	G	Public health: vulnerability assessment of increased heat waves from climate change	U1, U2*
2		Citywide adaptation effort	*U2, U3,P1-3*

Note: Italicized stages indicate initiatives intended but not yet realized;
(*) indicates the main focus of a period.

The periods described for this case are not as neat and chronological as those presented for Hayward. At the same time, San Francisco has at least initial adaptation efforts under way in many more departments than Hayward, and is poised to launch a more integrated effort. By contrast Hayward has made significant progress in one area, but has yet to tackle the cross-departmental coordination and integration challenges that San Francisco currently faces. While a number of city staff were aware of the regional adaptation efforts of BCDC and JPC (see Section 4.5), there was far less mention of coordination with other jurisdictions beyond the City/County boundaries. Given the significance of the city in the region, further progress toward comprehensive adaptation planning in San Francisco may well play an important catalyst role for other cities and counties in the Bay area.

4.3 Marin County

4.3.1 Introduction and Overview of Climate Action in Marin

Marin County is located in the North Bay, across the Golden Gate Bridge from San Francisco, bordering the Pacific Ocean to the West, the Bay to the East, and Sonoma County to the North, Figure 16). In 2010, it had a population of more than 250,000—mostly concentrated in communities along the Bay shoreline (US Census Bureau 2011a). Nearly 73 percent of the population is white/non-Hispanic, more than 5 percent Asian, almost 3 percent African American, and more than 15 percent claim Hispanic or Latino origin, with the remainder made up of other or multiple races. With its comparatively stable, older, and highly educated

population, the county is also known for its liberal politics, and its affluence. Median household income in 2009 was $30,000 dollars higher than in the rest of the state and its poverty rate half (~7 percent vs. 14 percent statewide) (US Census Bureau 2011a).

Figure 16: Location Map of Marin County

Numerous smaller communities hug the shoreline along the eastern portion of the county, much of the western and interior parts are held as open space and for agricultural land uses, with small unincorporated areas relying on agriculture and tourism there. The county seat is in the City of San Rafael and the largest employer is the county government, followed by big private-sector employers in the medical, pharmaceutical and insurance industries. Marin County is one of the 27 original counties of the state of California and maybe best known for its spectacular stretches of open ocean and nestled Bay shorelines (e.g., Point Reyes National Seashore or the Sausalito shoreline), famous sites such as San Quentin State Prison or Skywalker Ranch, and its natural beauty and outdoor opportunities (such as at Stinson Beach, Muir Woods redwood forests, and Mount Tamalpais). Given its varied topography and different climatic zones from West to East, the county boasts a rich diversity of habitat types and species, including significant endemism and some of the largest wild Coho salmon runs left in California.[9]

4.3.2 Climate Protection Efforts in Marin County

With a public commitment to sustainability since 1999, climate action was a logical next step for the County in the early 2000s. In 2002, the Board of Supervisors adopted a resolution that acknowledged the urgency of climate change as a global problem as well as the County's

[9] See the recent news article on this at: http://articles.sfgate.com/2010-12-17/news/25205585_1_coho-salmon-lagunitas-creek-salmon-protection.

responsibility for local action (County of Marin 2006). The resolution committed the County to the common five-step program of establishing its greenhouse gas (GHG) emissions, setting reduction targets, developing and implementing local reduction strategies, and monitoring its progress over time.[10] Its target was nearly as ambitious as that of San Francisco, aiming for a 15 to 20 percent reduction of GHG emissions below 1990 levels by 2020 in County operations and 15 percent countywide. The resulting short local action plan, released in 2006, acknowledged briefly what climate change effects may impact the county, pointing to temperature and sea-level increases, growing fire risks, threats to public health, and escalating electricity demand (County of Marin 2006, p.2). While the climate action plan itself did not include any adaptation measures, the county around that time was in the process of updating its countywide or general plan. The overarching theme of that plan was "planning sustainable communities." Toward the conclusion of that planning effort, adaptation measures entered into this guiding document.[11] Introduction of the need for adaptation at that time was spear-headed largely by one County department and one key actor within it.

Since the approval of the Countywide Plan update in late 2007 (amended in 2008), Marin has been involved in a small number, albeit rather separate, adaptation-related efforts across a range of departments. These separate efforts have varying degrees of momentum. The state of affairs at present is thus quite similar to that in San Francisco where independent efforts are under way in individual departments. In the interviews, several individuals looked toward a more concerted and integrated county-wide effort in the future, which is depicted here as a third period in the county's process. Interestingly enough, none of the current efforts are explicitly counted as part of the County's climate protection efforts and are not communicated to its residents as such from the Sustainability Team's website (accessible from: http://www.co.marin.ca.us/depts/CD/main/index.cfm). Figure 17 shows the timeline of Marin's adaptation process by clearly distinguishable periods. The core activities in each of these periods and sub-periods is summarized in Table 8, and described in more detail below.

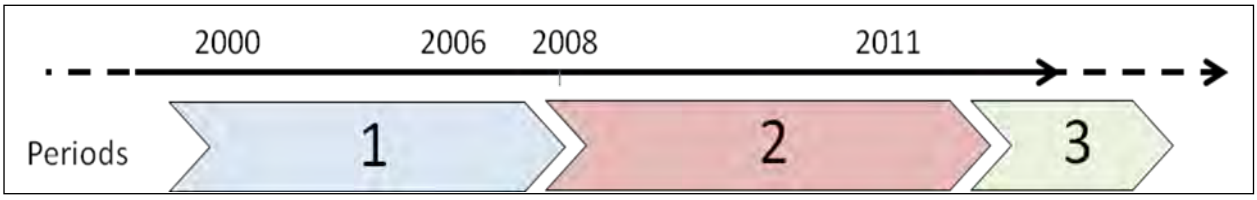


Figure 17: Timeline of the Adaptation Process by Periods Observed in Marin County

[10] Marin, too, is a member of ICLEI's Cities for Climate Protection Campaign.

[11] Marin County published an "indicators" report in 2009, showing progress toward achieving its sustainability goals (including climate protection). In it, the County includes "adaption to climate change" [sic] as part of its climate change goals, but no achievements in the adaptation arena were recorded that year (County of Marin 2009, p.3). At the same time, many of its other goals recorded in that plan (food security, open space preservation, sustainable water use, social equity) could be viewed as contributing to a reduction of the county's vulnerability.

Table 8: Summary of Marin County's Adaptation Activities by Period and Sub-period, Including Key Actors, System of Concern, and Bounds of the Governance System

Period		Summary	Key actors	System of concern	Bounds of governance system
1		Countywide Plan update includes climate adaptation strategies	Director and staff of the Community Development Agency; Board of Supervisors	County in general; flooding, fire, air quality	County's Community Development Agency
2	A	Water supply: Assessment and planning for shortage	Marin Municipal Water District	Water supply	Water supply county-wide
	B	General and coastal planning: implementation of adaptation strategies on hold; Coastal plan update with consideration of SLR	Community Development Agency	County planning and development; coastal areas	CDA, unincorporated areas
	C	Flood management: Shifting flood protection towards watershed approach	Department of Public Works and partners	Watersheds and flood protection	In flux – TBD as part of the adaptation process; coalition bldg to broaden governance system
	D	Emergency services: discussions of incorporating climate change into assessing risk	EOS	Areas and people potentially affected by disasters	Disaster response coordination
	E	Observation of adaptation (and other relevant) policy develop-ments at regional, state, and federal level	DPW, board of supervisors	Primarily exposed development in river and Bay floodplains	Coastal areas, 100-yr floodplains (under FEMA jurisdiction)
3 (not yet realized)		Future countywide, integrated adaptation process	All relevant departments	All climate-sensitive sectors of County	County (maybe in coordination with towns and cities)

Period 1: General plan update and initial adaptation planning

This first period of adaptation planning constitutes the time during which the Countywide Plan Update (update of the general plan) was developed (roughly from 2000-2007). Adaptation strategies (e.g., floodplain management using a watershed approach) were included only toward the end of the multi-year process, during which they seemed to get accepted or entered into the plan without much notice or discussion. In many ways this is a " "lone champion" period, much like in HASPA (see Section 4.1.2), where one actor overseeing the plan update introduced the adaptation ideas, engaged the department staff in developing them further, and then presented them to the Board of Supervisors, who approved and in some instances asked to see them strengthened. Thus, while several actors supported this initial adaptation planning effort, it was driven by one individual.

No formal information gathering or options development and assessment were conducted, but the champion (together with the staff) gathered knowledge about the issues over the course of the planning effort and thus brought at least basic knowledge and varyingly developed, general

adaptation strategies into the plan (U1, U2, U3, P1, P2, P3). The plan received awards for its visionary ambition and comprehensiveness. The major barrier created in this period (manifested in Period 2) was that other departments were not very much, if at all, involved in the process of developing these adaptation options, resulting in lack of awareness, buy-in, and a lack of a sense of accountability to implement what was in the plan. While the general plan is a "policy" document, providing general guidance, implementation depends on more specific directives from the Board of Supervisors and the resulting work and budgetary priorities from year to year. Thus, Period 1 ended with adaptation strategies embedded across the entire plan with only superficial ownership by the Board or other staff.

Period 2: Isolated efforts

This period represents adaptation-related activities in multiple sectors (and agencies) as they shift from a generalized awareness of the problem to beginning to get real about actions for dealing with the emerging or expected impacts of climate change. Each of these sets of activities is presented as a sub-period under Period 2 because they occur in isolation from each other, without mutual consultation or integration in different parts of the County government.

Period 2A: Water supply planning

The Marin Municipal Water District has long had a generalized concern about water supplies due to past experience with drought. The vast majority of its supplies comes from local sources—a rather different situation than San Francisco's, whose supplies come predominantly from the Sierras. These local concerns have been linked to climate change as that discussion has emerged in the media and on the state's policy agenda as well as on that of the state's water agency over recent years.

During the statewide drought in the late 2000s, this local concern over climate change impacts on demand and supplies fed heated public discussions over building a desalinization plant for the county. A few wetter years and a drop of 20 percent in water consumption dampening the urgency, together with delays due to local resistance (and legal action) put the plans for the desalinization plant (temporarily) on the backburner. Under the leadership of an articulate and concerned leader, the water district remains engaged, however, and is continuing its supply/demand assessments (sensitivity analysis) in light of changing climate and population and economic growth projections (U1-M3; complete and continuing).

Period 2B: Land use and coastal planning

This sub-period includes the implementation of selected aspects of the countywide general plan, which was written and passed during Period 1. The Development Agency does not have a clear mandate or support to really implement the Countywide Plan Update's adaptation strategies; adaptation is simply not a priority. Thus, whatever is getting done is "fit in" under existing priorities without necessarily declaring them explicit adaptation efforts. Many of the adaptation strategies included in the countywide plan are not in the near-term work plan or funding priorities, given more immediate issues and financial constraints. The chief planner in

the department is very attentive to scientific developments and continues to collect studies begin conducted for or within the county (M2), but is not taking a lead in pulling everyone together to develop an integrative effort or pushing the Board to authorize more implementation. Higher-level leadership and the Board are also not moving adaptation efforts forward.

One example of progress is incorporating sea-level rise in land use planning and development. The Community Development Agency is centrally involved in updating the County's Local Coastal Program, the land use and implementation plan for the coastal portion of the county. Local Coastal Programs are the mechanism through which local authorities share in the permitting and management of coastal areas.[12] According to the Coastal Commission, "Local Coastal Programs (LCPs) are basic planning tools used by local governments to guide development in the coastal zone, in partnership with the Coastal Commission. LCPs contain the ground rules for future development and protection of coastal resources" (see http://www.coastal.ca.gov/lcps.html). At the time of this writing, the draft released for public comment (in June 2011) indicates concern about climate change-driven sea-level rise, required a specific evaluation of sea-level rise in siting development, and suggests doing assessments in the future to better understand the impacts (U1-3, P3). In addition, an initial shoreline vulnerability assessment has been conducted (U2) by a consultant (the same one involved in the HASPA case), but that assessment has not been made public.

Period 2C: Flood management: Shifting toward watershed approach

This parallel sub-period includes the county's Department of Public Works' (DPW) efforts in planning of a watershed program. While staff had been aware of this particular approach to floodplain management for a while (U1-3; and it was mentioned as the preferred adaptation strategy for flooding in the Countywide Plan during Period 1, P3), the implementation of this approach (M1) was triggered largely in response to the floods in the winter of 2006/2007, during which San Anselmo and other areas in Marin County were flooded. This approach was first developed upon the Board of Supervisors asking the DPW to shift to a watershed approach, requiring internal building of an understanding (U1-3). At present, this activity is not really driven or motivated by climate change concerns, but can be viewed as an implementation of an adaptation strategy (and is being justified post-hoc as such). Implementation of the watershed management approach to flooding involves garnering support from other partners (cities, flood districts), thus can be considered a coalition building and awareness-raising period (U1). As

[12] According to the California Coastal Commission, "Under the California Coastal Management Program, planning for and regulating development in the coastal zone is shared by the Coastal Commission and local jurisdictions: upon completion of a certified Local Coastal Program (LCP), the local government assumes most permitting and planning responsibilities. The Commission retains some jurisdiction over development in the coastal zone. In addition, Section 30519.5 of the Coastal Act requires that the Commission 'review every certified local coastal program to determine whether such program is being effectively implemented in conformity with the policies' of the Coastal Act, and recommend corrective actions, where necessary" (cited from http://www.coastal.ca.gov/recap/rctop.html).

implementation progresses, more detailed planning (P2-3) and analyses (U2) and ultimately restorative actions (M1-3) can be expected.

Period 2D: Disaster response planning

The Emergency Services Agency of the County has been aware of climate change as a global problem for considerable time. In years past, under different departmental leadership, there were frequent internal discussions about the issue. At present, however, there are no efforts under way to address climate change (e.g., expected occurrence of more extreme events such as flooding or droughts or heat) through emergency management. With the loss of the very engaged and interested director a few years back, climate change has simply not been a priority or on the radar of the agency, leaving this sub-period without any momentum at present. Staff acknowledge that they have not linked their interest or concern about a problem perceived as global to their local jobs.

Period 2E: Observation of regional and federal efforts

This sub-period is essentially defined by the creation of a staff position dedicated to observing a variety of regional, state, and federal policy developments that are relevant to the county. The developments of interest to the county are directly linked to climate change or extreme event impacts, particularly FEMA's flood map updates, and the regional efforts under way to deal with sea-level rise (BCDC's Bay Plan Amendment, see Section 4.5). Initially the Board of Supervisors wanted DPW to attend BCDC meetings and follow the FEMA map update process, but it took too much staff time to do so. Consequently, the department hired a consultant to track these efforts for them. The implementation of this position (M1) was the realization of an observation and information sharing strategy they had selected previously (P3). The focus of this activity is primarily on Bay and open coast floodplains, as well as on inland floodplains. While funds are being dedicated thus to follow higher-level policy efforts, and to foster information sharing among staff in various departments, the Board of Supervisors and these policy developments at other levels, interviews revealed resistance to extra-local intervention in county planning and management. It was therefore impossible to determine how this sub-period will assist or support the County's adaptation efforts.

Period 3: Integrated countywide adaptation (not yet realized)

Finally, several interviewees hinted at a future time, when the County might approach adaptation in a more concerted and integrated fashion than at present. The actors in this yet-to-be-realized period would include representatives from all departments, as well as strong leadership from the Board of Supervisors prioritizing adaptation in its strategic and operational decisions. The system of concern would include all of Marin County, with all its climate-sensitive sectors. Examples of desired efforts in such a future period include a study of parcel-by-parcel coastal erosion due to the acceleration of SLR (U2); setting up an interagency climate change working group (M1); increased trust and better relationships over time among departments and among County partners (cities, non-governmental organizations (NGOs), scientists) that would lead to decreased turfism and improved data sharing; development of a

cohesive adaptation plan that would integrate county and city efforts (P1-3); seeking funding for and sharing cost of implementation of already-identified strategies (M1-3); and a clear prioritization of climate change in all relevant County programs and activities (e.g., watershed restoration, wetland restoration, existing operation and maintenance practices, planning processes) (U3, P1-3, M1-3).

To summarize Marin County's adaptation process to date, Figure 18 offers snapshots of the extent of the process in each of the periods and sub-periods.

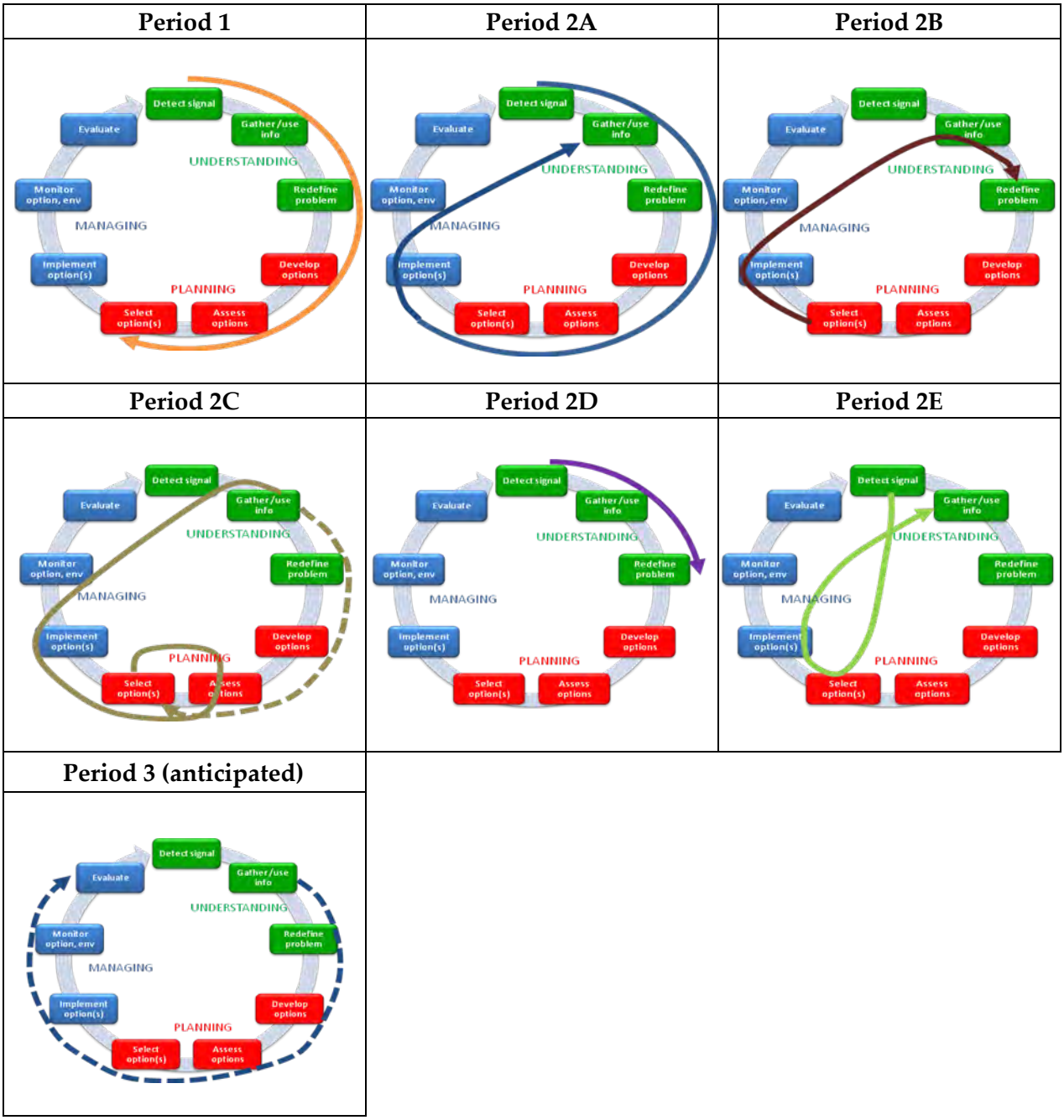


Figure 18: Adaptation Stages Completed or Anticipated in Marin County During the Three Periods and Their Sub-periods. Arrows drawn over the conceptual model of an adaptation process (replicas of Figure 1) indicate which stages were included in individual periods. Dotted lines indicate anticipated or not yet realized (but planned) efforts.

As in San Francisco, the actors, systems of concern, and the relevant governance system and context changes over the course of the adaptation process in Marin County. Another similarity between the second case and this one is the side-by-side processes in different departments without much cross-talk. The difference to San Francisco, however, is that a set of adaptation strategies that could provide guidance to individual departments and agencies already exists in Marin, but these strategies are only very selectively being implemented. Generally there seems to be less cross-departmental communication than in San Francisco about issues related to climate change in general and adaptation in particular.

While Marin is making small progress in some of its departments (watershed approach to floodplain management, expanding the consideration of accelerated sea-level rise as an issue in its local coastal program), the county is not otherwise engaged in active implementation of its adaptation strategies embedded in the Countywide Plan Update. However, the County continues to coordinate with the scientific work being carried out primarily through Our Coast–Our Future (http://www.prbo.org/ocof), and the Planning Department's GIS staff has provided the Our Coast–Our Future Project with new digital terrain and parcel maps for use in their modeling of SLR/storm scenarios. Overall, also a more skeptical attitude toward adaptation-relevant policy changes or actions at higher levels of governance emerges from Marin than from San Francisco or Hayward. After Period 1, clear leadership for adaptation has been missing in this case, allowing the issue to fall low on the priority list in the context of financial constraints.

As Table 9 shows, the process stages completed by key actors vary considerably across county government, creating unevenness in the degree of understanding, willingness to act, and perspective as to what may be the most useful or prudent way forward.

Table 9: Process Stages Observed in Each Period of Adaptation Planning and Implementation in Marin County

Period		Summary description	Stages
1		General plan update and initial adaptation planning	U1, U2, U3, P1, P2, P3
2 (isolated efforts)	**A**	Water supply planning	U1-M3
	B	Land use and coastal planning	M1, U2, U3
	C	Flood management: Shifting toward watershed approach	P3, P2, M1, U1
	D	Disaster response planning	U1, U2, U3
	E	Observation of regional and federal efforts	U1, P3 and M1
3		Integrated countywide adaptation (not yet realized)	U2, P1-3, M1-3*

* Stages assumed from informants' expectations, but period not yet realized.

4.4 Santa Clara County

4.4.1 Introduction and Overview of Climate Action in Santa Clara

The fourth case study for this project is Santa Clara County (Figure 19). This 1,290 square mile county is located in the southern part of the San Francisco Bay Area and includes densely populated areas as well as rural mountainous areas. It, too, was one of the original counties of California.

Figure 19: Location Map of Santa Clara County

Santa Clara's current population of over 1.7 million people has seen slower than statewide growth over the past decade, but has a fairly similar demographic structure. More than 35 percent of its population is White/non-Hispanic, almost 3 percent African American, 32 percent Asian (more than double the statewide average), and nearly 27 percent Hispanic/Latino (US Census Bureau 2011c). Uniquely, Santa Clara County's ethnic profile is not the product of cumulative immigration, but largely attributable to the high-tech boom over the last 25–30 years that created a new regional economy and global professional magnet. Median household income in the County ($84,990) is almost as high as in Marin County and thus significantly higher than the state's; moreover, the County has a poverty rate of just over 9 percent (compared to 14 percent statewide), clearly hinting at the high-tech, well-paying jobs in the highly urbanized Santa Clara Valley within the county—also known as Silicon Valley.

Economically, Santa Clara has evolved over two centuries from a predominantly agricultural county to a global high-tech center. While many technology firms are not at all recent arrivals, the moniker "Silicon Valley" was coined in the early 1970s, launching the computer era that took off in the 1980s and 90s, and continues today. Agriculture is now virtually gone from the northern part of the county. The County seat and dominant urban center is the Bay Area's largest city, San Jose. As a population center and technology engine not just for the county, but state economy, Santa Clara County is seen by many as a political spring board for elected officials. Besides San Jose, there are another 14 incorporated cities and towns in the county. As

is typical for county governments, jurisdiction—in most sectors—extends only over the unincorporated areas.

4.4.2 Climate Protection Efforts in Santa Clara County

In 2007, the Santa Clara County Board of Supervisors signed the Cool Counties Climate Stabilization Declaration, a nationwide voluntary effort among counties to lower their greenhouse gas emissions.[13] Signing the Declaration committed the County to stop increasing emissions by 2010, and reducing emissions by 10 percent every five years from 2010 to 2050, with an ultimate goal of 80 percent emission reductions over the baseline year (2005) by 2050. Two positions were created to realize these goals, a Climate Change and Sustainability Manager in the County Executive's Office and a Utilities Manager in the Facilities and Fleet Department. A Climate Action Plan (CAP) was prepared by the County's Climate Change and Sustainability Program (CCSP) under the leadership of its program manager and a countywide interdepartmental Climate Action Team to lay out near-term and long-term actions to reach this goal.

The CAP, adopted in September 2009, focused—as a first step—on County operations, facilities and employee actions (rather than all of the emissions released across the county), and as such was a precursor to a countywide climate action plan. In addition to working with other County departments on the CAP, the program also supported the development of a Green Building Policy (pertaining to County government buildings) and then the Green Building Ordinance (pertaining to unincorporated areas). As for adaptation in these plans, policies, and ordinances, the only strategy with direct adaptation benefits relates to water conservation. The Green Building Policy for County buildings requires no net increase in water consumption, while the Green Building Ordinance requires reduced water usage. In the case of the CAP, the water conservation strategy is not explicitly discussed as an adaptation strategy but justified entirely with energy consumption related to water conveyance, distribution and treatment) (County of Santa Clara, 2009, pp.21–22, 37–38); by contrast the green building policy and ordinance was guided by adaptation thinking according to interviewees. Thus, this time and set of activities constitute Period 1.

Since the development of the CAP, the County also signed onto the Bay Area Climate Collaborative (BACC; see http://baclimate.org/), which has 10 regional goals (including one focused on adaptation). Santa Clara County became the first local government besides the three biggest regional cities to be represented on the steering committee, and helped to start a grant

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[13] Catalyzed by the U.S. Mayors Climate Protection Agreement and supported by the Sierra Club's Cool Cities Program, 12 counties representing 17 million people launched "Cool Counties" at the annual conference of the national Association of Counties. (In parallel Alameda County launched the California Cool Counties Initiative to make California a 100 percent "cool counties" state.) Santa Clara County was one of the early counties to join the national effort. For more information on the Initiative launched by King County (Washington) and Fairfax County (Virginia), see the Initiative's website at: http://www.kingcounty.gov/exec/coolcounties/theinitiative.aspx. By 2009, more than 600 counties in the United States had signed on and made pledges to significantly reduce their GHG emissions.

process and the development of a regional energy program. County staff also participates on an ongoing basis in stakeholder meetings organized at the regional level (Section 4.5.2, Period 3) to help bring a local government perspective to the regional effort.

The Board of Supervisors also directed the County's Facilities and Fleet Department to assume internal efforts and objectives under the CAP[14], and established an Office of Sustainability under the County Executive's Office to reorient the County toward an all-encompassing sustainability policy.[15] This sustainability policy — written in early 2010 and approved by the Board of Supervisors in Spring 2010 — commits "government to a work ethic and philosophy that resilient communities, capable of growing successfully into the future, must balance ecological integrity, economic strength, and social equity and opportunity" (County of Santa Clara 2010). In the Office's charge for 2011, the County lists adaptation as one of its immediate priorities: "work with the 15 municipalities to develop a countywide Adaptation and Sustainability Plan, as a charter for circumventing or reducing adverse economic, ecological and social impacts of climate volatility" (County of Santa Clara, 2011, p.31). Several other priorities for 2011 can be considered supportive of adaptation (e.g., preserving the county's agricultural and ecological assets, reducing air pollution, and supporting the implementation of water-wise programs). Setting up an information clearinghouse and organizing the County and cities to work together on adaptation priorities is considered Period 2 in this study.

To facilitate countywide coordination and integration on joint activities and plans, the Office of Sustainability created a Climate Action and Sustainability Team (CAST) comprised of any climate action or sustainability managers/directors from each of the 15 cities within the County. At the time of this writing, a coalition of nine cities, the County, the Santa Clara Valley Water District, and several academic institutions are developing a regional grant proposal for a sustainability/adaptation project.

This project (tentatively entitled *SILICON VALLEY 2.0)* is currently in development, with a focus on shared assets (water, energy, and transportation), infrastructure planning (including issues of insurance), ecosystem services, and preemptive strategies for managing the disproportionate impacts of "climate volatility" (as the County likes to call it) on disadvantaged communities. In addition, the plan is envisioned to incorporate strategies that will secure the region's unique economic profile and business population. At the time of the interviews for this study other County agencies and departments were not yet fully integrated or directly involved in the Office of Sustainability in its efforts on sustainability and adaptation. To facilitate and accelerate that County government-wide coordination and integration process, the Office of Sustainability has formed the Sustainability Executive Council (SEC), comprised of the

[14] These internal efforts are now lead by CCSP's initial manager, who transferred to the County's Facilities and Fleet Department.

[15] This sustainability orientation actually dates back to several years earlier, when one of the Supervisors began advocating for such a broader vision. But it is only since 2010 that a policy under that banner is in place and guiding or framing the emerging adaptation discussions.

Executive Directors from all County departments. Of those interviewed for this study, only the Santa Clara Valley Water District had concerted efforts under way that consider the current and future impacts of climate change, while other departments were waiting for high-level guidance from the County Board, the Office of Sustainability or the regional efforts under way (see Section 4.5). These efforts are grouped here—each in separate sub-periods—under Period 3. Figure 20 illustrates the overall timeline of efforts under way in Santa Clara County, and Table 10 summarizes the different activities by period, including key actors, systems of concern, and the bounds of the respective governance systems.

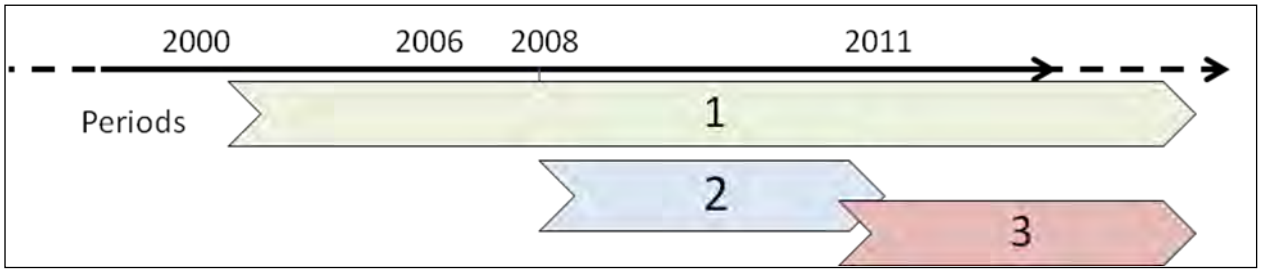

Figure 20: Timeline of the Adaptation Process by Periods Observed in Santa Clara County

Table 10: Summary of Santa Clara County's Adaptation Activities by Period and Sub-period, Including Key Actors, System of Concern, and Bounds of the Governance System

Period	Summary	Key actors	System of concern	Bounds of governance system
1	Initial climate action planning	Director of climate change in county executive office	County and cities, with initial emphasis on County operations and facilities	Unincorporated areas in county
2	Reorientation toward sustainability policy, internal organization and coalition building	Executive Office SCC, DPH, Department of Planning, representatives of cities in county	Entire county (county operations and municipalities)	County and cities (as independent partners)
3A	Water supply and flood protection – multiple initiatives and processes, organizing within and information sharing with others	SCVWD	Water supply and flood protection	Incorporated and unincorporated county
3B	Wait-and-see for guidance in other County departments	e.g., Planning, DPH	County	Individual department's jurisdictions

Below each of these periods is described in more detail, pointing to the phases and stages of the adaptation process completed or under way in each.

Period 1: Initial Climate Action Planning

This period was initiated by the Board of Supervisors and County Executive directing staff in the County government to begin the development of a climate action plan. Several staff played key roles during this period, motivated by their own prior experience and expertise (U1, U2). With the mandate of the Board to develop a Climate Action Plan (CAP), and with the support of the county manager, the initial Climate Program manager became the principal driver behind writing the County's CAP. A large group of individuals from across various County departments, however, were involved in developing that plan. The CAP mentioned potential impacts of climate change only in buried fashion, and was almost entirely focused on mitigation of GHG emissions. As mentioned above, it did include one recommendation to reduce water consumption (P1, P3), which has adaptation benefits. The strategy recommended that the County was to have no net increase in water demand as a result of new development.

Within a year of the approval of the CAP in 2009, the initial Climate Program Manager moved to a different position and was charged by the Board with implementing the CAP, , including the water conservation strategy (M1-2), in County operations. Efforts at internal capacity building are under way as of this writing, through ongoing staff development and education that aim to raise awareness and understanding for climate change, including adaptation among staff (U1-2).

Period 2: Reorientation, internal organization and coalition building

The establishment by the Board of a formal Office of Sustainability under the County Executive Office and the arrival of a new director of that office in November 2010 marked the beginning of Period 2 in Santa Clara County. The Office is generally tasked with representing the County and implementing its sustainability and climate action objectives at the regional, state, and national level. With more direct access to Board members and a broader charge (sustainability, alternatively framed as "resilience"), the new Office is focused on collaborative initiatives, data-sharing, and project-partnering with the County's 15 municipalities (the above mentioned "Climate and Sustainability Team" or CAST), as well as institutionalizing sustainability principles through the apparatus of the Sustainability Executive Council. In the latter case, this "top-down" dynamic is coordinated with the Facilities and Fleet programs ("bottom-up") to saturate the organization's structure and invest each department and level in collective outcomes (U1-3, P1-3). The work of the CAST is designed to build working relationships and capacity (M1) among otherwise under-resourced communities unable or less likely to conduct assessments, or develop adaptation plans by themselves.

Period 3: Independent efforts

Apart from the efforts in the County Executive Office and in the implementation of the CAP through the Facilities and Fleet Division, individual departments of the County government are not explicitly engaged in adaptation planning, though under the new sustainability policy—

some efforts are now described as having sustainability co-benefits. Efforts are under way in the Office of Sustainability, as of this writing, to develop—in response to the Board's request—an annual Sustainability and Climate Action Report, which will include a Countywide Sustainability Matrix identifying sustainability-influenced or driven programs, projects, policies, and initiatives from all departments.

