

GROWING EFFORT, GROWING CHALLENGE: FINDINGS FROM THE 2016 CALIFORNIA COASTAL ADAPTATION NEEDS ASSESSMENT

A Report for:

California's Fourth Climate Change Assessment

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DISCLAIMER

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We thank the hundreds of California coastal professionals who participated in our survey. Without them this report would not exist. We hope this report is informative to them and supports them as they confront the challenges of climate change on our coasts every day.

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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 the state of adaptation in the coastal sector, including drivers and barriers to adaptation with a particular focus on information, technical assistance, and other support needs.

ABSTRACT

The third coastal adaptation needs assessment, administered in 2016, provides a snapshot of the current state of coastal adaptation in California, and constitutes a longitudinal assessment of the changing needs of coastal professionals since 2006. The only comprehensive, longitudinal assessment of adaptation in the country, the study aimed to (1) understand the state and context of coastal adaptation and understand how to move it forward; (2) identify information, training, technical assistance, financial, and other support needs; and in so doing, (3) assess what difference past technical and financial assistance have made in advancing coastal adaptation. An extensive survey instrument was administered in the summer and fall of 2016. The target populations were local, regional, state, federal, private sector, and NGO professionals involved in coastal management and adaptation (total survey population was more than 2,700). The response rate and survey population are very similar to the previous survey population engaged in 2011, enabling a statewide comparison. Results are summarized in four parts: (1) current coastal management challenges; (2) attitudes toward climate change and adaptation motivations, actions, barriers, expenditures and needs; (3) information, technical support, and training needs to further advance adaptation; and (4) demographics of the survey participants. Moreover, in most instances the results are analyzed by different respondent groups and by region. The overarching finding is that sea-level rise has become the leading present-day coastal management concern and coastal adaptation is further advanced now compared to 2011 across California, but coastal professionals continue to face significant hurdles in moving from understanding coastal risks to planning and implementing actions.

Keywords: coastal management, adaptation, climate change, sea-level rise, needs assessment

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HIGHLIGHTS

Highlights are provided in two categories: (1) overarching findings for all of coastal California and (2) notable regional differences in survey findings.

Overarching findings for coastal California

- Sea-level rise has emerged as the dominant present-day coastal management concern (along with coastal flooding and erosion) across California. This is a notable shift among all types of survey respondents compared to 2011 survey results, when sea-level rise was mostly seen as a future coastal management challenge.
- Coastal adaptation is further advanced now compared to 2011 across California, but coastal professionals continue to face significant hurdles in moving from understanding coastal risks to planning and implementing actions. While the leading barriers are the same as in 2011 (lack of funding, limited staff capacity, and other pressing issues competing for coastal managers' attention), 8 (or 42%) of 19 barriers are now rated as bigger hurdles than they were rated in 2011.
- The biggest hurdle is lack of funding for implementation of adaptation actions. While this is unchanged from 2011, the 2016 survey – for the first time – quantified past adaptation expenditures and future funding needs. Findings suggest that expected coastal adaptation funding needs for implementation over the next five years are several orders of magnitude greater than expenditures to date.
- Coastal managers – generally a highly educated group of professionals – feel better informed about climate change risks now than in 2011. Formal training in adaptation, however, remains extremely limited among respondents; they have largely learned about adaptation “on the job” and the need for trainings persists.
- Technical assistance and investment in actionable scientific information have paid off in coastal California. “Lack of technical assistance” and “lack of access to relevant information and data” is now perceived as less of a hurdle to adaptation than it was in 2011. Moreover, there is a notable shift in information needs: while coastal professionals' dominant information needs focused on becoming more familiar with sea-level rise-related coastal risks in 2011, the greatest needs now concern solution options and how to implement them (e.g., costs, trade-offs).
- Equity and justice – a new aspect in the 2016 survey in response to state-level policy direction – is one of many motivations to begin adaptation; data on social equity are also of interest to coastal professionals now.

Regionally differentiated findings

- *Currently, pressing coastal management concerns* vary across coastal regions, with sea-level change ranking highest in Northern California and the Bay Area; coastal and shoreline erosion being of greatest concern along the Central and San Diego coasts; and

water quality concerns being seen as the greatest current challenge in Southern California.

- While most respondents felt the *severity of these challenges* had increased over the past five years, the severity of the most pressing current management challenge was perceived to have increased the most in Northern California (where 93% of respondents saw an increase), followed by respondents in San Diego (where more than 71% of respondents felt their top management concern had increased in severity).
- Southern California and Bay Area respondents indicated that they are *furthest along with coastal adaptation* (in the planning or implementation stage), while Central and Northern California respondents are still mostly in the early stage (either not begun or just beginning to assess the risks). San Diego falls in the middle of the range.
- As for regional differences in the *barriers to adaptation*, the top four barriers seen at the state level are also closely reflected regionally, with lack of funding for implementation of adaptation options being the top barrier in all regions except in San Diego, where lack of staff capacity ranks at the top. Lack of leadership from elected officials ranks among the top five biggest hurdles in San Diego and Northern California, whereas lack of public demand to launch adaptation planning figures highly in Southern California and lack of technical assistance is among the top five barriers for respondents in the Bay/Delta Region and Northern California.
- As for *information needs*, Northern California counties are distinguishable from all the other counties in their interest in changes in tidal range and changes in groundwater elevation, which were identified by >80% as "very useful" information. Similarly, information about the spread of invasive species was classified as "very useful" in the north (~70%) but ranged last or second to last in all other counties.
- All the regions need more formal *training on climate adaptation*. The San Diego region was the only region to have more of its respondents indicate that they had received some sort of formal training, only slightly ahead of other regions. In the Northern and Central coast counties, a majority of respondents indicated that they had not received any formal training (72% and 60% respectively).
- In *summary*, while regional representation in the survey was uneven (reflecting limits in existing lists of coastal professionals to whom the survey could be distributed), the emerging picture from all responses suggests that the urbanized areas are farther along with adaptation. Thus, relatively greater attention needs to be given in the future to the less densely populated, rural coastal regions with additional technical assistance and other support (trainings, outreach, backing of political leaders etc.). Such unevenness in capacity can magnify the challenges that all regions report, namely a lack of funding for planning and implementation and staff capacity constraints in light of other concurrent pressing issues.

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1: Introduction

The latest California Coastal Adaptation Needs Assessment survey presented here is the third in a series of coastal surveys conducted in California since 2006 (Moser and Tribbia 2006/2007; Tribbia and Moser 2008; Finzi Hart et al. 2012). To the best of our knowledge, it is the only longitudinal study of this kind anywhere in the US and provides critical insights into the changing coastal adaptation landscape in the state. Feedback from state and federal agency users to the research team suggests that the 2011 survey results in particular motivated state investment in coastal adaptation and also informed adaptation service providers' technical assistance offerings to coastal stakeholders. To continue to track the state of adaptation in coastal California and inform such critical decisions, we have committed to regularly examine progress and related changing adaptation needs.

Below, we first place our study in both the policy and research context (Sections 1.2 and 1.3) and provide details on the methodology (Section 2). In Section 3 we describe the 2016 survey respondent population to establish to what extent it is comparable to the 2011 survey population. Sections 4, 5, and 6 then present the findings of the 2016 study, focusing on current coastal management challenges, coastal adaptation, and information and support needs, respectively. We conclude in Section 7 with a number of recommendations for future research and action.

1.1 Context and Motivation

Over the past ten years, adaptation has risen in prominence on the policy agenda in California – both at the state level and locally. Since Governor Schwarzenegger's first adaptation-related Executive Order (S-3-05)¹ in 2005, which demanded that California state agencies “report on mitigation and adaptation plans to combat [the] impacts” of climate change, much has happened in adaptation policy. In 2007, the California Natural Resources Agency initiated adaptation planning; a year later, an Executive Order (S-13-08) directed state agencies specifically to plan for sea-level rise and climate change impacts; and in 2009, the State released its first statewide adaptation strategy (CNRA 2009). That strategy focused mostly on what state agencies could do to prepare for the impacts of climate change.

Over the course of Governor Brown's two terms in office, adaptation has gained in prominence, driven in part by the recognition that mitigation alone will not suffice to minimize the climate change risks Californians will be facing. To that end, Governor Brown has directed state agencies to take climate change impacts into account in all their planning and long-term investment decisions (Executive Order B-30-15). Adaptation policy advances were also driven by the emergence of climate change impacts and extreme events all across California, ranging from extreme downpours and tidal flooding, long-term drought and unprecedented wildfires, seasonal temperature shifts and heat extremes affecting human health, agriculture, and infrastructure. These events and disruptions from climatic extremes underline the urgency and imperative to prepare for and manage growing climate risks. As a result, the State now pursues

¹ All relevant executive Orders mentioned here can be found at: http://www.climatechange.ca.gov/state/executive_orders.html.

a three-pronged approach to climate action, including ever-more ambitious mitigation policy, adaptation policy, and research to support both.²

State legislation over the past few years has further advanced adaptation policy, maybe most significantly by mandating that local governments account for climate change impacts when updating their general plans and hazard mitigation plans (SB-379)³, as well as for environmental justice (SB-1000).⁴ The Office of Planning and Research (OPR) has released an initial Adaptation Planning Guide (California Emergency Management Agency 2012) on how to do so, and is also in the process of updating its guidance for general plan updates. In addition, OPR launched the Integrated Climate Adaptation and Resilience Program (ICARP)⁵, which creates a central adaptation clearinghouse (currently in beta version) and improves coordination between state and local governments' adaptation efforts.

More specifically in support of coastal adaptation, there have been a number of policy advances as well. The California Coastal Commission released guidance to local governments on how to integrate sea-level rise considerations when updating Local Coastal Programs (LCPs) (California Coastal Commission 2015), as well as guidance on how homeowners can adapt to growing coastal risks (draft guidance still in progress).⁶ Meanwhile, the California Ocean Protection Council (OPC) requested an update on sea-level rise science in 2017 (Griggs et al. 2017) to inform the update of its Sea-Level Rise Policy Guidance (OPC 2018).⁷ This guidance is aimed at both state and local governments.

In short, much has changed in the policy context in which coastal adaptation now takes place. In addition, scientific advances about future sea-level rise, and in particular the behavior of Earth's large ice sheets (Cayan 2018; see especially the Appendix in Griggs et al. 2017), have not necessarily added greater scientific certainty about the pace of sea-level rise, but they have raised the specter of potentially much more significant sea-level rise by 2100 than was previously believed to be possible.

The latest Coastal Adaptation Needs Assessment Survey aimed to find out how these contextual scientific and policy changes and the climate impacts Californians have experienced to date have translated into adaptation planning and implementation activities.

² The present report is an external contribution to California's Fourth Climate Change Assessment and did not receive state funding, but a number of state agencies contributed in-kind support to deploy the survey as widely as possible.

³ SB-379 (Jackson), see: https://leginfo.legislature.ca.gov/faces/billTextClient.xhtml?bill_id=201520160SB379.

⁴ SB-1000 (Levy), see: https://leginfo.legislature.ca.gov/faces/billTextClient.xhtml?bill_id=201520160SB1000.

⁵ For more information, see: <http://opr.ca.gov/clearinghouse/adaptation/>. The Program was established in response to SB-246 (Wieckowski), see: https://leginfo.legislature.ca.gov/faces/billTextClient.xhtml?bill_id=201520160SB246.

⁶ To track progress on the Commission's residential adaptation guidance, see: <https://www.coastal.ca.gov/climate/slr/vulnerability-adaptation/residential/>.

⁷ To learn more about OPC's updated policy guidance, see: <http://www.opc.ca.gov/climate-change/updating-californias-sea-level-rise-guidance/>.

1.2 A Longitudinal Study of Coastal Adaptation Needs

Adaptation has long been recognized as an ongoing process without a real endpoint, at least as long as environmental conditions continue to change (Wise et al. 2014; Maru and Stafford Smith 2014; Haasnoot et al. 2014; Jacobson et al. 2014; IPCC-Response Strategy Working Group 1989). What is far less well understood is how the needs of coastal managers change as they progress along their adaptation pathways. In fact, most studies to date that have examined coastal managers' adaptation-related needs have been one-off studies⁸ (e.g., Bulla, Craig, and Steelman 2017; Kettle and Dow 2016; Lindeman et al. 2015; Hamin, Gurran, and Emlinger 2014; Frazier, Wood, and Yarnal 2010; Cone et al. 2008). Together, these studies have produced valuable insights into the locally-experienced challenges in making progress on adaptation, but they have not traced the changing experience with adaptation and related shifts in barriers, information needs, and other aspects of coastal management.

California is in the fortunate position to be able to trace these developments over time. In 2005, researchers from the National Center for Atmospheric Research (NCAR, Boulder, CO) with funding from the California Energy Commission's PIER Program (Moser and Tribbia 2006/2007; Tribbia and Moser 2008) conducted a first survey to assess California's coastal communities' level of preparedness for the unavoidable impacts of climate change. While directed only at local government officials, it revealed important insights about "coastal managers' perceptions of current coastal management challenges and the added risks from climate change, their perceived vulnerability to the growing coastal problems, and the extent to which they were beginning to think about and tackle these increasingly difficult management challenges" (Finzi Hart et al. 2012, p.2).

A collaborative of 15 California-based coastal agencies and organizations came together five years later and produced a joint survey that replicated some of, but also expanded upon, the first coastal survey to better understand adaptation progress and barriers in coastal California. The survey was deployed in 2011 to a much-expanded survey population, including local, regional, state, and federal agency officials, as well as elected officials, NGOs, and private sector consultants active in coastal management, to obtain a more comprehensive picture of attitudes and needs. That survey also paid greater attention to the information and training needs of coastal professionals across the state so as to inform partner organizations support services (Finzi Hart et al. 2012).

The current survey, deployed in 2016, was supported by the same coalition of coastal organizations. It intentionally aimed to maintain comparability to the 2011 survey to enable longitudinal comparison and made three minor changes in contents:

- (a) It clarified questions that were reported to be unclear (insights volunteered by previous survey participants or collaborating organizations);
- (b) It added a small number of additional questions that collaborating organizations wished to gain insights on; and

⁸ Our review here is focused primarily on the US, but the situation is rather similar outside the US.

- (c) It dropped a small number of questions that collaborating organizations felt were no longer of interest or made no sense in light of the current policy context.

The results presented here now cover a decade of change in coastal California, providing a unique window into how attitudes toward climate change and adaptation change, how experience with adaptation evolves over time, and how related support needs change – or stay the same. Because of the greater consistency and comparability between the 2011 and 2016 surveys, we focus our presentation of results here on these two anchor points in time. However, a comparison of results of the first survey to the latter two reveals a clear trajectory of increasing adaptation activity.

2: Survey Methodology

2.1 Target Population

The survey was sent to 2,705 coastal professionals working along California’s open ocean, bay, delta, and estuarine coastlines. “Coastal professionals” were defined in an identical manner to how they were defined in 2011, namely as individuals involved in California coastal resource management, conservation, and protection from coastal hazards.⁹ Thus, the professionals approached included planners, resource managers, public works engineers, transportation managers, emergency response managers, public health officials, harbor managers, port commissioners, and elected officials, as well as representatives of environmental organizations working on coastal issues, private-sector consultancies, and officials at farm bureaus. Public sector respondents were drawn from the local, regional, state, and federal levels.

To generate the list of coastal professionals utilized for the 2016 survey, the project leads first tested and updated the 2011 list of coastal professionals with the help of collaborating partners. This list was then combined with additional regional stakeholder lists provided by the partner organizations.

2.2 Survey Design

The survey design was left largely unchanged from the 2011 survey. Its major sections focused on (1) current coastal management challenges, (2) attitudes about climate change and progress on adaptation, (3) information and training needs, and (4) demographics. After a screening question early on (distinguishing elected from non-elected officials), elected officials answered 50 questions and non-elected respondents (state/federal/regional, NGO representatives, consultants, and city/county government) answered 62, 65, 65 and 67 questions, respectively.

The section on current coastal management challenges aimed to characterize the context in which California coastal professionals currently work, including the geographic, socioeconomic, environmental, and political contexts. The section on climate change and adaptation (the largest

⁹ We predominantly use “coastal professional” in the remainder of the report, and occasionally alternate to “coastal manager”, “coastal practitioner”, or “coastal decision maker.” The latter may have narrower meanings than “coastal professional” and are used in specific contexts.

section of the survey) examined general attitudes toward climate change, the relative priority that adaptation is receiving compared to greenhouse gas mitigation, motivations for and barriers to adaptation, adaptation funding challenges, and familiarity and acceptability of different adaptation options. The information and training needs section aimed to understand what type of information coastal professionals already use and what more they might need to address the coastal management and adaptation challenges they face. It also sought to understand what adaptation-focused trainings coastal professionals had already received and would be interested in. Finally, the demographics section asked about respondents' professional position, affiliation and educational background, age, gender, and geographic location so as to allow us to characterize the respondent population and explore the geographic representativeness of the survey sample. Appendix A provides the exact wording of each of the questions, along with overview graphics of the responses received.

2.3 Survey Response and Completion Rate

Of the 2,705 coastal professionals approached, 698 responded to the survey invitation, yielding a survey response rate of 25.8 percent.¹⁰ This was an increase of 104 respondents and a 1% increase in the response rate compared to the 2011 survey. The slight increase in response rate was unexpected and counters downward trends in commonly-observed survey response rates since the 1950s (Cook, Heath, and Thompson 2000). It is consistent, however, with response rates achieved for online surveys (Nulty 2008; Holbrook, Krosnick, and Pfent 2007) and generally accepted standards for adequacy. Respondents received no incentives but were sent eight follow-up reminders to complete the survey. Still, it is possible – as in all surveys – that respondents more interested in the topic self-selected to offer their opinions. However, the cover note did not highlight climate change, sea-level rise, or adaptation, but spoke more generally about coastal management challenges. Respondents, on average, had a completion rate of 79% of the survey, i.e., they answered on average 79% of the questions. We consider both the response and completion rate as very good considering the length and scope of the survey (45-60 minutes to complete the full survey).

While the 2,705 contacts included nearly all of the same coastal professionals approached in 2011 (exceptions were those known to have left their positions in coastal management in California), the anonymity of the responses do not allow us to trace one-to-one changes in responses. Thus, the survey population can only be characterized as a block, and results denote any changes in attitude or opinion described for the survey population as a whole or for regional sub-populations.

2.4 Survey Analysis

For the purposes of this report, we focused our analysis on a simple first-order statistical analysis and a comparison of descriptive summary statistics from the 2016 and 2011 surveys. Where we make explicit statements about changes between 2011 and 2016, and the questions asked in 2011 and 2016 are identical or nearly identical, we also conduct tests of statistical significance (2-tailed Independent Samples t-test). Future survey analyses will examine more complex interactions among variables (correlations and causal links).

¹⁰ Percentages throughout the text are rounded to the nearest full number.

3: The Survey Population

Survey participants were asked to answer several demographic questions at the end of the survey. We present these results first to characterize the respondent population, and to establish whether or not the survey populations from 2011 and 2016 are comparable.

3.1 Respondent Types, Professions, Gender and Age

As Table 1 (and Figure A-2¹¹) indicate, the 2016 results are dominated by responses from local and state-level coastal professionals, followed by NGO representatives. Seven percent of respondents self-identified as representing the academic sector, identifying this affiliation through a write-in option in the “other” category. This sector was not specifically identified in the 2011 survey. Given a very limited list of tribal contacts to which the survey was sent, the lack of responses from individuals representing the tribal communities in California is not surprising but must be remedied in future surveys.

Table 1: Comparison of Survey Invitees and Survey Respondents by Affiliation Type of Respondent

Sector	Percent Invited (n=2,705)	Percent Responded (n=698)
Municipal/City Government	41%	26%
State Government	12%	20%
Non-Governmental Organization	5%	12%
County Government	17%	9%
Federal Government	8%	9%
Regional District or Association	4%	7%
Academia	4%	7%
Private Industry	1%	5%
Environmental Consultant	4%	5%
Tribal Nation	<1%	0%
Other	2%	<1%

Source: Authors' calculations

The vast majority of respondents (96%) are not elected officials (Figure A-1). Most of these respondents self-identify as planners (28%) or environmental specialists (16%), with a wide range of other professional groups represented (Table 2 and Figure A-4). Seven percent of

¹¹ We use the following naming convention throughout this report: Figures and tables in the body of the report are followed by simple numbers (e.g., Figure 1, Table 1). Figures and tables referenced from the appendix are followed by A.[number] (e.g., Figure A.1, Table A.1).

respondents indicated that they hold leadership or executive roles within their respective organizations, a category or group not specifically identified in the 2011 survey. The majority of respondents (56%) have worked for their employers for over 10 years, with 63% of respondents having held their current positions for more than 6 years and 38% for more than 10 years (Figure A-5 and A-6). The 2016 respondents are nearly evenly distributed by gender (Figure A-8), which constitutes a statistically significant increase in female survey respondents compared to 2011, when only 38% of respondents were female (Independent Samples T-test, $p < 0.05$). The majority (60%) range in age from 45 – 64 years of age (Figure A-7). Ninety-nine percent of respondents have at least bachelor’s degrees, with 70% having higher graduate or professional degrees (Figure A-9). Together, these demographics suggest a group of survey respondents that is highly educated and relatively senior in experience and positions.

