
ADAPTATION FINANCE CHALLENGES: Characteristic Patterns Facing California Local Governments and Ways to Overcome Them

A Report for:

California's Fourth Climate Change Assessment

Prepared By:

Susanne C. Moser, Ph.D., Susanne Moser Research & Consulting

Julia A. Ekstrom, Ph.D., University of California-Davis

Julia Kim, Local Government Commission

Samantha Heitsch, ICF International

DISCLAIMER

This report was prepared as the result of work sponsored by the California Natural Resources Agency. It does not necessarily represent the views of the Natural Resources Agency, its employees or the State of California. The Natural Resources Agency, the State of California, its employees, contractors and subcontractors make no warrant, express or implied, and assume no legal liability for the information in this report; nor does any party represent that the uses of this information will not infringe upon privately owned rights. This report has not been approved or disapproved by the Natural Resources Agency nor has the Natural Resources Agency passed upon the accuracy or adequacy of the information in this report.



Edmund G. Brown, Jr., *Governor*

August 2018

CCCA4-CNRA-2018-007

ACKNOWLEDGEMENTS

The research team would like to thank the California Natural Resources Agency (CNRA) for funding support, the University of California-Berkeley Energy and Climate Institute (BECI) for grant administration, and Jamie Anderson, DWR, and Michael McCormick, Office of Planning and Research (OPR) for project advice along the way.

The research would not have been possible without the workshop participants and survey respondents who gave generously of their time to share their experience of adaptation finance-related challenges. We hope this report will eventually lead to solutions that help them overcome them – the only true way for us to give something back to them.

Several individuals assisted this project at various points and we appreciate each and every one's contributions: The following individuals (many of whom were CivicSpark Fellows at the time), took copious notes during our workshops, including Mike Kloha, Anthony Primer, Hoi-Fei Mok and Carrie Metzgar (California Adaptation Forum), Rebecca True and Skylar Johnson (Capital Region), Jesse Carpentier and Jennifer Hooper (Central Coast), Janelle Del Campo and Chris Bjornstad (Central Valley), Mackenzie Bolger, Kellie Ryan, Carrie Metzgar, Breanna Swenson, Mike Kloha, Jennifer Truong and Grant Jean (Los Angeles), Patrick Cody-Carrese, Elliot Goodrich and Aisha Cissna (North Coast), Rick Ferrera, Jaclyn Mandoski, Laura Walsh and Tyler Valdez (San Diego), Matt Anderson, Gillian Corral, Clifford Wang, Hoi-Fei Mok and Anthony Primer (San Francisco), and Tashi Green (Sierra Nevada). We also appreciate the facilitation and logistical support provided by the following individuals at our workshops: Dana Boudreau, Lexie Fisher, and Pierce Schwalb (North Coast), Allison Brooks and Vijay Kesevan (San Francisco), Diana Madson (Sierra Nevada), Larry Allen and Adrienne Greve (Central Coast), Alyssa Newton Mann, Juliette Finzi Hart, Laurel Hunt (Los Angeles), Mallory Morgan, Kristen Goodrich, Dani Boudreau, Kim Serrano, and Devon Muto (San Diego).

Rob Kay, Brenda Dix, Maya Bruguera and Hannah Wagner (all ICF) contributed critical support on project management, the survey and literature review; Kif Scheuer (LGC) helped with the workshop facilitation and overall thinking, and LGC intern, Espen Scheuer, supported the document analysis of Chapter 6. Carol Berzonsky provided research assistance to Susanne Moser Research & Consulting. The research furthermore benefited from conversations with Nuin-Tara Key and Louise Bedsworth at OPR. Hillary Papendick, Office of Sustainability, San Mateo County, helped link our work to the Senior Practicum class in the Public Policy Program at Stanford University. There, Professor Lawrence Latvik and his students, Chelsea House, Daniel Marx, Peter Litzow, Justin Roberto, and Jacqueline Wibowo, contributed in crucial ways to the compilation of adaptation funding mechanisms.

Thank you also to Katie Grace Deane, Center for Community Investment, to allow Susanne Moser to participate in the Financing Climate Adaptation Roundtable in Oakland; and, similarly, thank you to Iain Hyde, Office of the Governor of Colorado, for the invitation to participate in the Innovative Finance for Resilience Workshop at Stanford University. Both events contributed to our thinking reflected in this report.

Finally, we also would like to thank Klaus Eisenack and Christoph Oberlack for their enthusiastic support for our project and welcoming our contribution to a forthcoming Special Issue on archetype analysis in *Ecology & Society*.

PREFACE

California's Climate Change Assessments provide a scientific foundation for understanding climate-related vulnerability at the local scale and informing resilience actions. These Assessments contribute to the advancement of science-based policies, plans, and programs to promote effective climate leadership in California. In 2006, California released its First Climate Change Assessment, which shed light on the impacts of climate change on specific sectors in California and was instrumental in supporting the passage of the landmark legislation Assembly Bill 32 (Núñez, Chapter 488, Statutes of 2006), California's Global Warming Solutions Act. The Second Assessment concluded that adaptation is a crucial complement to reducing greenhouse gas emissions (2009), given that some changes to the climate are ongoing and inevitable, motivating and informing California's first Climate Adaptation Strategy released the same year. In 2012, California's Third Climate Change Assessment made substantial progress in projecting local impacts of climate change, investigating consequences to human and natural systems, and exploring barriers to adaptation.

Under the leadership of Governor Edmund G. Brown, Jr., a trio of state agencies jointly managed and supported California's Fourth Climate Change Assessment: California's Natural Resources Agency (CNRA), the Governor's Office of Planning and Research (OPR), and the California Energy Commission (Energy Commission). The Climate Action Team Research Working Group, through which more than 20 state agencies coordinate climate-related research, served as the steering committee, providing input for a multisector call for proposals, participating in selection of research teams, and offering technical guidance throughout the process.

California's Fourth Climate Change Assessment (Fourth Assessment) advances actionable science that serves the growing needs of state and local-level decision-makers from a variety of sectors. It includes research to develop rigorous, comprehensive climate change scenarios at a scale suitable for illuminating regional vulnerabilities and localized adaptation strategies in California; datasets and tools that improve integration of observed and projected knowledge about climate change into decision-making; and recommendations and information to directly inform vulnerability assessments and adaptation strategies for California's energy sector, water resources and management, oceans and coasts, forests, wildfires, agriculture, biodiversity and habitat, and public health.

The Fourth Assessment includes 44 technical reports to advance the scientific foundation for understanding climate-related risks and resilience options, nine regional reports plus an oceans and coast report to outline climate risks and adaptation options, reports on tribal and indigenous issues as well as climate justice, and a comprehensive statewide summary report. All research contributing to the Fourth Assessment was peer-reviewed to ensure scientific rigor and relevance to practitioners and stakeholders.

For the full suite of Fourth Assessment research products, please visit www.climateassessment.ca.gov. This report advances the understanding of local governments' climate change adaptation finance challenges by examining the nature of those challenges and proposing solutions to address them.

ABSTRACT

Faced with increasing climate extremes and emerging climate change impacts, local governments in California are eager to advance their preparedness and adaptation measures and take action to build local resilience. However, as previous studies and day-to-day interactions with local leaders make clear, determining how to fund adaptation planning and implementation is frequently a significant barrier to progress. This study aims to answer one overarching research question: What is the nature of the funding challenges local communities in California face as they attempt to adapt to climate change? To comprehensively answer this question, it aims to better understand (1) the adaptation funding gap, (2) the nature of the finance challenges faced by local governments, and (3) potential finance solutions. Using a multi-methods approach, including a broad literature review, an online survey, multiple stakeholder workshops and documentary analyses, the study presents multiple findings, intended to be useful to local, regional and State actors, but may also be useful to philanthropy and federal agencies. The study finds financial barriers to be among the most significant adaptation barriers; determines adaptation to be extremely cost-effective; describes 15 unique “archetypes” of adaptation finance challenges (or clusters of interacting barriers) along with possible interventions; and develops an organizing framework of adaptation finance mechanisms that provides an overview of potentially available funding sources. Solutions and future research directions to address adaptation finance challenges are proposed.

Keywords: adaptation, local government, funding, financing, barriers

Please use the following citation for this paper:

Moser, Susanne C., J.A. Ekstrom, J. Kim, S. Heitsch. (Susanne Moser Research & Consulting, Department of Water Resources, Local Government Commission and ICF). 2018. *Adaptation Finance Challenges: Characteristic Patterns Facing California Local Governments and Ways to Overcome Them*. California’s Fourth Climate Change Assessment, California Natural Resources Agency. Publication number: CCCA4-CNRA-2018-007.

HIGHLIGHTS

This study constitutes an innovative, detailed and in-depth social science study of California local governments' adaptation finance challenges and potential solutions. A better understanding of the nature of these challenges constitutes a necessary precursor to developing incisive and appropriate solutions that are tailored and applicable to the wide variety of circumstances in which local adaptation investments need to be made. The study is the most in-depth research of local adaptation funding challenges produced for California and beyond, producing methodological and conceptual advances, and pointing to numerous practical opportunities for alleviating funding challenges.

Key highlights include:

- Funding and financing barriers are among the top barriers to adaptation.
- Many adaptation-related costs are high (though not all), but available evidence suggests they may be widely underestimated and incomplete. At the same time, the limited available data suggest that adaptation is extremely cost-effective compared to inaction.
- Local government staff and those supporting their adaptation efforts consistently bemoan the widespread inadequacy of available funds for adaptation related activities. This concern prevails even today when most local governments have not entered the implementation stage which is significantly more expensive.
- The study identified 15 characteristic patterns of adaptation finance challenges (here called “archetypes”), which we named as follows: *Low Priority, Lack of Champion/Leadership, Conflict of Interest, Disproportionate Burden/Prior Disadvantage, Inappropriate Funding Scale, Disjointed Risk Structure, Inability to Make the Economic Case, Chronic Underfunding or Basic Lack, Siloed Government Syndrome, Lack of Capacity (I and II), Discontinuous Funding, Aversion of Innovation, Funding Biases, Lack of Knowledge About Funding Sources or Happenstance, Eligibility*. Each requires not one “silver bullet” solution to be addressed but a range of complementary interventions to overcome the underlying drivers and barriers. Particular caution should prevail around “solutions” that might reinforce long-standing injustices and disparities.
- The focus on novel funding mechanisms and greater private-sector involvement in funding adaptation is necessary but insufficient and may reinforce existing fiscal capacity disparities.
- Future research should focus on the costs of inaction, the costs of adaptation, and on measures of success and progress to support proactive adaptation. Additional research is needed to deepen understanding of the precise challenges with particular funding mechanisms and how they might be alleviated.

TABLE OF CONTENTS

ACKNOWLEDGEMENTS	i
PREFACE	ii
ABSTRACT	iii
HIGHLIGHTS	iv
TABLE OF CONTENTS.....	v
1: Introduction	1
1.1 Motivation.....	1
1.2 Financial Barriers: The Known and the Unknown.....	1
1.3 Goals and Research Questions of This Study.....	2
2: Methodology	3
2.1 Literature Review	4
2.2 Empirical Data Collection and Analysis Methods	5
2.2.1 Survey	5
2.2.2 Workshops, Archetype Analysis and Coding.....	8
2.2.3 Document Analysis of Adaptation Expenditures and Needs	11
2.2.4 Compilation of Adaptation Funding Mechanisms	13
2.3 Integration.....	14
3: Situating California’s Challenges in the Broader Picture: A Literature Review	14
3.1 Introduction	14
3.2 Barriers to Adaptation.....	16
3.3 Key Concerns Regarding Adaptation Funding and Finance.....	18
3.4 Overview of Economic Analyses of the Cost of Inaction and Action.....	19
3.5 Calculating the Cost of Action and Inaction	21
3.6 Paying for Adaptation.....	25
3.7 Archetypes in Global Change Research.....	28
3.8 Conclusions.....	30
4: The State of Local Adaptation and Experiences with Funding: Survey Results	31
4.1 Introduction	31

4.2 Survey Findings and Discussion.....	32
4.2.1 How Far Along in the Adaptation Process?.....	32
4.2.2 Barriers to Climate Adaptation.....	34
4.2.3 Local Investment in Adaptation to Date.....	38
4.2.4 Funds Needed for Future Local Adaptation Activities	40
4.2.5 Status of Fundraising Efforts.....	41
4.2.6 Adaptation Funding Challenges and How Local Governments Have Attempted to Overcome Them to Date	42
4.3 Conclusions.....	44
5: Archetypes of Adaptation Finance Challenges	46
5.1 Introduction	46
5.2 Adaptation Finance Archetypes	46
5.2.1 Definition of an Adaptation Finance Archetype	46
5.2.2 The Landscape of Adaptation Finance Archetypes	47
5.2.3 The Archetypes: Problems and Possible Solutions	50
5.3 Conclusions.....	73
6: Local Adaptation Finance Experience: Estimating Funding Needs and Locating Funding Sources	74
6.1 Introduction	74
6.2 The Cost of Inaction.....	75
6.2.1 Available Data on the Cost of Inaction	75
6.2.2 Discussion	78
6.3 The Cost of Adaptation	78
6.3.1 Available Data on Adaptation Expenditures to Date	78
6.3.2 Available Data on the Expected Cost of Adaptation	79
6.3.3 Extrapolating Adaptation Costs Statewide	81
6.4 Known and Used Funding and Financing Sources.....	83
6.5 Conclusions.....	87
7: Integration, Recommendations and Future Directions	88
7.1 Synthesis.....	88
7.1.1 Major Advances.....	88

7.1.2 Key Findings and Insights	89
7.1.3 Limitations	91
7.2 Recommendations.....	91
7.2.1 Future Research Directions.....	91
7.2.2 Practical Steps Forward.....	93
7.3 In Closing	93
8: References.....	95
APPENDIX A: Adaptation Finance Survey and Responses	A-1
APPENDIX B: Local Government Adaptation-Related Plans	B-1
B.1 Plans Identified and Included in Our Analysis (Chapter 6).....	B-1
B.2 Additional Analytical Background in Support of the Document Analysis	B-9

1: Introduction

1.1 Motivation

There are 540 municipal and county governments in California, all with differing levels of capability for developing and implementing climate change adaptation actions. Faced with increasing climate extremes and emerging climate change impacts, many of these local governments are eager to advance their adaptation measures and take action to build local resilience. However, as previous studies have shown (Finzi Hart et al. 2012; Ekstrom, Moser and Tom 2011; Measham et al. 2011; Carmin, Nadkarni and Rhie 2012; Bierbaum et al. 2013) and day-to-day interactions with local leaders make clear, determining how to fund adaptation planning and implementation is frequently a significant barrier to progress.

It is critically important to develop ways to assist local governments in their effort to understand and overcome barriers to climate change adaptation financing and implementation. The State of California has recognized this need in its 2016 *Safeguarding California Implementation Plans*, in which it made the task to “identify significant and sustainable funding sources for investments that reduce climate risks, human loss, and disaster spending” a cross-cutting principle (CNRA 2016: p.13).

While climate change is a global problem, its impacts are felt locally, and many adaptation measures will need to be implemented locally in a way that is sensitive to context in terms of geography, ecology, and the social, economic, and political situation. Cognizant of the context in which local governments work on adaptation, namely that they face a wide range of competing short-term community concerns (e.g., education, public safety and justice, health care and the provision of community infrastructure and critical social services) finding funding for measures to protect local communities against increasingly pressing climate change challenges is thus a complex, difficult and often a political challenge.

To date, the precise nature of these complex challenges is not well understood, thus inhibiting the development of adequate policy interventions to address them. This study, prepared under Theme 7: Funding and Implementing Adaptation Projects and Measures in California of the State’s Fourth Climate Change Assessment, aims to help fill this key knowledge gap, namely to provide an in-depth and systematic examination of adaptation finance challenges and solutions.

1.2 Financial Barriers: The Known and the Unknown

In this study we focus on what is loosely defined as the “10th Sector” – a unique focus on local government within *Safeguarding California*, California’s statewide adaptation strategy.¹ The reason for this focus is that – despite climate change being a global problem – local governments often take the lead in identifying adaptation needs and options and are then required to find

¹ Originally, the statewide adaptation strategy (California Natural Resources Agency 2009) was focused on nine distinct sectors: Agriculture, Biodiversity and Habitat, Emergency Management, Energy, Forestry, Ocean and Coastal Ecosystems and Resources, Public Health, Transportation, and Water. Since the 2016 Implementation Plan (CNRA 2016), it includes a tenth sector, namely Land Use and Community Development, focused on local communities.

external funds or devise locally acceptable financing mechanisms to implement them. This places a significant burden and responsibility for the safety of the state's residents.

Past research has made abundantly clear – in California and beyond – that finding the necessary means to pay for adaptation is a widespread and serious problem for local governments and others. Studies completed over the past 5-10 years in California found that lack of funding for both adaptation planning and implementation is among the leading barriers to adaptation (Finzi Hart et al. 2012; Moser and Ekstrom 2012; Bedsworth and Hanak 2013). In fact, against the backdrop of the economic crisis of the first decade of the 21st century, finding the necessary means for adaptation was a challenge even for wealthy communities (Moser and Ekstrom 2012). While in their analysis, adaptation finance ranked among the top three but was not the most important barrier cited, they noted that local and regional adaptation efforts were so early that funding had not yet become the overriding issue.

Since then, adaptation efforts have been notably advancing (Moser, Coffee and Seville 2017), yet funding barriers still rank among the top impediments to moving from risk awareness to planning, and from planning to implementation (Moser et al. 2018).

These findings are by no means unique to California. US-wide and global surveys have identified funding for adaptation planning and implementation as a persistent challenge (Aylett 2014; Bierbaum et al., 2012, 2014; Carmin, Nadkarni and Rhie 2012). Internationally, the problem is discussed at the highest levels, to identify ways and means to support adaptation in the least developed countries (UNFCCC 2008; AGF 2010; Trabacchi and Mazza 2015), and there is a similarly growing focus on identifying adaptation resources within the US. Doing so, however, is viewed as seriously hampered since the change in federal administrations in 2017 (Moser, Coffee and Seville 2017). With limited federal and other public funding sources, the private sector is increasingly called upon to provide a greater portion of adaptation funding.

Whether or not this nearly exclusive focus on funding mechanisms is appropriate – to our knowledge – is unclear, however, as the precise nature of local funding challenges has not been established. Nor are there estimates available for California (or any state) for how much money has been spent on adaptation to date and how much more is needed to support local adaptation. Furthermore, there is no clear understanding of the extent to which and in what ways that need is currently being met.

1.3 Goals and Research Questions of This Study

Our study aims to contribute to finding feasible and effective solutions to the adaptation finance problem by answering one core research question: *What is the nature of the funding challenges local communities in California face as they attempt to adapt to climate change?* A number of sub-questions need to be explored to comprehensively answer this question, namely:

- **FUNDING GAP:** How big is the funding need? And how are local communities currently trying to meet it? Thus, can we specify the adaptation funding gap between need and availability?
- **NATURE OF FINANCE CHALLENGES:** What are the challenges specifically, including their underlying drivers? What are their immediate effects on the ability to generate adaptation funding?

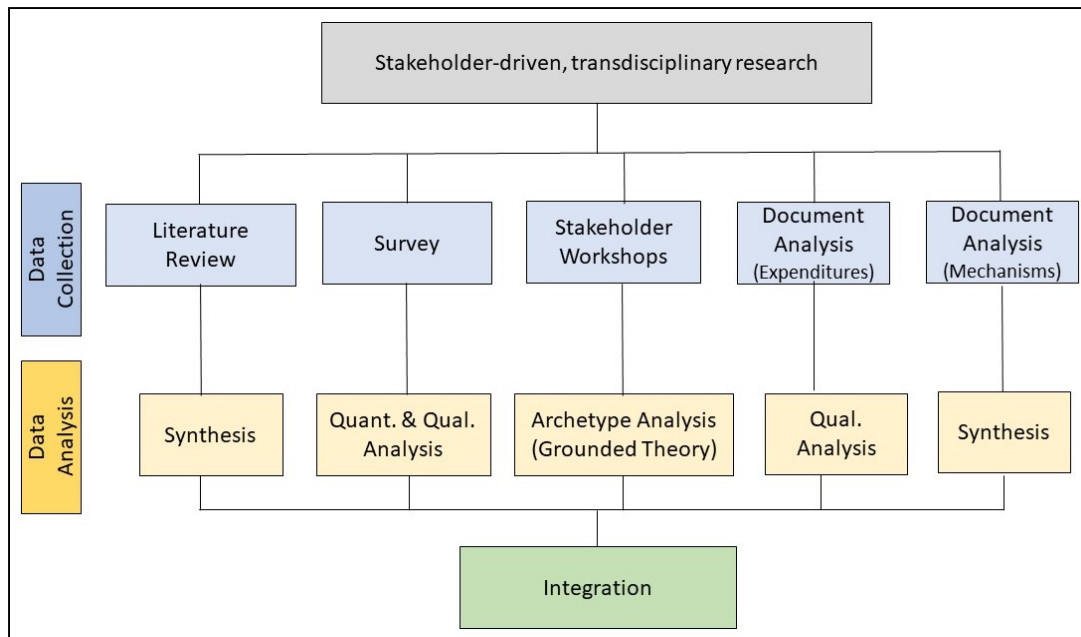
- **FINANCE SOLUTIONS:** What possible and feasible solutions exist to address these challenges? Do presently available or discussed funding mechanisms sufficiently address the funding challenges?

Answering these questions will provide local governments with actionable information for making effective adaptation finance decisions for their communities and provide insights to higher-level policy makers on policies that can effectively support local adaptation efforts. Because adaptation finance is not currently and cannot solely be addressed at the local level, this study aims to help support local, state and (perhaps) federal policy-makers as well as private sector and philanthropic funders in their efforts to develop adaptation finance solutions. We believe their interventions will be more effective when it is based on a solid understanding of the nature of existing adaptation finance challenges.

2: Methodology

The goal to better understand the persistent adaptation finance challenges experienced by local communities is fundamentally driven by the research team's commitment to help find feasible solutions for one of the most vexing challenges local communities face when attempting to prepare for and deal with the consequences of climate change. It is our overarching research question (what is the nature of these funding challenges?) and our ethical and professional commitment that drive our research approach, namely to approach the central matter of concern in a collaborative, transdisciplinary and sensitive way.

We employed multiple methods of data collection and analysis to ensure the greatest possible depth of investigation and robustness of the study (Figure 1). Foundational to this research is the solution-oriented and user-engaged nature of our approach. The various methods are described below along with notable data restrictions. Importantly, the research methods focused on different sub-questions, were deployed largely in parallel, rather than sequentially, and as such allow for triangulation. Each research component was carried out by different sets of research team members, but the overall approach was designed collaboratively and overseen by the lead author to ensure project coherence.



Source: The Authors

Figure 1: Methods Employed to Examine Patterns of Persistent Funding Challenges by California Local Governments

2.1 Literature Review

Over the entire course of the project, members of the research team (Moser, Heitsch, Dix, Kay) collected relevant literature on adaptation funding. This largely grey-literature collection was augmented with a systematic search for relevant adaptation literature using the EBSCO and Web of Science search engines. Search terms included (“adapt*” AND “climat*” AND “fund*”), (“adapt*” AND “climat*” AND “financ*”), (“cost” AND “adapt*” OR “action” AND “climat*”) and (“cost” AND “adapt*” OR “inaction” AND “climat*”) without data, geographic or publication type restrictions.

Surprisingly, items found via EBSCO and Web of Science had only a small percentage of overlap, giving us confidence that – between the two – essential literature was uncovered. After initial exclusion of unrelated items, all relevant items were considered in describing overall trends in this emerging area of research and practice, i.e., including work focused on developing and developed countries. Specific emphasis was given, however, to literature focused on the US and California, where available, to describe context, areas of focal attention, and gaps in understanding.

The main contribution of this review to the study is to contextualize our research, define key concepts, provide insights into funding mechanisms, and more generally, to better situate the specific funding challenges faced by local governments in California in the broader context.

In addition to adaptation funding specific literature, a separate search was undertaken to contextualize a central research method used in this study, namely archetype analysis. Web of Science and Google Scholar searches for studies using similar and related approaches (e.g.,

archetypes, syndromes, action situations) were conducted to place the present study in the appropriate conceptual and methodological context.²

2.2 Empirical Data Collection and Analysis Methods

The empirical portion of the research involved an online survey, stakeholder workshops, an in-depth review of local government adaptation plans and related implementation documents, and a compilation of adaptation funding mechanisms currently available to local governments. Each is described in more detail below.

2.2.1 Survey

2.2.1.1 Survey Questions

We developed a survey to collect background and contextual information for the stakeholder workshops described below, but more broadly to gain insights about adaptation efforts by local government entities in California. The survey contained 19 questions; most of them involved simple nominal or rating questions. Six questions focused on demographics; five were about climate change adaptation more generally, including a broad set of barriers to adaptation; the remaining eight questions were focused on funding and financing adaptation. Appendix A provides the survey questions.

2.2.1.2 Sampling and Survey Duration

The link to the online survey was distributed through several listservs, email contact lists for the Alliance of Regional Collaboratives for Climate Adaptation (ARCCA)³, the Local Government Commission (LGC), and to attendees of the Second California Adaptation Forum (CAF, Long Beach, September 7-8, 2016). It was also shared via a project website set up by LGC and at the California Climate Science Symposium (January 25-26, 2017) to reach the widest distribution, rather than specifically representing a bounded population. Reminders were repeatedly sent to contact lists to which the research team had ready access. The survey was open to respondents for a 13-month period from June 28, 2016 and July 27, 2017. Participation in the survey was not tied in an obligatory sense to participation in any other part of the study. Due to the distribution (sampling) method, we cannot construct a response rate. Instead, the responses create a non-parametric dataset, i.e., neither the data, nor its summary statistics, provide a representative sample of all local governments in California. In other words, if we report that x% of respondents from local governments expressed that funding climate adaptation is the main hurdle impeding their planning for climate change impacts, it does not necessarily allow us to conclude that that same x% of all local governments in California share that view.

2.2.1.3 Criteria for Data Inclusion

Survey questions were optional, so that for any given question a participant could skip to the next question without having to answer the previous question. This typically creates a lower

² In addition, the research team was able to draw on a personal collection of references on archetype analysis kindly offered by Dr. Christoph Oberlack (University of Berne, Switzerland) to the lead author.

³ ARCCA is a network of regional collaboratives from across California. The Local Government Commission (<https://www.lgc.org/>) serves as its coordinator. Each collaborative, and the statewide network of regional collaboratives, aims to advance adaptation statewide and increase local capacity to build community resilience (see <http://arccacalifornia.org>).

response rate per question but can also help prevent early drop-off from potentially frustrated respondents when they want to get through the survey more quickly (Dillman et al. 2009). As with any survey dataset, we reviewed the dataset to identify and eliminate those that did not meet our standards.

The criteria required for inclusion are as follows:

- Respondents must have answered one or more substance question, beyond the question of “do you collaborate...?”, thus fulfilling the criteria of being a partial or complete survey.
- Repeat respondents must have not already submitted a survey that met criteria #1.

We collected a total of 333 online survey responses, of which 251 met Criterion #1, i.e. respondents answered at least one substantive question. Criterion #2 implied that those responses associated with the same name and/or email address were removed if there was a prior complete or partial response associated with the same name and/or email address. The earliest dated eligible response was kept as part of the final dataset.

As a result, of the 251 acceptable responses, 18 were omitted from the analysis because they were identified as duplicates submitted by individuals on different occasions. The remaining 233 responses (70% of surveys started) were used in the statistical analysis. When discussing results, the question-specific number of respondents (N) is included, given that not all respondents answered every question.

2.2.1.4 Potential Biases in the Sample

There are 482 municipalities and 58 counties, for a total of 540 local governments in California. We received 233 valid survey responses, 173 respondents (or 74%) of which work for or with a city or county. Thus, we can assume to have captured a good proportion of local governments across the state. It is likely, however, that these responses are biased toward those more interested in and already working – in one way or another – on climate change adaptation, with fewer respondents who do not yet engage on this topic.

To better characterize our sample of responses and assess the potential for generalizability absent a known response rate, we compared the geo-location of respondents to the geographical distribution of cities and counties across the state. Table 1 and

Table 2 (see corresponding Figures in Appendix A, A.2 and A.3) compare the representation of cities and counties, respectively according to size. They show that our survey sample underrepresents small cities and counties and overrepresents large cities and counties. Only mid-sized cities are comparable in representation. This might indirectly confirm our suspicion that the survey might be biased toward respondents who are interested and engaged in climate change adaptation, possibly due to the more liberal leanings of larger urban settings or due to greater capacity to address adaptation.

Table 1: Distribution of California cities by size (based on US Census 2012) and of respondents' locations (based on reported affiliated city size)

Size of cities	Number of cities in CA (N=459)	Percent of total in California	Number of city respondents in survey (N=90)	Percent of city respondents in survey
<25,000	200	44%	17	19%
>25,000 - 50,000	90	20%	11	12%
>50,000 - 100,000	101	22%	22	24%
>100,000 - 500,000	63	14%	32	36%
>500,000	5	1%	8	9%

Source: The Authors

Table 2: Distribution of California counties by size (based on US Census 2012) and of respondents' locations (based on reported affiliated county size)

Size of counties	Number of counties in CA (N=58)	Percent of total in California	Number of county respondents in survey (N=45)	Percent of county respondents in survey
<25,000	9	16%	3	7%
>25,000 - 50,000	6	10%	1	2%
>50,000 - 100,000	8	14%	2	4%
>100,000 - 500,000	18	31%	20	44%
>500,000	17	29%	19	42%

Source: The Authors

As for the similarity of our survey sample in terms of the geographic distribution of respondents across the state, we placed CA cities and counties into the climate regions used in the Fourth Climate Change Assessment (CCA4)⁴ and compared the representation in the survey to the statewide distribution based on the US Census. Table 3 shows that comparison, illustrating that the proportion of city respondents was similar to proportions across regions statewide. For example, according to the 2012 US Census, 36% of CA cities are in the Los Angeles climate region and 34% of our respondents worked with or at cities in the Los Angeles region. Only a few regions are inadequately represented in the survey: for example, the San Joaquin Valley and Inland South are underrepresented, and San Francisco Bay Area is overrepresented in our survey compared to their Census-based prominence.

Table 3: Comparison of the Representation of Cities by Climate Region, Statewide and in the Survey

CCA4 Regions	Number of cities in CA (N=459)	Percent of total cities	Number of city survey respondents (N=90)	Percent of city survey respondents
--------------	--------------------------------	-------------------------	--	------------------------------------

⁴ To examine responses across regions within California, individual responses were tagged with a regional identifier, based on how respondents answered Question 2 "Please indicate the city or county you work with or serve. This is not for identification purposes, but to collate survey responses by region." The regional identifiers were derived from the climate regions created by the CCA4 team.

Central Coast	33	7%	9	10%
Inland South	23	5%	0	0%
Los Angeles	164	36%	31	34%
North Coast	23	5%	3	3%
Sacramento Valley	35	8%	9	10%
San Diego	18	4%	7	8%
San Francisco Bay Area	84	18%	27	30%
San Joaquin Valley	59	13%	2	2%
Sierra Nevada Mountains	20	4%	2	2%

Source: The Authors

In summary, while we cannot assess the statewide representativeness of our survey sample *statistically* by providing an assessment of the response rate, we can describe our sample in qualitative ways: it is likely biased toward more adaptation-interested and -engaged respondents, representing local governments across California, but particularly well from larger cities and counties and less well from smaller inland governments. This may well reflect the observation that larger cities are further advanced in their adaptation efforts, and thus more likely to run into finance challenges and thus more interested in the topic of this study.

2.2.2 Workshops, Archetype Analysis and Coding

2.2.2.1 Objectives

The project team held nine stakeholder workshops across the state, with the specific objectives of (1) hearing directly from local government staff and from organizations supporting local government efforts on the financing and institutional barriers cities and counties faced; and (2) discussing and exploring potential strategies to overcome these barriers.

To ensure opportunity for engagement from a wide variety of local governments – big and small; coastal and inland; north, central and south – we convened stakeholders in San Diego, Los Angeles, the Central Coast, the San Francisco Bay Area, the Capitol Region, the Central Valley, the North Coast, and the Sierra Nevada, and in an open workshop (without regional specificity) at the 2016 Third California Adaptation Forum in Long Beach.

2.2.2.2 Recruitment

The primary sources from which workshop participants were recruited included ARCCA email contact lists of local government officials and other individuals engaged in adaptation work across the state as well as LGC email lists of local government officials. While the ARCCA contact list is more specific to adaptation, it is more biased toward regions that already have established or emerging regional adaptation collaboratives, whereas the LGC email list is less specific to adaptation but provides better coverage across the state. The research team also sent personal invitations to any collaborators they knew in different regions across the state.

Workshop participation was open to any local government staff and anyone working with local governments on climate adaptation (e.g., consultants, NGO representatives, State agency personnel). Workshops were not size-restricted, but an online registration process (involving responding to the above described survey) was used to adequately prepare logistics for each event. Participation was uneven across the nine workshops, reflecting the size of interested and engaged individuals in each region. The pattern largely followed regional representation in the survey, with most participants from the major metropolitan regions, those attending the

California Adaptation Forum, and fewer participants from other regions. Between the nine workshops, there was a total of 149 participants.

2.2.2.3 Facilitation

The half-day workshops were organized into two main sessions. The first of these focused on the adaptation funding challenges, while the second focused on institutional barriers to adaptation (the latter is not further discussed in this report as a separate project report was prepared summarizing that effort; see Kay et al. 2018, *in review*). The project team served as facilitators.

The more specific aim of the funding-focused part of the workshop was to collect information about (a) the size of the funding and financing gap for California local governments, (b) existing economically and politically feasible financing options available to fill this gap, and (c) the nature of the financing challenges and how they can be overcome. The session aimed to answer these questions by (a) generating as much information as possible about the full range of adaptation funding-related challenges that local governments face and (b) engaging participants in sharing and learning about possible ways to minimize or overcome the financing challenges identified.

The workshop began with an introduction and framing of the session. The team highlighted that the session would focus on funding adaptation and climate change preparedness and resilience building efforts, and that any and all related activities and expenditures could be considered part of the conversation. The team also acknowledged that local governments are at various stages in their adaptation efforts, and will therefore vary in experience, knowledge and need. Due to this variance, the team noted that the session would focus on identifying common funding challenges that participants have encountered in other parts of their work; explore to what extent funding adaptation is similar to these common challenges; and examine what if anything is unique about the challenges around funding adaptation. Furthermore, the team noted that mainstreaming adaptation into other efforts (e.g., hazard mitigation planning and general plan updates) was within the workshop scope. Lastly, the team stressed that the session aimed to have a conversation that delved deeper than the oft-heard complaint that there is not enough money. The workshop aimed to explore whether there are challenges in applying for money, accessing or accepting money, limits on what money can be used for, administering money and so on to determine the exact nature of the finance-related problems participants face.

After the framing and introduction, the team engaged in a brainstorming session. Five "stations" (big notepads on tripods) were set up to explore funding challenges from different perspectives:

- Funding issues by **sector** (e.g., coastal, vs. wildfire, vs. health);
- Funding issues by **stage in the adaptation process** (e.g., completing initial assessments, planning, implementing actions or monitoring etc.);
- Funding issues by **size of community** (e.g., work for/with a smaller community vs. a larger city);
- Funding issues by **type of funding source/instrument** (e.g., from a State or federal agency, a foundation grant, or their own general funds; a tax or fee-based source vs. a bond or a grant); and,

- Funding issues that apply to **cross-cutting adaptation needs** (adaptation-related expenditures, e.g., outreach vs. shovel-ready projects)

Participants were given sticky notes to write down up to three issues that fell into one of the categories. They then placed these sticky notes on the corresponding notepads. Discussion circles of participants interested in a particular topic formed around each of the five stations to talk about the ideas generated in the brainstorm. Facilitators guided the sharing and discussion of the nature of the challenges written on the sticky notes. Any additional issues identified during the discussion circle were documented on a sticky note and added to the board. Participants then were asked to rotate to another station of interest, and another round of discussion deepened the understanding of the issues raised. Detailed notes were taken by pre-assigned note takers during these rounds of discussion.

Participants then reunited into the big workshop group, and facilitators led a debrief, focusing on the most difficult and complicated issues, the most common issues, and notable insights from the discussion circles. Facilitators also probed further with questions about how funding challenges have been overcome, how foundations, State and federal governments, and others can facilitate overcoming the challenges, what other support would be helpful, and any other ideas. Again, detailed notes were taken by pre-assigned note takers.

2.2.2.4 Archetype Analysis

The majority of available examples of archetype analysis are either expert elicitations or theory-driven (deductive) quantitative meta-analyses of existing case studies. Such studies typically involve elaborate searches for qualifying case studies, extensive coding of eligible studies or identification of quantifiable indicators, followed by qualitative or quantitative analyses of the information such as cluster analysis, principle component analysis, qualitative comparison analysis or fuzzy logic modelling to derive common patterns of associated factors that constitute the archetypes.

This approach was deemed not applicable to generating a first understanding of the persistent patterns of adaptation barriers that result in the adaptation funding challenges experienced by local governments in California. Instead, grounded theory (Glasser and Strauss 2011; Walsh et al. 2015) was used as a methodological innovation in archetype analysis. This bottom-up, inductive approach begins from letting stakeholders (after all, experts in their own funding problems) name and explain the funding challenges they experience. Post-workshop coding and sorting into larger categories by the researchers allowed repeated challenges to rise to the fore.

2.2.2.5 Coding

After each workshop, notes from all note takers were collated and once all workshops were completed, compiled and coded, using an iterative inductive-deductive and associative approach. In the first read, the workshop notes were screened independently by two researchers (Moser and Ekstrom) for repetitive themes or funding challenges; subsequent reads involved coding for associated challenges, contributing factors, underlying causes and conditions, and consequences of the challenges identified.

Care was taken to retain the associations between factors as they were discussed by workshop participants, rather than separating them on the basis of some pre-conceived logic. In other words, the coding approach was not driven by any single theory or underlying framework (as

is called for in the typical, deductive approaches to archetype analysis, see, e.g., Eisenack 2012), but rather adhered to the inductive approach of grounded theory. Moreover, initial coding rounds revealed factors not captured in any single applicable theory. For example, diagnostic approaches to understanding institutional barriers to adaptation (e.g., Oberlack 2017), make “funding resources” one of several explanatory variables of adaptation outcomes, but provide little depth to the many dimensions of these funding resources that are of central interest to this study. Other approaches have a sufficiently broad empirical basis to propose directional interactions among explanatory factors and expected outcomes that we deemed inappropriately early for a first-order identification and understanding of archetypal funding challenges (e.g., Kimmich 2013). However, the observed preponderance of institutional factors caused us subsequently also to examine the workshop notes deductively for additional items typically highlighted in studies of institutional settings and governance systems (e.g., Ostrom 2007, 2009, 2014; Young 2010). The coding also retained information about where particular challenges were identified (i.e., the region or sector); however, this turned out to be of small if any relevance, as nearly all core challenges associated with adaptation funding were identified in nearly every region and most cut across sectors.

Finally, a deliberative search for patterns among initial and second-order coding clusters revealed repetitive associations between factors, namely:

- observed funding challenges;
- core sources or focal points of each challenge;
- a set of underlying contributory factors; and,
- characteristic (and defining) outcomes.

Together, they resulted in 15 unique archetypes, several with notable sub-types/variants or specific expressions in different contexts.

2.2.3 Document Analysis of Adaptation Expenditures and Needs

2.2.3.1 Objective

In an attempt to specify adaptation-related expenditures and obtain a sense of adaptation funding needs by local governments in California to date, members of the research team (Kim and Scheurer) conducted two rounds of a California-specific document review – in December 2016 and again in December 2017. We compiled and reviewed California local government adaptation plans, vulnerability assessments and related documents (e.g. adaptation strategies, adaptation funding assessments).

2.2.3.2 Document Sources

First, we drew on OPR’s 2016 Annual Planning Survey (Office of Planning and Research 2016) to identify local governments that indicated working on climate adaptation. This survey can be considered the most comprehensive survey of local governments conducted roughly biannually in the state. In 2016, 404 of 540 California cities and counties (74.8%) completed that survey. Of these, 85 (21%) said they addressed climate adaptation in their general plans; 25 (6%) stated they addressed it in a separate special plan. More than half (227 or 56%) said they did not

address it in their General Plans, 22 (5%) did not know and 48 (12%) did not provide an answer. This information provided a first set of potential plans to examine.

The team then conducted a document search on Google, using search terms such as “California vulnerability assessments”, “California Adaptation Plans”, “California Adaptation Strategies.” We also searched the Georgetown Climate Center’s Adaptation Clearinghouse (see <http://www.adaptationclearinghouse.org/>) for California-focused resources. In addition, the team elicited submissions from the 300 members of the ARCCA network but did not receive any additional items not already identified through the other search approaches.

Overall, our search led to 63 plans, assessments and reports that were reviewed in detail for information on estimated cost or value of assets at risk to climate change impacts (i.e., the potential cost of inaction), estimated or actual costs for adaptation activities and projects, adaptation funding needs, funding sources and financing mechanisms used by local governments to support their adaptation efforts.

2.2.3.3 Data Restrictions

A consistent assessment of adaptation-related expenditures in California is not possible at this time. This is largely due to restrictions in the available data. For example, there is no clear definition of adaptation or classification of adaptation projects/ activities provided by the State and understanding of adaptation varies across local jurisdictions. Moreover, many local governments are undertaking projects that include an adaptation element, but we were not able to parse out how much of the total project budget is dedicated to adaptation. Even where plans or assessments focus on adaptation alone, most provide little to no information on projected or incurred expenditures, nor do they highlight viable funding sources or financing mechanisms. For those that do include such information, it is at a very high level and primarily indicates projected costs, not actual costs.

It is further made difficult to assess local government expenditures when local governments are “creative” in their funding, either by using local or State sources not expressly dedicated to adaptation or by leveraging other funding streams. For example, many local governments are leveraging climate mitigation funds to achieve adaptation co-benefits which are typically not monetized (e.g., energy efficiency funds through rate payer-funded local government partnerships or programs administered by IOUs⁵). Note also, while many State grant programs have begun to incorporate adaptation and resiliency as goals, for some it is only optional (e.g., California’s Strategic Growth Council’s Transformative Climate Communities Program⁶). Even for grant programs that mandate an adaptation element, it would be inappropriate to deduce that the full amount of the grant program is adaptation funding since they typically have multiple program priority areas (e.g., GHG emissions reduction).

⁵ According to an online dictionary, IOU stands for “I Owe yoU. Non-negotiable debt instrument addressed to a creditor, dated, and signed by the borrower. It serves as an informal acknowledgment of a debt of a specified sum but (depending on the terminology used) may or may not serve as an evidence of debt in a court” (<http://www.businessdictionary.com/definition/IOU.html>).

⁶ For more information, see: <http://sgc.ca.gov/Grant-Programs/Transformative-Climate-Communities-Program.html>.

The overall budget and timeline for this research project did not allow for an in-depth review of financing needs and sources on a project-by-project basis for all local jurisdictions. But given the above-mentioned data restrictions, we would deem even such a more detailed compilation severely limited.

2.2.4 Compilation of Adaptation Funding Mechanisms

2.2.4.1 Opportunity

A valuable extension of the originally proposed study emerged as the project got underway. As local communities and the State's Office of Planning and Research (OPR) became aware of this study (e.g., through the survey and workshops), opportunities for synergisms became apparent, particularly in light of the work underway under the auspices of OPR's Integrated Climate Adaptation and Resiliency Program (ICARP), established through Senate Bill 246 (Wieckowski, Public Resources Code Section 71354) in 2015.⁷ The Adaptation Clearinghouse – one of the tasks under ICARP – aims to provide State, regional and local government entities with adaptation resources, including information about funding sources.⁸

In addition, San Mateo County engaged students at Stanford University's Public Policy Program in a senior practicum project to identify appropriate funding sources for several anticipated local adaptation projects. San Mateo County Office of Sustainability staff were aware of the present study and connected the students with our team. One of the research team members (Moser) had developed a framework of adaptation funding and financing mechanisms, which the students then used as guidance to create a compendium of such funding sources.

2.2.4.2 Framework

The framework consists of a matrix describing different funding vehicles along a number of different criteria. It first provides a basic categorization of funding and financing options, derived from the literature review (described above). The descriptive criteria are derived from the literature, survey and workshop discussions. Conversations with staff of San Mateo County and OPR helped verify that they are of interest and importance to local governments.

2.2.4.3 Data Compilation

Funding mechanisms, once categorically identified through the literature review, were then described along the criteria using largely online searches, documents provided by San Mateo County to the Stanford students and a compendium of financing sources prepared for the San Francisco Bay Resilient By Design competition (Resilient by Design Bay Area Challenge, 2017), which became [available](#) toward the end of this project. A similar resource was developed by the Sustainable Solutions Lab (UMass-Boston; see Levy and Herst, 2018). Descriptions of funding mechanisms not described by the Stanford group were added by the research team (ICF staff), using relevant online resources.

⁷ For more information, see: <http://www.opr.ca.gov/clearinghouse/adaptation/>.

⁸ OPR points interested parties to the State's (Air Resources Board) Funding Wizard at <https://fundingwizard.arb.ca.gov/>, even though that tool is not specific to adaptation-related needs. In addition, it now points users to a suite of potential state funding programs and other grant aggregation sites (see: <http://resilientca.org/topics/investing-in-adaptation/>).

2.3 Integration

The various research components described in this report were extensive, time-consuming and multifaceted, each comprising a study in itself. Each is reported on in separate sections. However, while each of these sections reveals important findings about the state of adaptation funding and the needs of local government, we believe the integration of them all – even if largely qualitative at this point – builds a compelling picture, from which much future research and immediate policy action can be launched.

The literature review serves as background and as independent cross-check of observations emerging from the survey, workshops and adaptation document review. Survey results are linked to the discussion of archetypes of funding challenges. The review of adaptation expenditures to date are discussed considering the range of funding mechanisms theoretically available. Likewise, funding mechanisms are discussed in light of the archetypes to explore how well they address existing needs and challenges. From this integrative view of our research findings we derive recommendations for future research and policy action.

3: Situating California's Challenges in the Broader Picture: A Literature Review

3.1 Introduction

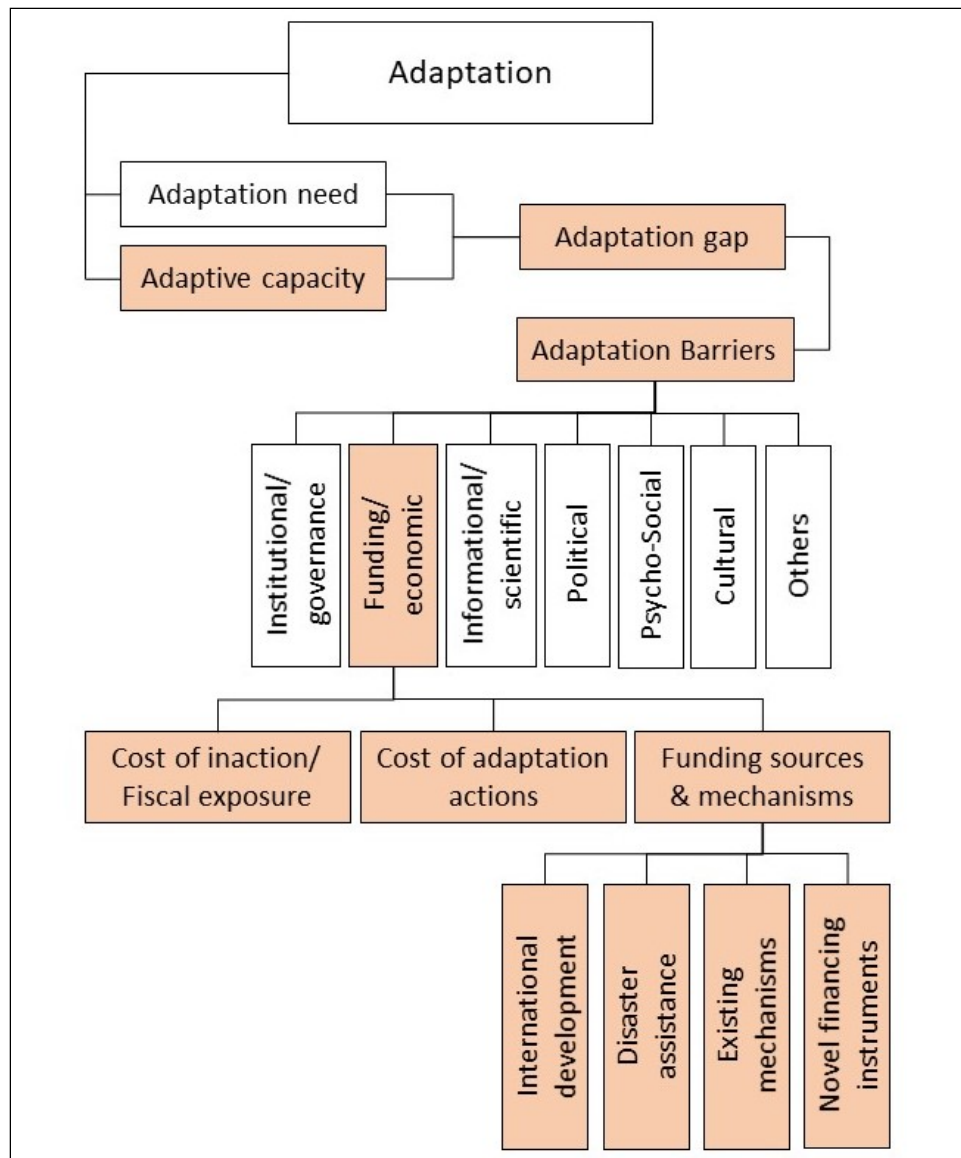
This literature review aims to place the current study into the broader context of adaptation barriers as well as work on adaptation funding challenges and their solutions. Our search for grey literature and our systematic search in academic search engines resulted in ca. 250 studies and reports relating to climate adaptation and its barriers, costs of implementation, and funding sources. Economic studies of adaptation and climate change impacts have long been an area of expert knowledge but those insights are not necessarily common knowledge among local government officials and the organizations that support their adaptation work. We have thus chosen to provide this review at some level of detail. Even so, we discuss the available literature in a summative fashion, yet reference it only selectively.