At the time of the interviews, however, very little effort that was clearly motivated as an adaptation effort had begun. While awareness of climate change risks is pervasive, adaptation was not prioritized in any of its departments. The sole exception is the independent Santa Clara Valley Water District (SCVWD). Efforts here are described under Period 3A; the state of affairs in other departments at the time of the interviews where little progress was reported under Period 3B.

Period 3A: Water supply and floodplain management

This sub-period is defined by the SCVWD's efforts for dealing with and preparing for climate change impacts. Its interest in, and leadership on, climate change adaptation must be seen in the context of its expressed vision and goals; namely "a healthy, safe, and enhanced quality of living in Santa Clara County through watershed stewardship and comprehensive management of water resources in a practical, cost-effective, and environmentally-sensitive manner for current and future generations" (information provided by interviewee). The District views it as essential to take an integrated approach in managing a sustainable water supply, achieving effective natural flood protection and maintaining healthy watersheds to prepare for the future.

The District is in charge of water supply and flood protection for Santa Clara County and does this through a variety of programs and divisions. The nature of climate change concerns (e.g., insufficient water supply due to several climate change influences, saltwater intrusion in coastal aquifers and wells due to SLR, flooding and inundation related to SLR and/or storm surge or extreme rainfall events), differ among these divisions, but the District made climate change a priority in 2007, thus requiring staff to "ask the climate question" in all its operations (U1, U2, P1-3). In addition, in January 2008, through a Board Resolution, the District's governing body communicated its aspiration for continued leadership and enhancing community understanding on climate change impacts on water resources management and established policies for reducing greenhouse gas emissions and adapting to climate change impacts.

Because of this diversity in planning processes, planning horizons, and climate change concerns relating to the District's water supply and flooding protection responsibilities, SCVWD decided not to have one integrated climate policy driving all its efforts at this point. Instead it tries to incorporate climate change adaptation into existing planning and operational efforts (M1), such as in updating the Urban Water Management Plan and the update of the 30-year Integrated Regional Water Management Plan (IRWMP) in collaboration with several other water districts in the Bay Area (http://bairwmp.org/). SCVWD updated its Urban Water Management Plan (UWMP) in 2011. It generally recognized the potential impacts of climate change on the District's water supply and demand, but the District acknowledged that uncertainties in the precipitation and water supply projections is prohibiting it from including it quantitatively in

its forecasts and plans. The California Department of Water Resources suggests that UWMPs recognize and incorporate climate change impacts and that they develop adaptation strategies in the process of updating the plans (DWR 2011) (P1-3).[16]In preparing the IRWMP, the state not just suggests, but actually requires that climate change impacts on the region and the state's water resources be considered, but leaves it up to the regional water agencies to assess their vulnerabilities and develop the adaptation strategies they deem necessary and most appropriate (CDM 2011). SCVWD is involved in the regional process (currently under way) that will update the Bay Area IRWMP.

The District overall has chosen to support these many planning processes in a two-fold way (M1). First, it has developed and maintains a frequently visited climate change web portal, on which staff regularly post new climate change studies and other relevant information and through which District staff have access to relevant tools and information (M2). While quite deeply hidden on the agency's website, the portal is available not just to staff but to the public, and thus is considered a public outreach tool. Second, the District designated a project manager to oversee and closely track the latest relevant climate change information (reports, data, studies, etc.) that could be useful to different planning processes among the divisions of the District (M2, U2). The program manager works closely with the librarian for the web portal to keep it up to date and relevant to District staff. This individual's responsibility includes bringing "the climate question" to other staff members' attention, thus maintaining a constant awareness for the need to at least recognize climate change qualitatively in ongoing planning and operational decisions (U2-3).

In addition, the SCVWD is actively involved in a variety of efforts that are relevant to (if not always labeled as) adaptation efforts, including the Santa Clara Basin Watershed Action Plan (http://cf.valleywater.org/_wmi/Participates_login/Participates/WAP/draft/Actiondraft0803.cfm), the Water Resources Protection Collaborative (see http://www.valleywater.org/EkContent.aspx?id=2279&terms=collaborative), other watershed stewardship plans, the South Bay Salt Pond Restoration effort, and the South Bay Shoreline Protection study. Its Emergency Response and Preparedness Program as described in the Local Hazard Mitigation Plan (http://www.valleywater.org/programs/LHMP.aspx) and its 15-year "safe, clean water and natural flood protection program" (http://safecleanwater.org/)include expansion to other South Bay cities, thus—according to interviewees—paving the way for a regional solution for sea-level rise adaptation along the South Bay shoreline. Finally, the District is also investing in expanding its local network of gauges, and building an "Environmental Monitoring and Assessment Data Collection and Decision Framework" which staff expect to support its ongoing adaptive management of water resources.

Period 3B: Wait and see and signs of cross-departmental communication

[16] To assist in that process, the State provides modeled projections for water supplies from the State Water Project and Central Valley Water Project.

Other County government agencies—at the time of the interviews—were not taking concerted steps to plan for or implement adaptation. The Department of Planning expressed interest in being involved in climate change adaptation (U1), but is waiting to see what the region will do(Section 4.5) so that they do not have to backtrack in their own progress. They anticipate that future updates of segments of the County's General Plan (e.g., emergency planning and disaster response) will allow them to integrate adaptation at a later time.

In addition, the Department of Public Health expressed interest in assessing impacts of climate change in this sector (U2) and anticipated incorporating options that are considered beneficial with or without climate change (so-called "no-regrets" options) as they participate in developing the update of the General Plan's Public Health element. While adaptation is not a priority for the department at present, individual staff members are quite knowledgeable about climate change-related health risks, and view mitigation efforts generally speaking as co-beneficial for adaptation.

With the establishment of the County's Sustainability Executive Council, these and other County departments may decide on additional, collective, or better-integrated adaptation actions in the future (albeit not far enough developed at this time to suggest a Period 4). Figure 21 summarizes Santa Clara County's adaptation process to date, where each panel offers a snapshot of the extent of the process in each of the periods and sub-periods.

In summary, the fourth case study shows—as of this writing—still relatively limited progress in concrete and comprehensive adaptation planning compared to the other cases, but under the recently established sustainability policy and efforts now under way under the auspices of the Office of Sustainability and the SEC, movement in that direction is indicated. The County's CAP lays a foundation for climate action generically, but holds little on adaptation specifically (only one specific strategy—water conservation—can be considered co-beneficial for adaptation). One the other hand, the County tries to reframe adaptation and all its climate actions under the broader heading of sustainability and resilience, and is reaching out to other County departments and the municipalities to develop a joint plan.

As in all the other cases, the actors, systems of concern, and the relevant governance system and context change over the course of the adaptation process. As in San Francisco and Marin, there was little cross-talk at the time of the interviews among the different departments about adaptation. With the recent change in leadership in the Office of Sustainability and the establishment of the cross-departmental Council, this is bound to change. An overarching impression in this case emerged of County staff deferring to County leaders and to the regional adaptation planning process awaiting further guidance and direction.

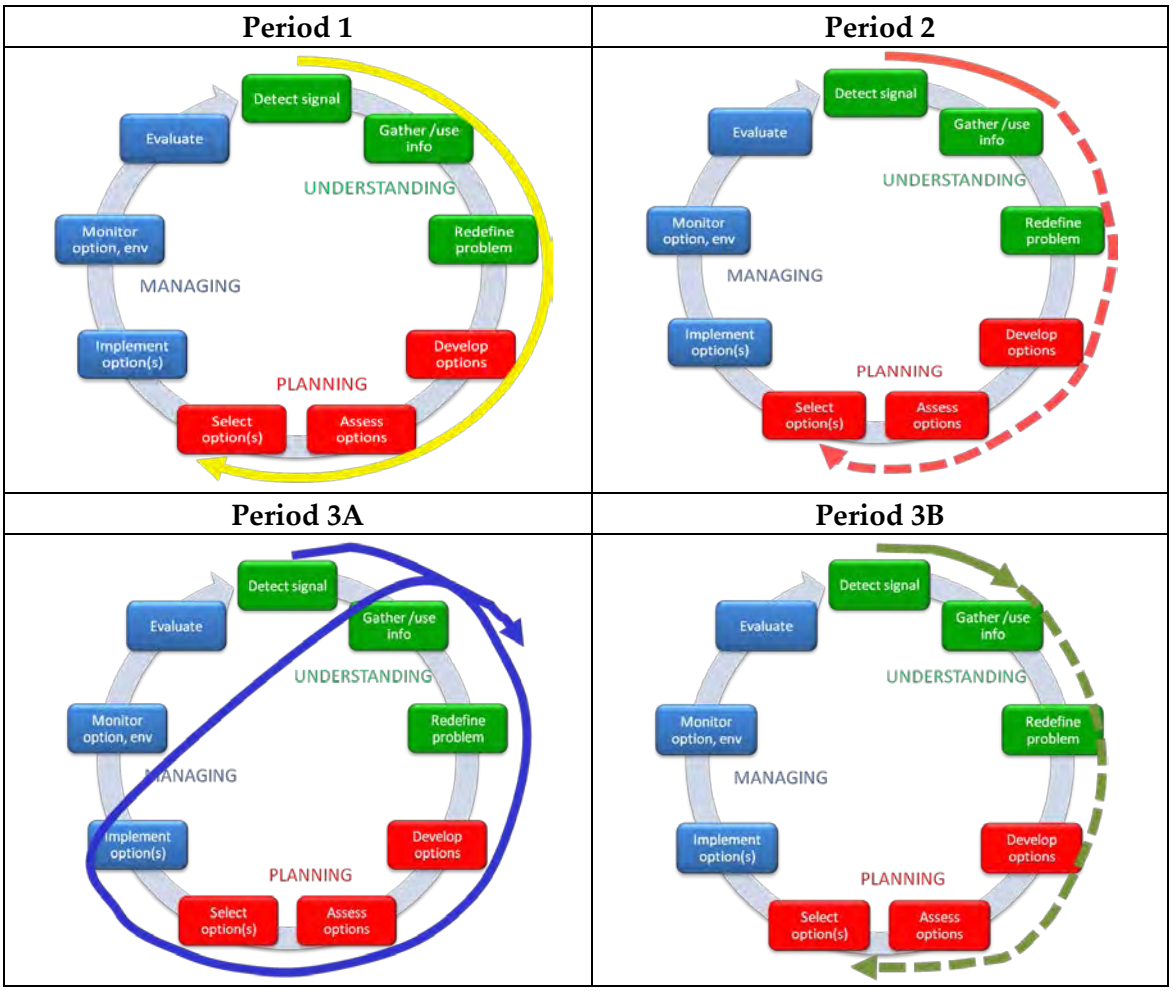

Figure 21: Adaptation Stages Completed or Anticipated in Santa Clara County During the Three Periods and Their Sub-periods. Arrows drawn over the conceptual model of an adaptation process (replicas of Figure 1) indicate which stages were included in individual periods. Dotted lines indicate anticipated or not yet realized (but planned) efforts.

As Table 11 and Figure 21 above show, the SCVWD is in many ways the leading agency in the County in terms of assessing and considering climate change in its plans and operations, while others are still in the very early stages of considering the potential impacts from climate change.

Table 11: Process Stages Observed in Each Period of Adaptation Planning and Implementation in Santa Clara County

Period	Summary Description	Stages
1	Initial Climate Action Plan	U1-U3, some P1 and P3
2	Reorientation, internal organization and coalition building	U1, U2 (intention to continue to P1-3)
3A	Water supply and floodplain management	U1-U3, P1-P32, M1 and return to U1-3
3B	Wait and see and signs of cross-departmental communication	U1, U2

4.5 The Regional Adaptation Process

4.5.1 Introduction and Overview of Climate Action at the Regional Level

San Francisco Bay is one of the largest metropolitan areas on the U.S. West Coast, a major transportation hub, a critical economic center not just for the state but also nationally and internationally, the largest estuary along the North or South American Pacific coastline, and thus a critical link in the Pacific Flyway for migratory birds. Depending on which sub-bays, estuaries and wetlands are included, the body of the Bay extends 3–12 miles west-to-east and 48–60 miles north-to-south, for a total area of 400–1,600 square miles (McGloin 1978; San Francisco Bay Watershed Database and Mapping Project, n/d). The flows of the Sacramento and San Joaquin Rivers drain through the Bay into the Pacific.

The "Bay Area" as a population center is made up of nine counties (Alameda, Contra Costa, Marin, Napa, San Francisco, San Mateo, Santa Clara, Solano, and Sonoma) and 101 cities and towns (the three largest of which are San Jose, San Francisco and Oakland, followed by 12 cities in the 100,000–250,000 category), with a total population of approximately 7.15 million people.[17] As described in Section 4.2 above, San Francisco is considered the cultural and financial center of the region; San Jose the technological center (Section 4.4), and Oakland, as the third most populous city, the central hub for the East Bay, and with its busy intermodal port, a major industrial center. The Bay Area includes the five highest California counties by per capita

[17]The San Francisco Bay Area (as defined here with its nine counties) is not recognized by the U.S. Census Bureau as a metropolitan area. The Census Bureau instead defines a larger 11-county Combined Statistical Area (CSA)—the San Jose-San Francisco-Oakland, California CSA—which includes Santa Cruz and San Benito counties. This CSA is home to 7.46 million people—the sixth-largest CSA in the United States (see http://www.census.gov/population/estimates/metro-city/03csa_ccbsa.txt). For Bay Area population data see http://www.bayareacensus.ca.gov/bayarea.htm.

income and two of the 25 wealthiest counties in the United States (Santa Clara and Marin). This high median household income is offset to some degree by the very high cost of living.

Despite its urban and industrial character, San Francisco Bay and the Sacramento-San Joaquin Delta contain some of California's most important ecological habitats. The Bay has 90 percent of California's remaining wetlands (San Francisco Bay Watershed Database and Mapping Project, n/d); unique species such as California's Dungeness crab, California halibut, and Pacific salmon fisheries use it as their nursery; and its marshes offer refuge to several endangered species. Both for its ecological, hydrological and aesthetic value, the San Francisco Bay is protected under a variety of policies aimed at preserving its water quality, preventing unmitigated fill of the Bay, protecting endangered species, and making access to the waterfront and to open space a priority.

The land areas around the Bay are also characterized by high climatic, topographic, and thus ecological diversity, with coastal areas generally cooler than inland areas, and the southern end of the Bay generally dryer than northern counties. While the area experiences overall cool foggy summers and mild rainy winters, some snowfall in higher mountain ranges is possible. Winter time flooding can occur along the open coast and Bay shoreline during coastal storms and in local watersheds under extended wet conditions when the ground becomes saturated (more common in the North than the South Bay), sometimes accompanied by mud and landslides. During spring and especially in the fall, when offshore winds and generally dry conditions prevail, the region also faces considerable wildfire hazards.

Known for its natural beauty, affluence, diversity and liberal politics, it is not surprising that many cities and counties in the region are actively involved in climate change mitigation, and to a lesser extent in adaptation efforts (see Appendix A). For example, of the 114 cities and counties in California that are members of ICLEI, a considerable number are in the Bay Area. (For a regularly updated Bay Area-wide inventory of climate change activities see: http://www.ca-ilg.org/node/2255). The focus here is not on these individual efforts, however, but on the overarching regional policy developments that may give regional guidance and help integrate and coordinate local efforts.

4.5.2 Climate Protection Efforts at the Regional Level

As Figure 22 shows, the adaptation policy developments are placed into five separate periods, some of which occur in parallel to each other. The first of these is a historical period, whose beginning dates back to the mid-1980s—compared to any of the other cases included in this study (and indeed by national standards) a remarkably early recognition of the threats from climate change, and one not generally known beyond insiders even in the region. The focus of this early development, and the driver of regional adaptation policy developments in more recent times, is sea-level rise and its impacts on the Bay Area. One state agency, with a mission focused entirely on the Bay Area, is the leading institution behind it: the San Francisco Bay Conservation and Development Commission (BCDC).

With renewed awareness and commitment by BCDC since the late 2000s, a distinct second period comprises a variety of activities, projects, and policy developments under BCDC's leadership, which continues at present (Period 2). Given its distinct mission, guiding policies and laws, and limited jurisdiction, BCDC's independent activities are distinguished here from those of and with other regional agencies (Period 3). There are four regional agencies that all have supra-local jurisdiction and are focused on the Bay Area: the Association of Bay Area Governments (ABAG), the Bay Area Air Quality Management District (BAAQMD), the Metropolitan Transportation Commission (MTC) and BCDC. The first three of these regional agencies have worked together over the past decade on integrative regional planning, and—specifically with regard to climate change—have been interested and engaged in supporting or financing mitigation activities for several years. Formalizing this collaboration, ABAG and MTC formed the "ABAG-MTC Task Force" in 2003 and formed a Joint Policy Committee (JPC). BAAQMD joined the JPC in 2005, and BCDC was added in 2008. Period 3 then begins with BCDC joining the JPC as it marks the time when adaptation—through BCDC—came onto the JPC's policy agenda. Period 3 is essentially a mission-finding time, described in more detail below, but with the four agencies working still relatively independently and some more reluctantly than others on adaptation.

A fourth period began in the spring of 2011 and is ongoing as of this writing. Period 4 is guided by a joint programmatic effort by the JPC to prepare a regional climate change impacts assessment (or synthesis report) and develop a broadly defined program to enhance the region's economic and climate resilience, with an emphasis on both energy (i.e., GHG emissions reductions) and adaptation. A future (not yet realized) Period 5 is included to hint at the possible future of the joint regional effort, as it was discussed by individuals in the interviews.

Each of these periods in the history of regional adaptation planning and policy development is summarized in Table 12 and described in more detail below. As that table makes clear, not only do the key actors change over time, but the sectors of concern, and thus the governance system also expand.

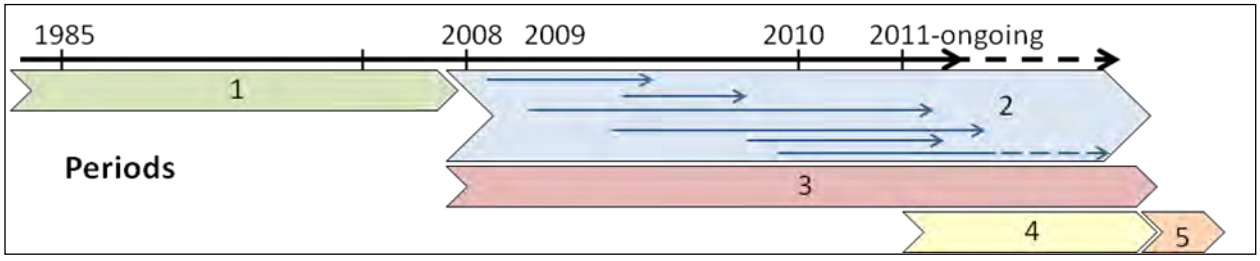

Figure 22: Timeline of Periods Observed in the San Francisco Bay Region

Table 12: Summary of the Bay Area's Regional Adaptation Activities by Period and Sub-period, Including Key Actors, Systems of Concern, and Bounds of the Governance System

Period	Summary	Key actors	System of concern	Bounds of governance system
1	BCDC puts SLR in its Bay Plan Amendment in 1989	BCDC	SLR, bay shoreline	100 ft of the shoreline
2	BCDC renews and increases its interest in SLR issues for the Bay	BCDC	SLR, bay shoreline	100 ft of the shoreline
2A	SLR inundation maps of the Bay are made and distributed	BCDC	SLR, bay shoreline	100 ft of the shoreline and beyond
2B	Bay Plan Amendment	BCDC and many stakeholders (comments and collected expertise and panels)	SLR, bay shoreline	100 ft of the shoreline and advisory guidance to local governments (the latter has been removed)
2C	Design competition for SLR	BCDC	SLR, bay shoreline	100 ft of the shoreline and beyond
2D	Local government assistance program initiated	BCDC and local governments	Capacity of local governments to deal with SLR, bay shoreline	Local governments in nine counties
2E	ART Project	BCDC, NOAA, regional partners, local communities and Alameda County	Natural habitats, built infrastructure, population, and physical assets at risk from SLR and flooding in Alameda County	At-risk shoreline areas in Alameda County, cities and county, relevant state and federal entities
3	BCDC becomes part of JPC	JPC (ABAG, BCDC, BAAQMD, MTC), State of California	Combination of jurisdictions: Air quality, shoreline, transportation, future development, public access	Combination of jurisdictions: Air quality, transportation, shoreline, future development, public access
4	JPC approves its climate and energy resilience program/initiative	JPC (ABAG, BCDC, BAAQMD, MTC)	All Bay Area, including economic impacts from CC and mitigation	JPC jurisdictions
5	Future regional adaptation efforts (not yet realized)	Expanded JPC or new formal or informal governance structure	TBD (all of Bay Area or specific focus areas?)	TBD

Period 1: BCDC puts SLR in Bay Plan Amendment of 1989

In 1985, BCDC leaders solicited a preliminary assessment of the state of climate change science, accelerating SLR and potential impacts of SLR on the Bay Area and the issues it has jurisdiction over (U1-U2). A more detailed quantitative assessment was conducted by consulting engineers (BCDC 1988) (U2-U3, P1-3), which ultimately led to changes in the Bay Plan—the agency's policy guidance document—in 1989 (M1). According to current staff at BCDC, these modified policies—which essentially required the consideration of growing tidal flooding risks due to relative sea-level rise in permitting of fill projects—were not implemented in day-to-day decisions for the subsequent 20 years. Lack of defensible science and clear guidance as to how to

implement the changed Bay Plan policies were among the reasons for not acting on this guidance.

Period 2: BCDC renews and increases its interest in SLR

Period 2 was initiated around 2006 when the leadership of the agency at that time —in the context of growing media coverage and a generally increasing "buzz" around climate change— became newly aware, interested, and increasingly concerned about sea-level rise (U1). While clearly initiated and sustained by its agency director (in office until the end of 2011), a growing circle of staff have been involved in various aspects of BCDC's intensifying work on raising awareness for the risks of sea-level rise in the region (U1-3), developing sea-level rise policies and building capacity among Bay area communities (P1-3). Over the last few years, this has also lead to increasing internal changes within the agency to better communicate among and coordinate strategic and operational arms of the agency. Distinct efforts are discussed separately as sub-periods below.

Period 2A: BCDC prepares and distributes SLR inundation maps of the Bay

In 2008, BCDC staff began preparing an extensively researched staff report on the region's vulnerability to SLR. The resulting draft report, first released in 2009, was subsequently updated and revised and a final version approved unanimously by the Commission in October 2011 (BCDC 2011a). As a public awareness raising tool (U1-3), the initial maps (produced in-house), and later versions published by USGS and other regional institutions, showed the extent of flooding during a 100 year flood with varying amounts of SLR. Assuming no shoreline protection, the images of the future Bay much resembled the historical outline of the Bay prior to human development and fill. Interviews for the local case studies indicated that these maps universally raised awareness and concern; with reactions ranging from initiating local adaptation planning and response to political outcry and resistance to BCDC's policy changes (see Period 2B).

Period 2B: BCDC works on Bay Plan Amendment

Around 2008, BCDC began work on its Bay Plan Amendment to strengthen its sea-level rise policy in place since 1989 (P1-3). The process, initially expected to be relatively quick, lasted until Fall 2011 and became highly contentious over the course of the 36 public hearings, workshops and meetings with local governments, an extended public comment periods, multiple staff reports and revisions to the proposed amendment, a campaign mis-portraying BCDC's intentions in strengthening its Bay Plan, and the changes to the Bay Plan that were ultimately (and unanimously) approved in October 2011.[18] Without changing its (already very narrow jurisdiction, see Table 12), the amended Bay Plan updated its findings section with the latest state of the science and updates on the policy landscape; it also modified prior policies

[18] The process garnered national attention with a news story on National Public Radio on October 6, 2011; see http://www.npr.org/2011/10/06/141102224/calif-agency-considers-climate-change-in-its-plans.

that "generally discourage building in shoreline areas that are vulnerable to current or future flooding." Assuming that the highly developed shoreline will be protected in the future, such development in low-lying areas is now allowed, "provided that flood risks are addressed, and encourage habitat preservation and enhancement in suitable areas."[19] Future shoreline developments within the agency's jurisdiction are required to prepare a risk assessment and adaptation plans for a range of SLR scenarios. With BCDC's entry into the JPC, staff and leaders of the agency expect that bigger policy changes will be addressed through the multi-agency regional effort (see Periods 3 and 4).

Period 2C: BCDC's design competition for SLR

In 2009, BCDC (with a series of co-sponsors) held an international design competition—open to anyone—to submit ideas for how to deal with the many challenges arising from SLR.[20] The competition laid out generically the risks faced from climate change and "rising tides" and stated that "a new suite of shoreline design concepts is needed" (M1, P1). From more than 130 entries, six winners were selected by a diverse jury. Some from within, others from outside the region, the winners shared a $25,000 cash prize and together with honorable mentions, could present their design ideas in a public exhibit. The competition raised awareness for SLR and its impacts on the Bay Area through extensive media coverage (U1-U3), and continues to do so as winning ideas have been shown in several exhibits around the region and featured on television.

Period 2D: BCDC initiates Local Government Assistance Program

In 2010, BCDC launched an "adaptation assistance program" (AAP) for local governments (M1). Through this program, the agency has assessed local government staff's needs and provides information and resources essentially to build adaptive capacity (U1-3). Its outreach efforts have been largely informal, small-scale, and face-to-face to date, and "primarily focus on addressing the needs of land use planning, public works, park and open space districts, flood control districts and wastewater authorities, as well as resource-based managers" (see http://www.bcdc.ca.gov/planning/climate_change/LocalGov.shtml). The program had five stated objectives: to (1) build partnerships among local government agencies; (2) build community and institutional support for adaptation planning; (3) educate planners and managers in the necessary knowledge and skills for adaptation planning; (4) create a web-based clearinghouse of information; and (5) develop and disseminate strategies to improve the region's resilience and adaptive capacity. The program was discontinued in the Winter of 2012, largely due to funding constraints.

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[19] See Resolution no. 11-08 available at: http://www.bcdc.ca.gov/proposed_bay_plan/10-01Resolution.pdf for a summary of the process of how the amendment was developed, including stakeholder concerns and objections, as well as the finally adopted changes.

[20] More details and winners are available at: http://www.risingtidescompetition.com/risingtides/Home.html.

Period 2E: The ART (Adapting to Rising Tides) Project

As part of its awareness raising (U1-3) and adaptive capacity building efforts, BCDC obtained funding from NOAA and (together with partner organizations) from the Federal Highway Administration to conduct a pilot project within a subregion of the Bay Area. This project, known as the ART or Adapting to Rising Tides Project, is focused on field testing vulnerability assessment and adaptation planning tools in a diverse and real-life context (P1-3). According to BCDC, the ART Project's goal is "to develop a template for integrative planning that addresses both the built and natural environment, and takes into account local conditions and interests, and supports local community adaptation planning" (http://www.bcdc.ca.gov/planning/climate_change/summCCP.shtml). BCDC selected the HASPA and neighboring jurisdictions in Alameda County to be the pilot subregion, and the project is ongoing at the time of this writing (albeit reduced in scope due to cut backs in funding).[21]

Period 3: BCDC becomes part of JPC – Mission-finding

This period is distinguished from Period 2 primarily by the set of actors involved and by the focus of efforts. While Periods 1 and 2 involved principally BCDC and its collaborators, Period 3 is focused on fostering a regional policy focus on adaptation through the key regional agencies —ABAG, BAAQMD, MTC, and BCDC. The period began when—upon BCDC's request and subsequent legislative action—BCDC became a voting member of the JPC in 2008. Joining JPC for BCDC was motivated at least in part by an emerging policy conflict where the other three regional agencies—in pursuing their respective policy goals—suggested concentrating future urban development in sea-level rise-exposed areas. The three agencies previously constituting the JPC were charged with developing an integrated regional plan that included priority areas for development that were subject to potential flooding and inundation from SLR (as the SLR inundation maps showed, see Period 2A). Entry of BCDC into the JPC—not immediately appreciated by existing members—nonetheless opened the possibility to develop a regionally integrated adaptation strategy that would extend far beyond BCDC's limited jurisdiction, and that could address more than SLR impacts (i.e., become multi-sectoral). Between 2008 and 2011, however, the now four-member group struggled to find common ground, develop a clear vision, and agree on a constructive process forward. While GHG mitigation had become a central focus for the agencies already (through Senate Bill (SB) 375, demanding a regionally integrated transportation and development plan that would reduce emissions), lack of familiarity with and mandate on adaptation, as well as very different agency missions, funding structures, and accountabilities, caused the JPC to search for a joint mission on adaptation for three years. With strong backing from the JPC's Executive Director and the persistent legwork of a consultant including the building of an extensive stakeholder network of NGOs, local governments, scientists and consultants (U1-U3), adaptation finally became part of a larger regional programmatic effort that JPC could endorse and rally behind.

[21] Detailed information and ongoing updates available at: http://risingtides.csc.noaa.gov/.

Period 4: JPC approves its regional economic development and resilience initiative

Efforts in Period 3 finally led in Spring 2011 to JPC passing a resolution to develop a regional resilience initiative (M1). This initiative is not exclusively focused on climate change, but simultaneously aims to address concerns about regional growth, economic development, and rising energy prices. Thus, in May 2011, the JPC approved a work plan to develop an integrated regional economic development and resilience program. Its three components include (1) a near-term green jobs program focused on residential and commercial building retrofits, local decentralized renewable power, and building the regional electric vehicle infrastructure; (2) the development of a Bay Area Economic Strategy Framework through a study of local economic dynamics, drivers of growth and an assessment of local industry needs; and (3) a Bay Area Climate and Energy Resilience Strategy, based on a clear understanding of projected climate change impacts on the region, an inventory of existing efforts, collaboration among regional actors, an assessment of additionally needed strategies, and an assessment of potential governance frameworks and supporting resources to implement such adaptation (resilience) activities. The activities in this work plan are under way as of this writing (U2, possibly U3, P1-2 over time). During Period 4, a change in leadership occurred in the JPC, which left the entity without executive leadership for several months. The new leader, in office since early 2012, is the former longer-term Executive Director of BCDC.

Periods 3 and 4 also mark a time in the region generally when climate change adaptation emerges more dominantly on the public agenda. Awareness-raising activities spread beyond the concerted efforts of BCDC. For example, the Public Policy Institute of California released several analyses on adaptation needs, options, and barriers in 2008 (Bedsworth and Hanak 2008), and in May 2011, the San Francisco Planning and Urban Research Association (SPUR) released a report on adaptation strategies specifically for the Bay Area that garnered significant press attention (SPUR 2011).

Period 5: Future regional adaptation efforts

During the interviews with key actors involved in the regional effort, discussions frequently turned to the future of the JPC, including a variety of efforts under way at present to alter its shape and functionality. With regard to a comprehensive regional adaptation strategy, several found that the four agencies do not sufficiently represent all the climate-sensitive sectors that would need to be at the table (e.g., water, human health, ecosystems and natural resource management). Others found it not effective enough as a regional governance body. Thus speculations as to the future shape of a regional governance body and the recognition of a broader set of actors who need to be included in integrated adaptation planning hint at a future period in the regional adaptation process. If and in whatever shape it will emerge, it will continue the regional adaptation planning that has only begun recently (P1-3) and begin the process of implementation (M1-3). Tensions between local and regional decision authority will need to be addressed as well as challenges in cross-jurisdictional and cross-sectoral integration and funding.

Figure 23 summarizes the periods and sub-periods completed, currently under way, or anticipated in the regional adaptation process, and Table 13 summarizes the phases and stages observed in each.

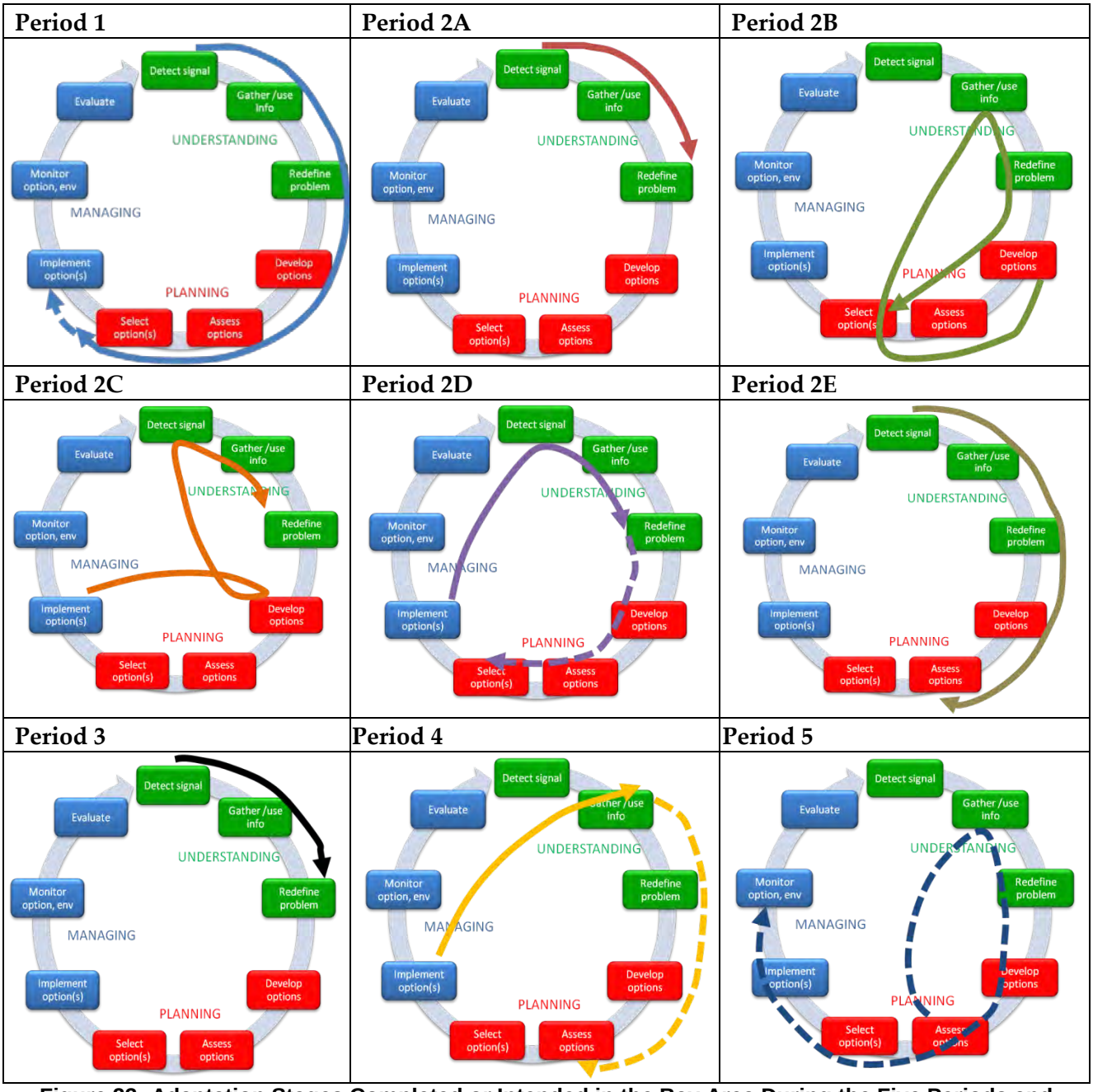


Figure 23: Adaptation Stages Completed or Intended in the Bay Area During the Five Periods and Their Sub-periods. Arrows drawn over the conceptual model of an adaptation process (replicas of Figure 1) indicate which stages were included in individual periods. Dotted lines indicate anticipated or not yet realized (but planned) efforts.