Table 2: Professions/Job Titles of 2016 Survey Participants

Type of Position	Percentage (n=411)
Planner	28%
Environmental Specialist	16%
Other ¹²	16%
Wildlife/Natural Resources Manager	9%
Leadership/Executive	7%
Public Works Engineer	5%
Academic	3%
Water Resources Manager	3%
Other, Engineer	3%
Multiple Responsibilities	3%
Harbor, Parks, or Beach Manager	2%
Community Development Coordinator	2%
Emergency Services Manager	1%
Educator	1%
Flood District Manager	1%

¹² Other types of positions included: architect, landscape architect, communications specialist, public information officer, legislative aide and technical consultant.

Permitting Officer	1%
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Source: Authors' calculations

To better understand the educational (disciplinary) background of professionals currently in or entering the coastal management field in California, we included a new question in the 2016 survey. The question was open-ended so respondents could self-identify their respective disciplines of study and professional training. While we did not specify undergraduate or graduate studies, some respondents provided multiple answers and some focused on the highest level of education. Planning and biology were identified as the top fields of study (both with 18%), followed by engineering (15%), environmental studies (11%), environmental science (8%), and geography and ecology (7% each) (Figure A-10). This indicates a workforce that has strong background in planning, science and/or engineering. By contrast, the social sciences, law, and business are less frequently encountered in coastal professionals' educational background.

3.2 Geographic Distribution

Respondents were also asked to give an indication of their geographic location, given that the range of coastal management challenges and approaches to managing coastal climate change risks in California varies across different geographic environments. The state is home to more than 1,100 miles of open ocean coastline, approximately 1,000 miles of shoreline along San Francisco Bay, and hundreds more miles of embayments. It was therefore important to determine whether the survey respondents adequately represented California's 23 coastal, bay, and delta counties.

Respondents were asked to select the California county or counties where they focus their work. Forty-six percent indicated that they work in California's five southern coastal counties (Santa Barbara, Ventura, Los Angeles, Orange and San Diego). San Diego County, which is considered a distinct region in California's Fourth Climate Change Assessment, represented 12% of all respondents. Thirty-five percent selected the 12 counties that make up the Bay Area (Santa Clara, Alameda, San Mateo, Contra Costa, San Francisco, Marin, Napa.¹³ Southern California and the Bay Area comprise the largest urban centers in the state. Less than 1% of respondents represented the state's Delta region (Sacramento, Solano, San Joaquin and Sonoma). The remaining responses include: 8% in Central Coast counties (San Luis Obispo, Monterey, San Benito and Santa Cruz), and 5% in northern counties (Del Norte, Humboldt, Mendocino). Four percent indicated they work statewide, and 1% of respondents preferred not to answer (Figure A-11). Overall, the survey adequately represents the different coastal regions of the state (except for the Delta and Northern California coastal regions), with urban areas most strongly represented.

Comparing the respondent populations from 2016 and 2011, the responses are similarly dominated by the urban centers in the state; however, we had slightly better representation in 2011 from the more rural coastal areas.

¹³ San Mateo, San Francisco, Marin Counties in the Bay Area and Sonoma County included in the Delta Region have both open ocean coastlines and a Bay shoreline.

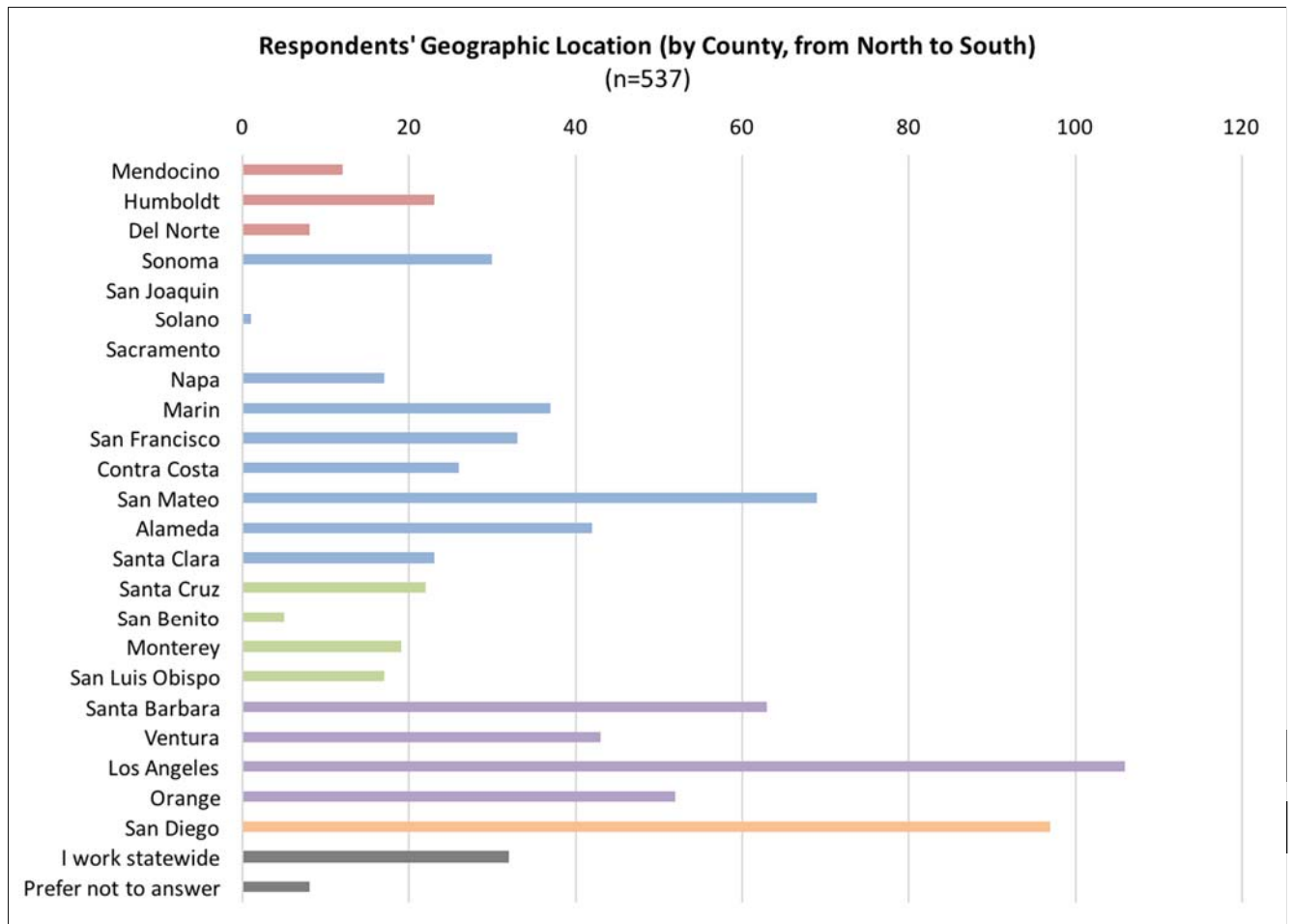
Table 3: Comparison of Geographic Representation in the 2016 and 2011 Surveys

	2016 Survey (n=537)	2011 Survey (n=424)
Southern	46%	42%
Central	5%	11%
Bay/Delta*	38%	36%
Northern	5%	11%
Statewide**	4%	N/A
Prefer not to answer	1%	N/A

Source: Authors' calculations

* The 2011 survey included Santa Cruz County in the Bay Area/Delta region. For the purpose of comparison, this table includes Santa Cruz in Bay Area/Delta; however, in the overall breakdown, we recognize that Santa Cruz County is a Central Region county. Note also that the Delta region is separated out in the Fourth Assessment, but for comparability, we show them here integrated with the Bay area, as it was handled in 2011.

** The 2011 survey did not ask this question of respondents working statewide.



Source: The Authors

Figure 1: Geographic Distribution of 2016 Survey Respondents by Coastal County

3.3 Conclusions

In summary, there are some, but no major deviations from the 2011 survey. Both were dominated by local and state government officials but had a similarly wide range of types of respondents. The greater female representation in 2016 compared to 2011 is notable but cannot be explained based on the information obtained in the survey. We hypothesize that this may reflect the strong presence of women in the adaptation/resilience field as a whole but would require further investigation to explain with certainty.

Overall, we are reasonably certain that based on the type of respondents, geographic representation of respondents, and positions of respondents, the two surveys are comparable. Because multiple additional types of professions/positions were offered in 2016 compared to 2011, a test of statistical significance could not be conducted. Based on this basic characterization of the respondent population, we now turn to the substantive results of this survey.

4: California Coastal Communities and Their Current Coastal Management Challenges

The first major substantive section of the survey was – as in 2011 – about current coastal management challenges in California. It aimed to characterize the coastal communities represented by the survey population and to understand how the coastal management challenges faced at present have or have not changed over time. These results provide insights into coastal management trends and contextualize efforts in coastal adaptation, which we discuss in Section 5.

4.1 Profile of California Coastal Communities

4.1.1 Economic and Demographic Characteristics

To set the stage for current coastal management challenges, survey respondents were asked to identify the population and the economic characteristics of the community, as well as what infrastructure, assets, and resources are located along their stretch of the coast (see Appendix A, Part 2). The majority of respondents represent urbanized regions, such as Southern California, San Diego, and the Bay/Delta region (Figure A-11), and also represent diverse communities of different sizes (Table 4 and Figure A-12). Sixty-eight percent of statewide respondents describe the economic base of their community as an *urban/mixed-economy* and 57% as *tourism / beach and recreational destinations* (Figure A-13). Although representation of *urban/mixed-economy* increased significantly from 2011 (by 42%) in the 2016 survey, having a *tourism / beach / recreation destination economy* was ranked high in both surveys.

Table 4: Comparison of Approximate Size of the Population of the Community Served by Respondents in the 2016 and 2011 Surveys

Total Population	2016 Survey (n=242)	2011 Survey (n=242)
< 10,000	7%	6%
10,000-49,999	27%	29%
50,000-99,999	16%	20%
100,000-499,999	25%	24%
500,000-999,999	7%	5%
>1,000,000	17%	16%

Source: Authors' calculations

The community size distribution in 2016 is similar to the 2011 results, although there is a slight increase in representation from larger cities in the 2016 study.

4.1.2 Coastal Development Pressures

We also asked respondents to characterize the amount of development and redevelopment they experienced at present. A plurality of respondents indicated that they currently experience *significant* development (29%) and redevelopment (31%) pressures within their municipal boundaries. That pressure is perceived to be more significant in 2016 than in 2011, where the majority indicated that they experience only *moderate* re-/development pressure (this finding is highly statistically significant; Independent Samples T-test, $p < 0.001$ for both development and redevelopment pressure). We hypothesize that this may reflect the economic situation in 2011 (a time when California and the nation were still in recovery from the 2007/08 housing-driven Great Recession) compared to the situation in 2016, when the economy is generally in better condition now. Most of the observed development is occurring *elsewhere within municipal boundaries* (55% for elected and 56% for city and county respondents), rather than in *immediate shorefront areas* (27% for elected and 39% for city and county respondents) (Figures A-15 and A-16).

4.1.3 Exposure of Sensitive Coastal Assets

When we asked respondents about the types of sensitive assets located in the immediate shoreline areas (such as infrastructure, development, and natural habitats), we found responses to reflect both ongoing development pressures and 40 years of efforts in protecting the natural beauty of coastal California (Table 5). Five of the top ten assets are natural areas, while the other five include various types of infrastructure, residential areas and fishing facilities.

Table 5: Predominant Types of Sensitive Infrastructure, Development, or Habitats Located in the Immediate Shorefront Areas

Type of Asset	Percent (n=599)
Wetlands (seasonal, restored or protected)	46%
Highways and roads	43%
Pristine or recreational beaches	37%
Endangered species habitat	31%
Residential buildings	31%
Storm-/wastewater infrastructure	30%
Open space and parks for recreation	28%
Public access facilities	25%
Marinas /recreational fishing facilities (e.g. piers)	21%
Water supply/treatment structures	19%
Levees/flood protection structures	17%

Commercial enterprises/businesses	16%
Port facilities	15%
Rail infrastructure	13%
Surf break	11%
Airport	10%
Power plant/energy utility	9%
Historic/cultural site or preserve	8%
Military installation	7%
Critical community services (e.g., schools, emergency response facilities, government buildings)	6%
Contaminated sites	6%
High-rise residential or tourist development	6%
Industrial facilities	5%
Commercial fishing facilities	4%
Other	2%
Agriculture	1%
None	1%
Cemeteries	0%

Source: Authors' calculations

As with the 2011 results, these findings paint a picture of a complicated coastal landscape with many competing uses and resources. While some important community lifelines such as *transportation* and *water infrastructure* are often found in the immediate shorefront, *critical community services* such as schools, emergency response facilities, and government buildings and *power plants/energy utility services* are not commonly located in the coastal zone (Figure A-14). This complex picture sets the stage for understanding the current management challenges coastal professionals face at the time of this survey. For example, it hints at the many local, regional, state, and federal agencies involved in managing the coastal landscape, and the need for coordination to appropriately manage these assets. The various land uses in the immediate shorefront also hint at the potential for conflicts and inherent differences in approaches that agencies might face in protecting these assets.

4.2 Coastal Management Challenges at Present

Coastal professionals work on a wide variety of coastal management challenges, not just climate adaptation. We had inquired about these challenges in 2011 to better understand what level of priority adaptation held against the backdrop of the broader set of challenges coastal professionals face on a daily basis.

4.2.1 Most Pressing Coastal Management Issues

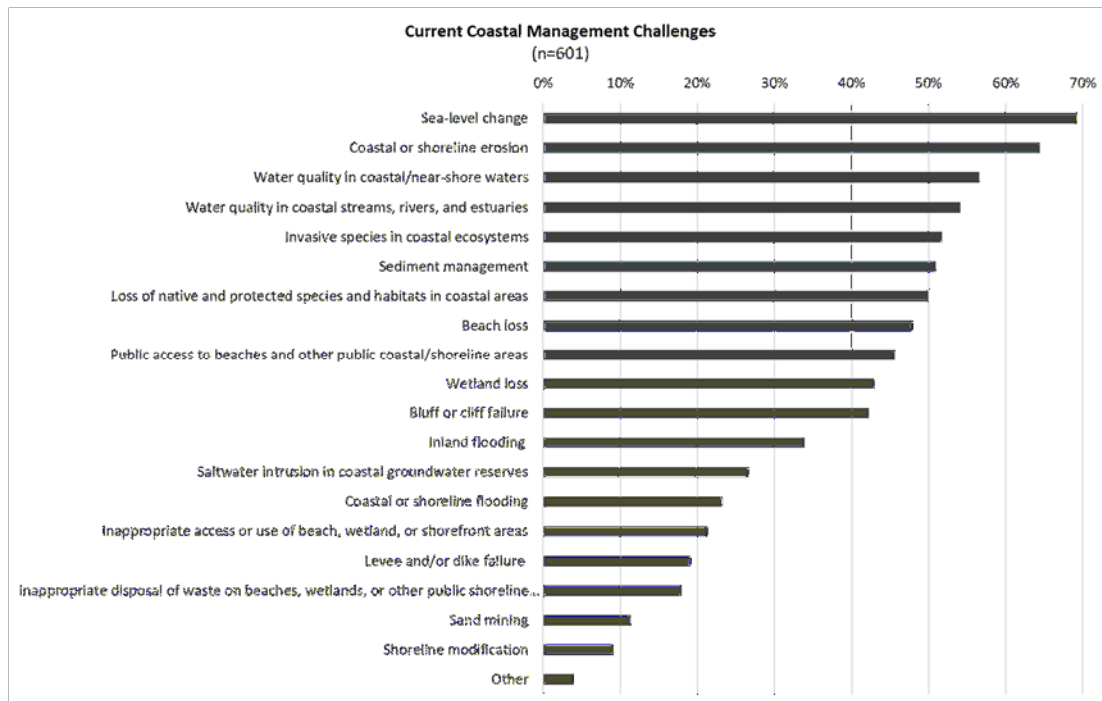
In 2016, we sought again to understand what coastal professionals perceived as the range of coastal management challenges (Figure A-17; all applicable challenges could be selected) as well as which of these they considered their most pressing coastal management challenges at the time of the survey (Figure A-18; up to five challenges could be selected and ranked by priority). The 2016 results show the following items as three most commonly mentioned management challenges: *sea-level rise*, *coastal/shoreline erosion*, and *water quality in coastal/near-shore waters* (chosen by 69%, 64% and 57% of respondents, respectively) (Figure 2). By contrast, in the 2011 survey *coastal/nearshore water quality*, *riverine and estuarine water quality*, and *too much sediment*¹⁴ were the three most commonly mentioned management challenges. Moreover, *sea-level rise* and *coastal/shoreline erosion* did not feature among the 10 most commonly mentioned current management challenges in 2011.¹⁵ The survey did not ask respondents to explain their selection.

We examined the observed shift for statistical significance in two different ways. A comparison of the weighted averages of the top five most pressing current management challenges clearly underscores the finding that *sea-level change* is now the most pressing issue, and the observed shift is statistically significant (Independent t-test, $p < 0.05$). The two *water quality* items remain among the top challenges by frequency of mention and by weighted average of priority, but we determined no statistically significant difference between the two years. *Coastal/shoreline erosion* also remains among the top five coastal management challenges by weighted average of priority but the shift between 2011 and 2016 is not statistically significant. In summary, these observations suggest sea-level rise and related adaptation challenges have moved from being perceived as future challenges to now constituting a present-day coastal management reality.

We also examined to what extent this perception differed across coastal regions. Currently, pressing coastal management concerns vary across coastal regions, with *sea-level change* ranking highest in Northern California and the Bay Area; *coastal and shoreline erosion* being of greatest concern along the Central and San Diego Coast; and *water quality* concerns being seen as the greatest current challenge in Southern California (Figures A-19).

¹⁴ We do not test for statistical significance of the change in this item, because the item was changed in the survey (to sediment management) and cannot be directly compared.

¹⁵ In 2011, *sea-level rise* ranked 3rd from last and *coastal erosion* ranked 6th from last (Finzi Hart et al. 2012).

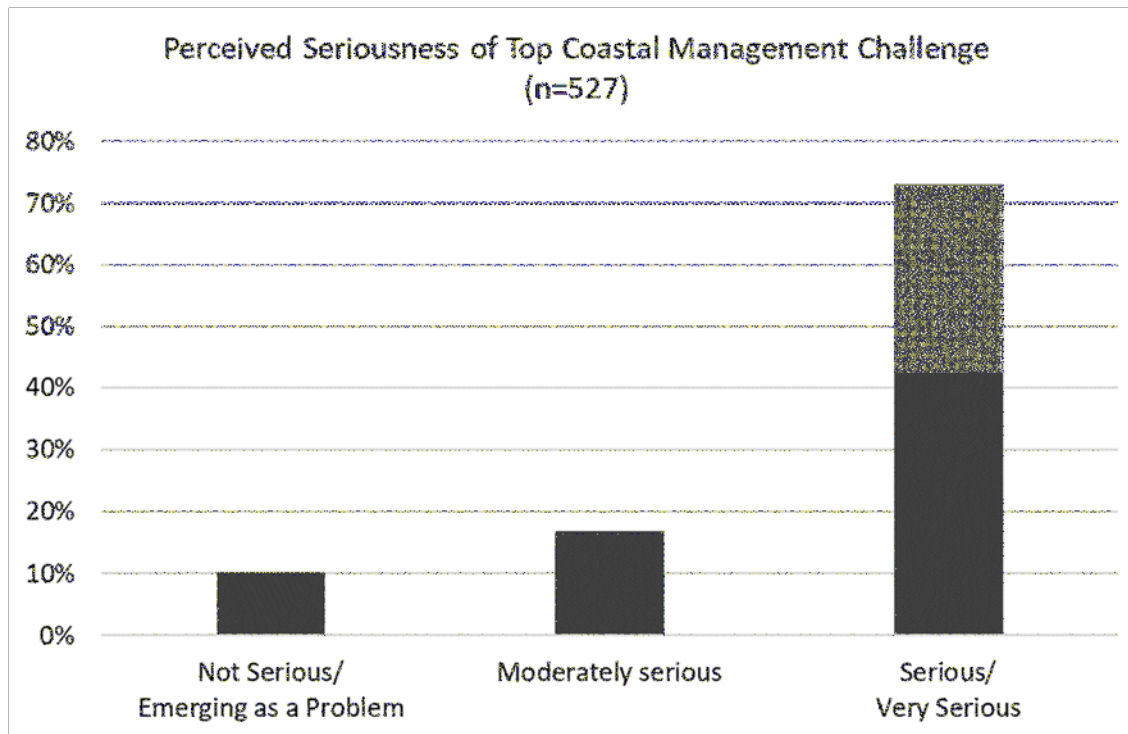


Source: The Authors

Figure 2: California’s Current Coastal Management Challenges

4.2.2 Severity of Current Coastal Management Issues

Respondents were then prompted to identify the severity of their top coastal management challenge in terms of perceived environmental or socioeconomic impact (Figure A-20). Across respondent types, an overwhelming majority of respondents identified these top concerns as *serious/very serious* (73%), with only 17% identifying them as *moderately serious* and 10% identifying them as *not serious/emerging as a problem* (Figure 3). Moreover, the severity of the top management challenges was perceived to have *increased* over the last five years (Figure A-21) and was expected to *increase* further in severity in the coming five years (Figure A-22).