Adaptation to climate change – while studied for several decades – became a prevalent topic in practice only in the past decade and a half. Internationally, adaptation first became a major strategy to addressing climate change impacts at the 2001 UN Climate Change Conference of the Parties (COP 7) in Marrakech, and the 2009 Copenhagen Accord at COP15 saw the first monetary pledges from developed countries towards adaptation in developing countries (Ciplet et al. 2013). In the US, adaptation began to be seriously considered in both policy and practice in the second half of the first decade of the 21st century (after Al Gore's movie *An Inconvenient Truth* [2006], the Fourth IPCC assessment [2007], and the failure of the federal Waxman-Markey Bill [the American Clean Energy and Security Act of 2009]). The failure to reduce emissions underlined the need to address climate change impacts through adaptation. Nearly simultaneously, California began paying serious attention to adaptation in 2008 with Governor Schwarzenegger's Executive Order [S-13-08](#).

There had been a long-standing focus in the literature on adaptive capacity to explain differences in adaptation actors' ability to take adaptive actions, including economic factors (Brooks and Adger 2005; Gallopín 2006; Engel 2011). Considering the slow pace at which adaptation has proceeded to date, the more recent literature on adaptation has bemoaned and tried to explain the growing gap between the need to adapt and the rate and scale at which planning and implementing of adaptive actions is actually occurring (Bierbaum et al. 2014; Klein et al. 2014; Nobel et al. 2014). At the international level, this led to the definition and quantitative assessment, of the observed "adaptation gap" between the amount of adaptation needed and being implemented (UNEP 2014; Koh, Mazzacurati and Swann 2016). The adaptation gap in UNEP's conceptualization is a function primarily of economic and technological factors. The related but not identical notion of a "resilience gap" was proposed recently in the US (Spanger-Siegfried et al. 2016). It is defined as the gap between the amount of (simultaneous) mitigation and adaptation needed and the climate actions that have been implemented, in a socially equitable way, to keep communities safe.

Within these larger conceptual developments, a dedicated focus on studying economic, funding and financing of adaptation has emerged only very recently, with about half of the academic articles (80 out of 158) and most of the grey literature (nearly 100 items) reviewed for this study published after 2014.

Figure 2 provides a concept map of the work we reviewed, providing an overview of major topics in the literature and their relationships to each other, with concepts in white boxes providing the larger context and concepts in colored boxes pointing to the line of thinking directly relevant to adaptation finance.



Source: The Authors

Figure 2: Concept Map of Topics Directly Relevant to the Study of Adaptation Funding Challenges and Their Solutions

3.2 Barriers to Adaptation

Despite the emerging climate change impacts and apparent necessity to prepare for and deal with these impacts and disruptions, adaptation has not seen widespread implementation worldwide or in the US (Moser, Coffee and Seville 2018; Sovacool, Linner and Klein 2017; Bierbaum et al. 2014; Klein et al. 2014). There is strong consensus on overarching barrier themes – institutional, informational, and resource/financial constraints – but there are also many other, more nuanced barriers within and exacerbating these broader challenges. Researchers also agree that barriers are highly context-specific (Moser and Ekstrom 2010; Measham et al. 2011).

In the context of international funding (particularly in relation to development), scholars persistently note the gap between the funds needed and funds made available to countries most vulnerable. Multiple factors are noted to explain that gap:

- *Bureaucratic hurdles* on the side of the funders, such as lack of agreement or understanding over what counts as adaptation or what should be funded (Biagini et al. 2014, Bouwer and Aerts 2006, Hall 2017, Matthews et al. 2015).
- The *lack of any legally binding obligations* under the UNFCCC for Annex-I countries⁹ to support adaptation (Bouwer and Aerts 2006); and sometimes substantial, but voluntary pledges.
- On the receiving end (i.e., developing countries), barriers largely relate to *institutional capacity constraints* (i.e., management of funds and corruption [Junghans and Kohler 2016]) as well as barriers rooted deeply in the fundamental problem of poverty, such as *lack of knowledge, capacity, information, and fiscal capacity* (Shackleton et al. 2015; Hacke et al. 2015).

More generally – i.e., apart from the international funding context – studies examining local adaptation barriers repeatedly identify institutional dilemmas and fragmentation, devolution, and other aspects related to governance as well as a lack of financial resources and political barriers as the greatest obstacles to advancing adaptation (Adams et al. 2015; Bedsworth 2009; Cortekar et al. 2016; Den Uly and Russel 2018; Hanemann, Lambe and Farber 2012; Hughes 2015; Juhola 2016; Lonsdale et al. 2017; Lubell 2017; Oberlack 2017; Root et al. 2016; Schenk and Ferguson 2012; Uittenbroek et al. 2013; Ekstrom, Moser and Torn 2011). However, some find that strong leadership can help overcome some of these constraints (Vignola et al. 2017; Shi et al. 2015; Moser and Ekstrom 2012).

These findings are echoed in the literature pertaining specifically to the United States and California, where five barrier themes emerge repeatedly:

- financial/resources;
- institutional/governance/legal;
- staffing capacity;
- informational/uncertainty;
- attitudinal; and,
- political.

Of these, financial and resource constraints are indeed the most frequently discussed, with nearly three-quarters of articles mentioning such barriers. Notably, none to date has explored this class of funding-related barriers in any detail, neither at the federal, state or local level. However, Moser and Ekstrom (2010) in their diagnostic framework of adaptation barriers

⁹ Annex-1 countries in the context of the UN Framework Convention on Climate Change (UNFCCC) include industrialized countries that are members of the OECD and countries in transition (see: http://unfccc.int/parties_and_observers/items/2704.php).

introduced the concept of “legacy barriers” to point to the historical roots of many barriers and that those require deeper work to be resolved.

Some barrier studies explicitly rank the importance of different barriers, and often (but not always) find funding to be the leading barrier. For example, Finzi Hart et al. (2012) found in coastal California that three of the four biggest hurdles to adaptation based on the 2011 Coastal California Adaptation Needs Assessment survey related to insufficient resources and lack of funding – a finding strongly reiterated in the 2016 follow-up survey (Moser et al. 2018, *in review*). Ekstrom and Moser (2012) found that the third-highest category of barriers to adaptation in local and regional governments in the San Francisco Bay Area was resource and funding issues. However, they also found that institutional governance issues and attitudinal issues can rank higher than resource and financial constraints. The handful of articles that do not discuss financial or resource constraints at all are commonly focused on one type of barrier, such as informational constraints or institutional barriers.

An additional funding-related challenge for adaptation is the perceived tension between adaptation and mitigation, particularly the idea that paying for one may need to come at the expense of the other (Measham et al. 2011; Moser 2012). There has been a bias in both the literature and in funding towards mitigation (Bendandi and Pauw 2016; Haemekoski and Sinkko 2016; Locatelli et al. 2016; Berry et al. 2015; Ruth et al. 2010). While most papers argue that adaptation is cost-effective (compared to no action; see discussion below) (e.g., EPA 2017a; GAO 2017; Executive Office of the President of the United States 2016; ECONADAPT 2015; Chambwera et al. 2014), and – depending on underlying assumptions and what is included in the economic modelling – constitute only a small percentage of GDP (e.g., Hof et al. 2010), upfront costs can be considerable, and benefits can be delayed, resulting in some pitting mitigation and adaptation against each other in light of limited funds. However, this need not be a barrier (Liverman et al. 2013). Importantly, many (but not all) mitigation actions have adaptation co-benefits and vice versa; mitigation reduces the ultimate adaptation costs and losses that will be incurred even with adaptation (e.g., Kajan et al. 2015); and regardless of any additional mitigation from here on, increasing climate changes and disruptions mean that adaptation can no longer be avoided (GAO 2017).

3.3 Key Concerns Regarding Adaptation Funding and Finance

Despite the prevalence of funding barriers identified above – even in developed counties and comparatively rich states like California – most of the literature on both available and proposed funding and financing mechanisms for climate change adaptation is concerned with international development, particularly the transfer of monies from Annex-1 countries towards developing nations. Of the articles we reviewed that pertained directly to adaptation funding and financing mechanisms, 36 out of 48 reviewed articles focused on development and the link between development aid and adaptation finance. Indeed, the most established streams of

funding, such as the Green Climate Fund¹⁰, the Climate Investment Funds¹¹, and the Adaptation Fund¹² are all channels of aid to developing countries. However, the general consensus in the literature is that current global adaptation funds are not commensurate with current adaptation needs (Barnard 2015; Bendandi and Pauw 2016; Coffee 2016; Nhamo and Nhamo 2016; Robinson and Dornan 2017; Smith et al. 2011; UN Global Compact, UNFCCC and UNEP 2015).

Another common concern – at least in the international development/adaptation funding literature – is social equity and justice in adaptation finance. The jury is out as to the success of adaptation funding in securing climate justice, though general conclusions point to inadequacy and disregard of justice concerns. Generally, developed nations have been slow to commit funds to those least responsible for anthropogenic climate change. Research has also found that the infusion of international climate adaptation finance into national and subnational contexts can lead to or perpetuate injustice (Barrett 2013). In addition, those most vulnerable often do not have the capacity to receive or utilize the financing they desperately need (Barrett 2014, Webber 2013). This finding is also true domestically and applies to community investment more generally (Hacke et al. 2015). Overall, it appears that justice or poverty alleviation have not been realized by UNFCCC-related funding (Ciplet et al. 2013; Mathy and Blanchard 2015) – a persistent concern now in the implementation of the Sustainable Development Goals¹³.

More recently, concern with identifying adaptation finance mechanisms has also grown in developed countries and in the US. Partly driven by the growing expenditures for losses from climate disasters (NOAA-NCEI 2018; GAO 2017), partly driven by funding being among the most significant adaptation barriers (see above), and partly driven by a growing interest in the private sector playing a bigger role in adaptation finance, there are a growing number of efforts underway to develop creative and novel funding and finance mechanisms (e.g., Barnard 2015; Build America Investment Initiative 2015; re:focus partners 2015, 2017¹⁴; Resilient by Design Bay Area Challenge 2017; Snyder and Valdez 2015; Zimring et al. 2015).

3.4 Overview of Economic Analyses of the Cost of Inaction and Action

Economic studies of adaptation generally fall into one of two basic categories. The first involves studies that aim to illustrate the cost of inaction, i.e., the fiscal exposure if no adaptive actions were taken. The second, more recent one, involves studies of the actual cost of adaptation actions. Cutting across both is a continual effort in improving economic assessment approaches (e.g., Hallegatte et al. 2016; Chambwera et al. 2014; Hallegatte et al. 2011; Hallegatte et al. 2007). Together they help decision-makers compare the cost and benefit of adaptation to inform their choices.

¹⁰ www.greenclimate.fund/

¹¹ <https://www.climateinvestmentfunds.org/>

¹² <https://www.adaptation-fund.org/>

¹³ <https://sustainabledevelopment.un.org/sdgs>

¹⁴ <http://www.refocuspartners.com/library/>

The first estimate of costs to be incurred by climate change-induced sea-level rise was conducted in 1980 by Schneider and Chen (Yohe 1996). Nearly 30 years later, Fankhauser (2009, p.3) noted that “policy interest in the cost of adaptation is growing but compared to the mitigation literature adaptation cost research is still in its infancy.” He judged the wide range of adaptation costs available in the literature at that time as “symptomatic of the poor state of knowledge.”

Understanding of the cost of adaptation has rapidly grown since, however, with one of the most comprehensive assessments identifying more than 500 relevant studies (ECONADAPT 2015).

Key advances pointed out by those researchers included the following:

- The significantly advanced knowledge base now includes *many more studies* conducted *at different scales* (from the local to the national) in *developed and developing countries*.
- While early studies focused mostly on coastal adaptation to sea-level rise, more recent studies also address *adaptation in other sectors*, e.g. water sector, inland riverine areas adapting to more flooding, agriculture, and the built environment.
- There is a notable *shift from basic cost-benefit assessments and modeling studies to more policy-oriented assessments*.
- Methods for assessing costs and benefits are changing by *assuming iterative climate risk management* (i.e., a phased approach to adaptation) rather than one-time adaptive actions under certain climate scenarios.
- While early studies (the majority, still) tended to focus on *technical interventions* (e.g., seawalls, crop changes, air conditioning), more recent studies also consider *low-regrets option such as capacity building and decision-making under uncertainty*.
- Earlier impact assessments with a focus on technical adaptations generally find that adaptation is extremely beneficial and has low cost, whereas more recent policy-oriented studies, using the iterative framing and considering opportunity and transaction costs, estimate *higher costs*.
- The wide range of assessment methods used, underlying objectives and embedded assumptions make *comparability difficult*.

These advances notwithstanding, our review of the academic literature revealed a strong preponderance still of theoretical studies or studies testing new methodologies, rather than place-based assessments (some of Hallegate’s work, cited above, may serve as an example particularly relevant at the urban scale). Moreover, the emphasis on estimating the costs of adaptation was still predominantly on engineering and other “hard” adaptation measure costs in water, energy, transportation and other infrastructural sectors, while only very few studies included cost estimates for “soft” adaptation measures, such as policies, planning, or community engagement (Borgomeo et al. 2016; Mosnier et al. 2014). Furthermore, there were very few studies that tried to estimate costs of adaptation at the municipal level, even though it is generally assumed that most adaptation measures are best understood and implemented at the local level. As we will show in the discussion on our survey results (Chapter 4) and adaptation expenditures in California (Chapter 5), such estimates and projected costs for all

types of adaptation expenditures can be found in the grey literature but are not readily or centrally available or in a comparable format.

3.5 Calculating the Cost of Action and Inaction

A number of studies exist that estimate the cost of adaptation globally and for the US. They differ in their definitions of adaptation, different assessment methods, assumptions about climate change and about adaptation, time horizons, discount rates and so on, which prohibit effective comparison. But even a cursory comparison of adaptation price tags is telling (Table 4).

Table 4: Selected Global and US Cost Estimates of Adaptation Costs

Type	Scale	Estimates Cost	Approach & Assumptions	Reference
Cost of adaptation	Global (agriculture, coastal zones, health, settlements, non-market time use, other vulnerable markets and catastrophic impacts)	US\$50-170 billion by 2030 (far smaller than estimated costs for mitigation and estimated residual damages) Significant differences in %/GDP by region	As part of a larger study, which also estimated mitigation costs and residual damages from impacts not avoided), the study modeled global costs of adaptation up to a presumed feasibility limit, using the Integrated Assessment model FAIR 2.1 (AD-RICE); assumed only optimal (cost-effective) adaptation strategies	Hof et al. (2010)
Damages without adaptation and cost of adaptation	Global coastal zone only	0.3–9.3% of global GDP annually at risk without adaptation US\$17-180 trillion in assets at risk under a low emissions scenario (RCP 2.6) and US\$21-210 trillion under a high emissions scenario (RCP 8.5) Annual global costs of protecting the coast with dikes (initial investment and maintenance): US\$ 12–71 billion by 2100 (significant, but much smaller than the no-action alternative)	Estimate of the value of assets exposed to SLR below the height of the 100-year flood event in the year 2100 under different climate scenarios	Hinkel et al. (2014)

Cost of adaptation	Developing countries only	From 2010-2050: US\$70-100 billion per year (in US\$ 2005, no discounting)	Defined adaptation costs as those “additional costs to cope with future climate change.” Estimated costs of adaptation up to 2°C of warming by 2050, under two extreme climate scenarios (“wettest” and “driest”). Focus on hard adaptation rather than soft adaptation. Assumed that countries would fully adapt.	The World Bank (2010)
Cost of adaptation	US (economy- wide, but not comprehensive)	Synthesizing many studies as “tens or hundreds of billions of dollars” per year (in US\$ 2010), but cautions that the cost could well be higher	Conducted literature review of economic studies published for the US in or before 2010;	Sussman et al. (2014)

Source: Compiled from indicated sources by the authors.

What is most notable is that global estimates of adaptation costs for the entire developing world (World Bank 2010) are at the same order of magnitude (same range) as potential adaptation costs for the US alone (Sussman et al. 2014), and that the highly-developed coastal areas alone will carry much of that burden (Hinkel et al. 2014).

Despite this emerging picture of significant adaptation costs, there is general consensus that adaptation measures are cost-effective, given the far worse no-action alternative (Bjarnadottir et al. 2011, Chow et al. 2017, Hinkel et al. 2014, Hof et al. 2010, Kumar et al. 2016, Palanisami et al. 2015, Rodriguez-Labajos 2013, Rojas et al. 2013, Ryan and Stewart 2017, Stewart et al. 2014, Ward et al. 2010, and Wreford et al. 2015). Table 5 lists a partial list of studies done for the United States that demonstrate what the “no action” alternative might entail.

Table 5: Selected Global and US Cost Estimates of Adaptation Costs

Type	Scale	Estimates Cost	Approach & Assumptions	Reference
Fiscal exposure assessment	US economy in six sectors (health, labor, coastal communities, energy, agriculture, crime)	US\$22-\$315.7 by 2050 under a scenario of “no additional mitigation measures”	Macroeconomic analysis to assess the economic damages/risks of potential climate changes on different sectors of the U.S. economy and regions of the country	Rhodium Group (2014) ¹⁵

¹⁵ The study is better known as *The Risky Business Project*; see: <http://riskybusiness.org/>.

Avoided cost/benefit of mitigation	US economy in six sectors (health, infrastructure, electricity, water resources, agriculture and forestry, ecosystems)	\$199.8-\$292.4 billion avoided costs/losses/damages by 2050 as a benefit of stringent emission reduction efforts compared to BAU (in US\$ 2014; annual estimates no discounting)	Estimated the economic benefits of a stringent GHG emission reduction; calculated avoided damages, losses,	EPA (2015)
Damages without further mitigation (and adaptation in selected sectors)	Selected economic impacts on several US sectors, including labor, infrastructure, health, agriculture, fisheries, forests, and electricity	\$507.62 billion in annual damages (RCP8.5) by 2090; damages are reduced – on average across all sectors – by 33% (i.e., to \$340.1 billion annual damages) under RCP4.5	Sectoral assessments include consideration of population change over time; some but not all sectors include modeled adaptation	EPA (2017b)

Source: Compiled from indicated sources by the authors.

To place these figures of adaptation costs and the unmitigated economic impacts from climate change in context, it is helpful to compare them to the cost of mitigation. One recent study (Risky Business Project 2016) examined the additional investment needed to reduce emissions across the US economy by 80% and found that while initial investment would be hefty, eventual benefits from savings in fuel costs alone (not even accounting for the avoided damages or avoided adaptation costs if global emissions followed a similar trend) would far outweigh the cost (Table 6).

Table 6: Annual Investment Needs and Fuel Cost Savings Over the Next Several Decades to Reduce Greenhouse Gas Emissions by 80%

Decade	Annual investment need	Annual savings in fuel cost
2020-2030	\$220 billion	\$70 billion
2030-2040	\$410 billion	\$370 billion
2040-2050	\$360 billion	\$700 billion

Source: Risky Business Project (2016)

In addition to the cost-effectiveness of mitigation investments alone, it is important to note that economic research on adaptation repeatedly emphasizes that damages and costs may be larger

than current models suggest. Ruth (2010), for example, suggests that the costs of inaction (i.e., losses or damages) are likely to be higher than calculated values and are often difficult to quantify (Ruth 2010). Adaptation cost may also be higher. For example, some articles explicitly note that they did not include estimates for capacity building in their calculations of adaptation costs, lowering their estimates (Agrawala and Fankhauser 2008). Similarly, Ebi et al. (2008) assumed in their calculations of future costs of treating diarrheal diseases, malnutrition and malaria that there would not be additional implementation of treatment in new areas, despite predictions that the geographic spread of such diseases will increase under climate change. The authors acknowledged that such an assumption would greatly underestimate full costs. Due to the indirect or complicated nature of future damages, many other studies made similar simplifying assumptions, leading to low or uncertain estimates of climate change costs (e.g., Chinowsky, Price and Neumann 2013; Hinkel et al. 2014; Stewart et al. 2014; Yohe 1998).

Finally, in a retrospective study, the European Commission (2009) examined “the total coastal protection and climate change adaptation expenditure between 1998 and 2015 (spent and committed costs). The researchers found that – with 500-1000 billion Euros of assets and 3.5% of EU coastal member states’ GDP at risk – adaptation was exceedingly cost effective. The actual adaptation costs amounted to 15.8 billion Euros or 0.88 billion Euros per year on average. When compared to other studies that estimated such costs, particularly the benchmark study PESETA (2009), however, they found that the actual reported costs were in the upper limit of the initial cost estimates, suggesting that estimates were too low or that real-life implementation is more expensive than modeling suggests (a point reiterated in Lubell [2017, p.8] for expected infrastructure adaptation cost in the San Francisco Bay area). The European study serves as a cautionary tale for estimates of potential adaptation costs elsewhere – they may well be too low. Moreover, the record-breaking year of climate-related disaster losses in 2017 (\$306 billion in the US alone) similarly suggest that potential losses without significant adaptation may also be underestimated (NOAA 2018). It is for these reasons – the enormous risks of unmitigated climate change impacts and the cost-effectiveness of both mitigation and adaptation – that credit rating companies (Standards and Poor’s, Moody’s) have begun contemplating making the credit ratings of local governments dependent on mitigation and adaptation actions (Moody’s Investor Services 2016; Kraemer 2014; Previdi et al. 2013).

California has commissioned a number of economic assessments in the context of its previous three climate change assessments (see reports listed at the California Climate Change Portal¹⁶). Those assessments were typically single-sector focused, mostly aimed to assess the economic impacts of climate changes under different climate scenarios, and some also estimating costs of sector- or impact-specific adaptation (e.g., the cost of structural coastal protection such as seawalls or beach nourishment, crop switching in agriculture, or the economic impact of energy efficiency measures to compensate for higher electricity prices as use of air conditioning increases). There are, however, to the best of our knowledge, no integrated, multi-sector statewide assessments of economic impacts of climate change; no statewide assessments of

¹⁶ See: <http://climatechange.ca.gov/>

adaptation costs; and no estimates of the additional financial burden on local governments which are expected to plan for and implement locally-specific adaptation strategies.

3.6 Paying for Adaptation

Despite the clear need for adaptation finance both domestically and internationally, the resources needed to enact adaptation commensurate with the growing risk has not been forthcoming, as the work on adaptation barriers suggests. Many adaptive actions are best suited to the local scale and involve public assets and infrastructure; however, the public sector often does not have the capacity or support to generate such funds on its own (OECD and Bloomberg Philanthropies 2014). This is why many have proposed that the private sector take on a far more significant role in resourcing adaptation. However, it is apparent that under current conditions, there is little incentive for private entities to invest its funds, largely because adaptation measures on their own do not necessarily yield a return on investment (OECD and Bloomberg Philanthropies 2014; Pauw 2017). In addition, there is little detailed familiarity between private and public-sector actors (Moser, Coffee and Seville 2018), and the support structure to navigate between the government and investment worlds is only beginning to emerge (e.g., the work of re:focus partners (link above) or that of the Center for Community Investment, which focuses particularly on supporting low-income communities¹⁷).

With such challenges in mind, experts often cite a need for a legal mandate or other top-down institutional support for adaptation in order to spur funding (Finzi Hart et al. 2012; Measham et al. 2011; Moser 2007). In California, there is one such mandate for grant funding towards greenhouse gas emission reduction projects (through the Transformative Climate Communities Program)¹⁸ and other State legislation now mandates inclusion of climate change considerations in the safety element of general plans (albeit without additional funding)¹⁹. California also has established the Integrated Climate Adaptation and Resiliency Program (ICARP, established through SB 246), to improve coordination around and point to (but not itself provide) funding for adaptation.²⁰ (Other funding sources available and used for adaptation in California will be discussed in more detail in Chapters 5 and 7.)

¹⁷ See: <http://centerforcommunityinvestment.org/> (a project of the Lincoln Institute for Land Policy).

¹⁸ AB 2722 (2016), Burke. Transformative Climate Communities Program. See: https://leginfo.legislature.ca.gov/faces/billNavClient.xhtml?bill_id=201520160AB2722.

¹⁹ SB 379 (2015), Jackson. Land use: general plan: safety element. See: https://leginfo.legislature.ca.gov/faces/billNavClient.xhtml?bill_id=201520160SB379.

SB 1 (2017), Beall. Transportation funding. The bill provides “starter funding” for adaptation (up to \$20 million) to local and regional agencies for adaptation planning). See: https://leginfo.legislature.ca.gov/faces/billNavClient.xhtml?bill_id=201720180SB1, Section 9.

SB 628 (Beall) Enhanced Infrastructure Financing District (EIFD)

²⁰ https://leginfo.legislature.ca.gov/faces/billTextClient.xhtml?bill_id=201520160SB246.

Given limited public purses and the hopes to find ways to engage the private sector more effectively in adaptation finance, the most rapidly growing segment in the literature we observed was on funding and financing mechanisms. The practice-oriented literature – while not consistent – typically distinguishes “funding,” i.e., revenue that does not have to be paid back, such as from a general fund or a grant, from “financing,” i.e., money that is available in the form of a loan and that debt or equity has to be paid back to the issuer of the load with interest (e.g., Resilient by Design Bay Area Challenge 2017, p.2; Grannis 2017). Adaptation finance is shorthand for the sum of all funding and financing available for use over the entire course of an adaptation project or process. We use these terms in this sense in this report.

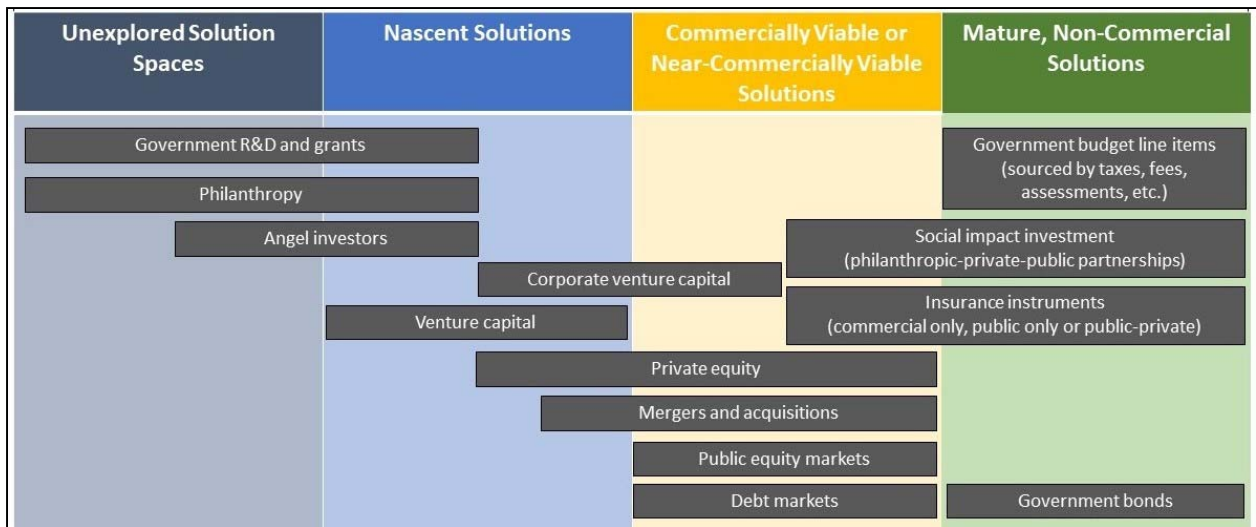
The aforementioned funding streams emanating from the UNFCCC are not accessible to communities in developed nations. Europe has set up funding mechanisms for countries within the EU (EU Commission 2013). There is nothing at that scale available at present in the US, although prior to the Trump Administration, federal leadership enabled various federal agency programs to explicitly support State and local adaptation efforts, and previous research found this federal financial support – together with philanthropic investment – to be a key driver behind advances in the US adaptation field in recent years (Moser, Coffee and Seville 2018).

In the absence of significant and reliable federal funding streams, we found a handful of case studies showcasing state- and local-level adaptation funding streams in the US. For example, Arizona has creatively used funds from its Water Infrastructure Finance Authority for adaptation measures (Craig 2010). The city of Asheville, North Carolina created a revolving climate fund via energy savings in partnership with a local utility (Cleveland and Ullman 2013). Cleveland, Ohio combined funds from a variety of sources, including grants, city fees, and federal funds, to create a City Climate Action Fund to which residents could apply for adaptation project funding (Abt Associates 2016). Boulder, Colorado funneled tax revenues towards adaptation measures (Bark 2009). While such examples seem to be the exception rather than the rule, they show that there are replicable mechanisms and available, albeit limited, pools that currently exist. We will return to the solutions local governments in California have found to fund their adaptation efforts in Chapter 5).

Many other references propose other adaptation funding mechanisms, which at this time are in various stages of development (listed below from those most familiar and established to those less well tested and established):

- *Mainstreaming of climate adaptation efforts into existing funding streams* (e.g., budget line item in general fund) is a commonly reported approach and comparatively easy as the funding stream already exists, the funding mechanism is technically proven, familiar and often more socially acceptable.
- *Innovation in existing financial pools* can help overcome some portion of the funding gap (Root et al. 2015). For example, prioritizing adaptation projects through specifying funding criteria in grant programs, can create incentives to focus on specific adaptation projects or adjust them to be better adapted to climate change.

- *Monetary exactions* – fees imposed on development – could be used to put a price on carbon emissions or other development-related impacts and resulting revenues could be used for climate action (Byrne and Zyla 2016).
- *Climate bonds* are a popular idea, and have even had a few examples of successful implementation, such as in Paris (European Climate Adaptation Platform 2016; Dauncey and Kroll 2017; ICLEI 2011). Climate bonds – a special case of environmentally conscious “green bonds” – are fixed-income financial instruments linked in some way to climate solutions. Most to date have been oriented toward mitigation.
- *Catastrophe bonds*, in use since the 1990s, are risk-linked securities (or high-yield debt instruments) that transfer a specified set of risks from a sponsor to investors. In essence, “cat bonds” insure that if the issuer, such as the insurance or reinsurance company, suffers a loss from a catastrophe (pre-defined), then its obligation to pay interest and/or repay the principal is deferred or forgiven (Investopedia 2017).
- *Resilience bonds*, a funding mechanism still in relatively early development phase, links insurance coverage (such as catastrophe bonds) of public sector entities (cities, utilities etc.) with capital investments in resilient infrastructure systems, and as such helps streamline funding for recovery after a disaster with disaster mitigation and forward-looking climate adaptation. (re:focus partners 2015, 2017)
- Echoing debates ongoing in California, Hsu et al. (2015) proposed the implementation of a *carbon tax* in the state of New York, which could be used – at least in part – for adaptation.
- The private market could provide some level of adaptation funding through *insurance incentives* or *vouchers* (The Heinz Center 2000; Kousky and Kunreuther 2015).
- Finally, the private sector can play a far more significant role in *public-private funding partnerships* or on its own in providing *investment capital* in developing adaptation solutions. There is an emerging market for such investment in innovations in the mitigation arena (Burger et al. 2018, see Figure 3), but this could be extended in the future into the adaptation arena, especially if there is a stable policy context that incentivizes or mandates adaptation.



Source: The Authors, building on a graphic idea developed by Burger et al. (2018).

Figure 3: Public and Private Funding and Financing for Climate Solutions Along an Innovation Continuum

However, the discussion of accessing and implementing such funds, whether actual or proposed, is limited. As touched on in the discussion of barriers above, there are often challenges to adaptation action beyond a lack of funds. Institutionally, staff capacity is often limited, and non-mandated actions such as adaptation are low priorities on the overwhelming to-do list of civil servants (Finzi Hart et al. 2012; Moser et al. 2018, *in review*; Moser 2007). Informationally, there is often a gap between what is available and what is useful or needed to local adaptation practitioners and planners (Bedsworth 2009; Kemp et al. 2015; Moser 2007; Tribbia and Moser 2008). There is also a networking gap between financial and adaptation staff (Williams and McNutt 2013). Attitudes and political inertia also pose barriers to planning and implementation, which makes it difficult to successfully argue for the setting aside of adaptation funds (Ekstrom and Moser 2013; Luers and Moser 2006; Mills et al. 2015; Moser 2007; Tribbia and Moser 2008).

3.7 Archetypes in Global Change Research

As the review of the literature so far has shown, there is widespread recognition of funding as a critical barrier to adaptation, but the examination of the nature of these challenges in developed countries, much less in the US and California, is uneven at best, and lacks depth even in the most generous read of the existing body of work. Rather, we would argue, while the problem is widely recognized and bemoaned, a deeper understanding of the detailed nature and underlying complex factors contributing to this persistent problem is lacking. There are neither case studies available to provide at least place-based, in-depth analysis, nor are there broader, systematic studies to date providing insight. The present study aims to begin to fill this void.

To do so, we build on a long-standing type of analysis in the global change literature, called archetype analysis, that emerged in the 1990s but is increasingly used in recent years, to better

describe and examine repeated patterns of commonly found sets of factors.²¹ A range of influences informed the emergence of this approach. Systems thinking, complexity theory, and – in particular – the articulation of system archetypes (Kim 1992) along with explorations of leverage points to intervene in complex systems (Meadows 1999), formed a critical theoretical and ontological underpinning. The extensive work in the lineage of Elinor Ostrom, examining the institutional arrangements supporting effective (and less effective) natural resource management, particularly common pool resources, became an important influence (e.g., Ostrom 1990; Keohane and Ostrom 1995; and later work). Global change researchers recognized growing numbers of symptoms of global change and how they interacted to produce repetitive patterns of social-environmental problems (Schellnhuber 1997). They noted the systemic nature of these problems and their characteristic trajectories of change, driven by complex interactions of underlying factors reinforcing and balancing each other to create the engrained challenges (Kasperson, Kasperson and Turner 1995). Yet they were equally aware of the context specificity of these challenges, that prevented easy generalizations and policy prescriptions.

Thus, a need emerged for an understanding of persistent challenges at an intermediate level of complexity and generalizability. This quest was further enabled by the growing availability of powerful computational and modeling tools. The result has been a growing portfolio of studies that analyze various phenomena, including:

- global change “syndromes” (Schellnhuber 1997; Petschel-Held et al. 1999; Lüdeke et al. 2004; Srinivasan et al. 2012);
- “archetypes” of social-ecological systems and related resource management challenges, including the analysis of underlying institutional arrangements such as polycentric governance systems and “(networked) action situations” (Eisenack et al. 2006; McGinnis 2011; Kimmich 2013; Cummings 2016; Kimmich and Tomas 2017);
- system archetypes of social-technological-economic systems (e.g., energy systems) (Dangerman and Schellnhuber 2013);
- land systems, their trajectories of change, and long-distance influences on land systems via tele-coupling (Václavík et al. 2013; Eakin et al. 2014; Messerli et al. 2014; Levers et al. 2015);
- (nested) vulnerabilities to climate and other environmental changes (Blaikie 1985; UNEP 2007; Sietz, Lüdeke, and Walther 2011; Oberlack et al. 2016; Kok et al. 2016; Sietz et al. 2017);
- climate change adaptation barriers (Eisenack, Lüdeke and Kropp 2006; Eisenack 2012; Oberlack and Eisenack 2014; Oberlack 2017); and,

²¹ The notion of archetypes is common in a much broader set of disciplines, ranging from psychology to organizational management, mathematics and statistics, geophysics, architecture, economics, ecology and political science. Our review here remains focused on the field of global change.

- assessment of the robustness of policy and management intervention in conservation (Cundill et al. 2013) and climate change adaptation contexts (Proust et al. 2012; Jäger et al. 2015).

Studies such as these commonly employ theory-driven deductive meta-analyses of existing case material to identify and examine archetypes. Others have used geospatial, fuzzy logic, integrated modeling or artificial neural networks. And while their nominal focus areas, i.e., the systems and their characteristic states and common patterns of behaviors vary, they share a common, basic understanding of archetypes as recurrent patterns of functional relationships between a set of drivers or factors.

Building on the syndromes concept, Eisenack (2012, p.4) defined “archetypes” as “representative patterns of the interaction between society and nature bringing about global environmental change and/or being responses to such changes.” Furthermore, they are “building blocks of social-ecological interactions that reappear in multiple case studies” and as such are not necessarily found in each case. Rather, individual cases are often constituted of several archetypes, while different cases can display different combinations of archetypes. But as consistent building blocks they point to similarities in the underlying factors and thus offer leverage points for policy intervention (Oberlack and Eisenack 2014).

Existing studies of archetypes in the climate vulnerability and adaptation context have focused on typical patterns of social-ecological vulnerability or on recurrent clusters of adaptation barriers to examine their archetypical impact on adaptation outcomes (see references above). In these studies, the capacity to pay for adaptation interventions (be it at the local/municipal or national levels) emerges consistently as a critical factor but is typically examined as one of many factors to adaptation progress being impeded. The patterns of factors creating this inability to finance adaptation actions themselves, however, have not or only rudimentarily been examined. Moreover, a focus on institutional barriers has dominated most of these studies to date – clearly an important focus (Moser 2009), but either “institutions” are so broadly conceived that they subsume virtually everything under them, or they leave important gaps in focus (such as economic, political, psycho-social, cultural, geographic or scientific factors). The present study takes a narrower interpretation of institutional factors and examines other underlying drivers explicitly to understand and explain adaptation finance challenges.

3.8 Conclusions

To date, research on barriers to adaptation has clearly shown the predominant significance of funding-related hurdles in both developed and developing countries. But work on climate adaptation funding has largely concerned itself with providing the needed means for developing countries, leaving a big gap in attention and understanding on the nature of funding challenges in developed countries like the US. This is also true for barrier studies done in California, with little in-depth understanding of (1) the cost of adaptation statewide or to local governments; (2) how local governments have funded their adaptation efforts to date; (3) what funding mechanisms local governments are using; and (4) why funding and financing appears to be such a difficult hurdle to overcome.

Additionally, the scales are tipped more heavily towards studies focused on adaptation costs, with fewer reports on actual realization of funds and implementation. This gap likely builds on itself – that is, because of the apparent barriers and high costs of adaptation, there has been little progress on securing and implementing funds on adaptation.

There is also little on the intersection of costs/funding of adaptation and building adaptive capacity. While such efforts are “soft” as well as more complex, they are vital to continued success in the adaptation field. The various strands of research undertaken as part of this study aimed to begin to fill these gaps.

4: The State of Local Adaptation and Experiences with Funding: Survey Results

4.1 Introduction

The study involved a survey of local government officials and individuals working with local governments to gain a first broad understanding of where they are with climate change adaptation, what barriers they had encountered in advancing adaptation to date (including financial ones), and how, if at all, they had managed to overcome them. The survey is the first *statewide* survey to our knowledge that examined these questions in detail.²² Care was taken to match the wording of questions asked about the state of adaptation, adaptation barriers and funding issues with those asked in other CCA4 barrier studies but which are focused solely on specific sectors (e.g., Ekstrom, Bedsworth and Fencel 2017; Moser et al. 2018) to ensure comparability.

As discussed in the Methodology section above (Section 2.2.1.4 on potential biases in the survey sample), we can characterize our respondent population as follows (detailed summary statistics are given in a series of tables and graphics in Appendix A):

- ***Good local government representation.*** Three-quarters of our survey respondents work for or with local governments (municipalities and counties), followed by regional districts or associations (Table A.1 and A.3).
- ***Predominantly planners and sustainability/climate professionals.*** Nearly a quarter of all respondents self-identified as planners, while all other job titles were represented in smaller percentages. However, the largest response category was “Other” – a category that included a significant number of sustainability, energy and/or environmental program professionals, climate action/resiliency program professionals, public health

²² We recognize the Office of Planning and Research’s Annual Planning Survey (most recently published for 2016), which asks several adaptation-related questions. While it has a wider distribution, its purpose is broader and thus asks fewer, less detailed questions about adaptation. We consider it an important touchstone against which we can assess our own findings. Other surveys conducted in the past have been sector specific.

professionals, policy, legal and legislative aides to elected officials, CEOs and (assistant) city managers, utility managers, planning commissioners and others. Only two respondents explicitly had financing in their job title (Table A.4).

- ***Mostly large cities and counties.*** Of those working with a local government, respondents were mostly from highly populated cities or counties. Out of 170 who answered the question, 75% worked with/for city or counties with over 100,000 people and over 25% worked in a city or county with over 500,000 people (Table A.5).
- ***Fewer small cities, but more low-population counties.*** Smallest sized cities (<25K population) were under-represented by respondents compared to other size classes. We observe a slightly different pattern for county-based responses. Smallest counties are over-represented, as are those larger with over 100K population (Table A.6 and A.7).
- ***Strong representation of coastal California, fewer from inland areas.*** Most respondents were located within coastal climate regions, which – though a coarse unit of analysis – is consistent with how the state’s population is distributed and reflects the stronger representation of large cities and counties (Table A.2, A.8 and A.10).

Together, this survey respondent profile is not entirely surprising as ARCCA is already better networked in these areas, reflecting where there is already greater adaptation-related activity. We therefore judge the remainder of the responses reflective of communities that have at least some basic concern about climate change impacts and are in various stages of the adaptation process. The survey provides no direct insights on those local governments that have not yet embarked on the adaptation journey, but potentially reflects that those missing from the survey face significant political, social and financial barriers to doing so.

With these caveats in mind, the next section present results about the state of adaptation, adaptation barriers and adaptation funding challenges in California.

4.2 Survey Findings and Discussion

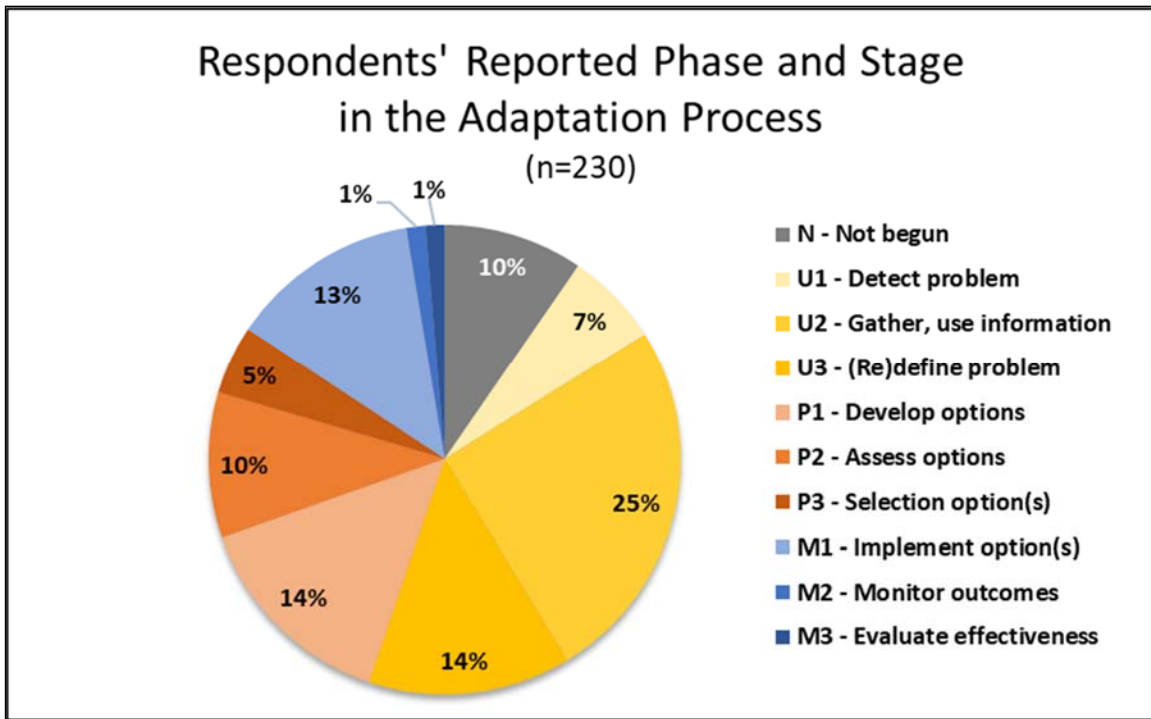
4.2.1 How Far Along in the Adaptation Process?

We begin by providing a snapshot of how far along respondents reported to be in their climate adaptation process. This important indicator helps contextualize the information gathered on barriers and funding issues. Moser and Ekstrom (2010) developed a diagnostic framework to identify and guide efforts in overcoming barriers to adaptation. The first step involves mapping where an individual or organization is in terms of thinking about or acting on adaptation, employing a heuristic of the process marked by three stages: Understanding (U), Planning (P), and Managing (M). Each of these stages is broken down further into three sequential phases. If respondents have not entered the adaptation process (however they understand it), they would be categorized as “Not begun.”

Figure 4 shows, the plurality of respondents (45%) reported being in the Understanding (U) stage, with most of those being in the second phase of that stage (Ub), which involves gathering information to understand the problem. Nearly 29% are in the Planning (P) stage; and the smallest number of respondents (16%) reported being in the Management (M) stage, with

hardly any in the advanced phases of evaluation and monitoring of implemented actions (c). Nearly 10% of respondents reported having taken no action toward adaptation yet (“Not begun” in Figure 4.

Overall, however, these responses – with 90% of survey responses being somewhere in the adaptation process compared to 27% affirmatively engaged in adaptation based on OPR’s Annual Planning Survey – confirms that our survey population is biased toward respondents engaged and interested in adaptation. Differently put, this is a survey of an already-adapting population and no information is available as to how well the results presented here do or do not reflect the opinions and experiences of those who have not yet entered the process.