Table 13: Process Stages Observed in Each Period of Adaptation Planning and Implementation in the Regional Adaptation Process

Period	Summary description	Stages
1	BCDC puts SLR in Bay Plan Amendment of 1989	U1-3, P1-3, M1
2A	BCDC prepares and distributes SLR inundation maps of the Bay	U1-3
2B	BCDC works on Bay Plan Amendment	P1-3
2C	BCDC's design competition for SLR	M1, P1, U1-U3
2D	BCDC initiates Local Government Assistance Program	M1, U1-3, (P1-3?)
2E	The ART (Adapting to Rising Tides) Project	U1-3, P1-3
3	BCDC becomes part of JPC – Mission-finding	U1-3,
4	JPC approves its regional economic development and resilience initiative	M1, U2, (U3, P1-3?)
5*	Future regional adaptation efforts	(P1-3, M1-3?)

* Not yet realized; stages anticipated in parentheses based on information obtained from interviews

In summary then, what becomes apparent in Figure 23 and from the more detailed description of the regional process is that the Bay Area's regional adaptation process has been primarily focused around sea-level rise to date, and thus largely driven forward by the one regional institution whose regulatory authority centers on Bay shoreline management issues: BCDC. At the same time, that agency has a very narrow—both geographically and substantively—jurisdiction and thus cannot shoulder even a regionally integrated coastal adaptation strategy alone, much less a sectorally more comprehensive effort. Not surprisingly, BCDC has focused its efforts largely on awareness raising, capacity building, and coalition building to move a broader, integrated regional adaptation effort forward. Its own policy amendment encountered significant support among some stakeholders and equally significant resistance from others, possibly foreshadowing what more significant, comprehensive regional efforts may face in the future. Momentum is building at present, however, to build a more effective regional governance structure (or modify the existing one), and to foster greater understanding of climate change impacts on the region as well as of the need for a regional approach to effectively address them.

While over the course of the regional process all involved regional agencies have advanced their understanding of climate change impacts and their respective roles in managing them, BCDC not only has the longest history of doing so, but has made adaptation—under strong and consistent leadership—a central priority and has created strategic and programmatic structures to support internal and external capacity building. Despite its limited regulatory jurisdiction, its sphere of influence now reaches across the Bay Area. But leadership in the region is not confined to BCDC. The JPC's executive director, the current chair of the Committee, and the

consultant who not only originally motivated the regional agencies leads to engage on mitigation, but more recently also on adaptation have played (or continue to play) critical roles in moving the regional process forward. The future of the regional governance structure will be interesting to observe as it unfolds as it might address the persistently challenging balance between local and supra-local decision-making powers as well as funding mechanisms, accountability, and long-range planning.

4.6 Comparison of Insights about Adaptation Processes

A number of overarching insights emerge from a comparative review of the local and regional cases. First, while the studied communities are indeed in very different stages of advancement in the adaptation process overall, all are actually doing less than their regional counterparts assume they have already accomplished.[22] At the same time, substantive changes in decisions, policies, or plans is apparent, but not always labeled adaptation or held up as climate protection.

This is reflective in part of the generally early stage of adaptation planning and implementation in California and the US (NRC 2010), in part of the politics of working on climate change at this time, but also of the different approaches each has taken. While Hayward and the Region are more narrowly focused on adaptation to one climate change threat (sea-level rise), San Francisco, Marin and Santa Clara clearly have a sea-level rise focus, but also aim to address climate change impacts in other sectors. Thus, overall, the cases studied show a predominance of efforts in the Understanding phase, and more recently in the Planning phase, but very little action to date in the Managing phase of the decision cycle.

It is interesting to place these case study findings into the context of the California coast-wide survey findings. Extracting the answers of just the local (municipal and county) officials for a total of 162 responses (from cities, towns or counties along the California open coast and Bay shoreline), the observations are indeed quite common (Figure 24).

The level of adaptation activity at the local level is significantly increased from about five years ago when a survey of California coastal communities was conducted (although the same question was not asked at the time) (Moser and Tribbia 2006/7; Tribbia and Moser 2008). At the same time, the vast majority (80 percent) of communities that has begun addressing adaptation is in the Understanding and Planning phases. More detailed survey results indicated that those in the Understanding phase are predominantly in the U2 stage (gathering more information); and those in the Planning Phase are predominantly in the P1 stage (brainstorming possible adaptation strategies).

[22] This conclusion is based on a number of points of reference, including comments from informants in one case about their sense of what those in other cases are already doing (in interviews and casual follow-up conversations) based on what they read on websites, in government documents or in the newspapers, as well as comments made to that effect at regional meetings. Often, such comments were made apologetically, such as "Oh, you should talk to [so-and-so]; they are much further along than we are."

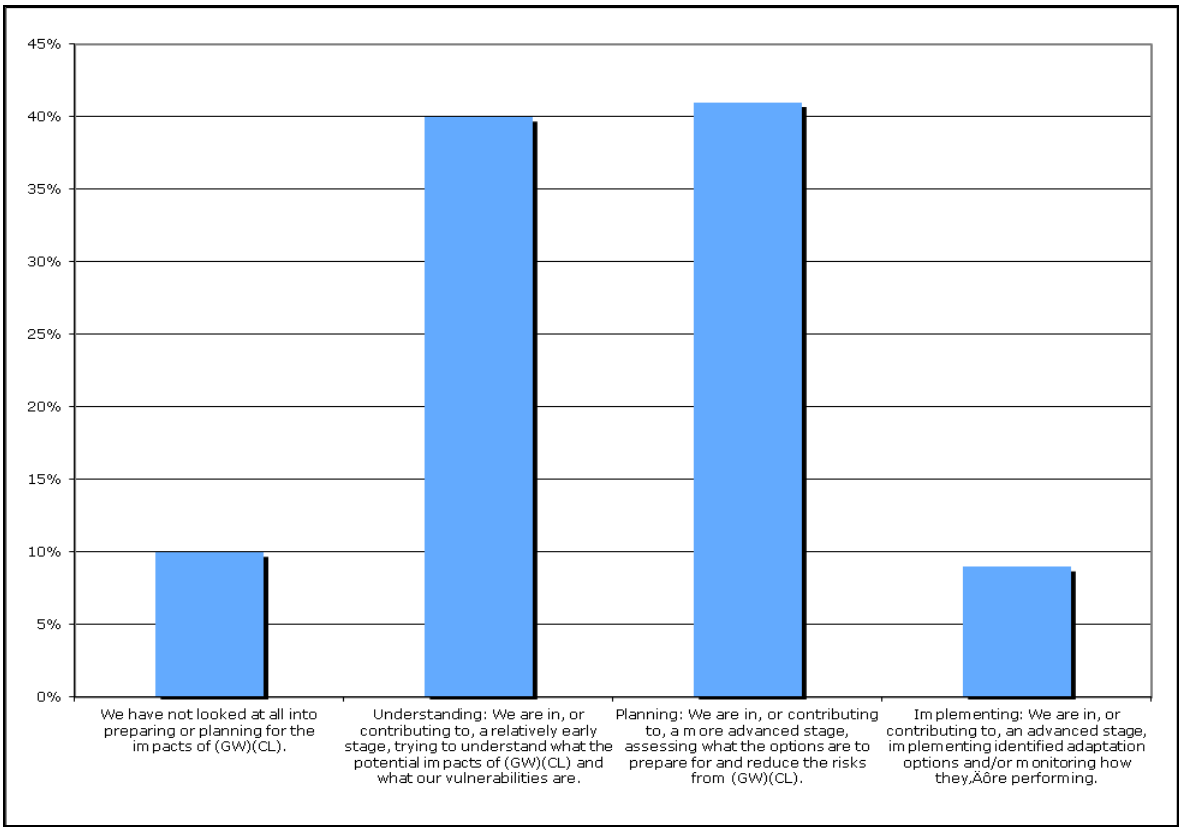


Figure 24: Survey Responses of California Coastal Communities and Counties Regarding the General Phase in the Adaptation Process (Status Summer 2010) (n=162)

In terms of governance and process there were several clear distinctions and some similarities between the cases studied in detail here:

- HASPA is very united over a single topic, and has support among both elected officials and departmental staff for moving forward with its strategy and plan. A trigger event helped "connect the dots." Being well organized and strategic in the past has paid off by attracting additional outside support and resources through the ART Project. At the same time, other climate sensitive sectors of the city have yet to catch up. It will be interesting to see whether success with adaptation planning in a single sector will pay off as a model for other sectors, thus accelerating the city's overall progress, or whether Hayward will experience similar cross-departmental integration challenges as other local communities studied here.
- San Francisco and Marin have a history of being progressive and proactive in their actions and policies. Marin was able to introduce adaptation into its latest countywide (general) plan update, which could be considered a major advancement, and an example of "mainstreaming" the issue into existing plans. However, the policies are not necessarily being implemented—not at present nor necessarily in the future—unless leaders among the Board or staff make it a priority in work plans and budgets. The isolated efforts in individual departments are slow, partial or stalled. By contrast, San Francisco has had

strong leadership at the staff level, but has been hampered in moving adaptation to the front burner due to frequent overturn in recent years at the mayoral level. Current work priorities trump adaptation, thus slowing down progress toward a more integrated effort. Outlook here appears promising, however, as good cross-departmental communication and persistent interest in a more integrated effort pave the way toward formalizing a joint process.

- Santa Clara County has had early leadership with climate change action in general, but has not explicitly prioritized adaptation. Local politics, funding constraints and more immediate priorities for the current elected leaders have only allowed for minor implementation of adaptive options in County operations. A recent change in leadership has triggered a reorientation toward a broader sustainability and resilience frame, within which climate action is finding its home. Staff are thus preparing and building a foundation for a broader adaptation planning process that aims to include municipal governments. Several of the individuals interviewed for this project are waiting for some top level guidance or directive, and are deliberately holding out for further progress at the regional level.
- The regional case is an interesting hybrid between the single-sector focus, largely driven by one actor (BCDC) and the growing expansion toward multi-jurisdiction, multi-sector, and cross-scale governance of a more integrated process.

Across most cases, "lone actor" phases (or at least periods in which the leadership of one or two actors was essential) seem common—sometimes for an entire case, sometimes just in a particular department. And even where individuals are not working alone or in the face of resistance, supportive leadership (at any level) emerges as an essential factor in strategically moving the process forward (e.g., through coalition building, capacity building, or awareness raising). Leadership in all studied cases was observed among elected officials, professional staff, and consultants. Missing leadership, turn-over among leaders, or obstruction of the process by people in positions of power was also found and has, at various times, played a decisive role in stalling further progress (e.g., San Francisco, Marin, Santa Clara), only further underlining its importance.

Leaders were instrumental in making use of serendipitous opportunities such as a storm or an unexpected funding source (e.g., through the American Recovery Act) as much as of "planned" opportunities such as periodic planning processes, or scientific studies. In some instances, they created opportunities (e.g., the ART project, design competition or ongoing efforts to restructure the JPC). Often, their actions and strategies were consciously taken to overcome barriers they encountered in the process. In fact, both the shift from one period to the next and the dynamic movement through the decision cycle were often a reflection of a barrier encountered, triggering a shift in approach, in the set of actors, a switch to a different governance system, or an alternative strategy to help overcome it.

When comparing these case study findings to the motivations identified in the coast-wide survey, quite similar findings again are found. Figure 25 shows the reasons that respondents

selected (from a given list of options, with a write-in option) for why they initiated adaptation planning in their local jurisdictions.

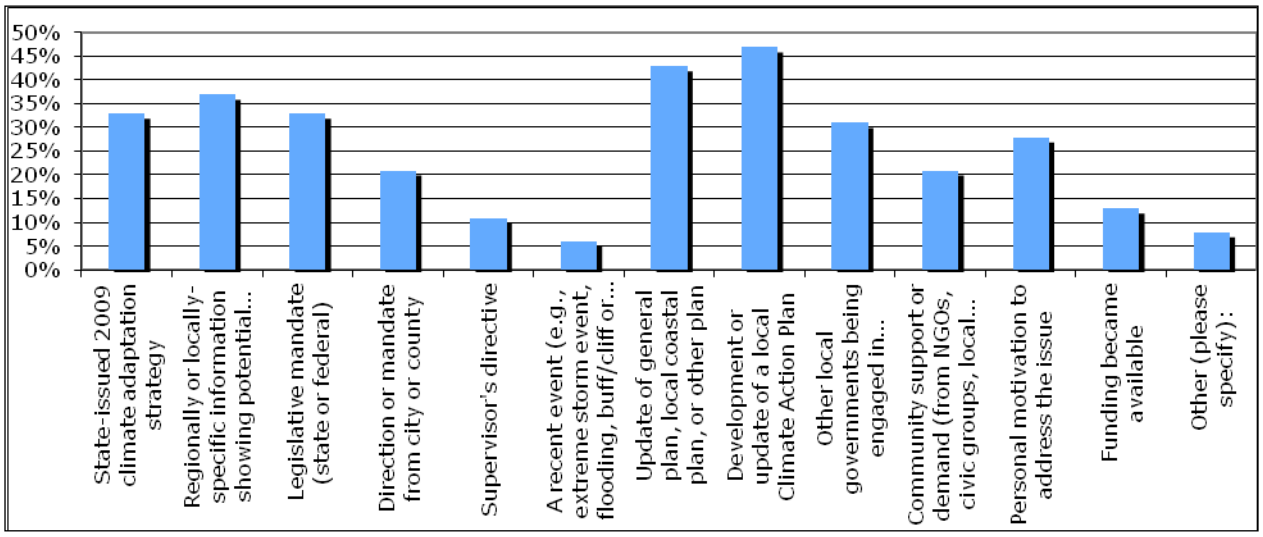


Figure 25: Motivation to Begin Adaptation Planning in California Coastal Communities (n=141)

Among the leading reasons were either the development or update of a Climate Action Plan (as in San Francisco), an update of general or coastal plans (as in Marin and to a lesser extent Santa Clara County), and regionally or locally relevant information making the potential risks of this global problem locally more tangible (this was true across the Bay area with the maps from BCDC and USGS), among a range of other reasons. If in fact the adaptation activity recorded along the state's coastline is similarly driven by communities with strong leaders (as in the cases studied here), it would be consistent to see personal motivation to be a stronger motivation than supervisory directives. It is also consistent with past observation that communities look to and work with neighboring communities as they launch novel efforts such as adaptation planning so as to share ideas and learn from each other. Much of the coalition building efforts, and face-to-face outreach to local communities, very much reflect just that type of activity. As interviewees in this study repeatedly acknowledged, the challenges associated with "being first" or doing something new are more easily overcome with partners.

Finally, in all cases, there appeared to be a movement from sectoral or narrow geographical approaches toward more comprehensive, integrated efforts, reflecting the growing understanding among the involved actors of the magnitude and pervasiveness of climate change threats and that climate change cannot be addressed in sectorally or geographically isolated, piecemeal fashion. This recognition notwithstanding, the challenges of achieving cross-sectoral and cross-jurisdictional integration were viewed and experienced as formidable. Institutional barriers in mission and jurisdiction, financial disincentives and constraints, competing priorities, as well as ambivalent power dynamics (i.e., unwillingness to give up local power to higher levels; yet also a clear need for higher-level support, guidance, and assistance and "push" to realize a more integrated approach) will color future efforts toward this end. The following section explores the issues of barriers in significant detail.

Section 5: Barriers to Adaptation: Types, Sources, Origin, and Ways to Avoid or Overcome Them

5.1 Introduction

In Section 5, the attention turns from the description of the adaptation processes under way in each of the cases studied to the analysis of adaptation barriers potentially hampering these processes. The focus will be on which barriers dominated overall and during different periods in each case and during different process stages; the sources of the barriers (actors, governance system/context, system of concern); and the temporal and spatial/jurisdictional origin of barriers. These three aspects, which are part of the diagnostic framework being tested in this study, together provide a more in-depth understanding of the barriers themselves, but also can be used to reveal ways to overcome or avoid the barriers. This section will also examine the aids, assets and advantages that helped communities and actors avoid barriers (aids and advantages) and the efforts made (strategies) to overcome them once barriers were encountered.

Section 2.3.2 above described in detail how the barriers were extracted from the interview transcripts, and then independently coded by the two researchers, using an inductively derived, but mutually reconciled categorization of barriers to allow similarities and differences to the diagnostic framework to emerge. Both explicitly mentioned and implicitly emerging barriers were included. The same procedure was applied for "aids and advantages" and "strategies to overcome barriers."

The goal of the coding and categorization was to discern *unique* barriers (i.e., not simply to count up the raw mentions of barriers, regardless of how many times the same barrier may have been mentioned by an interviewee for the same period, phase or stage). If different interviewees mentioned the exact same barrier independently, such prevalence was noted. Thus, if three science-related barriers were found in a particular period, then they reflect three different scientific issues (e.g., lack of downscaled climate data, lack of groundwater data, and inadequate understanding of impacts of heat on human health in that location). The categorization was derived by review of the raw data from all five cases, and then applied uniformly to each. Thus, in some cases certain types of barriers may have a count of zero, yet in other cases, the same type of barrier mattered more and one or more unique barriers in that category are counted. Appendix E lists the sort of issues raised by interviewees for each type.

It is important to recall why such a detailed coding and categorization procedure was undertaken. The interviews revealed—at a minimum—more than 100 unique barriers in each case, and in some instances significantly more. Such an unwieldy number makes it impossible to discern patterns in the decision-making cycle or over time, or in the sources of the barriers, the aids and advantages that helped avoid them, or the strategies actors employed to overcome them. The reconciled categorizations identified 12 types of barriers, 17 types of aids and advantages and 16 types of strategies with many more issues falling under each. Further bundling certainly would have been possible, e.g., using the simple typology used in the

National Research Council's *America's Climate Choices* report on adaptation (NRC 2010, p.150), which distinguishes only four types of barriers: inadequate information and experience, inadequate institutional support for adaptation, lack of resources and technology, and behavioral impediments. Each of these categories is highly ambiguous and imprecise. They also don't allow easy insight in the necessary intervention to overcome a barrier if actors wish to do so. Thus, a decision was made to retain a greater number of distinct categories to not lose the detail that is the unique hallmark of case studies. More detail may also provide more policy-relevant information.

The sections that follow present results for the five cases overall, and for each uniquely, highlighting similarities and differences among them.

5.2 Barriers to Adaptation in the Five Case Studies

5.2.1 Overall Patterns of Barriers Encountered Across all Cases

The overall occurrence of barriers revealed some interesting results, both looking across all cases and at the differences among them. Before looking at the overall pattern, it is important to recall what the "frequency" of a particular type of barrier means.

When coding the interviews, several possible ways of "counting" the barriers emerged: Counting every single mention of a barrier, counting how often the same barrier was mentioned, and counting all unique barriers. The first option would represent an absolute frequency without distinguishing whether the same barrier appeared, say, ten times or ten different barriers were mentioned just once. The second would give an indication of how often a particular barrier was repeated in the course of the conversation (a fact difficult to interpret, and a number difficult to normalize in key informant interviews of varying lengths). And the third would be a count of clearly distinguishable barriers without an indication of how frequently it was mentioned. In the results below, the latter of these three options is shown.

Our reasoning for this choice is partly driven by the primary methodology chosen for this study (key informant interviews) and partly by an inability to unambiguously interpret other frequency measures. The goal here was not to measure personality differences (e.g., an informant's passion, politics, or singular interest) or any possible "barrier de jour" phenomena, but the number of different barriers that seem to occur in people's experience. When these unique mentions are categorized into some bigger bins, frequencies per barrier type result.

These frequency measures should not be interpreted as simple indications of "importance" or how difficult it may be to overcome a particular category of barriers. Take, for example, the number of science-related barriers. Some scientific issues are easy to resolve by making available information more accessible, whereas others require 10 years of a national research program. Frequency does not resolve this degree of challenge. Or, among the many institutional barriers identified, there may be some that pose daunting challenges while others are more easily resolved. Again, this kind of information cannot be obtained from the frequencies reported here, and the subjective judgments of key informants – while interesting – may not easily map onto objective reality. As the purpose of this study was to test a diagnostic

framework of barriers, the number of unique, clearly distinguishable barriers was selected as the primary target for this analysis.

Taking all cases together, the most frequent type of barrier encountered in this study are related to institutional or governance issues (e.g., being stove-piped, legal barriers, limited jurisdiction) (Figure 26). These institutional barriers are followed in overall frequency by barriers categorized as "attitudes, values and motivations" (e.g., lack of interest, status-quo mindset, inability to accept change, narrow self-interest). Resource and funding issues (e.g., the economic crisis of recent years, inaccessible funding, cuts with implications for staff) are the third most common type of barrier, followed by a category entitled "politics" (e.g., lack of political will, rivalry, turfism, ulterior motives). Six types of barriers follow that were mentioned less frequently, but are still important, including issues related to leadership (e.g., lack, incompetence), the adaptation process or particular options (e.g., lack of guidance, lack of feasible options), understanding of climate change science and impacts, the science needed to support local adaptation (e.g., lack of data, uncertainty, lack of relevance or access), any relevant expertise among the involved actors, and communication (e.g., lack of or miscommunication, lack of clear message, lack of trusted messengers). Personality issues and technological or structural barriers (e.g., no feasible, affordable, or environmentally acceptable structural solution) feature the least in the cases studied here.

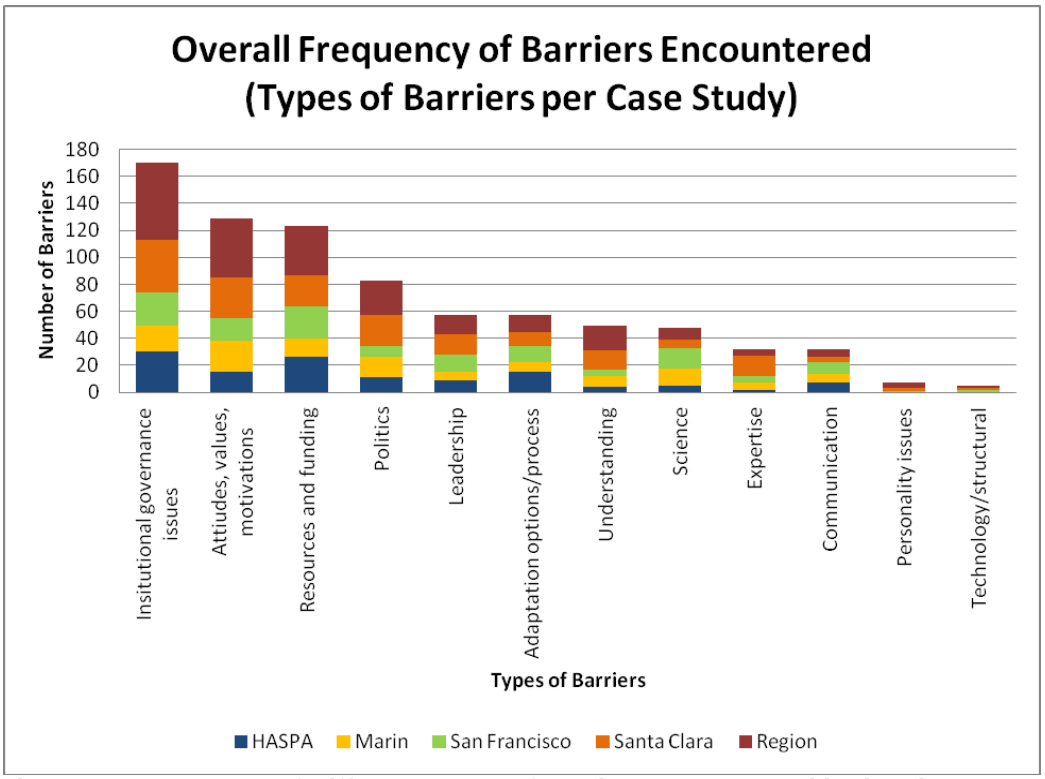


Figure 26: Frequency of Different Types of Barriers Encountered in the Five Cases

These results are surprising in a number of ways. For example, the predominance of institutional issues at this relatively early stage of adaptation planning is rather astonishing, yet

may reflect both the institutional issues involved in self-organizing for initiating and mobilizing for adaptive change, and some of the anticipated governance issues in yet-to-be-realized periods of the process.

Resource and funding issues are—as expected—very important. The only surprise maybe—against a backdrop of extensive literature reporting economic issues as the most important type or set of barriers—is that one may have expected them to be #1 rather than #3. This is, however, in line with other research that shows while the rhetoric may be about lack of financial means, the roots of the problem tend to be institutional or behavioral (e.g., Jantarasami et al. 2010; Adger, et al. 2009; Grothmann and Patt 2005). Important to note here is that while this study was undertaken at the tail end of a major recession (with lasting effects), economic constraints are of such importance even in highly developed nations like the United States (not just in developing nations), and even in some of the country's most affluent locations such as Santa Clara, Marin, and San Francisco.

As a barrier, lack, inadequacy or competition in leadership were of moderate importance, which is consistent with the observation noted in Section 4 that leaders in the five cases actually played critical roles in moving adaptation forward across all cases—a common observation in cases that can be described as pioneers. As the more detailed look at individual cases will show, those where leadership issues constituted greater barriers, less progress was indeed observed.

A greater surprise—at least at first glance—is the relative low importance of science as #8 as a barrier overall. Many scientists and practitioners frequently argue that lack of science is an impediment toward making more progress on adaptation. This is contradicted by the findings here where scientific barriers are much further down the list than expected. Based on the interview data obtained in this study, this can be explained principally by the early stage in the adaptation process. First, the leaders pushing adaptation onto the policy agenda were generally very well informed about climate change and its potential impacts; to them there was sufficient science to begin the adaptation process—either by initiating assessments or building adaptive capacity, or raise awareness and building coalitions. A second reason that science barriers may be relatively less important here is that few of the actions proposed or taken to date actually required sophisticated scientific information. And finally, the Bay Area is relatively well endowed with scientific capacity and has a comparative wealth of studies that were focused either on California or the region that was frequently acknowledged as being at least sufficient to get started. Some of the scientific barriers identified included a lack of particular types of information that were anticipated to be needed at a future time. Thus, one may expect that some scientific barriers may be more significant or more detailed at later stages when adaptation strategies become more concretely formalized. Regionally relevant science seems to be sufficient at least for those leading local governments that are inclined to take action.

Finally, technological or structural barriers are far more frequently mentioned in the literature than they show up as impediments here. This, too, may be reflective of the relatively early stages of the adaptation processes observed here. As Section 4 showed, there is very little activity yet that falls within the implementation stage of adaptation. Those technological and

structural barriers, however, that were mentioned by interviewees—particularly by knowledgeable engineers and others with technical expertise (e.g., challenges in protecting critical infrastructure such as the airports or raising the Embarcadero in San Francisco), suggest these issues will become significant in the future. Given the enormity of the challenge of protecting some of the Bay Area's critical infrastructure and highly developed shoreline (involving not just a technological feat, but extraordinary cost, environmental impact assessments, stakeholder engagement processes and permitting issues), and the possibility of significant sea-level rise acceleration, this future may not be as far in the future as some currently think.

The following sections summarize the overall occurrence of barriers observed in each of the cases, highlighting some interesting differences that help explain the state of progress observed to date as described in Section 4.

5.2.2 Adaptation Barriers Observed in HASPA

Figure 27 shows the prevalence of different types of barriers in the HASPA case, with different colors in each bar representing the number of barriers per period. This summary figure suggests that institutional, resource, attitudinal, and adaptation process or option-related barriers dominate in this case. This conclusion holds even if the barriers in the yet-to-be-realized Period 5 (yellow) are subtracted. Personality and technological/structural barriers were not mentioned at all here; and science, communication, understanding and expertise-related barriers, as well as leadership or political issues were not of particular concern.

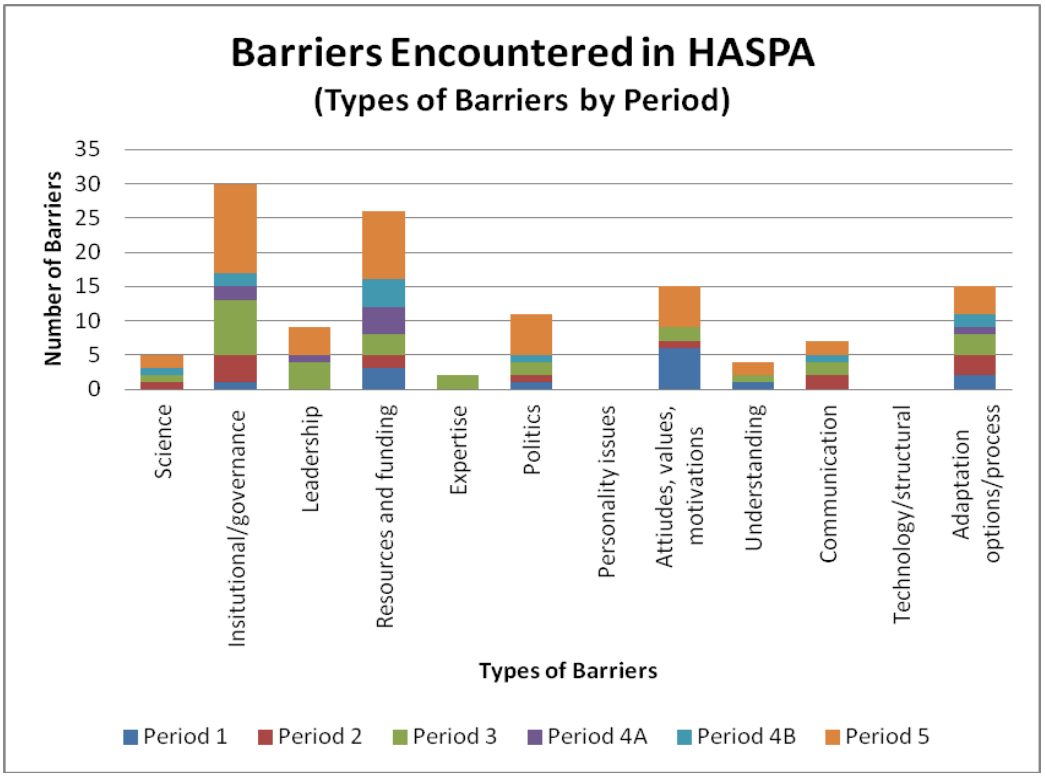


Figure 27: Barriers Encountered in HASPA's Adaptation Process

It is noteworthy to mention that HASPA had the overall smallest number of barriers for the already completed or current periods compared to any of the other cases, reflecting both the fairly advanced stage of that case, the strategic efforts put in by the key actors to move things forward, but maybe also its narrower sectoral focus. It is quite possible that a wider range of barriers may be observed once Hayward moves beyond the coastal sector. At the same time, HASPA represents a case where a significant amount of coalition building and collaboration across jurisdictional boundaries is already taking place. Moreover, actors repeatedly spoke of the challenges of "being first," i.e., trying something new, and figuring it out "as they go."Among the "firsts" would not just be (feasible) structural changes, but also changes in rules and regulations to allow them to pilot test an innovative adaptation option. Thus, interviewees were very aware of the legal changes or permitting obstacles they might encounter if the preferred option were to be implemented. To not have to deal with these obstacles alone, much of the emphasis was on building coalitions and broadening the governance structure to support the envisioned adaptation in the future. This is consistent with the dominance of institutional barriers found in this case.

5.2.3 Adaptation Barriers Observed in Marin County

Marin County had fewer major periods (two realized, and one anticipated in the future), with Period 2 subdivided into several sub-periods (not shown or discussed separately here). The barriers encountered in this simplified view of the case are shown in Figure 28.

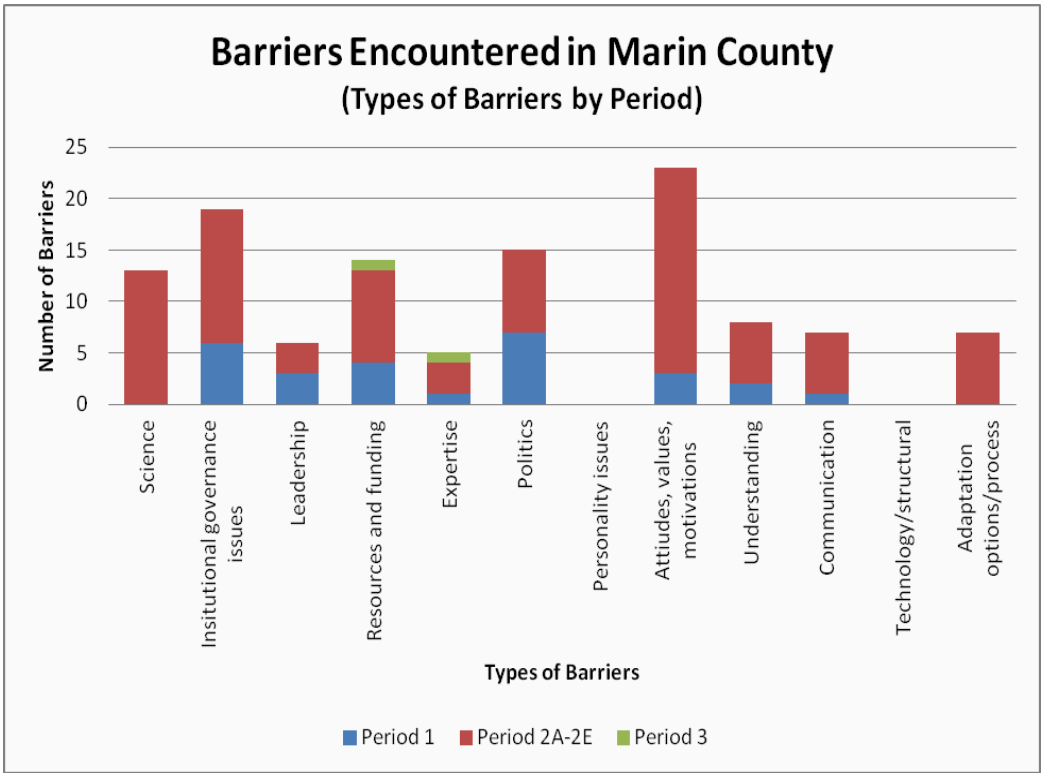


Figure 28: Barriers Encountered in Marin's Adaptation Process

A first interesting observation about the adaptation barriers in Marin is that relatively fewer unique barriers were encountered in Period 1, whereas many more are observed in the second Period. To recall, Period 1 was that in which essentially one key actor introduced adaptation into the Countywide Plan Update. Period 2 is the ongoing one of disparate efforts, where implementation of the general plan with all its adaptation strategies is largely stalled, and departments work without cross-coordination in their respective sectors.