Source: The Authors

Figure 3: Perceived Severity of Respondents' Top Current Coastal Management Challenge

But there were regional differences: the severity of the most pressing current management challenge was perceived to have *increased* the most in Northern California (where 93% of respondents saw an increase), followed by respondents in San Diego (where more than 71% of respondents felt their top management concern had *increased in severity*).

In 2011, respondents generally had the same overall pattern of response, i.e., they perceived an *increase in severity* from the past and expected to see a further *increase in severity* in the future. Compared to 2011, the severity of current and future coastal management challenges in 2016 was perceived as being worse than five years ago (a statistically significant finding; Independent Samples T-test, $p < 0.01$ for both). We thus might expect that water quality and sand management issues should be even more severe management challenges at the time of the 2016 survey. Interestingly, however, the 2011 top challenges ranked relatively lower in 2016, while different issues had risen to the top. This finding does not mean that coastal professionals were wrong in 2011, but it does suggest that sea-level rise and related coastal erosion and flooding jumped much higher on the radar screen than respondents assumed five years ago. In other words, water quality issues may still have worsened since 2011, but sea-level rise and its companion challenges are now perceived as even worse than those other coastal management challenges.

The survey does not provide enough detail to definitively answer what caused these shifts. For example, these shifts in perception may be due to some coastal management issues having been solved and/or others having become objectively worse, or alternatively the shifts in perception

may be due to political shifts or a reinforcing dynamic among coastal professionals talking to each other. It is possible that several or all these factors are at play.

4.2.3 Political Atmosphere Around Top Management Issue

To get a sense of the political atmosphere around the top management challenge, we asked survey participants to judge the level of contentiousness around their top management challenge. The results show that respondents are almost equally divided on the contentiousness of their top concerns, with 52% identifying them as *contentious* and 48% as *non-contentious* (Figure A-23). This is a slight but not statistically significant decrease since 2011 when 56% of respondents felt the atmosphere around their top challenge was *contentious*. A plurality of respondents (48%) indicates in 2016 that the political atmosphere around their top challenge has *improved* in the last five years. This is in comparison to 26% indicating it has *worsened* and 27% indicating there has been *no change*.¹⁶ By comparison, in 2011, respondents were equally divided in their perceptions on the political atmosphere surrounding their top management challenge, though they were less optimistic than that the political atmosphere would improve (a statistically significant finding; Independent Samples T-test, $p < 0.05$).

In short, while survey respondents in 2016 believe their top management challenge will *increase in severity* in the coming years, there is also the promising perception that their top concerns – notably sea-level rise, coastal erosion, and coastal flooding – can be managed in a less contentious political atmosphere.

4.2.4 Main Stakeholder Groups Involved in Coastal Management

To better understand the current coastal management context, we asked survey participants to identify the main stakeholder groups involved in the issues they noted. Across respondent types, *local* and *state governments* and *environmental advocacy groups* were identified as the leading actors (Table A-1).

While mentioned across respondent types, their exact rank varied slightly. This response was quite similar to the 2011 survey, which also listed *local government*, *state agencies/commissions*, and *environmental advocacy groups* as the most involved. The only shift was around *federal agencies/departments*, which were ranked in the top five stakeholder groups for all respondent types – an increase from the 2011 survey. In 2016, we also introduced *community members/residents* as a new stakeholder category to highlight the importance of stakeholder engagement, peer-to-peer learning and to explore whether new actors are entering the coastal management space. This stakeholder group was ranked in the top five for elected officials, city and county, and private industry representatives although, for state, federal and regional and NGO respondents, *community members/residents* was less important.

Based on this characterization of the broader coastal management context, we now turn to survey results regarding coastal adaptation.

¹⁶ Numbers do not add up to 100% due to rounding.

5: Progress on Coastal Adaptation to Climate Change

The next major substantive section of the survey focuses on coastal adaptation to climate change impacts. It assesses coastal professionals' attitudes toward climate change, including their causes. It examines whether coastal professionals are addressing climate change in their work, and, if so, how much of a priority it is and how far along they are in the adaptation process. In addition to similar questions asked in 2011, we updated several questions in this section to stay current with the changing field and to reflect changes in policy and law. We also added new answer options in 2016 on what prompted coastal professionals to begin the adaptation process, how work on climate change may or may not be contributing to coastal professionals' stress levels, and how likely it is that different adaptation strategies will be pursued in coastal communities. To better understand the commonly mentioned barriers encountered, we also asked additional questions on adaptation finance. Together with the information, training, and support needs explored in Section 6, the results help to identify how coastal professionals can be best supported in their efforts to prepare for and manage emerging climate change impacts.

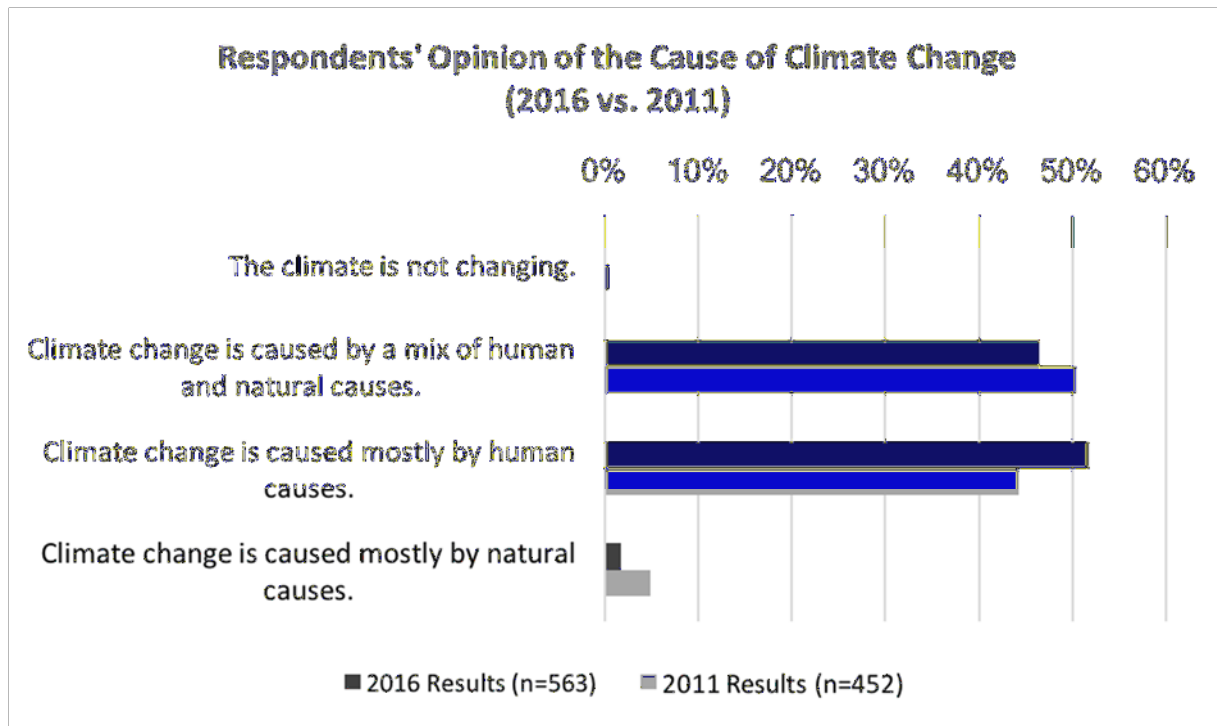
5.1 Attitudes Toward Climate Change

In this part of the survey, a series of questions focuses on understanding attitudes toward climate change among California's coastal professionals and how individuals and organizations are considering climate change in their work.

5.1.1 Existence and Causes of Climate Change

Very similar to 2011, the overwhelming majority of respondents is convinced that climate change is already happening and causing impacts now (Figure A-25). When asked about the causes of climate change and how concerned respondents are about these changes, we note an increase in the number of respondents who believe *climate change is mostly caused by human activity*. When asked which statement comes closest to their opinion about climate change, the 2016 respondents show a higher percentage of those who believe that *human activity is causing changes* (52%), rather than *a combination of human and natural causes* (47%) (Figure A-26). In 2011, those results were reversed, with more believing *a combination of human and natural activity* (between 48-53%), rather than *human causes* as the main culprit (between 40-49%) (Figure 4).¹⁷

¹⁷ In 2011, respondents were randomly assigned surveys that used the term "climate change" or "global warming," which is why there is a range of percentages. In 2016, this distinction was no longer made.

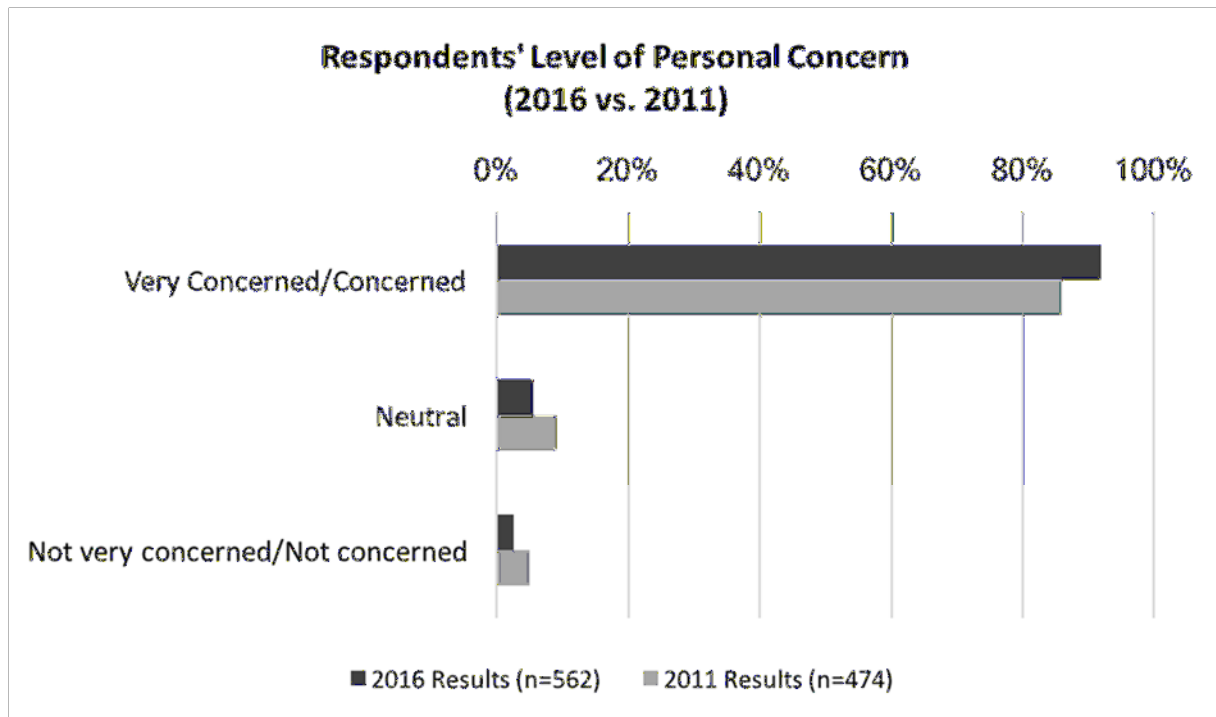


Source: The Authors

Figure 4: Changing Opinions about the Causes of Climate Change (2016 [top] vs. 2011 [bottom])

5.1.2 Concern about Climate Change

Furthermore, when asked about their personal level of concern, we note an increase (from 86% in 2011 to 92% in 2016, see Figure 5) among coastal professionals who say they are either *very concerned* or *concerned* about climate change. (Figure A-27).

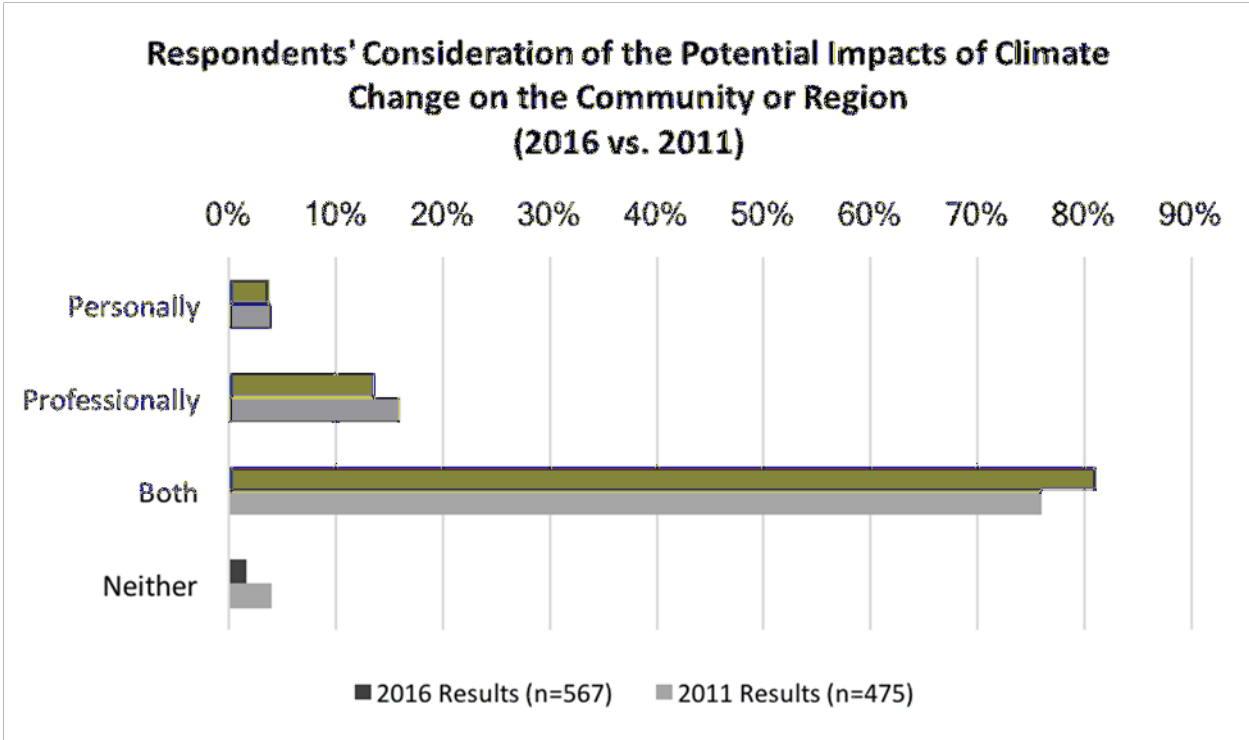


Source: The Authors

Figure 5: Change in Personal Levels of Concern (2016 vs. 2011)

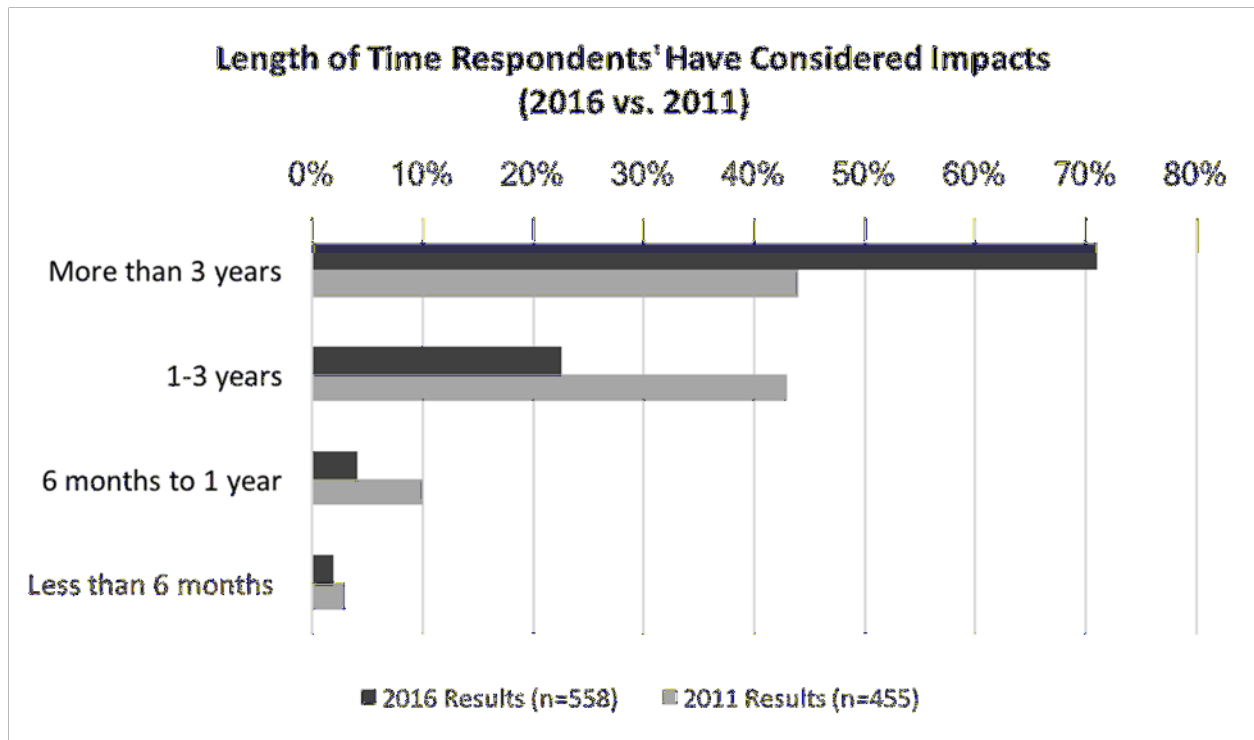
5.1.3 Acting on Climate Change Concerns

These questions were followed by a series of questions that address whether or not and how survey respondents, individually and through their organizations, are taking steps to address climate change impacts. When asked if they have considered the potential impacts of climate change on their community or region, 81% say they have done so *both personally and professionally* (Figure A-28). This is a statistically significant increase from 75% in 2011 (Figure 6) (Independent Samples T-test, $p < 0.05$). We also observed a considerable and statistically highly significant increase in the number of those who indicate that they have been working on it for more than 3 years, from 45% in 2011 to 71% in 2016 (Independent Samples T-test, $p < 0.001$) (Figure A-29 and Figure 7).



Source: The Authors

Figure 6: Change in Consideration of Climate Change Impacts Personally and Professionally (2016 vs. 2011)



Source: The Authors

Figure 7: Length of Consideration of Climate Change Impacts in Work (2016 vs. 2011)

5.1.4 Attitudes Toward Preparing for Climate Change Impacts

When asked which statement best represents their attitudes towards preparing for climate impacts, the results show an increase among those who believe they *should be preparing for these impacts in all decisions* across almost all respondent types. Since 2011, there has been a highly significant increase in respondents who believed so (Independent Samples T-test, $p < 0.001$). When broken down by respondent type, city and county respondents increased from 19% to 29%, elected officials from 42% to 45%, private sector and environmental consultants from 43% to 49%, and state, federal, and regional from 35% to 51% from 2011 to 2016, respectively. Sixty-two percent of the newly segmented respondent group of academic respondents believe *we should prepare for these impacts in all decisions*, and NGO respondents stayed consistent at 63% (Figures A-30a-f).

Together the results on climate change attitudes suggest greater concern, commitment, and advances in working on climate change.