Source: The Authors

Figure 4: Respondents Reported Phase and Stage in the Adaptation Process (Phases: grey – Not begun; yellow – Understanding; red – Planning; blue – Managing)

The reported stage in the adaptation process also varied by the size of the population served. For example, only one of the respondents from the largest local government size class reported no action on adaptation to date and, proportionally, this group of respondents reported to be in the Planning (P) stage more often than the smaller-size classes. Smaller-size classes (i.e., cities and counties of 100,000 or fewer) most often reported being in the Understanding (U) stage. When testing for a correlation between population class and stage in the adaptation process, we found there to be a slight but statistically significantly relationship (Pearson correlation, two-tailed, p-value <0.05 and R=0.174). To do so, we scored the adaptation stage from 0 to 3, where 0=Not begun, 1=Understanding, 2=Planning, and 3=Managing, and then compared the mean

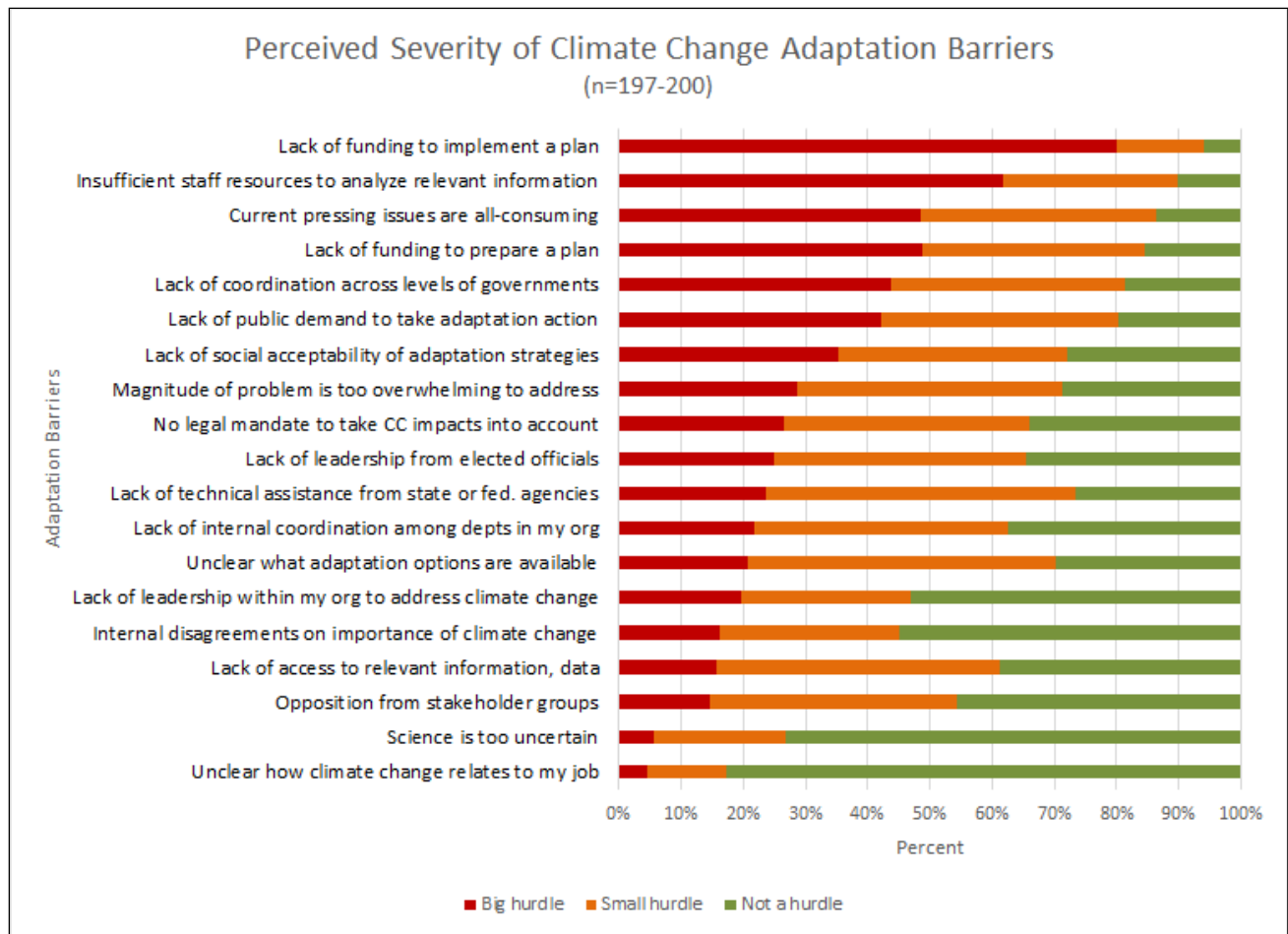
scores for each size class. This analysis revealed that larger-sized local governments tend to be further along in their adaptation process (Table A.12).

4.2.2 Barriers to Climate Adaptation

To place the discussion of funding barriers into the larger context of all types of adaptation barriers experienced by survey respondents, we asked survey participants to rate the severity of a list of 20 common adaptation barriers (“not a hurdle”, “small hurdle”, or “big hurdle”). These barriers had been derived from previous studies and have been used in similar surveys in CA and elsewhere before.

To calculate the ranking of the challenges based on the cumulative response set, we scored these barriers (1=not a hurdle, 2=small hurdle, and 3=big hurdle), and calculated the mean score for each barrier to evaluate which were the biggest challenges.

Figure 5 tallies the rankings of the adaptation barriers, organized from the largest to the smallest number of respondents considering a barrier a “big hurdle.” Across the full spectrum of barriers, the “lack of funding to implement a plan” scored as the biggest hurdle (nearly 80% marked this option as a “big hurdle”). “Insufficient staff resources to analyze relevant information” scored as the second biggest hurdle, followed by “current pressing issues are all-consuming.” “Lack of funding to prepare a plan” ranked as the fourth biggest hurdle. Lack of coordination across levels of government, lack of public demand to take adaptation action, and lack of social acceptability of adaptation strategies were also seen more often than others as “big hurdles.” Notably, uncertainty in the science and lack of clarity of “how climate change relates to my job” were seen as mostly insignificant to the progress on adaptation. These overall patterns are highly consistent with past and present barrier studies conducted in California (Finzi Hart et al. 2011; Moser et al. 2018).



Source: The Authors

Figure 5: Respondents' Ratings of Climate Change Adaptation Barriers

In addition to the options listed, respondents offered other barriers they had encountered. These included: lack of urgency about adaptation, lack of scientific evidence, lack of local government commitment, insufficient flexibility of funding, fragmented jurisdictions and social values/attitudes not supporting adaptation. Respondents also noted that existing guidance does not meet their local needs, that legislation is needed to require adaptation planning, and the challenge of the bigger political economy not being structured in a way that supports adaptation needs. Importantly, those in different stages of adaptation tend to encounter a different set of dominant barriers. To illustrate this fact, we cross-tabulated the mean barrier score (see scoring above) for each barrier with the stage in the adaptation process. Table 7 shows the results with color-coding to facilitate the interpretation.

Table 7: Significance of Adaptation Barriers Across Stages in the Adaptation Process

Adaptation barriers	Average rating score for each stage in the adaptation process					Diff (Not begun - Managing)
	Not Begun	Understanding	Planning	Managing	All stages	
Lack of funding to implement a plan	2.60	2.77	2.88	2.45	2.74	0.15
Insufficient staff resources to analyze relevant information	2.74	2.54	2.56	2.23	2.52	0.51
Current pressing issues are all-consuming	2.40	2.41	2.35	2.16	2.35	0.24
Lack of funding to prepare a plan	2.60	2.43	2.23	2.03	2.32	0.57
Lack of coordination across levels of governments	2.20	2.24	2.36	2.10	2.25	0.10
Lack of public demand to take adaptation action	2.50	2.28	2.29	1.83	2.23	0.67
Lack of social acceptability of adaptation strategies	2.20	2.13	2.12	1.77	2.08	0.43
Magnitude of problem is too overwhelming to address	1.80	2.14	1.88	1.94	1.99	-0.14
Lack of technical assistance from State, federal agencies	2.05	2.07	1.88	1.77	1.96	0.28
No legal mandate to take CC impacts into account	2.10	1.93	1.90	1.77	1.91	0.33
Lack of leadership from elected officials	2.25	1.94	1.92	1.58	1.91	0.67
Unclear what adaptation options are available	2.05	1.99	1.97	1.45	1.90	0.60
Lack of internal coordination among depts in my org	1.85	2.01	1.83	1.39	1.84	0.46
Lack of access to relevant information and data	1.85	1.83	1.76	1.55	1.76	0.30
Opposition from stakeholder groups	1.70	1.65	1.78	1.58	1.68	0.12
Lack of leadership within my organization to address CC	2.15	1.86	1.51	1.16	1.67	0.99
Internal disagreements on importance of CC	1.90	1.71	1.58	1.26	1.62	0.64
Legal pressures to maintain status quo	1.50	1.61	1.68	1.52	1.60	-0.02
Science is too uncertain	1.40	1.32	1.31	1.32	1.32	0.08
Unclear how CC relates to my job	1.35	1.31	1.12	1.10	1.22	0.25
	lowest average score (no/low hurdle)		>2.0 – ca. 2.5			
	<1.3		Second and third highest average scores (big hurdles)			
	>1.3 - <1.7		Highest average score (biggest hurdle)			
	>1.7 - <2.0					

Source: Authors' calculations

This analysis of average scores by stage allows for the following observations:

- The number of barriers per stage with the highest average scores (shown in red tones) are greatest in the early stages and tend to decrease thereafter. This suggest that initial entry into the adaptation process is a major milestone.
- Not having enough staff to begin to analyze relevant information dominates among those who have not yet begun the adaptation process, closely followed by lack of funds to prepare a plan and implement it. The lack of leadership, lack of familiarity with adaptation options and lack of legal mandates are bigger hurdles for these respondents than for those in later stages.
- For those in the Understanding Phase, the lack of funds to implement a plan dominates over insufficient staff resources and insufficient funds to prepare an adaptation plan. The lack of internal coordination within their organizations and the overwhelming nature of the climate change problem are higher for them than those in any of the other stages.
- Those who find themselves in the Planning Phase find the lack of funds to implement their plan most prohibitive, but limited staff resources and lack of coordination across levels of government and competition from other current issues rise near the top. In fact, the lack of coordination across levels of government is biggest for these respondents.
- Those who have entered the Managing Phase still struggle with insufficient funds to do so, followed by insufficient staff resources and competing issues. Here it is also noticeable that many barriers now have average scores smaller than the average for all stages (shown in green tones).
- Overall, the lack of leadership within respondents’ organization showed the biggest difference across stages of adaptation, followed by lack of leadership from elected officials and lack of public demand for adaptation. Those having not begun the adaptation process marked these as significantly bigger hurdles on average than those in the Managing stage. By contrast, lack of funding to implement adaptation and insufficient staff resources plagued respondents nearly as much regardless of their adaptation stage but is perceived as the greatest hurdle in the planning stage.

An ANOVA (analysis of variance, not shown) as well as a Spearman rho correlation test (Table A.13) among group means confirmed the statistical significance of these patterns.

When respondents were asked about how they had overcome these barriers or how they hoped they would overcome them, their responses fell into eight categories (Table 8).

Table 8: Respondents’ Strategies to Overcome Adaptation Barriers

Strategies to Overcome Adaptation Barriers	Specific Suggestions Made by Survey Respondents
None	Several reported not having overcome any barriers to date and gave no ideas.
Partnerships	The majority provided more substantial ideas, of which the most common was building or maintaining collaborations, partnerships, and other

	relationships. This involved partnerships with local NGOs (and developing these in a way that helped with funding, such as stopwaste.org), collaboration with State agencies, developing workgroups around issues of shared interest among agencies, and partnering with other regions to reframe issues (especially, downstream stakeholders reliant on upstream ecosystem services, such as water). This group also pointed to the effectiveness of working within existing institutional structures, including updating general plans and local hazard mitigation plans to include climate adaptation.
Increasing public awareness and political pressure	Another set of respondents described the need to increase public awareness and political will, as well as re-orienting messaging away from climate change and towards more socially acceptable issues (e.g., health communities).
Cross-sector integration and co-benefits	Several respondents mentioned using climate mitigation strategies and funding to support adaptation, including finding co-benefits with mitigation strategies and including adaptation as part of climate action plans.
Mandates	Another group mentioned the need for legal mandates to help overcome their barriers to adaptation. This included requiring local governments to do adaptation and requiring this progress to be reported regularly.
Demonstrating success	A related group of suggestions focused on the utility of documenting and demonstrating effective adaptation strategies.
Persistence	The need for persistence, dedication, and passionate staff to overcome barriers to adaptation was also mentioned by several respondents.
Technical assistance	Lastly, some suggestions pointed to assistance from the State, both in terms of the State providing more grant funding and of State agencies providing guidance and technical assistance to local governments early in the adaptation process.

Source: The Authors

4.2.3 Local Investment in Adaptation to Date

The survey next asked participants to focus on adaptation funding. Of the 233 survey participants, 195 responded to the question whether their jurisdiction had invested financially in adaptation activities (Table A.15). Of these 195, 64% reported having invested in various activities related to climate adaptation. This number is smaller than the 90% of respondents who stated that they are somewhere in the adaptation process (see above), suggesting that a significant amount of this early work has been done without explicit funding allocation, i.e., as pro bono work or as part of the day-to-day work of respondents.

When participants were asked about the types of adaptation-related activities and processes they had spent money on in the past two years, the three most frequently reported were risk or vulnerability assessments, community engagement and adaptation planning, largely confirming the relatively early adaptation stages observed earlier (Table 9).

The “other” actions respondents have invested in to date include climate action planning, development of sea-level rise guidance, stormwater planning, physical assessments (shoreline), and hazard mitigation/emergency planning, indicating how adaptation is often made part of ongoing planning processes (known as “mainstreaming”).

Table 9: Frequency of Expenditures for Different Adaptation-Related Activities

Activity	Frequency of Responses	Percent of Responses (N=195)
Climate change risk or vulnerability assessment	81	71.7
Community engagement in adaptation planning or implementation	65	57.5
Adaptation/preparedness planning	64	56.6
Implementation of adaptation actions	47	41.6
Monitoring and evaluation of implemented actions	24	21.2
Other (please specify)	12	20.6

"Other" responses discussed in text.
Source: Authors' calculations

Respondents were then asked to indicate how they had funded those activities to date. The most frequently reported funding source were general funds (35%), followed by State grants (27%), foundation grants (15%), and federal government grants (12%). By contrast, very few respondents reported having used bonds, special taxes or fees for adaptation to date (Table A.17, Figures A.7). Respondents had the option to name additional sources and mentioned regional collaborations, stormwater management fees, general plan fees, other internal/local funds, and waste fees.

Examining further whether reported adaptation activities had been preferentially funded by certain funding sources, we found similar patterns of frequency of funding sources across activities (Figure A.8 and Table A.18). Relatively speaking, this analysis revealed that general funds are more often used for some of the initial stages of adaptation work (vulnerability assessments and planning), but less so for implementation and monitoring and evaluation. In terms of frequency of use, State funding plays a relatively more significant role in implementation to date, even though it also supports all other activities. Foundation funding is more commonly mentioned as a source for community engagement, while bond funding – limited as it is for adaptation to date – is more frequently mentioned as a source of funding for implementation and monitoring and evaluation activities.

One notable conclusion we can draw from these analyses of survey responses is that local adaptation activities to date are getting funded through local governments' own general funds and from State grants, with federal and foundations grants being mentioned less frequently as funding sources – at least here in California.²³ We currently do not have data to draw

²³ We point, however, to the timing of the survey relative to recent disasters (5 Federal disaster declarations in 2017 alone!), which increases the influx of federal disaster response funding. In general, we would expect the

conclusions about the *amounts* of funding. It is important to view these initial insights against the backdrop of the previous finding, namely that survey respondents list the lack of funding for adaptation implementation and planning as the top and fourth most significant barrier to adaptation, respectively. In other words, local funds are barely enough to get communities going, but State, federal and foundation investment is not commensurate even with current adaptation needs. Thus, local governments draw on their own and a fragmented set of external sources, but what they have is insufficient. As the need for adaptation (particularly implementation) increases throughout the state, one would expect the need for adaptation funds to grow.

4.2.4 Funds Needed for Future Local Adaptation Activities

The survey then turned to anticipated activities in the near future, as a way to draw bounds around expected near-term funding needs. Not surprisingly, the greatest need is for additional funds for “implementation of adaptation actions,” indicated by 89% of respondents. That was followed closely by monitoring and evaluation of implemented actions (78%), and community engagement in adaptation (72%) (Table 10).

Table 10: Expressed Need for Funding for Climate Adaptation-Related Activities in the Next 5 Years

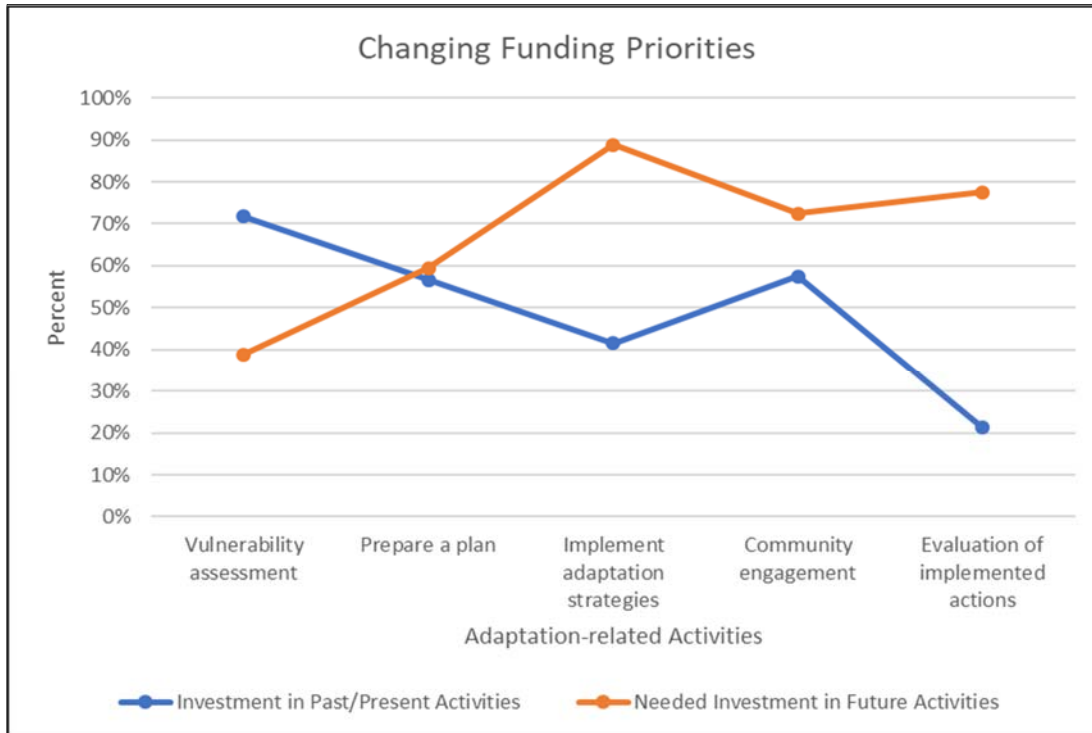
Activity	Frequency	Percent (N=116)
Vulnerability assessment	45	38.8
Prepare a plan	69	59.5
Implement adaptation strategies	103	88.8
Community engagement	84	72.4
Evaluation of implemented actions	90	77.6
Other	7	6.0
Total	398	

Source: Authors' calculations

Among the “other” needs noted by survey participants were funds to focus on equity and justice, funding to enable collaboration within regions or with State agencies, and funding for updating plans and guidance documents.

Figure 6 shows the difference in reported past/present investment in adaptation activities compared to expected future activities, indicating how demand in funding for different types of activities will change. Activities associated with the earlier stages, such as vulnerability/risk assessments and planning decline relative to implementation and M&E, which will increase. It is important to remember, however, that this only refers to the survey respondent population. Those local governments who have not yet entered the adaptation journey will need funding for the early stages, similar to what is reported here.

generalizability of this finding to depend on recent disaster experience, i.e., regions with significant influx of post-disaster funds (e.g., after Hurricane Sandy, Harvey or Maria) may have a greater Federal funding share.



Source: The Authors

Figure 6: Comparison of Past/Present and Future Adaptation Funding Priorities

Two preliminary conclusions can be drawn from these observations. First, since lack of funds for implementation is already the largest barrier to advancing adaptation now, further progress in making California local communities more resilient may become seriously stalled in the near future unless a significant change in the generation and availability of funding occurs; this may become even more acute as implementation is typically costlier than planning. Furthermore, funds for monitoring and evaluation are historically very difficult to obtain for extended periods of time (e.g., beyond 5 years), adding concern that the funding future for local adaptation faces serious hurdles.

4.2.5 Status of Fundraising Efforts

To gain deeper insights into the status and nature of funding challenges for adaptation related activities, survey participants were asked about the status of their fundraising efforts. Of the 113 people (less than half of the maximum survey population) who answered the question about their stage of acquiring funds to support their climate adaptation activities, less than two percent reported having secured all necessary funds (Table 11). Importantly, the question did not assume that the respondent knew the exact amount of what would be needed for the ongoing adaptation process, but simply asked about respondents' perception of whether they had the necessary funds from wherever they were in the adaptation process.

The most frequently reported stage in acquiring funds was "we have begun seeking the necessary funds" (37%), followed by "we have secured some of the necessary funds" (32%). Over 29% of respondents reported not having investigated funding options yet. In short, two

thirds of respondents did not yet have any of the needed funds, while less than the remaining third had some of what they needed.

Table 11: Status of Fundraising Among Survey Respondents for Climate Adaptation Related Activities

Response Options	Frequency of Responses	Percent of Responses
We have secured all of the necessary funds	2	1.8
We have secured some of the necessary funds	36	31.9
We have begun seeking the necessary funds	42	37.2
We have not yet looked into possible funding options	33	29.2
Total	113	100.1

Percent total does not add to 100 due to rounding.
Source: Authors' calculations.

The status of acquiring funds closely mirrors the state of advancement in the adaptation process reported on earlier (Figure 4).

Responses across the two questions were significantly correlated (using the Pearson correlation test; $R=0.291$, $p\text{-value} < 0.05$, $N=112$ [respondents who answered both the adaptation stage and fundraising question]). As may be expected, those earlier in the adaptation process more frequently said they had not sought funds or just had begun to seek funds, while those in more advanced stages of adaptation more frequently reported having secured some of the necessary funds.

4.2.6 Adaptation Funding Challenges and How Local Governments Have Attempted to Overcome Them to Date

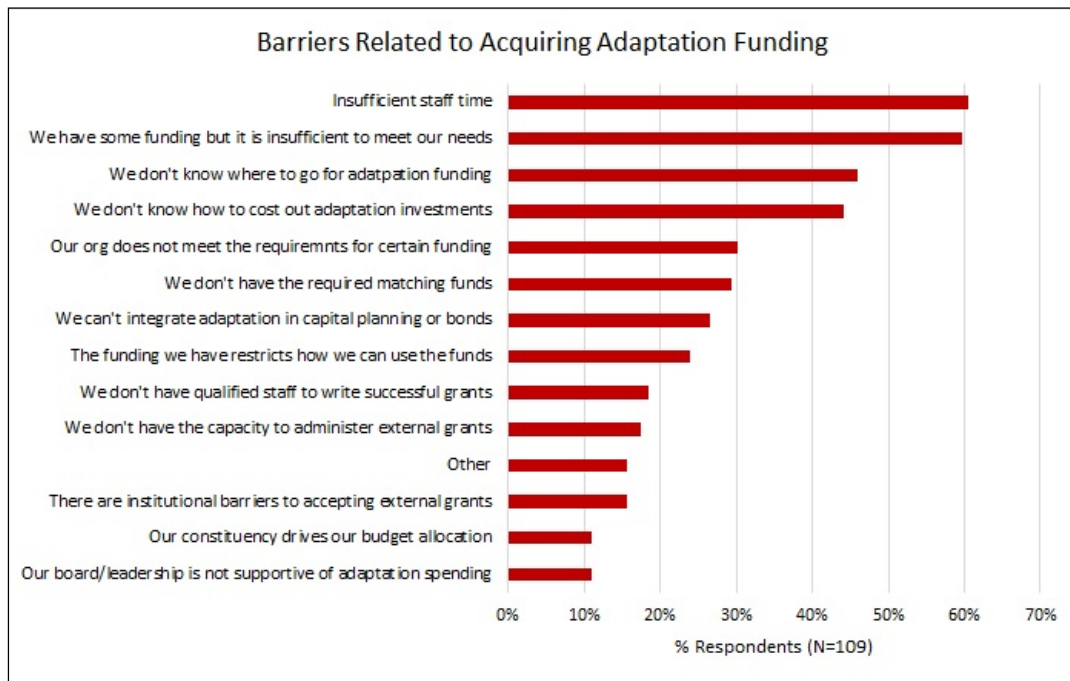
The remainder of the survey sought to understand what challenges survey participants had encountered in seeking funds and how – if at all – they had overcome them. In terms of the challenges of acquiring funds for climate adaptation activities, respondents reported insufficient staff time most frequently (60%), while nearly as many noted that they had some funding, but that it is insufficient to meet their needs. These leading funding challenges were followed by not knowing where to go for adaptation funding or how to cost out adaptation investments (Figure 7).

Approximately one third of respondents reported not meeting requirements of available funds and the same proportion expressed that they do not have the required matching funds.

Additional among the “other” challenges were issues related to specific funding mechanisms and the ability to use or adapt them for adaptation purposes, such as creating a fee, tax or bond that require voter approval or tapping regional governing bodies for funding.

We also examined whether different types of respondents experienced different funding challenges, and – indeed – there were some differences. Those *not working with/for a city or county* most often reported having some funding, but that it was insufficient to meet their needs. No data on the size of the gap (in \$) is available. By contrast, those *working in or with local*

governments most often reported the lack of staff time to write grant applications as a hurdle to funding adaptation, followed by having insufficient funding, and not knowing where to go to find funding (Figure A.11).



Source: Authors' calculations

Figure 7: Barriers Specifically Related to Acquiring Adaptation Funding

When asked how respondents had overcome these funding-related challenges, only 79 survey participants responded to this question, potentially indicating that many have not overcome the barriers they reported in the previous question. Of these 79, with the possibility of choosing multiple response options, more than 40% reported to have overcome their funding barriers by embedding climate adaptation in existing programs without additional funding, a process often referred to as “mainstreaming” (e.g., Cuevas 2016; Uittenbroek 2016; Wamsler, Luederitz and Brink 2014) (Table 12).

The second most commonly-reported strategy used to overcome financial challenges was to create a budget line item for adaptation-related activities (24%). Only one respondent reported having raised funds through a special fee or taxes, while 10% reported working on adaptation on a voluntary basis (outside official staff time). And another 10% reported hiring external grant writers, which directly gets at the lack of staff time and expertise to write successful grants, as noted frequently in the previous questions’ responses.

A significant number of responses (nearly 14%) mentioned “other” strategies. These included: adding an allocation for adaptation activities in revised general plan budgets, developing a capital improvement program to include some adaptation funding, hiring consultants, or obtaining limited grant funding.

Table 12: Strategies to Overcoming Funding Barriers

Strategies	Frequency of Responses	Percent of Responses
We have embedded climate change in existing programs without additional funding	47	40.5
We have created a budget line item for climate change adaptation-related activities	28	24.1
We have hired external professional grant writers	12	10.3
We are working on adaptation on a voluntary basis (outside our official staff time)	12	10.3
We have raised funds through special fees or taxes	1	0.9
Other	16	13.8
Total number of strategies	116	100

Source: Authors' calculations.

When we tested whether some barriers could be overcome more easily with certain strategies than with others, we found that proportionately across all reported financial barriers, the strategy of embedding adaptation into existing programs without additional funding is the most popular approach, followed by creating budget line items for adaptation. However, for some challenges hiring external help or working voluntarily is also pursued (Table A.23).

The patterns noted among challenges associated with funding adaptation experienced by local governments in California is indicative but does not allow for deep insights into the full range of factors and how they characteristically cluster to create the formidable hurdles respondents face. The workshop deliberations and document analysis synthesized in subsequent sections will provide significantly more insights.

4.3 Conclusions

Our survey – the first of its kind on funding challenges facing local governments in California – uncovered that funding is the biggest barrier overall among the broader spectrum of adaptation barriers, at least for this group of respondents. Particularly for the implementation of adaptation strategies, local governments lack the necessary means.

Most respondents reported that they had invested some money into adaptation-related processes and activities (64%), and those that have, predominantly draw on general funds and State grants to do so. To date, most funding has gone into activities associated with early stages of adaptation, while in the future, the greatest expected need is for implementation and

monitoring and evaluation funding – needs that are likely more expensive to meet and more difficult to get.

Mainstreaming into existing budgets and activities was the most frequently reported way that respondents had or thought to overcome financial barriers to adaptation. This could create a problem in the future as adaptation needs grow and the competition for funding to meet other, existing needs worsens (competing needs is already among the top barriers to advancing adaptation). The current approach suggests that adaptation funding may force local governments to divert funding from other pressing needs while drawing on existing and already at-capacity staff resources (the second highest adaptation barrier). Thus, without extra/new funds and capacity, local government will be hard pressed to succeed in making their communities safer. To date, only one respondent reported using a fee or tax, an approach that could potentially provide long-term stable funding, but is typically perceived as difficult to implement.

The next chapter examines the funding challenges uncovered in the survey through an in-depth analysis of what we learned in the stakeholder workshops. It allows us to connect adaptation barriers and reveal barrier-specific interventions that can point actors at all levels to useful interventions that support local governments in their adaptation efforts.

5: Archetypes of Adaptation Finance Challenges

5.1 Introduction

So far, our study has placed California local governments' adaptation finance challenges into the broader picture of adaptation barriers, showing how the situation in the state is highly consistent with that of local governments elsewhere; it also showed that of all adaptation barriers, financial ones are often among the most significant. Our study has also illustrated that while many local governments have begun the adaptation process, many are still in the very early stages. Much of this early work has been funded out of existing funds – predominantly local general funds and State grants – but is seriously hampered by the lack of much larger resources for implementing action. In this respect, too, the situation is consistent with that of many other US communities.

Additionally, our research so far has attempted to place some vague bounds around the size of the funding need (which when subtracted from local communities' available funds would circumscribe the adaptation funding gap). While there is no reliable estimate of the actual funding need for local adaptation, and not all will need to be paid at once, preliminary estimates based on local government documents suggest that California is facing a multi-billion-dollar problem per year annually and for decades to come. It is safe to assume that the estimates offered here are uncertain and low at best.

This discussion demonstrates why there is significant concern with devising new and creative funding mechanisms to fill the apparent (even if not clearly specified) funding gap. Before any suggestions should be offered on how to close this funding gap, we believe it is necessary to better understand the true nature of the funding challenges. In a state that is wealthy and economically strong but faces problems with uneven distribution of resources, it is important to delve into the nature of finance challenges, so as to propose solutions that can effectively address them. This section aims to unpack the perpetual complaint, “We don't have enough money!” What specifically is behind these financial challenges? What are the underlying drivers? What are their immediate effects on the ability to generate sufficient adaptation finance?

To do so, we draw on the second major empirical work of our study: the stakeholder workshops and what we learned about the characteristic patterns of funding challenges faced across the state. To recall, nine stakeholder workshops were held across the state to better understand what adaptation finance-related challenges local governments face, what leads to these challenges, and to what extent any of these challenges are unique by region, sector or local population size.

5.2 Adaptation Finance Archetypes

5.2.1 Definition of an Adaptation Finance Archetype

The core concept of this section is called “adaptation finance archetypes” or “archetypal challenges related to adaptation finance.” These archetypes constitute recurrent, representative and persistent patterns of challenges resulting from interlinked clusters of adaptation barriers that reinforce each other. Each archetype is a cause behind the funding challenges local

governments describe and as such points to a unique set of possible interventions to resolve it. Often one archetype is linked to another archetype, but not every archetype is present in every case. The detailed analysis of workshop notes revealed 15 of these unique and repeatedly mentioned archetypes. Below we provide the landscape of these interconnected archetypes as a whole and describe each pattern in detail.

5.2.2 The Landscape of Adaptation Finance Archetypes

Our analysis – as described in more detail in the Methodology section (Section 2.2.2) – progressed from workshop discussions to workshop notes to coding of repeatedly mentioned challenges that fundamentally differed in the factors that created or contributed to them. These contributory factors frequently involved long-standing conditions that resulted in economic, political, institutional, human, cultural and psycho-social, scientific-informational and geographic or physical barriers. Moreover, the focal point of the archetypal challenges (anchor) differed, ranging from being about one of seven distinct issues: (1) the problem of climate change adaptation itself; (2) establishing a need for funding; (3) the financial standing of the funding seeker; (4) the funding provider; (5) the type of funding or source sought; (6) the specific funding mechanism; or (7) the ability to use and administer funds.

Finally, each of the focal points or archetypal anchors had a unique funding-related outcome or immediate effect on the capacity to obtain and use the necessary resources for adaptation.

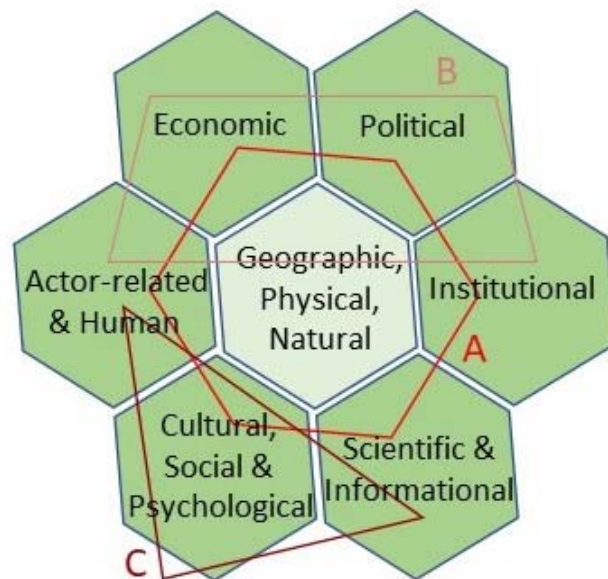
Figure 8 places these contributing factors, anchors, and immediate outcomes in relationships to each other in a simple matrix. Together, they frame this landscape of archetypes that we uncovered.

		Archetype Anchors: The Challenges Are Primarily About...						
		Adaptation and climate change risk	Adaptation funding need, costs & benefits	Adaptation funding seeker/ finan. standing	Adaptation funding provider	Adaptation funding source/type	Adaptation funding mechanism	Adaptation funding use & administration
Primary Contributing Factors or Barriers	Economic	Secondary Factors: Geographical, natural, physical	Disproportionate burden/prior disadvantage	Disjointed risk structure	Chronic underfunding/basic lack			
	Political		Conflict of interest	Inappropriate funding scale		Discontinuous funding		
	Institutional		Low priority		Lack of capacity (I)	Funding biases	Restrictions, conditions, eligibility criteria	Lack of capacity (II)
	Actor-related/human		Lack of champions, leadership	Silo'ed governance syndrome				
	Cultural, social & psychological							
	Scientific & informational			Inability to make economic case			Lack of knowledge about sources	
				Can't get started with adaptation	Can't justify adaptation expenditure	Can't apply for funding; tap or generate source	Can't rely on or get funding when needed	Can't access available/right funding source
Outcome on Financial Capacity								

Source: The Authors

Figure 8: Typical Adaptation Finance Challenges

While Figure 8 emphasizes the major contributory factors behind any one of the archetypes, often multiple factors contribute, as we document below. For simplicity's sake, only the dominant contributory factor or factors are shown. In reality, any number of underlying barriers that vary in their significance can contribute to an archetype, but not all of the factors have to be involved in each archetype (Figure 9). It is this interlocking of underlying barriers that causes the stability of these characteristic problematic patterns and explains why they are so difficult to change. We use the 6-sided comb pattern – one of the most stable patterns in nature – to represent this stability.



Source: The Authors

Figure 9: Interlocking Barriers Underlying and Contributing to Adaptation Finance Archetypes. Different archetypes are caused by different combinations of underlying factors, which is shown here conceptually (e.g., Archetype A might draw on all factors to some extent, while Archetypes B and C may draw on different subsets of underlying factors and may additionally vary depending on geography or other physical factors).

In parallel, and this is consistent with the literature discussed in Section 2, not all archetypes may be found in any one community but multiple ones may be required to explain the particular adaptation finance situation a community finds itself in. In fact, it is the presence of multiple archetypes in any one community that makes it unlikely that any single financing or funding-related solution resolves that community's adaptation finance challenges.

Having provided an overview of the basic thinking and elements underlying the archetype landscape, we describe each of them in some detail in the next section.

5.2.3 The Archetypes: Problems and Possible Solutions

The description and discussion of archetypes, including their characteristic manifestation, underlying causes and possible solutions, are listed in sets, according to the core issue or anchor to which they pertain.

5.2.3.1 Archetypes Pertaining to Adaptation and Climate Change Risks

The first set of archetypes relate to the challenge of getting climate change risks and the need for adaptation onto the local political agenda in the first place. Without being able to attain some level of importance or priority, local governments will not bother to allocate staff or funding resources toward it. Importantly, such perceptions of importance or urgency may not be universally shared. Many of the workshop participants reported being unable to get traction for adaptation, which they believed to be critically important but their superiors or elected officials did not.

Four archetypes fall into this category – *Low Priority, Lack of Champion/Leadership, Conflict of Interest, and Disproportionate Burden/Prior Disadvantage*. We discuss them sequentially, but many participants viewed them as deeply interrelated. Together, the outcome is that a local government or any of its entities may not be able to get started with thinking about adaptation. Consequently, no resources or staff are allocated to assess the issue and obtain the necessary funding, and those who wish to see adaptation action are hamstrung.

LOW PRIORITY. The *Low Priority* archetype is present when adaptation and planning for the long-term future is perpetually “back burned” behind more immediate or more salient issues. The most common cause mentioned beneath this archetype was the “tragedy of urgency” (or of immediacy), i.e., the constant pressure from immediate needs, daily demands or other pressing issues. Other underlying causes include the lack of understanding of climate change and the risks it poses to local communities, and sometimes the lack of desire to want to know. No or low public and/or top-level demand for climate action and lack of political will were repeatedly mentioned. Another set of repeatedly mentioned underlying causes was that many have a difficult time linking this relatively new concept to the core missions of what their agencies do. They also find it difficult to define an overarching goal that agencies and stakeholders across sectors can work towards together. Closely connected in this context (but showing up in other archetypes as well) was the lack of measures of success, progress, or performance. At this early stage in attempting to find resources for adaptation, it is not unusual to not have a line-item for it in the local budget; but having a line item would create its own pressure for attention. Attempts to do adaptation “behind the scenes” as part of other activities that are funded thus emerges as a double-edged sword: some initial work may get done in the “margins” of available staff and financial resources, but its very invisibility reinforces its seeming unimportance.

The intricate pattern of underlying barriers is mirrored in the range of mutually supportive interventions needed to address this archetype (Table 13).

Table 13: Characteristics, Underlying Causes and Potential Solutions to Address the Low Priority Archetype

Characteristics and Causes	Potential Solutions
<ul style="list-style-type: none"> • The “tragedy of urgency” (or of immediacy), i.e., the constant pressure from immediate needs, daily demands or other pressing issues • Backlog of other important issues that are not being addressed • The lack of understanding of climate change risks and lack of interest or even disbelief and avoidance (among leaders and stakeholders) • Lack of legitimacy of the adaptation issue (sometimes vis-à-vis mitigation) • Difficulty linking adaptation to core mission and difficulty defining an overarching goal to work towards together • Lack of measures of success, progress, or performance • Doing adaptation “behind the scenes” allows some work to get done in the “margins” of available resources, but invisibility reinforces its seeming unimportance • Lack of higher-level mandate, requiring that adaptation planning is being done 	<ul style="list-style-type: none"> • Education and trainings for local government staff that help make the link between existing core missions and adaptation; align goals, policies, fundraising and implementation • Help with framing, communication and engagement, particularly of skeptical audiences, with concrete examples, stories and visuals of what adaptation looks like, and linked to locally resonant values • Building communities of practice among local government staff to support peer learning and exchange of strategies • Local-to-local and local-to-state elected exchange on funding needs • Help with identifying measures of success and progress to evaluate resilience measures • Periodic evaluation of grant programs to show what is working will generate more interest and improve applications, efforts • Make planning allocation based on population size, without application, but mandate that adaptation planning is undertaken

Source: The Authors

LACK OF CHAMPIONS/LACK OF LEADERSHIP. Frequently, an issue becomes a priority when someone takes the initiative to make it one. In this way, the *Low Priority* archetype is linked closely to the *Lack of Champions/Lack of Leadership* archetype. But lack of leadership has its own set of underlying causes and is thus not considered just a variation on the first archetype, but a distinct one. One of the primary causes mentioned repeatedly by workshop participants was a sense of weak government and lack of empowerment among individuals within local government. While many emphasized that leadership can come from any position in the hierarchy, top-level leadership from a supervisor, mayor or other elected official is commonly critical to get adaptation on the agenda. They made utterly clear that when there is leadership, funding follows. The lack of a long-term vision, or ability to generate one, myopic thinking, lack of galvanizing energy, resistance to change, and weak action even where there is a mandate were other attributes of a government culture where there is no leadership. Nearly everyone spoke of the “politics” of taking on climate change, and the pronounced challenge of taking on the issue in rural and conservative areas, but political calculus plays a role even in more progressive contexts. Some mentioned that while a “solo fighter” is better than no champion at all, it takes a “perfect storm of leadership” with multiple individuals pulling together to really make a difference and set a new tone. Table 14 summarizes these barriers and suggests a set of interventions that can help address this particular archetype.

Table 14: Characteristics, Underlying Causes and Potential Solutions to Address the Lack of Leadership Archetype

Characteristics and Causes	Potential Solutions
<ul style="list-style-type: none"> • A sense of weak government and lack of empowerment, particularly problematic when among top-level executives • Lack of a long-term vision, or ability to generate one, myopic thinking, lack of galvanizing energy, resistance to change, and weak action • The “politics” of taking on climate change, particularly (but not only) in conservative contexts • Lack of higher-level mandate, providing cover for local-level officials to take up adaptation • Need of a “perfect storm of leadership” with multiple individuals pulling together 	<ul style="list-style-type: none"> • Much greater emphasis on education of local leaders and joint strategizing among them so they feel more comfortable taking on adaptation • Education of the public about climate change and to increase governance literacy so people can put pressure on their elected leaders and know when and where to speak out • Local and statewide mandates to provide cover • Neighboring community leaders serving as ambassadors to those not yet taking action • Within government entities, fostering a risk-taking organizational culture (“we have to fail a little to find success”) • Research and messaging on co-benefits and positive benefit-cost ratios • Create narrative of mitigation and adaptation synergies and complementarity that resonates • Pressure from rating agencies (such as Moody’s) and potential liability lawsuits are likely to spur greater leadership.²⁴

Source: The Authors

CONFLICT OF INTEREST. The *Conflict of Interest* archetype is a relative to the politics involved in the *Lack of Leadership* archetype, but – again – has a unique dynamic and underlying set of drivers. It is a cluster of barriers that do not only emerge out of a current set of conditions and interests but points to deep-seated, institutionalized, and often physically manifest interests with long historical roots. This makes this particular archetype very difficult to change without strong and persistent leadership, backed by a populace demanding change.

At the core of the *Conflict of Interest* archetype is the fact that while local government has an interest in protecting itself from the risks of climate change, it simultaneously has an interest in ignoring it. Local governments have multiple missions and climate change adaptation can be perceived as – or factually be – counter those interests. It may also force local officials to deal with a challenging trade-off (e.g., protecting a shoreline with a seawall may result in the loss of the beach that is the foundation of the local beach tourism economy. On the other hand, retreating inland and letting the ocean inundate prime real estate means loss of a crucial part of

²⁴ This suggestion was added post-stakeholder workshops to reflect recent development in the financial and legal world, though at the time of the workshops it was not mentioned.

the tax basis on which local government existentially depends). Local officials may choose to neglect the fiscally and politically “less expensive” issue (adaptation) in favor of interests that have a stronger constituency or promise greater near-term benefits. Some workshop participants noted that large companies can have an undue large influence in local decisions, and not necessarily for the common good. Others noted that if a community really wants to get serious about adaptation, it often has to model the right behavior for the community (e.g., stop contributing to the drivers of climate change that make adaptation harder in the long run, such as pushing for growth, land use expansion, higher resource consumption), but that is fiscally, politically and culturally difficult. Meanwhile, beginning to address adaptation will shine a light on past less-than-enlightened decisions (e.g., putting hazardous facilities into climate-exposed locations), and some felt local officials would rather avoid that. Finally, local governments in California can still get insurance coverage for local projects and thus fail to get a message that they may be too risky. These complex issues are summarized in Table 15 together with a handful of possible interventions.

Table 15: Characteristics, Underlying Causes and Potential Solutions to Address the Conflict of Interest Archetype

Characteristics and Causes	Potential Solutions
<ul style="list-style-type: none"> • Multiple (competing) missions can make it difficult to spend money on adaptation • Historical legacies (e.g., land use decisions and resulting patterns of vulnerability) are difficult to undo and potentially politically embarrassing • Mis-aligned incentives (e.g., insurance for exposed projects; subsidies for “bad” projects) can perpetuate trends that increase exposure • Political pressures and undue influence from local interests can undermine focus on broader community goals or the needs of the less powerful • Avoidance of facing difficult trade-offs 	<ul style="list-style-type: none"> • Education and training in how adaptation strategies can be linked to the core mission • Shifting of “zero-sum” narratives to “shared opportunity” narratives where communities learn to act together and shift priorities together • Need insurance companies to come to the table with local (and higher-level) governments to foster better alignment, identify strategies that redirect development into safer locations • Identify strategies to move away from dependence on revenue from greenhouse gas emitting activities • Need process to rethink fundamentally how existing (dis)incentives (e.g., tax structure, subsidies, lack of risk disclosure) undermine the financial future of local government

Source: The Authors

DISPROPORTIONATE BURDEN/PRIOR DISADVANTAGE. The final archetype in this first class, which we called *Disproportionate Burden* spans across categories, i.e., it also affects the next two issue areas, namely adaptation funding needs and the fiscal standing of the funding seeker. We discuss it here because the *Disproportionate Burden* archetype can prevent adaptation from becoming a priority issue. When it does not, none of the subsequent funding related challenges ever come into play. The *Disproportionate Burden* archetype has a number of sub-types or variations, which emerged in our workshops. Such subtypes display the same basic pattern but

have a distinct “flavor” and different policy instruments may be needed to address them. The observed sub-types where a disproportionate burden is experienced include:

- (a) small communities;
- (b) minority and/or low-income communities;
- (c) small businesses;
- (d) rural, remote, thinly populated and/or unincorporated areas;
- (e) areas with an already-high tax burden;
- (f) areas with a particularly high climate-risk burden; and,
- (g) future generations who will bear far greater adaptation challenges than current ones.

In some of these sub-types, the importance of our alternative name (prior disadvantage) for this archetype becomes obvious: institutionalized racism, long neglect of remote and low-income communities, legacies of deferred infrastructure maintenance and persistent lack of investment in education, diverse local economies, health care, environmental protection and so on, not only make current issues that much more pressing, but have also created long-standing vulnerabilities and undermined local governments’ adaptive capacity. Cash flow and general funds are much smaller, profit margins and the ability to tap into savings or “slush” funds to begin to think about adaptation are smaller to non-existent. Conservative governments, outdated models for governance (i.e., not community-driven or -engaged) and the difficulty to get certain issues on the “political radar screen” can aggravate these communities’ challenges. The ability to think about “the future” is severely constrained by the burdens of the present.

Table 16 summarizes these issues and proposes a sample of interventions offered by workshop participants, fully recognizing that such long-standing patterns of problems require deep, committed and persistent engagement to make a systemic difference over time.

Table 16: Characteristics, Underlying Causes and Potential Solutions to Address the Disproportionate Burden Archetype

Characteristics and Causes	Potential Solutions
<ul style="list-style-type: none"> • Long histories of institutionalized racism, neglect of remote and low-income communities, legacies of deferred infrastructure maintenance, persistent lack of investment in education, diverse local economies, health care, or environmental protection • Current problems are all-demanding • Long-standing vulnerabilities and lack of local governments’ adaptive capacity 	<ul style="list-style-type: none"> • Sustained funding for “disadvantaged” communities • Provide more capacity (building) grants • Earmark funding prior to distribution to ensure a set amount is dedicated to disproportionately burdened local governments • Regional approaches to adaptation, where greater-capacity local governments or non-profit entities carry the burden of applying for and administering funding.

<ul style="list-style-type: none"> • Outdated models of local governance with limited opportunity for meaningful stakeholder engagement • Limited political voice • Limited cash flow or reserves to divert to thinking about adaptation/the future • Perceived political/cultural limits to raise additional fees or taxes 	<ul style="list-style-type: none"> • Mandates for funding recipients to work with disproportionately burdened community groups. • Use existing templates to include community benefits agreements into statements of work with consultants • Provide grant writing services • Turn the stipend model on its head; instead charge a fee for non-participation, so local communities have a greater stake in participating in adaptation processes • Raise Pigouvian taxes/utility user taxes to relate spending to what the community wants
---	---

Source: The Authors

5.2.3.2 Archetypes Pertaining to Adaptation Funding Need, Costs and Benefits

The second class of archetypes relate to the challenge of establishing the funding need, i.e., to the ability to assess and justify costs and benefits of adaptation. So, even if local governments overcame the initial problem of making adaptation a priority, the set of interlinked challenges that faces them next may prevent them for persuasively arguing for funding. We found three distinct archetypes in this category.

INAPPROPRIATE FUNDING SCALE. During the workshops several participants questioned the basic premise of trying to solve adaptation funding challenges at the local level. We call this the *Inappropriate Funding Scale* archetype. This particular cluster is in large part driven by institutional factors and the geographic nature, scale and scope of the climate change problem, which can feed into psycho-social barriers. For example, climate change as a global problem is so big, it affects multiple systems at once and does not respect jurisdictional boundaries. For solutions to be effective, they must transcend institutional structures and boundaries. Thus, there is a fundamental mismatch between the problem and effective solutions on the one hand and the capability and institutional structure of local governments on the other. Related to that is a question of responsibility. Others considered it highly inefficient to approach adaptation (and funding for adaptation) in a project-by-project, community-by-community fashion. A few bemoaned “free-riding” of communities who cannot take on adaptation by themselves in the context of regional approaches. Given the need for systemic and regional approaches, some felt the State and federal agencies are too far removed from local concerns to appropriately administer funds. Meanwhile, regional entities may not exist or not have the capacity to receive and administer funds. Moreover, regional entities are typically not politically empowered to work toward larger-than-local solutions. Table 17 offers some potential solutions to this problem, although the overriding suggestion offered was to have a frank statewide conversation about the “right” scale to solve local adaptation funding challenges. In the absence of having a clear agreement to address adaptation funding at the local level, however, it is difficult to convince those already hesitant or burdened with numerous costly challenges to add adaptation to their “to fund” list.