In the first period, politics and institutional issues dominated, largely related to weaving adaptation into the Countywide Plan Update at all, but because it was essentially a planning process involving principally just one lead actor with supporting staff and the Board of Supervisors, there was little need for governance, coordination, or for financial commitments at that time.

In the second period attitudinal, scientific, and institutional barriers dominate, followed by resource/funding, politics, and issues related to the adaptation process, understanding and communication. Leadership, expertise are of lesser concern and personality issues and technological/structural barriers were not mentioned. The dominance of attitude/values/motivation barriers is reflective of the observed skeptical attitude among some in the county toward FEMA and regional (BCDC) policy changes, and the perceived challenges with implementing a Countywide Plan (CWP) that is rich in ideas but far more ambitious than current agency staff think can be realistically tackled. Interestingly, scientific barriers were more frequent in Marin, reflecting particular lack of data and regionally relevant model results, and lack of coordination, integration or accessibility of studies. These observations are not only consistent internally with the state of affairs in Marin at this time, but support the notion that locally relevant science becomes in many ways more important when comunities try to implement specific adaptation strategies. Generally relevant science may be sufficient to motivate people to begin an adaptation process, but more specific scientific information is needed further down the road.

Finally, the importance of institutional barriers in Marin reflects much of the disconnect among departments at present and the lack of prioritizing adaptation at this time. This is in part related to the economic downturn that has implications for staffing, resources for studies and implementation even for an affluent county like Marin.

5.2.4 Adaptation Barriers Observed in San Francisco

For San Francisco, a summary of barriers is given in Figure 29. Like in Marin, sub-periods of Period 1 were condensed (blue bars), and Period 2 is the anticipated future period, thus reflective mostly of anticipated, rather than already encountered barriers.

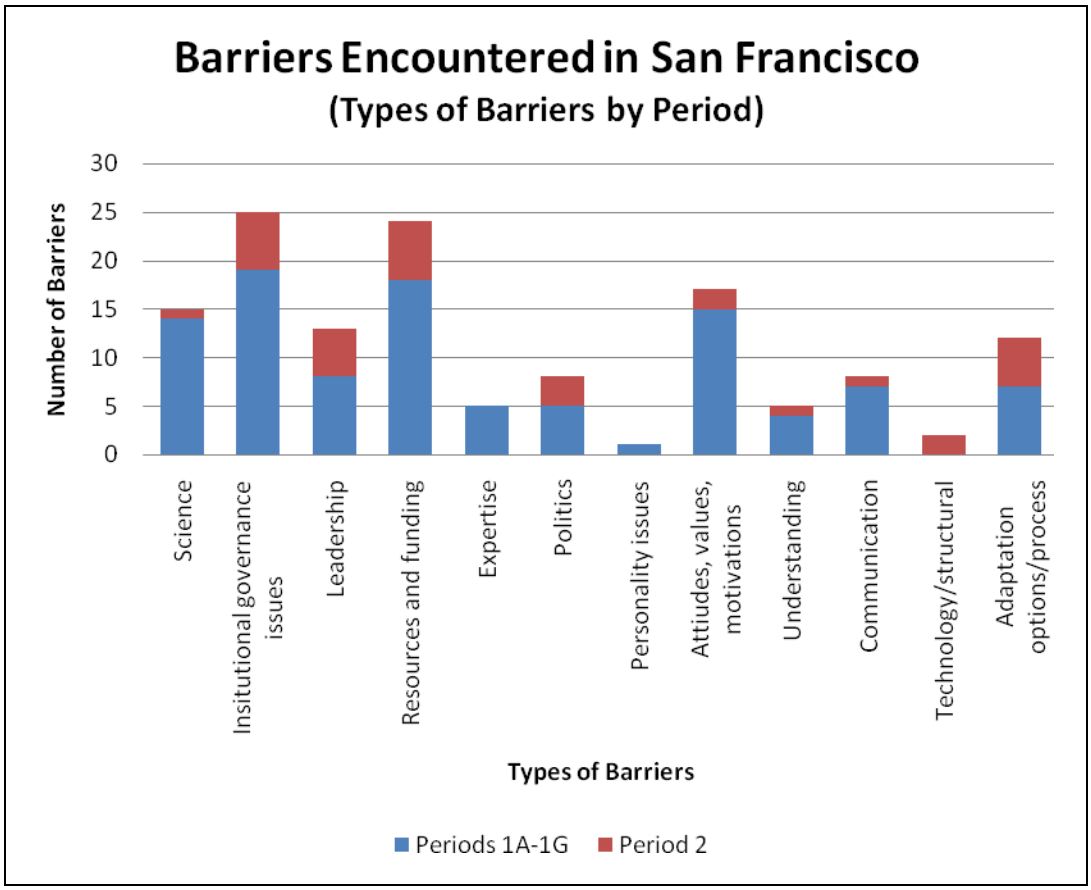


Figure 29: Barriers Encountered in San Francisco's Adaptation Process

Focusing on the barriers encountered in the various departmental efforts under way at present, some remarkable similarities to Marin (which is in a period of similarly separate efforts) emerge. Institutional or governance-related barriers and resource/funding issues dominate, followed closely by attitudinal barriers and scientific ones. Leadership challenges, communication and barriers related to the adaptation process and options also play a role. To recall, San Francisco had several efforts under way where departments are either already implementing some adaptive options, or where the key informants are involved in research efforts of their own at present. Together with the high level of sophistication of staff overall, it is not surprising that scientific barriers feature more strongly than in some of the other cases. Several interviewees reported that in cross-departmental meetings they could not agree on "the numbers" (i.e., which climate change and SLR scenarios to use) in light of scientific uncertainties, and considered that lack of agreement one of the reasons for why they had not yet agreed upon a more integrated citywide adaptation planning effort. A variety of institutional issues (e.g., lack of prioritization, competing tasks, workplans not including adaptation), limited funding, (i.e., limited staff time and resources to devote to adaptation), and turn-over of mayors and department heads also affeted their ability to launch a citywide adaptation effort. Again, it is noteworthy to point to the funding challenges even in a relatively affluent city. The bigger challenges in this regard were encountered among those departments that don't generate their own revenues.

5.2.5 Adaptation Barriers Observed in Santa Clara County

At first glance, Santa Clara County has a rather different barriers profile than the previous three cases. The three periods shown in Figure 30 are all past or current periods, and do not include any anticipated barriers at some future time because none were noted by informants. Period 2 and 3 (integrating various separate departmental efforts) are concurrent.

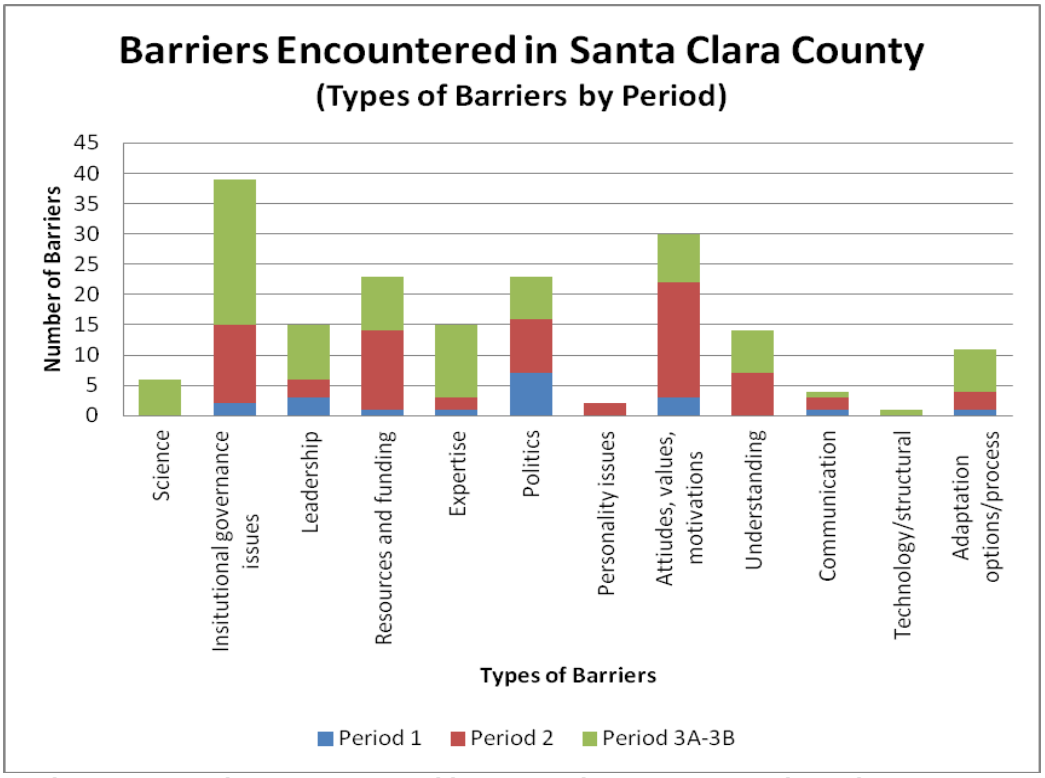


Figure 30: Barriers Encountered in Santa Clara County's Adaptation Process

A first notable observation is that Santa Clara is the case where the least progress has been made to date in terms of concrete adaptation planning and implementation, yet where the greatest number of unique barriers has been recorded. The types of barriers that dominate overall—institutional, attitudinal, financial, and political ones—go a long way toward explaining why this may be so. In fact, there is a stronger importance of politics as a barrier to adaptation than in any of the other cases, and interviewees reported this to be the case in internal dynamics among staff, in terms of the political ambitions of members of the Board of Supervisors, as well as in the relationship between the County and its major city, San Jose.

Period 1 did not encounter many barriers, largely because actors in that period laid only an initial foundation (and yet were already affected by politics) or are involved now in minor implementation efforts not even explicitly under the adaptation label (water conservation in County facilities and operations).

Period 2 is dominated by attitudinal/motivational and by funding and institutional barriers. This is a period where the County is reorienting its climate change efforts under a sustainability

and resilience frame, and just beginning to think about adaptation. Several interviewees saw the current time as one of getting internally organized, while waiting for the regional adaptation effort to get under way and provide clear guidance to the County.

The relatively few disparate efforts under way in Period 3 reflect similar institutional barriers as were encountered in the other cases among departments, but also the challenges in the Water District with its attempts to mainstream climate change into its ongoing operations and strategic planning efforts. It is also largely in that sub-period where scientific barriers emerged.

5.2.6 Adaptation Barriers Observed in the Regional Process

Finally, in the regional case a pattern emerges that features the same dominant types of barriers as in the local cases, but more distinctly so. Figure 31 shows a summary, where Periods 1-4 are past or current efforts and Period 5 reflect anticipated barriers that may arise in some future institutional arrangement through which regional adaptation planning and implementation may occur.

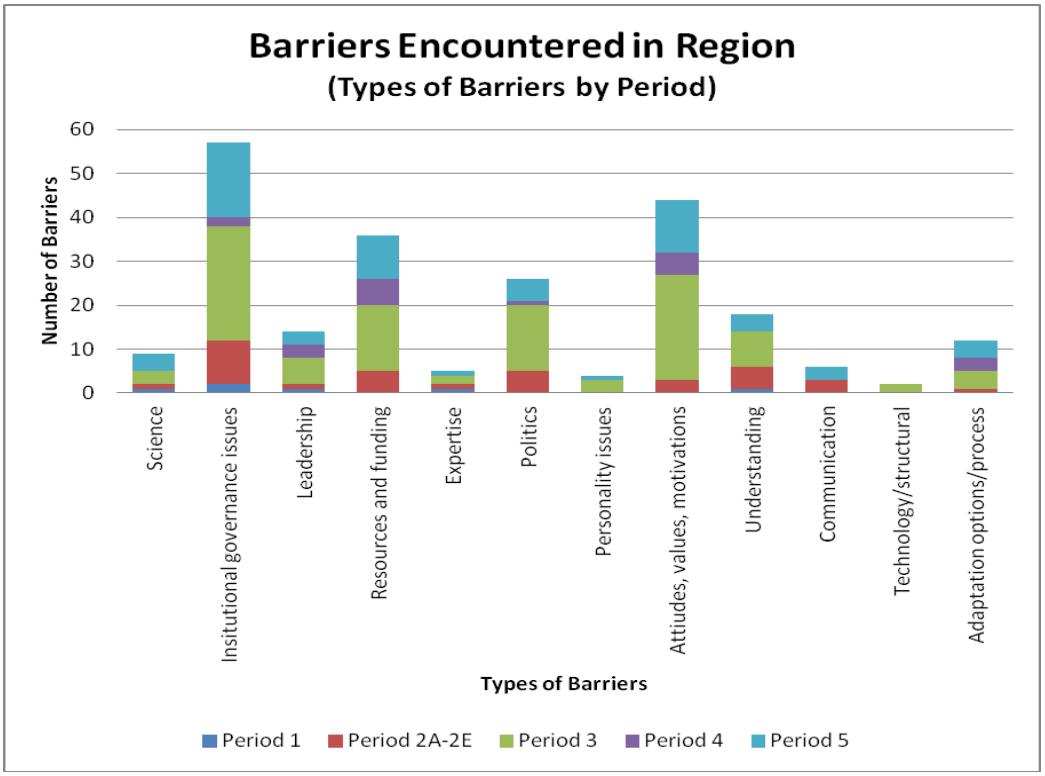


Figure 31: Barriers Encountered in the Regional Adaptation Process

The clearly dominant barriers in the regional case are institutional in nature—not surprisingly maybe since there is no overarching institutional structure through which any regional governance could occur, much less one focused on climate change and adaptation. Thus, creating such an arrangement is indeed an integral part of adaptation for the Bay Area. Seeking to develop such an arrangement and what its mission would be is clearly reflected in the predominance of institutional barriers in Period 3 (which is the time when BCDC joined JPC and adaptation came onto the policy agenda, forcing the participating regional agencies to grapple with their roles vis-à-vis adaptation). It is little surprise that attitudinal barriers are not only of second greatest importance for the region, but also particularly dominate during that same time. The resource issues relate particularly to the question how to fund a joint regional effort, which is intimately interwoven with the building of a regional governance structure. Finally, the fourth most important set of barriers are political ones, reflecting both internal dynamics among the four regional agencies, as well as the tension between local and regional authorities, and the question of who would have which powers over future adaptation decisions.

Compared to these four sets of barriers, all others seem to be significantly less frequent, maybe with the exception of lack of understanding. This latter set of barriers could reflect the fact that three out of the four agencies involved in JPC came to the issue of adaptation only relatively recently and are still involved in discerning what it is all about. It could also reflect (when viewed together with the small number of expertise and science-related barriers) that to date, the process has largely focused on defining a focus and mission for the regional agencies, rather than already developing specific plans and measures whose implementation would require more scientific information.

Finally, it is noteworthy that BCDC's efforts (sub-periods combined under Period 2, the red bars in Figure 31) have faced comparatively few unique barriers, and those that the agency has encountered are predominately related to institutional, political and funding matters. This may be reflective of the fact that efforts initiated by and within BCDC occur in a single, rather "flat" (nonhierarchical) agency, also by the fact that its jurisdiction is rather small, and that the strong internal leadership and commitment have enabled significant progress. The political and institutional barriers encountered particularly in the process of passing its most recent Bay Plan Amendment—while few in number—have in fact been challenging to overcome as the agency has attempted to change the rules by which it makes its permitting decisions.

5.2.7 Comparison with Barriers Encountered in Other Coastal Communities in California

To put the findings from each of the case studies in perspective, relevant results of the survey conducted in fall 2011 are offered here. Figure 32 shows the results to a question that asked respondents to judge how big of a hurdle a number of issues have been in their experience with adaptation to date (whether or not they had already begun or were already more deeply involved in the adaptation process). The results shown here include only the responses offered

by local (municipal or county) coastal professionals to allow for the most appropriate comparison with the results from the case studies.[23]

The overwhelming barriers in survey respondents' view are in the category classified in the case studies as "resource and funding" issues: lack of funding (from any source) for adaptation plan implementation, insufficient staff resources (which partly reflects funding constraints), all-demanding other issues that demand attention instead, and lack of funding (from any source) for developing an adaptation plan in the first place. Only three institutional or governance issues were asked in the survey, thus not touching on many of the issues that emerged as critical obstacles in the case studies. Those institutional issues that were asked about in the survey (lack of coordination, lack of a mandate to address climate change impacts, and legal pressure to maintain the status quo), were judged to be of medium to lower priority, at least in the sense of being a big hurdle. Had more items been included in the survey, it is possible they would have featured higher overall, similar to their importance in the case studies. Motivational issues, such as lack of social acceptability, issue is overwhelming, internal disagreements about importance or lack of public demand played a mid-level role, also somewhat lower than overall in the four case studies. On the other hand, the judgments about science as a hurdle are similarly low in the survey as in the case studies. Survey respondents bemoaned the lack of technical assistance, however, which may point to a lack of expertise or knowledge of relevant scientific assessments (a significant portion of the survey dealt with information needs and technical assistance needs, and those questions revealed significant interest and need for more scientific information).[24]

Finally, lack of leadership from agency leaders or elected officials played only a medium-level importance in the experience of survey respondents—which is quite similar to that assessment of interviewees in the case studies.

[23] Local coastal professionals represented 14 coastal counties and 45 different coastal cities and towns. Some of these locations were represented by more than one respondent. All respondents were asked to indicate on each of the options provided whether the issue presented a big, small or no hurdle.
[24] Details of those results will be discussed in a separate report.

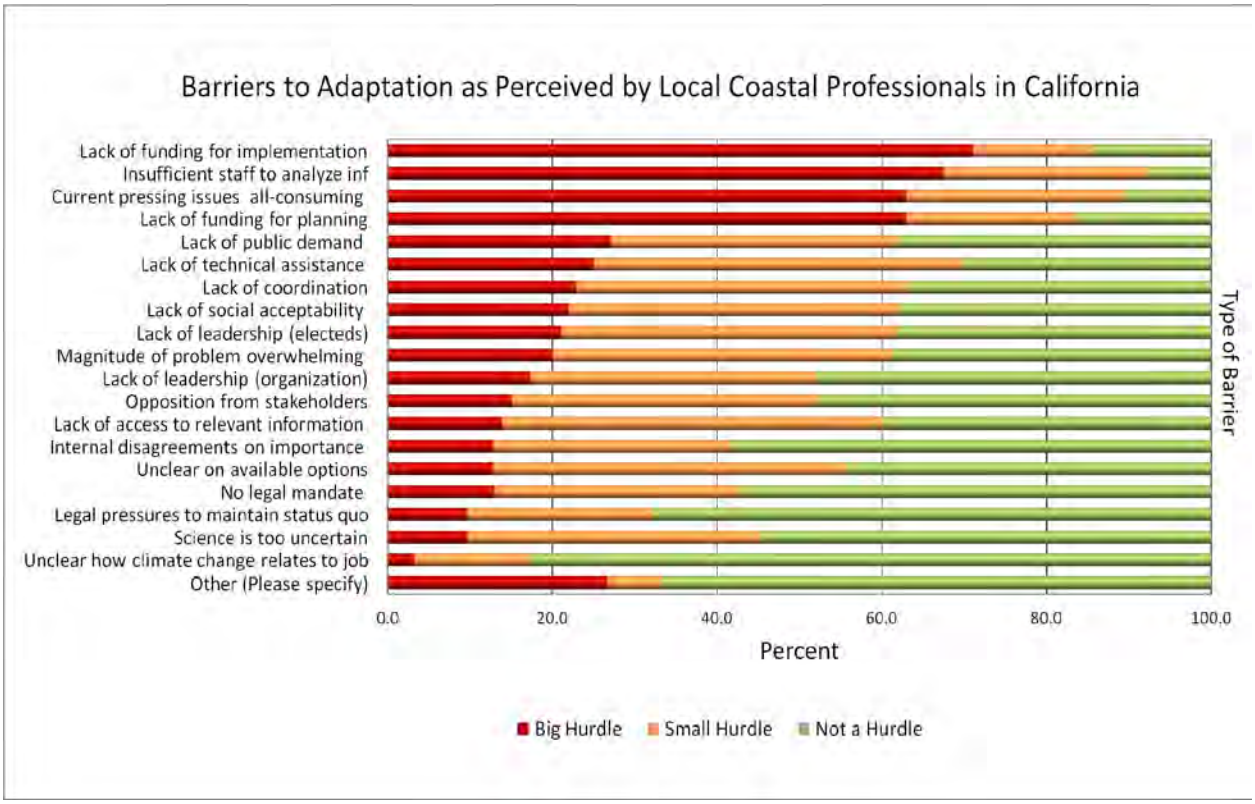


Figure 32: Barriers to Adaptation as Perceived by Local Coastal Professionals in California

The comparability of survey and interview-based results is limited in two ways. First, interviews could go in much greater depth than the survey and thus may have unearthed barriers that were simply not touched upon in the broader survey. Second, the range of options presented to survey respondents did not cover the same breadth of barriers as emerged inductively from the interviews. This is largely the result of the timing of the two independently developed studies, and the approach taken: a survey is necessarily deductive, in that it offers respondents a set of options to which they react, whereas the classification of barriers from the interviews was inductively derived. Despite these limitations, it is remarkable how similar the results are, thus giving confidence in the importance of these barriers statewide.

The economic and resource obstacles and the lack of time to obtain and analyze relevant information certainly go a long way toward explaining why a preponderance of local governments in coastal California are only in the very early stages of learning about the problem and beginning to develop an adaptation plan, and why implementation of agreed upon actions is hardly begun. If staff are too busy to even learn about what the threats and their vulnerabilities are, and how urgent it may be to begin climate change adaptation, and if communities do not have the resources to both develop a plan or implement one, it may be an inappropriate generalization to think of communities in wealthy countries such as the United States as being well positioned and able to prepare, much less being prepared, for the impacts of climate change.

5.3 Adaptation Barriers by Phase in the Process

Many of the barriers reported in this study matched up with the phases within the adaptation cycle (i.e., understanding, planning, and managing), while others spanned multiple phases and/or stages (distinct times within each of these three phases). To the extent the barriers align with phases and stages in characteristic ways, this sort of break down could prove helpful as a way to give actors a "heads up" as they proceed through the adaptation process. Importantly, interviewees sometimes explicitly and sometimes implicitly associated certain barriers with the stages in the stylized decision-making cycle. In classifying barriers by stage, the context of the interview had to be taken into account when interviewees did not make this link explicit.

The prevalence of barriers per stage varied, with some managers facing more barriers in certain stages than in others. Given the particular timeline of activities in each case (i.e., the sequence of distinct periods and what happened in each), barriers were also more prevalent in those stages that were passed through repeatedly. Thus, as an overall observation for the five cases examined here, the greatest number of barriers occurred in the first two Understanding stages (Problem Detection -U1, Initial Information Gathering-U2), the first and—to a lesser extent—the second Planning stages (Development of options-P1 and Assessment of options-P2), and the first managing stage (Implementation of selected option-M1) (

Figure 1Figure 33; see also

Figure 1 above to recall the stages of the stylized decision-making cycle). This finding is consistent with the observations made in previous sections that the dominant activities to date in the five cases include understanding the issue (climate risks and vulnerabilities), and exploring and assessing adaptation responses, with still relatively little actual implementation activity on the ground. The relatively large number of barriers in the M1 stage thus reflects primarily *anticipated* barriers. The fact that the latter stages of the Managing phase (Monitoring-M2, Evaluation-M3) are hardly represented to date in this study further substantiates the early nature of the adaptation process. These patterns overall and in each case are discussed below.

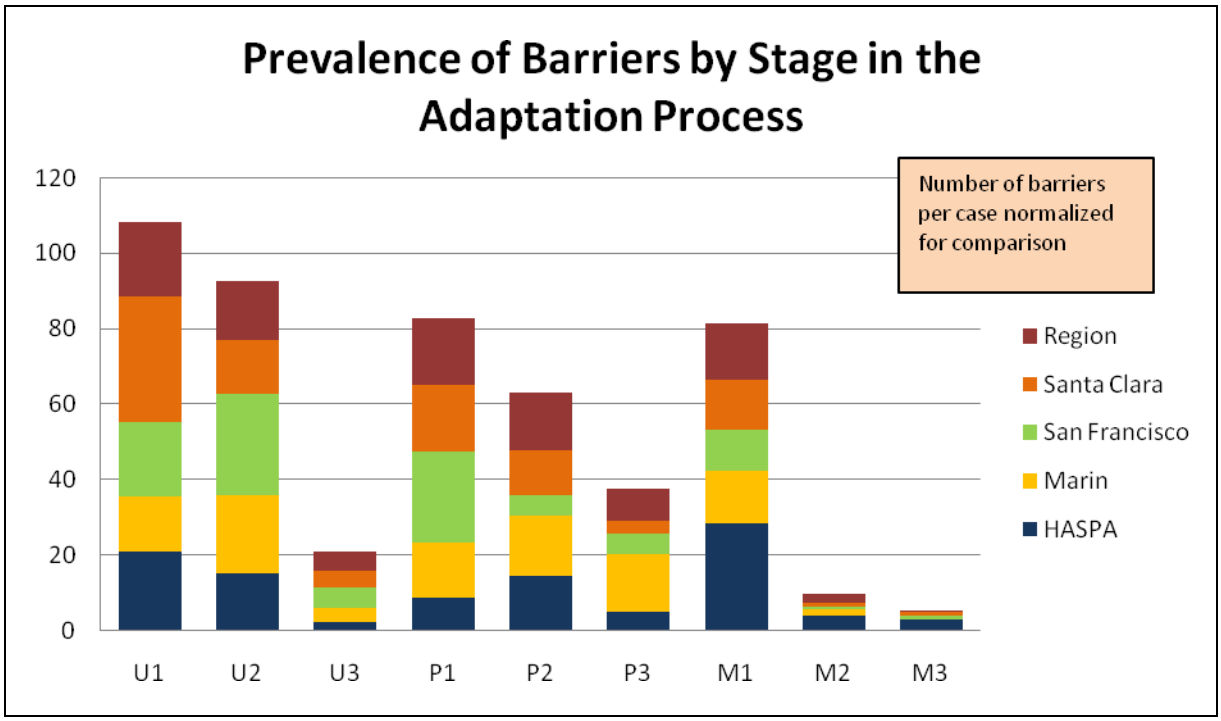


Figure 33: Prevalence of Barriers by Stage in the Adaptation Process

5.3.1 Adaptation Barriers in the Understanding Phase

Given that several of the communities are still or repeatedly in the various sub-periods of the Understanding phase, it is not surprising that most of the barriers are found here. For the specific stages of U1 and U2, there were a few dominant types of barriers that arose across cases.

Problem Detection(U1): In this stage a broader range of barriers dominate, including

- Insufficient interest in, concern about, or understanding of the problem (urgency of climate change not realized, SLR is viewed as a slow problem with impacts at least a generation away, no clear indication of local changes, etc.)
- Overwhelming other priorities are preventing people from taking notice, learning about, and focusing on climate change (more pressing current problems)
- People are unable to make the connection to this global problem
- Lack of knowledge on how to start (problem viewed as too big, viewing climate change as a new and different issue)
- Lack of obvious solutions stops people from even starting to explore adaptation options (no good solutions story; problems without solutions don't attract political attention etc.)
- Lack of mandate or guidance from within departments or from the region (wait-and-see attitude) to begin dealing with it

- Leadership hasn't brought adaptation to the fore, or made it a priority yet (directive to focus on more immediate priorities; assumption that someone else will provide leadership and give marching orders).

Initial Information Gathering(U2): In this stage, science and knowledge barriers and those factors that would support the production and expert use of science clearly(and logically) dominate:

- Lack of (relevant, accessible, understandable) science (getting data at higher resolution, different model projections, etc.)
- Lack of adequate staff expertise on climate change and vulnerability assessments
- Lack of funding (for doing initial threat or vulnerability assessments)
- Local or regional agencies don't keep data records that would be useful to do vulnerability assessments

(Re)Definition/Reframing of Problem (U3): In this stage little consistency was found because the stage was often difficult to tease out from the other stages within the phase (i.e., a reframing of the problem was not always apparent or explicitly stated). If anything, the reframing that occurred through the work in U2 often helped overcome barriers (e.g., making the issue more salient for key staff or elected leaders). Those barriers that repeatedly occurred in this stage often had to do with the following:

- Inability to communicate risks to staff, elected officials or the public (e.g., lack of vision, lack of long-term perspective, not connecting to near-term priorities or interests)
- Inability to message the story in an appealing or politically salient way (e.g., avoidance of politically hot topic, fear of push back)
- Lack of critical mass or enough common interest to proceed (lack of coordination among different players)
- Sense of powerlessness (adaptation as defeat; climate change too big of a problem, someone else will find a solution)

5.3.2 Adaptation Barriers in the Planning Phase

The barriers in the Planning stage are predominantly institutional, attitudinal, and financial in nature, though differences among the different stages exist. Some interviewees—particularly those who served as leaders in their particular locations or departments—arrived in this phase having overcome at least an initial set of barriers in the Understanding phase. Others found themselves in a planning process, and either became aware or were made aware of climate change and the need for adaptation. Thus, the question of whether or not climate change is worth bothering with was less of a barrier than whether or not there was good enough information to proceed, or how best to go about preparing for the expected impacts. Dominant types of barriers in this phase are listed below by stage.

Development of Options (P1): To initiate an adaptation planning process, key informants in this study reflected the challenges of really "getting into" adaptation planning. The dominant barriers reoccurring across the cases included the following:

- Lack of a process for adaptation planning (is it new or different than other types of planning processes?; lack of governance structure through which to initiate or formalize an adaptation planning process; being first; don't know what to do or how to do it)
- Lack of mandate or requirement to do adaptation planning
- Lack of funding to undertake an adaptation planning process (not in work plan, not in budget, no outside funding)
- Lack of technical expertise or guidance
- Institutional fragmentation
- Lack of communication and/or coordination among institutions, agencies (fragmentation, lack of clarity on responsibility, leadership, turf issues, lack of agreement over options and goals of options)
- Lack of vision and/or openness (assumptions about politics, public acceptability of solutions, short-term perspective limiting the range of initially considered options, status quo mentality)

Assessment of Options (P2): Assessing adaptation options—to the extent this has occurred to date at any depth at all—is affected by similar constraints as the U2 stage (see above), in that available resources, knowledge and expertise, and data or scientific understanding play a large role in how deep or extensive such an options assessment can be. Observed or anticipated obstacles in this stage mentioned repeatedly include the following:

- Lack of funds for detailed assessments (incl. environmental impact assessments [EIAs])
- Lack of coordination among departments, agencies, institutions (incl. lack of integrative or systems perspective; institutional fragmentation, stove-piping)
- Lack of knowledge and expertise among staff
- Lack of data and science
- Lack of leadership (e.g., no lead agency, no guidance or directive or mandate to undertake assessment; short-term perspective that prevents effective integration of climate change)
- Lack of time or staff (competing priorities, capacity constraints)
- Options perceived as unpleasant, negative, politically too hot or publically unacceptable

Selection of Options (P3): Finally, fewer barriers overall have been encountered in this stage, in part because few actual decisions have been made to date. The common barriers encountered or anticipated, however, include the following:

- Limited or lack of options (dislike of feasible options; cost of options; negative side effects of options, narrow range of options, limitation on innovation, etc.)
- Politics and the political process (e.g., property rights issues; political ambition of decision-makers, fear of legal repercussions, resistance to collaboration, people's values, narrow interests)
- Public or stakeholder opposition to choices (e.g., campaign against policy change)
- Lack of or limited actual jurisdiction over option
- Lack of governance structure through which to make and implement decision

5.3.3 Adaptation Barriers in the Managing Phase

The majority of barriers encountered in the Managing phase feature in its first stage—the implementation process (M1). In and of itself, implementation is a complex, multi-tiered process involving a variety of actors and governance entities. Many of the barriers here are also ones that are anticipated rather than actively encountered already. But some clear patterns emerge.

Implementing option(s) (M1): There is a clear pattern of barriers in the first Management phase, with dominant barriers falling into the funding and institutional barriers, and several other types of barriers of secondary importance:

- Lack of funding to implement option (competition for funds with other jurisdictions, other priorities, overall budget cuts, economic crisis, lack of revenues; different revenue sources and funding structures)
- Legal barriers (current law preventing implementation of option, lengthy process of obtaining permits, bureaucracy, lack of state or federal mandate, etc.)
- Lack or fragmentation of governance structure (lack of regional policy or guidance, lack of decision-making structure that cuts across jurisdictions, resistance to regional approach, lack of coordination across agencies, divisions, jurisdictions; different missions)
- Resistance from affected parties (property rights issues, general resistance to regulation, power issues, greed, home rule etc.)
- Lack of political will and commitment (glasshouse syndrome, etc.)