5.2 Knowledge About Climate Change and Adaptation

In this part of the survey, questions queried more deeply into coastal professionals' knowledge of climate change and familiarity with current scientific information available both at the global scale and in their region.

5.2.1 Self-Assessed Understanding and Factual Knowledge About Climate Change

Respondents were first asked to self-assess how well informed they feel about climate change. Results suggests that over the last five years, coastal professionals have moved from predominantly feeling that they are *moderately informed* on climate change to asserting that they feel *well informed* about it. This positive trend tracks across all respondent types, indicating a growing confidence in respondents' understanding of climate science. City and county respondents increased from 30% reporting being *well informed* in 2011 to 39% in 2016; state, federal, and regional respondents increased from 37% to 69%; NGO representatives from 54% to 82%; private industry and consultancies from 56% to 74%; and elected officials from 48% to 62% (Figures A-31a-f).

Respondents were then asked a series of questions to test their factual knowledge. They were asked how various climate change impacts may affect the local average conditions and natural environment in their region over the next 3-4 decades. Respondents' answers to each item of this question were logged as being either consistent or inconsistent with prevailing scientific consensus (Table A-2).^{18,19} Items with no clear scientific consensus were excluded from the analysis. Using an arbitrary threshold of at least 80% of responses being consistent with the scientific consensus (Figures A-32a-f), and comparing results with the 2011 survey results, we find that:

- State, federal, and regional respondents and NGO representatives are well informed about climate change. These groups answered correctly for 10 of the 16 impacts.
- City and county respondents, who do not feel as well informed as other respondent groups (55% moderately informed, 39% well informed), were only correct for 3 of the 16 impacts, and scored below 70% for 7 impacts. This is a significant change compared to 2011, where city and county respondents were correct for 8 of the possible 13 impacts asked about five years earlier. While the survey does not offer an explanation for this decline, possible explanations include confusion, a greater sense of uncertainty, and being overwhelmed from too much or even contradictory information.
- Elected officials were correct for 5 of the 16 impacts; however, they scored below 70% for 6 impacts.
- Private industry and consultants were correct for 7 of the 16 impacts and academics were correct for 6 of the 16 impacts.

Overall then, our results suggest that California coastal managers – who already are a highly educated group of professionals – feel better informed about climate change risks now than in 2011 (a highly statistically significant increase, Independent Samples T-test, $p < 0.001$), even if there remains a gap between what they believe to be true and the scientific consensus. In fact, in

¹⁸ If responses are consistent with prevailing scientific consensus, they are referred to as “correct.”

¹⁹ As in 2011, scientific consensus was determined in consultation with climate expert, Dr. Dan Cayan of Scripps Institution of Oceanography, an internationally renowned climatologist and the lead scientist on updates to the California's climate change and sea-level rise projections for California's Fourth Climate Change Assessment.

all but one respondent group (local government staff), there seems to be greater perceived confidence in one's knowledge than factually exists.

The final question in this section of the survey assessed respondents' sense of how climate change could affect their work. The majority (67%) selected the statement, *it's clear that these changes already do or will affect my work and we have begun preparing in a number of ways*. This is a statistically highly significant increase from 49% choosing that answer in 2011 (Figure A-33, Independent Samples T-test, $p < 0.001$). Nine percent selected *even if the science isn't telling me about local specifics yet, I can see how these impacts could impact my work and I am about to start preparing for them*. This is a marked decrease from 17% in 2011, perhaps mirroring the above-mentioned increase in people preparing for impacts in their work. We also observe a decrease (from 18% to 9%) in the percent of respondents who say that they expect climate changes *may well affect the things they manage but don't know how to prepare for them*. This decrease is consistent with the observed increase in adaptation activity, i.e., people know more about how to address sea-level rise because they are further along in the adaptation process, learning what they need to do as they go along. Ten percent of respondents indicate that while they *understand how climate change may impact their work, management decisions prevent them from working on the issue*. This percentage is unchanged compared to 2011.

These numbers are consistent with the earlier finding that coastal professionals recognize the threat of climate change, are feeling more confident that they understand the science, and many are actively preparing for impacts personally, professionally, or both. In the next section, we explore how these concerns, growing confidence and readiness translate into adaptation action.

5.3 Adaptation Activity Underway in Coastal California

The next series of questions asked respondents to indicate what activities related to climate change are underway in their organizations, what stage in the adaptation process they are in, and what prompted their adaptation planning efforts.

5.3.1 Climate Action Priorities

First, respondents were asked to indicate how high a priority both mitigation (efforts to reduce greenhouse gas emissions from energy and land use) and adaptation (efforts to plan and prepare for the projected impact of climate change) are in their work. Results show that both mitigation and adaptation continue to be identified as *high priorities* across all respondent types by a wide margin (Figure A-34). Overall, adaptation continues to be a higher priority of the two as a top priority; however, the spread between the two has widened. The percentage of respondents that identify adaptation as a *high priority* has increased (from 78% in 2011 to 86% in 2016, a statistically highly significant increase, Independent Samples T-test, $p < 0.001$) relative to mitigation, which has decreased slightly in priority (from 74% in 2011 to 73% in 2016) although this difference is not statistically significant.

This finding might at first be considered counter-intuitive given that local municipalities only very recently got a legislative mandate to address climate change adaptation, but they have had such a mandate for mitigation under California's Global Warming Act since 2006 (AB32). However, the question did not ask how important adaptation and mitigation is for their jurisdictions, but what priority these two types of climate action held within respondents' own work. Thus, the result is a reflection of the types of respondents we approached for the survey and is consistent with the shifts in attitudes toward climate change discussed earlier. It is also

consistent with sea-level rise having moved to the top of current coastal management challenges and other findings on adaptation discussed below.

This becomes clearly evident when the results are organized by respondent type (Figures A-35a-f). Adaptation is a higher priority than mitigation across all respondent groups, except for city, county, and elected officials, who rate both issues as equally high priorities. Those types of survey respondents often include professionals with broad job responsibilities (e.g., planners, public works officials, sustainability directors, and elected officials), who often have to look at both types of climate action in their work.

5.3.2 Motivations to Begin Adaptation

We then sought to determine what motivated coastal professionals to begin planning for climate impacts. Options were updated for the 2016 survey to reflect changes in the policy landscape at the local, regional, state, and federal levels. While thus not directly comparable, some answers were consistent across the 2011 and 2016 surveys. Overall, the pattern of motivations is coherent and intuitive (Figures A-36a-f and A-37a-f; multiple options could be chosen by respondents). *Personal motivation to address the issue* continues to be a top motivation to prompt adaptation action for several respondent types, including elected officials, state, federal, and regional respondents, NGOs, and academics. For city and county respondents, *personal motivation* moved up the list from the seventh spot to the fourth but for them and private sector consultants, *updating a general plan* and the *California Coastal Commission's Sea-level Rise Policy Guidance* of 2015 were the most significant motivators. Other important motivators in 2016 include *regionally or locally-specific information showing potential impacts and activities related to updating or developing a specific community plans* (i.e. *local coastal programs, general plans, climate actions, etc.*). *Equity and justice* – a new aspect in the 2016 survey in response to state-level policy shifts – is one of many motivations to begin adaptation.

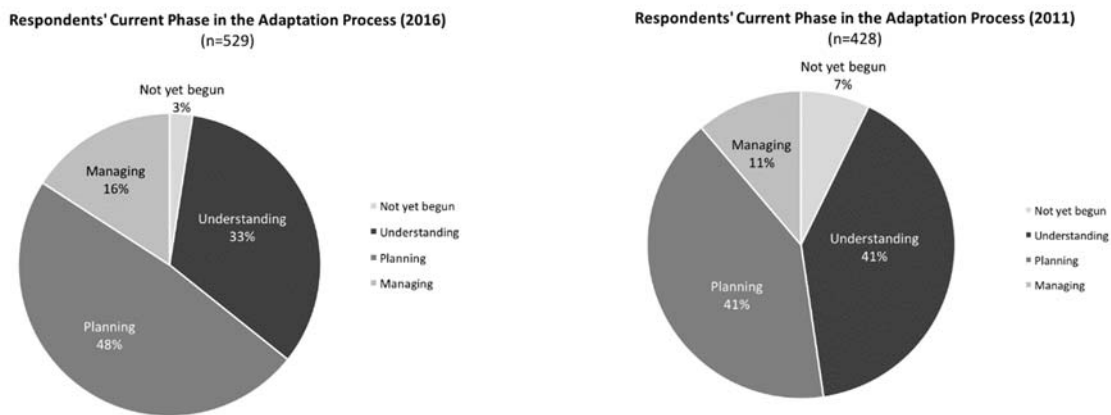
Overall, these motivations point to both the importance of guidance documents and policy mandates but also to the often-ignored personal motivations that feature prominently in the absence of policy mandates. Locally-relevant scientific information can both add to this motivation and serve an enabling function.

5.3.3 Stage in the Adaptation Process

To gauge how far along California coastal communities are in their adaptation efforts at this time and to assess progress against the 2011 survey results, respondents were asked to indicate the phase that best describes their current climate preparedness or adaptation efforts. To do so, we used the same question that we asked in the 2011 survey, which was based on a stylized planning and decision-making cycle (Moser and Ekstrom 2010). Respondents could indicate whether they had not yet begun to think about climate change and related adaptation needs, had moved to assessing their climate risks (*Understanding*), advanced to planning for and assessing potential adaptation options (*Planning*), or initiated implementation, monitoring, and assessment of selected adaptation options (*Managing*). Each of these major phases has several stages, and respondents were asked about their status at that more detailed level (Figures A-38a and A-39a-c).

Figure 8 demonstrates that the respondents' movement from *Understanding* to the *Planning* phase is highly statistically significant (Independent Samples T-test, $p < 0.001$). Three percent of respondents indicate that they *have not begun*, a decrease from 7% in 2011. Thirty-three percent

said that they are somewhere in the *Understanding* phase, a decrease from 41% in 2011, and 48% said they are somewhere in the *Planning* phase, an increase from 41% in 2011 (though these differences are not statistically significant). Finally, we also found an increase in respondents who indicate that they are somewhere in the *Managing* phase, with 16% of respondents saying so in 2016 versus only 5% in 2011. While the latter remains a relatively small group overall, the change over five years here is the most notable, although not statistically significant. Together, these findings suggest that coastal adaptation is progressing, even if the majority of respondents are still in the relatively early stages of adaptation. This finding is consistent with numerous older and more recent assessments of the state of adaptation in general (e.g., Moser, Coffee and Seville 2018; Woodruff and Stults 2016; Bierbaum et al. 2014; Preston et al. 2011; Measham et al. 2011; Ford and Berang-Ford 2011), suggesting that there must be significant hurdles in play that hold practitioners back in advancing adaptation.



Source: The Authors

Figure 8. Advances in Adaptation in Coastal California (2011 to 2016)

This overall finding is further supported by a deeper probe into the detailed stages respondents are in. For example, in 2016, the proportion of respondents *gathering information and brainstorming* is smaller now while that of people *conducting assessments* has increased compared to 2011 (Figure A-39a-c). This finding is statistically highly significant (Independent Samples T-test, $p < 0.001$). A similar advance is seen in the *Planning* phase, although the percent that indicated that they have *selected a subset of response options to move forward* did not change (13%) from 2011. This points to how long adaptation planning can take and hints at some of the barriers respondents may encounter (see discussion below). Finally, in the *Managing* phase, we also see movement: while in 2011 83% of respondents in this category indicated they are in the first stage (*beginning to implement*), that number is relatively smaller now (67%), but the next two stages show increases with people *monitoring* the performance of their implemented actions rising from 6% in 2011 to 17% in 2016, and those who are *evaluating implemented actions* rose from 11% in 2011 to 16% in 2016. It is notable, however, that while we see changes in the percentages within these stages, these differences are not statistically significant. That said, these numbers tell an internally consistent story of at least incremental adaptation progress along the coast of California, with significant hurdles persisting, thus holding back greater

progress with the adaptation process. We will examine these hurdles in more detail in the next section.

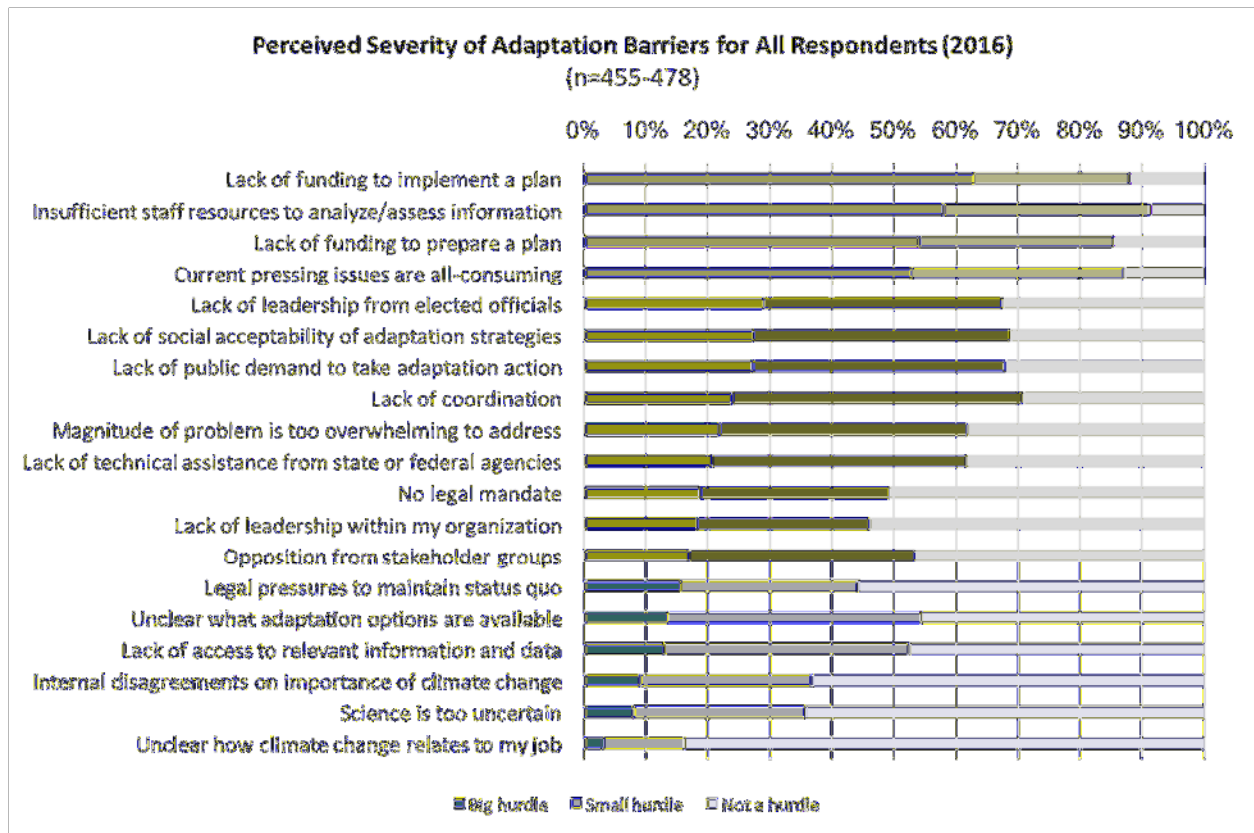
Progress is not even across different coastal regions however (Figures A-38a-g). When we look at this question by region²⁰ rather than respondent group, we find that there has been more progress in the Bay Area (*Understanding* 35%/ *Planning* 52%) and in San Diego (35%/50%) but less advancement in Southern California (39%/43%) and along the Central Coast (44%/42%). The largest relative differences across regions are in the *Managing* phase with 15% saying they are in that phase in Southern California, 12% in San Diego, 11% in the Bay Area/Delta, and 11% in the Central Region. No one in Northern California indicated that they are implementing adaptation strategies in 2016. We would point out, however, that the number of respondents who answered this question in that region constituted a small respondent pool (n=11), thus these results may not adequately represent the region as a whole. In fact, personal communications with coastal professionals in the Northern California counties indicate there is more work ongoing in these regions than is reflected in the survey responses. Altogether, however, these results support the conclusion that California's coastal communities, while advancing incrementally on preparing for climate change, have not yet crossed the frontier into implementation of their adaptation strategies, a finding consistent with a recent assessment of progress in adaptation across all sectors and for the US as a whole (Moser, Coffee, and Seville 2017).

5.4 Barriers to Coastal Adaptation

While coastal professionals see adaptation as a top priority, are personally motivated to act, and are moving adaptation planning along, the 2011 survey and countless other studies on adaptation suggest significant barriers to making progress. We thus asked the barriers question again in 2016 to better understand the realities coastal professionals encounter in their efforts to prepare their communities for climate change impacts and make them more resilient.

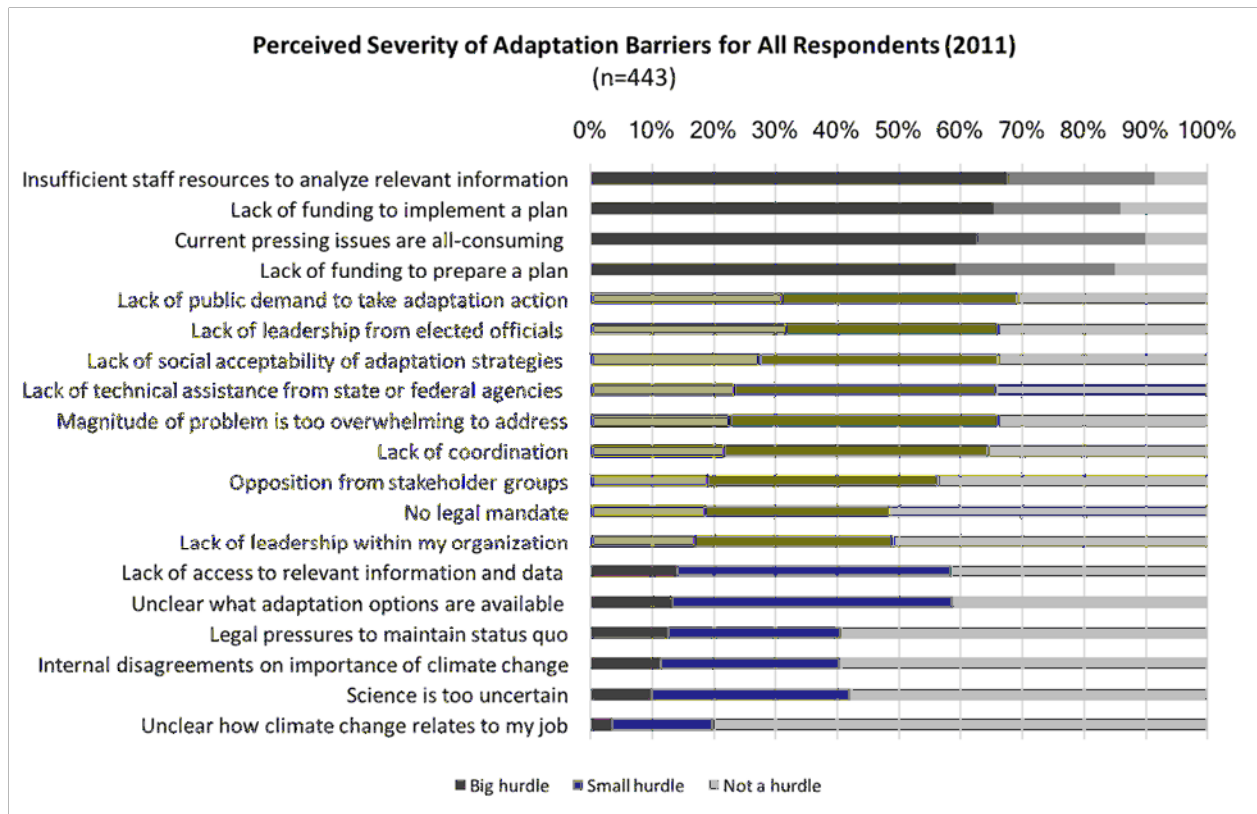
Respondents were asked to indicate which of 19 barriers are experienced as either a *big hurdle*, *small hurdle*, or *not a hurdle* in their adaptation efforts to date. The top four hurdles identified as *big hurdles* by a considerable margin are *lack of funding to implement a plan*, *insufficient staff resources to analyze and assess relevant information*, *lack of funding prepare a plan*, and *other pressing issues are all-consuming*. All other issues (e.g., *unclear how the issue relates to my job*, *the science is too uncertain*, *legal pressures*, *opposition*) are perceived as less problematic (Figure 9a and 9b).

²⁰ The regional analysis only included responses from individuals who selected one region. Respondents who selected multiple regions or who work statewide were excluded from the analysis.