Table 17: Characteristics, Underlying Causes and Potential Solutions to Address the Inappropriate Funding Scale Archetype

Characteristics and Causes	Potential Solutions
<ul style="list-style-type: none"> • Scale mismatch between global change problem and local capacity to address its impacts • Responsibility for climate adaptation is incommensurate with responsibility for climate change problem • Inefficiency of project-by-project approach to adaptation and adaptation finance • Problem of piecemeal interventions when systemic solutions are needed • Lack of capacity of local governments to take on long-term funding challenge • Lack of appropriate funding recipient for systemic solutions at the regional scale 	<ul style="list-style-type: none"> • Need for WWII mobilization to address mitigation and adaptation (and thereby contain the problem to something more manageable) • Need for State and federal solutions at bigger scale (e.g., funded mandates, changes in statewide tax law, block grants etc.) • Alternatively, assume that there will be <u>no</u> State or federal money forthcoming, to spur radical rethinking and solutions • Need for an empowered regional authority to apply for and receive significant regional adaptation funds, with clear on decision-making, control and disbursement rules • Greater state leadership to help local communities • Creating regional legislative caucuses to foster understanding of local/regional funding needs • Mandates to look longer term would enable utilities and agencies to demand fees and plans for longer-term solutions • Look to Integrated Regional Water Management (significant funding, robust decision-making structure) to apply model to other sectors/areas • Use Proposition 50 funding for regional collaboration • Look beyond California (e.g., Southeast Florida 4-County Compact for Climate Adaptation) for alternative supra-local funding models • Educate and lobby at State and federal levels to bring more money to local level, to invest in critical land areas and assets that have local benefits • Conditions to consider climate change on other State and federal funds can go a long way to get local communities to take on adaptation • State should pursue more federal funding opportunities on behalf of locals and regions

	(e.g., HUD or landscape-scale conservation funding) <ul style="list-style-type: none"> Federal mitigation fees should come back to local communities for use in adaptation
--	---

Source: The Authors

DISJOINTED RISK STRUCTURE. A different but related archetype – economic, institutional and political at its core – that makes it difficult to establish funding need and get the cost and benefit distribution right is the *Disjointed Risk Structure*. In essence, this archetype describes the situation where those enjoying the benefits of residing in or using highly desirable locations and resources that are also at risk from climate change impacts do not carry a commensurate share of the burden of keeping them safe. For example, developers may profit from the sale of a prime-location property now, which was built without consideration of future climate impacts and without any obligation on behalf of the developer toward the property over the long-term, but the new owners and/or occupants will face the consequences (and financial burden) of those impacts. Insurance subsidies hide the true cost of living in at-risk areas. Local governments might promote development at the urban-wildland interface, but tax payers ultimately have to pay for wildfire prevention and firefighting. At the heart of this archetype is the disconnect between “the public dollar and the private gain.” Long-standing interest politics and associated institutionalization of risk structures have maintained a situation where the true risk and cost is not borne by those who enjoy the greatest benefit. This creates incentives to live in risky places and undermines the ability to amass sufficient resources to address them through adaptation. Table 18 synthesizes this cluster of challenges along with possible interventions.

Table 18: Characteristics, Underlying Causes and Potential Solutions to Address the Disjointed Risk Structure Archetype

Characteristics and Causes	Potential Solutions
<ul style="list-style-type: none"> The true risk and cost is not borne by those who enjoy the greatest benefit Disconnect between “the public dollar and the private gain” Subsidies and incentives to live in risky places, while undermining the ability to collect sufficient funding for adaptation Interest politics prevent frank and early disclosure of true risks Institutionalization of disjointed risk structure Short-term private profit thinking prevails over longer-term community benefit thinking In addition to risk disconnect (which is essentially a temporal disconnect), there is also a geographic disconnect between 	<ul style="list-style-type: none"> Create “benefit districts” wherein people with the greatest capacity pay proportionate fees; fund can be used for district-wide solutions Privatization of flood risk, but requires careful attention to “climate gentrification” More incentive programs to implement hazard mitigation measures to lower insurance premiums (assist communities so as to massively expand the uptake of the National Flood Insurance Program’s Community Rating System) Establish success metrics of adaptive design in risky locations so investors and developers can see the benefit of investment and long-term planning Build pay-for-ecosystem-service alliances between urban and rural areas, upstream and

resource or commodity producers and users (e.g., watershed stewardship and downstream use; species conservation and ecosystem services)	downstream local governments to build resource security for some and generate the necessary means to protect those resources for others
---	---

Source: The Authors

INABILITY TO MAKE THE ECONOMIC CASE. The final archetype in this class – *Inability to Make the Economic Case* – was a frequently mentioned cluster of challenges, one that had three distinct variations or sub-types, albeit all with the same outcome:

- (a) The inability to illustrate the cost of inaction (i.e., demonstrate the need);
- (b) The challenge of valuing uncertain risks and benefits; and
- (c) The ability to adequately compare monetary and non-monetary values.

In essence, this archetype is about not being able to justify the expense for adaptation vis-à-vis other potential budget items. While there are several underlying drivers, this archetype is strongly scientific and technical in nature. When local government staff cannot make the economic case for adaptation or illustrate return on investment, the issue simply loses out in difficult budget negotiations. Underlying causes mentioned included the lack of economic training and expertise, the lack of tools to do the requisite economic assessments, the lack of knowledge of what different adaptation aspects might cost, and the complexity of adaptation projects (and lack of economic assessment tools to match that complexity). Here, too, did the issue of lack of metrics of success or performance show up, in that analysts cannot easily demonstrate return on investment and prioritize one approach over another without them. Others bemoaned the bias toward “dollars and cents” as the common denominator; it makes valuation and inclusion of non-monetized or hard-to monetize aspects much more difficult. Often the rules of doing benefit-cost analyses also make it harder to justify proactive adaptation (e.g., buy-outs are expensive over short-term, but become economical over the long term). Workshop participants also spoke to the politics that play into this archetype. The ability to clearly establish the need for adaptation, to show its benefits to the public, which would give politicians cover to promote them, and to confront the above-discussed challenges of dealing with difficult trade-offs all get in the way of arguing the economic case for adaptation. Table 19 summarizes the challenges and possible solutions, with a strong emphasis on trainings and building the necessary tools to help local government staff be more effective in arguing for resourcing adaptation.

Table 19: Characteristics, Underlying Causes and Potential Solutions to Address the Inability to Make Economic Case Archetype

Characteristics and Causes	Potential Solutions
<ul style="list-style-type: none"> • Inability to illustrate the need for and benefits of adaptation and to justify the expense for climate adaptation vis-à-vis other budget items 	<ul style="list-style-type: none"> • Advancing research on adaptation costs and benefits • Advances in establishing common sets of metrics of success and performance; development of some metrics at least should

<ul style="list-style-type: none"> • Lack of economic training and expertise among local government staff • Lack of tools to do the requisite economic assessments • Lack of knowledge of what different adaptation aspects might cost • The complexity of adaptation projects (and lack of economic assessment tools to match that complexity) • Lack of metrics of success or performance to help show the benefits of investment and to prioritize adaptation strategies • Bias toward “dollars and cents” as the common denominator in assessments, hindering proper appreciation of non-monetized values • Rules of doing benefit-cost analyses can bias against strategies where benefits only accrue over the long term • Lack of public and political support for long-term investments • Political challenges of dealing with difficult trade-offs 	<p>be done with financial experts to ensure they hear what they need to be willing to invest</p> <ul style="list-style-type: none"> • Development of tools, alongside trainings to use those tools in combination with legal requirements to use them would help staff and consultants perform valuations of monetized and non-monetized risks and benefits • Staff trainings in economic assessment tools (particularly in combination with requirements or incentives to use them) • Moving adaptation funding from grant-based, project-based funding to established budget line-item to minimize project-by-project justification need • Foundation investment in tool development and demonstration projects • Support project pre-development phase through dedicated adaptation services to help make the link between public sector adaptation and private-sector investors
--	--

Source: The Authors

5.2.3.3 Archetypes Pertaining to the Fiscal Standing of the Adaptation Funding Seeker

Three distinct archetypes constitute the third class of challenge related to adaptation funding, all of which are about the adaptation funding seeker. Together, they profoundly affect local governments’ ability to apply for funding or financing or tap or generate a steady source for adaptation.

CHRONIC UNDERFUNDING/BASIC LACK. The first of these we call the *Chronic Underfunding* or *Basic Lack* archetype, and it overlaps in important ways with the *Disproportionate Burden* archetype detailed above (Section 5.2.3.1) but is broader and has a different set of underlying drivers. As is apparent by now, many archetypes interact and reinforce each other, yet are still uniquely recognizable problems. The *Chronic Underfunding* archetype speaks to the fundamental condition that California local governments face. This is a common but not necessarily transferable archetype to other contexts due to the specific nature of its underlying causes. What local communities across the US and thus California share, is the general culture of limited government and the widespread tax aversion across American society. What is specific to local governments here is the fact that California is a tax-restricted state since it voted for Proposition 13 in 1978.²⁵ Prop.13 limits the ability of local taxation and

²⁵ See: [https://en.wikipedia.org/wiki/California_Proposition_13_\(1978\)](https://en.wikipedia.org/wiki/California_Proposition_13_(1978)).

restricts the uses of taxpayer money. If local governments wish to raise taxes, such a decision requires a two-thirds majority. This has significant implications for political maneuvering and outreach should a local government wish to increase its revenue base through a local tax: the hurdle is difficult, though not impossible to overcome. It is easier, by contrast, to locally raise special fees – a decision that requires only a 50+1 majority of votes – but such special fees come with tighter use restrictions: those who pay the fee must also benefit from its use. The implications of these tax laws are profound for local communities’ ability to fund new, costly and above-normal efforts like adaptation – an issue not yet on political radar screens when Prop. 13 was decided. One is chronic insufficient funding of local governments as a general condition; another is growing internal competition among government departments for limited general funds. In addition, local governments are increasingly dependent on grant funding, which places the onus on local government staff to spend considerable time writing grants without assured outcome. In this way, successful adaptation by local governments becomes a matter of grant-writing prowess. Workshop participants noted how this favors the larger, high-capacity cities and counties, while systematically perpetuating the disadvantage of smaller, lower-capacity governments. As climate change impacts accelerate, this dependence on external funding will only increase, as will the competition for State, federal and foundation grants and the self-reinforcing process of favoring high-capacity and dis-favoring low-capacity communities. Participants also noted that even though tax laws protect against undue over-taxation, Californians feel “that government is already taking too much money from people” and many oppose tax increases, yet still expect local government to provide adequate services and guard their safety. The solutions to this archetype would require profound rethinking of California local government funding and taxation policy (Table 20).

Table 20: Characteristics, Underlying Causes and Potential Solutions to Address the Chronic Underfunding Archetype

Characteristics and Causes	Potential Solutions
<ul style="list-style-type: none"> • General US culture of limited government • Widespread tax aversion across American society • Tax-restricted state since 1978 when Californians voted in favor of Proposition 13 (2/3 majority required to change taxation); taxes come with certain use restrictions • Special fees (50+1 majority required) are easier to raise but are more restricted in use • Chronic insufficiency of local funding and chronic underinvestment in infrastructure • Internal competition for limited general funds • Growing dependence on external grant funding and significant staff time required to write grants 	<ul style="list-style-type: none"> • Rethink fundamentally and reconsider approaches to local taxation in California • Rethink adaptation fundamentally as widespread community redevelopment into resilient, safer communities • Use existing funds for climate-safe redevelopment creatively and tap/re-purpose existing non-adaptation funding streams (e.g., Clean Air Act, Clean Water Act, agricultural funding sources) • Mainstream climate change adaptation into existing funding streams • Explore more “carrot and stick” approaches to get adaptation done

<ul style="list-style-type: none"> • Larger, high-capacity cities and counties tend to have better success rates than smaller, lower-capacity local governments, a self-reinforcing situation • Popular sense that Californians are over-taxed, yet expectation that government should pay for adaptation and functional community services 	<ul style="list-style-type: none"> • Access non-traditional funding sources, e.g. international competitions to pilot and showcase potential adaptation solutions • Provide training to become better at accessing state and federal-level funding sources • Integrate training on (institutionalized) racism and how to embed equity into funding applications and adaptation approaches to make systemic changes • Establish relationships with private sector to design innovative financing vehicles • Educate local government staff on how to effectively work with private sector and/or support “boundary organization” navigating between local public sector and international and national private/investment sector • Move money out of unsustainable sectors (subsidies for oil) and move into resilience • Partner with non-profits whereby they apply for funds and do key work on their own and local government’s behalf but don’t lose sight of integrating climate change within all aspects of local government
---	--

Source: The Authors

SILOED GOVERNMENT SYNDROME. One of the most frequently cited problems – here in its distinct implications for securing adaptation finance – is the *Siloed Government Syndrome*. While all-too-familiar, it emerged in six variations on the theme of disconnected governance. Silos were noted:

- (a) Within one jurisdiction;
- (b) Across jurisdictions and types of government (e.g., tribal vs. local government);
- (c) Across sectors;
- (d) Across levels of government;
- (e) Across private and public sectors; and
- (f) Across the rural-urban divide.

Workshop participants noted how the *Siloed Government Syndrome* not only characterizes and affects the local funding seeker, including their ability to justify adaptation expenditures, but is also a problem among funding providers (e.g., State and federal agencies, foundations). We centrally anchored it in this class of archetypes because it is fundamentally rooted in how local government is organized and what workshop participants could adequately judge, but silos are a pervasive problem. Some pointed out how the structure of government is fundamentally at odds with a problem that does not respect sectoral, geographic or jurisdictional boundaries. It is

not inherently clear, however, who then should take the lead and who should be in charge within any one jurisdiction or among different jurisdictions to coordinate across artificial organizational divisions. To the extent higher-capacity units take the leads, lower-capacity entities may or may not have equal say. How to include community groups and non-profits is not always clear. Administrative differences may make integration and collaboration difficult. Varying capacities, requirements and access to officials (e.g., in work with tribes) or different organizational cultures, mindsets and functional time scales (e.g., in work with private sector) are additional obstacles. Necessary expertise and tools are not effectively connected, and learning is hampered. Effective communication is time consuming and rarely rewarded. Fair distribution of costs, work burdens and benefits are another challenge, as is timely distribution of funds throughout a coordinated process (not just at the end). Many pointed to the challenge of accounting for and allocating cost and benefits if they did not all accrue within the same administrative unit, as budgeting is just as siloed as the rest of government functions. Some worried about how to balance regional integration with local autonomy (home rule) – a long-standing cultural-political taboo. “Every mayor wants to either take the lead or not be told what to do.” Politics, differing priorities across jurisdictions and self-interest, several emphasized, clearly magnify the siloed governance problems.

Others bemoaned that siloed governance structures created siloed minds, with funding requests rarely asking for or encouraging cross-silo/cross-issue collaborations; funding seekers always looking in the same places for funding and not coordinating or pooling their resources for greater effectiveness, thereby creating “funding ghettos” instead and missing opportunities for leveraging. Issues are being addressed as separate problems (e.g., mitigation and adaptation) even if they are systemically related and considering synergies and trade-offs would make for better outcomes for all. Ongoing tasks like outreach, risk assessments, fundraising and engagement with experts get repeated countless times, even if it could be done jointly and more efficiently. For some, this raised ethical concerns and felt like a waste of taxpayer money. Yet those who had engaged in cross-silo collaborations noted that there are considerable capacity issues involved in breaking down silos: large, complex projects can become unwieldy and difficult to manage. The result is a bias toward many smaller funds and projects as opposed to big funding for comprehensive approaches. The many challenges associated with governance silos offer numerous leverage points (Table 21).

Table 21: Characteristics, Underlying Causes and Potential Solutions to Address the Siloed Government Archetype

Characteristics and Causes	Potential Solutions
<ul style="list-style-type: none"> • Silos are pervasive among funding seekers, funding providers, and affect the ability to make the economic case for adaptation • Structure of government is fundamentally at odds with a problem that does not respect sectoral, geographic or jurisdictional boundaries 	<ul style="list-style-type: none"> • Learn from examples that have intentionally overcome siloed governance problems (Measure AA in San Francisco Bay Area; Joint Powers Authorities or looser county-based Task Forces; Community Choice Energy Aggregation; special assessment districts etc., sectors such as water, transportation, forestry, landscape conservation and hazard mitigation that have worked across jurisdictions; examples outside of California)

<ul style="list-style-type: none"> • Lack of clarity on who should lead, who is in control in multi-unit collaborations, and how to include community groups and non-profits • Higher-capacity units may have stronger influence than lower-capacity units • Cultural and administrative differences can make integration and collaboration difficult • Fair distribution of costs, work burdens and benefits are challenging, as is timely distribution of funds throughout the process • Challenge of accounting for and allocating cost and benefits if they do not all accrue within the same administrative unit • Difficult balance between regional integration and local autonomy (home rule) • Politics, differing priorities across jurisdictions and self-interest magnify the problem of silos • Siloed thinking is related problem: issues are being addressed as separate problems (e.g., mitigation and adaptation) even if they are systemically related and considering synergies and trade-off • Funding requests rarely ask for or encourage cross-silo/cross-issue collaborations • Funding seekers always look in the same places for funding and don't coordinate or pool their resources for greater effectiveness, creating "funding ghettos" and missing opportunities for leveraging • Ongoing tasks (e.g., outreach, risk/vulnerability assessments, fundraising and engagement with experts) are repeated countless times, raising ethical concerns and wasting taxpayer money • The bigger the collaboration, the greater the challenges of managing complex projects • Varying capacities, requirements and access to officials (e.g., in work with tribes) or very different organizational cultures, mindsets and functional time scales can inhibit efforts in breaking down silos 	<ul style="list-style-type: none"> • Use Urban Sustainability Directors Network peer learning funding opportunities for collaboratives • Form and support regional research collaboratives to respond to regional information needs; share data and tools freely • Rewrite grant funding guidelines to incentivize collaboration/give extra points in proposals) • If coordination is required, fund the coordinating entity to support this work • Enable local and regional input into State agency funding allocation decisions • Make better use of regional councils of governments (COGs), regional foundations • Establish fiscally capable regional organization as central organizational entity; engage in transparent priority setting and decision-making • Establish relationships among adjoining communities with significant lead time before applying for federal or State funding • Create sector-based and cross-sector partnerships to improve chances at successful funding application • Provide more grants to regional collaboratives for common work (vulnerability assessments, outreach/stakeholder engagement, education); will help reduce burn-out • Look for solutions that solve multiple problems or have multiple benefits as a starting point for collaborative pilots • Shift the narrative to "shared opportunity" • Need big-picture thinkers as leaders of regional, integrated efforts • Streamline regulations and permitting process as well to reduce cost and time of permitting adaptation projects • Integrate adaptation in virtually every job description to make everyone feel responsible for it getting done; educate and train staff (e.g., climate change, funding, systems thinking, social equity)
--	---

Source: The Authors

LACK OF CAPACITY (I). The final complex of challenges in this category is the *Lack of Capacity* archetype. We distinguish two versions of this archetype, deeply related at the level of their underlying drivers. But we discuss them separately in two different classes of archetypes because this first type affects the ability to apply for funding or tap and generate a source of funding, whereas the second variety affects a later stage in the funding process, namely the ability to administer and use funds (even if a local government succeeded in obtaining them).

Workshop participants noted the link between the *Basic Lack* and *Disproportionate Burden* challenges describe above. Past financial choices (e.g., debt burden) can affect how much additional financial burden and what types of external funding they can take on. Where local governments are already “in the red,” staff cuts or greater work burden on existing staff can be a challenge. Some never recovered to full staff capacity after the Great Recession a decade ago. Limited staff capacity causes many existing obligations to be done with delays, to remain undone all together, or leave little to no capacity to even think about how adaptation could be woven into existing work and funding streams. Crucially, given the tax law-driven dependence on external grant funding, lack of staff limits the capacity to look for grant opportunities, the ability to make sense of foundation and government grant funding, which is dispersed and difficult to navigate. Moreover, limited staff capacity constrains the ability to apply for grants that would provide resources or increase capacity. While bigger cities and counties may have a “dedicated adaptation person,” many pointed to the fact that most cities do not have that luxury. Most government employees must add adaptation to the “many hats they already wear.” Staff turn-over, low confidence in the ability to be successful and high competition for particular grant opportunities can result in local government staff not even trying to apply for funding. Another facet of this archetype is not just to have the capacity to write grants at all, but to write high-quality, competitive applications. That, in turn, requires greater expertise in adaptation and in the economic side (costs and benefits) of adaptation. While many described how they draw on external consultants to fill this gap, they did not view this as a good solution as it drains available funds and does not build internal capacity. Workshop participants wished for more (free) technical assistance, training and internal capacity building because they cannot find funding to pay for it. Other possible solutions are offered in Table 22, where the key emphasis was on breaking the self-reinforcing cycles of “money begets money” while low-capacity communities rarely can get ahead.

Table 22: Characteristics, Underlying Causes and Potential Solutions to Address the Lack of Capacity (I) Archetype

Characteristics and Causes	Potential Solutions
<ul style="list-style-type: none"> • Many local governments are significantly staff constrained, either due to chronic lack of funds, currently “being in the red,” or not having rebuilt full staff capacity after the recession • Staff must wear many hats; few have the luxury to have a dedicated “adaptation person” 	<ul style="list-style-type: none"> • Review and reduce onerous grant-writing requirements in State and federal funding (esp. water boards, USACE, Federal Highway Administration); consider stipulating that funds be used in part for internal capacity building • Size-adjust grant-writing requirements (simplify for smaller grants)

<ul style="list-style-type: none"> • Staff turn-over/retirements of long-term staff is always problematic, but particularly for short-term projects and grants (lack of institutional memory) • Limited staff capacity affects time for looking for funding opportunities, time for writing grant applications, and ability to write competitive applications • Low confidence in ability to succeed with grant writing can undermine the willingness to apply • Burden to apply for small grants (\$20K) is nearly as great as for bigger grants (\$100K) and grant writing requirements can be onerous; work burden may outweigh financial benefit • Grants for capacity building and training or to build up the “development” arm of local government are extremely limited • Expertise in adaptation may be low (even if there is grant-writing capacity) • “Best practice list for adaptation” and greater knowledge in how to quantify cost and benefits of adaptation would make application easier • Difficulty seeing opportunities for leveraging • Lack of technical assistance from State and other sources for grant-finding and -writing • Use of outside consultants can be efficient but drains available funds and prevents the building up of internal capacity (vicious cycle of dependence on external expertise) 	<ul style="list-style-type: none"> • Scale up intern and fellowship programs to assist particularly lower-capacity communities • Mandate regular updates to plans (that include adaptation) with assured funding if the updated plan is approved • Provide more block grants as they allow local governments to hire staff for multiple years • Provide more technical assistance and State-sponsored training programs on adaptation, systems thinking, grant writing best practices • Provide and use grant writing services (e.g., external specialized organizations or County-based grant-writing assistance to smaller communities) • Use ARCCA collaboratives or other consortia to build better relationships with scientists to make up for lack of technical expertise • Develop public-private-civic partnerships to help disproportionately burdened and lower-capacity communities overcome initial hurdles and begin to have better access to funding • Create pooled funds (e.g. at the regional level) and streamline application process; specifically task regional entities to administer pool or create capable, sufficiently staffed oversight or financial sponsor organizations willing to take on liability and responsibility to do so • General Assistance Programs (similar to EPA’s GAP program for tribes²⁶) should be created for other types of local government • Use the “100 Resilient Cities” as a model and build statewide program • Provide examples of where, when and how more complicated funding mechanisms or public-private funding models were successfully used to support replication/adaptation
--	---

Source: The Authors

5.2.3.4 Archetypes Pertaining to the Adaptation Funding Provider

With the fourth set of archetypes, we turn to adaptation funding related challenges that – in the eyes of workshop participants – rest with the funding providers. As a class, the challenges

²⁶ See: <https://www.epa.gov/tribal/indian-environmental-general-assistance-program-gap>.

described here significantly contribute to the fact that local governments – even if they could overcome all the previous funding-related challenges – cannot rely on or find appropriate funding opportunities when and where they need them. Philanthropy, State and federal government funders and the private sector are in a process of catching up to a world of continuous change and adaptation themselves – processes which were not examined as part of this study but worthy of investigation. Thus, the archetypes described are only those that emerged from participants’ rather than a complete list of all barriers that funding providers face in their own respective worlds.

DISCONTINUOUS FUNDING. The *Discontinuous Funding* archetype is fundamentally about the disconnect between the dynamic and ongoing nature of climate change and hence that of adaptation and a tradition and philosophy of short-term, finite funding for projects and even programs. We found two variations on this archetype:

- (a) Funding of ongoing change; and
- (b) Funding pre- and post-disaster.

Many workshop participants put their fingers on this mismatch: “climate change is ongoing, but funding comes and goes.” They bemoaned how difficult it is in general to get longer-term funding, saying “there is no 20-year money out there” to take a project from beginning to end. And while disasters can free up a lot of money, it comes all at once and goes away fairly shortly after the event. Moreover, how that money can be used depends on the rules and regulations of recovery funds. Pre-disaster hazard mitigation grants were perceived as too small to cover the need. And because grants are so much smaller than the actual full cost of projects, “everyone is ... doing piecemeal work,” “spinning wheels without getting anywhere.” They spoke of the need for a “life-long funding source” that could cover all aspects of adaptation-related work. Participants noted that grants are typically for specific projects, but much work in adaptation (education, outreach, monitoring and evaluation, collaboration etc.) requires ongoing work and is much harder to get supported. A few spoke of investment funds and financing, which can provide a longer-term stream of resources, but experience with such approaches (particularly involving the private sector) for adaptation is limited to date and many aspects of adaptation-related work are not fundable through these means. Mainstreaming those expenses instead into general funds or creating budget line items were also mentioned but run into many of the challenges discussed above under the *Chronic Underfunding* archetype. Those and other solutions are listed in Table 23.

Table 23: Characteristics, Underlying Causes and Potential Solutions to Address the Discontinuous Funding Archetype

Characteristics and Causes	Potential Solutions
<ul style="list-style-type: none"> • General difficulty of getting longer-term funding • Disasters can free up a lot of money, but is available quickly, unpredictably and is short-term 	<ul style="list-style-type: none"> • Provide block grants for longer-term continuous funding • Establish a “Climate Resilience Authority” to aggregate risk and pool risk insurance premiums into a regional fund), set asset retirement obligations over time, invest in

<ul style="list-style-type: none"> • Pre-disaster hazard mitigation grants are too small to meet the needs • Grants are typically for specific projects and often do not cover all aspects of adaptation-related work, leaving many aspects (e.g., outreach, collaboration) unfunded • Lack of experience with investment funds and financing mechanisms (especially with private sector involvement) • Mainstreaming adaptation expenses into general funds or creating budget line items is possible, but difficult for chronically under-resourced communities 	<ul style="list-style-type: none"> regionally significant risk reduction measures (e.g., buy-outs) from funding pool to buy down risk and to administer finances • State should facilitate building relationship with private investors to design innovative funding vehicles for long-term stable funding • Use more “carrot and stick” approaches that link risk reduction measures with funding • Create a long-term vision and intermediate milestones to measure progress against, so that people see progress over time. • Establish post-disaster rebuilding requirements/criteria to ensure adaptation is built into the recovery • Have post-disaster adaptation plans ready to go, so that opportunities of post-disaster funding don’t pass by untapped
---	--

Source: The Authors

AVERSION OF INNOVATION. The second archetype related to funding providers that emerged from the workshop discussions is the *Aversion of Innovation* archetype. In essence, this archetype captures the challenge that adaptation is (and will increasingly be) a deviation from traditional approaches and designs, but many funders (particularly in the public sector) view investment in such innovative efforts as too risky. In that way, funders can hold back adaptation and stymie experimentation. Clearly, this is not a pervasive problem with all funders, and funders can use the power of their purse to do exactly the opposite – namely, to foster innovation among funding recipients. But several workshop participants noted State, federal and philanthropic funders where innovative proposals were rejected because they did not replicate the tried and proven approaches. A slight variation on this theme was the complaint – particularly noted about philanthropic funders – that there is little understanding of the innovation process: once something new has been tried, it typically needs to be refined and improved and then supported to be spread more widely before it becomes common practice, but many foundations want something completely new every two years, not investing in a sustained and strategic manner in the most promising seeds and bringing them to fruition. Workshop participants attributed these problems to myopic and non-strategic thinking, lack of a long-term perspective, comfort in the status quo and familiar, lack of understanding that adaptation is required (i.e., that the old approaches won’t work anymore) and that it won’t go away, and the institutionalization of what is permissible in funding rules and requirements. Table 24 offers some initial set of solutions, but more are needed.

Table 24: Characteristics, Underlying Causes and Potential Solutions to Address the Aversion to Innovation Archetype

Characteristics and Causes	Potential Solutions
<ul style="list-style-type: none"> • Funders (particularly in the public sector) view investment in innovative approaches and designs as too risky • Experimentation is stymied • Lack of understanding of the innovation process, and the need for sustained and strategic investment to bring innovative approaches to fruition • Myopic and non-strategic thinking, lack of a long-term perspective, comfort in the status quo and familiar • Lack of understanding that adaptation is required (i.e., traditional approaches won't work anymore) and ongoing • Institutionalization of what is permissible in funding rules and requirements 	<ul style="list-style-type: none"> • Work through the rule-making process at relevant agencies to change funding requirements • Invest in demonstration projects to show what works, what is cost-effective and other lawful co-benefits of innovative ideas • Establish pilot programs, especially to spur innovation and test effectiveness, without immediately requiring wholesale program changes • Provide strong state-level leadership to direct agencies appropriately • Tap into new narratives and values to make the new attractive (rather than a threat to the familiar), e.g., risk aversion to bad things as opposed to risk aversion to new things • Invest much more in outreach to overcome resistance to science, reality of change • Seek out foundations that support innovation to pilot test new ideas • Task certain organizations with identifying innovative, best practice approaches for local governments • State should use and invest in bottom-up, participatory processes (crowd-sourcing, competitions) to generate novel ideas; permitting agencies would need to be at the table from the start

Source: The Authors

5.2.3.5 Archetypes Pertaining to the Adaptation Funding Source or Type

The fifth set of archetypes relate to particular funding types and sources. Even if local governments can overcome the barrier clusters discussed so far, they encounter biases toward and against certain adaptation needs, and because of the dispersed nature of adaptation funding across many sources, they find it difficult to know what sources might be available to meet them. The effective outcome of the two archetypes discussed in this class is that local governments can't access available or find an appropriate funding source.

FUNDING BIASES. The first in this category is the *Funding Biases* archetype. At heart, this is about the perception – and often reality – that there simply is no or only limited funding to meet adaptation-related needs. Interestingly, we observed a bifurcation in views on these biases. Many insisted that there is more funding available for building things, for shovel-ready

projects, i.e., the implementation stage, and less funding for earlier stages in the adaptation process (pre-development, planning, communication and engagement), and what comes after implementation (monitoring and evaluation). The second, contrasting and dominant, view was that there is more money for planning, but hardly any for implementation. Some thought that particularly in prime real estate markets such as urban and coastal areas, many adaptation options are so expensive and politically contested that it is difficult to find sufficient funding and garner the necessary political support. Other reasons for this bifurcation relate to the second archetype in this class (not knowing about available funding, discussed below) and reflect views from people in different stages of adaptation. Generally, however, workshop participants agreed that there is a bias toward discrete, smaller projects and efforts with a corresponding bias against broader programmatic funding. They noted, however, that “there are not many small projects in adaptation.” This view is consistent with the *Discontinuous Funding* archetype. Many attributed these biases also to the fact that “shovel-ready is quick; the rest of it [e.g., building cross-sector or cross-jurisdictional relationships, outreach] is slow.” This observation relates this archetype to the *Siloed Governance Syndrome*. In the discussion about funding biases, workshop participants also shared their experience with funding for different sectors, most noting that funding for health-related adaptation is much more difficult to come by than for coastal and water projects or other major infrastructure. Finally, identifying adequate measures of success for longer-term, complex programmatic efforts may be harder than doing so for smaller projects – another reason why they are harder to sell to potential funders. Table 25 lists an initial set of possible solutions.

Table 25: Characteristics, Underlying Causes and Potential Solutions to Address the Funding Biases Archetype

Characteristics and Causes	Potential Solutions
<ul style="list-style-type: none"> • Perception (and often reality) that there is no or only insufficient funding to meet adaptation-related needs • One view that there is more funding for implementation than for earlier and later stages of adaptation • A second (dominant) view that there is more funding for planning than for implementation • Bias toward discrete projects • Bias against broader, programmatic efforts • Bias toward structural adaptation measures (coastal, water, infrastructure), while neglecting human health impacts • Bias against adaptation options that are very expensive and politically contested • Lack of political and public support for expensive and contested adaptation options 	<ul style="list-style-type: none"> • Apply a life-cycle funding approach to adaptation, with the ability to go back to the same funder for later needs • Change funding requirements for shovel-ready projects to mandate inclusion of “soft” aspects of adaptation (outreach, engagement, planning, monitoring and evaluation over time) • Look to other models for “whole-project funding” (e.g., California Building Healthy Communities 10-year funding model) • Conduct more outreach and education to help communities understand adaptation needs, outlook over the long-term • Conduct cost-effectiveness studies to illustrate effectiveness • Invest in efforts to develop measures of progress and success

<ul style="list-style-type: none"> • Lack of knowledge of what funding sources are available • Lack of clear measures of success and progress for programmatic efforts 	
--	--

Source: The Authors

LACK OF KNOWLEDGE ABOUT FUNDING SOURCES/HAPPENSTANCE. The second archetype in this class we called *Lack of Knowledge About Funding Sources* or *Happenstance* for short. The latter captures the essence and the sentiment expressed by workshop participants better than its longer name. Many spoke about their “pure luck” that they found a particular grant announcement, some serendipitous alignment of circumstances, or the benefit of being on a listserv through which they happened to learn of an opportunity, one they might otherwise never have known about. Others felt “some are in the know, while the rest of us aren’t.” In a state where local governments are strongly dependent on external funding, not having a single place to go look for grant opportunities was perceived as a big problem. Some felt this fostered the perception that there is no funding, when there is a lot of money out there, people just cannot find it. One of the principal underlying reasons mentioned is that the world of funders is just as siloed as the world of funding seekers. As one put it, “when the funding is siloed, your work is siloed.” Each funder only funds a piece of the work, and it would be a full-time job to find and write grants to each to get all aspects of adaptation supported. In addition, participants noted that while there are many foundations and many fund bits and pieces, there are actually relatively few who are specifically dedicated to adaptation. Many bemoaned how hard it is to find grants, how difficult sites are to navigate and understand, and that they had “no one in charge of looking for grants” either on their staff or doing so for a region or for all local governments (the funding wizard envisioned under ICARP was not yet set up at the time of this research). Clearly, these challenges echo the *Lack of Capacity (I)* archetype described above. Potential solutions are offered in Table 26 but must be considered carefully and in concert with other needed solutions so as not to ultimately undermine local governments’ ability to acquire the funding they need.

Table 26: Characteristics, Underlying Causes and Potential Solutions to Address the Happenstance Archetype

Characteristics and Causes	Potential Solutions
<ul style="list-style-type: none"> • Siloed nature of funding sources • Many foundations fund relevant “bits and pieces” but only a relatively small number focus on adaptation • No centralized place to find funding opportunities • Happenstance to find or learn about funding opportunities • Capacity constraints to look for and take advantage of grant opportunities 	<ul style="list-style-type: none"> • Easily navigable clearinghouse of funding opportunities, constantly kept up to date; but fear that it will increase competition for limited funds if more know about them • Host of clearinghouse should have staff capacity to maintain, push out, and do some hand-holding of funding seekers; alternatively work closely with regional collaboratives or regional adaptation assistance centers to support local governments • Need to build up the “development” capacity of local governments, a funded staff assigned

	<p>to search for grants, assign them to departments and assist technical staff in writing successful applications</p> <ul style="list-style-type: none"> • Introduce and pass State legislation for PACE-like program for adaptation-related needs (at the level of property owners) • Host California-based foundation summit to help foundations see why adaptation needs to become part of their portfolios • Create a statewide dedicated Climate Adaptation Fund • State and adaptation service providers should provide more technical assistance to local governments • Use of B Corporations, venture trust funds etc. to launch adaptation initiatives; then get bigger investments from private sector
--	---

Source: The Authors

5.2.3.6 Archetypes Pertaining to the Adaptation Funding Mechanism

The sixth category is closely related to the previous class of archetypes but relates specifically to the funding mechanisms or vehicles themselves. We single it out because of the growing interest in and attention to funding mechanisms. It includes only one archetype, which we named *Restrictions, Conditions and Eligibility Criteria*, or the *Eligibility* archetype for short.

RESTRICTIONS, CONDITIONS AND ELIGIBILITY CRITERIA. The *Eligibility* archetype is technical, institutional and political in nature and is focused on the minute details of a particular funding mechanism, rather than the broader circumstances in which local governments try to find support for their adaptation efforts. It involves lack of clarity on what the eligibility criteria of certain grants are or simply not meeting those criteria. And even if a local government application might meet them, often grant applications are difficult to understand, get right and generally onerous to complete. Those who try to be creative in using whatever funds available to work adaptation into them, often encounter restrictions whereby they can't build adaptive strategies and designs into them. Rules, regulations, design standards, mandates and professional practices applicable in the local jurisdiction can similarly restrict the ability to mainstream adaptation into existing work and prevent application for funding that is specifically for adaptation. Sometimes even the guidelines and rules to help lower-capacity communities can get in the way, e.g., if a community does not perfectly fit the definition of being "disadvantaged," it may lose access to dedicated funding opportunities. Others noted, however, that "EJ (environmental justice) guidelines" that have been developed to enable more effective input and participation from disadvantaged communities are not always implemented. With the restrictions on both the giving and receiving end, staff often must patch together grants, which is time-consuming and extremely difficult for already capacity-constrained local governments, especially when grants require significant preparatory work. Matching fund requirements were pointed out as often being prohibitive. Finally, there are long-standing legacies - institutional, economic and political - that can make it difficult or

impossible to pursue certain funding opportunities (e.g., non-attainment status vis-à-vis federal standards prevent application for certain federal grants; bad prior experience with a funder). Table 27 offers a long, but likely incomplete list of potential solutions.

Table 27: Characteristics, Underlying Causes and Potential Solutions to Address the Eligibility Archetype

Characteristics and Causes	Potential Solutions
<ul style="list-style-type: none"> • Lack of clarity on eligibility criteria or application not meeting them • Difficulty understanding grants and application process • Certain types of funding are restrictive and can't be used for adaptation activities (e.g., building back better or using adaptive designs can be prevented by requirements to build back the same) • Existing mandates, rules and regulations may be so narrowly defined and restrictive that adaptive measures can't be integrated and staff can't apply for available funds • Need to patch funding together from multiple sources to compensate for restrictions • Patch-work approach is time consuming and difficult to impossible for staff-constrained communities; undermines implementation of a broader vision • Matching fund requirements can undermine lower-capacity communities' ability to take advantage even where funds are available • If funding applications require a lot of prior planning or development work, timelines and opportunities are missed • Legacies and bad past experiences with certain funders (e.g., regulatory agencies) can bias against repeated application or engagement with funder • Legacies (e.g., being in non-attainment of certain regulations; lack of structural soundness of buildings) can undermine eligibility for grant funding or ability to use certain adaptation strategies 	<ul style="list-style-type: none"> • Add adaptation criteria to existing funding streams and related legal frameworks • Establish dedicated "transition funds" (additional to other funding) so people have the necessary means to move out of old ways of doing things to new ways • Establish a pool of matching funds that small communities can tap into for grants that require them • Update codes, standards and guidelines to incorporate changing conditions and enable mainstreaming adaptation • Strengthen code implementation to ensure adaptation is incorporated • Revisit definition of "disadvantaged", "diversity" and "vulnerability" in State code, CAL Environscreen and other grant stipulations, which can be too limiting at the local level • Review CEQA and ensure that it accounts for climate change impacts and makes explicit space for adaptation • Review conditions on mitigation grants and make room for adaptation co-benefits • Add adaptation criteria to GGRF • For communities that prepare separate general and hazard mitigation plans, integrate at the next update to create cost efficiencies and better integration across the community

Source: The Authors

5.2.3.7 Archetypes Pertaining to the Use and Administration of Adaptation Funding

The seventh and final archetype relates to local communities’ ability to use and administer funds. We view it as a variation or expression of a previously introduced archetype, Lack of Capacity, as it has the same underlying drivers and is similar in nature, but it has a distinct effect. We thus distinguish it here.

LACK OF CAPACITY (II). Many workshop participants pointed out that even if a community could manage somehow to apply for funding and succeed, it takes a particular kind of qualification and capacity to administer the received funds. It is also not entirely rare that communities can’t use grant funding during a specified grant period (for a whole variety of reasons) and must return unspent funds. The former problem is distinctly bigger, however, and in fact can lead some lower-capacity communities to not even bother to apply. They may not meet required accounting standards, or they may simply not have the staff capacity to manage multiple or even few but bigger and complex grants (Table 28).

Table 28: Characteristics, Underlying Causes and Potential Solutions to Address the Lack of Capacity (II) Archetype

Characteristics and Causes	Potential Solutions
<ul style="list-style-type: none"> • Lack of staff capacity to administer complex or multiple grants; serves as disincentive to apply for funding • Lack of skill in administering complicated funding models • Lack of capacity to implement a project (for a variety of reasons) creates a disincentive to apply for funding • Onerous reporting requirements 	<ul style="list-style-type: none"> • Establish and support capable lead organizations to assist local communities in grant administration or do it for them entirely • Trainings in grant administration • Build staff capacity more fundamentally (see Lack of Capacity I archetype interventions)

Source: The Authors

5.3 Conclusions

In this chapter, we have looked beneath the superficial complaint, heard so often in the adaptation world, that “we don’t have enough money” to advance climate change preparedness. The financing archetypes introduced here are a shorthand for interlinked clusters of adaptation barriers (institutional, human, political and economic, and so on) that mutually reinforce each other. Thinking of archetypes in this way constitutes an important advance in adaptation research, which – historically – has considered different types of barriers in isolation from each other or has recognized their inter-relatedness but not fully explored it. In our view, this is particularly critical in practical contexts where one-size solutions cannot adequately address real-world problems.

The archetype discussion has also added depth to the findings in the survey in that it qualitatively relates the barriers encountered during different stages and offers many concrete suggestions – all generated from workshop participants across the state themselves – for how to begin to address them.

Another important insight from this discussion is that addressing any one archetype alone, in the hopes of having found the silver bullet solution, will not address the deep-seated funding challenges laid bare in this study. For example, the elegant, albeit elusive solution of “simply providing more funding” to local governments – while absolutely critical – will not by itself be enough. If there is no capacity to apply for funding or no capacity to administer funds, making more funds available that remain beyond reach will not fix the problem. Similarly, the highly commendable idea of providing a one-stop information clearinghouse (as is in progress under ICARP), which will offer – among other things - a central point of information about ongoing State funding programs and other grant aggregation sites, thereby helping to resolve one of the archetypes we found, may well backfire without additional interventions: many more people will be aware of limited funding sources and by applying for them inadvertently increase the competition and opportunity cost (i.e., the time spent applying for grants), but if the success rate and funding amounts stay the same, the clearinghouse alone will not necessarily help local communities get more funding.

In short, there is no “single” solution, nor can any actor alone – local, state, federal, philanthropic or private – make sufficient progress. Similarly, resolving one archetype may constitute important and even necessary progress, but our study makes clear that it cannot and will not fix the whole problem. Comprehensive and complementary sets of interventions may have a better chance at affecting long-standing patterns of thinking, habitual behavior, organizational silos, and rules and regulations.

Finally, adaptation finance archetypes identified in this study reflect the state of adaptation at the local level in California at this time; they can be expected to change in importance over time; they may improve or worsen. In fact, a repeat investigation of these archetypes in several years from now may be a way to measure adaptation progress in the state and its regions.

The next chapter examines – on the basis of local governments’ adaptation plans and related implementation documents – what California cities and counties have already spent on adaptation, how they assess the cost of inaction and the cost of adaptation, and what specific sources they have drawn on to do so. This examination allows us to draw some very preliminary boundaries around the adaptation funding need and the unfilled funding gap.

6: Local Adaptation Finance Experience: Estimating Funding Needs and Locating Funding Sources

6.1 Introduction

In previous chapters of this report, we have attempted to place the situation of local governments in California into the broader context (Chapter 3), get a first-order sense of adaptation barriers and funding challenges from the survey (Chapter 4), and then examine the nature of the observed funding challenges in more detail through the archetype analysis

(Chapter 5). Here we seek to accomplish several additional things to solidify the understanding of adaptation finance challenges as well as of possible solutions.

On the basis of our document analysis, we first assess what local governments can tell us about the financial risks they face if no adaptive action were taken (Section 6.2), and then do a similar analysis of the estimated cost of adaptation (Section 6.3). Together, these two sections provide insight into the cost-effectiveness of adaptation and allow us to draw some conclusions about the adaptation funding need and gap. Finally, in Section 6.4, we summarize what could be gleaned from the documents about how California local governments currently envision meeting those needs. It paints a partial picture of the world of funding mechanisms that is available to meet local governments' adaptation finance needs.

As noted in the Methodology section (Chapter 2), for this section, we reviewed local government vulnerability assessments, climate action plans, climate adaptation plans, and resilience strategies that included information on the cost of inaction and the cost of implementing adaptation strategies. Of the 63 local government plans and assessments reviewed, only 21 included specific information on estimated costs with significant variability in the methods used to arrive at these estimates. The project budget did not allow for a more comprehensive review of local government budgets or other plans that may have included information on adaptation costs (an issue of particular relevance in those communities that have decided to mainstream adaptation into existing work, budgets and processes. It is also important to note that, in some cases, the estimated costs of adaptation exceed municipal budgets, and that we did not assess the ability of any municipality included in this assessment to fund or finance those costs.

6.2 The Cost of Inaction

There are a number of ways in which climate change does already – and will increasingly – force local governments in California to expend resources. First, there will be financial burdens from the direct impacts from specific climate stressors including damages to and losses of municipal- and community-owned assets, as well as indirect economic impacts that may be traced to those stressors. Second, there will be direct costs associated with replacing and retrofitting assets and infrastructure as well as expenses for planning and implementing adaptation strategies.

6.2.1 Available Data on the Cost of Inaction

Our document analysis revealed – first and foremost – that the vast majority (86%) of local government plans and assessments reviewed do not provide an analysis of the economic and fiscal impacts of climate change. Only 11 reports (17%) presented actual dollar figures for replacement values or potential damages, property values at risk, and/or economic vulnerabilities. These reports represent 10 unique California local governments: Benicia, Carlsbad, County of Marin, Goleta, Hermosa Beach, Huntington Beach, Imperial Beach, Los Angeles, San Francisco, and Santa Cruz.²⁷

²⁷ The full references for the plans included in this analysis are listed in Appendix B.1.

Table 299 summarizes the cost estimates for assets at risk identified in these documents. For these ten communities alone, the estimated cost of inaction totals over \$100 billion. It is important to note, however, that the underlying methodologies used to arrive at these estimates vary widely, thus the numbers should not be directly compared to each other.