Monitoring option, outcomes and environment (M2): Fewer barriers were mentioned in this stage, largely because there are already very limited (or even declining) resources spent on monitoring and few adaptation options have been implemented to track their impact and effectiveness. Of those that were mentioned, they appear to be similar to the challenges affecting monitoring at present:

- Lack of leadership (no lead agency to implement, coordinate monitoring)
- Lack of funds (locally, from state or federal government; competition for limited available funds; state budget crisis)
- Lack of attention to certain issues (e.g., lack of saltwater intrusion monitoring)
- Lack of guidance and different requirements (overlapping requirements, data not published, establishing monitoring stations, maintaining them, keeping transmission frequencies open, evaluating the data)
- Scientific uncertainties (not sure what to monitor; SLR projections)

Evaluating (M3): Finally, very little is usually done, and has been done to date specifically in evaluating the effectiveness of an implemented adaptation options. Thus, very little can be said here, other than about predominately anticipated barriers, including:

- Financial concerns (need to show reasonable/positive return on investment)
- Attitudes (people don't want to know about failure, negative impacts; personal or political interest getting hurt)

- Scientific uncertainty (if reality turns out different than projections, risk of misspending of public funds)

How these patterns played out in each of the case studies and in California coastal communities more generally is summarized in the next section.

5.3.4 Barriers by Stage in the Adaptation Process in each of the Case Studies

Next to these overarching summary findings, the cases differed quite markedly in their predominance of the numbers of barriers per stage and in the specifics of the barriers, even though the general types of barriers (as discussed in sections 5.3.1–5.3.3) were quite similar. The five cases are briefly discussed below.

HASPA:

Understanding – In the Hayward/HASPA case, not detecting the signal (from science) and not overcoming the threshold of concern (not seeing impacts that would raise alarm) were important barriers at first, making it difficult for the leaders to garner support for initiating an adaptation process. Limited funding for doing an initial and more detailed assessment, access to high-resolution data, and poor understanding of the climate change challenge among some players also were issues in the multiple rounds that actors there cycled through the Understanding phase. This phase overall dominates in the number of barriers encountered in this case.

Planning – In the planning phase, lack of funds for a more detailed assessment, the need to bring different players on board and overcoming their respective attitudes and mentalities played an important role here (incl. lack of a big vision, lack of agreement on options, mentality to stick with the status quo and known options), very much strengthened by a difficult economic situation.

Managing – Funding for doing environmental impact statements and implementing any of the potential options, as well as overcoming the permitting and regulatory hurdles clearly dominate this phase, although most of the barriers here are anticipated, rather than already encountered ones. Due to the regional or at least cross-jurisdictional nature of the most desirable option, identification of a leader and lead agency (for funding and administrative purposes) would be challenging. For adequate funding, federal agencies (particularly the Corps of Engineers) would need to get involved, but both regulatory and bureaucratic hurdles were anticipated in doing so. Figure 34 summarizes the prevalence of barriers per stage for the HASPA case.

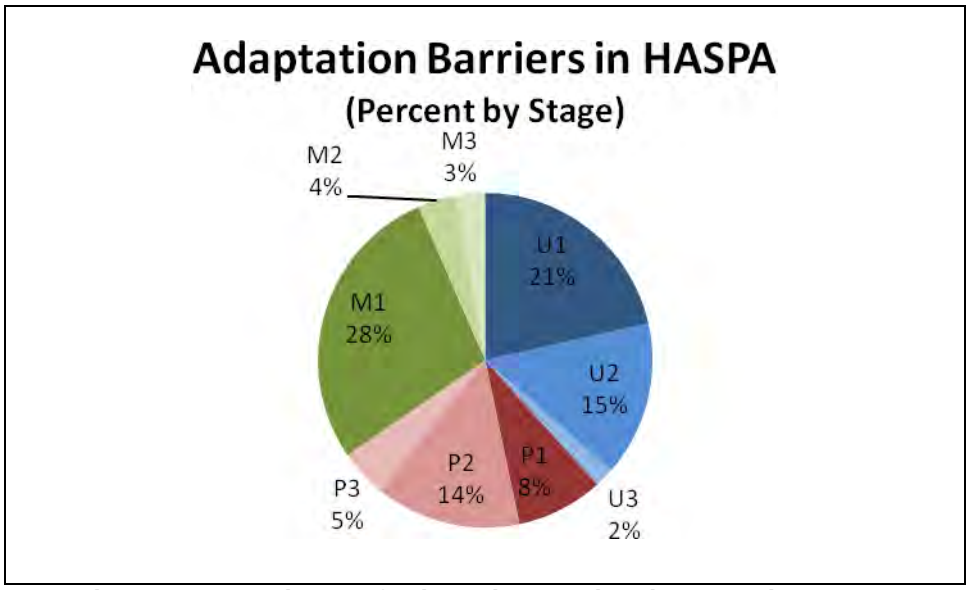


Figure 34: Prevalence of Adaptation Barriers by Stage in HASPA

Marin County:

Understanding – In Marin County, a variety of Understanding-phase barriers were encountered over the course of multiple sub-periods, including challenges with scientific data and climate change projections (resolution, availability, not good enough to do anything about it, inconsistent projections from models, high uncertainty, research not being salient, etc.). Lack of concern, need for higher-level guidance, limited resources (time), fragmented, uncoordinated efforts, and various attitudinal barriers also played a role there.

Planning – The adaptation planning stages saw the greatest number of barriers in Marin, quite evenly distributed over the initial option brain storm, in-depth analysis, and the selection. Some of these barriers arose during the initial countywide plan update, but most of them during the more dispersed process of developing concrete strategies in individual departments in more recent times. Common barriers in the Planning phase included institutional fragmentation, limits of jurisdiction, challenging city-county relationships, preexisting land use conflicts, lack of state or federal mandates or guidance, lack of funding, opposition from outside parties and or fear of creating or encountering opposition, mentality to remain with status quo, limited methods for assessment of options and lack of agreement on options.

Managing – Finally, in the Managing phase, the fewest barriers arose, partly because implementation and subsequent stages have barely begun. Staff turn-over, lack of funds, fragmented county governance, lack of political will, attitudinal barriers and short attention spans, as well as distrust of regional adaptation activities, and public opposition all play a role here. Figure 35 summarizes the prevalence of adaptation barriers per stage for Marin County.

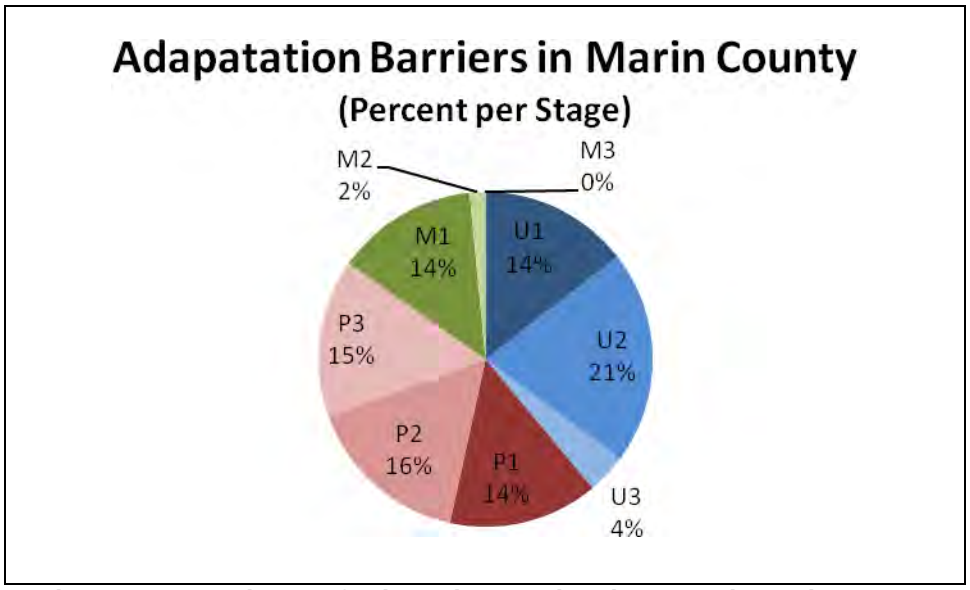


Figure 35: Prevalence of Adaptation Barriers by Stage in Marin County

San Francisco:

Understanding – San Francisco is one of two cases in which the Understanding phase clearly dominates in the prevalence of barriers. Interestingly enough, in this case, it is directly related to the high scientific literacy and sophistication of the key players (and informants interviewed for this study). In other words, because of a high level of understanding of climate science, uncertainties in the science, lack of (access to) data or limited resolution of data, and disagreements about which models and scenarios to use for an impacts and vulnerability assessment came to the fore. In a large city governance structure with multiple largely independently functioning units and each with their own concerns and funding structure, it is difficult in San Francisco to agree on a unifying focus or concern. Significant heterogeneity in the degree of concern was also found. Other barriers that played a role here included leadership turn-over and lack of prioritization of adaptation by leaders, lack of guidance, precedence of other priorities, including climate change mitigation, and—consequently—not placing adaptation in work plans, job descriptions, and budgets. Those decisions resulted in lack of funds and staff time for focusing on impacts or vulnerability or for supporting a citywide adaptation process.

Planning – The Planning phase in San Francisco is affected and dominated by virtually the same set of dominant barriers—lack of leadership at the highest level with individual department or agency leads disagreeing on a joint path forward; lack of funding resources for a citywide planning process; competing priorities leaving little time to focus on adaptation; lack of a framework or guidance for adaptation planning; and finding an institutional home for the adaptation process.

Managing – Finally, in the Managing phase, a number of strategies are being implemented largely away from the lime light of public attention or even under the adaptation label. The

biggest challenges arising in this process include public resistance to certain options, lack of funding for (and anticipated cost of) implementing large-scale structural adaptation options (including just even keeping up with ongoing maintenance of infrastructure), and legal barriers or institutional challenges to realize some options. Figure 36 summarizes the prevalence of adaptation barriers per stage for San Francisco.

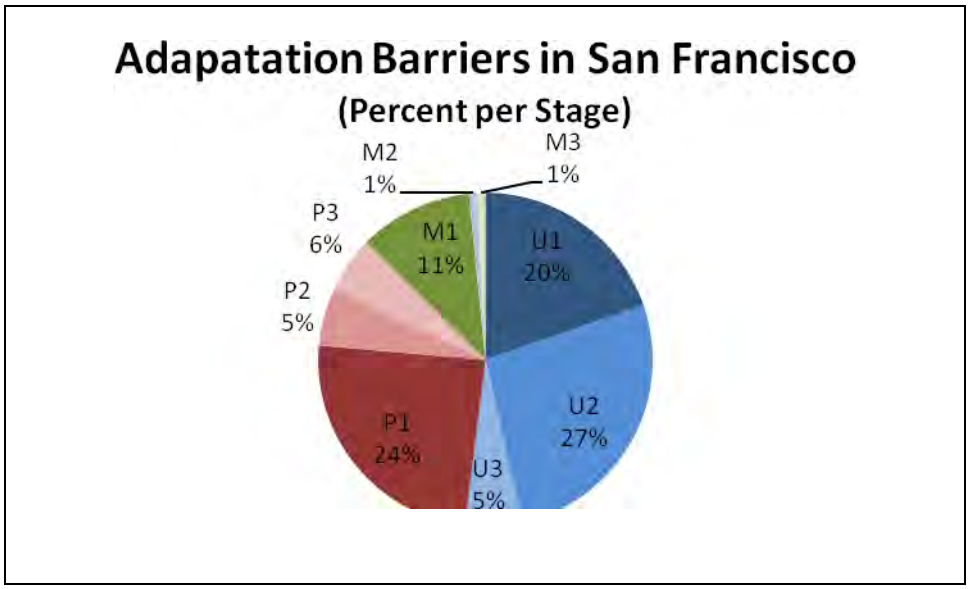


Figure 36: Prevalence of Adaptation Barriers by Stage in San Francisco

Santa Clara County:

Understanding – Santa Clara is the other case in which the Understanding phase dominates, albeit for different reasons than in San Francisco. Here, lack of leadership on adaptation at the highest levels, leadership turn-over at the staff level, and personality issues have contributed to a waxing and waning focus on adaptation. Furthermore, turfism, more immediate and all-consuming priorities, lack of concern about climate change as impacts are expected far in the future, and an assumption that the County should wait for regional or higher-level guidance have all contributed to relatively limited or shallow exploration of the threats and vulnerabilities. The overarching funding constraints affecting all of the cases (state budget crisis, general economic downturn), also play an important role in setting priorities and limiting staff capacity to delve into climate change.

Planning – During the planning phase, particularly the Water District has run into barriers with scientific uncertainty: challenges related to climate change science (especially precipitation), makes integration of climate change in ongoing planning processes difficult. Otherwise insufficient financial resources (and consequently lack of prioritization of adaptation and lack of staff time) dominate this phase in Santa Clara. Fragmentation of county government resulting in people working by themselves rather than together on a joint countywide adaptation plan was

also mentioned repeatedly. Communication channels both among departments and between staff and elected officials also play a role here.

Managing – Among the dominant barriers in Santa Clara in the Managing phase were those related to the relationships between the County and other local jurisdictions (in particular the largest city in the County, San Jose), and other smaller cities. The resistance of local governments to share authority or their opposition to being regulated and told what to do leads to opposition and stalemate. Institutional fragmentation within County government and disconnects between planning and implementation (practice) also stalls implementation. In addition, lack of prioritizing adaptation politically, i.e., lack of political, also will hinders actual implementation. Many anticipate the cost of adaptation options to be major hurdles. Figure 37 summarizes the prevalence of adaptation barriers per stage for Santa Clara County.

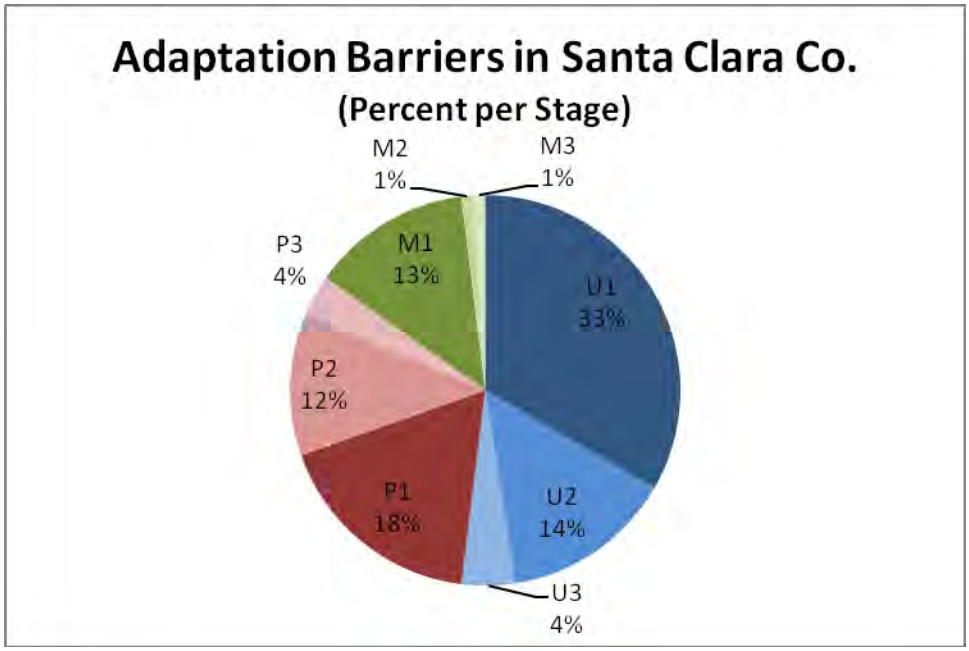


Figure 37: Prevalence of Adaptation Barriers by Stage in Santa Clara County

Region:

Understanding – Barriers in the Understanding phase are quite different for BCDC compared to the other regional agencies. Leaders and staff at the coastal agency have long been aware of and engaged with climate change, whereas the other regional agencies have not had an adaptation focus until recently—largely due to their very different focus and mission, including policy goals and legal mandates. This has resulted in adaptation rising on their radars later than for BCDC. Capacity limits, time pressures, and competing priorities have affected everyone's ability to take up or consider closely the issue of climate change adaptation. To the extent regional agencies had a direct mandate to help with mitigation, adaptation was also perceived as a competing concern.

Planning – The challenges in the Planning phase for the region are quite different when considering what BCDC could do on its own, versus what barriers are being encountered for the regional agencies as they are trying to figure out how to work together and develop a regional adaptation strategy. Within BCDC, being quite stove-piped historically, facing staff-related capacity limits, and not being very strategic (but rather opportunistic) in its approach were among the dominant hurdles. Among the four regional agencies and in the larger context of regional governance, adaptation planning is hindered by their very different missions and goals, funding structure and access to resources, lack of a joint focus or concern, lack of higher-level guidance or mandate, and a common governance structure through which it could take place. Moreover, all agencies spoke of capacity limits.

Managing – In the absence of a functional comprehensive regional governance system that could address adaptation challenges for the Bay area, and that has decision-making powers, it is not surprising that the Managing phase is marked predominantly by institutional and governance-related barriers. For BCDC alone, the issue is the spatially very limited jurisdiction; for JPC the issue is lack of power, and for the other regional agencies it is their sectoral limitation. Coordination, communication, trust, differences in mission and goals, and leadership issues all play a role. The tension between local and regional decision-making power, particularly over land use, also looms large. Figure 38 summarizes the prevalence of adaptation barriers per stage in the regional case.

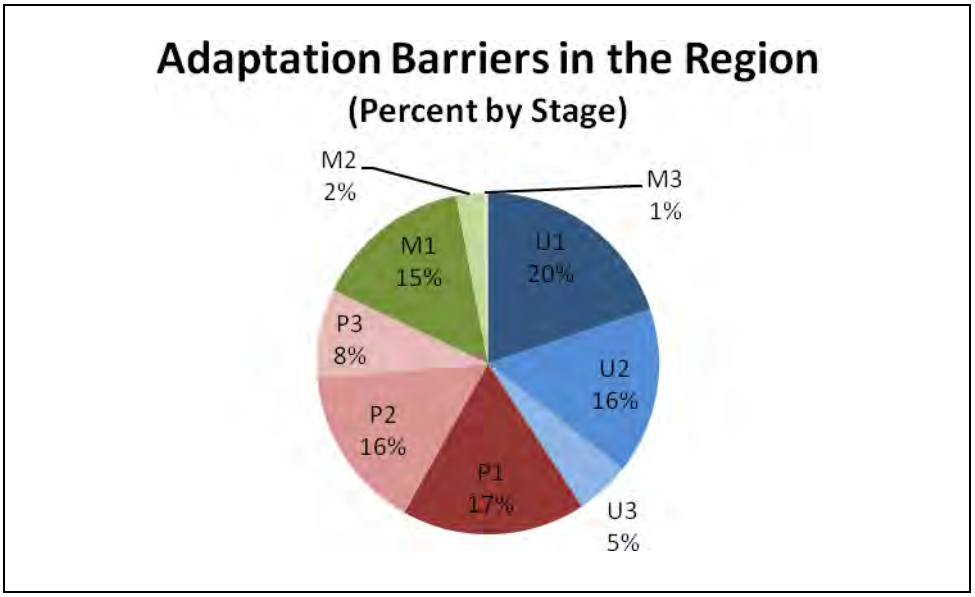


Figure 38: Prevalence of Adaptation Barriers by Stage in the Regional Process

In summary, the brief synopses of barriers by stage in the adaptation decision process revealed that San Francisco and Santa Clara are most similar in terms of the prevalence of barriers in the three basic phases, whereas Marin County and the region are most similar in their pattern. HASPA stands out somewhat as the case where the frequency of barriers is most evenly distributed across the three phases, although many of the Managing-related barriers are

anticipated, rather than already experienced ones. This may suggest, in fact, how much those actors are already thinking through the process ahead.

In the statewide survey undertaken in parallel to this set of case studies, 40 percent of respondents identified themselves as being in the Understanding phase, and 75 percent of those found themselves in the "Initial information gathering" stage. To the extent that the city and county cases investigated here are comparable with the statewide sample, it can be assumed that lack of science, lack of adequate staff expertise on climate change and vulnerability assessments, lack of funding and lack of adequate data gathering and keeping are among the key challenges for 30 percent (0.4 * 0.75 = 0.3) of California's coastal communities.

Similarly, of the 41 percent of local survey respondents who identified themselves as being in the Planning phase, 55 percent responded that they had just initiated planning (P1). Thus, common barriers for the roughly 23 percent (0.41 * 0.55 = 0.23) of coastal towns, cities and counties in this stage can be expected to include lack of knowhow about the adaptation planning process, lack of a mandate or requirement to do adaptation planning, lack of funding to undertake an adaptation planning process, lack of technical expertise or guidance; Institutional fragmentation; lack of communication and/or coordination among institutions and agencies ; and potentially a lack of vision and/or openness to undertaking a comprehensive and far-reaching adaptation process.

Finally, just 15 percent of local government respondents in the survey said that they were in the Managing phase, and 95 percent of those had just begun implementing one or more adaptation strategies (M1). Dominant barriers for those 14 percent of local governments (0.15 * 0.95 = 0.14) thus may well include lack of funding to implement options, legal barriers, lack or fragmentation of governance structure, resistance from affected parties and lack of political will and commitment. In the next section, the analysis of types of barriers by period (Section 5.2) and that of barriers by stage in the decision-making cycle (5.3) is extended by a closer look at the sources of the barriers.

5.4 Sources of Barriers: Actors, Governance and Systems of Concern

In Section 1, it was explained how three fundamental structural elements contribute to a barrier occurring. Those structural elements or sources included (1) the actors involved in the adaptation process, (2) the larger context in which they act (particularly, the governance system and socio-economic conditions), and (3) the object upon which they act (here called the system of concern, which is the system that is exposed to climate change impacts and needs to be managed)(see Figure 2 above).

To understand the significance of these structural elements in this study, an attempt was made to identify them in the case studies, either from the direct information an interviewee supplied, or by indirect deduction from the context of what (s)he was talking about. In some cases, categorization was easy, for example when a permit could not be obtained (marked as governance/context). Or when the informant expressed a certain attitude toward climate change (e.g., something that won't happen until 100 years from now), the source of this barrier was marked as "actor."By contrast, when key informants spoke of not having adequate scientific

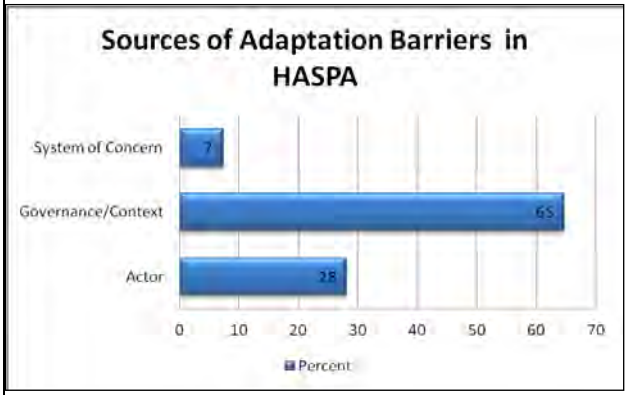
information because lack of monitoring did not allow them to understand groundwater dynamics, the source was considered as stemming from the "system of concern."

Other cases were more challenging, such as when the informant was concerned about a given climate change impact, but the decision to make the issue a funded priority for the department was decided at a higher level, such as with the Board of Supervisors. This was considered a "governance/ context" barrier, but if the barrier were viewed from the Board of Supervisor's perspective, the source of the barrier could be categorized as that of an "actor."To avoid this ambiguity, a decision was made to categorize the barrier always from the perspective of the informant.

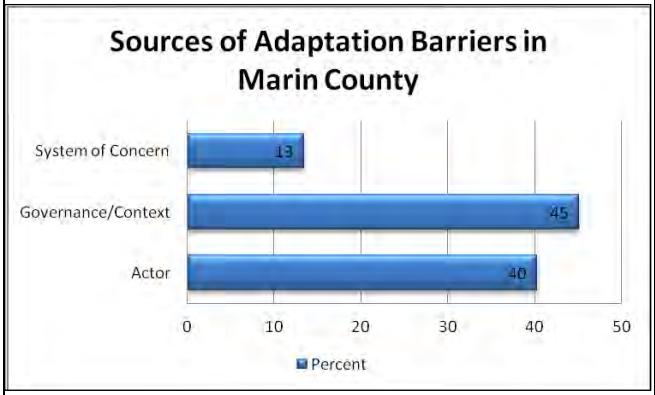
To enable comparison across cases, while recognizing the uneven number of barriers identified in each case, the sources of barriers were normalized (i.e., expressed as percent). Results are shown in a series of simple figures—one per case—below.

One overarching finding from this categorization is that the dominant source of observed and anticipated barriers was "governance and context" whereas the "system of concern" was the source of the fewest barriers. This observation holds true for each individual case (see Figure 39, A-E, below) and overall (55 percent). This gives both confidence to the finding, and is not entirely surprising. Structures and context strongly constrain (and enable) individual actors' decisions and activities. This finding is supported by the strong overall importance of institutional, resource and process-related barriers (Section 5.3). The relative unimportance of barriers stemming from the systems of concern (9 percent overall) may reflect a number of situational facts: given the relatively early state of climate change impacts materializing in the mid-latitudes, the systems to be managed are not so different yet from those which managers have dealt with for their entire careers (and their predecessors before them). This means, they understand the present systems sufficiently well to manage them at present. Moreover, adaptation is relatively new for most managers, and thus the level of understanding still relatively superficial. A clear exception is the case of San Francisco, where greater sophistication about the science has surfaced many more 'system' related barriers. Moreover, very few actual adaptive management changes have taken place to date that take uncertain future states of the systems into account. It is noteworthy that few barriers at this time relate to the system of concern, a fact that corresponds to the result of few science and information-related barriers (see Figure 26).Thus, the many unknowns about the systems to be managed—while the central focus of much research—are simply not yet fully known or present to those who are just beginning to think about possible changes and needed shifts in management.

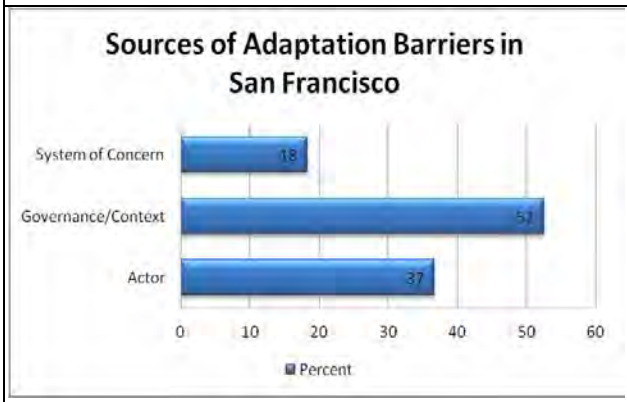
The most variable structural source of adaptation barriers is the "actor" (36 percent overall, ranging from 28 percent to 40 percent in individual cases). Relatively speaking then, the actors in each case make the biggest difference. This observation corresponds with an earlier finding of the surprisingly large importance of actor-related barriers such as attitudes and motivations, leadership, expertise, understanding, communication, and personality issues (Section 5.3).



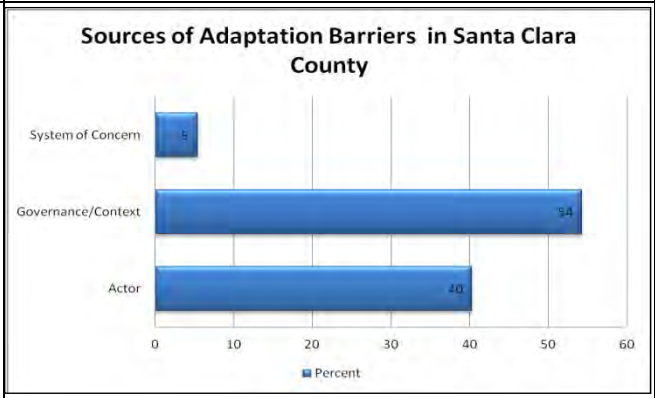
A: Source of Adaptation Barriers in HASPA



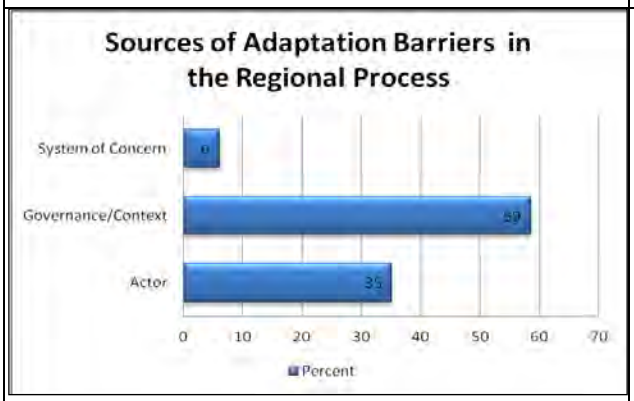
B: Source of Adaptation Barriers in Marin Co.



C: Source of Adaptation Barriers in San Francisco



D: Source of Adaptation Barriers in Santa Clara Co.



E: Source of Adaptation Barriers in the Region

Figure 39: Sources of Adaptation Barriers in the Five Case Studies (A-E)

5.5 Origins of Barriers

In the introduction (Section 1.2) a third component of the diagnostic framework was brought in that aimed to locate the origin of the barrier. This simple matrix is meant to help map the genesis of the barrier relative to an actor current position and influence (see **Error! Reference source not found.** above). The two axes of this matrix locate the origin of these barriers—and thus the locus of control over them—along a temporal and a spatial/jurisdictional axis, thus offering a first indication as to where to intervene in a system if one wanted to overcome a certain barrier.

Similar to the classification of the sources of barriers (actors, context/governance and system of concern), it was not always easily apparent how to locate the origin of a barrier. Both the explicit explanations by interviewees and the implicit context of the interviews were used to arrive at the classification for each case. The key issue was to locate the origin of the barrier relative to the actor (i.e., from the actor's perspective), as he or she experienced or saw it as such. In some instances, the origin is in the past but continues to the present, and thus both categories were marked down (e.g., current funding challenges can stem from decisions made previously, or are a continuation of previous challenges such as a multi-year economic recession). Similarly, a barrier occasionally could not be pinned down to a remote or proximate source (e.g., when the interview context left unclear whether funding failed to come from local funds or state and federal sources). In such instances, too, both categories were marked (about 80 percent of all barriers could be categorized uniquely as falling into just one of the four categories, with the remainder spanning more than one). Several overarching findings can be observed, before highlighting specifics about each case.

5.5.1 Overarching Findings on the Origin of Adaptation Barriers

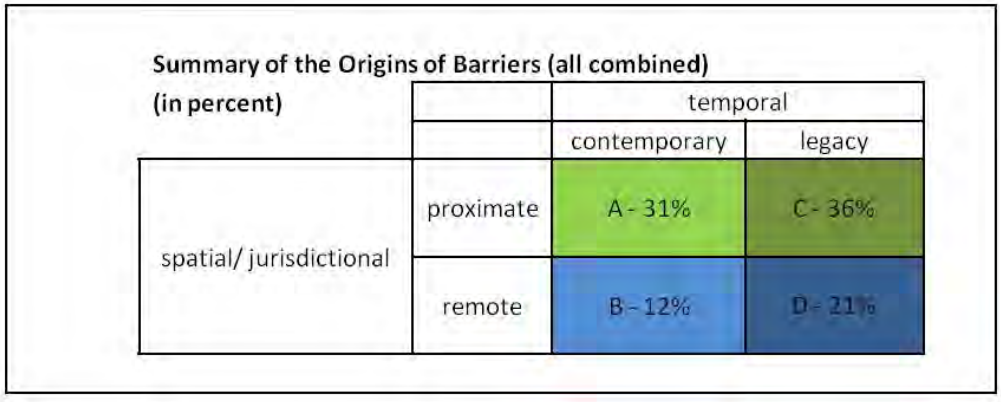


Figure 40 provides a study-wide summary, i.e., combining the results for all cases. The first pattern that emerges from this summative view is that the majority of barriers (67 percent) are local in origin (i.e., at or near the actor's point of influence), whereas the smaller portion (33 percent) stems from remote origins. This can be viewed (at first glance) as good news in that a barrier originating from local sources can more easily be influenced by local actors than ones that are created remotely. A second overarching pattern is that legacy barriers (i.e., those that stem from decisions made in the past) are more common (57 percent) than contemporary

barriers (i.e., those that are created and/or can be influenced at this point in time) (43 percent). This may indicate just how influential and persistent those past decisions were and how difficult they are to change. When viewed in combination with the fact that the overwhelming majority of barriers identified in this study are institutional and attitudinal in nature, this result does not surprise, but in fact is confirmatory. Most institutions were built previously and thus constrain actors now as they attempt to adapt to climate change. Similarly, attitudinal barriers, rooted as they are in longstanding worldviews, beliefs, and values of individuals, tend to affect individuals not just sporadically but quite consistently over time, and many are not easily changeable.

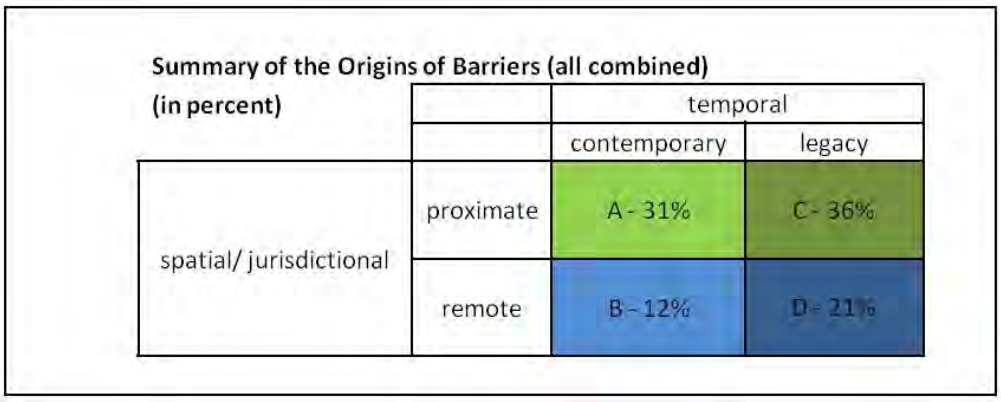


Figure 40: Summary of the Origins of Barriers (all cases combined)

A finer look at the matrix and the underlying data reveals that the plurality of barriers are proximate/legacy barriers (36 percent) and stem primarily from issues related to the actors, such as attitudes, expertise, staffing levels and capacity, and the context and local governance system, including political dynamics or decisions, local institutional set-ups, institutional fragmentation and so forth. Thus, even though a change could be made locally by relevant actors, both institutional and attitudinal issues can be very difficult to change among local actors alone. It is here where some degree of intervention from non-local actors can be helpful to help shift the local politics or personal and interpersonal dynamics; alternatively very strong local leadership may be needed to overcome this type of barrier.