Source: The Authors

Figure 9a: The Leading Barriers to Coastal Adaptation in 2016



Source: The Authors

Figure 9b: The Leading Barriers to Coastal Adaptation in 2011

Looking at the barriers question longitudinally, we can also see that these top barriers to adaptation have persisted over the past five years. The 2011 survey results showed the same pattern of these four issues standing out as the biggest hurdles to adaptation progress. The pattern also persists, whether the results are organized by respondent type or by region (Figures A-40, A-41a-f and A-42a-e). *Lack of funding to implement a plan* is the top barrier for the Southern, Central, and Bay Area regions. San Diego identified *insufficient staff resources* as their top barrier, with *lack of funding to implement a plan* and *lack of funding to prepare a plan* a close second and third. *Current pressing issues* continues to be a significant barrier, identified as the second biggest hurdle in Southern California, third in the Central region, and fourth in both San Diego and the Bay Area. In addition, *lack of leadership from elected officials* ranks among the top five biggest hurdles in San Diego and Northern California, whereas *lack of public demand to launch adaptation planning* features highly in Southern California and *lack of technical assistance* is among the top five barriers for respondents in the Bay/Delta Region and Northern California.

The fact that funding and staffing (also linked to funding) persist as major hurdles may be even more significant in 2016. Beginning in 2013, California state agencies began providing grant programs to coastal communities for sea-level rise planning and coastal climate adaptation. Between the grant programs managed by the OPC, the California Coastal Commission, and the California Coastal Conservancy, approximately \$11.8 million has been provided across the state (CCC 2018; SCC 2018; CCC, OPC, SCC 2013). The OPC grant program even cited the 2011

survey as motivation for releasing \$2.5 million in 2013 (CCC, OPC and SCC 2013). These resources may have played a significant part in helping coastal communities advance their adaptation efforts (see adaptation funding discussion below, but also Moser et al. [2018] for a broader assessment of adaptation finance challenges across California local governments). But the findings here suggest that the need is bigger than the resources available as lack of funding and staff resources continue to pose the greatest hurdles for coastal communities to move forward.

5.5 Coastal Adaptation Funding – Status and Challenges

For the first time in 2016, we asked coastal professionals in greater detail about how they resource their adaptation efforts. Our questions were motivated by a desire to more deeply understand the frequently heard – and here confirmed – prevalence of financial barriers to adaptation.

We asked respondents to provide insights into any adaptation-related activities they may have invested in over the past two years, and what their expected funding needs are over the next five years. Specifically, we asked:

- whether any money had been spent;
- if so, the type of actions and processes they had spent money on;
- from what source(s) these activities were resourced;
- whether the funded work was done largely by staff in-house, by external consultants or a combination of the two;
- to the extent respondents could answer, to specify the amount of money spent; and
- to the extent possible, to estimate future funding needs.

We discuss their responses in the following sections.

5.5.1 Overview on Adaptation Expenditures

The first notable insight we gained was that respondents reported spending most commonly on *climate change risk and vulnerability assessments* and second most frequently on *adaptation/preparedness planning*, followed (at a sizable distance) by *communication and engagement* (Figures A-43b-e). Regardless of respondent group, at least 50% have spent some money on assessments and between 40% and 65% have spent money on planning. Half as many spent money on *implementation* as did on *planning*. *Monitoring and evaluation* was even less frequently funded (Figure A-43a). This overall picture is consistent with the previously discussed finding that many coastal professionals are still in the relatively early stages of adaptation and that few have advanced to implementation and monitoring. It is also consistent with the findings on adaptation barriers, namely that the greatest hurdle was lack of funds for implementation. In fact, relatively few respondents report having been able to obtain resources.

5.5.2 Completion of Funded Work Internal/External Staff

We asked stakeholders about who did the funded work – internal staff, external consultants, or both – because partner organizations wished to better understand whether the funding going to

adaptation (at the local level in particular) helps build internal capacity or gets passed on to external experts and consultants. Responses received revealed differences both by type of adaptation-related activity and by respondent type (Figures A-44a-d).

First, almost all activities are being carried out by a mix of personnel, with few exceptions. *Climate risk and vulnerability assessments* are done either (1) internally only; (2) externally only; or (3) collaboratively between internal and hired staff. Academics stand out here as the respondent group that does these sorts of analyses almost exclusively by themselves. *Adaptation planning* is more often (compared to risk assessments) done in-house by local, state, federal and, regional staff respondents, as well as NGOs and academics, but typically also involves external assistance for these respondent groups. Public sector respondents conduct *community engagement* by themselves or with external assistance while private industry or consultants more commonly hire external expertise to help with this type of work, and academic respondents did community engagement by themselves. *Implementation of adaptation options*, quite similar to adaptation planning, is done predominantly in-house but still requires external help. And finally, *monitoring and evaluation of implemented actions* is also an in-house or collaborative aspect of adaptation work for most respondent types. Only academics said they had this part of the work done by external consultants. Thus, overall, the picture that emerges is consistent with what might be expected in terms of strengths and roles in public planning and decision-making processes.

Accordingly, there is no clear indication that scarce adaptation funds are being redistributed immediately to consultants. But if one focuses only on local respondents, it is possible to understand where that perception may come from: for a predominantly local survey population, one that is still in the relatively early stages of adaptation, almost 80% of the funded climate risk and vulnerability assessments involves consultants – solely or collaboratively with local staff. Similarly, more than 70% of adaptation planning involves consultants (even if they do their work in collaboration with local staff). The survey does not provide answers as to which capacities were built internally with the received funding, nor does it allow us to say when local governments call on external expertise, or how the work is split up between internal and external personnel. Thus, we cannot exclude or conclude from this survey whether the funding is making fundamental changes in local government capacity.

5.5.3 Level of Past Adaptation Expenditures

We did, however, obtain considerable insight into the level of adaptation-related expenditures over the past two years and expected financial needs over the next five years (Table 6).

Table 6: Average Adaptation-Related Expenditures (in nominal \$) Over the Past 2 Years and Expected Need Over the Next 5 Years (all respondents)

	MEAN		MEDIAN		HIGH END OF RANGE	
	Past 2 yrs	Next 5 yrs	Past 2 yrs	Next 5 yrs	Past 2 yrs	Next 5 yrs
Climate Vuln/ Risk Assmt (n=101; 155)*	286,220	1,805,850	108,333	233,333	2,193,333	46,666,667
Adaptation Planning (n=74; 167)	342,232	2,306,864	76,667	283,333	2,400,000	46,666,667
Implementation of Actions (n=49; 151)	2,551,063	4,200,808,568	375,000	6,083,333	16,000,000	78,333,333,333
Monitoring & Evaluation (n=37; 145)	216,071	2,276,732	65,000	258,333	1,050,000	45,000,000
Community Engagement (n=55; 159)	159,294	1,726,178	60,000	183,333	1,016,667	46,666,667

Source: Authors' calculations

* For each adaptation-related activity, the first n provided pertains to the number of respondents answering the question about expenditures over the past 2 years; the second n indicates the number of respondents answering the question about expected financial needs over the next 5 years.

Across respondent groups (city and county local governments; state / federal / regional governments; and others [combined due to small number]), median and average (mean) amounts of past spending were roughly within the same order of magnitude for each of the activities about which we inquired. Also - as expected - expenditures incurred at the state / federal / regional levels were generally somewhat higher than for the other respondent groups. The only exception are average expenditures for implementation over the past two years, where the "other respondents" (dominated by NGOs) showed a higher average.

Across the five categories of adaptation-related activities, the pattern is also as expected: more was spent on implementation - by far - than on any of the other four activities, even more than for the other activities combined. In light of other responses to the survey discussed so far (and the lower number of responses for implementation than for risk assessments and planning), we conclude this is because implementation is significantly more expensive, not because it was done more often.

Based on these figures, we can estimate that if respondents spent money on adaptation at all and if they spent money on all aspects of adaptation, the total average annual expenditure would have been ca. \$1.78 million (median of \$342,500). Many respondents did not report spending on all aspects of adaptation; thus, this overall average may serve better as a general guide post, while the average expenditures on specific types of activities may serve as a more useful indicator as to what coastal managers should expect to spend in the initial phases of adaptation.

Of course, the complexity and size of any adaptation effort determines its actual costs. We developed a range based on reported expenditures over the past two years, which started from \$0 at the low end (where respondents completed the activity on the basis of pro bono work) to the high-end figures reported in Table 6 above: \$3 million for risk assessments, \$6 million for planning, \$25 million for implementation, \$1.5 million for monitoring and evaluation, and \$2 million for engagement. These high-end expenditures are frequently not just a multiple of the two-year figure, but an order of magnitude greater than those averages (Figures A-46a-e).

5.5.4 Expected Future Funding Needs for Adaptation

Table 6 above also lists expected funding needs for each type of adaptation activity over the next five years as recorded by our survey respondents (see also Figures A-47a-e). Here we show these figures as *annual* averages by category of adaptation activity for easier comparison of how adaptation spending (or at least needs) are changing over time (Table 7).

Table 7: Comparison of Normalized Past Annual Adaptation Expenditures and Normalized Expected Annual Adaptation Funding Needs (all respondents)

	Annual past expenditures (based on expenditures over past 2 years)	Annual expected funding need (based on expressed needs over next 5 years)	Factor
Climate Vuln./Risk Assmt.	\$ 143,110	\$ 361,170	2.5
Planning	\$ 171,116	\$ 461,373	2.7
Implementation	\$ 1,275,532	\$ 840,161,714	658.7
M&E	\$ 108,036	\$ 455,346	4.2
Community Engagement	\$ 79,647	\$ 345,236	4.3
Average annual total	\$ 1,777,440	\$ 841,784,839	473.6

Source: Authors' calculations

The first observation from Table 7 is that coastal professionals indicate future funding needs that are a multiple of past expenditures. At the low end, their responses suggest they need 2.5 - 2.7 times the funding per year spent on climate risk assessments and adaptation planning, and 4.2 to 4.3 times the annual funding spent on monitoring and evaluation and community

engagement, respectively. By stark contrast, the expected funding need for implementing adaptation actions is three orders of magnitude higher (or a factor of ~660!).

Focusing on the lower numbers first, what might account for this expressed increase in adaptation-related expenditures? First, the figures are expressed in nominal numbers (not inflation adjusted) and we did not ask respondents to take inflation into account. We suspect two other factors at work instead: first, many of the respondents who answered the question about future needs also shared what they spent in the past. For these respondents, the increase may reveal their desire for more adequate funding given a prior experience with insufficient funds (consistent with the findings on the top adaptation barriers, reported above in Section 5.4). Alternatively, they may see a need for more sophisticated analyses, planning, outreach efforts, etc. in the future. Many more respondents indicated a need for future funding than indicated past spending on adaptation, however, and for these respondents, the higher expected future needs may be an overestimate (based on lack of experience) or a realistic estimate based on similar past experiences.

The survey does not allow us to conclusively answer this question, but it does allow us to conclude that with what has been spent over the past two years, significant progress has been made, and yet, funding-related barriers constitute the greatest hurdles to further adaptation progress. Thus, we caution that the “must-do” budgets over the past two years are inadequate, and that the increased funding needs suggested for the next five years may be a more realistic measure of what is actually needed even in these early stages of adaptation.

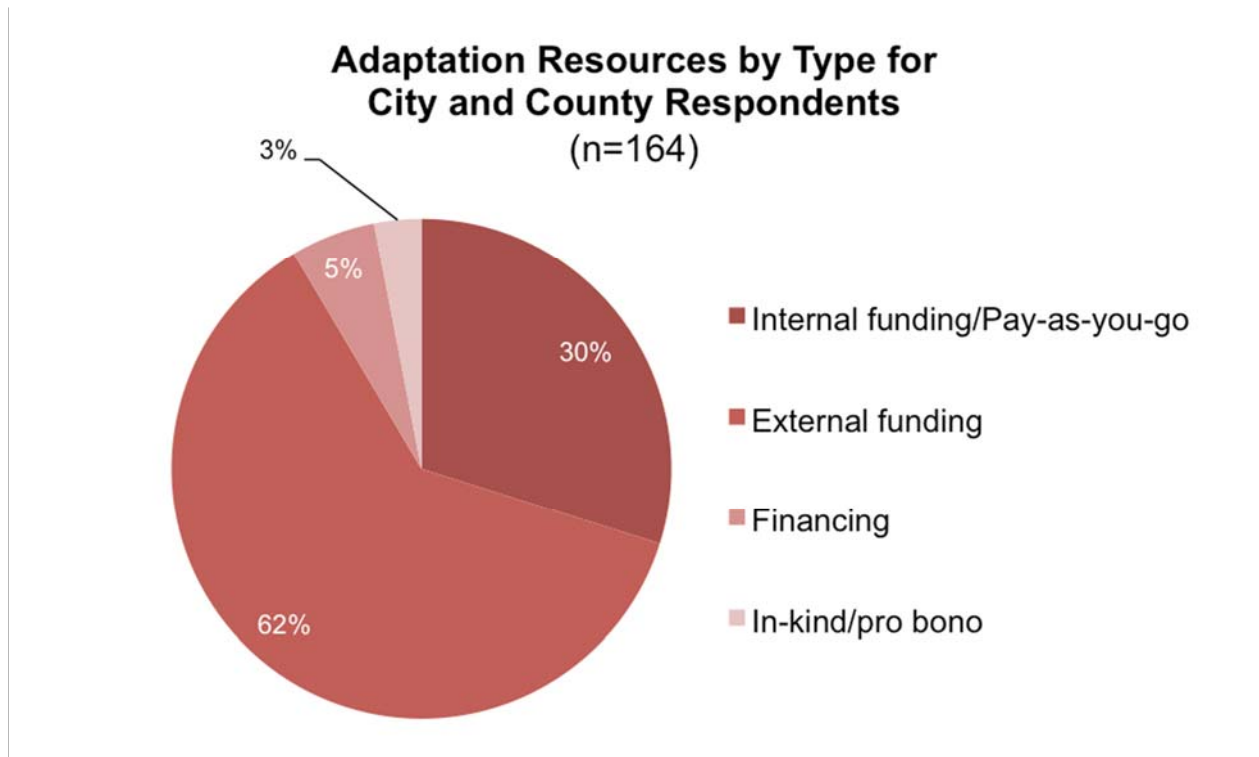
The biggest future need and largest increase, of course, is in the implementation category. This increase is seen in the comparison of median, mean, and high-end estimates and for each group of respondents (Figures A-48a-l), most starkly, when shown in a linear (as opposed to a logarithmic) scale. In short, future expected funding needs for implementation of coastal adaptation actions (normalized annual cost of more than \$840 million across all respondent types and nearly \$82 million/year for local respondents) simply dwarf all other adaptation-related funding needs. These figures may be affected by experience of implementation to date or lack of experience, as discussed above, for other adaptation-related activities. We note, however, that the leading adaptation barrier found in the 2016 survey is *lack of funding to implement adaptation actions*. Thus, while the actual figures for future adaptation may be higher or lower than the ones reported here, the story these findings tell is internally consistent.

5.5.5 Common Funding Sources for Coastal Adaptation in California

Coastal survey respondents were also asked what sources they had received funding from to support their adaptation activities. We summarize them here by respondent type.

The responses by *local government respondents* (city and county staff) revealed, first of all, that state sources constitute the largest share of funding sources (ca. 45%), followed by local governments’ own sources (ca. 33%), foundation and other sources (ca. 10%), federal sources (8.5%) and district and regional sources (ca. 4%) (Figures A-45a-f). Among the state grants, the California Coastal Commission (CCC), Ocean Protection Council (OPC) and the State Coastal Conservancy (SCC) are the most important sources of adaptation-related funding. Among the local sources, communities’ general funds constitute – by far – the largest source. Federal sources are more evenly spread across different agencies’ grant programs. Remarkably, local government staff reported drawing on 2.7 different sources on average (range 1-8) to piece

together their needed funding (Figure A-45b). Equally noteworthy is their large dependence on external funding (62%), as opposed to internal/pay-as-you go funding (30%). At this time, hardly any financing options are used to complete local adaptation work (5%) (Figure 10).



Source: The Authors

Figure 10: Adaptation Resources by Type at City/County Level

State/federal/regional survey respondents painted a somewhat different picture. State sources once again constitute the largest source of funding (with ca. 45%), followed by federal sources (ca. 39%), “other” sources (a wide collection, largely of unspecified funding sources; ca. 13%) and also some local sources (presumably as contributory sources for regional activities; ca.4%) (Figures A-45g-l). The largest differences are in the diversity of specific funding sources hidden within each of these categories. Respondents listed no fewer than 20 unique state sources, led by Coastal Conservancy, Prop. 84, OPC, and unspecified state sources. Respondents also listed a larger number of federal sources, some of which were not mentioned at the local level, with National Oceanic and Atmospheric Administration (NOAA), the US Fish and Wildlife Service, the Federal Highway Administration, Environmental Protection Agency (EPA), and unspecified federal funds playing the leading roles. Respondents in this category put together their adaptation funding from nearly five sources on average, and while a considerable number drew on just one source, some acquired funding from as many as 12 different sources (Figure A-45h). Remarkably, dependence on external sources of funding is even more pointed among these coastal professionals, with 79% depending on external grants, 15% drawing on internal/pay-as-you-go sources, and only 4% on financing (Figure A-45g). A companion report produced for California’s Fourth Climate Assessment (Moser et al. 2018) examines in some detail the complex nature of local governments’ adaptation finance challenges. It explores in greater depth than is

possible here the reasons why financing instruments such as bonds are not (yet) used more broadly for adaptation.

Finally, the remaining respondents (predominantly NGO and private industry/consulting respondents) produced a slightly different picture. Dependence on state sources was slightly less (ca.41%), while federal funding sources (ca. 21%) and other sources (ca. 24%) played secondary, but almost equal roles. Local sources came in last with approximately 14%. Among the state sources, the coastal agencies, as well as the California Department of Fish and Wildlife, featured most strongly. NOAA and EPA, as well as unspecified sources, led among the federal sources. In the “other” category, foundation grants for the first time played a truly dominating role. And among local sources, both general funds and utilities played a significant role for these respondents (Figures A-45o-r). As for piecing adaptation budgets together, this respondent group falls in the middle between local and state/federal/regional respondents, with an average of 3.6 sources per respondent (range 1-7) (Figure A-45n). However, the dependence on external grant funding is nearly complete (94%), with very little internal funding and no financing at all (Figure A-45m).

Overall, these findings are not surprising, but confirm the critical roles higher levels of government play in supporting lower-level adaptation activity. The state’s overall dominant role emerging from the financial questions in the 2016 survey is also an important, if not surprising observation, pointing to the strong supporting role it plays both in terms of motivation to begin adaptation (see discussion above), and in overcoming adaptation barriers by providing political leadership, technical assistance, scientific guidance, and – most critically – crucial financial assistance. In the longer run, however, this dependence on state funding points to a potential bottleneck: unless local and federal sources are increased and financing options made more widely accessible and used, the state is bound to be financially responsible for a far greater contribution to adaptation than it may be capable or willing to foot.

5.5.6 Contextualizing Adaptation Finance-Related Findings

The survey leaves many questions unanswered regarding adaptation finance. For example, there is no direct or independent verification of past or future estimates of adaptation costs; there is some (indeterminable) risk of double counting as state and federal respondents may have reported adaptation grant programs benefiting local respondents, which they also reported as expenditures.