Table 29: Summary of Estimates for Assets at Risk and Replacement Values

Location	Replacement Value or Costs of Damage	Property Value at Risk	Economic Value at Risk	Source
Benicia	n/d	\$213,000,000	n/d	Benicia Climate Change Vulnerability Report Summary
Carlsbad	\$2,000,000,000	n/d	\$3,000,000,000	Carlsbad Climate Action Plan
County of Marin	n/d	\$1,729,000,000	n/d	Marin Ocean Coast Sea Level Rise Vulnerability Assessment
Goleta	\$259,676,509	n/d	n/d	City of Goleta Coastal Hazards Vulnerability Assessment and Fiscal Impact Report
Hermosa Beach	\$44,000,000	n/d	n/d	Vulnerability and Adaptation to Sea-Level Rise: An Assessment for the City of Hermosa Beach
Huntington Beach	\$221,673,000	n/d	n/d	City of Huntington Beach Sea Level Rise Vulnerability Assessment
Imperial Beach	n/d	\$72,600,000	\$179,430,721	2016 City of Imperial Beach Sea Level Rise Assessment
Los Angeles	\$8,936,000,000	\$2,059,200,000	n/d	Sea Level Rise Vulnerability Study for the City of Los Angeles
San Francisco	n/d	\$80,700,000,000	n/d	San Francisco Climate Action Strategy: 2013 Update; San Francisco Sea Level Rise Action Plan
Santa Cruz	n/d	\$1,021,310,300	n/d	City of Santa Cruz Climate Adaptation Plan Update 2017-2022
Total	\$11,461,349,509	\$85,795,110,300	\$3,179,430,721	

Source: The Authors

While the above estimates from local government assessments indicate just how high the cost of inaction could potentially be, we also caution that the data may not accurately reflect the total value of local assets at risk. These figures entail a number of significant uncertainties and point to ways in which the estimates may be too low, including:

- The calculations and methodologies used to determine cost and value estimates were not sufficiently described in the documents reviewed to determine completeness, accuracy and inter-comparability.
- None of the assessments estimated all three asset classes we list in Table 29. About half of the cells remain empty, suggesting that even for just these 10 communities, the cost may be more than what is reflected here.
- Studies were completed at different times, and estimated costs are provided in nominal figures (that is the value of the year in which they were assessed), rather than all adjusted to a common base year to provide the real value. Some documents provided this information, others did not, so we could not adjust the figures uniformly.
- The 10 local governments that included concrete asset valuations in their vulnerability assessments are all coastal, but they do not include some of the largest (San Diego, Oakland, San Jose, Berkeley) nor some of the smallest along California's North Coast. Inland municipalities are completely unrepresented, such as Sacramento, Fresno, and other major cities. In short, the 10 do not constitute a representative sample.
- The documents only include assets at risk from sea-level rise and they make differing underlying assumptions about sea-level rise scenarios to derive their economic estimates (ranging from 1.4 to 1.7 to 2.7 meters of sea-level rise by 2100). This variability reflects different risk tolerances but makes comparison across communities impossible.
- The assessments also did not evaluate concurrent climate change impacts such as inland flooding, extreme heat, cycles of drought and extreme precipitation, and wildfires; nor did they include the compounding effects of climate change such as the increased risk of landslides as a result of heavy precipitation events after prolonged drought or severe wildfires.
- Only two of the 10 local governments included the value of lost economic activity in their assessments. Internalizing these costs would likely lead to a substantial increase in the total value of assets at risk for these local governments.
- Some local government plans do not include the non-structural assets at risk including the value of industries and economies that enable Californians to thrive. Only two assessments included such valuation, which includes broad economic vulnerabilities identified by the City of Imperial Beach and agricultural impacts from decreasing water supplies identified by the City of Carlsbad. In addition to extending these evaluations to all municipalities, other key industries should be included such as technology and tourism.
- The vulnerability assessments reviewed did not include specific cost estimate for social vulnerabilities and local government services that will be needed during and after times of disaster such as to support displaced residents.
- Future costs and values of these assets may be very different from present costs, which will depend on a variety of factors including population size and additional assets at risk.

- Finally, the extrapolation of assets at risk and the cost of inaction for California are only based on the limited information provided in local government assessments and does not include other important actors including regional districts, utilities, State agencies, private landowners, and decision-makers.

6.2.2 Discussion

Given the large uncertainties and limitations in the available data base, we decided against extrapolation to assess the total economic value of property and economic activity at risk. To do such an assessment would require significantly more consistent data and more sophisticated methods.

It is notable, however, that just 10 local communities in California, focusing on just one climate change risk (sea-level rise), can have a financial exposure of at least \$100 billion. This is significantly higher than any previous (partial) coastal economic impacts studies have estimated (Pendelton et al. 2009; Heberger et al. 2009). In the next section, we turn to the question of experience with or estimates of adaptation costs to see whether it is cost effective to protect these assets.

6.3 The Cost of Adaptation

6.3.1 Available Data on Adaptation Expenditures to Date

The local government documents we reviewed did not provide any information on adaptation-related expenditures to date. Obtaining local government data on adaptation expenditures was beyond the scope of this project due to the following reasons:

- Funding and timeline for this project did not allow for a comprehensive review of local government budget reports. With 540 local government in California, this type of analysis would have required reviewing tens to hundreds of thousands of pages of budget reports.
- Many local governments are striving to mainstream adaptation into existing activities and budgets in order to integrate adaptation into agency processes and to get started on adaptation despite limited dedicated adaptation funds. While desirable for many reasons, mainstreaming makes it impossible to parse out - on a line-by-line basis - what does and does not count towards adaptation.
- Without a clear definition of adaptation that is broadly accepted by local governments throughout California, a detailed analysis of adaptation expenditures would not produce meaningful results.

These observations make clear that even with more time and research funding, it would be extremely difficult to devise a reliable methodology to determine adaptation expenditures given inconsistent definitions, parameters and difficulty in accessing information.

To our knowledge there is no comprehensive effort underway in California to date to provide clear guidelines and collect such information from local governments on a regular basis. The OPR Annual Planning Survey does not inquire about adaptation in this detail. The 2016 Coastal

Adaptation Needs Assessment Survey collected some very preliminary data on coastal adaptation expenditures (Moser et al. 2018), but deeper analysis is required. The only systematic effort in collecting adaptation data (the Sea-Level Rise Database, mandated under AB 2516²⁸) focuses primarily on adaptation by State entities, only captures selected local government efforts, and is only focused on coastal adaptation.

6.3.2 Available Data on the Expected Cost of Adaptation

We then explored what could be learned about expected *future* expenditures on adaptation from our collection of documents. Of the 63 local government plans, assessments, and reports we reviewed, only 10 (16%) provided cost estimates for specific adaptation strategies to be implemented in nine unique local governments: Benicia, Chula Vista, County of San Luis Obispo, Goleta, Imperial Beach, Laguna Woods, Sacramento, San Diego, and Santa Cruz.²⁹

Quite similar to assessments of the cost of inaction, the approaches used and considerations included differed widely. While some reports included both one-time costs and ongoing or annual costs (e.g., Benicia), others did not differentiate between upfront costs of implementation and/or construction and maintenance costs over time (e.g., Goleta). Additionally, some reports only included cost ranges (e.g., Laguna Woods) while others provided detailed cost estimates (e.g., Imperial Beach). Methods used to arrive at these cost estimates varied from general estimates provided by staff, to estimates derived from interviews with experts, to specific calculations determined on a per unit basis.

Importantly, cost estimates were detailed for a total of 227 unique adaptation strategies, which we grouped into four categories (Table 30 Table 30).

Table 30: Frequency of Adaptation Strategies with Cost Estimates in Local Plans

Types of Adaptation Strategies with Cost Estimates in Local Plans	Number of Adaptation Strategies Mentioned
Research and monitoring	27
Community engagement and coordination with external partners	32
Developing and updating plans, updating design guidelines, codes and standards, and developing policies	80
Implementation and construction	88
Total	227

Source: The Authors

²⁸ See: AB 2516 (Gordon), Sea level rise planning: database. https://leginfo.legislature.ca.gov/faces/billTextClient.xhtml?bill_id=201320140AB2516.

²⁹ All plans included in this analysis are listed in Appendix B.1. Note, we used only the latter of the two reports prepared for Santa Cruz to avoid double counting and to use only the most recent estimates.

While some plans focused almost entirely on the costs of implementation (e.g., Imperial Beach), others focused primarily on planning and policymaking (e.g., Chula Vista). Some plans listed many strategies, while others focused on only a small number of strategies. For example, the City of Sacramento’s Climate Action Plan for Internal Operations only provided cost estimates for two strategies related to water conservation and LED retrofit programs, and the County of San Luis Obispo’s Preliminary Climate Change Vulnerability Assessment for Social Systems only provided cost estimates for the construction and maintenance of a new levee and seawall.

These differences notwithstanding, we compiled the one-time and ongoing costs of adaptation strategies identified in these local government plans in Table 311. In total, the nine local governments included in this analysis estimated funding needs of over \$935 million to implement their adaptation strategies and over \$515 million for ongoing maintenance.

Table 31: Summary of Local Adaptation Cost Estimates (Based on 9 Local Plans)

Municipality	Total / One-time Cost	Ongoing / Annual Cost	Source
Benicia	\$29,490,000	\$482,000	Climate Change Adaptation Plan, Preparing Benicia for a Resilient Future
Chula Vista	\$536,900	\$320,000	Chula Vista Climate Adaptation Strategies: Implementation Plans
County of San Luis Obispo	\$210,000,000	\$21,000,000	Developing Adaptation Strategies for San Luis Obispo County: Preliminary Climate Change Vulnerability Assessment for Social Systems
Goleta	\$358,027,980	n/d	2015 City of Goleta Coastal Hazards Vulnerability Assessment and Fiscal Impact Report
Imperial Beach	\$89,646,000	\$491,556,250	2016 City of Imperial Beach Sea Level Rise Assessment
Laguna Woods	\$547,990	\$450,000	City of Laguna Woods Climate Adaptation Plan
Sacramento	\$4,440,000	n/d	Climate Action Plan for Internal Operations
San Diego	\$87,060,950	n/d	City Heights Urban Greening Plan; Climate Action Plan: Fiscal Year 2017 Funding &

			Implementation Report
Santa Cruz	\$156,000,000	\$2,050,000	City of Santa Cruz Climate Adaptation Plan Update 2017-2022
Total	\$935,749,827	\$515,858,250	

Source: The Authors

While the above cost estimates from local government plans shed light on the importance of acknowledging both upfront costs and maintenance costs, again we would urge readers to proceed with caution as these estimates may not accurately reflect local government adaptation funding needs. Moreover, as mentioned above, some of the adaptation cost estimates exceed some local governments' entire municipal budget, and we did not assess how or whether these local governments would be capable of generating the necessary funds. Moreover, there are important uncertainties in these figures, which future research could help reduce:

- The basis for cost estimates included in local government plans is highly uneven in terms of what is and is not included, the level of specificity of adaptation strategies, economic assessment methods used, and any underlying assumptions for determining cost estimates (discount rates, design life vs. life of structures, assumptions about changing costs of adaptation measures over time etc.).
- Climate change-driven needs may require more or less action than the plans suggest. The cost estimates are based on certain assumptions about the scale, pace and severity of climate change impacts, as well as on assumptions about the efficiency with which they will be implemented. If climate change impacts are worse than current projections, these plans underestimate the cost; if climate change impacts are less severe or slower than current projections, these plans may overestimate the cost.
- Lastly, these cost estimates are not linked to potential co-benefits and savings or economic opportunities (e.g., lives saved, protected tax base, enhanced environment, improved public health) that could potentially offset certain costs.

6.3.3 Extrapolating Adaptation Costs Statewide

The uncertainties discussed above and the limited number of economic assessments of adaptation costs available do not allow for a credible extrapolation from these estimates to the statewide cost of adaptation to local governments.

For example, the plans and reports reviewed here only represent a very small portion of California's local governments. With only 8 cities and 1 county represented, this analysis reflects 1.67% of all California municipalities (1.66% of California's 482 cities and 1.72% of California's 58 counties). On a population basis, our sample of nine communities represents only 6.7% of the state, and on an area basis only 2.7% (see Table B.1 in Appendix B).

Population size, land area and number of local governments all could serve as the basis for such extrapolations, but this would only be meaningful if the underlying data were more robust and if the sample size was larger and more representative of the types of California communities.

Thus, currently available data constitutes a rather weak and inconsistent basis on which to put forward a credible estimate of statewide adaptation costs at this time. Thus, we recommend further in-depth analysis to develop better estimates in the future.

Such an analysis would need to carefully consider and work effectively through the following uncertainties:

- The nine municipalities that included cost estimates in their reports are relatively small cities and counties with the exception of Sacramento and San Diego. Future extrapolated estimates of statewide costs to local governments must weight available assessments according to the real distribution of community size.
- The local governments represented in this analysis are predominantly coastal and do not represent a weighted sample of local governments based on type and location (e.g., urban vs. rural, inland vs. coastal).
- Some local government plans do not include the non-structural aspects of adaptation that are critical to successfully adapting to climate change such as meaningful and sustained community engagement, supporting small business resiliency, coordinating across jurisdictions, and overcoming institutional barriers to implementing adaptation strategies. Future estimates must include more comprehensive assessments of all types of adaptation-related expenditures.
- Many plans only include an initial set of strategies, and future adaptation plans that are more comprehensive will undoubtedly identify additional costs. Future assessments should establish common time horizons (e.g., estimated costs over the next 10-20 years) and then revisit and update those estimates at regular intervals.
- Adaptation costs assume implementation without delay, disruption or disasters. It is likely that these costs would be significantly higher if they included the costs of delays, disaster damages and costs associated with rebuilding after disasters. The estimated funding needs also assume that there are no legal challenges to implementing adaptation strategies, which are difficult to predict or assess but likely very costly.
- Future costs of these strategies may be very different from present costs, which will depend on a variety of factors including supply and demand for adaptation services, population size, and value of assets at risk.
- In many communities, adaptation will need to be pursued on the back of many years of deferred infrastructure maintenance or neglect. Adaptation costs may be higher than estimated to account for the substantial work that needs to occur in order to implement selected adaptation strategies in those cases.
- Finally, the estimated adaptation costs do not include other important actors including regional or special local districts, and other entities. A comprehensive assessment of statewide adaptation costs to all actors (including utilities, State agencies, businesses, households and other private sector entities) has not been undertaken to date, neither in California or anywhere, to the best of our knowledge.

These challenges noted point to several additional insights that must be kept in mind: (a) economic assessment methodologies have a crucial influence on the results; and (b) given the incompleteness of data and the many gaps noted, we believe there is strong grounds to believe that costs of adaptation to local governments have been underestimated to date. Even with the

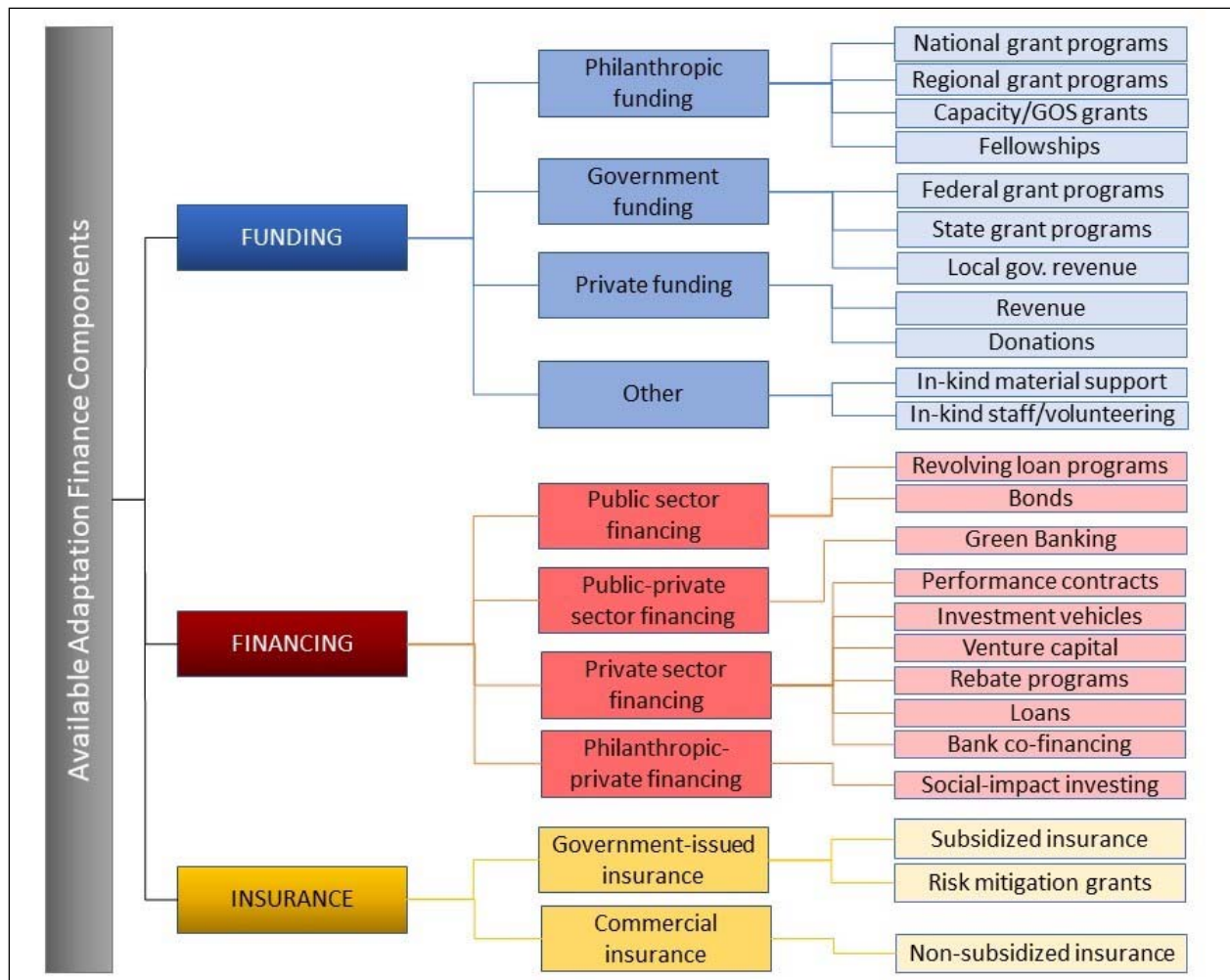
limitations of our analysis, the available local plans provide a window into the practical details of adaptation, and thus give a better sense of the ultimate true costs of adaptation.

6.4 Known and Used Funding and Financing Sources

The final step in our document analysis was to examine local plans for any information they could provide about how local governments are expecting to meet those adaptation funding needs. Of the 63 local government plans, assessments, and reports we reviewed, only 14 (22%) contained any information on potential or secured funding sources for specific adaptation strategies.

From these 14 reports, it is clear that many local governments are striving to pursue both traditional and innovative strategies to fund local adaptation. Local agencies – and the consultants that support their assessment and planning efforts – identified numerous potential funding sources that could be pursued. We list every source we found in Table B.3 for the benefit of other local governments seeking funding. This collection of sources points to 10 federal agencies, 13 State agencies, 3 distinct local sources, 4 different philanthropic sources, and 7 private sources, each with numerous sub-categories, for a total of 114 unique funding mechanisms.

Figure 10 provides a general framework to help organize these examples (e.g., as a basis for organizing ICARP’s currently-planned funding wizard for adaptation (*Note: A future, separately developed compendium of funding mechanisms will provide a detailed matrix, listing specific funding mechanisms and programs in each category, along with programmatic description and eligibility criteria*)).



Source: The Authors

Figure 10: Organizing Framework of Adaptation Finance Mechanisms

Based on our own review of funding mechanisms in the literature and our knowledge of additional philanthropic and federal funds alone, we judge this to be a strong but incomplete list. For example, it does not include two innovative funding measures just recently created:

- Los Angeles County - Measure M: Traffic Improvement Plan Ordinance (sales tax)³⁰
- San Francisco Bay Area - Measure AA: Clean and Healthy Bay Area (parcel tax)³¹

³⁰ See: <http://theplan.metro.net/>.

³¹ See: [https://ballotpedia.org/San_Francisco_Bay_Restoration_Authority_“Clean_and_Healthy_Bay”_Parcel_Tax,_Measure_AA_\(June_2016\).](https://ballotpedia.org/San_Francisco_Bay_Restoration_Authority_“Clean_and_Healthy_Bay”_Parcel_Tax,_Measure_AA_(June_2016).)

The documents also did not make any mention of the Bay Conservation and Development Commissions recently established *Financing the Future Working Group*³² – an effort intended to identify financing solutions for Bay Area local governments.

State funding sources are also incomplete, based on our knowledge of available programs and on what we learned from stakeholders in the workshops. Many pointed not just to explicit adaptation funding programs, but the creative use of traditional, non-climate programs that they drew on for adaptation purposes. Table B.4 lists adaptation-related bills from the past five years and indicates what, if any, funding provisions they contain.

Finally, the list of sources compiled from local documents also does not include several important federal grant opportunities (e.g., NOAA, other EPA programs, DOE or other parts of DOI). It also is highly selective of available philanthropic funding sources, given that there are hundreds of smaller regional and several large national foundations based in California alone. Particularly, some of the leading adaptation and resilience-focused foundations, such as the Kresge and Rockefeller Foundations, or foundations particularly engaged on public health, urban sustainability or social equity (such as Surdna, Kaiser, JPG, Summit), or on conservation issues (e.g., Packard, Moore) are not on this list.

These omissions notwithstanding, the documents revealed that local governments “mix and match” to meet their funding needs from a variety of sources. For example, of the plans reviewed, seven municipalities (Berkeley, Chula Vista, Laguna Woods, Oakland, Sacramento, San Diego, and Santa Cruz) identified potential funding sources for a combined total of 176 specific adaptation strategies. The frequency with which these municipalities draw on different funding sources is categorized and summarized in Table 32.

Table 32: Frequency of Adaptation Strategies and Associated Funding Sources Identified in Local Government Adaptation Plans

Funding Source	Frequency of Mention	Percent
General Fund (general fund, operating budget, division funding)	108	29
Other Local Funds (fees, taxes, and new measures)	55	15
Regional grants and programs	7	2
State grants	61	16

³² See: <http://www.bcdc.ca.gov/fwg/2017meetings.html>.

Federal grants	61	16
Philanthropy (foundation grants)	53	14
Private (corporate sponsorships, loans, utility programs, pro-bono support, PACE)	28	8
Total	373	100

Source: The Authors

In addition, some of the documents we reviewed revealed or offered specific strategies to help overcome funding challenges (Table 33).

Table 33: Strategies to Overcome Funding Challenges Proposed in Local Government Documents

Strategy	Description	References
Collaborate	<ul style="list-style-type: none"> Local governments can help to ensure that State and federal grant programs are responsive to local needs by communicating findings, issues, and processes to key government agencies Neighboring cities can work with regional partners to jointly fund the preferred adaptation strategy Collaborating on funding applications can make partners more competitive to fund critical planning and implementation efforts 	(Adapting to Rising Tides 2016; Mann et al. 2016)
Use or develop creative and innovative funding means	<ul style="list-style-type: none"> Combine funds from several sources, such as recreation, restoration, and infrastructure, to secure necessary funds for implementation Leverage seed money to pursue larger funding opportunities, or reserve seed money for long-term maintenance requirements By customizing incentives and financing mechanisms, local governments can secure the funds necessary to accelerate projects in priority locations 	(Adapting to Rising Tides 2016; Fulton 2016; Mann et al. 2016)
Apply lessons learned from other efforts	<ul style="list-style-type: none"> Re-align investments, including new and existing incentives, disincentives, and funding streams, to support climate-resilient behavior Transfer lessons from how mitigation programs, such as transportation service fees, in-lieu parking fees, congestion pricing, climate mitigation fees or rate-payer programs have been set up to adaptation 	(Regional Climate Protection Authority 2016; City of Berkeley 2009)
Review rate structures	<ul style="list-style-type: none"> Review the ways in which the funding of agencies is dependent on unsustainable behavior (e.g., the 	(Moore et al. 2012)

	<p>greater the water consumption, the greater the agency's income); adjust rate structures to favor sustainable behavior</p> <ul style="list-style-type: none"> • Use penalties for unsustainable behavior to build up local adaptation funds 	
Start with low-cost initiatives	<ul style="list-style-type: none"> • Examples include establishing storm watch and notification systems, civic monitoring programs of beach width and cliff retreat, King Tide programs to foster public engagement and education 	(Grifman et al. 2013)
Change the narrative	<ul style="list-style-type: none"> • Talk about the need to invest in resilient infrastructure now for future benefit as akin to retirement planning on a personal level or investing in youth education and growth activities at the community scale 	(Greer et al. 2014)

Source: Compiled by the Authors

6.5 Conclusions

The local government adaptation plans and vulnerability assessments reviewed as part of this analysis serve as an independent source of data to triangulate our understanding of local government adaptation challenges, but also to get a bottom-up, detailed perspective on assets at risk from climate change and potential adaptation costs.

The analysis revealed that there is no consistency in how such data is presented or how economic or financial assessments are done. Without a standardized approach for assessing assets and adaptation project costs, it will be impossible to obtain an accurate understanding of California's true adaptation funding need and a better sense of the gap between available programs and that need. In the absence of great familiarity with economic assessment methodologies (including more complex assessment approaches such as robust decision-making or multi-criteria analysis) and limitations of traditional or even more advanced cost-benefit approaches, many local governments are looking to the State for help. The State can play an important role by developing guidance to not only help local agencies adopt a standardized methodology for evaluating adaptation costs, but also to develop policies and programs to collect such information on a regular basis.

While it is difficult to put forward a credible estimate for the total value of assets at risk and the amount of resources needed to pursue adaptation initiatives throughout California, our preliminary analysis suggests that the cost of inaction is likely far greater – by multiple orders of magnitude – than the cost of adaptation, even though that, too, is currently underestimated. In order to safeguard California against the worst impacts of climate change, local governments need easier access to existing funds and better guidance and support on how to create new funding streams and explore partnership opportunities. The proposed funding wizard as part of the State's OPR program could draw on the framework for funding mechanisms developed here, as well as on the compilation of resources referenced in this chapter. It would raise awareness and broaden the menu of funding options that local governments can use to meet their needs.

Importantly, an accurate assessment of funding needs and opportunities will always remain a problem due to the discrepancies in how local governments define adaptation and how they

choose to approach their resiliency-building efforts. Some communities focus on specific climate change impacts (e.g., sea-level rise), others take a more holistic approach that combines environmental, economic, and social resiliency to address a wider range of hazards and issues facing them. A more holistic approach opens more funding opportunities, but – in the dispersed world of funding – only aggravates the challenge of how to assess funding needs and expenditures and the need to put together sufficient funding from multiple sources.

Although the State has promoted the more holistic approach through programs like the Strategic Growth Council’s Transformative Climate Communities program³³, the vast majority of State grant programs are sector-specific. To help overcome challenges associated with piecemeal approaches (in funding and implementation) at the local level, the State can take a leadership role in exploring alignment opportunities of funding at the state and regional levels.

7: Integration, Recommendations and Future Directions

7.1 Synthesis

7.1.1 Major Advances

The study in hand constitutes an innovative, detailed and in-depth body of work on California local governments’ adaptation finance challenges and potential solutions. We have argued that a better understanding of the nature of these challenges is a necessary precursor to developing incisive and appropriate solutions that are tailored and applicable to the wide variety of circumstances in which adaptation investments need to be made.

Our study took a multi-methods approach. Given the depth of each approach and the significant database on which each study component relied, one might view each as a study in itself. To view them in concert, however, provides the confidence that comes from triangulation.

Most in-depth study of local adaptation funding challenges. To the best of our knowledge, we are not aware of any other study that has taken such a detailed and comprehensive look at funding challenges. In-depth case studies are rare at best, other past surveys have been superficial on funding matters, and other studies, while important and necessary, have addressed a smaller set of questions.

Methodological innovation. Surveys, literature reviews and document analyses are well established social science methods, but archetype analysis has traditionally relied on quantitative modeling and meta-analyses of existing case studies. Such case studies are not available for the matter of concern here. Instead, we chose to conduct stakeholder workshops and use grounded theory to uncover common patterns of interacting barriers, which we call adaptation financing archetypes. Survey results, document analysis findings and the broader literature confirm the archetype analysis findings, whereas the archetype analysis provides the in-depth qualitative insights that explain the survey findings. We believe this approach offers

³³ See: <http://sgc.ca.gov/Grant-Programs/Transformative-Climate-Communities-Program.html>.

new avenues for analysis of complex problems. Moreover, the interactive design of the workshops also unearthed many suggestions for how to resolve them or at least where to look for lessons with potential application to adaptation. As such, each workshop was a peer learning event, and all workshops together provide an opportunity for local governments from across the state to share what they struggle with and exchange lessons learned about how to move forward in the face of difficult odds.

Novel focus and conceptual advances. Typically, past studies have viewed adaptation barriers as distinct challenges. At best, researchers have acknowledged that they interact, but have not necessarily studied their interaction. Studies on adaptation barrier *archetypes* to date have been predominantly focused on institutional barriers to explain the lack of progress on adaptation. We are not aware of one that has taken financial challenges as its focus. Our study makes the interaction among barriers the very center of attention, focuses on finance issues and considers the full range of barriers – institutional, social, political, human, organizational, physical, scientific and economic – to understand and explain them.

Practical opportunities. Our study, while scientifically interesting and robust, aims to be of practical value. Its findings, we hope, will provide an important basis to assist local, state and other stakeholders in finding solutions to one of the greatest challenges local governments face in preparing for climate change impacts and making their communities resilient. Each component of this study revealed not just problems but also solutions or at least suggestions worthy of further pursuit. Survey respondents clearly expressed expected funding needs and volunteered ways in which they have overcome funding challenges. The workshop discussions – which resulted in the articulation of 15 distinct archetypes – revealed possible interventions for each of the archetypes, and surprisingly, often longer lists of ideas to resolve them than lists of barriers that characterize them. This is not to say that these challenges are easy to overcome. Far from it. But the lists of possible solutions for each archetype counteract the potential sense of overwhelm that a long list of problems can invoke. Similarly, the document analysis and the work to date on funding mechanisms, as well as specific ideas unearthed from local government documents provide a wealth of concrete places to look for funding. We return below to some concrete recommendations to advance a priority set of solutions.

7.1.2 Key Findings and Insights

We highlight seven synthetic findings here that emerge from our study.

Funding and financing barriers are among the top barriers to adaptation. The foundation of our study is a focused literature review on barriers to adaptation, especially funding barriers. A number of prior studies (mostly, but not exclusively survey-based) have focused on adaptation in California and have established the significance of adaptation financing barriers. Our survey and workshops – while drawing on an already-interested audience – confirms and strengthens this finding. It is consistent with findings from across the US and, indeed, the world, reiterating the need to address them seriously.

Adaptation costs are high, yet widely underestimated. Our study revealed that local governments in California know very little to date about what adaptation may cost them. Workshop participants acknowledged their lack of expertise in economic assessments; survey respondents listed that lack of knowledge as a top barrier to acquiring funding; and the document analysis revealed that less than 1/5 of available local adaptation documents even

attempt to assess such costs. A cautious extrapolation of adaptation cost estimates from just 9 communities to the rest of California – recognizing that these communities represent only 1.67% of all local governments, 2.7% of the state by areal extent, and 6.7% of the state’s population, and adding many caveats – suggests that the total one-time cost of adaptation in California could range from \$14 billion to more than \$56 billion, with ongoing maintenance costs between \$39 million to over \$30 billion. These assessment approaches used to arrive at these figures leave many adaptation aspects unaccounted for. Even so, these figures are on the same order of magnitude as published estimates for the US as a whole.

In light of the potentially very high cost of adaptation, mitigation – even ambitious mitigation – is highly cost effective. Our literature review compared published cost estimates of inaction with cost estimates of adaptation and cost estimates of mitigation and found that while near-term (2020-2050) annual mitigation investments US-wide are significant (between \$220-410 billion), by mid-century they are cost effective on fuel-savings alone, not even counting the damages from inaction or the cost of adaptation to greater global warming that could be avoided.

Adaptation is extremely cost-effective compared to inaction. Estimates of the cost of inaction do not exist for the State of California as a whole, and our sample of local government documents that provided such information just for their jurisdictions is not sufficiently representative to dare an extrapolation. However, estimated costs of inaction for just this small sample of local jurisdictions is \$100 billion. This suggests that even with the expected high cost of adaptation across the state, adaptation will be vastly more cost-effective than inaction.

Adaptation funding challenges are about more than “not having enough money.” Clearly, the cost of all aspects of adaptation – risk and vulnerability assessments, planning, implementation, monitoring and evaluation, and community engagement throughout the process – come with a hefty price tag. In a tax-restricted state and against a backdrop of chronic underfunding and many competing needs, it is no surprise to repeatedly hear the complaint from local governments that “we just don’t have enough money for adaptation.” Cost-effectiveness arguments – while powerful and needed in concrete dollar figures at the local scale – are insufficient by themselves, however, to move the needle on local adaptation. The fuller understanding of funding-related challenges provided in this study opens up the “not enough money” argument to a broader set of interventions.

The focus on novel funding mechanisms and greater private-sector involvement in funding adaptation is necessary but insufficient and may reinforce existing fiscal capacity disparities. The literature review revealed a surge in attention in recent years on the development of innovative funding mechanisms as an attempt to generate “new” funding. This is true internationally as well as in the US (not surprisingly, given international financial markets). Our in-depth analysis of adaptation finance archetypes suggests, however, that many (if not most) communities will not have the technical or staff capacity to take advantage of these complex funding vehicles. Similarly, in the literature and in the workshops, we heard repeated calls for greater private-sector involvement in funding adaptation. Discussions revealed a significant lack of familiarity with the private sector, as well as wishful thinking among some that the private sector would see a business opportunity in adaptation. Social equity concerns, worries about neglect of the public interest, and no or low returns on investment of many forms of

adaptation raise significant questions, however, whether these hopes are realistic. A significant support structure would need to be developed to make public-private financing a reality.

There are no easy solutions, only long-overdue ones. The in-depth analysis of adaptation finance archetypes suggests that the focus on centralized clearinghouses with adaptation funding information (such as within the State’s Adaptation Clearinghouse) and on funding vehicles are welcome and useful but constitute interventions that are relatively superficial and come relatively late in the adaptation and fundraising process, respectively. The bigger and deeper problems do not get addressed by these solutions. A serious and dedicated commitment to addressing adaptation finance challenges would need to address capacity issues, attitudinal and political challenges among funding providers and funding recipients, lack of technical assistance, scientific gaps, and – ultimately - deep-seated legacies of neglect and injustice, and institutional barriers to adequate local government funding.

7.1.3 Limitations

We recognize throughout our study where there are uncertainties and inadequate data for analysis and interpretation. We could not ascertain the statistical representativeness of our survey sample but have tried to describe the survey population as well as our data allowed and placed our survey population into the context of California local governments. This analysis suggested we have better representation of the highly urbanized areas and coastal areas, but less insight into inland areas. We also know less about communities that have not yet entered the adaptation process – as many have not done so, but our survey included only very few of these communities.

We also have recognized numerous uncertainties in the economic estimates of the cost of inaction and of adaptation – both in the literature review and in our document analysis. We have tried to contextualize dollar figures where they are available but noted that the majority of documents do not provide estimates. While this observation limits the validity and interpretation of our quantitative assessments, the lack of adequate data only reinforces our conclusions in the archetype analysis: namely, just how limited local technical capacity is in this regard. Only clear definitions, assessment guidance, better statewide data collection and widespread capacity building will make future assessments more reliable.

These uncertainties and limitations notwithstanding, the mutual confirmation of findings made possible by triangulation across independent analyses should leave little doubt about the overarching findings of this study.

7.2 Recommendations

7.2.1 Future Research Directions

Given the noted uncertainties and limits of our study, we believe there is significant potential for improving our understanding of several aspects of adaptation finance challenges and solutions.

Cost of inaction. As indicated above, we do not recommend using our quantitative estimates of the costs of inaction and of adaptation in policy or practice. They should serve, however, as motivation to get a much more detailed understanding of the true costs associated with climate

change adaptation. Thus, we believe significantly improved studies of the fiscal exposure of the state could and should be undertaken, and – in order to have such analyses support local governments who cannot undertake such assessments by themselves – should be done using a bottom-up approach, as opposed to top-down modelling approach. Such studies should look at all classes of assets at risk to help build persuasive arguments in favor of proactive adaptation actions and flexible adaptation pathways over time.

Costs of adaptation. Similarly, better estimates of the cost of adaptation would be enormously helpful. We would propose that such studies examine *common expense ranges* for all aspects of adaptation, to answer practical questions such as:

- What is the common range of expenses for community engagement, community outreach and education?
- What is the typical range of costs for adaptation planning, distinguishing mainstreamed and independent processes and distinguishing community size?
- What are common costs for the range of adaptation strategies in different sectors? What expenses are associated with monitoring and evaluation?
- What are the one-time and ongoing/maintenance costs?

Answering these questions in a transparent and modular way might provide local communities with the kind of transferable input they can use with relative ease in their locally specific contexts. In short, just as local officials ask for detailed locally-specific climate impacts information, they also need locally-specific adaptation cost and solution information. Such studies would be a step in this direction.

Both the cost of inaction and adaptation require a much better foundation of data than is currently available. We doubt such information can be obtained using survey instruments (such as OPR's annual planning survey) because gathering such information to respond effectively to survey questions is time consuming. Yet, time is often what local government officials do not have. Instead, detailed case-bases assessments with a valid weighted sampling approach may be more feasible. Thus, careful trade-offs need to be made between efficient data collection and the quality of the data obtained.

Measures of success and progress. We repeatedly heard that arguing for money requires metrics of success, performance and progress. The question of adaptation success – and even more so the development of effective indicators and metrics of success – is an extremely complex and difficult one to address (Moser and Boykoff 2013; Arnott, Moser and Goodrich 2016). It very quickly runs into the same political, institutional and capacity constraints as generating sufficient adaptation finance. But significant work can and must be done to support local communities with better guidance on how to measure their progress and the benefits of adaptation.

Exploration of funding vehicle-specific barriers. Those interested in making certain funding mechanisms like Green Bonds or Climate Bonds or certain grants more accessible might wish to know more specifically what the common problems are for communities in adopting them. Such funding-mechanism specific work was beyond the scope of this research but could be

extremely helpful follow-up work to deep understanding on that particular archetype (“Restrictions, conditions, eligibility criteria”).

7.2.2 Practical Steps Forward

Intervene by archetype. The overarching practical implication from this study is to start the search for solutions by thinking differently about the problem. The problem of adaptation finance challenges is not simplistically a matter of “not enough money,” not even about “not enough information about where the money is.” Both are true, as we demonstrated. But only by looking at the underlying constellation of interacting barriers that cause unique challenges during different phases of the adaptation fundraising process can local and other actors address them in a coordinated fashion and thus make a systemic and lasting difference. The archetype analysis offered 15 tables of potential interventions – a wealth of ideas that could be taken up directly by local governments, as well as by foundations, State and federal agencies, adaptation service providers, ARCCA regional collaboratives and researchers. Additional ideas were generated in the survey and the document analysis.

Address more than one archetype. The search for “silver bullet” solutions is pervasive at every level of government and in every sector, but this study demonstrated once again that, and why, this search is elusive. While focused and sustained attention on any one archetype of challenges is needed, singular focus on just one will leave others unattended. Such singular focus may either result in negligible results, or even backfire as the systemic nature of finance problems have not been addressed.

Heed special caution with “solutions” that reinforce long-standing injustices and disparities. Given the prevalence of problems that – in one way or another - affect local communities’ capacities to look and apply for funding, be successful with grant applications, and use and administer funds, there is some risk that higher-capacity communities will be able to obtain funding while lower-capacity communities cannot, entering a virtuous reinforcing cycle for some, but a vicious reinforcing cycle for others. Systemic, comprehensive capacity building and putting local governments on fundamentally more stable footing are required to address this issue at its root.

7.3 In Closing

Adaptation finance challenges are deeply rooted in historical choices and multiple interacting drivers. They are institutionalized and extremely stable. Accelerating climate change and associated impacts will increasingly be at odds with these stable societal conditions. With the development of innovative funding mechanisms and the rapid entry of private sector actors into the adaptation arena, we expect additional forces of change in the near future. Some of this change is to be welcomed, as it comes with the promise of new resources. But for some, this influx aggravates an already complex problem and for many it is not helpful as they cannot partake in the opportunities. In the findings of this study, and in the eagerness of our study participants, we see significant opportunity for local, regional, state, federal and philanthropic actors to create the conditions together that will allow a much broader set of communities to

enter the adaptation process and garner the necessary resources to create a safe and dignified future.

8: References

- Abt Associates. 2016. *Climate Adaptation: The State of Practice in U.S. Communities*. Troy, MI: The Kresge Foundation. Available at: <https://kresge.org/climate-adaptation>.
- Adams, S., M. Crowley, C. Forinash, and H. McKay. 2015. *Regional Resilience Primer*. Institute for Sustainable Communities. Available at: <http://www.iscvt.org/wp-content/uploads/2015/11/Regional-Resilience-Report-FINAL-small2.pdf>.
- AGF. 2010. *Report of the Secretary General's High-level Advisory Group on Climate Change Financing*. New York: United Nations.
- Agrawala, S., and S. Fankhauser (Eds.). 2008. *Economic Aspects of Adaptation to Climate Change: Costs, Benefits and Policy Instruments*. Paris: OECD.
- Arnott, J. C., S. C. Moser, and K. A. Goodrich. 2016. Evaluation that counts: A review of climate change adaptation indicators & metrics using lessons from effective evaluation and science-practice interaction. *Environmental Science & Policy* 66: 383-392.
- Aylett, A. 2014. *Progress and Challenges in the Urban Governance of Climate Change: Results of a Global Survey*. Cambridge, MA: MIT.
- Banson, K. E., N. C. Nguyen, and O. J. H. Bosch. 2014. Using system archetypes to identify drivers and barriers for sustainable agriculture in Africa: A case study in Ghana. *Systems Research and Behavioral Science Syst. Res.*: 21 pp., online only, at: doi:10.1002/sres.2300.
- Bark, R.H. 2009. *Assessment of Climate Change Impacts on Local Economies*. Tucson, AZ and Cambridge, MA: Sonoran Institute and Lincoln Institute of Land Policy.
- Barnard, S. 2015. *Climate Finance for Cities: How Can International Climate Funds Best Support Low-Carbon and Climate Resilient Urban Development?* London: Overseas Development Institute. Available at: <https://www.odi.org/sites/odi.org.uk/files/odi-assets/publications-opinion-files/9660.pdf>.
- Barrett, S. 2013. Local level climate justice? Adaptation finance and vulnerability reduction. *Global Environmental Change-Human and Policy Dimensions* 23(6): 1819-1829.
- Barrett, S. 2014. Subnational climate justice? Adaptation finance distribution and climate vulnerability. *World Development* 58: 130-142.
- Bedsworth, L.W. 2009. Preparing for climate change: A perspective from local public health officers in California. *Environmental Health Perspectives* 117(4): 617-623.
- Bedsworth, L.W. and E. Hanak. 2013. Climate policy at the local level: Insights from California. *Global Environmental Change* 23 (3): 664-677.
- Bendandi, B. and P. Pauw. 2016. Remittances for adaptation: An 'alternative source' of international climate finance? In *Migration, Risk Management and Climate Change: Evidence and Policy Responses*, eds. A. Milan, B. Schraven, K. Warner and N. Cascone, pp. 195-211, Heidelberg: Springer International Publishing.

- Berry, P., S. Brown, M. Chen, A. Kontogianni, O. Rowlands, G. Simpson, and M. Skourtos. 2015. Cross-sectoral interactions of adaptation and mitigation measures. *Climatic Change* 128 (3-4): 381-393.
- Biagini, B., R. Bierbaum, M. Stults, S. Dobardzic and S.M. McNeeley. 2014. A typology of adaptation actions: A global look at climate adaptation actions financed through the Global Environment Facility. *Global Environmental Change-Human and Policy Dimensions* 25: 97-108.
- Bierbaum, R., J. B. Smith, A. Lee, M. Blair, L. Carter, F. S. C. III, P. Fleming, S. Ruffo, M. Stults, S. McNeeley, E. Wasley, and L. Verduzco. 2012. A comprehensive review of climate adaptation in the United States: more than before, but less than needed. *Mitigation and Adaptation Strategies for Global Change* 18 (3): 361-406.
- Bierbaum, R., A. Lee, J. Smith, M. Blair, L. M. Carter, F. S. C. III, P. Fleming, S. Ruffo, S. McNeeley, M. Stults, L. Verduzco, and E. Seyller. 2014. Ch. 28: Adaptation. In *Climate Change Impacts in the United States: The Third National Climate Assessment*, eds. J. M. Melillo, T. T. C. Richmond and G. W. Yohe, 670-706. Washington, DC: U.S. Global Change Research Program.
- Bjarnadottir, S., Y. Li and M.G. Stewart. 2011. A probabilistic-based framework for impact and adaptation assessment of climate change on hurricane damage risks and costs. *Structural Safety* 33(3): 173-185.
- Blaikie, P. 1985. *The Political Economy of Soil Erosion in Developing Countries*. New York: Longman.
- Borgomeo, E., M. Mortazavi-Naeini, J.W. Hall, M.J. O'Sullivan, and T. Watson. 2016. Trading-off tolerable risk with climate change adaptation costs in water supply systems. *Water Resources Research* 52(2): 622-643.
- Bouwer, L. M. and J. Aerts. 2006. Financing climate change adaptation. *Disasters* 30(1): 49-63.
- Brooks, N., and W. N. Adger. 2005. Assessing and enhancing adaptive capacity. In *Adaptation Policy Frameworks for Climate Change: Developing Strategies, Policies and Measures*, ed. E. Spanger-Siegfried, B. Lim, I. Burton, E. Malone, and S. Huq, pp. 165-181. Cambridge: Cambridge University Press.
- Build America Investment Initiative. 2015. Federal Resource Guide for Infrastructure Planning and Design. Washington, DC: Build America Investment Initiative.
- Burger, S. P., F. Murray, S. Kearney, and L. Ma. 2018. The investment gap that threatens the planet. *Stanford Social Innovation Review*; available at: https://ssir.org/articles/entry/the_investment_gap_that_threatens_the_planet; 9 pp.
- Byrne, J.P. and K.A. Zyla. 2016. Climate exactions. *Maryland Law Review* 75: 758-786.
- California Natural Resources Agency. 2009. *2009 California Climate Adaptation Strategy: A Report to the Governor of California in Response to Executive Order S-13-2008*. Sacramento, CA: CNRA.

- California Natural Resources Agency. 2016. *Safeguarding California: Implementation Action Plans*. Sacramento, CA: CNRA.
- Carmin, J., N. Nadkarni, and C. Rhie. 2012. *Progress and Challenges in Urban Climate Adaptation Planning: Results of a Global Survey*. Cambridge, MA: MIT.
- Chambwera, M., H. G., C. Dubeux, S. Hallegatte, L. L., A. Markandya, B. A. McCarl, R. Mechler, and J. E. Neumann. 2014. Chapter 17 - Economics of adaptation. In *Climate Change 2014: Impacts, Adaptation, and Vulnerability. Part A: Global and Sectoral Aspects. Contribution of Working Group II to the Fifth Assessment Report of the IPCC*, eds. C. B. Field, V. R. Barros, D. J. Dokken, K. J. Mach, M. D. Mastrandrea, T. E. Bilir, M. Chatterjee, K. L. Ebi, Y. O. Estrada, R. C. Genova, B. Girma, E. S. Kissel, A. N. Levy, S. MacCracken, P. R. Mastrandrea and L. L. White, 945-977. Cambridge, UK: Cambridge University Press.
- Chinowsky, P.S., J.C. Price and J.E. Neumann. 2013. Assessment of climate change adaptation costs for the US road network. *Global Environmental Change-Human and Policy Dimensions* 23(4): 764-773.
- Chow, A., T. Leung and F. Lee. 2017. Benefit-cost analysis on coastal structures: Design for climate change adaptation in Hong Kong. *Coastal Engineering Journal* 59(2): 740005. Available at: doi:10.1142/S0578563417400058.
- Ciplet, D., J.T. Roberts, and M. Khan. 2013. The politics of international climate adaptation funding: Justice and divisions in the greenhouse. *Global Environmental Politics* 13(1): 49-68.
- Cleveland, J., and M. Ullman. 2013. LED streetlights make dollars and sense. Asheville LED Street Light Case Study – Update 5.31.13. Urban Sustainability Directors Network. Available at: <https://www.usdn.org/uploads/cms/documents/asheville-led-streetlights-and-green-capital-improvement-program-best-practices-case-study.pdf>
- Coffee, J. 2016. Let's create a climate adaptation opportunity standard to catalyze investors. Chicago, IL: Climate Resilience Consulting. Available at: <https://www.climate resilience consulting.com/blog/759>.
- Cortekar, J., S. Bender, M. Brune, and M. Groth. 2016. Why climate change adaptation in cities needs customised and flexible climate services. *Climate Services* 4: 42-51.
- Craig, S. 2010. Arizona uses the water infrastructure finance authority to provide funding for infrastructure projects that address climate impacts. In *2016 State Water Agency Practices for Climate Change Adaptation*. Washington, DC: US EPA. Available at: https://www.epa.gov/sites/production/files/2016-12/documents/arizona_uses_the_water_infrastructure_finance_authority_to_provide_funding_for_infrastructure_projects_that_address_climate_impacts.pdf.
- Cuevas, S. C. 2016. The interconnected nature of the challenges in mainstreaming climate change adaptation: evidence from local land use planning. *Climatic Change* 136 (3-4):661-676.
- Cumming, G. S. 2016. Heterarchies: Reconciling networks and hierarchies. *Trends in Ecology & Evolution* 31 (8): 622-632.