The proximate/contemporary barriers (with 31 percent a close second) are theoretically the barriers that can be affected most easily by actors locally now. A closer look at the underlying data reveals that they relate primarily to the actors (such as level of understanding of climate change or adaptation, and communication issues) and the governance/context (e.g., prioritization of adaptation or not; not knowing how to do adaptation planning or having a clear process for it yet). These barriers appear to be most amenable to being addressed through such things like trainings, information sharing, funding support, and help to frame the issue in locally salient ways.

By contrast, remote/contemporary barriers (12 percent) relate frequently to the surrounding political climate, current funding allocations, missed opportunities (such as lack of coordination or cooperation) with others, and turn-over in leadership of relevant players. While they can be

changed now, they are not directly under the actor's control. Thus, intervention by a higher level of governance through mandates and funding or strong leadership can help. But it is also in this context where political maneuvering by actors (i.e., leaders-in-action, not necessarily from positions of authority) can help foster a political climate or knowledge environment that can lead those in positions of power to take action.

Finally, remote/legacy barriers (21 percent) are those barriers that are most difficult to access in the "here and now" by an actor, as the locus of control is elsewhere and the origin of the barrier in the past. The three dominant types of such barriers include institutional ones such as the existing or missing governance structure and laws; economic and funding issues (such as the global economic crisis or state budget cuts); and attitudinal issues (relating to such things as the public's attitude, awareness and understanding of climate change, or longstanding personality conflicts). Intervention in this case is remedial and compensatory by local actors: those who can and those who take it upon themselves "make lemonade" from the lemons they have been given. In the following sections, brief summaries are provided for each of the five cases.

5.5.2 Origins of Adaptation Barriers in HASPA

The HASPA/Hayward case is one of two cases (the other one being Marin County) that diverts slightly from the overall patterns described above (Figure 41). While the proximate barriers here dominate just as they do generally in all five cases, the contemporary ones (40 percent) are almost twice as significant as the legacy barriers (22 percent). A closer look reveals that the barriers are predominantly related to the governance systems and context (including lack of funds stemming from the broader economic situation, current and prior funding allocation decisions related to agency mandates, missions and work plans), lack of governance structure that can bring all relevant actors together to implement a desired future, legal/permitting hurdles, and so on) and to the actors (e.g., lack of concern, lack of understanding or expertise, lack of community awareness and buy-in, and "status quo" mentalities).

Proximate/legacy barriers (22 percent) stem overwhelmingly from the context and governance, such as the current economic crisis that affects staff capacity and available resources to conduct a vulnerability assessment (or to implement adaptation options), competing priorities due to previously established policies and work plans, and public and staff attitudes toward and understanding of climate change. Remote/contemporary barriers in HASPA (16 percent) have had mostly to do with lack of regional leadership and guidance, competition among individuals for the leadership role, lack of political will and uncertainties about funding from outside sources. Finally, the remote/legacy barriers (22 percent) that play or have played a role in this case include institutional barriers such as fragmentation and lack of coordination or communication across levels of government (local to state and federal agencies), existing laws and regulations, slow-moving federal bureaucracy, lack of locally relevant science, etc. Some of these legal issues are anticipated ones; however, they stem from the constraints that existing laws place on the ability to implement an innovative structural solution to Hayward's shoreline problem.

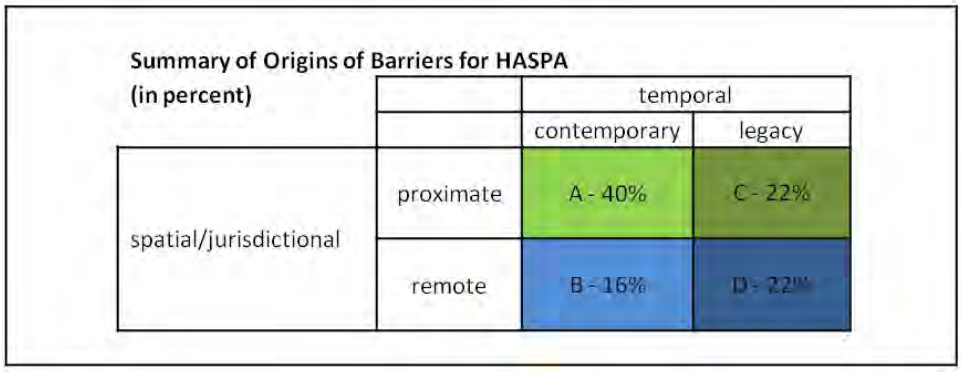


Figure 41: Origins of Adaptation Barriers for HASPA

5.5.3 Origins of Adaptation Barriers in San Francisco

In San Francisco, the local pattern of barrier origins is consistent with that described for the study as a whole, and is similar to that in Santa Clara County (described below) (Figure 42).

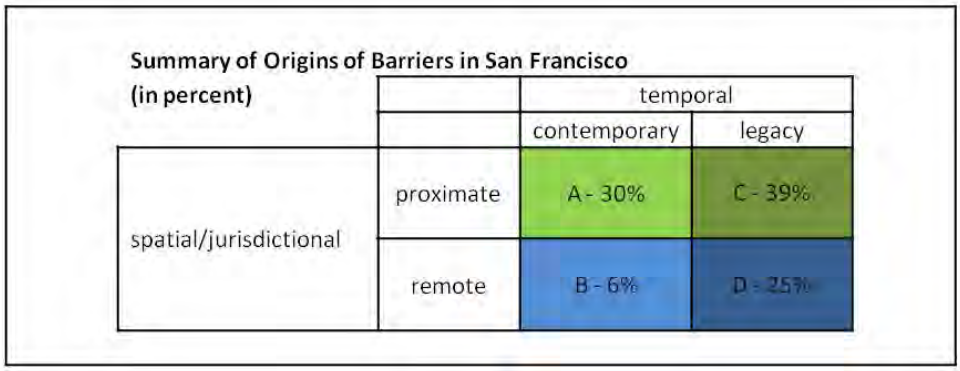


Figure 42: Origins of Adaptation Barriers for San Francisco

The greatest number of barriers in San Francisco is of the proximate/legacy variety (39 percent) —with issues such as lack of communication, fragmented governance with independent, uncoordinated efforts, lack of high-level leadership, lack of funding, personality issues, and limited staff capacity next to all other duties and priorities dominating the situation. Many of the same issues play a role "here and now", i.e., with the contemporary/proximate barriers (30 percent). What was frequently mentioned here in addition to those just mentioned is the question of how or where to start, i.e., questions about the process, and identifying and placing a lead agency.

The smallest category of barriers, with just 6 percent, is made up of remote/contemporary barriers, including the extremely high cost and difficulty of implementing some of the major structural adaptation options, or issues related to the local population not yet fully grasping what climate change may mean to their city.

Unique among all case studies, the remote/legacy barriers (25 percent) are dominated by scientific ones, reflecting—as discussed previously, the sophisticated understanding of climate change science. Economic and budget-related barriers as well as lack of federal leadership and state or regional guidance that could provide a framework for adaptation have also been mentioned here.

5.5.4 Origins of Adaptation Barriers in Marin County

Marin County is similar to the HASPA case in its pattern of barrier origins. As such it deviates from the overall pattern described in Section 5.5.1 (

Figure 43). In Marin, the proximate barriers dominate—and more strongly so than they do overall—but the contemporary ones (41 percent) are more significant than the legacy barriers (35 percent). A closer look at the underlying data shows that those "home-grown" barriers are primarily related to lack of prioritization of climate change adaptation, thus lack of funding, and limited staff capacity, lack of understanding of the challenges ahead, including skepticism, and lack of political will or leadership on adaptation among staff and elected officials.

The proximate/legacy barriers are almost as important in this county (35 percent) and include fragmented county government, staff turnover and loss of leaders in the past, lack of collaboration and coordination, some litigation-related delays, and generalized funding challenges.

Interestingly, a minority of barriers stem from remote sources in this case. Those related to current or contemporary issues (5 percent) include a history of lack of coordination both in governance and among scientists doing studies in Marin County. Those stemming from remote sources (19 percent) concern the often challenging relationship between counties and municipalities, turf issues among agencies, lack of cross-scale coordination between local, state and federal agencies, standards and rules not being flexible enough to account for changing conditions as are expected with climate change, and lack of locally relevant science.

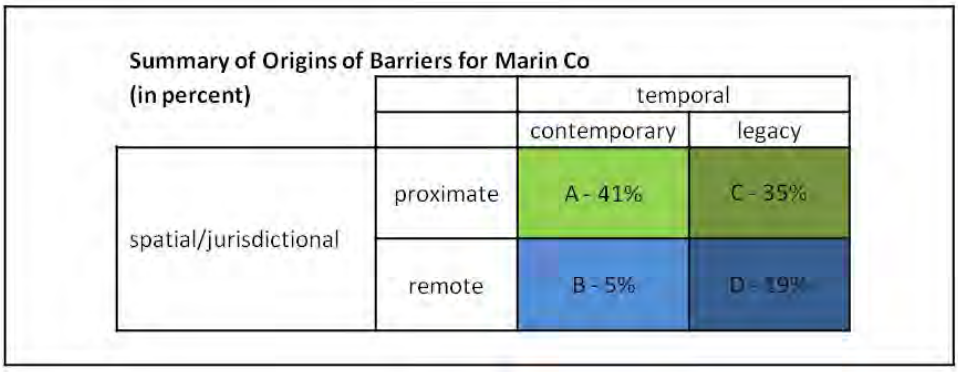


Figure 43: Origins of Adaptation Barriers for Marin County

5.5.5 Origins of Adaptation Barriers in Santa Clara County

Santa Clara County displays an interesting hybrid pattern of barrier origins (Figure 44). Like in Marin, the proximate barriers dominate strongly (in fact, more strongly than in all the other cases), but unlike there, and resembling more the situation in San Francisco, the legacy barriers (49 percent) are far more significant than the contemporary ones (29 percent).

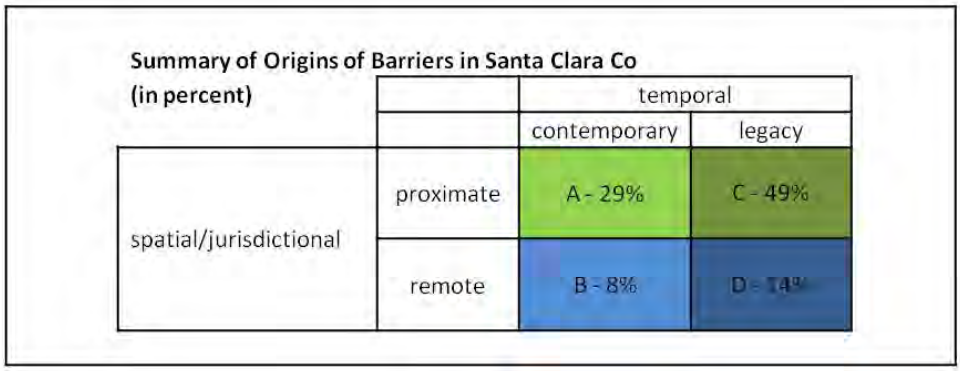


Figure 44: Origins of Adaptation Barriers for Santa Clara County

Examining the data more closely reveals that these dominant proximate/legacy barriers stem from constrained interaction between staff and elected officials, lack of leadership at the highest levels, resulting in adaptation not being prioritized (and under-funded), lack of expertise among staff and Board of Supervisors about these issues, political ambitions of elected leaders that focuses them on other priorities, fragmented county government, limited or challenging relationships between the county and its cities, and lack of communication among departments.

The proximate/contemporary barriers bring out these same challenges even more strongly, particularly lack of understanding and expertise, lack of staff capacity, and competing priorities. In addition, a repeated barrier here is to not want to be a local leader and instead wait for regional leadership.

Contemporary/remote barriers (8 percent) in Santa Clara are overwhelmingly related to the general lack of public awareness, understanding, sometimes skepticism, and lack of demand for adaptation action. Finally, the remote/legacy barriers (14 percent) here frequently relate to the challenged relationship between cities and the County (i.e., resistance to relinquishing authority or control), lack of adequate scientific information that could readily be integrated into long-term planning, and—unique in this study—the political climate in the county. Santa Clara, with its political, demographic and economic centers of San Jose and Silicon Valley, was variably described as "politically hot" and "full of big egos," seemingly implying that some local leaders seemed to be more interested in politically safer bets and "win-win" issues rather than the more messy management of climate change impacts.

5.5.6 Origins of Adaptation Barriers in the Regional Process

Finally, in the regional process, a somewhat unique pattern of barrier origins emerged. While proximate barriers still made up the majority of barriers (55 percent) compared to the remote

ones (45 percent), the proportion of barriers in each of the four quadrants is much more even than in the other cases (Figure 45).

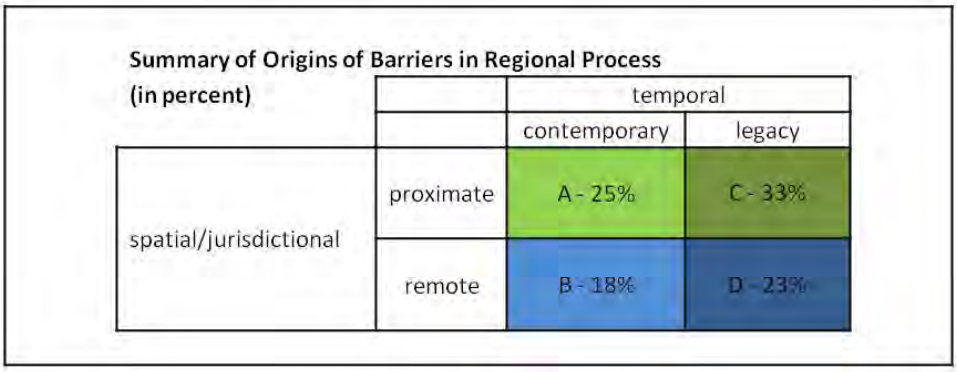


Figure 45: Origins of Adaptation Barriers for the Region

A closer look at the strongest category, the proximate/legacy barriers (33 percent), indicates that it is dominated by institutional matters, in particular the limited authority or jurisdiction of BCDC, the different missions and goals of the different regional agencies, different funding structure and financial capacity, limited staff capacity in virtually all agencies, including the JPC, and lack of long-term perspective or bigger vision among key players.

The proximate/contemporary category of barriers (25 percent) is dominated—in the case of BCDC's efforts—by both governance and communication issues related to the Bay Plan Amendment. With regard to the barriers affecting the joint efforts of the regional agencies, funding and staff capacity limits, competing priorities, lack of vision and both a long-term and regionalist perspective among some of the players, limited attention spans (described by one interviewee as the "two-second consciousness"), distraction and overwhelm were mentioned repeatedly.

Contemporary/remote barriers (18 percent) stem primarily from issues such as public misunderstanding and/or stakeholder resistance to BCDC's policy change, lack of concern about climate change and its impacts on the region (including in some instances denial or skepticism), myopic views, and strong capacity limits that resulted from budget cuts, the economic downturn, and hiring freezes. Climate change adaptation portrayed or perceived as a "doomsday conversation" or defeat was also mentioned as affecting the adaptation discourse in the region.

Finally, the remote/legacy barriers (23 percent) were somewhat unique in this case, as they frequently related to the lack of a regional governance structure (incl. failed past attempts at building such structures). But the familiar canon of lack of state or federal mandate, the constraints resulting from existing laws and regulations, and the state of the science for regional application also featured significantly here.

5.6 Aids and Advantages that Help Avoid Barriers

After four sections exclusively focused on barriers to adaptation, it is important not to lose sight of the many assets—human, institutional, economic, and natural—that counterbalance the challenges that hinder or delay progress in adaptation planning. As argued repeatedly throughout this paper, institutions and physical structures can help or hinder human actions—they structure, guide, enable, and constrain ongoing activities. One might say they create "path dependencies" constraining and guiding the current course of actions. In fact, it is the generalized purpose of institutions to streamline, facilitate, and make human decisions and actions more predictable. At the same time, actors are not "victims" of institutions in the sense that they cannot rise above them and change them. Therein lies the possibility for innovation, the hope for renewal, and the reason for social and political processes that ultimately change and establish new institutions.

In this section then, the focus turns to those assets, aids, and advantages that either helped avoid encountering certain adaptation barriers in the first place or that facilitated overcoming them. The subsequent, and final section of Section 5, will focus on the conscious strategies actors in each of the case studies employed to overcome those barriers that emerged in their process.

To begin, it is important to mention that there was no intention at first to examine aids and advantages in this study, as they were not originally included in the framework to diagnose barriers. The interviews revealed repeatedly, however, some remarkable qualities of individuals, circumstantial factors that aided in making progress and the supportive efforts of others elsewhere that helped advance efforts locally. This section, therefore, is an attempt to capture what those supportive factors are. Appendix E.2 shows how these factors were coded and classified to allow for a synthetic perspective and comparison across cases.

Figure 46 offers a graphic summary of the normalized prevalence of aids and advantages for all five cases, with each individual case shown in a different color. Two types of these aids and advantages stand out above all others. This study found that the most important advantage any community could have to advance adaptation is people with certain personal qualities. These qualities included being interested in serving the common (regional) good, rather than being self-interested, being an innovator or early adopter, having a broad, long-term and/or integrative perspective, being a networker, a good collaborator and communicator, being passionate, knowledgeable, experienced, and caring, being strategic, bringing a systems and forward-thinking mind to the issue, and being a visionary, committed and progressive. In the cases examined here, people enacting such skills and qualities appear to be crucial in breaking out of institutional or other constraints.

The second most important aid or advantage across the board was related or relevant plans and policies that facilitated and allowed integration of adaptation and climate change. Among the most frequently mentioned were Local policies, laws, plans and mandates (e.g., policy set in a general plan, climate action plan or a master plan), preceding or concurrent state policies, laws, and mandates (e.g., AB32, SB 375, or the state's adaptation plan), existing Federal policies, laws, and mandates (e.g., ACE 2009 SLR policy; FEMA flood mapping), also the anticipated passage

of laws/policy, and any other laws or policies that could motivate and make room for adaptation discussions.

While related policies and plans featured as very important, this study did not allow answering the question whether having done work on mitigation is a "necessary" condition for doing adaptation or in any way causally connected. Of the nearly 600 US members of *ICLEI—Local Communities for Sustainability*, only a small handful (maybe 40) has begun adaptation planning to date. On the other hand, the CA survey results suggest that writing or updating a climate action plan has been the "hook" for initiating adaptation planning in some communities. This is not always the case, however, suggesting that prior mitigation work is not a necessary condition. As the policy history of climate change suggests, however, mitigation was the first one on the docket, so generally speaking, mitigation is more likely to have been the first climate issue they deal with (Moser 2012). Having said this, all of the case studies included in this paper prize themselves as being rather progressive politically, and thus they all have done work on mitigation or on sustainability more broadly. For them, adaptation has been a logical extension.

People and institutions thus, yet again, make the biggest difference—not only in creating or constituting barriers to adaptation, but also in avoiding and overcoming them. In fact, the dominance of individuals with certain personal qualities, combined with leadership (the third strongest category of aids and advantages), knowledge and expertise, and effective communication all underline the importance of actors in avoiding barriers and making progress on the process.

Adaptation is also buoyed by growing public awareness of, and interest in, climate change and —importantly—the signalizing value of existing vulnerabilities and/or extreme events (e.g., a flooding disaster, a drought) that local leaders either explicitly connect to climate change or make use of in the process of improving resource management, changing land use, or implementing infrastructure upgrades. To the extent governance structures are already in place that can be used for adaptation (especially forums and mechanisms to bring together different agencies, departments or jurisdictions), the process is also supported.

Embedded in several of these aids—such as the improved understanding and growing "buzz" about climate change in the public—is what has come forth from the scientific community (often via effective communication). Thus, while "science and available knowledge" features only as an aid of medium importance in and of itself, as do science and practitioner interactions, climate change science has been important as it emerges in and through these other, related categories.

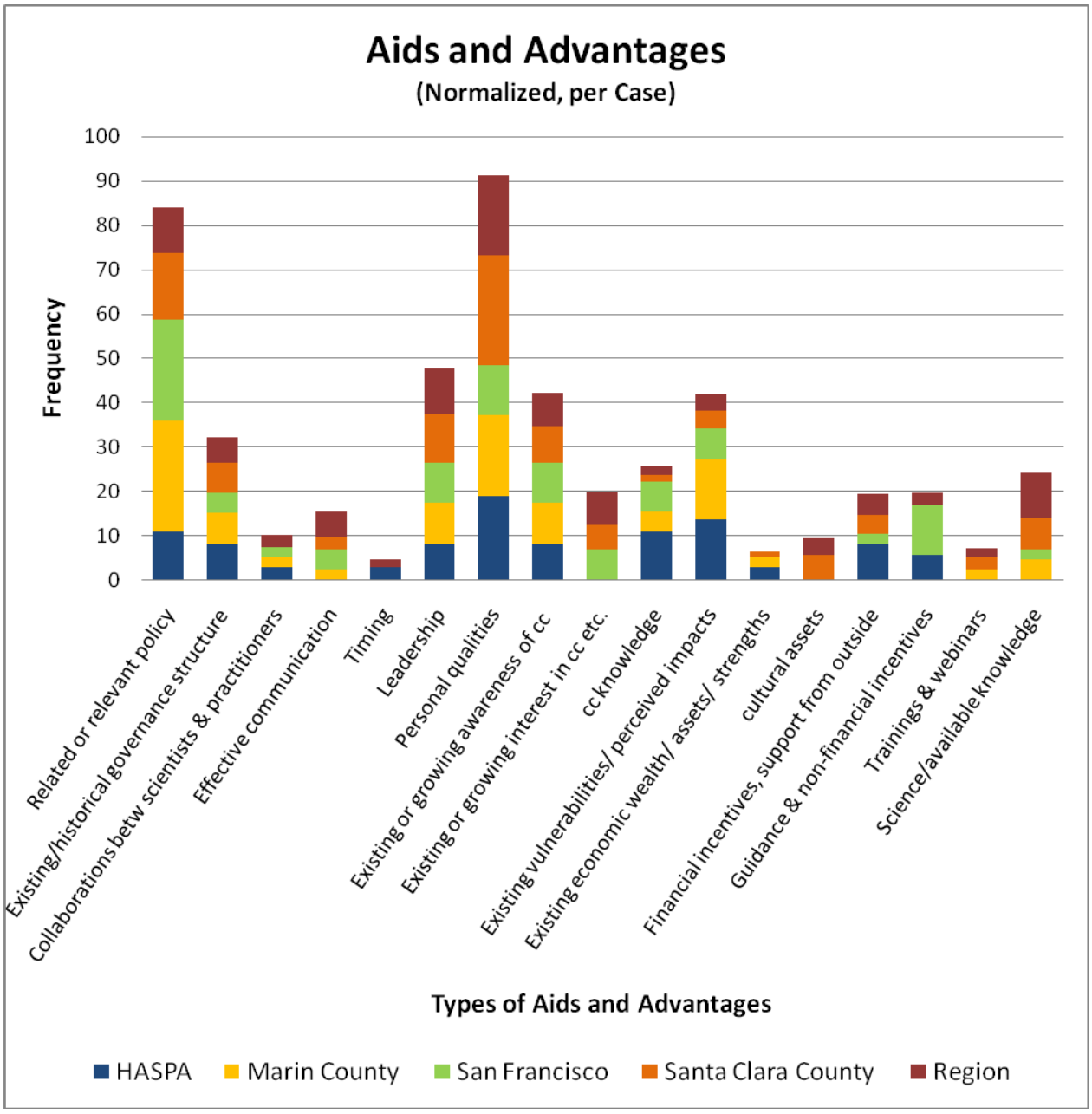


Figure 46: Aids and Advantages that Helped Avoid Barriers

Maybe somewhat surprisingly, economic wealth and assets appear to play only a minor role—at least as explicitly mentioned categories—in supporting adaptation. This seems counter-intuitive at first, given the overwhelming importance that economic assets and wealth are usually given in the context of determining an entity's adaptive capacity. A closer look at the underlying data reveals that wealth was only mentioned a few times in the context of explaining why the overall economic crisis has not hit some of the cases less hard than other, less fortunate communities, or expressing an opinion that California communities would experience less difficulty with adaptation than communities in developing countries. Overall,

this observation of the relative unimportance of economic wealth as an asset is, in fact, consistent with the importance of lack of funding, funding cuts, general economic crisis and resulting cut backs or declines in revenues that form the backdrop to study of adaptation at this time in the United States.

Importantly, one finding that is not apparent in Figure 46, is that most of the aids and advantages—just as was observed with different types of barriers—were often mutually supportive and occurred in clusters, i.e., in a combination of circumstances. For example good or serendipitous timing sometimes occurred together with an extreme event and the process of a general plan update; Cultural assets and personal qualities often go together in the local, regional or organizational context; or good collaboration between scientists and practitioners and a solid base of climate change and adaptation-relevant knowledge.

Table 14 below summarizes these findings again with the normalized values (percentages) of individual aids and advantages delineated per case.

Table 14: Normalized Frequency of Aids and Advantages in the Five Cases

Summary of Aids and Advantages (normalized, per case, in %)*	Related or relevant policy	Existing/historical governance structure	Collaborations betw. scientists & practitioners	Effective communication	Timing	Leadership	Personal qualities	Existing or growing awareness of cc	Existing or growing interest in cc etc.	cc knowledge	Existing vulnerabilities/ perceived impacts	Existing economic wealth/ assets/ strengths	Cultural assets	Financial incentives, support from outside	Guidance & non-financial incentives	Trainings & webinars	Science/available knowledge
HASPA	11	8	3	0	3	8	19	8	0	11	14	3	0	8	5	0	0
Marin Co.	25	7	2	2	0	9	18	9	0	5	14	2	0	0	0	2	5
San Francisco	23	5	2	5	0	9	11	9	7	7	7	0	0	2	11	0	2
Santa Clara Co.	15	7	0	3	0	11	25	8	5	1	4	1	5	4	0	3	7
Region	10	6	3	6	2	10	18	8	8	2	4	0	4	5	3	2	10
Total	84	32	10	15	5	48	91	42	20	25	42	6	9	19	20	7	24
Avg. frequency	17	6	2	3	1	10	18	8	4	5	8	1	2	4	4	1	5

(* The top three aids and advantages per case are highlighted in yellow.)

It is worth mentioning a few similarities and differences among the cases. For example, HASPA and San Francisco informants noted one type of advantage that Marin did not: outside funding. In HASPA, Santa Clara, and the Region, the personal qualities of key individuals were distinct drivers and advantages in those locations, whereas related policies and processes were of foremost help in Marin and San Francisco.

In all four local cases three types of advantages played an important motivational or supportive role: ongoing or concurrent work on climate change mitigation and/or sustainability, available science, and good timing for updating infrastructure or bringing adaptation into the planning processes (e.g., general plan update). In fact, such existing and relevant policies and planning processes, and the momentum they already had, clearly propelled adaptation forward. Finally, perceived existing vulnerabilities or impacts easily linked to climate change (overtopping of levees during flood, water supply shortage, etc.) played a more important role in HASPA and Marin (and to a lesser extent in San Francisco) than in the other two cases. Clearly, this aid or "advantage" is a negative motivator, and while clearly useful in advancing the case for reactive adaptation, it is one that cannot be wished upon communities, and surely one that cannot be fostered or supported through outside intervention.

As alluded to above, many of these aids and advantages can be viewed as indicators of adaptive capacity (or adaptive potential). But economic wealth featured less strongly than is common in discussions of adaptive capacity, while institutional issues featured as strongly as one might expect. On the other hand, the personal qualities of individuals are not typically singled out as a component of adaptive capacity. "Social capital"—a now-accepted element of adaptive capacity—does not adequately reflect these personal qualities of individuals, nor does it adequately capture leadership or the other actor-centric advantages mentioned here. Thus, this study provides much richer insight into, and evidence for, what really initiates and sustains a local adaptation process. While existing collaborations and relationships as well as personal commitment and focus might be more difficult to bolster through outside intervention, they offer an indication as to where to begin: with committed individuals and through collaborative relationships and networks, which can be extended over time. While this finding may be intuitive, this aspect of adaptive capacity is rarely directly fostered or funded compared to planning processes that produce a more tangible output such as a plan or policy on paper.

5.7 Strategies to Overcome Barriers

5.7.1 Overarching Findings on Strategies to Overcome Adaptation Barriers

When faced with a particular set of barriers and equipped with certain aids, assets and advantages, what do actors do to circumvent or overcome their challenges? This question guides this final section of Section 5.

A first and overarching answer to this question—at least at this relatively early stage in the adaptation processes of the four local governments and the regional agencies studied here—is that the strategies employed to overcome or avoid adaptation barriers <u>are</u> the adaptation strategies each is pursuing. Just to name a few examples: where there is no governance structure to support regional adaptation, efforts are under way to build one. Where there is not enough public awareness of climate change risks or buy-in into an adaptation effort, efforts are under way to compile scientific information and/or to conduct a risk assessment to show what is at stake. Where money to conduct a vulnerability assessment is lacking, fundraising or pooling available resources are possible strategies. Where leadership from individuals in positions of power is challenged or lacking, someone steps up to try to influence those in decision-making

positions, or begins to mobilize pressure on those in positions of power. Alternatively, people undertake all sorts of political maneuvers to make initiation of an adaptation process or passage and implementation of a policy more likely.

Importantly, the use of different strategies—even if categorized here into 16 distinct types—is both context- and barrier-specific and thus fine-tuned to the specific situation, including whether it is needed earlier or later in the adaptation process. This will be demonstrated with some examples for each of the cases below.

Figure 47 summarizes for the study as a whole and for each of the case studies (indicated by different colors) what common strategies are being used by the actors interviewed for this study.

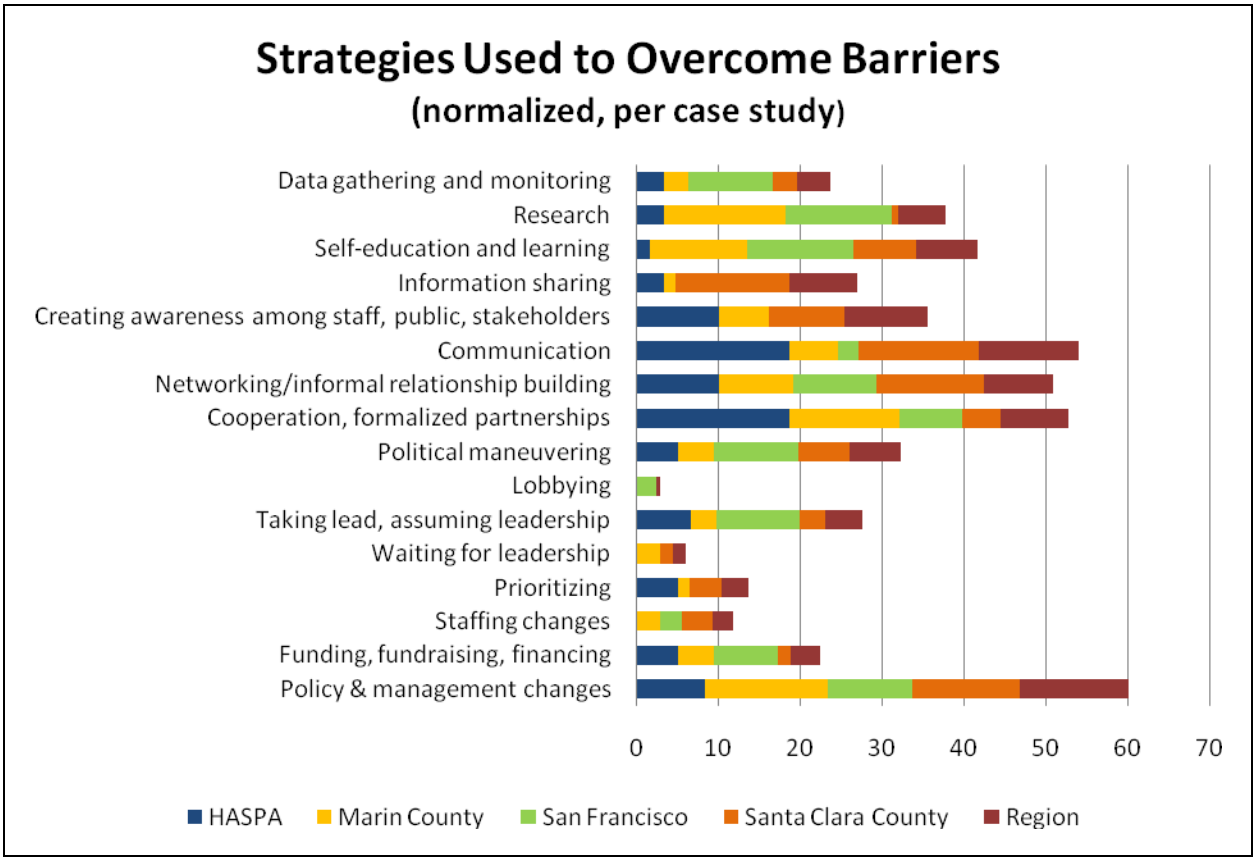


Figure 47: Strategies Used to Overcome Adaptation Barriers

The prevalence of different strategies must be read within the context of, and the knowledge from, Section 4 (i.e., the summary and detailed descriptions of the adaptation processes). Differently put, to understand what, for example, "policy and management changes" as a strategy means, how far reaching or big these changes are and what their nature is, it is necessary to return to the in-depth insights gained in the interviews. Just as in the previous discussion of types of barriers (Sections 5.2 and 5.3), sources of barriers (Section 5.4), origins of

barriers (Section 5.5) or types of aids and advantages (Section 5.6), however, the loss of detail is compensated for by insights from the overall patterns.