We have an opportunity, however, to contextualize the above findings by comparing results to those obtained in a separate contribution to the Fourth Climate Assessment, which focused specifically on adaptation finance challenges and also involved a survey component (for more details, see Moser et al. 2018).²¹

The key comparative findings are as follows:

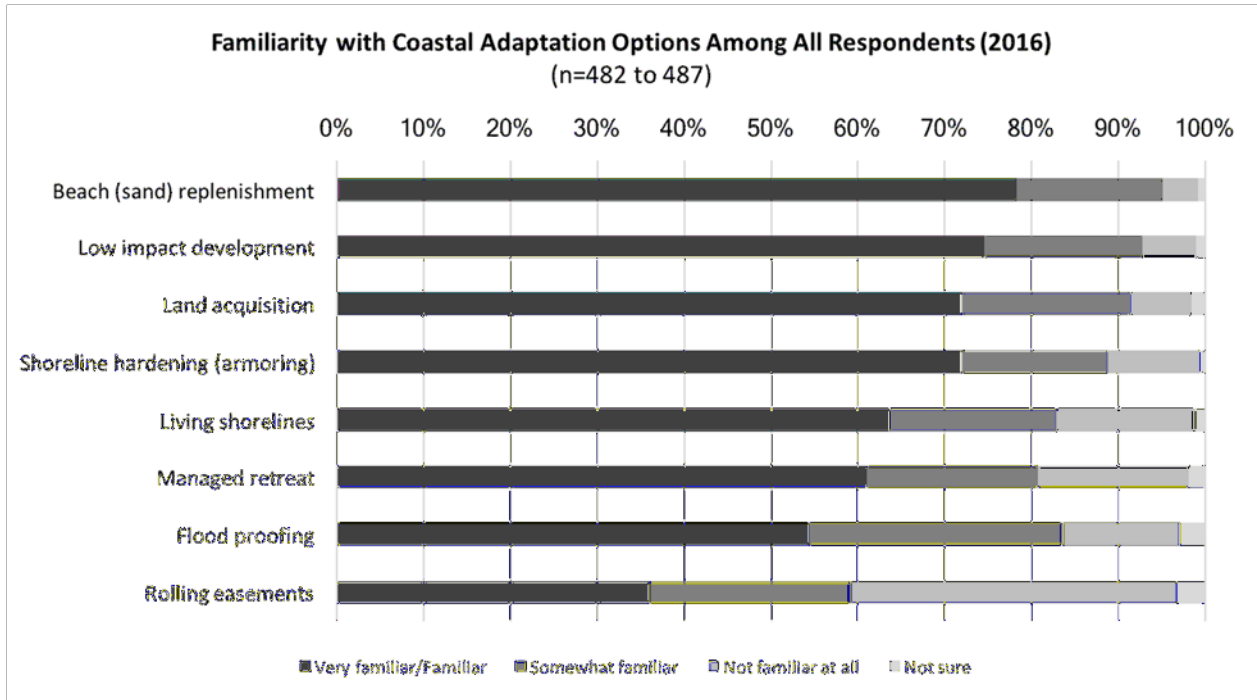
²¹ Both surveys were designed for comparability to the extent possible, given different study purposes. While the finance-focused survey was shorter and only oriented toward local government staff and their supporting service providers across California (not just coastal), several key adaptation and finance questions were identical. The adaptation finance survey was – similar to the coastal survey – biased toward southern, Bay Area, and coastal/urban regions, and is thus quite comparable, at least for the coastal survey’s local government sub-population.

- Respondents in both surveys report being in similarly early stages of the adaptation process.
- The top four barriers to adaptation are the same, even if they are more sharply separated in importance from the remaining hurdles in the coastal context than elsewhere in the state. Lack of funding for implementation clearly leads in both studies.
- In the adaptation finance survey – likely due to selection biases of respondents – a greater number of respondents indicated having already spent some money on adaptation compared to the coastal survey. The pattern of most spending on early adaptation stages and less spending on later adaptation stages, however, is consistent across surveys.
- Both surveys are also similar in reporting a predominant reliance on external funding, although drawing on general fund and other local sources was even more prevalent in the adaptation finance survey. Federal funding and financing through bonds are both relatively limited in both surveys.
- The large increase in funding needed for implementation is also consistent between the two surveys.

Questions asking respondents to name specific funding sources and to indicate the amounts expended to date or needed in the future were not asked in the same way, and thus do not allow for direct comparison. Overall, however, the basic take-aways are consistent across surveys and thus lend considerable confidence in our assessment of the situation pertaining to funding challenges reported here.

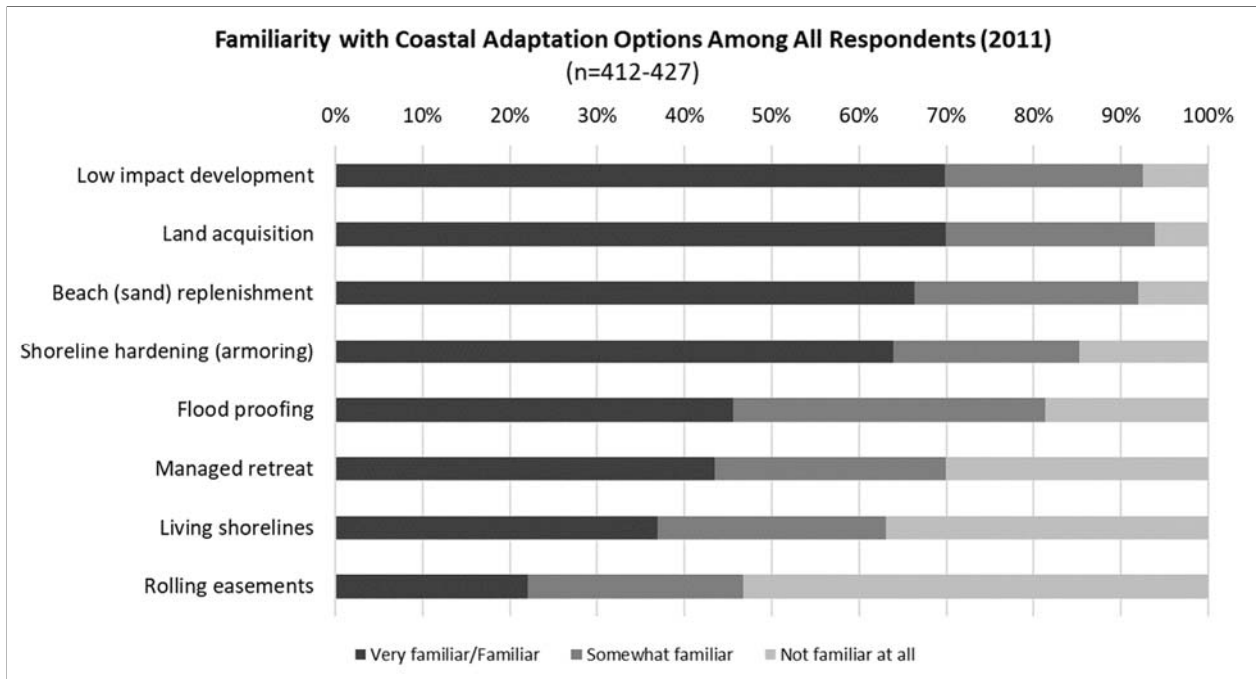
5.6 Adaptation Options and Implementation

The final questions in this part of the survey about adaptation progress and challenges focused on coastal professionals' familiarity with various coastal adaptation approaches and the likelihood that those approaches will be implemented in their communities. Overall, California coastal professionals indicated they are most familiar with *beach (sand) nourishment* (78%), followed by *low impact development* (75%). This is a shift from 2011, which identified *low impact development* (68%) and *land acquisition* (68%) as the adaptation options most familiar to respondents five years earlier. Moreover, 72% in 2016 survey respondents indicated they are *familiar* or *very familiar* with *shoreline hardening*, an increase from 62% of respondents in 2011. Familiarity with *living shorelines* and *managed retreat* has also increased since 2011 from 35% to 64% and 41% to 61%, respectively (Figure 11a and 11b; see also Figures A-49a-g).



Source: The Authors

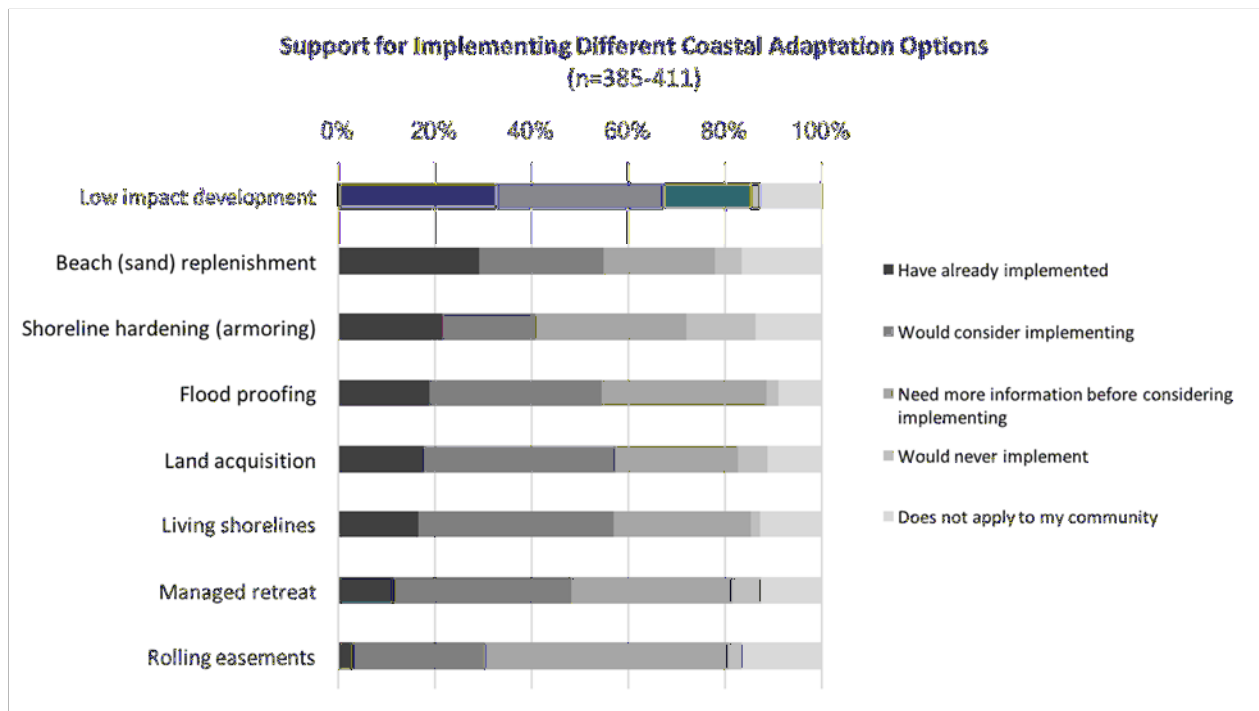
Figure 11a: Familiarity with Different Coastal Adaptation Options in 2016



Source: The Authors

Figure 11b: Familiarity with Different Coastal Adaptation Options in 2011

Finally, we asked respondents (for the first time in 2016) about the likelihood that the various approaches will be implemented in their communities. The strategies most commonly identified as *already being implemented* include *low impact development* (38%), *beach nourishment* (35%) and *shoreline hardening* (25%) (Figure 12). When asked which options they would *consider implementing*, *living shorelines* (46%) and *land acquisition* (45%) topped the list. *Rolling easements* stood out (61% of respondents) as a strategy that would *require more information before it would be considered for implementation*. Notably, 17% of respondents said that they *would not consider implementing shoreline hardening*. No other strategy had that level of opposition (Figure 12; see also Figures A-50a-g for a summary and breakdown by respondent type).



Source: The Authors

Figure 12: Support for Implementing Different Coastal Adaptation Options

In the next section, we turn to the information, training, and other support needs coastal professionals have at this time to further advance adaptation in California.

6: Information, Training, and Decision Support Needs

Questions about information, training, and decision-support needs are investigated in the last major substantive section of the survey to provide valuable information to those who provide resources, technical assistance, and professional development opportunities to coastal managers

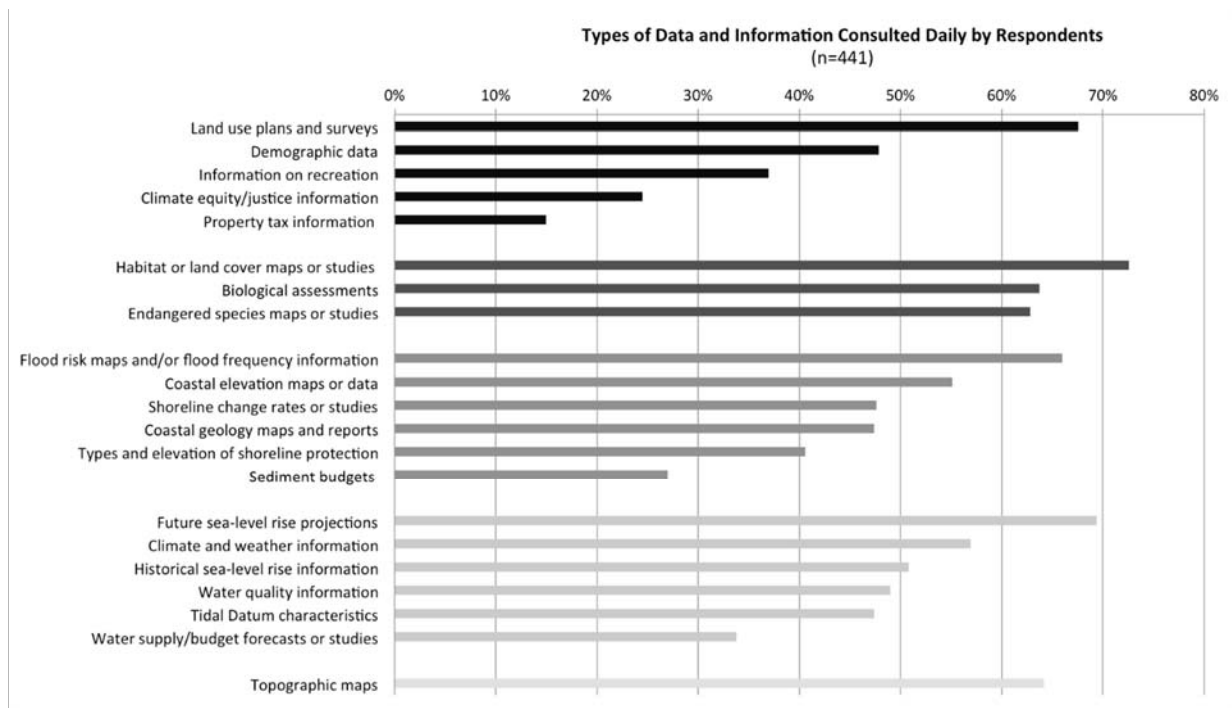
and community leaders. We sought to understand the types of technical and information assistance available to respondents, what resources coastal professionals value, and what other kinds of support they need in their adaptation planning efforts.

6.1 Information Used in Coastal Management at Present

Before addressing the information needs specifically around managing the impacts of climate change, we first sought to understand what types of information survey respondents use most regularly in their daily job responsibilities. More specific information types were categorized into:

- socioeconomic data;
- environmental resource information;
- geological or geomorphological information;
- weather, climate and water information; and
- other information.

Figure 13 illustrates the types of data and information coastal professionals consult on a daily basis.



Source: The Authors

Figure 13: Types of Information Consulted Daily by Coastal Managers

Habitat or land cover maps and studies were identified as the most frequently consulted information of all the options identified (72%). This is followed by 69% of respondents indicating that they utilize *future sea-level rise projections* in their daily responsibilities. *Land use plans and surveys* (68%) and *flood risk maps and/or flood frequency information* (67%) were the next most utilized, followed by *biological assessments* (64%) and *endangered species maps or studies* (63%). The prominence of environmental information is consistent with the mixed-use coastal areas and continued (re)development pressures. Use of such information is legally required in the context of California coastal management and land use.

Overall, the findings on information use are generally consistent with the 2011 findings, with most of the same data and information cited as most commonly utilized. The notable difference is the considerable increase in respondents who now say they use *sea-level rise information* compared to 2011 (69% vs. 57%, respectively). This finding is consistent with the earlier reported shift toward coastal professionals now seeing sea-level rise as a present-day (as opposed to future) management challenge.

In the 2016 survey, we distinguish between *future sea-level rise projections* and *historical sea-level rise information*; the latter was utilized by fewer respondents (51%). Because this is a new distinction, we are not able to discern a trend from the previous survey. Nonetheless, it is clear that *future sea-level rise projections* are now a very commonly used source of information in coastal professionals' daily work. The use of other types of geological/geomorphological data either increased or stayed the same, reflecting physical shoreline change concerns noted in the questions on current management challenges, and likely a continued strong focus on permitting conditions and/or land use planning and decision-making, given continued (re)development of the coastal zone.

The use of socioeconomic data sources, however, remained among the least-utilized types of information. With a growing recognition of the need to incorporate climate justice and equity in all planning and decision-making, we included a new question in this survey to ascertain the level of use of *climate equity/justice information*. Only 24% of respondents indicated that they utilize this information – the lowest after *property tax information* (15%). Thus, despite significant federal, state, regional, and local discussion about this important component of adaptation planning, at the time of the survey this type of information was not being readily used. At the same time, at the time of the survey, social equity was not yet a required component of local comprehensive plan updates. It will be interesting to see how this item changes in importance over time.

6.2 Identified Information Needs for Adaptation Planning

As the survey transitioned from assessing information use in daily job responsibilities to information needs in support of climate change/adaptation planning, respondents were asked to identify the most useful types of information to assess the risk from climate change to local resources. These were divided into weather/climate, physical, biological, and socioeconomic information. We discuss each in turn.

6.2.1 Weather & Climate Information

All respondents (except academics) identified *regionally-specific projections of climate change (for the next 2-3 decades)* as *very/fairly useful* information for climate-related work. The next most useful categories of information identified by respondents included *CA climate change projections*

(2-3 decades), and regionally-specific climate change projections (end of century). Compared to 2011, across all sectors and groups, a highly statistically significant larger percentage of respondents identified these data and information as *very useful* in 2016 (e.g., *regional climate projections* are listed as *very useful* by a range of 65% - 85% in 2016 compared to 48% - 65% in 2011, Independent Samples T-test, $p < 0.001$ for CA- and regionally-specific projections for next 2-3 decades and end of century and $p < 0.01$ for regionally-specific projections for end of century). This indicates a growing interest and use of these types of information across all respondent groups. Among city and county respondents, however, ~15% identified these types of information as *not useful*, indicating that there are still some communities that do not see the utility of this type of information at all (Figures A-52a-e).

When examining the responses by regions, the regions largely follow the same pattern as the sectoral breakdown, with *regional climate projections (2-3 decades)* identified as most useful in all regions. By contrast, academic respondents indicated that information about *climate variability* and *seasonal climate predictions* and *future climate variability* were the most useful for their work. This difference is not entirely surprising. Government officials, consultants, and NGOs' interest in near-term climate information reflects the time scale that is most relevant to their common planning horizons, such as updates of local coastal programs, comprehensive plans, and hazard mitigation plans. Academics are not restricted to current planning practices and may pursue other interests. Among all respondents and regions, *weather forecasts* and *seasonal climate projections* were identified as the *least useful* information for assessing and planning for climate change impacts.

6.2.2 Physical Information

Respondents across all sectors identified the usefulness of the same top datasets, albeit in slightly different orders: future sea-level rise projections (~70%-90%), shoreline change under SLR scenarios (~65%-89%), and changes in flooding of shoreline areas (63%-84%). The least useful datasets varied among the different respondent types, but most identified ocean acidification as being not at all useful, likely a reflection that many coastal professionals do not see the open ocean as part of their responsibility. Considering the focus on equitable beach access mandated through the CA Coastal Act, it is surprising to note that information on changes in beach access did not rank higher for respondents (Figures A-54a-e).

There is close alignment on the physical information needs across coastal regions, although there are some regional differences in what is deemed most useful. In Northern California counties, for example, *changes in groundwater elevation* was ranked in the top 4, along with *changes in tidal range*, *shoreline change*, and *fine-scale digital elevation information*, likely reflecting the most immediate concerns for that region.

6.2.3 Biological Information

Extent of wetlands was identified as the most useful data sources by government representatives, NGOs, and environmental consultants (~52%-90%). Since the 2011 survey, there has been an increase in the discussion of the role of wetlands, natural migration of coastlines, and living shorelines (a.k.a. natural infrastructure) as important adaptation strategies (as demonstrated also in the adaptation options discussion above). We have observed this in our work with

coastal stakeholders. In addition, NOAA²², EPA²³, the US Army Corps of Engineers²⁴, and several other institutions have released guidance documents encouraging the use of natural infrastructure in coastal management (Bridges et al. 2015; Clements and St. Juliana 2013; Cunniff and Schwartz 2015; Davis et al. 2015; EPA 2014; NOAA Living Shorelines Workgroup 2015; NOAA OCM 2015; RAE 2015). A companion study for the Fourth Climate Assessment is providing guidance and case studies on where certain types of natural infrastructure could be used, along with providing high-level blueprints (Newkirk et al. 2018). It is therefore not surprising to see that the call for information on wetlands has increased among all the respondents.

Depending on respondent types, other sources of information were also identified as most useful, including: *critical habitats and corridors* (56%) for city and county representatives; *species response to climate change* (65% and 70% for consultants and state, federal, and regional representatives, respectively); and, *ecosystem health or stress* (~83%) for NGO respondents (Figure A-56a-e). The usefulness of these types of data were not statistically significantly different between the years. Conversely, we see a decrease in the perceived usefulness of information on *invasive species* compared to 2011, which was ranked as *very useful* information by most respondents then, though this decrease was also not statistically significant. Academics also identified the *extent of wetlands* but found *monitoring protocols* and *ecosystem health or stress* to be even more useful information for their purposes.