- Cundill, G., G. S. Cumming, D. Biggs, and C. Fabricius. 2012. Soft systems thinking and social learning for adaptive management. *Conservation Biology* 26 (1): 13-20.
- Dangerman, A. T. C. J., and H. J. Schellnhuber. 2013. Energy systems transformation. *Proceedings of the National Academy of Sciences* 110 (7): E549-E558.
- Dauncey, G. and M. Kroll 2017. The biggest climate solution you have never heard of: The world's central banks to the rescue. *The Practical Utopian* (blog), Available at: <https://thepracticalutopian.ca/2017/05/09/the-biggest-climate-solution-you-have-never-heard-of/>.
- Den Uyl, R. M., and D. J. Russel. 2018. Climate adaptation in fragmented governance settings: The consequences of reform in public administration. *Environmental Politics* 27(2): 341-361.
- Dillman, Don A., Jolene D. Smyth and Leah Melani Christian. 2009. *Internet, Mail and Mixed Mode Surveys: The Tailored Design Method*, 3rd edition. John Wiley: Hoboken, NJ, 499 pp.
- Dowds, J. and L. Aultman-Hall. 2015. Barriers to implementation of climate adaptation: Frameworks by state departments of transportation. *Transportation Research Record* 2532: 21-28.
- Eakin, H., R. DeFries, S. Kerr, E. F. Lambin, J. Liu, P. J. Marcotullio, P. Messerli, A. Reenberg, X. Rueda, S. R. Swaffield, B. Wicke, and K. Zimmerer. 2014. Significance of Telecoupling for Exploration of Land-Use Change. In *Rethinking Global Land Use in an Urban Era*, eds. K. C. Seto and A. Reenberg, 141-161. Cambridge, MA: The MIT Press.
- Ebi, K.L. 2008. Adaptation costs for climate change-related cases of diarrhoeal disease, malnutrition, and malaria in 2030. *Globalization and Health* 4: 9. Online at: doi:10.1186/1744-8603-4-9.
- ECONADAPT. 2015. The Costs and Benefits of Adaptation: Results from the ECONADAPT Project. In *ECONADAPT Policy Report*, ed. P. Watkiss. Bath, UK: ECONADAPT Consortium.
- Eisenack, K., M. Lüdeke, and J. Kropp. 2006. Construction of archetypes as a formal method to analyze social-ecological systems. Paper read at International Dimensions of Global Environmental Change Synthesis Conference, Bali; available at: https://www.uni-oldenburg.de/fileadmin/user_upload/wire/fachgebiete/envdev/download/arch-eisenack3.pdf.
- Eisenack, K. 2012. Archetypes of adaptation to climate change. In *Human-Nature Interactions in the Anthropocene: Potentials of Social-Ecological Systems Analysis*, eds. M. Glaser, G. Krause, B. M. W. Ratter and M. Welp, 18 pp. New York: Routledge.
- Ekstrom, J.A. and S.C. Moser. 2013. Institutions as key element to successful climate adaptation processes: Results from the San Francisco Bay Area. In *Successful Adaptation to Climate Change: Linking Science and Policy in a Rapidly Changing World*, eds. S. C. Moser and M. T. Boykoff, pp. 97-113. London, New York: Routledge.

- Ekstrom, J. A., L. W. Bedsworth, and A. Fencl. 2017. Gauging climate preparedness to inform adaptation needs: Local level adaptation in drinking water quality in CA, USA. *Climatic Change* 140 (3-4):467-481.
- Engle, N. L. 2011. Adaptive capacity and its assessment. *Global Environmental Change* 21(2): 647-656.
- EPA. 2017a. Green Infrastructure Cost-Benefit Resources. Washington, DC: Environmental Protection Agency. Available at: <https://www.epa.gov/green-infrastructure/green-infrastructure-cost-benefit-resources>.
- EPA. 2017b: Multi-model framework for quantitative sectoral impacts analysis: a technical report for the fourth National Climate Assessment. U.S. Environmental Protection Agency, EPA 430-R-17-001. Available at: https://cfpub.epa.gov/si/si_public_record_Report.cfm?dirEntryId=335095.
- EPA. 2015. Climate Change in the United States: Benefits of Global Action. Report from The Climate Change Impacts and Risk Analysis. Washington, DC: EPA. Available at: <https://www.epa.gov/cira>.
- European Climate Adaptation Platform. 2016. Climate bond financing adaptation actions in Paris. *Brussels* and Copenhagen: European Commission (DG CLIMA, DG Joint Research Centre and other DGs) and the European Environment Agency. Available at: <http://climate-adapt.eea.europa.eu/metadata/case-studies/climate-bond-financing-adaptation-actions-in-paris>.
- European Commission (EC). 2009. *The Economics of Climate Change Adaptation in EU Coastal Areas. Summary Report*. Luxembourg: Office for Official Publications of the European Communities.
- . 2013. *Climate Change Adaptation Practice Across the EU: Understanding the Challenges and Ways Forward in the Context of Multi-Level Governance*. Brussels: EU Publications Office.
- Executive Office of the President of the United States. 2016. Standards and Finance to Support Community Resilience. Washington, DC: The White House.
- Finzi Hart, J. A., P. M. Grifman, S. C. Moser, A. Abeles, M. R. Myers, S. C. Schlosser, and J. A. Ekstrom. 2012. *Rising to the Challenge: Results of the 2011 Coastal California Adaptation Needs Assessment*. Los Angeles: University of Southern California Sea Grant Program.
- Flavelle, C. 2017. Moody's Warns Cities to Address Climate Risks or Face Downgrades, ed. Available at: <https://www.bloomberg.com/news/articles/2017-11-29/moody-s-warns-cities-to-address-climate-risks-or-face-downgrades>: Bloomberg, November 29, 2017.
- Gallopín, G. C. 2006. Linkages between vulnerability, resilience, and adaptive capacity. *Global Environmental Change* 16: 293-303.
- Glasser, B., and A. Strauss. 2011. *The Discovery of Grounded Theory: Strategies for Qualitative Research*. London, UK: Transaction Publishers.

- GAO. 2017. *Climate Change: Information on Potential Economic Effects Could Help Guide Federal Efforts to Reduce Fiscal Exposure*. GAO-17-720. Report to Congressional Requesters. Washington, DC: United States Government Accountability Office.
- Governor's Office of Planning and Research. 2016. 2016 Annual Planning Survey Results. Sacramento, CA: OPR. Available at: http://opr.ca.gov/docs/2016_APS_final.pdf.
- Grannis, J. 2017. Funding and Financing Adaptation. Presentation offered during an EPA webinar, April 2017.
- Hacke, R., D. Wood, and M. Urquilla. 2015. *Community Investment: Focusing on the System*. Troy, MI and Cambridge, MA: The Kresge Foundation and Initiative for Responsible Investment at the Hauser Institute for Civil Society at Harvard University.
- Hall, N. 2017. What is adaptation to climate change? Epistemic ambiguity in the climate finance system. *International Environmental Agreements-Politics Law and Economics* 17(1): 37-53.
- Haemekoski, K. and H. Sinkko. 2016. Mobilizing private sector funds for climate change adaptation: Nordic Climate Facility (NCF) as a case study. In *Climate Change Adaptation, Resilience and Hazards*, eds. W.L. Filho, H. Musa, G. Cavan, P. Ohare and J. Seixas, pp. 443-456. Heidelberg: Springer International Publishing.
- Hallegatte, S., J. Rogelj, M. Allen, L. Clarke, O. Edenhofer, C. B. Field, P. Friedlingstein, L. van Kesteren, R. Knutti, K. J. Mach, M. Mastrandrea, A. Michel, J. Minx, M. Oppenheimer, G.-K. Plattner, K. Riahi, M. Schaeffer, T. F. Stocker and D. P. van Vuuren. 2016. Mapping the climate change challenge. *Nature Clim. Change* 6: 663-668.
- Hallegatte, S., F. Henriot and J. Corfee-Morlot. 2011. The economics of climate change impacts and policy benefits at city scale: a conceptual framework. *Climatic Change* 104: 51-87.
- Hallegatte, S., J. C. Hourcade and P. Dumas. 2007. Why economic dynamics matter in assessing climate change damages: Illustration on extreme events. *Ecological Economics* 62: 330-340.
- Hanemann, M., D. Lambe, and D. Farber. 2012. *Climate Vulnerability and Adaptation Study for California: Legal Analysis of Barriers to Adaptation for California's Water Sector*. Publication number: CEC-500-2012-019. Sacramento, CA: California Energy Commission.
- Heberger, M., H. Cooley, P. Herrera and P. H. Gleick. 2009. *The Impacts of Sea-level Rise on the California Coast*. Sacramento, CA: California Energy Commission. Publication Number: [CEC-500-2009-024-F](#).
- Hinkel, J., D. Lincke, A.T. Vafeidis, M. Perrette, R.J. Nicholls, et al. 2014. Coastal flood damage and adaptation costs under 21st century sea-level rise. *Proceedings of the National Academy of Sciences*, 111(9): 3292-3297.
- Hof, A.F., M.G.J. den Elzen, and D.P. van Vuuren. 2010. Including adaptation costs and climate change damages in evaluating post-2012 burden-sharing regimes. *Mitigation and Adaptation Strategies for Global Change* 15(1): 19-40.
- Hsu, S., C. Krosinsky, C. Kosmider, M. Reichenbach and J. Sandberg. 2015. *CO₂ Tax and Refund for New York State*. The Network for Sustainable Financial Markets. Available at:

http://www.sustainablefinancialmarkets.net/files/wp-content/uploads/2009/02/CO2-Tax-and-Refund-Concept-White-Paper-Signed_0.pdf.

- Hughes, S. 2015. A meta-analysis of urban climate change adaptation in the U.S. *Urban Climate* 14(Part 1):17-29.
- ICLEI. 2011. Financing the Resilient City: A Demand Driven Approach to Development, Disaster Risk Reduction and Climate Adaptation. An ICLEI White Paper, *ICLEI Global Report*. Bonn: ICLEI. Available at: http://resilient-cities.iclei.org/fileadmin/sites/resilient-cities/files/Frontend_user/Report-Financing_Resilient_City-Final.pdf.
- Investopedia. 2017. Catastrophe bonds – CAT. Available online at: <https://www.investopedia.com/terms/c/catastrophebond.asp>.
- Jäger, J., M. D. A. Rounsevell, P. A. Harrison, I. Omann, R. Dunford, M. Kammerlander, and G. Pataki. 2015. Assessing policy robustness of climate change adaptation measures across sectors and scenarios. *Climatic Change* 128(3): 395-407.
- Jantarasami, L.C., J.J. Lawler, and C.W. Thomas. 2010. Institutional barriers to climate change adaptation in US National Parks and Forests. *Ecology and Society* 15(4): 33; available at: <https://www.ecologyandsociety.org/vol15/iss4/art33/ES-2010-3715.pdf>.
- Juhola, S. 2016. Barriers to the implementation of climate change adaptation in land use planning: A multi-level governance problem? *International Journal of Climate Change Strategies and Management* 8(3): 338-355.
- Junghans, L. and M. Kohler. 2016. Cropping and cashing: Institutional solutions for synergetic climate finance for mitigation and adaptation in agriculture. *Climate and Development* 8(3): 207-210.
- Kajan, E., K. Tervo-Kankare and J. Saarinen. 2015. Cost of adaptation to climate change in tourism: Methodological challenges and trends for future studies in adaptation. *Scandinavian Journal of Hospitality and Tourism* 15(3): 311-317.
- Kasperson, J. X., R. E. Kasperson, and B. L. Turner II eds. 1995. *Regions at Risk: Comparisons of Threatened Environments*. Tokyo: United Nations University Press.
- Kay, Robert, Kif Scheuer, Brenda Dix, Maya Bruguera, Angela Wong, Julia Kim (ICF and Local Government Commission). 2018. **Overcoming Organizational Barriers to Implementing Local Government Adaptation Strategies**. California's Fourth Climate Change Assessment, California Natural Resources Agency. Publication number: CCCA4-CNRA-2018-005.
- Kemp, K.B., J.J. Blades, P.Z. Klos, T.E. Hall, J.E. Force, P. Morgan, and W. T. Tinkham. 2015. Managing for climate change on federal lands of the western United States: Perceived usefulness of climate science, effectiveness of adaptation strategies, and barriers to implementation. *Ecology and Society* 20(2): 17; available at: <https://www.ecologyandsociety.org/vol20/iss2/art17/>.
- Keohane, R. O., and E. Ostrom eds. 1995. *Local Commons and Global Interdependence: Heterogeneity and Cooperation in Two Domains*. London: Sage Publications, Ltd.

- Kim, D. H. 1992. System Archetypes I: Diagnosing Systemic Issues and Designing High-leverage Interventions, 29 pp. Waltham, MA: Pegasus Communications Inc.
- Kimmich, C. 2013. Linking action situations: Coordination, conflicts, and evolution in electricity provision for irrigation in Andhra Pradesh, India. *Ecological Economics* 90(Supplement C): 150-158.
- Kimmich, C., and S. V. Tomas. 2017. Assessing action situation networks: A configurational perspective on water and energy governance in irrigation systems. *Water Economics and Policy*; online first at: doi:10.1142/S2382624X18500054.
- Klein, R. J. T., G. F. Midgley, B. L. Preston, M. Alam, F. G. H. Berkhout, K. Dow, and M. R. Shaw. 2014. Adaptation opportunities, constraints, and limits. In *Climate Change 2014: Impacts, Adaptation, and Vulnerability. Part A: Global and Sectoral Aspects. Contribution of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change*, eds. C. B. Field, V. R. Barros, D. J. Dokken, K. J. Mach, M. D. Mastrandrea, T. E. Bilir, M. Chatterjee, K. L. Ebi, Y. O. Estrada, R. C. Genova, B. Girma, E. S. Kissel, A. N. Levy, S. MacCracken, P. R. Mastrandrea and L. L. White, 899-943. Cambridge, UK and New York: Cambridge University Press.
- Koh, J., E. Mazzacurati, and S. Swann. 2016. Bridging the Adaptation Gap: Approaches to Measurement of Physical Climate Risk and Examples of Investment in Climate Adaptation and Resilience. In *Discussion Paper*. New York: Global Adaptation Risk and Investment (GARI) Working Group (<https://garigroup.com/>).
- Kok, M., M. Lüdeke, P. Lucas, T. Sterzel, C. Walther, P. Janssen, D. Sietz, and I. de Soysa. 2016. A new method for analysing socio-ecological patterns of vulnerability. *Regional Environmental Change* 16(1): 229-243.
- Kousky, C. and H. Kunreuther. 2015. Addressing affordability in the National Flood Insurance Program. *Journal of Extreme Events* 1(1): 1450001; available at: doi:10.1142/S2345737614500018.
- Kraemer, M. 2014. Climate change is a global mega-trend for sovereign risk. New York: Standard and Poor's Ratings Services. Available at: <http://www.maalot.co.il/publications/GMR20140518110900.pdf>.
- Kumar, S., A. Naresh, M. Rashid, S. K. Bandyopadhyay, R. Padaria, and M. Khanna. 2016. Adaptation of farming community to climatic risk: Does adaptation cost for sustaining agricultural profitability? *Current Science* 110(7): 1216-1224.
- Levers, C., D. Müller, K. Erb, H. Haberl, M. R. Jepsen, M. J. Metzger, P. Meyfroidt, T. Plieninger, C. Plutzer, J. Stürck, P. H. Verburg, P. J. Verkerk, and T. Kuemmerle. 2015. Archetypical patterns and trajectories of land systems in Europe. *Regional Environmental Change*, 18pp., online only at: doi:10.1007/s10113-015-0907-x.
- Levy, D. L. and R. Herst. 2018. *Financing Climate Resilience: Mobilizing Resources and Incentives to Protect Boston from Climate Risks*. Boston, MA: UMass-Boston Sustainability Solutions Lab, Barr Foundation, Boston Green Ribbon Commission, 64pp.

- Liverman, D., S. C. Moser, P. S. Weiland, L. Dilling, M. T. Boykoff, H. E. Brown, E. S. Gordon, C. Greene, E. Holthaus, D. A. Niemeier, S. Pincetl, W. J. Steenburgh, and V. C. Tidwell. 2013. *Climate Choices for a Sustainable Southwest*.
- Locatelli, B., G. Fedele, V. Fayolle, and A. Baglee. 2016. Synergies between adaptation and mitigation in climate change finance. *International Journal of Climate Change Strategies and Management* 8(1): 112-128.
- Lonsdale, W.R., H.E. Kretser, C.L.B. Chetkiewicz, and M.S. Cross. 2017. Similarities and differences in barriers and opportunities affecting climate change adaptation action in four North American landscapes. *Environmental Management* 60(6): 1076-1089.
- Lüdeke, M. K. B., G. Petschel-Held, and H.-J. Schellnhuber. 2004. Syndromes of global change: The first panoramic view. *GAIA - Ecological Perspectives for Science and Society* 13 (1): 42-49.
- Lubell, M. 2017. *The Governance Gap: Climate Adaptation and Sea-Level Rise in the San Francisco Bay Area*. Davis, CA: University of California-Davis.
- Luers, A.L. and S.C. Moser. 2006. *Preparing for the Impacts of Climate Change in California: Advancing the Debate on Adaptation*. PIER Research Report CEC-500-2005-198. Sacramento, CA: California Energy Commission, Public Interest Energy Research Program and the California Environmental Protection Agency.
- Mathy, S., and O. Blanchard. 2016. Proposal for a poverty-adaptation-mitigation window within the Green Climate Fund. *Climate Policy* 16(6): 752-767.
- Matthews, T., A.Y. Lo, and J.A. Byrne. 2015. Reconceptualizing green infrastructure for climate change adaptation: Barriers to adoption and drivers for uptake by spatial planners. *Landscape and Urban Planning* 138: 155-163.
- McGinnis, M. D. 2011. Networks of adjacent action situations in polycentric governance. *Policy Studies Journal* 39(1): 51-78.
- Measham, T., B. Preston, T. Smith, C. Brooke, R. Gorrdard, G. Withycombe and C. Morrison. 2011. Adapting to climate change through local municipal planning: Barriers and challenges. *Mitigation and Adaptation Strategies for Global Change* 16(8): 889-909.
- Meadows, D. 1999. Leverage Points: Places to Intervene in a System. *Sustainability Institute Papers*. Hartland, VT: Sustainability Institute.
- Messerli, P., M. Giger, M. B. Dwyer, T. Breu, and S. Eckert. 2014. The geography of large-scale land acquisitions: Analysing socio-ecological patterns of target contexts in the global South. *Applied Geography* 53(Supplement C): 449-459.
- Mills, M., R. Weeks, R.L. Pressey, M.G. Gleason, R.-L. Eisma-Osorio, A.T. Lombard, J.M. Harris, A.B. Killmer, A. White and T.H. Morrison. 2015. Real-world progress in overcoming the challenges of adaptive spatial planning in marine protected areas. *Biological Conservation* 181: 54-63.
- Moody's Investors Service. 2016. Environmental risks – sovereigns: How Moody's assesses the physical effects of climate change on sovereign issuers. New York. Online at

www.eticanews.it/wp-content/uploads/2017/01/Moodys-climatechange-and-sovereigns-November-7.pdf.

- Moser, S.C. 2007. Is California preparing for sea-level rise? The answer is disquieting. *California Coast and Ocean* 22(4): 24-30.
- Moser, S. C. 2009. Whether our levers are long enough and the fulcrum strong? -- Exploring the soft underbelly of adaptation decisions and actions. In *Adapting to Climate Change: Thresholds, Values, Governance*, eds. W. N. Adger and et al., 313-343. Cambridge, UK: Cambridge University Press.
- Moser, S.C., and J.A. Ekstrom. 2010. A framework to diagnose barriers to climate change adaptation. *Proceedings of the National Academy of Sciences of the United States of America* 107(51): 22026-22031.
- Moser, S.C. 2012. Adaptation, mitigation, and their disharmonious discontents. *Climatic Change* 111(2): 165-175.
- Moser, S.C. and J.A. Ekstrom. 2012. *Identifying and Overcoming Barriers to Climate Change Adaptation in San Francisco Bay: Results from Case Studies*. Sacramento, CA: California Energy Commission, CEC-500-2012-034.
- Moser, S. C., and M. T. Boykoff eds. 2013. *Successful Adaptation to Climate Change: Linking Science and Practice in a Rapidly Changing World*. London: Routledge.
- Moser, S. and J.A. Ekstrom. 2014. Identifying and overcoming barriers in urban climate adaptation: Case study findings from the San Francisco Bay Area, California, USA. *Urban Climate* 9: 54-74.
- Moser, S. C., J. Coffee, and A. Seville. 2018. *Rising to the Challenge, Together*. Troy, MI: The Kresge Foundation. Available at: <https://kresge.org/content/rising-challenge-together>.
- Moser, Susanne, Juliette Finzi Hart, Alyssa Newton Mann, Nick Sadrpour, Phyllis Grifman. (Susanne Moser Research & Consulting, U.S. Geological Survey, The Nature Conservancy and USC-Sea Grant). 2018. *Growing Effort, Growing Challenge: Findings from the 2016 CA Coastal Adaptation Needs Assessment Survey*. California's Fourth Climate Change Assessment. Publication number: CCCA4-EXT-2018-009.
- Mosnier, A., M. Obersteiner, P. Havlik, E. Schmid, N. Khabarov, M. Westphal, H. Valin, S. Frank, and F. Albrecht. 2014. Global food markets, trade and the cost of climate change adaptation. *Food Security* 6(1): 29-44.
- Narain, U., S. Margulis and T. Essam. 2011. Estimating costs of adaptation to climate change. *Climate Policy* 11(3): 1001-1019.
- Nhamo, G., and S. Nhamo. 2016. Paris (COP21) Agreement: Loss and damage, adaptation and climate finance issues. *International Journal of African Renaissance Studies* 11(2): 118-138.
- NOAA National Centers for Environmental Information (NCEI). 2018. U.S. Billion-Dollar Weather and Climate Disasters. Available at: <https://www.ncdc.noaa.gov/billions/>.

- Noble, I. R., S. Huq, Y. A. Anokhin, J. Carmin, D. Goudou, F. P. Lansigan, B. Osman-Elasha, and A. Villamizar. 2014. Adaptation needs and options. In *Climate Change 2014: Impacts, Adaptation, and Vulnerability. Part A: Global and Sectoral Aspects. Contribution of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change*, eds. C. B. Field, V. R. Barros, D. J. Dokken, K. J. Mach, M. D. Mastrandrea, T. E. Bilir, M. Chatterjee, K. L. Ebi, Y. O. Estrada, R. C. Genova, B. Girma, E. S. Kissel, A. N. Levy, S. MacCracken, P. R. Mastrandrea and L. L. White, 833-868. Cambridge, UK and New York, NY: Cambridge University Press.
- Nordhaus, W.D. and J. Boyer. 2000. *Warming the World: Economic Models of Global Warming*. Cambridge, MA: The MIT Press.
- Oberlack, C. and K. Eisenack. 2014. Alleviating barriers to urban climate change adaptation through international cooperation. *Global Environmental Change-Human and Policy Dimensions* 24: 349-362.
- Oberlack, C., L. Tejada, P. Messerli, S. Rist, and M. Giger. 2016. Sustainable livelihoods in the global land rush? Archetypes of livelihood vulnerability and sustainability potentials. *Global Environmental Change* 41(Supplement C):153-171.
- Oberlack, C. 2017. Diagnosing institutional barriers and opportunities for adaptation to climate change. *Mitigation and Adaptation Strategies for Global Change* 22(5): 805-838.
- OECD and Bloomberg Philanthropies. 2014. Cities and Climate Change: National Governments Enabling Local Action. *OECD Policy Perspectives*. Paris: OECD. Available at: <http://www.oecd.org/env/cc/Cities-and-climate-change-2014-Policy-Perspectives-Final-web.pdf>
- Ostrom, E. 1990. *Governing the Commons: The Evolution of Institutions for Collective Action*. Cambridge, UK: Cambridge University Press.
- Ostrom, E. 2007. A diagnostic approach for going beyond panaceas. *Proceedings of the National Academy of Sciences* 104(39): 15181-15187.
- Ostrom, E. 2009. A general framework for analyzing sustainability of social-ecological systems. *Science* 325 (5939): 419-422.
- Ostrom, E. 2014. A polycentric approach for coping with climate change. *Annals of Economics and Finance* 15 (1): 71-108.
- Palanisami, K., K.R. Kakumanu, C.R. Ranganathan and N.U. Sekhar. 2015. Farm-level cost of adaptation and expected cost of uncertainty associated with climate change impacts in major river basins in India. *International Journal of Climate Change Strategies and Management* 7(1): 76-96.
- Pauw, W.P. 2017. Mobilising private adaptation finance: Developed country perspectives. *International Environmental Agreements: Politics, Law and Economics* 17(1): 55-71.
- Pendleton, L. P. King, C. Mohn, D.G. Webster, R.K. Vaughn, and P. Adams. 2009. *Estimating the Potential Economic Impacts of Climate Change on Southern California Beaches - Final Report*.

- Sacramento, CA: California Energy Commission. Publication Number: [CEC-500-2009-033-F](#).
- Petschel-Held, G., A. Block, M. Cassel-Gintz, J. Kropp, M. K. B. Lüdeke, O. Moldenhauer, F. Reusswig, and H.-J. Schellnhuber. 1999. Syndromes of global change: A qualitative modelling approach to assist global environmental management. *Environmental Modeling and Assessment* 4: 295-314.
- Previdi, J., C. Krahe, L. Schroerer, H. Aldrete-Sanchez, K. Jacob, M. Reining, J. Ridley. 2013. U.S. Local Governments General Obligations Ratings: Methodology and Assumptions. New York: Standards & Poor's Rating Services, Ratings Direct. Available at: <http://www.nasra.org/Files/Topical%20Reports/Credit%20Effects/SandPlocal1309.pdf>.
- Proust, K., B. Newell, H. Brown, A. Capon, C. Browne, A. Burton, J. Dixon, L. Mu, and M. Zarafu. 2012. Human health and climate change: Leverage points for adaptation in urban environments. *International Journal of Environmental Research and Public Health* 9(6): 2134; available at: doi:10.3390/ijerph9062134.
- re:focus partners. 2015. *Levering Catastrophe Bonds as a Mechanism for Resilient Infrastructure Project Finance*. Available at: <http://www.refocuspartners.com/wp-content/uploads/2017/02/RE.bound-Program-Report-December-2015.pdf>.
- re:focus partners. 2017. *Re:bound: A Guide for Public-Sector Resilience Bond Sponsorship*. re:focus partners. Available at: <http://www.refocuspartners.com/wp-content/uploads/pdf/RE.bound-Program-Report-September-2017.pdf>.
- Resilient by Design Bay Area Challenge. 2017. *Finance Guide for Resilient by Design Bay Area Challenge Design Teams*, Final Version 1.0. San Rafael, CA: NHA Advisors.
- Rhodium Group. 2014. *American Climate Prospectus: Economic Risks in the United States*. New York: Rhodium Group LLC. Available at: <http://riskybusiness.org>.
- Risky Business Project. 2016. *From Risk to Return: Investing in a Clean Energy Economy*. New York: Risky Business Project. Available at: <http://riskybusiness.org>.
- Robinson, S.A. and M. Dornan. 2017. International financing for climate change adaptation in small island developing states. *Regional Environmental Change* 17(4): 1103-1115.
- Rodriguez-Labajos, B. 2013. Climate change, ecosystem services, and costs of action and inaction: scoping the interface. *Wiley Interdisciplinary Reviews – Climate Change* 4(6): 555-573.
- Rojas, R., L. Feyen, and P. Watkiss. 2013. Climate change and river floods in the European Union: Socio-economic consequences and the costs and benefits of adaptation. *Global Environmental Change-Human and Policy Dimensions* 23(6): 1737-1751.
- Root, L., E. van der Krabben and T. Spit. 2015. Bridging the financial gap in climate adaptation: Dutch planning and land development through a new institutional lens. *Journal of Environmental Planning and Management* 58(4): 701-718.

- Ruth, M. 2010. Economic and social benefits of climate information: Assessing the cost of inaction. In *Proceedings of the 3rd World Climate Conference (WCC) on Climate Prediction and Information for Decision-Making*, eds. M.V.K. Sivakumar, B.S. Nyenzi and A. Tyagi, Vol. 1, 387-394; available at: doi: 10.1016/j.proenv.2010.09.026.
- Ryan, P.C. and M.G. Stewart. 2017. Cost-benefit analysis of climate change adaptation for power pole networks. *Climatic Change* 143(3-4): 519-533.
- Schellnhuber, H.-J., A. Block, M. Cassel-Gintz, J. Kropp, G. Lammel, W. Lass, R. Lienenkamp, C. Loose, M. K. B. Lüdeke, O. Moldenhauer, G. Petschel-Held, M. Plöchl, and F. Reusswig. 1997. Syndromes of global change. *GAIA - Ecological Perspectives for Science and Society* 6(1): 18-33.
- Schenk, T. and O. Ferguson. 2012. *Coastal States' Climate Adaptation Initiatives: Sea Level Rise and Municipal Engagement*. Cambridge, MA: Lincoln Institute of Land Policy. Available at: [http://research3.fit.edu/sealevelriselibrary/documents/doc_mgr/456/Schenk & Ferguson . 2012. States' Climate Adaptation Initiatives.pdf](http://research3.fit.edu/sealevelriselibrary/documents/doc_mgr/456/Schenk_&_Ferguson_.2012.States'_Climate_Adaptation_Initiatives.pdf).
- Shackleton, S., G. Ziervogel, S. Sallu, T. Gill, and P. Tschakert. 2015. Why is socially-just climate change adaptation in sub-Saharan Africa so challenging? A review of barriers identified from empirical cases. *Wiley Interdisciplinary Reviews-Climate Change* 6(3): 321-344.
- Shi, L., E. Chu, and J. Debats. 2015. Explaining progress in climate adaptation planning across 156 US municipalities. *Journal of the American Planning Association* 81(3): 191-202.
- Sietz, D., M. K. B. Lüdeke, and C. Walther. 2011. Categorisation of typical vulnerability patterns in global drylands. *Global Environmental Change* 21(2): 431-440.
- Sietz, D., J. C. Ordoñez, M. T. J. Kok, P. Janssen, H. B. M. Hilderink, P. Tittonell, and H. V. Dijk. 2017. Nested archetypes of vulnerability in African drylands: where lies potential for sustainable agricultural intensification? *Environmental Research Letters* 12 (9): 095006.
- Smith, J.B., T. Dickinson, J.D.B. Donahue, I. Burton, E. Haites, R.J.T. Klein and A. Patwardhan. 2011. Development and climate change adaptation funding: Coordination and integration. *Climate Policy* 11(3): 987-1000.
- Snyder, G., and M. Valdez. 2015. *Enhanced Infrastructure Districts: A Flexible New Tool for Local Governments*. *Law360*, April 17. San Francisco: Pillsbury Winthrop Shaw Pittman LLP.
- Sovacool, B. K., B. O. Linner, and R. J. T. Klein. 2017. Climate change adaptation and the Least Developed Countries Fund (LDCF): Qualitative insights from policy implementation in the Asia-Pacific. *Climatic Change* 140(2): 209-226.
- Spanger-Siegfried, E., J. Funk, R. Cleetus, M. Deas, and J. Christian Smith. 2016. *Toward Climate Resilience: A Framework and Principles for Science-Based Adaptation*. Cambridge, MA: Union of Concerned Scientists.
- Srinivasan, V., E. F. Lambin, S. M. Gorelick, B. H. Thompson, and S. Rozelle. 2012. The nature and causes of the global water crisis: Syndromes from a meta-analysis of coupled human-water studies. *Water Resour. Res.* 48: W10516.

- Stewart, M.G., X. Wang and G.R. Willgoose. 2014. Direct and indirect cost-and-benefit assessment of climate adaptation strategies for housing for extreme wind events in Queensland. *Natural Hazards Review* 15(4); available at: <https://ascelibrary.org/doi/abs/10.1061/%28ASCE%29NH.1527-6996.0000136>.
- Sussman, F., N. Krishnan, K. Maher, R. Miller, C. Mack, P. Stewart, K. Shouse and B. Perkins. 2014. Climate change adaptation cost in the US: What do we know? *Climate Policy* 14(2): 242-282.
- The H. John Heinz III Center for Science, Economics and the Environment (Heinz Center). 2000. *The Hidden Costs of Coastal Hazards: Implications for Risk Assessment and Mitigation*. Washington, DC: Island Press.
- Trabacchi, C. and F. Mazza. 2015. *Emerging Solutions to Drive Private Investment in Climate Resilience*. Climate Policy Initiative Working Paper. San Francisco, CA: Climate Policy Initiative. Available at: <https://climatepolicyinitiative.org/wp-content/uploads/2015/06/Finance-for-Climate-Resilience.pdf>.
- Tribbia, J. and S.C. Moser. 2008. More than information: What coastal managers need to plan for climate change. *Environmental Science & Policy* 11(4): 315-328.
- Tucker, M. 1997. Climate change and the insurance industry: The cost of increased risk and the impetus for action. *Ecological Economics* 22(2): 85-96.
- Uittenbroek, C. J. 2016. From Policy Document to Implementation: Organizational Routines as Possible Barriers to Mainstreaming Climate Adaptation. *Journal of Environmental Policy & Planning* 18 (2):161-176.
- Uittenbroek, C.J., L.B. Janssen-Jansen, and H.A.C. Runhaar. 2013. Mainstreaming climate adaptation into urban planning: Overcoming barriers, seizing opportunities and evaluating the results in two Dutch case studies. *Regional Environmental Change* 13(2): 399-411.
- UNEP. 2007. *Vulnerability of People and the Environment – Challenges and Opportunities*. Background Report on Chapter 7 of the Fourth Global Environment Outlook (GEO-4). Nairobi, Kenya: United Nations Environment Program and Netherlands Environmental Assessment Agency.
- UNEP. 2014. *The Adaptation Gap Report: A Preliminary Assessment*. Nairobi: United Nations Environment Program.
- UNFCCC. 2008. *Investment and Financial Flows to Address Climate Change: An Update*. FCCC/TP/2008/7, Geneva, Switzerland: UNFCCC.
- UN Global Compact, UNFCCC and UNEP. 2015. *The Business Case for Responsible Corporate Adaptation: Strengthening Private Sector and Community Resilience*. A Care for Climate Report by the UN Global Compact, UNFCCC, and UNEP Finance Initiative, CEO Water Mandate, Oxfam, ARISE, World Resources Institute, UNEP, UNEP DTU Partnership, CDP, Four Twenty Seven, Rainforest Alliance, University of Notre Dame Global Adaptation Index. New York: UN. Available at:

https://www.unglobalcompact.org/docs/issues_doc/Environment/climate/Adaptation-2015.pdf.

- Václavík, T., S. Lautenbach, T. Kuemmerle, and R. Seppelt. 2013. Mapping global land system archetypes. *Global Environmental Change* 23(6): 1637-1647.
- Vignola, R., G. Leclerc, M. Morales, and J. Gonzalez. 2017. Leadership for moving the climate change adaptation agenda from planning to action. *Current Opinion in Environmental Sustainability* 26-27: 84-89.
- Walsh, I., J. A. Holton, L. Bailyn, W. Fernandez, N. Levina, and B. Glaser. 2015. What grounded theory is: A critically reflective conversation among scholars. *Organizational Research Methods* 18(4): 581-599.
- Wamsler, C., C. Luederitz, and E. Brink. 2014. Local levers for change: Mainstreaming ecosystem-based adaptation into municipal planning to foster sustainability transitions. *Global Environmental Change* 29(11): 189-201.
- Ward, P.J., K.M. Strzepek, W.P. Pauw, L.M. Brander, G.A. Hughes and J.C.J.H. Aerts. 2010. Partial costs of global climate change adaptation for the supply of raw industrial and municipal water: A methodology and application. *Environmental Research Letters* 5(4); available at: doi:10.1088/1748-9326/5/4/044011.
- Webber, S. 2013. Performative vulnerability: Climate change adaptation policies and financing in Kiribati. *Environment and Planning A* 45(11): 2717-2733.
- Williams, R.A. and K. McNutt. 2013. Climate change adaptation and policy capacity in the Canadian finance sector: A meso analysis. *Review of Policy Research* 30(1): 91-113.
- World Bank. 2010. *Economics of Adaptation to Climate Change - Synthesis Report*. Washington, DC: World Bank. Available at: <http://documents.worldbank.org/curated/en/646291468171244256/Economics-of-adaptation-to-climate-change-Synthesis-report>.
- Wreford, A., D. Moran, A. Moxey, K.A. Evans, N. Fox, K. Glenk, M. Hutchings, D.I. McCracken, A. McVittie, M. Mitchell, C.F.E. Topp and E. Wall. 2015. Estimating the costs and benefits of adapting agriculture to climate change. *Eurochoices* 14(2): 16-23.
- Yohe, G., J. Neumann, P. Marshall and H. Ameden. 1996. The economic cost of greenhouse-induced sea-level rise for developed property in the United States. *Climatic Change* 32(4): 387-410.
- Yohe, G. W. 1998. Sea-level change: The expected economic cost of protection or abandonment in the United States. *Climatic Change* 38(4): 447-472.
- Young, O. R. 2010. Institutional dynamics: Resilience, vulnerability and adaptation in environmental and resource regimes. *Global Environmental Change* 20(3): 378-385.
- Zimring, M., E. Hallstein, L. Blumberg, M. Kiparsky, and J. Downing. 2015. *New Prospects for Financing Natural Infrastructure*. A TNC White Paper. San Francisco: The Nature Conservancy of California.

APPENDIX A: Adaptation Finance Survey and Responses

Appendix A provides the survey questions verbatim along with results and – where we did further analysis – additional derivative results. Questions and results are presented in the order in which they were asked in the survey.

Question 1: Please indicate whether you work with or serve a city or county. This is not for identification purposes, but to collate survey responses by region.

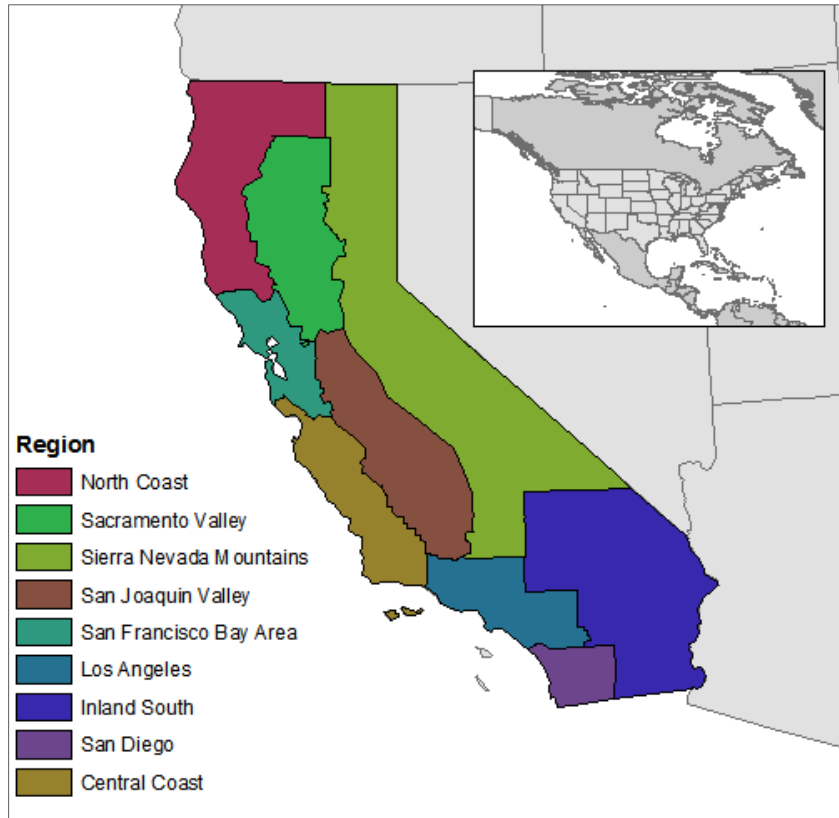
Table A.1: Proportion of Respondents Who Reported to Work with or for a Local Government

Response Options	Frequency of Responses	Percent of Responses
I work with/for a city or county	173	74.2
I do not work with/for a particular city or county	60	25.8
Total	233	100.0

Source: Authors' calculations

Question 2: Please indicate the city or county you work with or serve. This is not for identification purposes, but to collate survey responses by region.

Individual responses not shown to protect confidentiality, but responses collated according to the Fourth Climate Change Assessment Regions.



Source: CCA4 Editorial Team

Figure A.1: Fourth Assessment Climate Regions

Table A.2: Survey Respondents Per Climate Region

Climate Region	Frequency of Responses	Percent of Responses
North Coast	6	2.6
Bay Area	53	22.7
Sacramento Valley	19	8.2
San Joaquin Valley	3	1.3
Central Coast	22	9.4
Los Angeles	41	17.6
Inland South	1	.4
San Diego	13	5.6
Unknown, statewide*	66	28.3
Total	233	100.0

*Those marked as "unknown" did not provide location-specific information.
Source: Authors' calculations

Question 3: Please indicate the type of entity in which you work. If you work across multiple sectors, please choose the one that best matches your primary work responsibility. (Please select only one answer.)

Table A.3: Distribution of Respondents by Employment Type

Response Options	Frequency of Responses	Percent of Responses
Municipal/City Government	90	52.3
County Government	45	26.2
Regional District or Association	14	8.1
State Government	1	0.6
Non-Governmental Organization	7	4.1
Environmental Consultancy	4	2.3
Private Sector/Industry	1	0.6
Other (please specify)	10	5.8
Subtotal	172	100.0
No Response	61	
Total	233	

Source: Authors' calculations

Question 4: Please indicate what type of position you hold in your organization.

Table A.4: Distribution of Respondents by Position

Response Options	Frequency of Responses	Percent of Responses
Planner	57	33.5
Public Works Engineer	6	3.5
Environmental Specialist	22	12.9
Elected Official	5	2.9
Community Development Coordinator	2	1.2
Water Resources Manager	3	1.8
Emergency Services Manager	1	0.6
Wildlife/Natural Resource Manager	1	0.6
Financial Planning Officer	1	0.6
Other (please specify)	72	42.4
Subtotal	170	100.0
No Response	63	
Total	233	

Source: Authors' calculations

Question 5: What is the approximate size of the city or county you serve?

Table A.5: Distribution of Respondents by City County Size

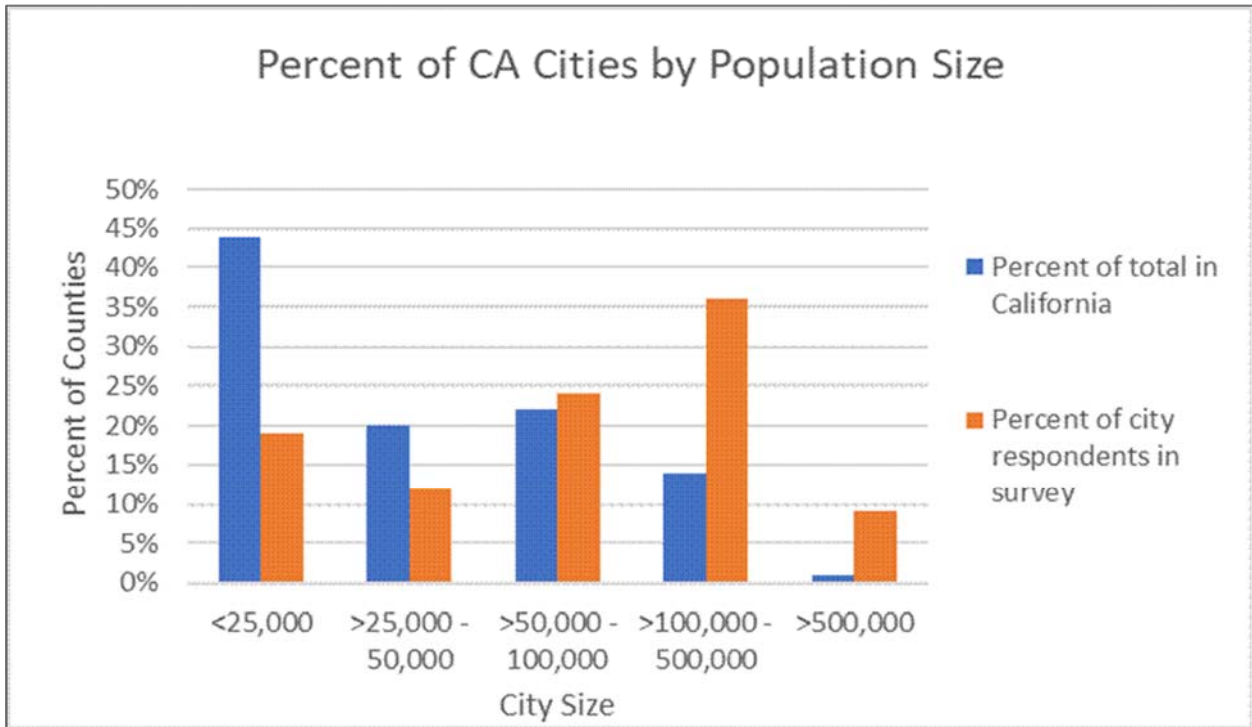
Population Size	Frequency of Responses	Percent of Responses
<25,000	23	13.5
>25,000 – 50,000	14	8.2
>50,000 – 100,00	25	14.7
>100,000 – 500,00	60	35.3
>500,000	48	28.2
Subtotal	170	100.0
No Response	63	
Total	233	

Source: Authors' calculations

Table A.6: Distribution of California Cities by Size (based on U.S. Census 2012) and of Respondents' Locations (Based on Reported Affiliated City Size)

Size of Cities	Statewide # (N=459)	Percent of total in California	Respondents # (cities, N=90)	Percent of Respondents (Cities)
<25,000	200	44	17	19
>25,000 - 50,000	90	20	11	12
>50,000 - 100,000	101	22	22	24
>100,000 - 500,000	63	14	32	36
>500,000	5	1	8	9

Source: Authors' calculations



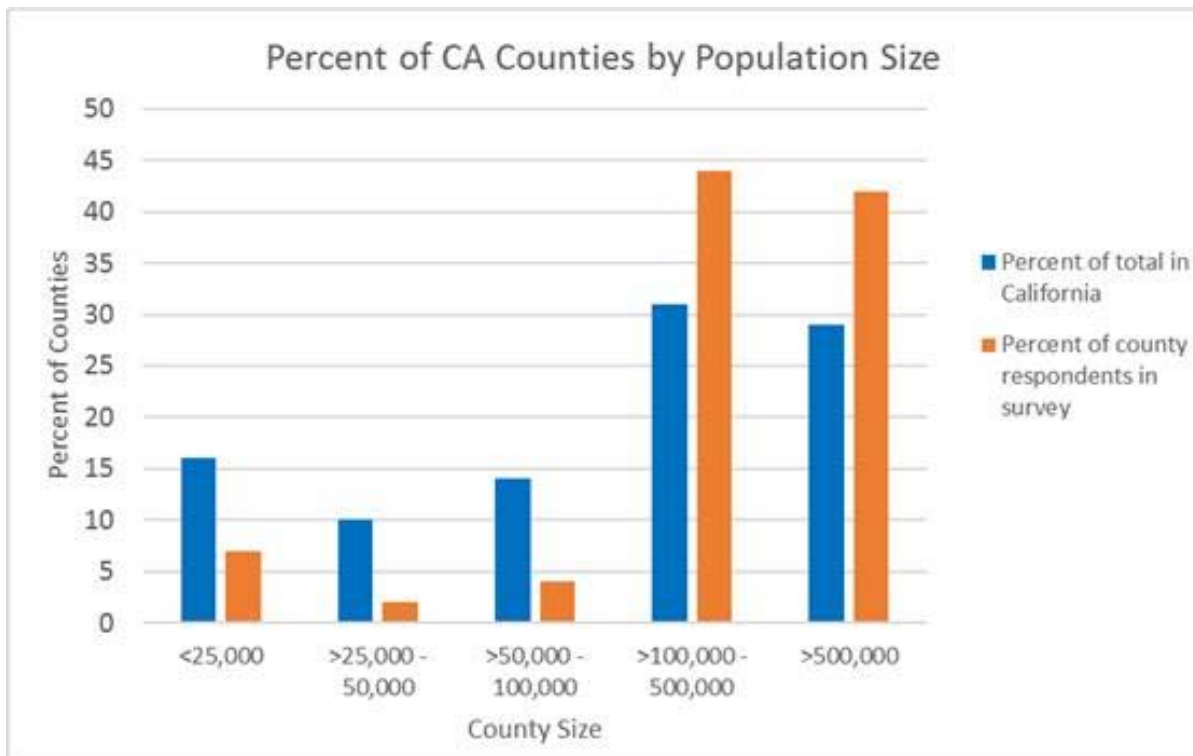
Source: Authors' calculations

Figure A.2: Representation of City Survey Respondents Compared to Statewide City Distribution

Table A.7: Distribution of California Counties by Size (based on U.S. Census 2012) and of Respondents locations (Based on Reported Affiliated County Size).