Thus, it is remarkable, and maybe even surprising, to note that the most common type of strategy involves policy, planning and management changes, including efforts to build new or change existing governance structures. A detailed look at the data reveals that most often these changes are actually very minor in and of themselves, but can be considered—and are viewed as such by the actors involved—as foundational, as "getting a foot in the door." Examples include setting an overarching theme for a general plan, asking for more studies in a plan update, building governance coalitions without asking for any political or financial commitments, making small and piecemeal changes in infrastructure or development decisions, or requiring development applicants to assess risks under different SLR scenarios. Most often, these strategies garnered positive public attention, left much room for flexibility and interpretation, and involved relatively small actual changes in decision-making. Most informants, however, viewed them as essential as a basis for bigger changes down the road when elected officials and the public are more receptive to, or see a greater need for, more substantive changes.

The second most frequent type of strategy employed relates to conscious and strategic communication. This is sensible in light of the polarized and politicized quality of the public discourse on climate change in general, and the need for making climate change real and tangible for the lay public and non-scientific audiences. Santa Clara, for example, decided to frame its climate protection efforts (mitigation and adaptation) as efforts to build local "resilience." Interviewees there emphasized how starting a conversation with climate change often goes nowhere, and is more alienating than inviting. And "adaptation"—to them—had a connotation of reactivity and survival, and thus was not a winning concept.

The next most important set of interrelated strategies used across the case studies involves informal networking and relationship building, and forming more formal partnerships and cooperative agreements. It is a notable finding of this study just how much of this informal activity goes on in support of moving adaptation forward. While intuitively not surprising, the prevalence of the informal political process, the forming of coalitions and alliances, and the countless efforts to overcome stove-piping, fragmentation and lack of formal interaction within government, across scales of governance, and among practitioners, scientists and stakeholders speaks volumes as to the importance of actors, the needed alignment of influence and authority, and the dominance of governance and institutional barriers reported on earlier.

Self-education and learning, data gathering and undertaking more research to fill knowledge gaps, raising awareness among others, and sharing information are clear indications of the early stage of adaptation research and reflect the still-limited climate change and adaptation expertise and knowledge most practitioners have at this time.

A number of formalized and less formalized political actions constitute another set of strategies, including political maneuvering around individuals, interest politics, and limiting rules or combersome procedures; active political lobbying at higher levels of governance; choices

around taking or waiting for leadership; and setting priorities. The latter has occurred in a few cases (e.g., the Santa Clara Water District, or the San Francisco Public Utilities Commission), while most informants bemoaned that adapatation was not really prioritized yet. Often, they entailed staffing changes—e.g., assigning individuals to take clear responsibility for climate change planning, incl. adaptation.

Fundraising or shifting, pooling and prioritizing funds is an important supportive strategy. While outside funding can be a motivator to begin adaptation, having the necessary funds for assessing the threats and vulnerabilities, for a comprehensive planning process, much less for implementation and monitoring of a selected option is a necessity. It is reflective of the relatively early stage that this strategy is simply not yet dominant. It should be expected to become a more frequently used one as adaptation rises on the political agenda.

5.7.2 Findings on Strategies to Overcome Adaptation Barriers in the Five Cases

Table 15 below summarizes the prevalence of strategies used in each case to overcome the specific adaptation barriers encountered there. A first impression is that the set of dominant strategies is quite different from case to case, consistent with the different institutional complexity, set of actors, and the range of systems for which adaptation planning is under way. The differences are also related to the length of time that the process is under way and the intended goal that actors have in each instance. For example, a rather different set of challenges are encountered when trying to change the policy of a regulatory agency, than when trying to upgrade infrastructure, undertake a detailed risk assessment, or get past permitting hurdles to pilot an innovative adaptive strategy.

Table 15: Normalized Frequency of Strategies Employed in the Five Cases to Overcome Barriers

Case // Strategy (normalized, per case) (in %)	Policy & management changes	Funding, fundraising, financing	Staffing changes	Prioritizing	Waiting for leadership	Taking lead, assuming leadership	Lobbying	Political maneuvering	Cooperation, formalized partnerships	Networking/informal relationship building	Communication	Creating awareness among staff, public, stakeholders	Information sharing	Self-education and learning	Research	Data gathering and monitoring
HASPA	8	5	0	5	0	7	0	5	19	10	19	10	3	2	3	3
Marin County	15	4	3	1	3	3	0	4	13	9	6	6	1	12	15	3
San Francisco	10	8	3	0	0	10	3	10	8	10	3	0	0	13	13	10
Santa Clara County	13	2	4	4	2	3	0	6	5	13	15	9	14	8	1	3
Region	13	4	2	3	2	4	0	6	8	8	12	10	8	7	6	4
Average	**12**	**4**	**2**	**3**	**1**	**6**	**1**	**6**	**11**	**10**	**11**	**7**	**5**	**8**	**8**	**5**
Sum	**60**	**22**	**12**	**14**	**6**	**28**	**3**	**32**	**53**	**51**	**54**	**35**	**27**	**42**	**38**	**24**

(* The top three strategies per case are highlighted in yellow.)

Hayward/HASPA:

Based on the generalized comments above, it is not surprising to see a strong dominance in HASPA of strategies that aim to build coalitions—formally and informally, to communicate strategically and create awareness among potential coalition partners. For example, the main barrier in the first period was that no one was detecting a signal for SLR. The "lone voice" advocating for climate action thus continued his personal awareness raising efforts, and was especially helpful in connecting a flood event with climate change.

Once adequate concern was established by and within HASPA (Period 2), members recognized that they needed to better understand the problem for their local area but did not have the internal capacity or sufficient funds to do conduct or support such an assessment by themselves. Strategies used to overcome those obstacles included conducting only a preliminary vulnerability and options assessment with the help of a knowledgeable outside consultant, and to focus on one of the recommended alternatives that involved coalition building and a focus on

joint governance among a variety of affected entities. The latter, combined with extensive communication and awareness raising efforts characterized Period 3.

Period 4 (more extensive vulnerability assessment) was triggered by key barriers, namely the narrow scope of the initial SLR assessment and the lack of an established adaptation process for the affected and relevant agencies. A series of strategies were pursued at that time to help overcome these obstacles: Consciously embracing an attitude of 'we are inventing the process as we go', initiating discussions with permitting agencies to draw attention to likely regulatory obstacles; and broadening the scope of the assessment to obtain broader buy-in from other cities and department representing other relevant sectors (water, wastewater, etc.). What was initially intended to be a geographically more focused assessment got changed—or at least temporarily refocused—when BCDC selected Alameda County, including HASPA as its pilot region to undertake an even more comprehensive vulnerability assessment (and possibly adaptation planning process). Actors in this case welcomed the opportunity and associated strategies (stakeholder engagement, communication, data gathering etc.) to foster greater awareness, understanding and buy-in.

Finally, in the anticipated future Period 5 lack of political will, lack of funding, and regulatory obstacles for physically protecting the restored marshland from SLR will need to be addressed. Strategies being considered to overcome them include conducting a relatively small-scale pilot project to test and illustrate the preferred strategy; public education; gaining political support; applying for federal funds to support the project implementation; and engaging early and often with permitting agencies.

Marin:

In Marin County, the top three types of strategies involve policy changes, more research, and fostering greater cooperation and formal partnerships. To recall, in that case's Period 1, the chief planner was intent on building a wide variety of adaptation strategies into the countywide plan update. This was inspired by the lack of movement towards dealing with the projected impacts of climate change combined with elected officials' and the staff's interest in enhancing the sustainability theme in the guiding document for the county. The overall strategy used to achieve this goal was to "mainstream" adaptation strategies into the plan, but in general, these strategies remained fairly general, involved more study rather than actual changes in decisions or practices, and encouraged greater collaboration across and within jurisdictional boundaries.

The second period of multiple disparate efforts is one of little active planning or changing policies but—in the absence of political will and prioritization of adaptation, staff instead are monitoring the evolving science, conducting some studies themselves, and are monitoring external policy changes. Externally driven mandates (such as the consideration of climate change in the integrated regional water resources management plan, currently under way) and efforts (e.g., BCDC's Bay Plan Amendment, FEMA floodplain updates) may help push climate change adaptation further up on the priority list. Thus, current strategies can be considered to help position staff to be ready for a countywide, more integrated process in a future Period 3.

San Francisco:

San Francisco shows a somewhat unique pattern among the five cases, in that self-education and learning as well as additional research are the dominant strategies, followed by a diverse set of frequently used additional strategies. Period 1 in that case was characterized by a number of disparate efforts where staff worked primarily on their own without serious collaboration or citywide integration, and by a repeated acknowledgement of lack of knowledge about the impacts of climate change at the local level and a lack of capacity internally to focus on the issue or make sense of the science. Thus, conducting formal and informal assessments and collecting more information on impacts or projections of climate change to specific sector (water, wastewater, heat waves, open space reserves, etc.), self-education, seeking funding and opportunities to do research, and to support the process more generally, as well as initial (albeit not entirely successful attempts) at brining the different departments of the city together to work collaboratively are obvious strategies.

The majority of strategies in the anticipated (citywide integrated) Period 2 will involve increasing capacity and laying a solid foundation for its adaptation process over the long term. Anticipated strategies will entail developing internal knowledge about what other places have done, getting leadership for the adaptation process anchored in a department that is relatively sheltered from election cycles and leadership turnover; creating guidance in terms of a methodology and process for developing a city-wide adaptation plan; and garnering support from outside experts to contribute technical knowledge/data to the process as needed.

Santa Clara County:

In Santa Clara County, the dominant strategies involve policy and management changes, relatively informal networking and relationship building, strategic framing and communication of climate change, and information sharing. Most of the policy and management changes were made in the first Period in which an initial climate action plan and a sustainability policy were established. The former included some water conservation measures now being implemented in internal operations, whereas the latter involved the establishment of a sustainability office. It aims to develop an adaptation plan in the future, but at present is largely focused on building relationships to surrounding cities and sharing resources and information with those communities that lack such information.

Period 3 – characterized by a variety of independent efforts in different agencies and departments—also involves some policy changes, including mainstreaming climate change considerations into the updates of different general plan elements, or into the various planning processes of the Water District. Due to scientific uncertainties, however, actual changes are still relatively minor, and an emphasis there is on tracking the science and widely sharing relevant information across the agency and among water districts.

Region:

Finally, in the regional process policy and management changes, including efforts in building new governance structures where they are missing or changing those that exist (e.g., the formation and growth of JPC over time), make up the dominant set of strategies to overcome adaptation barrier. This is true both within BCDC (with its Bay Plan update in Period 1, the more recent update in Period 2 along with other internal changes and activities) and among the four agencies (Periods 3, 4 and the anticipated future Period 5). Communication and awareness raising efforts are logical complements to the accomplished and anticipated policy changes and building of a functional regional governance structure to overcome the still-widespread lack of concern, lack of awareness and understanding (or misunderstandings), and to find a common focus and approach to developing a regionally integrated strategy.

To conclude, Section 5 aimed to give a detailed and rigorous analysis of overall and case specific patterns in the types of barriers encountered in this study, their occurrence over the course of the stylized decision-making cycle, their sources and origins, the aids and advantages that helped avoid them, and the strategies actors employed to overcome them. This in-depth analysis has resulted in one of the most detailed studies on adaptation barriers—not just in California but nationally and internationally—known to the authors. In the concluding section, the results are synthesized briefly to set the stage for future research directions and policy recommendations.

Section 6: Synthesis and Recommendations

The research reported on in the preceding sections sought to contribute to an improved understanding of barriers to adaptation to climate change. Scientific evidence of already occurring impacts of climate change and particularly the projections of future impacts support the need for governments and private sector actors to incorporate climate change in their ongoing planning and decision-making. However, clear evidence of adaptation to anthropogenic climate change is only beginning to emerge (Adger et al. 2007; NRC 2010; Ford et al. 2011). This study aimed to answer the overarching question what is delaying this process, and how, if at all, can it be accelerated so as to improve communities' readiness for climate change impacts?

More specifically, the research goals of this project were threefold:

1. **Systematically identify the adaptation barriers encountered by local communities (local government entities, i.e., municipalities and counties) in San Francisco Bay.** Specifically explore the following sub-questions: How are communities adapting to climate change? How does their progress differ by place and level of government? What hurdles have they encountered in the past and which are they encountering at present? What are the causes of the barriers and how do they differ by locations, levels of government, stage in the adaptation process? Which hurdles have they overcome and how?

2. **Empirically test the robustness and practical usefulness of a diagnostic framework (previously developed by the authors) so as to modify or refine its components.**

3. **Draw larger lessons about the adaptation process and the importance of adaptation barriers—even in highly developed nations—for the scientific community in terms of future research priorities and for policy-makers.**

To fulfill these goals and answer the specific research questions, an in-depth study of five California case studies in the San Francisco Bay region was undertaken. The cases were selected on the basis of several criteria and variables, aiming to cover a range of levels of social vulnerabilities, physical exposure to climate change risks, and different degrees of advancement in their adaptation efforts. Relevant data were collected through 43 key informant interviews, a review of public documents, observation of and/or participation in public meetings, and a statewide survey (the California Coastal Adaptation Needs Assessment, co-lead by S. Moser and J. Hart). The collected data were subjected to a variety of analyses.

Table 16 provides a condensed (and hyperlinked) summary of the types of analyses undertaken and where the results for each case can be found in the preceding sections.

6.1 Summary of Findings

The analysis yielded several important and novel insights.

- **Increasing but still limited adaptation activity to date**. First, the selected communities are all engaged in some level of adaptation planning (as this was a criterion for case selection), but generally are doing quite little yet and frequently less than their neighbors give them credit. As an overarching finding about communities that are engaged in adaptation efforts, this hints at just how limited the overall level of preparedness for climate change impacts in California communities is at this time, with many that have not yet overcome the initiation hurdles. Most of those examined here are still in the early Understanding and Planning phases of the decision cycle, with only rare instances of implementing policy or structural changes on the ground. At the same time, substantive changes in decisions, policies, or plans are apparent, but not always labeled adaptation or held up as climate protection. Several lines of analysis support this finding. This case-specific observation is consistent with those from the statewide adaptation needs assessment survey: The level of adaptation activity at the local is significantly increased from about five years ago when a survey of California coastal communities was conducted but coastal communities are still early in the process (Moser and Tribbia 2006/7; Tribbia and Moser 2008).

Table 16: Summary and Reference List of Analyses Conducted for This Study

Case / Focus of Analysis	HASPA	San Francisco	Marin	SCC	Region	State
Flood Risk with SLR	Sec. 3 Figure 6	Sec. 3 Figure 6	Sec. 3 Figure 6	Sec. 3 Figure 6	Sec. 3 Figure 6	
Social Vulnerability Index (SoVI)	Sec. 3 Figure 7 Figure 8	Sec. 3 Figure 7 Figure 8	Sec. 3 Figure 7 Figure 8	Sec. 3 Figure 7	Sec. 3 Figure 7	
Combined SoVI/Flooding	Sec. 3 Figure 9 Table 3	Sec. 3 Figure 9 Table 3	Sec. 3 Figure 9 Table 3	Sec. 3 Figure 9 Table 3	Sec. 3 Figure 9 Table 3	
Geography/Background/ Overview	Sec. 4.1.1 Figure 10	Sec. 4.2.1 Figure 13	Sec. 4.3.1 Figure 16	Sec. 4.4.1 Figure 19	Sec. 4.5.1	
Adaptation Process Timeline	Sec. 4.1.2 Figure 11 Table 4	Sec. 4.2.2 Figure 14 Table 6	Sec. 4.3.2 Figure 17 Table 8	Sec. 4.4.2 Figure 20 Table 10	Sec. 4.5.2 Figure 22 Table 12	
Phases and Stages over Time Periods and Sub-periods	Sec. 4.1.2 Figure 12 Table 5	Sec. 4.2.2 Figure 15 Table 7	Sec. 4.3.2 Figure 18 Table 9	Sec. 4.4.2 Figure 21 Table 11	Sec. 4.5.2 Figure 23 Table 13	Sec. 4.6 Figure 24 Figure 25
Barrier Types - Overall Frequency - Specific per case	Sect. 5.2.2 Figure 26 Figure 27	Sect. 5.2.4 Figure 26 Figure 29	Sec. 5.2.3 Figure 26 Figure 28	Sec. 5.2.5 Figure 26 Figure 30	Sec. 5.2.6 Figure 26 Figure 31	Sec 5.2.7 Figure 32
Prevalence of Barriers by Stage - Overall - Specific per case	Sec 5.3.4 Figure 33 Figure 34	Sec. 5.3.4 Figure 33 Figure 36	Sec. 5.3.4 Figure 33 Figure 35	Sec. 5.3.4 Figure 33 Figure 37	Sec 5.3.4 Figure 33 Figure 38	Sec. 5.3.4
Sources of Barriers (actors, context, system)	Sec. 5.4 Figure 39A	Sec. 5.4 Figure 39C	Sec. 5.4 Figure 39B	Sec 5.4 Figure 39D	Sec. 5.4 Figure 39E	Sec. 5.4
Origins of Barriers	Sec. 5.5 Figure 41	Sec 5.5 Figure 42	Sec. 5.5 Figure 43	Sec. 5.5 Figure 44	Sec. 5.5 Figure 45	
Aids and Advantages	Sec. 5.6 Figure 46 Table 14	Sec 5.6 Figure 46 Table 14	Sec 5.6 Figure 46 Table 14	Sec 5.6 Figure 46 Table 14	Sec 5.6 Figure 46 Table 14	
Strategies to Overcome Barriers	Sec. 5.7.2 Table 15	Sec. 5.7.2 Table 15	Sec. 5.7.2 Table 15	Sec. 5.7.2 Table 15	Sec. 5.7.2 Table 15	

Note: Figure and table references are hyperlinked for easy access to those summaries)

- **Movement from narrow, fragmented to more comprehensive and integrated effort**. In all cases, there appeared to be a movement from sectoral or narrow geographical approaches toward more comprehensive, integrated efforts, reflecting the growing

understanding among the involved actors of the magnitude and pervasiveness of climate change threats and that climate change cannot be addressed in sectorally or geographically isolated, piecemeal fashion.

- **Institutional and attitudinal barriers dominate**. The analysis of the adaptation barriers showed that institutional hurdles and—surprisingly—attitudinal barriers are the dominant types of obstacles encountered in this study, followed by economic and resource-related barriers. This finding holds for the study overall and for each of the case studies and is supported by several lines of analyses (types, origins, and sources). Other important types of barriers include: "politics", lack of, inadequate or competitive leadership, the adaptation process or particular options, understanding of climate change science and impacts, the science needed to support local adaptation, relevant expertise among the involved actors, and communication. Personality issues and technological or structural barriers feature the least in the cases studied here.
- **Economic barriers are important, even in wealthy locales.** The study confirms the importance of economic barriers, but found them to be secondary to institutional and attitudinal ones. It also contradicts commonly held assumptions about the readily available adaptive capacity (with its lead indicator being plentiful financial resources)in highly developed nations like the US and even in some of its most affluent locations such as Santa Clara, Marin, and San Francisco. The worldwide and national economic crisis has lowered the country's adaptive capacity across the board and in the less affluent localities even more so.
- **Leadership is critically important**. Across most cases, "lone actor" phases (or at least periods in which the leadership of one or two individuals was absolutely critical) seemed common—sometimes for an entire case, sometimes just in a particular department or period. And even where individuals were not working alone or in the face of resistance, leadership (at any level) emerged as an essential factor in strategically moving the process forward (or serving as obstacles in that they prevented advancement of a process). This conclusion is also supported by several lines of analysis, particularly the source of many barriers being the actors involved, as well as by the key finding that personal qualities of key individuals are the most important aid or advantage a community can have in advancing adaptation. Also, in some of the cases here, sufficient insights allows the distinction of political leadership (known to be important often in the early phase of policy development) from technical leadership (often more critical during planning and implementation phases), but interesting relationships between political and technical leaders exist that blur any chronological order.
- **Science matters at certain times and for certain purposes**. A greater surprise—at least at first glance—is the relative low importance of science as #8 as a barrier overall. Many scientists and practitioners frequently argue that lack of science is an impediment toward making more progress on adaptation. This is contradicted to some extent by the findings of this study: leaders pushing adaptation onto the policy agenda are generally very well informed; for them, there is sufficient science to begin the adaptation process; few of the actions proposed or taken to date actually required sophisticated scientific

information; and the region is relatively well endowed with scientific capacity and has a comparative wealth of studies already. Science, uncertainties in the science and gaps in understanding will matter more, as communities enter more fully into the adaptation process. Without concerted investment in the science communities need, this barrier can be expected to grow in significance in the future.

Relating the case study findings to survey findings, the following additional conclusions can be drawn:

- **Key barriers for communities just beginning the adaptation process:** In the statewide survey undertaken in parallel to the case studies, 40 percent of respondent identified themselves as being in the Understanding phase, and 75 percent of those found themselves in the "Initial information gathering" stage. To the extent that the city and county cases are comparable with the statewide sample, it can be assumed that lack of science, lack of adequate staff expertise on climate change and vulnerability assessments, lack of funding and lack of adequate data gathering and keeping are among the key challenges for 30 percent of California's coastal communities.
- **Key barriers for communities in the adaptation planning process**: Of the 41 percent of local survey respondents who identified themselves as being in the Planning phase, 55 percent believed to have just initiated planning (P1). Thus, common barriers for the roughly 23 percent of coastal towns, cities and counties in this stage can be expected to include lack of knowhow about the adaptation planning process, lack of a mandate or requirement to do adaptation planning, lack of funding to undertake an adaptation planning process, lack of technical expertise or guidance; institutional fragmentation; lack of communication and/or coordination among institutions and agencies; and potentially a lack of vision and/or openness to undertaking a comprehensive and far-reaching adaptation process.
- **Key barriers for communities in the implementation and managing process**: Just 15 percent of local government respondents in the survey said that they were in the Managing phase, and 95 percent of those had just begun implementing one or more adaptation strategies (M1). Dominant barriers for those 14 percent of local governments thus include lack of funding to implement options, legal barriers, lack or fragmentation of governance structure, resistance from affected parties and lack of political will and commitment.

In terms of overcoming barriers to adaptation, the case studies revealed important insights:

- **There is significant opportunity to affect and overcome barriers "here and now"**. The analysis showed that a plurality of barriers is made up of proximate/legacy barriers (36 percent) which stem primarily from issues related to the actors, such as attitudes, expertise, staffing levels and capacity, and the context and local governance system, including political dynamics or decisions, local institutional set-ups, institutional fragmentation etc. The second most important category of barriers in terms of their origin is made up of proximate/contemporary barriers (31 percent). They constitute theoretically the barriers that can be affected most easily by actors locally now. A closer

look at the underlying data reveals that they relate primarily to the actors and the governance/context. These barriers appear to be most amenable to being addressed through such things like trainings, information sharing, funding support, and help to frame the issue in salient ways. To the extent that these barriers involve setting up institutions for the future, it will be critical for actors to avoid creating "future legacy" barriers, but more research will be needed to be able to say how that could be done. However, those observed barriers that align in characteristic (predictable) ways with certain phases and stages in the adaptation process, could prove helpful as a way to give actors a "heads up" as to what challenges may lie ahead as they proceed with their adaptation effort.

- **Local communities need outside intervention to address "legacy" and "remote" barriers.** Remote/contemporary barriers (12 percent) relate frequently to the surrounding political climate, current funding allocations, missed opportunities with others, and turn-over in leadership of relevant players. While they can be changed now, they are not directly under local control. Thus, intervention by a higher level of governance through mandates and funding or strong leadership can help. But it is also in this context where political maneuvering by actors can help foster a political climate or knowledge environment that can lead those in positions of power to take action. Remote/legacy barriers (21 percent) are those that are most difficult to address in the "here and now", as the locus of control is elsewhere and the origin of the barrier in the past. The three dominant types of such barriers include institutional ones; economic and funding issues; and attitudinal issues. Intervention in this case is remedial and compensatory by local actors: those who can and those who take it upon themselves "make lemonade" from the lemons they have been given. Outside intervention may take some time to take effect.
- **Communities have assets, aids and advantages that can help them avoid barriers.** It is important not to lose sight of the many assets—human, institutional, economic, and natural—that counterbalance the challenges that hinder or delay progress in adaptation planning. The most important advantage this study found that any community could have to make progress on adaptation is people with certain personal qualities. These qualities included being interested in serving the common (regional) good, rather than being self-interested, being an innovator or early adopter, having a broad, long-term and/or integrative perspective, being a networker, a good collaborator and communicator, being passionate, knowledgeable, experienced, and caring, being strategic, bringing a systems and forward-thinking mind to the issue, and being visionary, committed and progressive. The second most important aid or advantage across the board was related or relevant plans and policies that facilitated and allowed integration of adaptation and climate change. Among the most frequently mentioned were local policies, laws, plans and mandates, preceding or concurrent state policies, laws, and mandates, or existing Federal policies, laws, and mandates. People and institutions, yet again, make the biggest difference.

- **Adaptation = strategies for overcoming barriers to change**. When faced with a particular set of barriers and equipped with certain aids, assets and advantages, actors circumvent or overcome their challenges in creative ways. At least at this relatively early stage in the adaptation processes of the four local governments and the regional agencies studied here this study revealed that adaptation may not just be policies or structural changes, but instead better be thought of precisely as the strategies employed to overcome or avoid adaptation barriers.
- **Key strategies to overcome adaptation barriers**. The most common type of strategy involves policy, planning and management changes, including efforts to build new or change existing governance structures. While these are often minor to date, they are foundational for the continued adaptation process. The second most frequent type of strategy relates to conscious and strategic communication which is sensible in light of the polarized and politicized quality of the public discourse on climate change in general, and the need for making climate change real and tangible for the lay public and non-scientific audiences. Finally, informal networking and relationship building, and forming more formal partnerships and cooperative agreements are important strategies atthis time in coastal communities.

6.2 Critical Evaluation of the Diagnostic Framework

One of the principal purposes of this study was to empirically test a theoretical diagnostic framework previously developed by the authors (Moser and Ekstrom 2010a; Ekstrom, Moser and Torn 2011). Several observations can be made toward that end:

First, many of the barriers identified in this study matched up well with the dynamic phases within the adaptation cycle (i.e., understanding, planning, and managing), while others spanned multiple phases and/or stages (distinct times within each of these three phases). This may in part be due to inadequate data (i.e., further probing with interviewees may have revealed greater clarity), and in part due to the nature of the barriers involved. The resulting ambiguity does not undermine the overall validity of the framework, but simply suggests that barriers can span multiple stages or phases.

Second, the structural element of the decision cycle proved useful as an ordering device. Clearly it is not reflective of the real-world dynamics of planning and political decision-making. Rather the deviations from the cyclical process reflected barriers and actors' strategies to overcome them, thus resulting in a much more messy process. At the same time, key informants hold that cyclical mental model of the process in their minds and have no trouble locating their activities within it. Thus it also serves as a useful communication tool.

It was not always easy to identify unambiguously the sources of barriers or their spatial/jurisdictional and temporal origins; again, there are overlaps among the respective categories. In the case of barrier sources, this may again be a reflection of data limitations, and/or may be inherent to the nature of the barriers. In the case of barrier origins, it is definitely related to the nature of the barriers and how long-lasting and widespread they can be. Further research could explore this in greater detail, yet for now, this ambiguity is seen as an

opportunity for intervention. If it is not known with certainty whether a barrier is local or supra-local in origin, or whether it stems from past or present sources, the possibility of local and current influence over it and thus intervention exists.

Overall, however, these components of the diagnostic framework have proven useful and generally practicable. Particularly the identification of origins is useful as a first step in identifying possibilities for intervention. Combined with the discovery that actors—relatively speaking—make the biggest difference in whether or not a local government was making progress on adaptation, this analysis give significant hope for the future.

Future research should explore possible ways of adding in explicitly the diagnosis of aids and advantages to the framework, and examine more closely how they, the barriers and the strategies to overcome them relate.

Finally, this research produced an inductively derived typology of adaptation barriers that is far richer than that which was originally gathered from the relevant literature. Detailed coding and rigorous application of the typology to the raw data thus produced a richer set of barriers in each Phase and Stage. This may well suggest that this study is more thorough and robust than those conducted previously—at least those known to the authors. Dominant types of barriers could be associated with each phase and stage of the decision cycle, and thus can be further tested in other cases to increase reliability and confidence that the most important ones have been identified. Future studies may explore how the dominance of certain types of barriers change over time, i.e., as adaptation advances.

In addition, while the framework served well the purpose of identifying unique barriers and the coding resulted in a greater number of barrier types than previously found in the literature, the framework did not permit easy conclusions as to the perceived importance of different barrier types or of unique barriers, nor any judgments about the potential difficulty in overcoming them. Improved ways of getting at these dimensions of the barriers would significantly add to the usefulness of this diagnostic approach.

While the framework thus has held up well in certain respects (its fundamental elements), rigorous application has yielded far greater detail than was previously available and included in a previous publication on this topic (Moser and Ekstrom 2010a). The labor intensity of conducting this detailed analysis (from lengthy interviews to transcripts and multiple rounds of coding) proves it to be a sharp instrument for academic analysis, but not easily a decision support tool for application in the world of practice. Identifying ways to simplify this process so as to transform the framework into a planning tool would be very useful. On the other hand, the research conducted here does provide extensive ideas for strategies that could help other localities in their adaptation processes, thus serving both the scientific understanding of adaptation and simultaneously benefiting on-the-ground adaptation efforts.

6.3 Future Research Directions

As mentioned in the previous section already, there are several areas for refinement and extension of the diagnostic framework. Maybe most importantly among them would be

additions that (a) help identify the relative importance of certain barriers, (b)the difficulty with which they can be overcome, and (c) allow for recommendations as to how to avoid creating barriers for future adaptation processes and decisions. In the meantime, and as a step in that direction, it should be possible to increase confidence in the substantive findings established in this study if other researchers apply the tools and analyses used here both in other geographic locations and with different sectoral emphasis, maybe even in contexts where private sector decision-makers dominate.

Whenever communities and other governance systems advance further in the adaptation process, it would also be interesting and valuable to examine whether new types of barriers emerge, how the balance of barrier types shifts; how the aids and advantages change over time; and, similarly, how consistent or not the strategies to overcome barriers are over time, and in different contexts.

In a special application to California, it would be interesting to use this framework in other sectors, maybe priority sectors such as water and public health or agriculture, so as to generate insights that can inform state, regional and local decision-makers in the state. Similarly, it would be interesting to apply this framework to studying barriers in the climate change mitigation process to see how results are similar or different. Comparable to the similarity between mitigative and adaptive capacity (see Yohe 2001), there may be some barriers that are impeding both mitigation and adaptation efforts, and these could be, therefore, tackled together as a high priority.

In addition to refining and applying the framework further and in other contexts, this study revealed some interesting details about a locality's adaptive capacity. Interventions to overcome barriers to adaptation may well be indicative of adaptive capacity, and at the same time a way of building greater adaptive capacity. Considerably more work is needed to confidently establish the relative importance of different components of adaptive capacity and to refine the understanding of the role of individuals. Of particular interest here is the role of leadership – what type of leadership is helpful when in the process? When is leadership inadequate or even an obstacle (see Storbjörk 2007, 2010)? How can the emergence of (the right kind of) leadership be fostered? Together, such advances could help reform the concept of adaptive capacity in important ways.

Finally, critical further work should be done in moving from a diagnostic framework toward a "predictive" or even normative framework, i.e., from learning what constitutes and creates barriers to helping inform the establishment of processes and institutional structures that avoid creating more barriers (that is, "future legacy" barriers).

6.4 Policy Relevance and Recommendations

This study of local communities in one region of California provided detailed, empirically grounded, and comparative insights that have been related to findings from a statewide survey. Together – the analytical depth, the multiple lines of supporting evidence, and the comparison to results from a broader sample of coastal communities in the state give significant confidence that the overarching findings of this study are robust. Moreover, the rich detail included here

provides practitioners with generic options to preemptively intervene and maybe better manage the challenges that arise in the adaptation process, and learn from the challenges and successful strategies of others. Particularly the overarching patterns of which types of barriers, which aids and advantages, and which strategies mattered most, may prove informative to other local communities and particularly state agencies that may have the power and capacity to assist local communities. While not studied in any detail here, it is assumed, that state-level practitioners face a similar set of barriers, if specific to their particular missions, goals, staff, and elected leaders. Thus, there is no illusion that states can easily fill the gaps or help local communities overcome the barriers they face, especially as every decision-making institution can be expected to be affected by remote and legacy barriers that limit its action space.

Nevertheless, the survey revealed that mandates, guidelines, and the 2009 state adaptation strategy (CAS) have proven instrumental in motivating locals to act. State funding is of critical importance, and should be spent strategically (e.g., using a carrot and stick approach) in support of greater preparedness locally. To focus limited resources strategically, state and federal agencies should intervene on barriers that are beyond local control. Careful examination of state and federal laws and regulations, for example, that may hinder innovative solutions, should begin immediately. Pilot projects in which innovative solutions are tried could be used to test and study the implications of opening up existing law.

In prioritizing what to support, this study suggests a novel, innovative, and powerful leverage point: state, federal, and foundation funding and other opportunities (such as trainings) should be made available for the "softer" side of local action—i.e., networking, partnerships, communication, leadership development, and more formal cross-jurisdictional forums for integrated adaptation planning. Much of the adaptation process is less tangible than reports and plans, seawalls or building standards, but—as this study showed—quite possibly more important at this early stage in the era of adaptation to climate change.