These findings persist in the regional breakdowns, with *wetlands* and *habitat connectivity* ranking among the most useful types of information across regions. Northern California diverges again from the others, however, in elevating the importance of information on *invasive species*.

6.2.4 Socioeconomic Information

As in 2011, information on the *costs of adaptation options* and the *tradeoffs of adaptation options* was identified in 2016 as the most useful information for all respondents, including academics. However, there was a substantial increase in the relative percentage of respondents who deemed this information as *very useful* (Table 8).

Table 8: Selected Socioeconomic Information Deemed “Very Useful” (range across respondent types, 2011 vs. 2016)

	2011	2016
Cost of adaptation	55% - 65%	71% - 82%
Tradeoffs	48% - 68%	68% - 82%

Source: Authors' calculations

²² NOAA provides trainings in green infrastructure; see: <https://www.coast.noaa.gov/digitalcoast/training/green>.

²³ EPA provides a range of tools and resources at: <https://www.epa.gov/green-infrastructure/coastal-resiliency> and at: <https://www.epa.gov/green-infrastructure/green-infrastructure-cost-benefit-resources>.

²⁴ USACE has built its own web-based resources (Engineering with Nature) at: <https://ewn.el.erdc.dren.mil/nbnf.html>

As discussed in Section 5 above, the practitioner community has generally advanced in the adaptation process, with more now in the *Planning* phase of adaptation, i.e., where they have *completed an assessment of risks* and have moved into *brainstorming and assessing a range of options to prepare and plan for risks*. Therefore, identifying how much the strategies will cost and which ones to select, and information on how to weight different adaptation options, is becoming more important and useful to coastal professionals (Figures A-58a-e). We see the same shift in the regional breakdowns.

6.2.5 Perceived vs. Actual Usefulness of Information

In order to provide the most relevant information to users, the sectoral and regional distinctions observed in the above section are important for information providers as they work to connect end users with the most relevant and needed science. However, these findings should not preclude the sharing of other types of science and information, since the perception of usefulness may not translate directly to what is actually most pressing and/or what climate impacts may create the greatest vulnerabilities for a region. As we have seen in the findings thus far, perception of useful information has shifted in just five years. While we may speculate as to the causes for these shifts (given that they are not discernible from the survey results alone), there may be many drivers behind them. For example:

- The increased focus on and funding for local coastal program updates, which require attention to sea-level rise and coastal erosion/flooding vulnerabilities, can elevate the perceived usefulness of information about these hazards.
- Coastal Conservancy grants for coastal habitat restoration can elevate the importance of biological information.
- Policy drivers can bring attention to information not considered relevant before (e.g., we expect social equity to become more important in the future, given recent mandates to account for it in general plan updates).
- Informational webinars and other education and outreach by service providers can help shape perceptions of importance, credibility and usefulness.

By contrast, issues that are not directly mandated, supported by funding, or elevated in outreach can slip in recognition, even if they are just as important to the comprehensive management of coastal areas. For example, issues that we found to rank lower on the list of perceived usefulness – e.g., *ocean acidification, invasive species*, and how best to *monitor impacts to natural systems* – are extremely important for healthy coastal communities. Thus, we caution information and service providers to balance responding to perceived needs with helping coastal professionals recognize the importance of other types of information.

6.3 Information Sources, Communication Channels, and Tools Used by Coastal Professionals

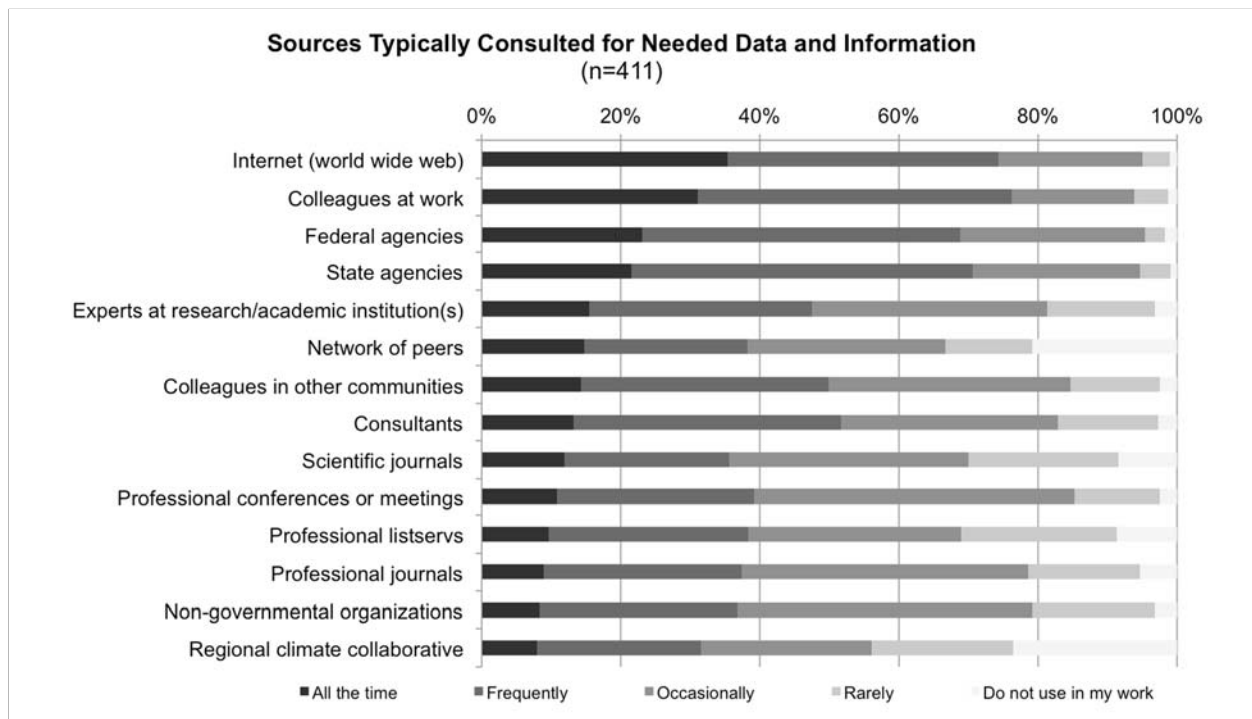
6.3.1 Preferred Information Sources Consulted by Coastal Professionals

In addition to asking coastal professionals about their information needs, we also asked them to identify the sources they typically turn to for trusted information (Figure A-123). Across respondent types, the *internet* – loosely defined as the world wide web – was also identified as the most important source to turn to across respondent types, as it was in 2011. This is

understandable as most state resources and scientific information are now commonly accessible through the web. However, the ease of access via the internet also raises concerns, as it is difficult to ensure that practitioners are using vetted and authoritative information.

Colleagues at work and *federal agencies* also feature near the top of the sources used frequently or all of the time. Still within the top four, survey participants identified *state agencies* among the most common source they turn to. This finding reflects the growing role of the state in developing information and guidance for coastal practitioners (recall, e.g., the importance of various state policies and guidance documents in prompting coastal managers to begin adaptation planning).

And while *scientific journals* remain near the bottom of the list, reiterating the need for scientists to find other ways of sharing their results if they wish or expect them to be utilized by coastal practitioners (Figure 14), *experts at research/academic institutions* are quite frequently consulted. In other words, the importance of their work and expertise is recognized, but their most common outputs remain inaccessible to coastal practitioners.



Source: The Authors

Figure 14: Commonly Consulted Sources for Needed Data and Information

All of these observations are quite similar to findings in 2011. Despite the development of *regional climate collaboratives*²⁵ in many coastal regions, they rank at the bottom of the list as

²⁵ This was a new answer option in 2016 so no comparison is available for 2011.

sources of information for adaptation planning. The exceptions are city and county respondents who place regional collaboratives in the center of the distribution (Figure A-60). While the survey does not provide sufficient information to explain this low ranking of regional collaboratives, we suspect that regional collaboratives serve an important information sharing and peer-learning function but are not themselves an independent source of information.

6.3.2 Preferred Communication Channels

When asked to identify the information channels coastal professionals use to get information for their work, *newspapers* and *institutional email alerts* were identified as preferred sources of information over *Facebook* and *Twitter*. This is an important finding for communication and outreach professionals, indicating that the increasing reliance on social media may not be the most effective way to reach professional coastal audiences looking for information. We note, too, that at the time this survey was administered, “fake news” and divisive social media battles were not yet as common as they are at the time of this study.

6.3.3 Information Processing Tools Used by Coastal Professionals

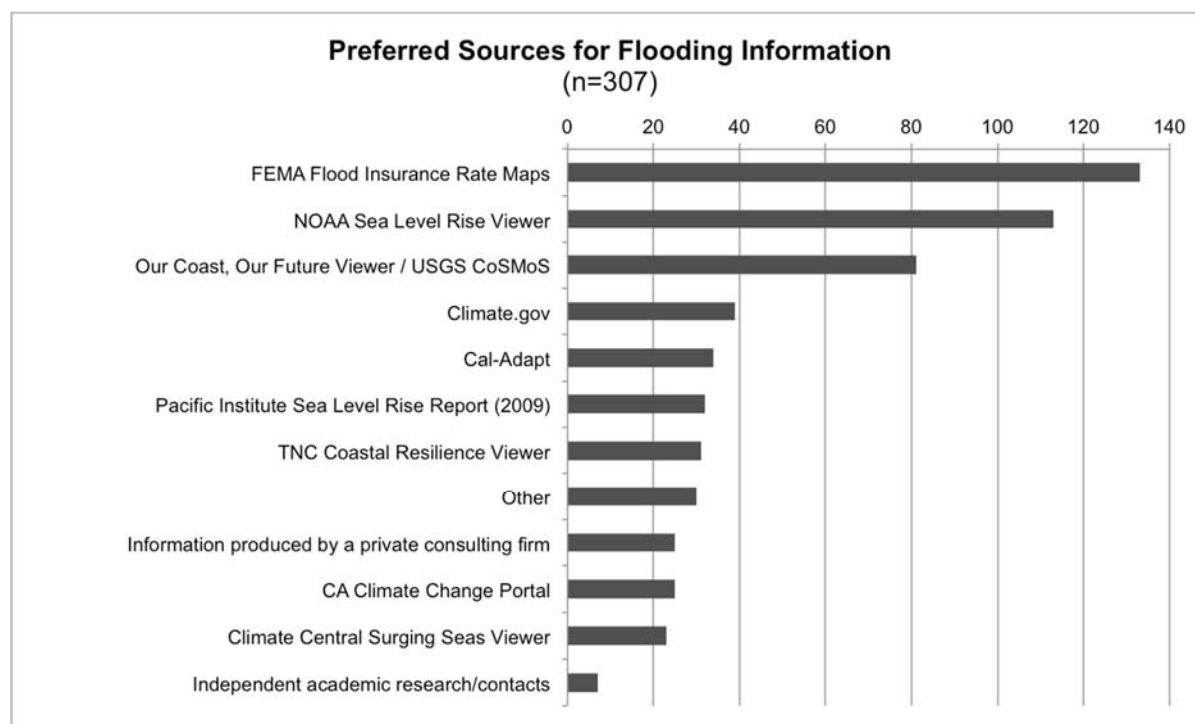
In rating the use of various processing tools, we observe an increase in the use of more sophisticated tools either by respondents themselves or by people within their offices (Figures A-65a-d). *Paper maps and overlays* are commonly used by all sectors, both now and in 2011. However, city and county respondents indicated that *geographic information systems (GIS)* are now being used by 62% of those respondents themselves compared to only 42% in 2011. We also observe an increase in the number of respondents utilizing *scenario planning* (between 24% and 60% of respondents use this tool themselves in the 2016 survey, whereas this was ranked the tool used by the fewest respondents (16%) in 2011).

Similarly, since 2011, there has also been a proliferation of flood and coastal hazard viewers that are now available to – and readily used by – coastal practitioners (Figures A-63a-e). Several of them, such as NOAA’s *Sea Level Rise Viewer* and *Climate Central’s Surging Seas* online sea-level rise visualization tool, are national in scope, while others, such as the *Our Coast, Our Future (OCOF)* and *The Nature Conservancy (TNC) Coastal Resilience* sites, are regional. Site-specific hazard viewers have also emerged, such as the *Flood Resilient Infrastructure and Sustainable Environments (FloodRISE)* online viewer for three southern/Baja California locations.²⁶ When respondents were asked to identify their preferred source for flooding information, the *NOAA Sea Level Rise Viewer* and *Federal Emergency Management Agency’s (FEMA) Flood Insurance Rate Maps* were identified as the most frequently consulted tool, followed by the *Our Coast, Our Future* viewer. The latter is a notably high ranking, given that the tool (based on USGS’s CoSMoS model) at the time of the survey was only available for southern California and the SF Bay Area and its associated outer coast (see CoSMoS report prepared for the Fourth Assessment). *Climate.gov* and *Cal-Adapt* were the next most frequently selected options (Figure 15).

This pattern of preferences persists across all respondent types. The national/CA-scale viewers were also ranked the same across regions but the *TNC Coastal Resilience Viewer* rose higher in the Central Coast (where it originated for California), while *OCOF* was selected most often in

²⁶ For more information, see: <http://floodrise.uci.edu/>.

the Southern, San Diego, and Bay/Delta regions. *OCOF* and *TNC* are not yet available for the Northern California counties, thus did not rank high in those responses.



Source: The Authors

Figure 15: Preferred Sources for Flooding Information

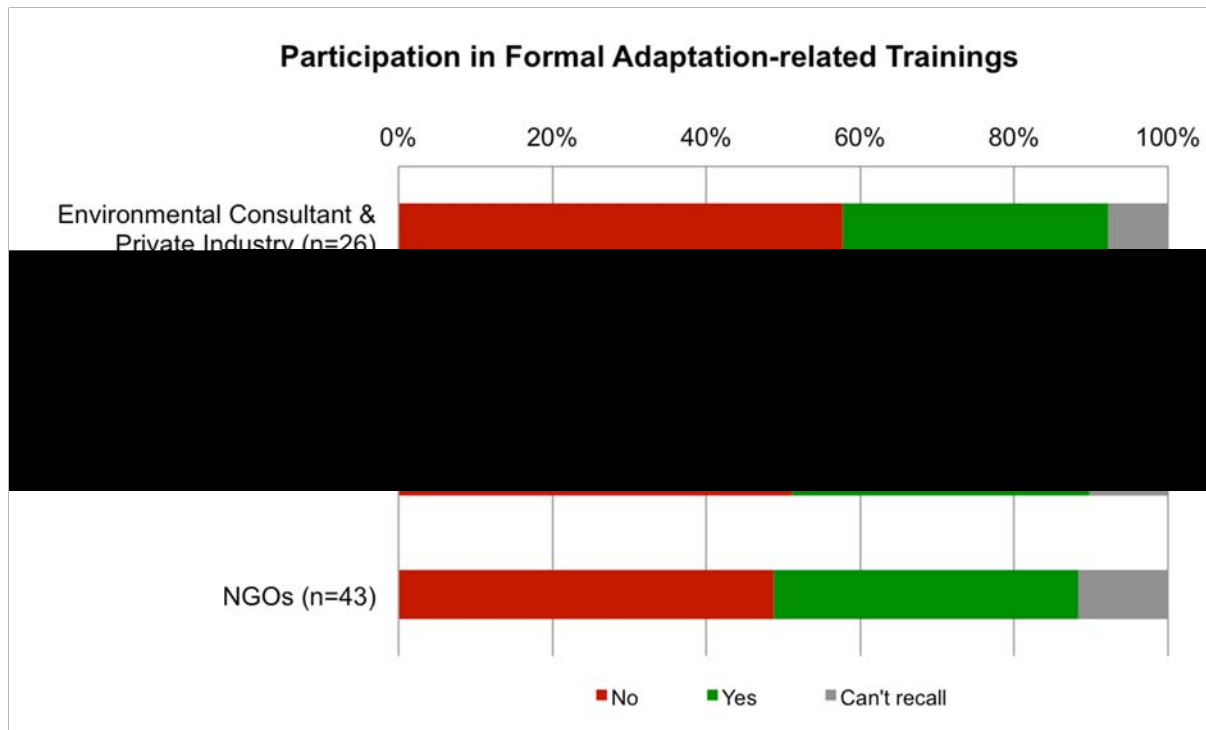
When asked why coastal professionals preferred a certain flood viewer, the three most common responses included some combination of *ease of use*, *familiarity*, or *region-specificity*, followed by *accessibility/availability* (Figure A-64). These factors – along with the direct link to regulation and insurance – help explain why FEMA’s Flood Insurance Rate Maps rose to the top of every list. Findings suggest that both FEMA and NOAA are viewed as authoritative sources on past and future flooding, respectively. In fact, regulatory requirements and brand recognition can outweigh other factors (such as greater geographic resolution) in the selection of sources for flooding information. The high ranking of CoSMoS/OCOF, which provides detailed projections of future coastal flooding, is consistent, however, with the growing interest and perceived usefulness of locally-specific, forward-looking flooding information.

6.4 Training for Coastal Adaptation Practitioners

Despite the growing sophistication and utilization of more complex processing tools, most coastal practitioners are still essentially learning about adaptation “on the job” rather than through formal training opportunities. As in 2011, the majority of respondents indicated that they had not received any formal training in adaptation (no statistically significant differences between the years, Independent Samples T-test). This response is consistent across all sectors

and all regions, except for the San Diego region, where a slightly greater number of respondents indicated that they had received some kind of training.

The majority of respondents – across all sectors – say they have not participated in formal adaptation training (Figure 16), but they indicate *in-person trainings* as their preferred method for learning about available information and tools. These were followed by *webinars* and *web-based trainings*. Thus, as in 2011, there continues to be a strong appetite for in-person opportunities to connect and learn, yet respondents are either not attending those opportunities (lack of time, after all, was identified as a major hurdle for coastal professionals) and/or they do not identify available workshops they have attended as “formal” training opportunities (see also Figure A-66a-b). For elected officials, *training for staff* ranked the most useful for helping them learn about adaptation-relevant information, resources and tools, followed by *one-on-one briefings* and *speakers to attend hearings* (Figure A-67b).