Size of Counties	Statewide # (N=58)	Percent of total in California	Respondents # (counties, N=45)	Respondents (counties)
<25,000	9	16	3	7
>25,000 - 50,000	6	10	1	2
>50,000 - 100,000	8	14	2	4
>100,000 - 500,000	18	31	20	44
>500,000	17	29	19	42

Source: Authors' calculations



Source: Authors' calculations

Figure A.3: Representation of County Survey Respondents Compared to Statewide County Distribution

Table A.8: Comparison of the Representation of Cities by Climate Region, Statewide and in the Survey

Region	All Cities (Count)	All Cities (% , N=459)	Respondent Cities (Count)	Respondent Cities (% , N=90)
Central Coast	33	7	9	10
Inland South	23	5	0	0
Los Angeles	164	36	31	34
North Coast	23	5	3	3
Sacramento Valley	35	8	9	10
San Diego	18	4	7	8
San Francisco Bay Area	84	18	27	30
San Joaquin Valley	59	13	2	2
Sierra Nevada Mountains	20	4	2	2

Source: Authors' calculations

Question 6: Do you currently actively participate in coordinated adaptation efforts in your region (i.e., through the Alliance of Regional Collaboratives for Climate Adaptation or another network)?

Table A.9: Regional Coordination of Adaptation by Respondent Type

Respondent Types	Yes	No	Not Sure	Total
County Government	27	13	5	45
Municipal/City Government	25	46	19	90
Regional District or Association	8	4	2	14
Non-Governmental	6	1	0	7
Environmental Consultancy	3	1	0	4
State Government	1	0	0	1
Private Sector/Industry	1	0	0	1
Other (please specify)	6	1	3	10
Total	77	66	29	172
Percent	44.8	38.4	16.9	100

Source: Authors' calculations

Question 7: If you participate in the discussions of a regional adaptation collaborative or network, please indicate which one.

Table A.10: Survey Respondents' Participation in Regional Adaptation Collaboratives

Response Options	Frequency of Responses	Percent of Responses
Sierra Climate Adaptation & Mitigation Partnership (Sierra CAMP)	8	5.2
Capital Region Climate Readiness Collaborative (CRCRC)	12	7.8
Bay Area Regional Collaborative (BARC)	36	23.5
Los Angeles Regional Collaborative for Climate Action and Sustainability (LARC)	12	7.8
San Diego Regional Climate Collaborative (SDRCC)	11	7.2
I work collaboratively on adaptation in another region (please identify below)*	46	30.1
I do not work on adaptation within a regional collaborative of any kind	28	18.3
Total	153	100.0

* Included ca. 10 responses of respondents involved in the Central Coast Climate Collaborative (in the forming stage), a variety of county-based or other sub-regional climate initiatives (often within the region of an existing ARCCA collaborative, such as the SF Bay Area Coastal Hazards Adaptation Resiliency Group [CHARG]), Associations of Governments, northern California, Delta and northern California-Sacramento headwaters and a few cross-regional and beyond-California mentions.

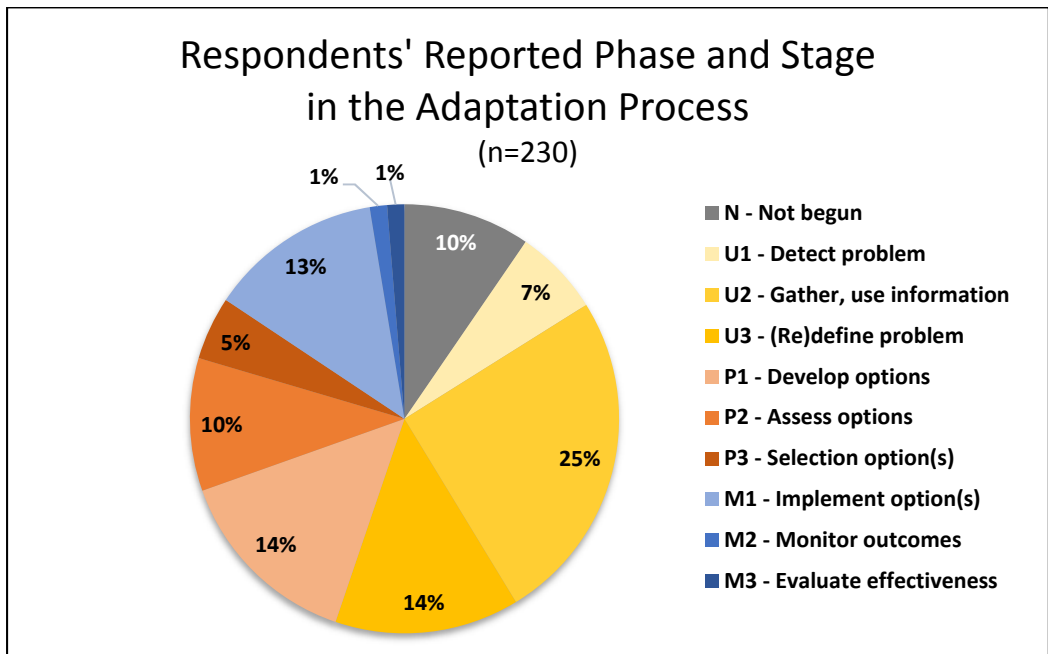
Source: Author calculations

Question 8: Which category best describes your current phase of climate change adaptation/ preparedness/resilience planning and implementation? (Select only one option that comes closest to your current level of activity.)

Table A.11: Respondents' Reported Phase in the Climate Change Adaptation Process

Response Options	Frequency of Responses	Percent of Responses
Not Begun	22	9.4
Understanding	105	45.1
Planning	67	28.8
Managing	36	15.5
No Response	3	1.3
Total	233	100.0

Source: Authors' calculations



Source: The Authors

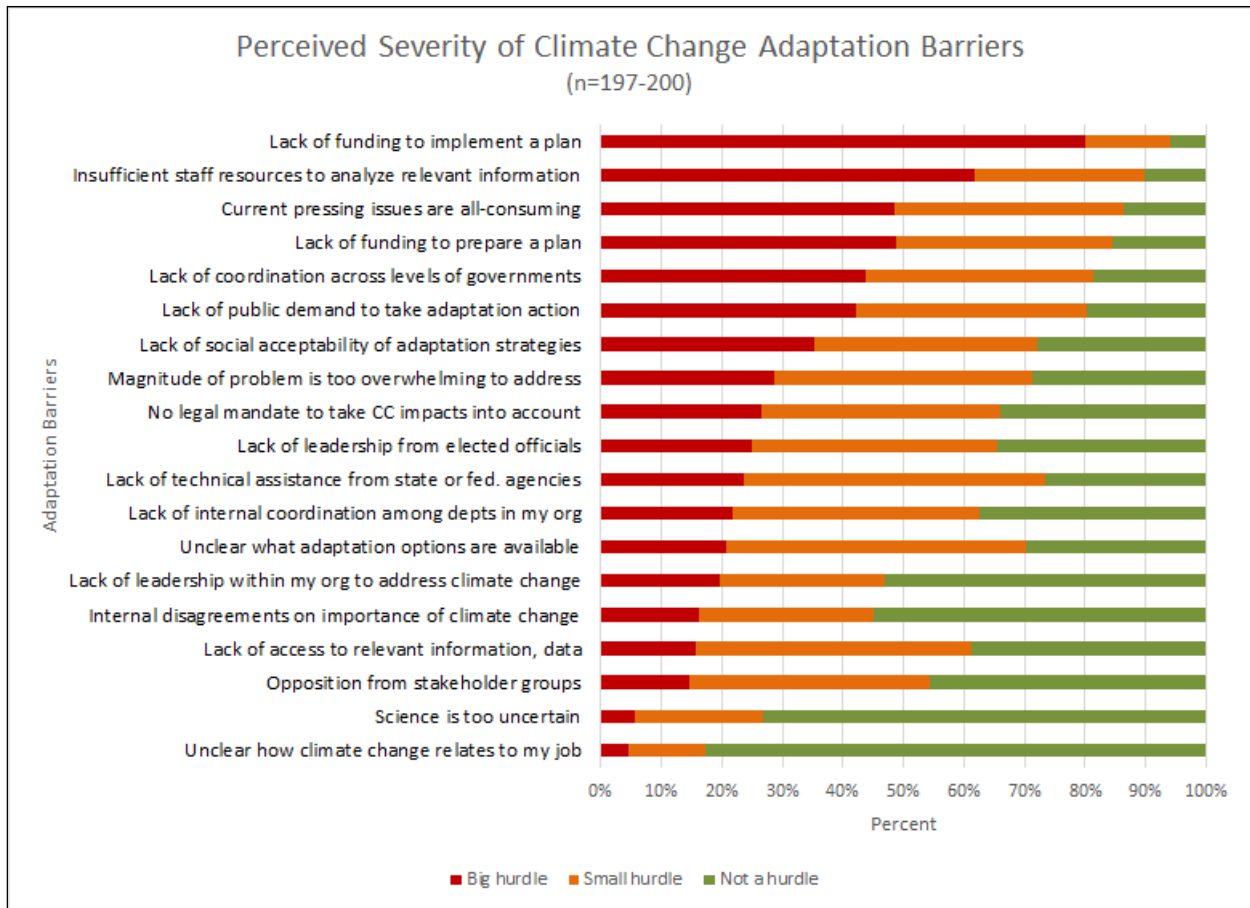
Figure A.4: Respondents Reported Phase and Stage in the Adaptation Process (Phases: grey – Not begun; yellow – Understanding; red – Planning; blue – Managing)

Table A.12: Cross-Tabulation of City/County Size and Reported Stage of Climate Change Adaptation

City/County Size Served	Not Begun	Under-standing	Planning	Managing	No Response	Total
<25,000	4	13	4	2	0	23
>25,000-50,000	5	7	1	1	0	14
>50,000-100,000	3	13	2	7	0	25
>100,000-500,000	6	30	15	9	0	60
>500,000	1	24	18	4	1	48
Total	19	87	40	23	1	170
Percent	11.2	51.2	23.5	13.5	0.6	100

Source: Authors' calculations

Question 9: Whether or not your organization has already taken action to prepare for the possible impacts of climate change, how much of a hurdle has each of the following issues been in your efforts to date or do you anticipate it to be?



Source: The Authors

Figure A.5: Perceived Severity of Climate Change Adaptation Barriers

Adaptation barriers	Average rating score for each stage					Diff (Not begun - Managing)
	Not Begun	Under-standing	Planning	Manag-ing	All stages	
Lack of funding to implement a plan	2.60	2.77	2.88	2.45	2.74	0.15
Insufficient staff resources to analyze relevant information	2.74	2.54	2.56	2.23	2.52	0.51
Current pressing issues are all-consuming	2.40	2.41	2.35	2.16	2.35	0.24
Lack of funding to prepare a plan	2.60	2.43	2.23	2.03	2.32	0.57
Lack of coordination across levels of governments	2.20	2.24	2.36	2.10	2.25	0.10
Lack of public demand to take adaptation action	2.50	2.28	2.29	1.83	2.23	0.67
Lack of social acceptability of adaptation strategies	2.20	2.13	2.12	1.77	2.08	0.43
Magnitude of problem is too overwhelming to address	1.80	2.14	1.88	1.94	1.99	-0.14
Lack of technical assistance from state, federal agencies	2.05	2.07	1.88	1.77	1.96	0.28
No legal mandate to take CC impacts into account	2.10	1.93	1.90	1.77	1.91	0.33
Lack of leadership from elected officials	2.25	1.94	1.92	1.58	1.91	0.67
Unclear what adaptation options are available	2.05	1.99	1.97	1.45	1.90	0.60
Lack of internal coordination among depts in my org	1.85	2.01	1.83	1.39	1.84	0.46
Lack of access to relevant information and data	1.85	1.83	1.76	1.55	1.76	0.30
Opposition from stakeholder groups	1.70	1.65	1.78	1.58	1.68	0.12
Lack of leadership within my organization to address CC	2.15	1.86	1.51	1.16	1.67	0.99
Internal disagreements on importance of CC	1.90	1.71	1.58	1.26	1.62	0.64
Legal pressures to maintain status quo	1.50	1.61	1.68	1.52	1.60	-0.02
Science is too uncertain	1.40	1.32	1.31	1.32	1.32	0.08
Unclear how CC relates to my job	1.35	1.31	1.12	1.10	1.22	0.25



Source: Authors' calculations

Figure A.6: Significance of Adaptation Barriers Across Stages in the Adaptation Process

Table A.13: Spearman's rho Correlation Test for Significance of Relationship between Barriers Encountered in Different Stages of the Adaptation Process

Barriers at Reported Stage of Adaptation	Spearman's rho correlation test Sig. (2-tailed)	
Magnitude of problem is too overwhelming to address	Correlation Coefficient	-0.062
	Sig. (2-tailed)	0.385
	N	196
Unclear what adaptation options are available	Correlation Coefficient	-.217**
	Sig. (2-tailed)	0.002
	N	196
Lack of social acceptability of adaptation strategies	Correlation Coefficient	-0.130
	Sig. (2-tailed)	0.070
	N	195
Lack of public demand to take adaptation action	Correlation Coefficient	-.198**
	Sig. (2-tailed)	0.005
	N	196
Insufficient staff resources to analyze relevant information	Correlation Coefficient	-.163*
	Sig. (2-tailed)	0.022
	N	196
Current pressing issues are all-consuming	Correlation Coefficient	-0.110
	Sig. (2-tailed)	0.122
	N	197
Lack of funding to prepare a plan	Correlation Coefficient	-.235**
	Sig. (2-tailed)	0.001
	N	197
Lack of funding to implement a plan	Correlation Coefficient	-0.073
	Sig. (2-tailed)	0.305
	N	198
No legal mandate to take climate change impacts into account	Correlation Coefficient	-0.093
	Sig. (2-tailed)	0.192
	N	197
	Correlation Coefficient	-.185**

Unclear how climate change relates to my job	Sig. (2-tailed)	0.010
	N	194
Lack of leadership within my organization to address climate change	Correlation Coefficient	-.385**
	Sig. (2-tailed)	0.000
	N	195
Internal disagreements on importance of climate change	Correlation Coefficient	-.242**
	Sig. (2-tailed)	0.001
	N	195
Lack of internal coordination among departments in my organization	Correlation Coefficient	-.225**
	Sig. (2-tailed)	0.002
	N	195
Lack of coordination across levels of governments	Correlation Coefficient	0.000
	Sig. (2-tailed)	0.997
	N	196
Science is too uncertain	Correlation Coefficient	0.002
	Sig. (2-tailed)	0.976
	N	195
Lack of technical assistance from state or federal agencies	Correlation Coefficient	-.153*
	Sig. (2-tailed)	0.032
	N	197
Lack of access to relevant information and data	Correlation Coefficient	-0.118
	Sig. (2-tailed)	0.100
	N	195
Opposition from stakeholder groups	Correlation Coefficient	-0.008
	Sig. (2-tailed)	0.908
	N	196
Legal pressures to maintain status quo	Correlation Coefficient	0.005
	Sig. (2-tailed)	0.945
	N	197
Lack of leadership from elected officials	Correlation Coefficient	-.187**
	Sig. (2-tailed)	0.008
	N	198

** . Correlation is significant at the 0.01 level (2-tailed).

* . Correlation is significant at the 0.05 level (2-tailed).
--

Source: Authors' calculations

Question 10: Can you share how you overcame the barriers you encountered, or provide 1-2 creative ideas for overcoming these barriers?

Write-in answers summarized only.

Table A.14: Respondents’ Strategies to Overcome Adaptation Barriers

Strategies to Overcome Adaptation Barriers	Specific Suggestions from Survey Respondents
None	Several reported not having overcome any barriers to date and gave no ideas.
Partnerships	The majority provided more substantial ideas, of which the most common was building or maintaining collaborations, partnerships, and other relationships. This involved partnerships with local NGOs (and developing these in a way that helped with funding, such as stopwaste.org), work with state agencies, developing workgroups around issues of shared interest among agencies, and partnering with other regions to reframe issues (especially, downstream stakeholders reliant on upstream ecosystem services, such as water). This group also pointed to the effectiveness of working within existing institutional structures, including updating general plans and local hazard mitigation plans to include climate adaptation.
Increasing public awareness and political pressure	Another set of respondents described the need to increase public awareness and political will, as well as re-orienting messaging away from climate change and towards more socially acceptable issues (e.g., health communities).
Cross-sector integration and co-benefits	Several respondents mentioned using climate mitigation strategies and funding to support adaptation, including finding co-benefits with mitigation strategies and including adaptation as part of climate action plans.
Mandates	Another group of mentioned the need for legal mandates to help overcome their barriers to adaptation. This included requiring local governments to do adaptation and requiring this progress to be reported regularly.
Demonstrating success	A related group of suggestions focused on the utility of documenting and demonstrating effective adaptation strategies.
Persistence	The need for persistence, dedication, and passionate staff to overcome barriers to adaptation was also mentioned by several respondents.
Technical assistance	Lastly, some suggestions pointed to assistance from the state, both in terms of the state providing more grant funding and also for local governments to ask for state agency assistance early in the adaptation process for guidance and technical assistance.

Source: The Authors

Question 11: We are interested in how your jurisdiction finances climate adaptation/preparedness action. Over the past 2 years, has your jurisdiction spent money on any aspect of climate adaptation/preparedness/resilience building?

Table A.15: Jurisdictions Spending Money on Adaptation Over the Past Years

Response Option	Frequency of Responses	Percent of Responses
Yes	125	64.1
No	51	26.2
Don't know	19	9.7
Subtotal	195	100.0
No Response	38	
Total	233	

Source: Authors' calculations

Question 12: If in the last 2 years you have invested in climate adaptation/preparedness/resilience building, please list the type of actions and processes you have spent money on (check all that apply).

Table A.16: Frequency of Expenditures for Different Adaptation-Related Activities

Adaptation-Related Activity	Frequency of Responses	Percent of Responses (N=195)
Climate change risk or vulnerability assessment	81	71.7
Adaptation/preparedness planning	64	56.6
Implementation of adaptation actions	47	41.6
Community engagement in adaptation planning or implementation	65	57.5
Monitoring and evaluation of implement actions	24	21.2
Other (please specify)	12	20.6

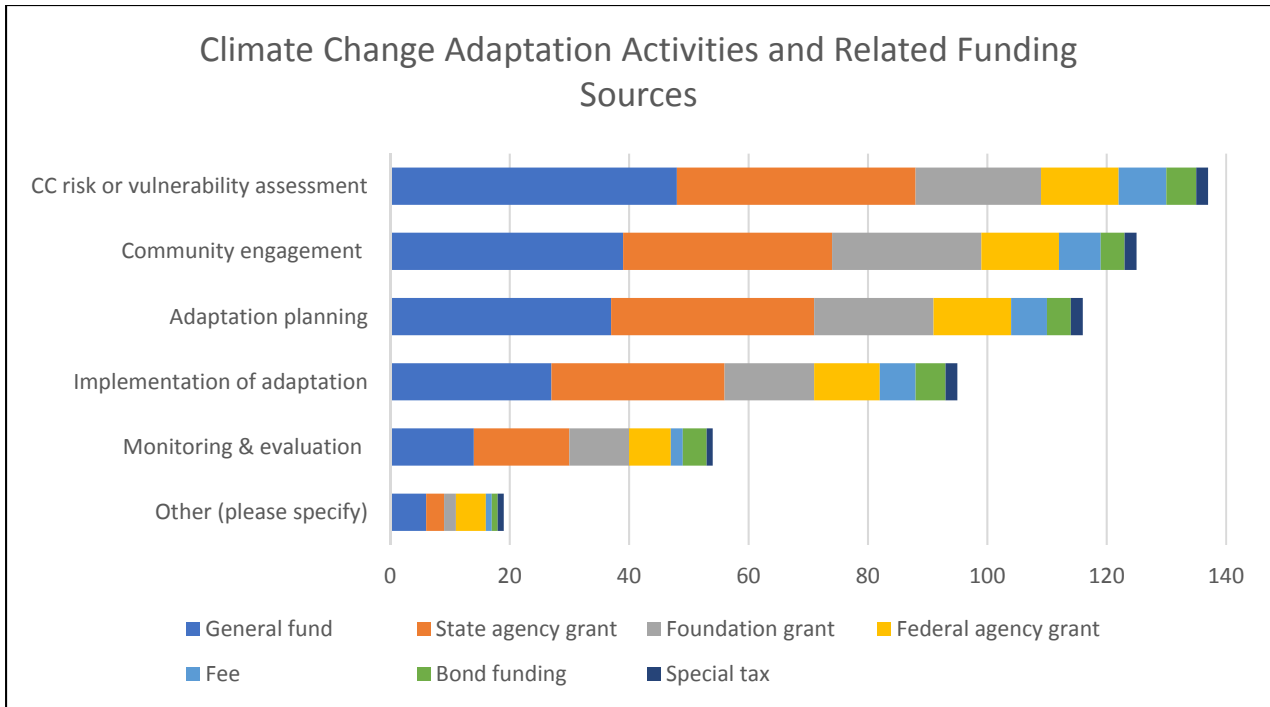
"Other" responses discussed in text.
Source: Authors' calculations

Question 13: For the activities you checked in Question 12, what sources of funding did you use (please check all that apply).

Table A.17: Cross-Tabulation of Climate Change Adaptation Activities and Related Funding Sources

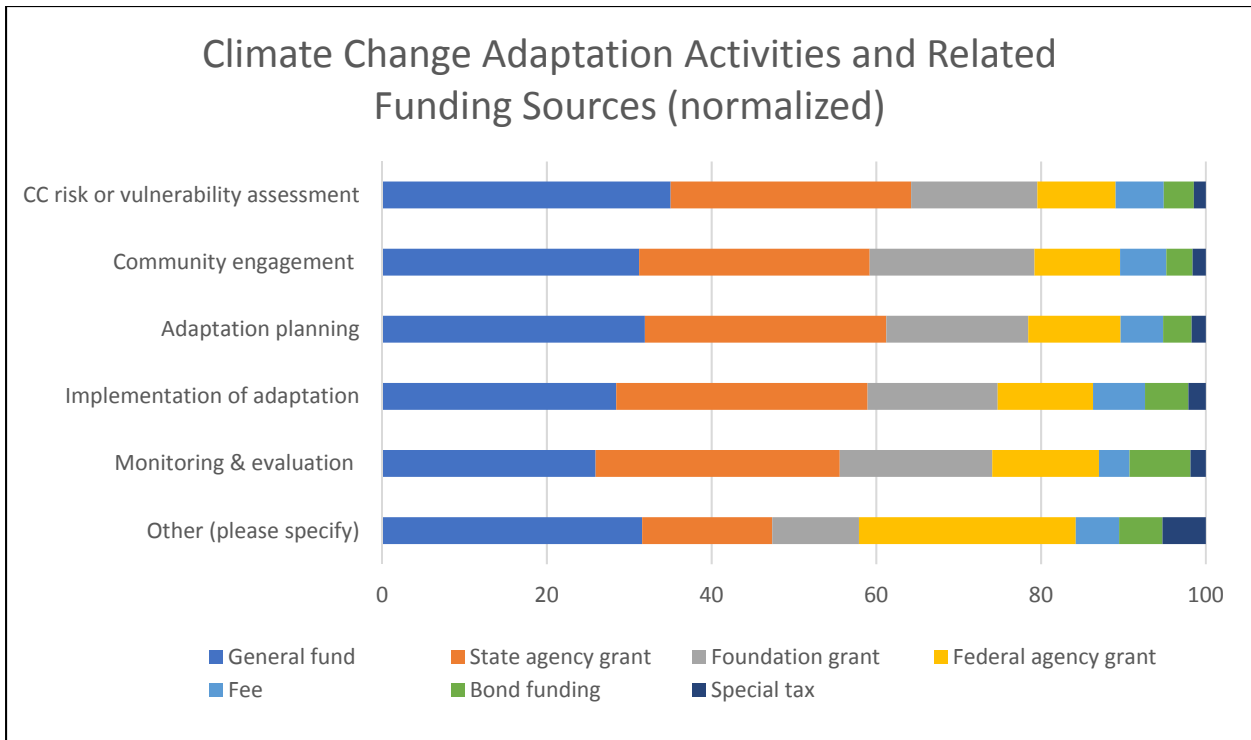
Type of Investment Activity	General Fund	State Agency Grant	Foundation Grant	Federal Agency Grant	Fee	Bond Funding	Special Tax
Climate change risk or vulnerability assessment	48	40	21	13	8	5	2
Adaptation/ preparedness planning	37	34	20	13	6	4	2
Implementation of adaptation actions	27	29	15	11	6	5	2
Community engagement in adaptation planning, implementation	39	35	25	13	7	4	2
Monitoring and evaluation of implemented adaptation actions	14	16	10	7	2	4	1
Other (please specify)	6	3	2	5	1	1	1

Source: Authors' calculations



Source: The Authors

Figure A.7: Frequency of Funding Sources for Different Adaptation-Related Activities



Source: The Authors

Figure A.8: Normalized Frequency of Funding for Different Adaptation-Related Activities

Table A.18: Percent of Respondents Having Used a Particular Funding Sources for Specified Adaptation-Related Activities

Adaptation-Related Activity	General fund	State agency grant	Founda- tion grant	Federal agency grant	Fee	Bond funding	Special tax
CC risk or vulnerability assessment (N=137)	35.0	29.2	15.3	9.5	5.8	3.6	1.5
Community engagement (N=125)	31.2	28.0	20.0	10.4	5.6	3.2	1.6
Adaptation planning (N=116)	31.9	29.3	17.2	11.2	5.2	3.4	1.7
Implementation of adaptation (N=95)	28.4	30.5	15.8	11.6	6.3	5.3	2.1
Monitoring & evaluation (N=54)	25.9	29.6	18.5	13.0	3.7	7.4	1.9
Other (please specify) (N=19)	31.6	15.8	10.5	26.3	5.3	5.3	5.3
Average of Percentages for Type of Funding Source	30.7	27.1	16.2	13.7	5.3	4.7	2.3

(red = below average for type of funding source; green = above average for type of funding source; darker shades indicate a >3-point deviation from the average)

Note: Averages of Percentages for Type of Funding Source is not necessarily the same as the average use of a particular source overall, due to rounding errors.

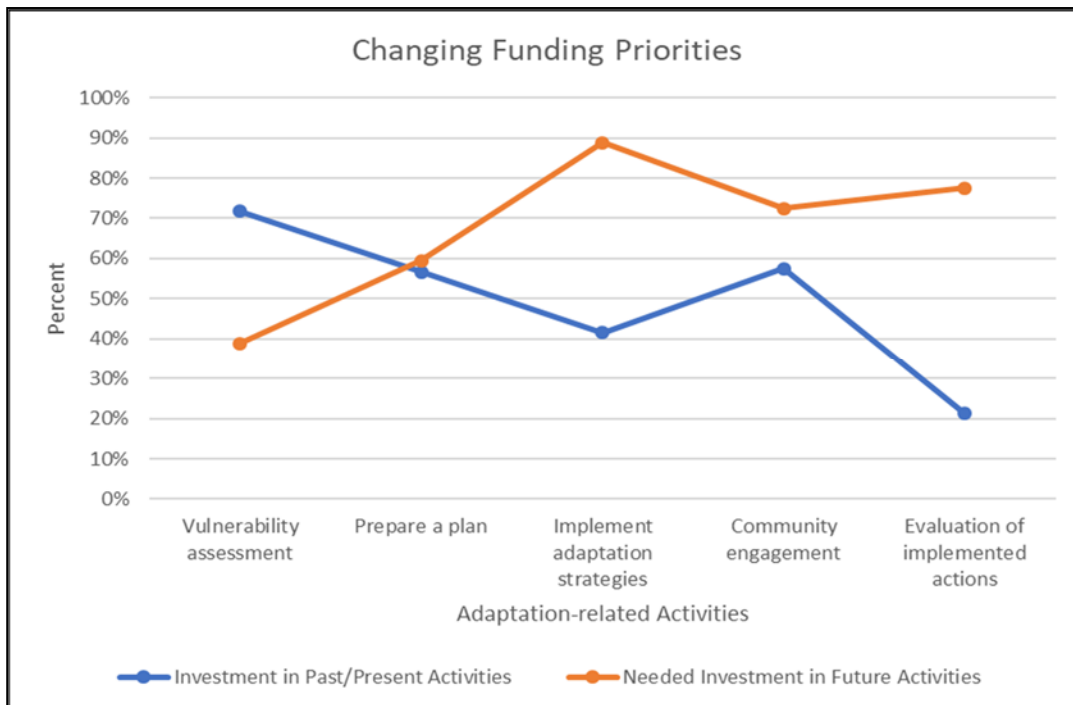
Source: Authors' calculations

Question 14: In the next 5 years, for which areas of climate change adaptation/preparedness/resilience building do you expect to need additional funds? (check all that apply).

Table A.19: Expressed Need for Funding for Climate Adaptation-Related Activities in the Next 5 Years

Future Activity	Frequency of Responses	Percent (N=116)
Vulnerability assessment	45	38.8
Prepare a plan	69	59.5
Implement adaptation strategies	103	88.8
Community engagement	84	72.4
Evaluation of implemented actions	90	77.6
Other	7	6.0
Total mentions	398	

Source: Authors' calculations



Source: The Authors

Figure A.9: Comparison of Past/Present, and Future Investment in Adaptation Activities

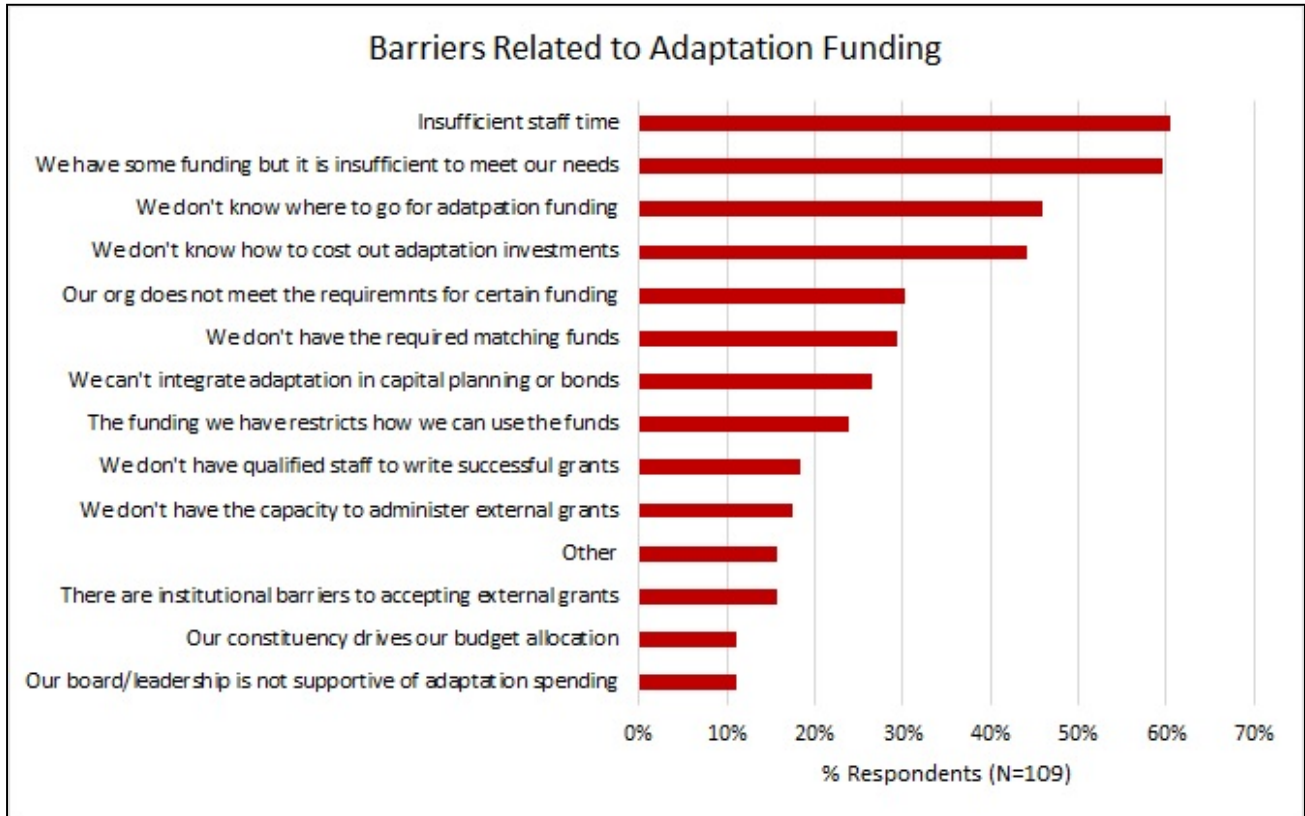
Question 15: Please indicate the status of your fund-raising efforts for the activities listed in Question 14 (select the option that best describes the current status).

Table A.20: Status of Fundraising for Climate Adaptation Related Activities

Response Option	Frequency of Responses	Percent of Responses
We have secured all of the necessary funds	2	1.8
We have secured some of the necessary funds	36	31.9
We have begun seeking the necessary funds	42	37.2
We have not yet looked into possible funding options	33	29.2
Total	113	100.1

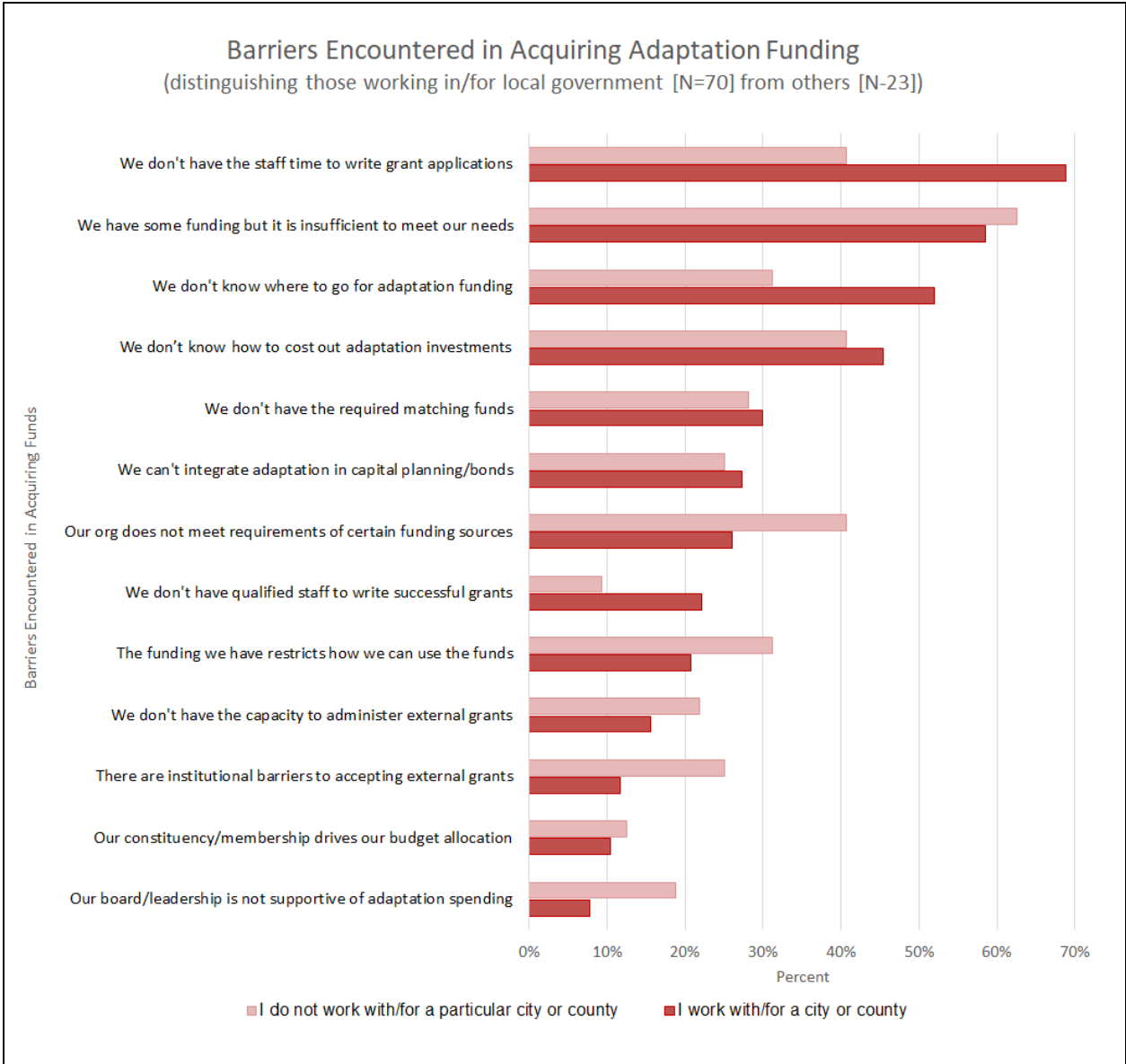
Percent total does not add to 100 due to rounding.
 Source: Authors' calculations

Question 16: To date, when attempting to acquire funds to finance adaptation-related activities, which challenges have you encountered (check all that apply).



Source: The Authors

Figure A.10: Barriers Encountered in Adaptation Funding



Source: The Authors

Figure A.11: Barriers Encountered in Acquiring Adaptation Funding (Distinguishing Those Working in/for Local Government from Others)

Question 17: If you have successfully obtained funds to finance adaptation-related activities, how have you overcome the above-mentioned challenges (please check all that apply).

Table A.21: Strategies to Overcoming Funding Barriers

Strategies	Frequency of Responses	Percent of Responses
We have embedded climate change in existing programs without additional funding	47	40.5
We have created a budget line item for climate change adaptation-related activities	28	24.1
We have hired external professional grant writers	12	10.3
We are working on adaptation on a voluntary basis (outside our official staff time)	12	10.3
We have raised funds through special fees or taxes	1	0.9
Other	16	13.8
Total	116	100

Source: Authors' calculations

**Table A.22: Strategies Used to Overcome Funding Barriers
(in Percent of Barrier-Specific N)**

Financial Barrier	Hired external professional grant writers	Raised funds through special fees or taxes	Embedded CC adaptation in existing programs without additional funding	Created a budget line item for CC adaptation	Working on adaptation on a voluntary basis	Other
We don't know where to go for adaptation funding (N=50)	10	2	30	18	12	14
We don't know how to cost out adaptation investments (N=48)	13	2	40	31	6	13
Our organization does not meet the requirements to apply for certain funding sources (N=33)	15	0	44	24	11	12
We don't have the staff time to write grant applications (N=66)	12	0	44	24	11	12
We don't have qualified staff to write successful grants (N=20)	25	0	25	25	10	14
We don't have mechanisms to integrate adaptation in capital planning or in bonds (N=29)	10	3	48	28	10	14
There are institutional barriers to accepting external grants (N=27)	12	0	47	18	24	6
We don't have the capacity to administer external grants (N=19)	11	0	37	0	5	11
We have some funding but it is insufficient to meet our needs (N=65)	11	2	55	32	15	9
We don't have the required matching funds (N=32)	9	0	53	28	16	16
Our governing board or other leadership is not supportive of adaptation-related spending (N=12)	17	0	42	17	17	0
Our constituency/ membership drives our budget allocation (N=12)	8	0	33	33	25	0

The funding we have restricts how we can use the funds (N=12)	15	0	54	27	19	4
---	----	---	----	----	----	---

Cells marked in red are the most frequently used strategies; darker red – most common strategy; lighter red – second most common strategies.

Source: Authors' calculations

Question 18: Please share any additional thoughts you might have about financial or institutional barriers that were not covered in the questions above. We welcome your thoughts and insights.

Responses discussed in text.

Question 19: Please provide your name and email below if you're willing to be contacted about follow-up questions. Your responses will be kept confidential.

Responses not provided to protect confidentiality.

APPENDIX B: Local Government Adaptation-Related Plans

B.1 Plans Identified and Included in Our Analysis (Chapter 6)

The following documents were identified through an extended search (see Methodology, Chapter 2) and included in the document analysis. Status January 2018.

Adapting to Rising Tides. 2016. Oakland/Alameda Resilience Study. San Francisco, CA: San Francisco Bay Area Conservation and Development Commission.
(<http://www.adaptingtorisingtides.org/wp-content/uploads/2014/12/Oakland-Alameda-Resilience-Study-Final.pdf>)

AECOM, Ascent Environmental, Inc., Fehrs & Peers, CTG. 2011. Yolo County Climate Action Plan: A Strategy for Smart Growth Implementation, Greenhouse Gas Reduction, and Adaptation to Global Climate Change. County of Yolo.
(<http://www.yolocounty.org/home/showdocument?id=18005>)

Atchison, C. 2011. City of Santa Cruz Climate Adaptation Plan: An update to the 2007 Local Hazard Mitigation Plan: 2012-2017. Santa Cruz, CA: City of Santa Cruz, Public Works Department. (<http://www.cityofsantacruz.com/home/showdocument?id=23644>)

Atkins. 2016. Del Mar Climate Action Plan. Del Mar, CA: City of Del Mar.
(<http://www.delmar.ca.us/DocumentCenter/View/2421>)

Brandeberry, T. (Great Northern Services, Strata Research). 2016. City of Weed Community Inspired Resilience Plan. Weed, CA: City of Weed. (https://www.gnservices.org/wp-content/uploads/2016/05/City-of-Weed-Resilience-Plan_Final.pdf)

Broderick, M., M. de Roos, J. Lotzgessell, B. Madeo, P. Rowland. 2010. Draft Trinidad Climate Action Plan. City of Trinidad.
(http://www.trinidad.ca.gov/phocadownload/PlanningCommission/GeneralPlanUpdate/Background/draft_cap_for_trinidad1.pdf)

Bryan, L., T. Thaler, G. Griffith, J. Morris, T. Crossett, R. Rasker. 2012. Forest and Water Climate Adaptation: A Plan for Shasta County, California. Model Forest Policy Program, Western Shasta Resource Conservation District, Cumberland River Compact,

Headwaters Economics. (http://www.mfpp.org/wp-content/uploads/2013/05/Shasta-County_Forest-Water-Climate-Adaptation-Plan-Final_v4-2013.pdf)

City and County of San Francisco. 2016. San Francisco Sea Level Rise Action Plan. San Francisco, CA: City and County of San Francisco. (http://default.sfplanning.org/plans-and-programs/planning-for-the-city/sea-level-rise/160309_SLRAP_Final_ED.pdf)

City of Benicia. 2015. Climate Change Vulnerability Report Summary. Benicia, CA: City of Benicia. (<http://www.ci.benicia.ca.us/vertical/sites/%7BF991A639-AAED-4E1A-9735-86EA195E2C8D%7D/uploads/VulnerabilitySummary.pdf>)

City of Berkeley. 2009. Climate Action Plan. Berkeley, CA: City of Berkeley (https://www.cityofberkeley.info/uploadedFiles/Planning_and_Development/Level_3_Energy_and_Sustainable_Development/Berkeley%20Climate%20Action%20Plan.pdf)

City of Berkeley. 2016. Berkeley Resilience Strategy. Berkeley, CA: City of Berkeley (https://www.cityofberkeley.info/uploadedFiles/City_Manager/Resilient_Berkeley/Berkeley_Resilience_Strategy_LowRes.pdf)

City of Chula Vista. 2011. Climate Adaptation Strategies: Implementation Plans. Chula Vista, CA: City of Chula Vista. (<http://www.chulavistaca.gov/home/showdocument?id=5443>)

City of Elk Grove. 2015. Elk Grove General Plan: Sustainability Element. Elk Grove, CA: City of Elk Grove. (http://www.elkgrovecity.org/UserFiles/Servers/Server_109585/File/Departments/Planning/Projects/General%20Plan/16_Sustainability.pdf)

City of Goleta, Revell Coastal. 2015. 2015 City of Goleta Coastal Hazards Vulnerability Assessment and Fiscal Impact Report. Goleta, CA: City of Goleta. (<http://www.cityofgoleta.org/home/showdocument?id=11317>)

City of Huntington Beach. 2014. City of Huntington Beach Sea Level Rise Vulnerability Assessment. Huntington Beach, CA: City of Huntington Beach.

http://www.hbthenextwave.org/wp-content/uploads/Final-HB-SLR-Vul-Assessment_12-18-2014-compiled.pdf)

City of Laguna Woods, PMC. 2014. City of Laguna Woods Climate Adaptation Plan. Laguna Woods: City of Laguna Woods. (<http://cityoflagunawoods.org/wp-content/uploads/2015/06/2014-12-17-Adopted-Climate-Adaptation-Plan.pdf>)

City of Monterey. 2016. City of Monterey Climate Action Plan. Monterey, CA: City of Monterey. (https://monterey.org/Portals/0/Reports/ForPublicReview/Draft_Climate_Action_Plan.pdf)

City of Novato. 2015. City of Novato General Plan 2035 Policy White Paper: Climate Change Action Plan. Novato, CA: City of Novato. (<http://novato.org/home/showdocument?id=12601>)

City of Richmond. 2012. Richmond General Plan 2030: Energy and Climate Change. Richmond, CA: City of Richmond. (<http://www.ci.richmond.ca.us/DocumentCenter/Home/View/8813>)

City of Sacramento. 2012. Sacramento Climate Action Plan. Sacramento, CA: City of Sacramento. (http://ascentenvironmental.com/files/9714/0537/0505/Sacramento_CAP_Final_Draft.pdf)

City of San Diego, Economic Development. 2016. Climate Action Plan: Fiscal Year 2017 Funding & Implementation Report. San Diego, CA: City of San Diego (https://www.sandiego.gov/sites/default/files/fy17_cap_funding_implementation_memo_may_2_2016_final_2.pdf)

City of San Diego, Krout Associates, Energy Policy Initiatives Center. 2015. City of San Diego Climate Action Plan. San Diego, CA: City of San Diego. (https://www.sandiego.gov/sites/default/files/final_july_2016_cap.pdf)

City of Woodland. 2014. City of Woodland Preliminary 2020 Climate Action Plan. Woodland, CA: City of Woodland Public Works Department, City of Woodland Community Development Department. (<http://cityofwoodland.org/civicax/filebank/blobdload.aspx?blobid=13682>)

Clark, R., C. Streight, C. Lewis. 2012. Climate Action Plan. Santa Cruz, CA: City of Santa Cruz
(<http://www.cityofsantacruz.com/home/showdocument?id=27824>)

County of Solano, 2011. Solano County Climate Action Plan. County of Solano.
(<http://www.co.solano.ca.us/civicax/filebank/blobdload.aspx?blobid=10080>)

De Cordova, D., J. Jesser (City of Carlsbad). 2015. Climate Action Plan. Carlsbad, CA: City of Carlsbad, Dyett & Bhatia.
(<http://www.carlsbadca.gov/civicax/filebank/blobdload.aspx?BlobID=29361>)

Ekstrom, J.A., S. C. Moser. 2016. Vulnerability and Adaptation to Sea-Level Rise: An Assessment for the City of Hermosa Beach. Susanne Moser Research & Consulting, Raimi & Associates.
(<http://www.hermosabch.org/modules/showdocument.aspx?documentid=9181>)

ESA. 2013. City of Hughson Climate Action Plan. Hughson, CA: City of Hughson.
(<http://worldcat.org/arcviewer/12/CBG/2016/09/09/H1473459030538/viewer/file2.pdf>)

ESA. 2014. City of Ukiah Climate Action Plan. Ukiah, CA: City of Ukiah.
(<http://www.cityofukiah.com/NewWeb/wp-content/uploads/2013/05/Final-Draft-Climate-Action-Plan.pdf>)

Fulton, B., M. Prinz, M. Singleton, J. An, J. Taylor, M. Carpenter, J. Lean, K. Ferrier, J. Ramierz, M. Kenney, J. Lopez, M. Cairns. 2014. City Heights Urban Greening Plan. City of San Diego Planning Department, KTU+A, Circulate San Diego, Kenney Engineering, Lopez Engineering and Cvaldo Corporation for the City of San Diego. San Diego, CA: City of San Diego.
(https://www.sandiego.gov/sites/default/files/final_city_hts_urban_greening_plan.pdf)

Garzon, C., H. Cooley, M. Heberger, E. Moore, L. Allen, E. Matalon, A. Doty, The Oakland Climate Action Coalition. (Pacific Institute). 2012. Community-Based Climate Adaptation Planning: Case Study of Oakland, CA. California Energy Commission.
(<http://pacinst.org/wp-content/uploads/2014/04/community-based-climate-planning-Oakland.pdf>)