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Glossary

AB 32	Assembly Bill 32 (Global Warming Solutions Act of 2006)
ABAG	Association of Bay Area Governments (San Francisco Bay)
ACCPP	Alameda County Climate Protection Project
ART	Adapting to Rising Tides Project (led by BCDC)
BAAQMD	Bay Area Air Quality Management District (San Francisco Bay)
BCDC	Bay Conservation and Development Commission (San Francisco Bay)
CAP	Climate Action Plan
CEC	California Energy Commission
CWP	Countywide Plan (Marin County)
DE	Department of Environment (San Francisco)
DPH	Department of Public Health
DPW	Department of Public Works
DWR	Department of Water Resources (State of California)
EIA	Environmental Impact Assessment
FEMA	Federal Emergency Management Agency
FHA	Federal Housing Administration
GHG	Greenhouse gas
GIS	Geographic Information System
GP	General Plan
HASPA	Hayward Area Shoreline Protection Agency
ICLEI	International Consortium for Local Environmental Initiatives
IRWMP	Integrated Regional Water Management Plan
JPA	Joint Power Authority
JPC	Joint Policy Committee (San Francisco Bay)
MOU	Memorandum of Understanding
MTA	Municipal Transportation Agency (San Francisco)
MTC	Metropolitan Transportation Commission (San Francisco Bay region)
NGO	Non-governmental organization
NOAA	National Oceanographic and Atmospheric Administration (Department of Commerce)
PIER	Public Interest Energy Research (CEC Research program)
PUMA	Piloting Utilities Modeling Application (WUCA activity)
PWA	Philip Williams and Associates (consulting firm)
RISA	Regional Integrated Sciences and Assessments Program (NOAA)
SB 375	Senate Bill 375 (Sustainable Communities and Climate Protection Act of 2008)
SCS	Sustainable Communities Strategy (see SB375)
SCVWD	Santa Clara Valley Water District
SFEI	San Francisco Estuary Institute
SFO	San Francisco Airport

SFPUC	San Francisco Public Utilities Commission
SoVI	Social Vulnerability Index (after Cutter et al. 2003)
SLR	Sea-level rise
USC	University of Southern California
USGS	United States Geological Survey
UWMP	Urban Water Management Plan
WUCA	Water Utility Climate Alliance

Appendix A: Overview of Adaptation Activity in the San Francisco Bay Region

(Status of adaptation processes as of Fall 2010)

Jurisdiction	Bounds	Exposure to 100-year flooding w/SLR	Social vulnerability (SoVI)	Adaptation process
*Marin County	County	High in parts	Low to high	**Planning/managing**: Incorporates SLR in County flood plan (2005), has proposed vulnerability assessment
Belvedere	City	Low	Moderate	**Understanding** (initial info gathering): To include adaptation in CAP
* San Francisco	City/County	Low to moderate	Low to high	**Understanding/planning:** RFP for vulnerability assessment released?
** Sonoma County	North Bay Climate Adaptation Initiative, regional/county sector (C)	High	High	**Understanding**: (to be verified)
* East Palo Alto	City	High	High	Unknown (none?)

Jurisdiction	Bounds	Exposure to 100-year flooding w/SLR	Social vulnerability (SoVI)	Adaptation process
* Hayward	HASPA Joint Powers Authority, regional sector (C)	High to wetlands, some infrastructure		**Understanding/Planning**: preliminary SLR assessment completed
* Pacifica	City, specific project	High	Moderate	None? Managing current coastal
** Santa Clara Valley Water Authority	County, sector (W)	High	Low to high	**Planning/Managing**: incorporates climate change in long-term plans and decisions
** South Bay Salt Pond Restoration	Region, sector (C)	High to wetlands	Low to moderately high	**Understanding/Planning/Managing:** Implementation of wetland restoration plans, adaptive mgmt approach
ABAG, BCDC, JPC, MTC	Region, selected sectors	Varies	Varies	**Understanding/Planning**: TBD
Oakland	City	High	Moderate to high	**Understanding**: Adaptation language in draft CAP
San Mateo	City	High	Low	**Understanding**: Intension to include SLR in CAP

Appendix B: Key Informants to this Study

The following individuals gave generously of their time and knowledge to this study. They are listed here in acknowledgement of their contributions. None of their comments, however, are directly attributed to their names, positions, or affiliations in the body of this paper.

Case	Name of interviewee	Affiliation
HASPA	Jeremy Lowe	Consultant with PWA
HASPA	Erik Pearson	Principal Planner, Development Services Department, City of Hayward
HASPA	David Rizk	Director, Development Services Dept., City of Hayward
HASPA	Bill Quirk	City Council, Hayward
HASPA	Mike Anderson	Asst. to General Manager, East Bay Regional Park District
HASPA	Mike Connor	Director, East Bay Discharge Authority (EBDA)
HASPA	Ralph Johnson	(retired), Alameda Flood Control District, South Bay Salt Pond Restoration Project
Marin County	Alex Hinds	Past Director, Community Development Agency
Marin County	Jack Liebster	Director, Community Development Agency
Marin County	Siavash Baramand	Consultant to Marin Department of Public Works, Climate Change Coordinator
Marin County	Bijan Karimi	Manager, Marin County Office of Emergency Services
Marin County	Paul Helliker	General Manager, Marin Municipal Water District
Marin County	Liz Lewis	Principal Planner, Flood Control, Marin County
San Francisco	Kate McGee	Director, Climate Protection Initiatives, SF Planning Dept.
San Francisco	David Behar	Climate Program Director, SF Public Utilities Commission
San Francisco	Johanna Partin	Climate Protection Coordinator, SF Mayor's Office
San Francisco	Marty Mellera	Manager of Sustainability Implementation, long Range and Capital Planning, SF Municipal Transport Agency
San Francisco	Peter Brown	Capital and Climate Action Project manager, SF Municipal Transport Agency
San Francisco	Uday Prasad	Senior Civil Engineer, Port of San Francisco
San Francisco	Jim Chiu	Facilities Engineer, San Francisco Airport
San Francisco	Calla Ostrander	Climate Action Coordinator, SF Department of Environment
San Francisco	Greg Braswell	IT and GIS Manager, San Francisco Department of Public Works
San Francisco	Cyndy Scully-Comerford	Senior Environmental Health Planner, San Francisco Department of Public Health

Santa Clara County	Demetra McBride	Director, Office of Sustainability, Executive Office
Santa Clara County	Jill Boone	Climate Change and Sustainability Manager, Fleets and Facilities
Santa Clara County	David Hill	Senior Health Policy Advisor, Santa Clara Department of Public Health
Santa Clara County	Sarah Young	Senior Project Manager, SC Valley Water District
Santa Clara County	Susan Stuart	Health Planner, Santa Clara County Department of Public Health
Santa Clara County	Stephen Ross	Planner III, Santa Clara County Planning Department
Region	Wil Travis	Executive Director, San Francisco Bay Conservation and Development Commission (BCDC)
Region	Steve Goldbeck	Chief Deputy Director, BCDC
Region	Joe LaClair	Chief Planner, BCDC
Region	Sara Polgar	Planner, BCDC
Region	Wendy Goodfriend	Senior Planner, BCDC
Region	Brad McCrea	Regulatory Program Director, BCDC
Region	Bruce Riordan	Consultant to Joint Policy Committee (JPC), Climate Bay Area
Region	Ted Droetboom	Executive Director (now departed), JPC
Region	Tom Bates	Chair of JPC, Mayor of Berkeley
Region	Jean Roggenkamp	Deputy Director, Bay Area Air Quality Management District
Region	Ann Flemer	Deputy Executive Director, Policy, Metropolitan Transportation Commission
Region	Ezra Rapport	Executive Director, Association of Bay Area Governments
Region	Andy Gunther	Executive Coordinator, Bay Area Ecosystems Climate Change Consortium
State	Abe Doherty	Project Specialist, Ocean Protection Council, California Coastal Conservancy

Appendix C: Interview Schedule

The interview schedule in its entirety was never used in this study because either the entity had gone through the entire process cycle or no single interviewee knew of all aspects of the adaptation process. Instead, individual interviews were tailored to the particular key informant, his or her position, the particular case study, and whatever aspects of the process the informant was knowledgeable about. The entire interview schedule is reproduced here, however, as the document that was approved by the University of California-Berkeley Human Subjects Research Internal Review Board, and to provide maximum transparency.

Interview questions for San Francisco Bay Area city, county and regional government officials, staff, consultants, and other key informants

Interview introduction:

This study is to document different processes under way that are geared to help prepare and adapt cities and counties to climate change. Our focus is on four cities and counties in the Bay Area and any regional efforts for adaptation.

Basically the information we're seeking from you includes background about your and your agency's involvement and role in adaptation in the city/region and any challenges you may have encountered along the way.

Section I: Background on institution(s) and interviewees

1. **Please tell us about your agency's management responsibilities.**

Follow up (FUP) A: Could you tell me a bit about the *current priorities* your agency has?
FUP B: Does your agency interact with other local, state, regional or even federal agencies to do its work and meet its goals?

2. **And what specifically does your work entail?**

FUP A: So you manage …. What does that actually mean as far as your daily work is concerned?
FUP B: Who do you interact with regularly to accomplish this?
FUP C: How long have you been in this position?
FUP D: What is your education background (degrees and discipline)?

3. **You have listed [x] *different management functions* that you have to accomplish, [x] distinct kinds of decisions that you are involved in making. We would like to *understand these a bit better* still. So, let's take these one at a time.**

Management function A

FUP A: Can you describe the *decision-making process* a bit more:

- Who applies/proposes/initiates?....
- Who else is involved?
- Are your decisions reviewed by some higher authority? Can anyone appeal or supersede your decisions? How does that process work?
- What information is required so you can make an adequate assessment?
- How long does it take to complete one project/application? How often do you have to make these kinds of decisions?

[do same for other management functions]

Section II. Establishing how the informant thinks about adaptation and climate change (also part of identifying his/her problem framing).

Now I'd like to turn to how your work, and your agency's work, may be affected by climate change.

4. What are the main concern about climate change for your agency? How do you think CC will (or already does) affect the resources and responsibilities within your jurisdiction (including infrastructure, social well-being, ecosystems, etc.)?

FUP A: Say more…
FUP B: Over what time scale?
FUP C: Are you experiencing these threats now or has your agency/city in the past?
FUP D: When do you think impacts are likely to start being felt, and in what way?

5. What does adaptation to climate change mean to you?

FUP B:Would you say that the people you work with share your understanding of adaptation?

6. What do you think are the advantages of starting to adapt to climate change now?

FUP A: What are the disadvantages?
FUP B: Have these advantages and disadvantages played into your agency/organization/community's decision to start adaptation planning?

Section III. Establish where they are in the adaptation process

So now we'd like to understand you agency's adaptation efforts.

7. **Can you give me a sense of what your agency/organization/community has done to date in terms of adaptation?**

8. **What has your role been in these?**

FUP A: Is this part of your job description?
FUP B: Is adaptation something that is added to your responsibilities or has it become part and parcel of what you do on a daily basis?
FUP C: And what has that been like?

9. **We would like to better understand where you currently are in the adaptation process as an organization overall**. Picking up on what you just said about what your agency has done so far, would you say you are still trying to **understand** the problem you need to adapt to, or have you moved on to trying to **develop some plans of what to do**, or are you actually already **implementing** some of these plans?

FUP A: *Probe for stages in each of these phases:* For example, have you collected, discussed or used information on climate impacts for the [system of concern]? Or: have climate adaptation options been proposed/developed and if so, have these been assessed?
FUP B: *Probe for more detail on what they have or haven't done.*

Section IV: Process Description and Associated Barriers

Now we'd like to learn more about each of the steps you've gone through so far to better understand the process and any challenges you might have run into along the way.

A1. Understanding: Signal Detection

10. **When did this [*climate change impacts of concern*] first come to your attention?**

FUP A: Do you remember if something in particular happened or raised the concerns? What triggered attention to the issue?
FUP B: Who initiated it?
FUP C: *Follow-up with questions that relate timing to other events*
FUP D: What were some of the first signs to you that it was a concern of the agency/department?
FUP E: When was this?

11. **How did you first learn about this issue?**

FUP A: Back then, when you first heard about this, what did people in your agency think about that? Where they interested, responsive? Did they take it seriously or dismiss it? What was it like?
FUP B: *Depending on the response, additional follow-up questions such as:* what were the indicators that the signal was taken seriously/dismissed? By anyone in particular?

12. What is your sense of why the issue was taken seriously/dismissed?

FUP A: Was there any reason why it was/was not? Did/do laws, policies, and social norms support or prevent taking [impact of concern] seriously and responding to it?
FUP B: Has [climate impact of concern] previously been a problem prior to the concern over climate change? What populations, area, and/or infrastructure is at risk?
FUP C: Who is responsible for preventing [climate impacts of concern]?

A2. Understanding: Information Gathering

13. Has information been compiled (or an assessment been done) about climate change impacts for the city/county?

FUP A: *If so, the interviewer will probe further to find out:* What type of information has been collected? What led to this assessment? Who was involved? Who conducted the assessment?
FUP B: Did you look at potential climate change impacts on specific sectors or areas? Did you also look at existing vulnerabilities and how non-climatic issues might interact with climate change?
FUP C: Who did this study for you?
FUP D: If you had all the money you wanted, what exactly do you need to know about climate impacts—what would be the information? (e.g., new flood models, social vulnerability, forecasts,?)

14. You mentioned earlier that your or your agency's biggest or primary concerns for climate change were [impacts mentioned previously]. Do these issues fall within the agency's priorities?
FUP A: If so, how were these established? Is your concern shared by others in your agency and your constituents (public, city residents, consumers of your resource, etc.)?

15. Were you able to get the information you wanted to assess these challenges?
FUP A: What kind of information was needed or wanted to assess the potential problems from climate change?
FUP B: Did you all agree on that or how was it decided what you would look at?
FUP C: If you were able to get the information you were hoping for, how has the information been used (and what did you have to go through to get it?)
FUP D: If not, does this information exist somewhere? Was it just not accessible to you? What did you do without that information? Are there plans for obtaining what is needed?
FUP E: Who did the work for you to collect all this information? For example, do you call on scientists to do the research needed, do you hire consultants, do you compile existing peer-reviewed literature yourself or someone else in the department, or do you do your own in-house research?
FUP F: Of these, are some preferred more than other? Say more…

16. Do you think there are any constraints on what issues you looked at? For example, given the jurisdiction of your agency, is there something you could not look at?

FUP A:What about your or anyone else's personal interests—anyone who has been involved so far?

FUP B: What about financial constraints?

FUP C: What about political considerations?

FUP D: Do existing policies or decision processes at all constrain what kind of information you can consider?

17. In terms of the information you gathered, how will you use that?

FUP A: Is the information compatible with existing decision-making processes and models?

FUP B:What made this information salient, credible and legitimate to you

FUP C: Tell me more…

A3. Understanding: Problem (re)Definition—*this stage requires much of the same information as the first stage (signal detection), therefore these questions are not repeated.*

18. After information was collected, did your/your agency's concerns about climate change modify from their original concerns?

FUP A: If so, how did they change?

FUP B: Were there any new people involved in the adaptation process?

FUP C: Was there agreement on how the problem was defined between people and organizations involved? And was it important to have such agreement?

19. Is there a particular person or group of people in your city/region/agency who is advocating for preparing for climate change?

FUP: *If yes, then follow up with questions about that person's or group's concern and perceived need for preparing for climate change impacts.*

20. Do any local, state or federal laws and policies support or prevent you from taking the threat/problem seriously and responding to it?

FUP: How so?

21. Do the other agencies you work with agree on what the problem is?

FUP: Have you had to negotiate about this in any way?

22. Is there social/community support for addressing the threats?

FUP A: If so, in what way?

FUP B: If not, has there been opposition?

B1. Planning: Developing Options

23. Have you developed options to deal with these problems? If so, what are they?

FUP A: *Depending on informant's response, ask about that process:*
Who led/is leading this process? What is their jurisdiction (or control over the process)? How much control do they have over what options are developed? Are there other organizations, entities or individuals that are/were involved in this process? If so, what has been their influence?
FUP B: Was there any broader stakeholder participation? Who (public, other agencies, departments, orgs) was solicited for feedback on developing these options? Do the mandate of the lead entity and stakeholder interests align or diverge?

24. Do the options fit within the existing public or policy agenda?
FUP A: Do you feel that your agency's pre-existing mission and policy agendas pre-determined the range of options that were being considered?

25. Are there overarching goals for the options that you developed?
FUP: Are the goals made explicit to those involved in developing the options? Were there any criteria used?

26. Have there been sufficient resources to develop these options and facilitate the process?
FUP: Depending on answer, probe for staff time, financial, technical resources.

B2. Planning: Assessing Options

27. Has there been an assessment (formal or informal) of which options to select?
FUP: If so, could you tell me about this process? Who designed the assessment, who ran it, what data was used, were participants trained/educated (and how so)? What resources were made available for this process? By whom and for what?

28. Did you have specific goals and criteria in mind when you selected among all the options?
FUP A: If so, how were these developed and by whom?
FUP B: Do actors agree on goals, criteria and resulting options?
FUP C: If no goals developed, has this hindered the process (created any conflict?)?

29. Do the involved parties agree on the selected approach to assessing options?

30. How much time was given to this assessment? What other timing issues affected the time available for this assessment? Was there enough time?

B3. Planning: Selecting Strategies

31. Was one or more adaptation strategy selected to be implemented?

FUP A: How did this work? Tell me more…

FUP B: Who are all the people that were/are/will be involved in the selection process? Did they have conflicting values or preferences?

FUP C: Was it based on consensus or something else?

FUP D: Were/are there laws or decision making procedures that favor or inhibit certain options more than others?

FUP E: Who was in charge of the process? Was the authority clear?

FUP F: Do you see participants of selection process as risk-seeking or risk-adverse in their selection process?

32. Do you think the selected options are broadly supported in your community to implement right now?

FUP: Tell me more…

C1. Managing: Implementing

Depending on what has been learned so far about the state of adaptation planning and decision-making, the following questions will be asked.

33. Have any of [the selected adaptation actions] been implemented already?

FUP A: *In cases where nothing has been implemented, but strategies for adaptation have been selected, ask questions to understand why no implementation has yet occurred, e.g.:* Was the intent to implement set? Was the necessary authorization given? Insufficient resources? Was anyone accountable to implement? Were strategies clear enough to implement? Were the selected options procedurally possible? Was there the necessary political will/support? Or other?

FUP B:*In cases where informant is just beginning or in the middle of implementation, a different set of questions will be asked, including:* Do current laws and institutional requirements support your intent to implement [X]? Do you anticipate social and/or political acceptance of the strategies to implement? Does implementation require explanation, education, and skill building within your agency?

34. Is implementing the strategy within the responsibility or authority of your agency?

FUP A: Will it (did it) require coordination with other agencies or entities?

FUP B: Was an implementation strategy developed as part of the planning process?

FUP C: What is the role of other relevant agencies, institutions, or actors?

FUP D: Do these have overlapping authorities with your agency? How, and how well, do you coordinate what each one of you does?

35. **Are there any practices or policies within your agency that overlap with or contradict the adaptation strategy?**

If the adaptation strategies have been implemented in the past, then the above questions will be reframed as appropriate.

C2. Managing: Monitoring

36. **Is there a monitoring plan for [X] (flood protection/levees and other climate change stressors) initiatives?** If so, what is being monitored?

FUPs: Over what time scale? Over what time scale does funding exist? What does the funding support? How is the information evaluated and how often?

37. **Have the [relevant agencies] agreed on what and how things are going to be monitored?**

FUPs: What about agreement on goals, design, targets, needed resources, and the intent and schedule for analysis and assessment of the obtained data?

38. **What additional capacity (resources) and/or expertise do you need to design and implement the monitoring program for it to deal with climate change impacts?**

FUP A: Are sufficient resources allocated to implement this (staff, $)?

FUP B: Does your agency or others you work with invest in human capital (expertise, time) to carry out the monitoring program?

C3. Managing: Evaluating

39. **Does the monitoring program allow for periodic evaluations?**

FUPs: How often? What triggers the evaluation? How about unplanned evaluations?

40. **Has a system been set up (or planned) for storing, organizing, analyzing, and retrieving the data?** If so, could you tell me about it?

41. **Who is accountable (e.g., through formal mandates or plans) to conduct these evaluations?**

42. **Have there been any evaluations yet?**

FUP: *If so, follow up with questions asking such as*: When and by whom, and what were the goals, outputs, outcomes, and impacts?

43. **How do the findings of the evaluation get incorporated/feedback into management?**

FUPs: Are there mechanisms that support or prevent this? Do you think decision-makers are willing and legally and politically able to revisit and change past decisions based on evaluations?

44. Are there sufficient resources to conduct these periodic evaluations?

Section V. Synthesizing questions on informant's jurisdiction.

45. How often do you think you're going to have to revisit the issue of adapting to climate change? Do you see any specific needs on the horizon that you think you should plan or prepare for? If so, what are these?

FUP A: Can your agency do these in its current jurisdiction?

FUP B: What has your agency/department/city done that addresses these threats? Does this fit with other existing priorities you have?

FUP B: How come you didn't already address these?

FUP C: What makes you think they will become issues in the future?

Section VI. Connectivity with other initiatives, leaders and resources

46. Are you aware of any other cities, counties, or agencies in the Bay Area working on adapting to climate change?

FUP A: How did you learn about their efforts?

FUP B: Do you or your department/agency work with any of these directly and in what capacity?

47. Have you participated in any climate change-related training? If so, what and when?

FUP A: How was it/did it help you with your job?

FUP B: If you haven't participated in such a training, did anyone in your agency?

FUP C: If you had the opportunity, what kind of training would be helpful to you? Do you think this kind of training exists, you just haven't been able to attend one or is it just not out there?

48. Does your city or county have a climate action plan? If so, when was it adopted ?

FUPs: What does it focus on? Does it include any discussion of adaptation (if so, to what extent)? Who helped write it?

49. Finally, what do you see as the biggest challenges as you continue through this process of adaptation [or in dealing with X impact of climate change]?

50. Closing. [*at discretion, depending on length of interview*] Is there anything else we might have missed that you want to add about the adaptation process you've gone through so far?

Appendix D: Constructing a Social Vulnerability Index with Factor Weighting

The Social Vulnerability Index (SoVI) is a well-established index method applied in natural disaster research to provide an objective snapshot of relative social vulnerability for a specified region. The social vulnerability index (SoVI) uses 32 variables of Census data to capture generic indicators of sensitivity, adaptive capacity, and social exposure. These variables are statistically integrated to create a single vulnerability score for a given census unit (census tract, block group, county, etc, depending on research needs and data availability). The standard deviations of the resulting scores are displayed visually using GIS mapping, showing patterns of how and where vulnerability ranges within a given region. The following provides a summary of steps used to produce the map (for a more detailed description of methods, refer to "The SoVI Recipe,", as described on the Hazards & Vulnerability Research Institute website: http://webra.cas.sc.edu/hvri/docs/SoVIRecipe.pdf).

In the study of the San Francisco Bay Area nine counties, the analysis was conducted for the nine county using U.S. Census tract level data. The 32 variables collected for this study came from the U.S. Census (Data Ferret *beta* database) from the year 2000. Principal Components Analysis was conducted on the normalized data, resulting in a set of factors. Each factor is "composed" of a set of one or more variables that highly correlate to it (dominant variables listed in Table 1). Socio-economic status, to which eight of the variables were highly correlated, was the largest contributor to vulnerability for this region. This factor explains 27 percent of the variation within the dataset analyzed, and Factors 1–8 explain 73 percent of the variation in the dataset. Table 1 shows which variables were most highly correlated to each factor and the degree to which each factor explains the variation in the dataset.

Table D.1 shows which variables were most highly correlated to each factor (Dominant variables) and the degree to which each factor explains the variation in the dataset (Percent variance explained).

Table D.1: Factor Analysis Results: Factors, Dominant Census Variables, and Percent Variance Explained

Factor	Name (representing dominant variables)	Dominant variables	Percent variance explained
1	**Socio-economic status**	• % population employed in service industry • Population over 25 not graduated from high school • % population living below federal poverty • # physicians • Median rent • Median household value	**26.7**

		• Per capita income • Proportion of population earning >$100K/year	
2	**Population structure**	• Median age • % population 65 years and over • % receiving social security	**10.8**
3	**Housing and employed**	• % Hispanic/Latino • Average # people per household • % civilian labor force participation • % population 5 years and younger	**8.7**
4	**Agriculture**	• Land designated as rural farm • % urban land • % employed in agricultural industry	**8.4**
5	**Gender**	• % homes with females as head of household • % Native American • % female in population • % females in labor force	**5.9**
6	**Housing and employment**	• % renters • % population employed in transportation industry • % born outside United States • Nursing home resident population	**4.3**
7	**Race and employed**	• % unemployed • % African-American population • % households living mobile homes	**4.1**
8	**Race**	• % Asian population • Housing density	**4.0**

(References for this appendix included in References for the paper.)

Appendix E: Typologies of Barriers; Aids and Advantages; and Strategies to Overcome Barriers

The typologies of barriers, aids and advantages, and strategies have been used to categorize and code the barriers that emerged in interviews. The development of each typology is described below.

E.1 Typology of Barriers to Adaptation

Barrier typologies were inductively generated by both researchers independently. The draft typologies were subsequently integrated and reconciled where necessary into one final typology. Barriers identified in the interview transcripts were then classified accordingly, with researchers cross-checking each other's classification. There are 12 major types of barriers, with a range of impediments falling under each type.

Science/Scientific understanding

- Uncertainty/too much uncertainty
- Lack of data
- No access/not finding info/data
- Not adequately understood, translated
- Confusion
- Not practically relevant
- Data inadequately managed

Institutional/Governance issues

- Lack of internal/external cooperation/collaboration
- Stove-piped organization
- Bureaucracy
- Mandate, lack of mandate, contradictory mandates
- Lack of agreement on goals, purpose
- Lack of an institution (incl. boundary org)
- Lack of governance structure
- Legal barriers from existing law
- Lack of policy/law
- Cross-scale disconnects, mutually contradictory interests
- Competing priorities between and within agencies
- Ineffective meetings
- Limited jurisdiction
- Fragmentation
- Not everyone at the table
- Lack of implementation of existing policy

Leadership

- Problematic leadership
- Lack of leadership
- Too many leaders

Funding issues/Resources

- Economic crisis
- Funding inaccessible
- Funding sources unknown
- Too many demands on/competition for existing funds
- Funding not prioritized
- Lack of money for science/assessment
- Lack of money for planning
- Lack of money for implementation
- Implication for staffing
    - Lack of staff
    - Hiring freeze/positions unfilled
    - Lack of capacity among staff
    - Distraction with other responsibilities
    - Lack of time

Expertise on climate change and/ or adaptation

- Lack of expertise among staff, board members, leaders
- Lack of knowledge of options

Politics

- Lack of political will
- Ulterior motives/political ambitions/political agendas
- Infighting
- Turfism
- Rivalry
- Unwillingness to share resources
- Distrust
- Fear of opposition
- Political gambling/positioning

Personality issues

Attitudes, values, motivations

- Lack of caring/concern
- Lack of interest
- Greed
- Selfishness, narrow self-interest

- Politicization of climate science
- Negative campaigns, intentional representation
- People not understanding or not making an effort to understand issues
- Inability to accept change, dynamic nature
- Wait and see attitude
- Inability to think long-term
- Inability to see common interest
- Desire for/mindset of status quo

Public understanding of climate change

- Signal not detected
- People not connecting the dots between events/impacts
- Lack of understanding of cc
- Lack of knowledge about adaptation
- Denial

Communication

- Lack of communication
- Miscommunication
- Lack of a story/narrative
- Lack of clear message
- Lack of a focus on communication
- Lack of trusted messengers

Technology/Structural Options

- Lack of structural alternatives
- Structural alternatives too expensive
- Structural solution has too many negative env. impacts

Adaptation options/Process

- Lack of guidance
    - Where to start
    - Risk/vulnerability assessment
    - Strategic thinking
- Not knowing where to begin/what to do
- Lack of (feasible) options
- Limited vision
- Narrow perspective
- Problems with process

E.2 Typology of Aids and Advantages (helping to avoid barriers)

Typologies of aids and advantages were inductively generated by both researchers independently. The draft typologies were subsequently integrated and reconciled where necessary into one final typology. Aids and Advantages identified in the interview transcripts were then classified accordingly, with researchers cross-checking each other's classification. There are 17 major types of aids and advantages that helped avoid the occurrence of barriers in the first place, each major type with a range of issues falling under each type.

Related/relevant policies

- Local policies, laws, and mandates (e.g., policy set in a GP or a CAP or a master plan)
- State policies, laws, and mandates (e.g., AB32, SB 375/SCS, State adaptation plan)
- Federal policies, laws, and mandates (e.g., ACE 2009 SLR policy; FEMA flood mapping)
- Existing or anticipated passage of laws/policy
- Momentum to focus on CCA comes from existing policy or laws

Existing/historical governance structure

- Formal (existing decision-making structures)
- Informal governance structures (close, effective collaborative relationships)
    - Within government
    - Across jurisdictions
    - Among organizations (gov/NGOs/priv sector orgs)
- Long-term planning or decision-making horizons

Effective collaborations between scientists and practitioners

Effective communication

- Channels across jurisdictions, divisions, disciplines
- Of climate change

Timing

Leadership

- Existence of champions
- Among staff or agency leaders
- Providing "cover" or mandate or vision
- In right place at the right time
- In key positions
- Political will

Personal qualities/attitudes/values/motivations of key individuals

- Regional interest (over self-interest)
- Wanting to serve the common good
- Innovator/early adopter

- Broad perspective
- Integrator
- Networker
- Good collaborator
- Good communicator
- Passionate
- Knowledgeable, experienced
- Caring
- Being strategic
- Systems thinking
- Forward thinking
- Visionary, strong, commitment, progressive leadership

Existing or growing awareness of climate change
- Al Gore's movie/communications training
- General increase of cc in news media, public conversation
- Books and other (specific) publications
- Extreme events bringing attention to CC

Existing or growing interest in climate change/sustainability/green economy issues
- Among staff
- Among agency leaders
- Among political leaders
- Among public

Climate change knowledge
- Understanding of science
- Understanding of need for long-term view/planning
- Understanding of integrative nature of issues
- Understanding of mitigation, adaptation, and their potential overlaps

Existing vulnerabilities or already perceived climate change impacts (incl. system of concern already priority)
- Impacts re: water, drought, SLR, flooding, heat, air pollution, biodiversity/ecosystems, saltwater
- intrusion
- Exposure in certain areas
- Lack of response capacity (e.g., weakness of levees, poverty, inadequate disaster plans)

Existing economic wealth/assets/strengths
- Economic wealth/affluence
- Economic driver of regional economy

Cultural assets
- Cultural diversity
- Desirability of region
- History or spirit of place

Financial incentives, support from outside
- State grants
- Federal grants
- Foundation support
- NGO support
- Private sector support

Guidance and non-financial incentives
- From local, state or federal (or non-governmental) entity
- Examples as models for others
- Rewards and recognition

Trainings and webinars
- On adaptation
- On communication
- On risk/impacts/vulnerability assessments

Science/Availability of relevant knowledge
- Someone else doing relevant research (academics, state/PIER Program, feds)
- Ongoing collection of relevant data
- Ongoing monitoring to support adaptive management

E.3 Typology of Strategies to Overcome Barriers

Typologies of strategies to overcome barriers were inductively generated by both researchers independently. The draft typologies were subsequently integrated and reconciled where necessary into one final typology. The strategies identified in the interview transcripts were then classified accordingly, with researchers cross-checking each other's classification. Note, some strategies (either by design or accidentally) can address multiple barriers at once. Some strategies are at first glance quite similar to each other, but are categorized under different types. The key distinction between one strategy and another is whether or not it addresses a different problem or aims to overcome a different barrier. Based on this logic, 16 major types of strategies have been identified, with each major type including a "family" of related strategies.

Data gathering and monitoring
- Monitoring climate change, impacts, policy outcomes
- Monitoring what others do (local, regional agencies)
- Monitoring new scientific findings

Research
- On climate change science/projections (reducing uncertainty)
- On climate change impacts/assessing vulnerabilities/risks
- On adaptation
- Answering locally specific management/policy questions
- Doing research oneself, requesting studies from others, or collaborating with researchers

(Self-)Education and learning
- Learning about climate change, adaptation
- Learning what others do

Communication
- Strategic framing of climate change/adaptation
    - Connecting climate change to existing priorities/concerns
    - Linking global problem to local/personal interests/concerns
    - Linking climate change/adaptation to resonant policy frame (resiliency, sustainability)
    - Present solutions as cool, linked to cultural legacy, political ambitions
- Deliberate avoidance of contentious issues
- Use of common vocabulary
- Translation of science into understandable language
- Having multiple ways to talk about cc to different audiences

Awareness raising (among staff, public, particular stakeholders)
- Education of and outreach to others (new or existing outreach mechanisms)
- Trainings
- Giving presentations
- Advocacy

Information sharing
- Passing on of information
- Information portal (creation or maintenance)
- Assigning staff to gather and distribute information
- Convening conversations, dialogues, discussions, workshops, presentations

Networking [informal meetings, collaboration, coordination]
- Informal relationship-building

Coordination
- Timing
- Sharing responsibilities
- Bringing everyone to the table
- Gaining a seat at the table

Cooperation/partnerships [formalized (cf. networking)]

- Internally, among divisions, agencies
- Externally, among cities, across jurisdictions, across scales
- More or less formalized cooperative agreements, partnerships, MOUs, resolutions
- With government programs, NGOs, scientists, other agencies, levels of government etc.
- Coalition building/focus on governance
- Develop coherent strategy

Political maneuvering

- Providing cover for others to do needed work
- Consensus seeking/building
- Breaking big problems into smaller ones that attract political support and resources
- Offering solutions, not just problems
- Planned or opportunistic use of timing (windows of opportunities)

Lobbying

- At state or federal level

Taking the lead/assuming leadership

- Setting example; modeling for others
- Participating in pilot project
- Shaping policy environment
- Creating/fostering a sense of ownership
- Building momentum
- Provide incentives for others
- Going above and beyond the call of duty

Waiting for leadership

- Preparing but postponing action
- Relying on others to take action, provide knowledge, etc.

Prioritizing

- Focus on politically feasible
- Focus on no regrets
- Focus on win-win strategies
- Focus on solutions that buy time
- Focus on strategies that have adaptation co-benefits (even if they are not billed as such)
- Setting policy priorities

Staffing

- Assigning staff on cc
- Leveraging existing capacity
- Adding capacity/hiring

- Training to increase expertise on climate change/adaptation
- Calling on consultants/NGOs for additional technical expertise, info, assistance

Funding/Financing/Fundraising
- Allocating special/extra resources
- Writing/obtaining/competing for grants (alone or together)
- Doing new things under existing budget categories
- Cost-sharing

Policy, planning, and management changes
- Adjustment of standards
- Integrating climate change (qualitatively or quantitatively) into ongoing processes
- Mainstreaming
- Diversification of approaches
- Empowerment of staff through mandates, requirements, charges, etc.
- Process and rule changes (e.g., agenda setting)
- Granting authority
- Resolutions
- Combining powers into a more powerful JPA
- Create framework for others
- Incremental (project-based) ways of addressing adaptation
- Building a governance structure