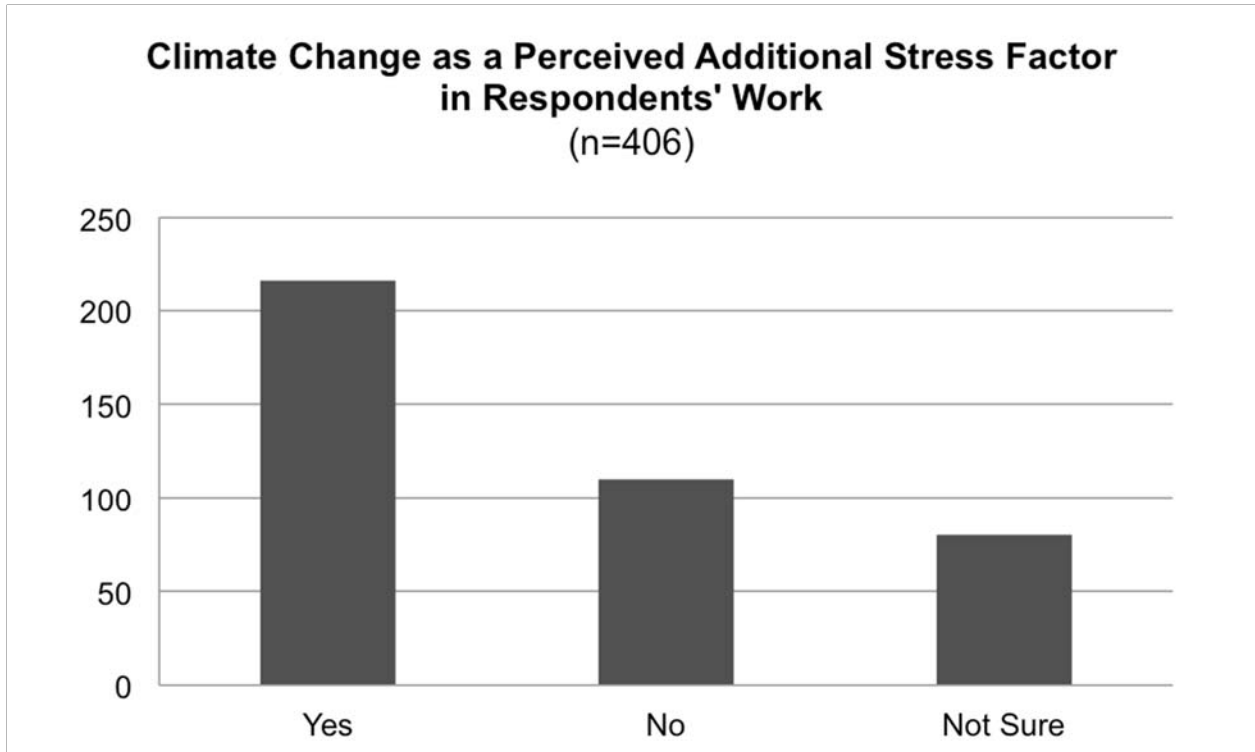


Source: The Authors

Figure 16: Coastal Professionals' Participation in Adaptation Trainings

6.5 Support Beyond Information and Training

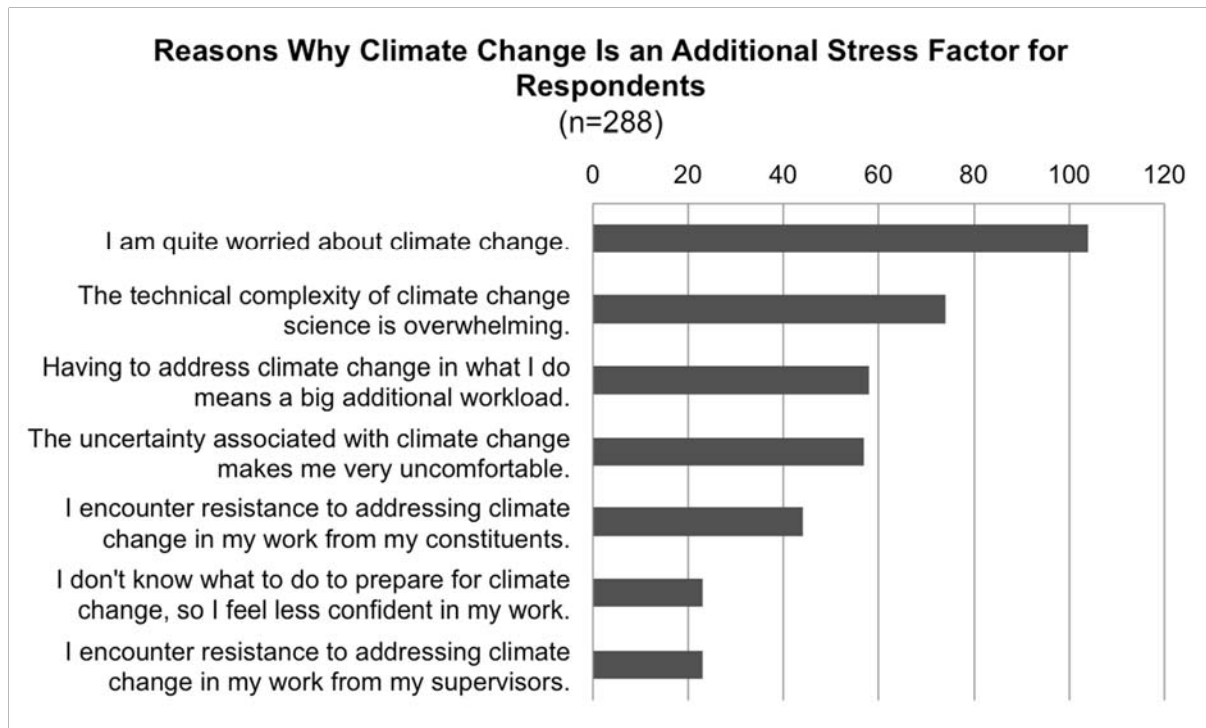
For the 2016 survey, we inserted a new question in response to the growing professional – and psychological – demands on coastal practitioners to consider the impacts of climate change in their work and to include climate mitigation and adaptation in their work portfolios. We sought to ascertain whether climate change constitutes an additional stress factor in their work. Across all sectors and regions, and among elected officials, respondents overwhelmingly indicated that it did (Figure 17).



Source: The Authors

Figure 17: Experience of Climate Change as an Additional Stress Factor

When further questioned on the source of the stress, the majority of both elected officials and other respondents indicated that they are stressed for a number of reasons (Figure 18), including: *I am quite worried about climate change* (35%); *The technical complexity of climate change science is overwhelming* (27%); *The uncertainty associated with climate change makes me very uncomfortable* (20%); and *Having to address climate change in what I do means a big additional workload* (20%).



Source: The Authors

Figure 18: Common Reasons Why Climate Change Serves as an Additional Stress Factor

Across the regions, *I am quite worried about climate change* ranked at the top (or near the top) for all respondents, but the ranking of other responses varied from region to region. Interestingly, the least selected responses included *encountering resistance from either constituents or supervisors*. For Southern and Central California counties, these reasons were also ranked last, but they were essentially on par with all the other responses (Figures A-69).

6.6 Contextualizing Support Needs

Around and since the time this survey was administered to coastal professionals in California, a number of independent efforts commenced to better understand coastal professionals' information and technical support needs around planning for sea-level rise. These stakeholder consultations were conducted in the context of several parallel, ongoing efforts, including:

- The establishment of a statewide adaptation clearing house (ICARP);
- The update of the statewide sea-level rise guidance (under the leadership of OPC);
- The establishment of a sea-level rise action database, driven by AB2516²⁷; and

²⁷ Ab 2516 (Gordon) demands the establishment of a Sea-level Rise Planning Database; see: https://leginfo.legislature.ca.gov/faces/billNavClient.xhtml?bill_id=201320140AB2516. Work is conducted by Bruce Riordan and colleagues at UC-Berkeley's Climate Readiness Institute.

- Ongoing stakeholder engagement in the context of partner organizations working with coastal professionals to meet their needs.

Insights gained from those independent efforts largely confirm and reinforce these survey findings. A clear finding from those efforts, for example, is the challenge for coastal professionals of dealing with conflicting climate change information. Several of the author team have been involved in those stakeholder solicitations and all work frequently with coastal communities. We are thus aware of significant confusion among coastal practitioners about how to relate – for example – FEMA’s current-day flooding information with the various sea-level rise projections available for the same locations (past and currently updated OPC sea-level rise guidance, Fourth Assessment study results, CoSMoS results etc.). With state sea-level rise policy guidance pointing coastal managers to consider significantly different flooding projections from those that are based on historical data, we see a critical opportunity for FEMA, NOAA, and the other modeling groups to work together to better communicate to coastal practitioners what each product offers and how to use the information for different planning and management purposes.²⁸

Similarly, continually expressed misperceptions or misinterpretations of climate change information and articulated needs to better understand certain aspects of the adaptation process suggest that our survey findings of a continuing need for trainings is a high-confidence finding. Importantly, the list of what coastal professionals need is expanding, not shifting wholesale. For example, some increasingly wonder what adaptation actions are effective and how one would measure adaptation “success.” There are still many communities, however, who have not yet begun adaptation or who are still in the early stages, while others are further advanced and have growing needs with respect to economic assessments, trade-off analysis, performance assessment, and so on. Thus, adaptation service and technical assistance providers have license to offer a wider set of training opportunities.

Agencies have not yet paid attention to the non-technical, psychological support needs of coastal professionals, and we see opportunities for traditional “coastal” agencies at the state, local, and federal levels to work together with public health agencies and mental health service providers to assess and develop supporting structures and resources.

7: Conclusions and Future Directions

7.1 Key Takeaways

Taking an integrative look at the results of the 2016 coastal adaptation needs assessment survey reveals a maturation of coastal climate adaptation in California. Increasing numbers of coastal

²⁸ Several of the report authors, project partners and FEMA are working to better understand each other’s products and to develop planning alignment guidance and resources that will help coastal communities navigate the wealth of information currently available. A future step will be to harmonize this with OPC’s sea-level rise guidance (update published in early 2018). This and previous efforts (such as Climate Central’s efforts in developing a comparative overview of SLR viewers, or the “Lifting the Fog” workshop (see: <https://www.nerra.org/projects/our-coast-our-future-planning-for-climate-change-in-san-francisco/>)) are all pointing in the right direction.

professionals believe human activity is causing the climate to change. Their personal concern about these changes has increased. They strongly believe that they should be considering climate change impacts in all decision-making and have been doing so for several years now. Combined with demographic results that suggest a highly educated and seasoned respondent pool, these results lead us to conclude that coastal professionals are leading the way in advancing climate change adaptation in California.

Whether it is due to the impacts of climate change and sea-level rise emerging as an everyday reality, and/or whether it is due to coastal professionals increasingly recognizing the need for proactive adaptation planning, our survey results show clearly that sea-level rise has emerged as the dominant present-day coastal management concern (along with coastal erosion and water quality concerns) across California. This is a notable shift among all types of survey respondents compared to 2011 survey results, when sea-level rise was mostly seen as a future coastal management challenge.

Coastal adaptation itself is also further advanced now compared to 2011 across California, but coastal professionals continue to face significant hurdles in moving from understanding coastal risks to planning and implementing actions. While the leading barriers are the same as in 2011 (lack of funding, limited staff capacity, and pressing other issues competing for coastal professionals' attention), 8 (or 42%) of 19 barriers are now rated as bigger hurdles than they were rated in 2011.

Overall, the survey suggests that technical assistance and investment in actionable scientific information have paid off in coastal California. *Lack of technical assistance* and *lack of access to relevant information and data* is now perceived as less of a hurdle to adaptation than in 2011. Moreover, there is a notable shift in information needs: while coastal professionals' dominant information needs in 2011 focused on becoming more familiar with sea-level rise-related coastal risks, the greatest needs now are knowledge of solution options and how to implement them (e.g., costs, trade-offs). Equity and justice – a new aspect in the 2016 survey in response to state-level policy direction – is one of many motivations to begin adaptation; consequently, data on social equity are also of interest to coastal professionals now.

Support needs extend beyond the technical, however. For the first time, the 2016 survey asked whether coastal professionals experience climate change as an additional stress factor and found that they do, largely because they worry about the profound implications of climate change, because of the technical complexity of what they now face, and because of the growing debates that tough adaptation choices place before coastal decision-makers.

Already in this survey, we observe quick and significant changes in the coastal environment – in terms of problem perceptions, attitudes, current stage in the adaptation process, and in information and support needs. Based on our own ongoing experience working with coastal professionals across California and beyond, we believe this observation of rapid change will continue and accelerate as climate change itself, and the demands on coastal professionals, increase in the future.

7.2 Future Survey Adjustments and Research Needs

As the longitudinal study that this survey represents, we see great value in continuing to periodically reassess where coastal professionals are in California in their adaptation efforts and how the conditions and support needs for adaptation are changing over time. Given the

influence that past surveys have had on coastal agencies and service providers, we recommend that similar longitudinal surveys be conducted for other sectors to adequately support resource managers wherever they are (e.g., water, forests, agriculture) as well as public health/social service providers, and to enable cross-sector comparisons.

Our survey revealed several limitations and challenges that should be addressed in future iterations. For example, we noted that the survey over-represents Southern California and Bay Area urbanized coastal regions, while it has less-than-adequate representation of the Delta and Northern California regions. It also is completely inadequate in capturing tribal concerns. Future studies will need to strengthen representation from this important stakeholder community and also consider different methodologies for assessing their activities, barriers, and needs.

In line with the benefits of building a longitudinal understanding of changing adaptation conditions across coastal California, we anticipate that future surveys will hold some questions steady while adjusting others to better account for changing needs and circumstances.

We already see several areas in which the survey could examine changing needs more deeply. For example, future surveys could ask with greater specificity about training needs. We know for example from our experience working with coastal professionals that they increasingly wonder which adaptation actions are most effective and how to monitor and track their performance, but how to do so is not widely known. Thus, a future survey could more specifically inquire about needs in this regard. Our experience also suggests that coastal professional work increasingly in tension-filled public debates around adaptation choices, as the grave implications of climate change become ever-more apparent to their stakeholders. However, economic dependencies, financial and legal barriers, policy mandates from the state, and heated local public sentiment leave many coastal professionals in unenviably difficult situations. We anticipate these debates will only grow in complexity and possibly in difficulty as risk disclosure mandates, changes to climate action-dependent credit ratings, and federal budget cuts impact the adaptation agenda at the local level. Future studies should better capture how coastal managers' needs are changing and how they can be better supported without giving up on their fiduciary, legal and public obligations to prepare for a more difficult future.

7.3 Implications for Policy and Adaptation Service Provision

Coastal management in California has always been and will continue to be heavily influenced by policies made and enacted at all levels of government. Increasingly, it will also be heavily influenced by the private sector entering the adaptation space in greater force than to date (Moser, Coffee and Seville 2017). Increasingly, state policy influence comes via specific adaptation-related policies, guidance documents, and financial incentives (grant programs). The survey results compiled here show the important influence these policy directives have had both in motivating and positively advancing coastal adaptation, but they also show that they don't support adaptation quite enough yet.

The greatest gap that holds communities back from entering the adaptation process and moving adaptation plans to implementation action is the financing gap. Our survey results not only demonstrate that lack of funding and related capacity constraints constitute the biggest barriers to advancing adaptation, but it also - for the first time - gives order-of-magnitude estimates of

what the funding need in coastal California might be. The sheer size of that need underlines what many already recognize, namely that competitive grant-making will not suffice to adequately prepare coastal communities and keep them safe in light of growing climate change-driven coastal hazards and disruptions. This approach frequently favors higher-resourced communities and disadvantages lower-resourced communities, and thus constitutes – among other things – a significant equity concern. (For further examination of the complex adaptation finance related challenges local governments face and ways to address them more comprehensively than thru more money alone, see Moser et al. 2018.)

The findings presented here, instead, demand a fundamental rethinking not just of how to finance adaptation, but how local coastal communities fund their operations given their large dependence on property tax income, which is increasingly threatened by climate change impacts. This dependence points to a clear conflict of interest with some adaptation options (such as managed retreat), and places local communities increasingly at odds with state coastal policy. Political leadership from the gubernatorial and legislative branches of state government is required, as well as courageous, forward-looking leadership from local-level officials and other influential stakeholders (e.g., NGOs, philanthropy) to initiate a sustained, albeit difficult dialogue on these interlocking challenges. Simplistic pointers to “greater private sector” involvement in adaptation finance will be insufficient, given the great complexity, difficulty, and often infeasibility of profit-driven, private sector involvement in the provision of public goods and services (again, for an in-depth discussion of these issues facing California communities, see Moser et al. 2018).

Pragmatically, our survey points to several other action recommendations oriented toward those who provide information, technical assistance, training, and other adaptation services to coastal managers. For example, the results presented above on coastal professionals’ knowledgeableability suggest that more outreach and training on the science of climate change is needed for local government professionals, both at the staff and elected levels. Private sector representatives, consultants, and academics would also benefit from this outreach and education. State, federal, regional, and NGO respondents continue to have a good grasp of the current science of climate change and are becoming more confident in that knowledge. But, as indicated, the needs of coastal professionals are shifting; thus, there is a need for continuing professional development and education to stay ahead of emerging support needs. Concurrently, a strong need for capacity building, educational outreach, and training persists, particularly for local government staff and elected officials. The offerings need to range from entry-level introductions to the basics of adaptation to the more advanced challenges coastal professionals now face, e.g., economic analyses, trade-off analyses, enhanced communication trainings, and guidance in forming and managing complex public-private partnership on novel adaptation finance mechanisms.

Our survey also revealed that urbanized areas in particular are farther along regarding adaptation, while rural areas are still in the earlier stages. We believe greater attention needs to be given now to the less densely populated, rural coastal regions, with additional technical assistance and other support (e.g., trainings, outreach, backing up of political leaders). Lack of technical and political capacity can magnify the challenges that accrue because of lack of funding for planning and implementation, and those around lack of staff capacity in light of concurrent other pressing issues.

We believe that far more rapid and significant progress could be made in leveling out regional differences in skill and capacity and in advancing adaptation, if the state – together with professional societies such as the American Society of Adaptation Professionals, universities, and qualified adaptation service providers and NGO partners – were to develop a pilot certification program for adaptation professionals, similar to what is expected of chiropractors, teachers, and any number of other specialized professional fields. After testing and refinement, such a certification program could be overseen and implemented on an ongoing basis and eventually become a requirement for employment, grant or contract acceptance, and permitting for any adaptation-related effort. In light of growing concerns with liability and fiduciary responsibility, such a certification program – together with state policy guidance and state-sanctioned best available climate change science – would provide a cost-effective and legally defensible basis on which to rapidly advance adaptation in coastal California and beyond.

8: References

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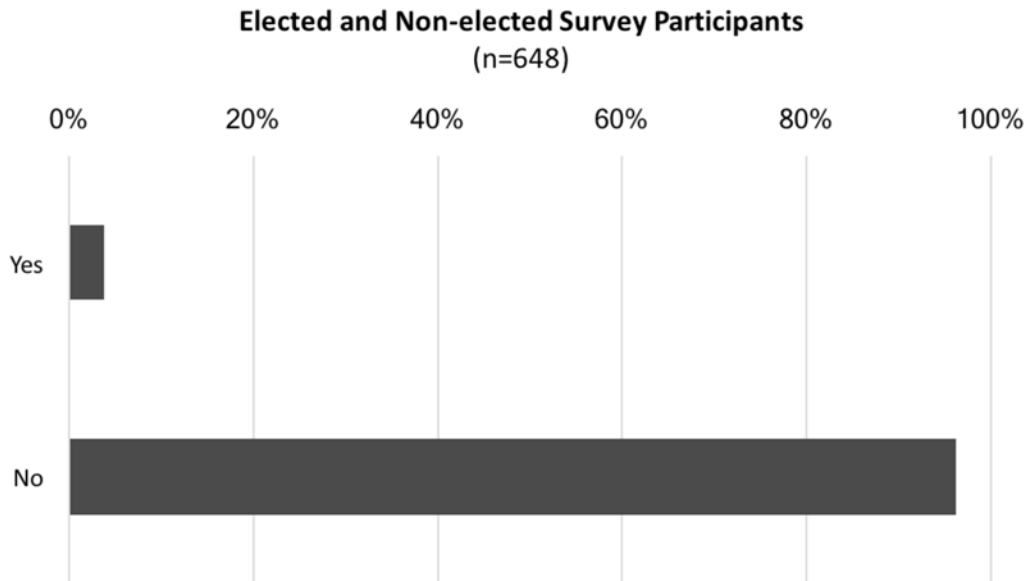
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APPENDIX A: Coastal Adaptation Needs Assessment Survey

Part 1: Survey Population

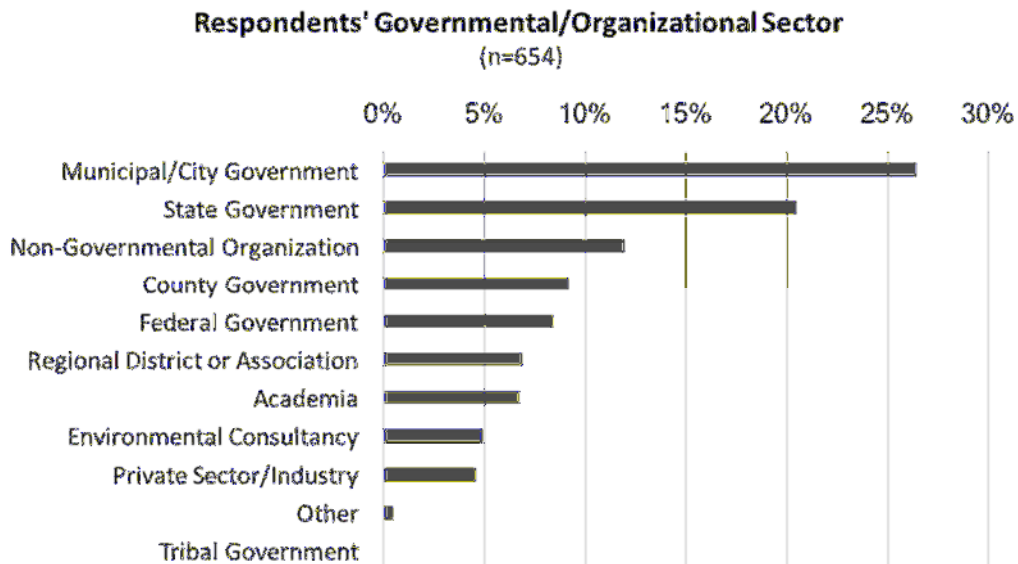
1. Please indicate if you are an elected official.



Source: The Authors

Figure A-1: Elected and Non-elected Survey Participants

2. If a non-elected official, please indicate the governmental/organizational sector in which you work.



Source: The Authors

Figure A-2: Respondents' Governmental/Organizational Sector