Geos Institute. 2013. Future Climate, Wildfire, Hydrology, and Vegetation Projections for the Sierra Nevada, California: A climate change synthesis in support of the Vulnerability Assessment/Adaptation Strategy (VAAS) process. USDA FS Pacific Southwest Research Station. (<http://climatewise.org/images/projects/sierra-nevada-report-projections.pdf>)

Greer, B., T. Thaler, G. Griffith, T. Crosset, J. Perry. 2014. Forest and Water Resources: Preliminary Resilience Framework: A Sound Investment to Safeguard Tehama County. Model Forest Policy Program, Resource Conservation District of Tehama County and the Cumberland River Compact. (http://tehamacountyrcd.org/library/publications/forestAndWater_Dec2014.pdf)

Grifman, P., J. F. Hart, J. Ladwig, A. N. Mann, and M. Schulhof. 2013. Sea Level Rise Vulnerability Study for the City of Los Angeles. Los Angeles, CA: University of California Sea Grant Program. (https://dornsife.usc.edu/assets/sites/291/docs/pdfs/City_of_LA_SLR_Vulnerability_Study_FINAL_Summary_Report_Online_Hyperlinks.pdf)

Griggs, G., N. Russell (University of California, Santa Cruz). 2012. City of Santa Barbara Sea-Level Rise Vulnerability Study. Sacramento, CA: California Energy Commission (<http://www.energy.ca.gov/2012publications/CEC-500-2012-039/CEC-500-2012-039.pdf>)

Griggs, G., B. Haddad. 2011. City of Santa Cruz City Climate Change Vulnerability Assessment. Santa Cruz, CA: City of Santa Cruz (<https://seymourcenter.ucsc.edu/OOB/SCClimateChangeVulnerabilityAssessment.pdf>)

Hirschfield, Daniella, B. Holland. 2012. Sea Level Rise Adaptation Strategy for San Diego Bay. San Diego, CA: ICLEI-Local Governments for Sustainability USA, The San Diego Foundation, Tijuana River National Estuarine Research Reserve. (http://www.imperialbeachca.gov/vertical/sites/%7B6283CA4C-E2BD-4DFA-A7F7-8D4ECD543E0F%7D/uploads/San_Diego_Bay_SLR_Adaptation_Strategy_Complete.pdf)

ICF International, Michael Baker International, Moffat & Nichol, PlaceWorks. 2016. Climate Change Adaptation Plan: Preparing Benicia for a Resilient Future. Benicia, CA: City of Benicia. ([http://www.ci.benicia.ca.us/vertical/sites/%7BF991A639-AAED-4E1A-9735-86EA195E2C8D%7D/uploads/Final_Adaptation_Plan\(1\).pdf](http://www.ci.benicia.ca.us/vertical/sites/%7BF991A639-AAED-4E1A-9735-86EA195E2C8D%7D/uploads/Final_Adaptation_Plan(1).pdf))

- ICF International. 2014. City of Ontario Community Climate Action Plan. Ontario, CA: City of Ontario. (http://www.ontarioca.gov/sites/default/files/Ontario-Files/Planning/Applications/ccap_12-16-2014.pdf)
- ICLEI. 2011. San Mateo County Climate Action Plan: Climate Change Vulnerability Assessment. County of San Mateo. (<http://planning.smcgov.org/sites/planning.smcgov.org/files/documents/files/Vulnerability-Assesment-Report---December-Final.pdf>)
- Jain, K. 2016. Resilient Oakland. New York: 100 Resilient Cities, Rockefeller Foundation. (http://www.100resilientcities.org/wp-content/uploads/2017/07/Resilient-Oakland_11-22_web.pdf)
- Kershner, J. 2014. A Climate Change Vulnerability Assessment for Focal Resources of the Sierra Nevada. EcoAdapt. (http://www.cakex.org/sites/default/files/documents/EcoAdapt_CALCC_SierraNevadaVulnerabilityAssessment_26Feb2014%20%281%29.pdf)
- Kinison Brown, Polaris. 2015. City of Pacific Grove Climate Change Vulnerability Assessment. Pacific Grove, CA: City of Pacific Grove. (<http://www.cityofpacificgrove.org/sites/default/files/general-documents/local-coastal-program/pg-lcp-final-vulnerability-assessment-011515.pdf>)
- Koopman, M. E., K. Meis, and J. Corbett. 2011. Integrated Strategies for a Vibrant and Sustainable Fresno County. ClimateWise and Local Government Commission. (http://www.lgc.org/wordpress/docs/adaptation/fresno/Integrated_Strategies_for_Vibrant_Sustainable_Fresno_County_3011.pdf)
- Mann, A.N., C. Kuklowsky, E. Elkind, F. Federico, G. Gero, J. Matute, J.F. Hart, K. Reich, S. Pincetl, Z. Elizabeth. 2016. A Greater LA: Climate Action Framework. Los Angeles, CA: Los Angeles Regional Collaborative for Climate Action and Sustainability, LA County Metro. (http://climateaction.la/wp-content/themes/larc/report/AGreaterLA_ClimateActionFramework_Dec-19-2016.pdf)
- Medley-Daniel, M., T. Thaler, G. Griffith, J. Morris, T. Crossett. 2011. Forest and Water Climate Adaptation: A Plan for Trinity County, CA. Model Forest Policy Program, The Watershed Research and Training Center, Cumberland River Compact, Climate

Solutions University. (<https://thewatershedcenter.com/wp-content/uploads/2016/12/climate-adaptation-plan.pdf>)

Moore, S., E. Zavaleta, and R. Shaw. 2012. Decision-Making Under Uncertainty: An Assessment of Adaptation Strategies and Scenario Development for Resource Managers. Sacramento, CA: California Energy Commission. (<http://uc-ciee.org/downloads/CEC-500-2012-027.pdf>)

Moser, S.C., J.A. Ekstrom. 2012. Developing Adaptation Strategies for San Luis Obispo County: Preliminary Climate Change Vulnerability Assessment for Social Systems. Sacramento, CA: California Energy Commission. (<http://www.energy.ca.gov/2012publications/CEC-500-2012-054/CEC-500-2012-054.pdf>)

Murry, K., J. Davis. 2012. City of San Luis Obispo Climate Action Plan. San Luis Obispo, CA: City of San Luis Obispo Community Development Department. (<http://www.slocity.org/home/showdocument?id=4086>)

Ostrander, C. and D. Oliveira. 2013. San Francisco Climate Action Strategy: 2013 Update. San Francisco, CA: San Francisco Department of the Environment. (https://sfenvironment.org/sites/default/files/engagement_files/sfe_cc_ClimateActionStrategyUpdate2013.pdf)

PMC. 2012. City of San Gabriel Energy Action Plan. San Gabriel, CA: Southern California Edison Company Local Government Strategic Plan Strategies Program, California Public Utilities Commission. (<http://www.sangabrielcity.com/DocumentCenter/View/1531>)

PMC. 2014. Butte County Climate Action Plan. County of Butte. (<http://www.buttecap.net/documents2/butte-cap-attachment-c-butte-county-climate-action-plan/download>)

PMC. 2015. City of San Mateo Climate Action Plan. San Mateo, CA: City of San Mateo. (<https://www.cityofsanmateo.org/DocumentCenter/View/45410>)

Regional Climate Protection Authority. 2016. Climate Action 2020: Community Climate Action Plan, Chapter 6: Sonoma County Climate Readiness. Regional Climate Protection Authority.

http://climate.calcommons.org/sites/default/files/basic/CA2020_CCAP_Chapter6_RCPA.pdf)

Revell, D.L., P. King, A. Snyder, J. Calil, J. Giliam, C. Slaven, J. Hart, D. Boudreau, J. Nakagawa, R. Mercer. 2016. 2016 City of Imperial Beach Sea Level Rise Assessment. Revell Coastal, LLC, USC Sea Grant, Tijuana River National Estuarine Research Reserve and City of Imperial Beach for the San Diego Foundation, Coastal Conservancy. San Diego, CA. (http://www.imperialbeachca.gov/vertical/sites/%7B6283CA4C-E2BD-4DFA-A7F7-8D4ECD543E0F%7D/uploads/100516_IB_Sea_Level_Rise_Assessment_FINAL.pdf)

Rincon Consultants, Inc. 2013. City of Paso Robles Climate Action Plan. California Public Utilities Commission. (<http://www.prcity.com/government/departments/commdev/pdf/ClimateActionPlan.pdf>)

Sacramento Area Council of Governments, CivicSpark. 2015. Sacramento Region Transportation Climate Adaptation Plan. Sacramento, CA: Sacramento Area Council of Governments. (<http://www.sacog.org/sites/main/files/file-attachments/fullplanwithappendices.pdf>)

San Francisco Department of Public Health. 2013. Climate and Health: Understanding the Risks: An Assessment of San Francisco's Vulnerability to Extreme Heat Events. San Francisco, CA: Center for Disease Control. (<https://extxfer.sfdph.org/gis/ClimateHealth/Vulnerability%20Assessments/climate%20and%20health%20report%20130628.pdf>)

Sierra Nevada Conservancy, California Natural Resources Agency. 2009. The Climate Action Plan of the Sierra Nevada: A Regional Approach to Address Climate Change. Sierra Nevada Conservancy. (http://www.sierranevada.ca.gov/docs/climate_action_plan_1.pdf)

Van Belleghem, Westerhoff, A., L. Armstrong, N. Le Baron, J. Liebster. 2015. Marin Ocean Coast Sea Level Rise Vulnerability Assessment. County of Marin, Marin County Community Development Agency, Environmental Science Associates. (https://www.marincounty.org/~media/files/departments/cd/planning/slr/vulnerability-assessment/part-01_draft_marin_coast_slr_va_v2.pdf?la=en)

Way, J., T. Davis, J. Blank, Y. Rincon, and J. Venema. 2016. Climate Action Plan for Internal Operations. Sacramento, CA: City of Sacramento. (<https://www.cityofsacramento.org/-/media/Corporate/Files/Public->

[Works/Facilities/CityOfSacramento_1606_ClimateActionPlan_InternalOps_FINAL.pdf?la=en](#))

Weiss, B., J. Ledbetter, B. Shelton. 2012. City of Santa Barbara Climate Action Plan. Santa Barbara, CA: City of Santa Barbara, Community Development Department, Planning Division.
<https://www.santabarbaraca.gov/civicax/filebank/blobdload.aspx?BlobID=17720>)

Wells, A., C. Slaven, A. Newkirk, and R. Walters. 2014. Final Climate Action Plan. Goleta, CA: City of Goleta <http://www.cityofgoleta.org/home/showdocument?id=9735>)

Western Riverside Council of Governments. 2014. Subregional Climate Action Plan: Adaptation and Resiliency Strategy. Western Riverside Council of Governments.
<http://www.wrcog.ca.us/DocumentCenter/View/186>)

Wise-West, T., R. Solick, and M. King. (City of Santa Cruz). 2017. City of Santa Cruz Climate Adaptation Plan Update 2017-2022. City of Santa Cruz.
<http://www.cityofsantacruz.com/home/showdocument?id=63040>)

B.2 Additional Analytical Background in Support of the Document Analysis

Table B.1: Population and Areal Extent of Local Governments Included in the Adaptation Cost Analysis

Municipality	Population (2016)	Area (square miles)
Benicia	28,174	12.93
Chula Vista	262,172	49.63
County of San Luis Obispo	282,887	3,298.57
Goleta	30,850	7.90
Imperial Beach	27,418	4.16
Laguna Woods	16,272	3.12
Sacramento	495,234	97.92
San Diego	1,406,630	325.19

Santa Cruz	64,465	12.74
Sample Total	2,614,102	3,812.16
California Total	39,250,017	155,779.22
Representation	6.66%	2.69%

Population has been calculated using U.S. Census Bureau's July 1, 2016 population estimates, and land area

has been calculated using U.S. Census Bureau's 2010 land area data.

Source: The Authors

Table B.2: Support for the Cost-Effectiveness of Adaptation from Other US Cities

Metropolitan Area	Population (Thousands)	Avoided Costs Through Watershed Protection
New York City	9,000	\$1.5 billion spent on watershed protection over 10 years to avoid at least \$6 billion in capital costs and \$300 million in annual operating costs.
Boston, Massachusetts	2,300	\$180 million (gross) avoided cost.
Seattle, Washington	1,300	\$150-\$200 million (gross) avoided cost.
Portland, Oregon	825	\$920,000 spent annually to protect watershed is avoiding a \$200 million capital cost.
Portland, Maine	160	\$729,000 spent annually to protect watershed has avoided \$25 million in capital costs and \$725,000 in operating costs.
Syracuse, New York	150	\$10 million watershed plan is avoiding \$45-\$60 million in capital costs.
Auburn, Maine	23	\$570,000 spent to acquire watershed land is avoiding \$30 million capital costs and \$750,000 in annual operating costs.

Source: Greer et al. (2014), Reference in Appendix B.1

Table B.3: Potential Sources of Adaptation Funding Identified in California Local Government Documents (Based on References in B.1)

Type	Origin	Funding Source(s)
Federal	Center for Disease Control	<ul style="list-style-type: none"> ● ACHIEVE
Federal	Federal Housing Administration	<ul style="list-style-type: none"> ● PowerSaver Loan Program
Federal	Federal Housing Finance Agency	<ul style="list-style-type: none"> ● Energy Efficient Mortgages
Federal	Federal Emergency Management Agency	<ul style="list-style-type: none"> ● Hazard Mitigation Assistance Grant Programs ● Flood Mitigation Assistance ● Pre-Disaster Mitigation ● Severe Repetitive Loss Grant Program
Federal	U.S. National Parks Service	<ul style="list-style-type: none"> ● Land and Water Conservation Fund ● Urban Community Forestry Program
Federal	U.S. Environmental Protection Agency	<ul style="list-style-type: none"> ● Brownfields Clean Up & Assessments
Federal	U.S. Department of Housing and Urban Development	<ul style="list-style-type: none"> ● Choice Neighborhoods Implementation Grant ● Community Development Block Grants ● Urban Revitalization & Livable Communities Act ● Sustainable Communities Planning Grant and Incentive Program ● Title 1 - Home Improvement Loans
Federal	U.S. Department of Agriculture	<ul style="list-style-type: none"> ● Community Forest and Open Conservation ● Urban and Community Forest Program ● Wildlife Services
Federal	U.S. Forest Service	<ul style="list-style-type: none"> ● Cooperative Landscape Conservation ● Recovery Act Funds - Habitat Enhancement, Restoration and Improvement ● Save America's Treasures

		<ul style="list-style-type: none"> • Undesirable/Noxious Plant Species
Federal	National Center for Safe Routes to School	<ul style="list-style-type: none"> • Safe Routes to School Mini-grants
State	CA Air Resources Board	<ul style="list-style-type: none"> • <i>Cap-and-trade grant programs</i> • Air Quality Improvement Plan • Carl Moyer Program - Voucher Incentive Program • Goods Movement Emission Reduction Program • Loan Incentives Program • Lower-Emission School Bus Programs/School Bus Retrofit and Replacement Account
State	CA Coastal Conservancy	<ul style="list-style-type: none"> • <i>Coastal Conservancy Grants</i>
State	CA Department of Parks and Recreation	<ul style="list-style-type: none"> • Land and Water Conservation Fund • Nature Education Facilities • Prop 1E - Stormwater Flood Management • Prop 12 - 2000 Parks Bond Act • Prop 40 - 2002 Resources Bond • Prop 84 - Stormwater Grant and Statewide Park Program • Prop 117 - Habitat Conservation • Recreational Trails Program • Watershed Program
State	CA Department of Boating and Waterways	<ul style="list-style-type: none"> • Aquatic Center Grants • Boat Launching Facilities
State	CA Department of Forestry and Fire Protection	<ul style="list-style-type: none"> • Urban Forestry Program (Leafing Out, Leading Edge, and Green Trees Grants)
State	CA Department of Transportation	<ul style="list-style-type: none"> • Active Transportation Program • Community Based Transportation Planning, Environmental Justice & Transit Planning • Job Access and Reverse Commute Program

State	CA Energy Commission	<ul style="list-style-type: none"> • Alternative Fuel and Vehicle Technologies Program • Electric Vehicle Charging Infrastructure
State	CA Natural Resources Agency	<ul style="list-style-type: none"> • Environmental Enhancement & Mitigation Program • California River Parkways and Urban Streams Restoration Grant
State	CA Ocean Protection Council	<ul style="list-style-type: none"> • <i>OPC Grants</i>
State	CA Public Utilities Commission	<ul style="list-style-type: none"> • Self-Generation Incentive Program
State	Office of Traffic Safety	<ul style="list-style-type: none"> • Traffic Safety Grants
State	State Water Resources Control Board	<ul style="list-style-type: none"> • Non-point Source Pollution, Watershed Plans, Water Conservation (Props 13, 40, 50, 84)
State	Strategic Growth Council	<ul style="list-style-type: none"> • Sustainable Communities Planning, Regional SB-375
Local	Local Jurisdictions	<ul style="list-style-type: none"> • Advertising Sales/Naming Rights • Business Recruitment Incentive Program • Capital Improvement Program • Community Facilities District • Community Reinvestment Capital Improvement Program • Development Impact Fees • Enhanced Infrastructure Financing District • Facilities Benefit Easement District • Easement Agreements/Revenues • Ecosystem Damage Fees • Equipment Rental Fees • Facility Use Permit Fees • Fees and Charges/Recreation Service Fees • Food and Beverage Tax • General Fund

		<ul style="list-style-type: none"> ● General Obligation Bonds ● Geological Hazard Abatement Districts ● Intergovernmental Agreements ● Lease Revenues ● Mello Roos Districts ● Park Dedication Fees ● Park Impact Fees ● Pouring Rights Agreements ● Private Development Agreements ● Public Recreation Impact Fees ● Surplus Real Estate Sales Revenues ● Revenue Bond Revenues ● Sales Tax Revenues ● Sand Mitigation Fees ● Transient Occupancy Tax Revenues ● User Fees ● Utility Taxes
Local	Regional MPOs / Local Jurisdictions	<ul style="list-style-type: none"> ● Smart Growth Incentive Programs ● Special Habitat Conservation Programs ● Special Parks and Recreation Bond Revenues ● Special Transportation Bonds and Sales Tax Initiatives
Local	Local Jurisdictions, Non-Profits, or Business Organizations	<ul style="list-style-type: none"> ● Business Improvement Districts ● Maintenance Districts ● Property Based Improvement Districts ● Landscape Maintenance Districts
Philanthropy	California Council for the Humanities	<ul style="list-style-type: none"> ● Community Stories Grant
Philanthropy	California State Parks Foundation	<ul style="list-style-type: none"> ● Grants for Parks

Philanthropy	National Endowment for the Humanities	<ul style="list-style-type: none"> • America's Historical Planning Grants
Philanthropy	National Trust for Historic Preservation	<ul style="list-style-type: none"> • Preservation Funding
Private or Public	Utilities	<ul style="list-style-type: none"> • Automated Demand Response Program • Base Interruptible Program • Business Rebates • Customized Retrofit Incentives • Demand Bidding Program • On-Bill Financing • Savings by Design Rebate Program
Private	California ReLeaf (Providing pass-through grants)	<ul style="list-style-type: none"> • Urban Forestry Grant
Private	Corporate Citizens	<ul style="list-style-type: none"> • Corporate Sponsorships
Private	Non-Profit Corporations	<ul style="list-style-type: none"> • Land Trusts
Private	PACE Providers	<ul style="list-style-type: none"> • Property Assessed Clean Energy Programs
Private	Private Corporations	<ul style="list-style-type: none"> • Home Depot: Community Impacts Grant Program • Private Sector Partnerships
Private	Private Individuals	<ul style="list-style-type: none"> • Private Donations • Irrevocable Remainder Trusts

Source: Compiled by Authors

Table B.4: Adaptation-Related Bills Deliberated in the California State Legislature (2013-2018)

Note: Rows highlighted in yellow are companion bills in the Assembly and Senate.

Bill #	Lead sponsor, Title, Short hand, Purpose	Funding Provisions	Status	Weblink to bill
2017-2018				
SB 263	Leyva. Climate Assistance Centers. to establish no less than 10 regional climate assistance centers	No funding, but enables the SGC to solicit and accept external funding	Last amended 5/3/17; placed on suspense file	https://leginfo.ca.gov/faces/billTextClient.xhtml?bill_id=201720180SB263
SB 780	Wiener. Water Conservation in Landscaping Act.	Within 6 months of adoption of law, all state agencies with grant or loan programs must adopt and require adoption of water-conserving or water-efficient landscape approaches; no funding	Last amended 4/4/17; placed on suspense file	http://leginfo.ca.gov/faces/billTextClient.xhtml?bill_id=201720180SB780
SB 262	Wieckowski. Climate change: climate adaptation: advisory council.	Stipulates that members of OPR's climate adaptation advisory council would serve 4-year staggered terms and have the council elect a chair person; no funding	Introduced 2/8/17; active bill--in committee process	http://leginfo.ca.gov/faces/billTextClient.xhtml?bill_id=201720180SB262
AB 18	Garcia. California Clean Water, Climate, Coastal Protection, and Outdoor Access For All Act of 2018. relating to a clean water, climate, coastal protection, and outdoor access for all program, by providing the funds necessary therefor through an election for the issuance and sale of bonds of the State of California and for the handling and disposition of those funds, and declaring the urgency thereof, to take effect immediately.	Would authorize the issuance of a \$3.47 billion General obligation bond; significant portions of the program would be dedicated to disadvantaged and small communities/counties	Last amended 8/30/17; active bill--in committee process	http://leginfo.ca.gov/faces/billTextClient.xhtml?bill_id=201720180AB18

SB-5	De León. California Drought, Water, Parks, Climate, Coastal Protection, and Outdoor Access For All Act of 2018. An act to add Sections 5096.611 and 75089.5 to, and to add Division 45 (commencing with Section 80000) to, the Public Resources Code, and to add Section 79772.5 to the Water Code, relating to a drought, water, parks, climate, coastal protection, and outdoor access for all program, by providing the funds necessary therefor through an election for the issuance and sale of bonds of the State of California and for the handling and disposition of those funds, and declaring the urgency thereof, to take effect immediately.	Bill would - once voter approved in June 2018 election - reallocate \$100 million of unissued bond funding from Proposition 1, Proposition 84 and Proposition 40 to finance a drought, water, parks, climate, coastal protection, and outdoor access for all program.	Approved by Gov and chaptered by Secretary of State. Chapter 852, Statutes of 2017. 10/15/17	http://leginfo.ca.gov/faces/billTextClient.xhtml?bill_id=201720180SB5
AB-1617	Bloom. Department of Fish and Wildlife: Fish and Game Commission: funding: strategic vision.	This bill would require the DFW in cooperation with specified parties, to identify and propose new sources of revenue to fund the department's necessary wildlife, land, and marine conservation, restoration, and resources management and protection responsibilities.	Last amended 5/15/17; active bill; 07/03/17 in committee: Set, first hearing. Hearing canceled at the request of author.	http://leginfo.ca.gov/faces/billTextClient.xhtml?bill_id=201720180AB1617

<p>AB-1530</p>	<p>Fletcher. Urban forestry.</p>	<p>Authorizes the DFFP to do more on urban forestry. The act authorizes the director of the department to make grants to provide assistance for projects and to waive the cost sharing requirement for projects that are in disadvantaged and severely disadvantaged communities. The act defines disadvantaged community and severely disadvantaged community for these purposes.</p> <p>This bill would redefine a disadvantaged community as one that is identified as such pursuant to the Greenhouse Gas Reduction Fund Investment Plan and Communities Revitalization Act. The bill would delete the definition of severely disadvantaged community and instead use low-income community as that term is used in the Greenhouse Gas Reduction Fund Investment Plan and Communities Revitalization Act. The bill would authorize the director to authorize advance payments from a grant awarded to a nonprofit organization that is located in or providing service to disadvantaged or low-income communities, as provided.</p> <p>The act authorizes certain types of assistance, including funding for development of urban tree plans that include coordination of local agency efforts and citizen involvement.</p> <p>This bill would also authorize assistance for funding for improved urban forest maintenance, and projects that respond to events that impact urban forest health, as provided, and funding for planning and technical assistance for eligible applicants assisting disadvantaged communities. (See specified conditions in SEC. 6. Section 4799.12; no indication that this is new funding)</p>	<p>Chaptered by Secretary of State - Chapter 720, Statutes of 2017; 10/12/17</p>	<p>http://leginfo.legislature.ca.gov/faces/billTextClient.xhtml?bill_id=201720180AB1530</p>
----------------	----------------------------------	---	--	--

AB-108	Committee on Budget (Assembly Members Ting (Chair), Arambula, Bloom, Caballero, Chiu, Cooper, Cristina Garcia, Jones-Sawyer, Limón, McCarty, Medina, Mullin, Muratsuchi, O'Donnell, Rubio, Mark Stone, Weber, and Wood). Public Resources	Codifies proposed amendments to local general plans (safety elements) or local hazard mitigation plans to take climate change adaptation into account. No special funding provisions.	Last amended 6/12/17; active bill--in floor process; [07/20/17 Ordered to inactive file at the request of Senator Mitchell.]	http://leginfo.legislature.ca.gov/faces/billTextClient.xhtml?bill_id=201720180AB108
SB-92	Committee on Budget and Fiscal Review. Public Resources	Codifies proposed amendments to local general plans (safety elements) or local hazard mitigation plans to take climate change adaptation into account. No special funding provisions.	Chaptered by Secretary of State. Chapter 26, Statutes of 2017, 6/27/17	http://leginfo.legislature.ca.gov/faces/billTextClient.xhtml?bill_id=201720180SB92
AB-398	Eduardo Garcia (A), De León (S), Chu (S), Dababneh (S), Bloom (S), Levine (S), Gipson (S), Santiago (S), Quirk (S), Mullin (S), Weber (S), Nazarian (S), Cristina Garcia (S), Wood (S), Gonzalez Fletcher (S), Muratsuchi (S). California Global Warming Solutions Act of 2006: market-based compliance mechanisms: fire prevention fees: sales and use tax manufacturing exemption.	It is the intent of the Legislature that moneys collected from the auction or sale of allowances pursuant to a market-based compliance mechanism established pursuant to the California Global Warming Solutions Act of 2006 (Division 25.5 (commencing with Section 38500)) shall be appropriated to include, but need not be limited to, the following priorities at the time an expenditure plan is adopted: includes climate resilience and adaptation, and climate and clean energy research (and several adaptation-relevant practices in urban, forested, and agricultural sectors).	Chaptered by Secretary of State - Chapter 135, Statutes of 2017. 07/25/17	http://leginfo.legislature.ca.gov/faces/billTextClient.xhtml?bill_id=201720180AB398

AB-115	Committee on Budget (A) - (Assembly Members Ting (Chair), Arambula, Bloom, Caballero, Chiu, Cooper, Cristina Garcia, Jones-Sawyer, Limón, McCarty, Medina, Mullin, Muratsuchi, O'Donnell, Rubio, Mark Stone, Weber, and Wood). Transportation	As part of a loan repayment scheduled to be prepared by the Dept of Finance, there shall be Up to 20 million dollars made available to local and regional agencies for climate change adaptation planning (between enactment and June 2020).	Chaptered by Secretary of State - Chapter 20, Statutes of 2017, 6/27/17	https://leginfo.ca.gov/faces/billTextClient.xhtml?bill_id=201720180AB115
SB-99	Committee on Budget and Fiscal Review. Transportation.	As part of a loan repayment scheduled to be prepared by the Dept of Finance, there shall be Up to 20 million dollars made available to local and regional agencies for climate change adaptation planning (between enactment and June 2020).	Active bill - In Committee Process; Re-referred to Com. on BUDGET pursuant to Assembly Rule 97, 6/19/17	https://leginfo.ca.gov/faces/billTextClient.xhtml?bill_id=201720180SB99
SB-1	Bealle. Transportation funding.	As part of a loan repayment scheduled to be prepared by the Dept of Finance, there shall be Up to 20 million dollars made available to local and regional agencies for climate change adaptation planning (between enactment and June 2020).	Chaptered by Secretary of State. Chapter 5, Statutes of 2017, 4/28/17	https://leginfo.ca.gov/faces/billTextClient.xhtml?bill_id=201720180SB1
AB-1	Frazier. Transportation Funding	Recognizes that "advance mitigation" efforts as part of transportation projects can meet adaptation goals. No adaptation-specific funding specifications (other than in this indirect way).	Active Bill - In Committee Process. Referred to Coms. on TRANS. and NAT. RES, 1/9/17	https://leginfo.ca.gov/faces/billTextClient.xhtml?bill_id=201720180AB1
AB-1756	Brough. Transportation funding.	would eliminate the \$20 million dollars for local and regional adaptation provided in other bills	Active Bill - Pending Referral; May be heard in committee February 4 (1/5/18)	https://leginfo.ca.gov/faces/billTextClient.xhtml?bill_id=201720180AB1756

AB-96	Ting. Budget Act of 2017. An act making appropriations for the support of the government of the State of California and for several public purposes in accordance with the provisions of Section 12 of Article IV of the Constitution of the State of California, relating to the state budget, to take effect immediately, budget bill.	Budget for Department of Transportation contains a Provision whereby 330 million is made available for the Transit and Intercity Rail Capital Program, and \$20 million of that would be made available to local and regional agencies for climate change adaptation.	Active Bill - In Committee Process; Re-referred to Com. on BUDGET, 6/20/17	https://leginfo.ca.gov/faces/billTextClient.xhtml?bill_id=201720180AB96
AB-97	Ting. Budget Act of 2017. An act making appropriations for the support of the government of the State of California and for several public purposes in accordance with the provisions of Section 12 of Article IV of the Constitution of the State of California, relating to the state budget	Of the amount identified in Provision 3, up to \$20,000,000 shall be available to local and regional agencies for climate change adaptation planning.	Chaptered by Secretary of State - Chapter 14, Statutes of 2017, 6/27/17	https://leginfo.ca.gov/faces/billTextClient.xhtml?bill_id=201720180AB97
SB-72	as amended, Mitchell. Budget Act of 2017. This bill would make appropriations for the support of state government for the 2017–18 fiscal year.	Of the amount identified in Provision 3, up to \$20,000,000 shall be available to local and regional agencies for climate change adaptation planning.	Active Bill - In Committee Process; last amended 5/26/17	https://leginfo.ca.gov/faces/billTextClient.xhtml?bill_id=201720180SB72

2015-2016				
SB-246	Wieckowski. Climate change adaptation. Bill would establish the Integrated Climate Adaptation and Resiliency Program to be administered by the Office of Planning and Research to coordinate regional and local efforts with state climate adaptation strategies to adapt to the impacts of climate change, as specified; also establish a clearinghouse for climate adaptation information, as specified.	Funding for ICARP through OPR and SGC appropriations. Requires the SGC, among other things, to identify and review the activities and funding programs of member state agencies that may be coordinated to improve air and water quality. The Adaptation Clearinghouse shall include information concerning funding opportunities for adaptation research, planning, and projects.	Chaptered by Secretary of State. Chapter 606, Statutes of 2015, 10/18/15	https://leginfo.ca.gov/faces/billTextClient.xhtml?bill_id=201520160SB246
AB-1482	Gordon. Climate adaptation	Requires CNRA, by July 1, 2017, and every 3 years thereafter, to update the state's climate adaptation strategy. No additional funding provisions.	Chaptered by Secretary of State - Chapter 603, Statutes of 2015, 10/8/15	https://leginfo.ca.gov/faces/billTextClient.xhtml?bill_id=201520160AB1482

SB-379	Jackson. Land use: general plan: safety element. Bill would, upon the next revision of a local hazard mitigation plan on or after January 1, 2017, or, if the local jurisdiction has not adopted a local hazard mitigation plan, beginning on or before January 1, 2022, require the safety element to be reviewed and updated as necessary to address climate adaptation and resiliency strategies applicable to that city or county. The bill would require the update to include a set of goals, policies, and objectives based on a vulnerability assessment, identifying the risks that climate change poses to the local jurisdiction and the geographic areas at risk from climate change impacts, and specified information from federal, state, regional, and local agencies.	This bill would, upon the next revision of a local hazard mitigation plan on or after January 1, 2017, or, if the local jurisdiction has not adopted a local hazard mitigation plan, beginning on or before January 1, 2022, require the safety element to be reviewed and updated as necessary to address climate adaptation and resiliency strategies applicable to that city or county. Establishes that adding this mandate on local governments requires no compensation from the state.	Chaptered by Secretary of State. Chapter 608, Statutes of 2015, 10/8/15	https://leginfo.ca.gov/faces/billTextClient.xhtml?bill_id=201520160SB379
SB-1000	Leyva. Land use: general plans: safety and environmental justice.	This bill would, among other things, add to the required elements of the general plan an environmental justice element. Establishes that adding this mandate on local governments requires no compensation from the state.	Chaptered by Secretary of State. Chapter 587, Statutes of 2016, 9/24/16	https://leginfo.ca.gov/faces/billTextClient.xhtml?bill_id=201520160SB1000
AB-2651	Gomez. Greenway easements. relating to open-space lands	Amends the laws pertaining to writing general plans to include a safety element that must account for climate change impacts. No specific funding provisions.	Chaptered by Secretary of State - Chapter 471, Statutes of 2016, 9/22/16	https://leginfo.ca.gov/faces/billTextClient.xhtml?bill_id=201520160AB2651

SCR-68	Galgiani. California Invasive Species Action Week.	Declares the California Invasive Species Action Week. No funding provisions.	Chaptered by Secretary of State. Res. Chapter 144, Statutes of 2015, 8/26/15	https://leginfo.ca.gov/faces/billTextClient.xhtml?bill_id=201520160SCR68&
AB-2800	Quirk. Climate change: infrastructure planning.	Asks CNRA to establish the Climate-Safe Infrastructure Working Group. No funding provisions. Work supported by departmental appropriations.	Chaptered by Secretary of State - Chapter 580, Statutes of 2016, 9/24/16	https://leginfo.ca.gov/faces/billTextClient.xhtml?bill_id=201520160AB2800
AB-2139	Williams. Ocean Protection Council: ocean acidification and hypoxia.	Subject to the availability of funding, the council may develop an ocean acidification and hypoxia science task force to ensure that decision-making is supported by the best available science. Subject to available funding, that Task Force is charged with implementing measures to adapt in the oceans.	Chaptered by Secretary of State - Chapter 352, Statutes of 2016. 9/14/16	https://leginfo.ca.gov/faces/billTextClient.xhtml?bill_id=201520160AB2139
SB-1386	Wolk. Resource conservation: working and natural lands. Would declare it to be the policy of the state that protection and management of natural and working lands is an important strategy in meeting the state's greenhouse gas reduction goals, and would require all state agencies, departments, boards, and commissions to consider this policy when revising, adopting, or establishing policies, regulations, expenditures, or grant criteria relating to the protection and management of natural and working lands.	Acknowledges that the protection and management of natural and working lands provides multiple public benefits, including, but not limited to, assisting with adaptation to the impacts of climate change. No funding provisions.	Chaptered by Secretary of State. Chapter 545, Statutes of 2016; 9/23/16	https://leginfo.ca.gov/faces/billTextClient.xhtml?bill_id=201520160SB1386

SB-974	Committee on Governance and Finance. Local government: omnibus.	Existing law establishes the city clerk as responsible for fiscal accounting. Existing law also authorizes the legislative body of a local agency having money in a sinking fund or money in its treasury not required for immediate needs to invest any portion of the money that it deems wise or expedient in specified securities and financial instruments. Existing law requires that certain of these instruments be rated at least "A" or "AA," as applicable, by a nationally recognized statistical rating organization (NRSRO). This bill would specify that these instruments must be in a ratings category of at least "A" or "AA," as applicable, or its equivalent. This bill would also require a planning agency to review and revise the safety element to identify new information, as described above, only to address flooding and fires (and how these are affected by climate change)	Chaptered by Secretary of State. Chapter 366, Statutes of 2016. 9/14/16	https://leginfo.legislature.ca.gov/faces/billTextClient.xhtml?bill_id=201520160SB974
AB-498	Levine. Wildlife conservation: wildlife corridors. would declare that it is the policy of the state to encourage, wherever feasible and practicable, voluntary steps to protect the functioning of wildlife corridors through various means, as applicable.	Declares the intend of the Legislature that the Wildlife Conservation Board use various funds to work with the department to complete a statewide analysis of wildlife corridors and connectivity to support conservation planning and climate change adaptation activities.	Chaptered by Secretary of State - Chapter 625, Statutes of 2015. 10/8/15	https://leginfo.legislature.ca.gov/faces/billTextClient.xhtml?bill_id=201520160AB498

SB-859	Committee on Budget and Fiscal Review. Public resources: greenhouse gas emissions and biomass.	Asks the Secretary of CNRA to convene a nine-member Scientific Advisory Panel on Environmental Farming; one of whom must have expertise in adaptation in agriculture. In addition, ensures that some money from the Greenhouse Gas Reduction Fund can be used - particularly for disadvantaged and severely underserved communities - for a variety of multi-benefits projects, including resiliency building and climate adaptation. ("Moneys from the Greenhouse Gas Reduction Fund, created pursuant to Section 16428.8, shall be available, upon appropriation by the Legislature, for allocation by the secretary pursuant to this section. ... The secretary shall allocate at least 75 percent of the moneys available for the purposes of this section to projects that are located in, and that provide benefits to, disadvantaged communities."); also specifies that moneys appropriated the DFW should be used to support - among other things - wildlife adaptation.	Chaptered by Secretary of State. Chapter 368, Statutes of 2016. 9/14/16	https://leginfo.ca.gov/faces/billTextClient.xhtml?bill_id=201520160SB859
AB-197	Garcia. State Air Resources Board: greenhouse gases: regulations.	No funding provisions. But notes that the cost of adaptation enters into calculations of the social cost of carbon: SEC. 3. Section 38506 is added to the Health and Safety Code, to read: 38506. For purposes of this division, "social costs" means an estimate of the economic damages, including, but not limited to, changes in net agricultural productivity; impacts to public health; climate adaptation impacts, such as property damages from increased flood risk; and changes in energy system costs, per metric ton of greenhouse gas emission per year.	Chaptered by Secretary of State - Chapter 250, Statutes of 2016. 9/8/16	https://leginfo.ca.gov/faces/billTextClient.xhtml?bill_id=201520160AB197

AB-92	Committee on Budget. Water.	<p>Natural Resources code amendment asks the DFW to make grant available to local communities to foster adaptation on forested land; Water code amendments: (a) (1) 5 million for a pilot project for local agencies to provide water efficiency upgrades to eligible residents at no upfront cost.</p> <p>(2) 5 million dollars for local agencies to provide low-interest loans to customers to finance the installation of onsite improvements to repair or replace, as necessary, cracked or leaking water pipes to conserve water.</p> <p>(b) The department may implement this section by providing to a local agency a zero-interest loan of up to 3 million dollars</p> <p>(c) A local agency that receives a loan pursuant to this section shall exercise reasonable efforts to recover the costs of the loan. However, the department may waive up to 10 percent of the repayment amount for costs that could not be recovered by the local agency.</p> <p>(d) The department and a local agency that is an urban retail water supplier and that receives a loan pursuant to this section may enter into a mutually agreeable schedule for making loan repayments into the CalConserve Water Use Efficiency Revolving Fund.</p>	Chaptered by Secretary of State - Chapter 2, Statutes of 2015. 4/2/15	https://leginfo.ca.gov/faces/billTextClient.xhtml?bill_id=201520160AB92
AB-2087	Levine. Regional conservation investment strategies.	Directs DFW to develop regional conservation investment strategies that can serve as mitigation credit areas. Allows DFW to raise funds from mitigation credit applications. But exempts the use of mitigation fees for any Delta-related expenses	Chaptered by Secretary of State - Chapter 455, Statutes of 2016. 9/22/16	https://leginfo.ca.gov/faces/billTextClient.xhtml?bill_id=201520160AB2087

SB-839	Committee on Budget and Fiscal Review. Public resources	Enables the DFW to use funds to provide grants to local communities for - among other things - adaptation on forested land.	Chaptered by Secretary of State. Chapter 340, Statutes of 2016. 9/13/16	https://leginfo.ca.gov/faces/billTextClient.xhtml?bill_id=201520160SB839
AB-93	Weber. Budget Act of 2015. bill would make appropriations for the support of state government for the 2015–16 fiscal year.	Asks DWR in using Disaster Preparedness and Flood Prevention Bond Fund of 2006, to give special attention, among other things, to flood protection and climate change adaptation	Chaptered by Secretary of State - Chapter 10, Statutes of 2015. 6/24/15. 01/15/16 Consideration of Governor's item veto stricken from file. 06/24/15 Consideration of Governor's item veto pending.	https://leginfo.ca.gov/faces/billTextClient.xhtml?bill_id=201520160AB93
2013-2014				
ACR-160	Gordon. Sea level rise. would encourage state agencies to communicate with the public, local, regional, and federal agencies and nonprofit organizations and businesses regarding the risks of sea level rise and the development and implementation of adaptive and protective measures to address those risks, and other impacts of climate change. This measure would encourage the Ocean Protection Council to work with the California Coastal Zone Management Agencies, the State Lands Commission, other state agencies, and nonstate partners to consider establishing goals and planning principles to help prepare the state's shoreline and coastal	A resolution to encourage state agencies to consider establishing coastal climate adaptation goals and planning principles and do more public outreach around coastal risks; no funding provisions.	Chaptered by Secretary of State - Res. Chapter 146, Statutes of 2014. 9/2/14	https://leginfo.ca.gov/faces/billTextClient.xhtml?bill_id=201320140ACR160&

	community for the impacts of climate change, incl. sea level rise.			
SJR-20	Leno. Safeguard Our Coast Day. This measure would recognize the 50th anniversary of the state's leadership and innovation in coastal planning and management and would proclaim February 16, 2015, and each 3rd Monday of February thereafter, as "Safeguard Our Coast Day."	No funding provision	Chaptered by Secretary of State. Res. Chapter 110, Statutes of 2014. 8/11/14	https://leginfo.ca.gov/faces/billTextClient.xhtml?bill_id=201320140SJR20
AB-2516	Gordon. Sea level rise planning: database. bill would require, Natl Resources Agency, in collaboration with the Ocean Protection Council, to create, update biannually, and post on an Internet Web site a Planning for Sea Level Rise Database describing steps being taken throughout the state to prepare for, and adapt to, SLR; would require various public agencies and private entities to provide to the agency SLR planning information, that is under the control or jurisdiction of the public agencies or private entities; would require agency to determine which information is necessary for inclusion in the database and to organize the database by geographic region and provide an entry for each city, county, and city and county	no special/extra funding provision (but CNRA contract to BECI enabled setting up of database)	Chaptered by Secretary of State - Chapter 522, Statutes of 2014. 9/21/14	https://leginfo.ca.gov/faces/billTextClient.xhtml?bill_id=201320140AB2516

	within the coastal zone and San Francisco Bay area.			
AB-691	Muratsuchi. State lands: granted trust lands: sea level rise.	Requires local trustees of public lands to prepare an assessment of the impacts of SLR on public trust land, including an "estimate of the financial cost of the impact of sea level rise on granted public trust lands"; does not allocate funds to prepare such assessments, but expects the assessment to be paid for solely from the revenues derived from the public trust lands and assets that are granted to that local agency by the state. Local trustees are exempt from this law if their land does not generate sufficient revenue to cover the cost	Chaptered by Secretary of State - Chapter 592, Statutes of 2013. 10/5/13	https://leginfo.ca.gov/faces/billTextClient.xhtml?bill_id=201320140AB691
SB-866	Wolk. Water Quality, Supply, and Infrastructure Improvement Act of 2014.	This bill would enact the Water Quality, Supply, and Infrastructure Improvement Act of 2014, which, if approved by the voters, would authorize the issuance of bonds in the amount of \$7,120,000,000 pursuant to the State General Obligation Bond Law to finance a water quality, supply, and infrastructure improvement program. This bill, upon voter approval, would reallocate \$425,000,000 of the unissued bonds authorized for the purposes of Propositions 1E, 13, 44, 50, 84, and 204 to finance the purposes of a water quality, supply, and infrastructure improvement program.	Active Bill - In Floor Process. 11/30/14 Consideration of Governors veto died on file. 08/14/14 in Senate. Consideration of Governor's item veto pending.	https://leginfo.ca.gov/faces/billTextClient.xhtml?bill_id=201320140SB866
AB-1471	Rendon. Water Quality, Supply, and Infrastructure Improvement Act of 2014.	This bill would enact the Water Quality, Supply, and Infrastructure Improvement Act of 2014, which, if approved by the voters, would authorize the issuance of bonds in the amount of \$7,120,000,000 pursuant to the State General Obligation Bond Law to finance a water quality, supply, and infrastructure improvement program. This bill, upon voter	Chaptered by Secretary of State - Chapter 188, Statutes of 2014. 8/13/14	https://leginfo.ca.gov/faces/billTextClient.xhtml?bill_id=201320140AB1471

		approval, would reallocate \$425,000,000 of the unissued bonds authorized for the purposes of Propositions 1E, 13, 44, 50, 84, and 204 to finance the purposes of a water quality, supply, and infrastructure improvement program.		
SB-861	Committee on Budget and Fiscal Review. Public resources: trailer bill.	Directs CNRA to promote implementation of the state adaptation strategy through grant programs that advance adaptation in the forestry sector; grants dependent on appropriations to the agency. Not further specified	Chaptered by Secretary of State. Chapter 35, Statutes of 2014. 6/20/14	https://leginfo.ca.gov/faces/billTextClient.xhtml?bill_id=201320140SB861
SJR-17	Corbett. Coastal resources: San Francisco Bay. This measure would declare the Legislature's endorsement of S. 97 and H.R. 3034, and would urge the United States Congress to enact the San Francisco Bay Restoration Act at the earliest possible time.	No funding provision	Chaptered by Secretary of State. Res. Chapter 76, Statutes of 2012. 8/6/12	https://leginfo.ca.gov/faces/billTextClient.xhtml?bill_id=201120120SJR17
AB-1492	Committee on Budget. Forest resource management.	Creates a 1% assessment on the sale of any timber products; resulting moneys can be used for forest adaptation projects	Chaptered by Secretary of State - Chapter 289, Statutes of 2012. 9/11/12	https://leginfo.ca.gov/faces/billTextClient.xhtml?bill_id=201120120AB1492
AJR-26	Chesbro. Climate change. This measure would request the Congress of the United States to establish a comprehensive framework, including dedicated funding, for adapting our nation's wildlife, habitats, coasts, watersheds, rivers, and other natural resources and ecosystems to the impacts of climate change.	No funding provision	Chaptered by Secretary of State - Res. Chapter 114, Statutes of 2010. 8/30/10	https://leginfo.ca.gov/faces/billTextClient.xhtml?bill_id=200920100AJR26&

AB-2376	Huffman. Fish and wildlife: strategic vision. bill would require the Secretary of the Natural Resources Agency to convene a committee, with membership as prescribed, to develop and submit a strategic vision for the department and the commission that addresses specified matters relating to state fish and wildlife resource management.	No funding provision	Chaptered by Secretary of State - Chapter 424, Statutes of 2010. 9/28/10	https://leginfo.ca.gov/faces/billTextClient.xhtml?bill_id=200920100AB2376
AB-2125	Ruskin. Coastal resources: marine spatial planning. Bill would, subject to the availability of funding, require the Ocean Protection Council, to support state agencies' use and sharing of scientific and geospatial information for coastal- and ocean-relevant decision-making, as specified ... The bill would authorize the council to award grants, enter into interagency agreements, and provide assistance to public agencies and nonprofit organizations to support the achievement of these goals and would require the council to give preference to public agencies that are meeting these goals.	Bill would authorize OPC to award grants to carry out tasks of the bill; but no new funding allocation	Chaptered by Secretary of State - Chapter 544, Statutes of 2010. 9/29/10	https://leginfo.ca.gov/faces/billTextClient.xhtml?bill_id=200920100AB2125
SBX7-2	Cogdill. Safe, Clean, and Reliable Drinking Water Supply Act of 2010. bill would enact the Safe, Clean, and Reliable Drinking Water Supply Act of 2010, which, if approved by the	Explicitly dedicates 10 million to CNRA for adaptation planning; and 100 million to DFFP for forest adaptation; and some portion of \$350 million for water adaptation efforts	Chaptered by Secretary of State. Chapter 3, Statutes of 2009-10 Seventh Extraordinary Session. 11/9/09	https://leginfo.ca.gov/faces/billTextClient.xhtml?bill_id=200920107SB2

voters, would authorize the issuance of bonds in the amount of \$11,140,000,000 pursuant to the State General Obligation Bond Law to finance a safe drinking water and water supply reliability program.			
--	--	--	--

Source: Compiled by Authors