

ADAPTING COASTAL CITIES AND TERRITORIES TO SEA LEVEL RISE IN NORTH AMERICA - U.S. WEST COAST

Challenges and Leading practices



OCEAN & CLIMATE
PLATFORM



SHARING SOLUTIONS WITH COASTAL
CITIES TO TACKLE SEA LEVEL RISE

Partners



UC SANTA CRUZ



Center for
**SEA RISE
SOLUTIONS**

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The Ocean & Climate Platform, Who are we?

The Ocean & Climate Platform (OCP) is an international network of more than 100 organizations from civil society - including NGOs, research institutes, foundations, local authorities, international organizations, and private sector entities - that draws on the best available science to promote ocean-based solutions to tackle climate change and biodiversity loss. The OCP provides a space where relevant stakeholders can engage in a constructive dialogue, fostering exchanges and reflections. Through its role as a science-policy interface, the OCP supports decision makers in need of scientific information and guidance in the definition and implementation of public policies.

The OCP's agenda on adaptation at the United Nations Framework Convention on Climate Change (UNFCCC)

As an observer organization to the UNFCCC, the OCP has been working towards the integration and mainstreaming of the ocean in its mandate and work plans since its creation in 2014.

National Climate Plans. The OCP is committed to a better integration of ocean-related mitigation and adaptation measures into climate strategies, most notably the Parties' Nationally Determined Contributions (NDCs) and National Adaptation Plans (NAPs), and as such, is mobilized to scale up States' ambitions to meet the goals of the Paris Agreement.

The Ocean and Climate Change Dialogue under the Subsidiary Body for Scientific and Technological Advice (SBSTA). Pursuant to the [decision 1/CP.26 paragraph 64](#), the Ocean and Climate Change Dialogue was mandated by the 26th Conference of the Parties (COP 26) to be organized annually to strengthen the understanding of and action on ocean and climate change adaptation and mitigation. One year later, COP 27 established two-facilitators to conduct this dialogue and drive ambition ([decision 1/CP.27, paragraph 45](#)). The OCP will actively take part in future sessions of the Dialogue and support the work of the co-facilitators.

Expert Group on "Ocean and Coastal Zones" of the Nairobi Work Programme on adaptation (NWP-Ocean). Acting under the aegis of SBSTA, the NWP-Ocean aims to develop knowledge tools for a better understanding and integration of marine issues in States' adaptation strategies, in particular developing countries, including the Least Developed Countries and Small Island Developing States. Since 2019, the OCP has been one of the 23 constituting organizations.

The Global Climate Action Agenda under the Marrakech Partnership (MP-GCA). The MP-GCA establishes a dialogue between Parties and non-Party stakeholders (e.g., cities, regions, NGOs, businesses, and investors) around seven priority climate actions, including the ocean, divided into seven groups. As focal point for the "Ocean and Coastal Zones", the OCP mobilizes non-state actors around key messages, aligned with the Ocean Pathway, to scale up ocean-based climate action towards a resilient, nature-positive, and net-zero future.

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The Sea'ties Initiative

The Sea'ties Initiative aims to facilitate the development of public policies and the implementation of adaptation solutions to support coastal cities threatened by sea level rise. Led by the Ocean & Climate Platform, the initiative is intended for elected representatives, administrators and stakeholders involved in this transition as a forum to exchange knowledge and experiences of sustainable solutions towards coastal resilience. Sea'ties is an international initiative which mobilizes coastal experts and cities from five regions of the world featuring a diversity of climatic, geographic, social, economic, and political contexts. A diversity of solutions has already been implemented across the world and can be inspirational for other coastal cities and territories. By connecting experiences, characterizing them through scientific works and disseminating them in a range of formats, we can promote leading practices and support the choices of political decision makers and regional administrators.

Primary goals

1/ **Compile scientific knowledge and data** into accessible summaries and databases, identifying and analyzing solutions deployed by coastal cities across the world.

2/ **Foster the emergence of good practices and facilitate the exchange of knowledge and experiences** among coastal stakeholders during regional workshops. Leverage collective reflection to identify enabling factors for the deployment of sustainable, equitable adaptation solutions.

3/ **Encourage the integration of adaptation challenges into public policies** by promoting real world experience complemented with scientific knowledge, and by submitting policy recommendations to decision makers so they can integrate the most suitable solutions into public policies at scales from local to global.

Regional workshops

By bringing together experts and stakeholders working on adapting coastal cities and territories to sea level rise – scientists, regional planners, NGOs, civil society representatives, elected officials – regional workshops aim to provide an understanding of the plurality of adaptation responses deployed in diverse geographical and socio-economic settings. Five regional workshops were scheduled between 2021 and 2023. Returns on experience shared by participants will inform the production of recommendations and advocacy work to improve the integration of adaptation challenges into public policies.



Reference tools and documents

The Sea'ties Initiative contributes to the enhancement and dissemination of knowledge on adaptation issues through the production of scientific papers, reports, reference tools, and other material for the scientific community, policy makers, and the public.

• Regional Reports

Each Sea'ties workshop, complemented by preliminary interviews, informs the production of a regional report providing an overview of the current obstacles and needs to be addressed to implement adaptation strategies, highlighted by regional experiences. Intended for policy makers, city and territorial planners, and residents willing to pursue transformational change on their coasts, the reports shed light on good practices to inspire action. The reports "[Adapting Coastal Cities and Territories to Sea Level Rise in Northern Europe, Challenges and Best Practices](#)" and "[Adapting Coastal Cities and Territories to Sea Level Rise in the Mediterranean Region, Challenges and Best Practices](#)",² are available on the Sea'ties webpage.

• The Sea'ties Declaration

Initiated by the OCP, the French Government and the City of Brest, with the support of ICLEI and Race to Resilience, the Sea'ties Declaration mobilizes more than 40 mayors, governors, and city networks across the world to address the challenges of adapting coastal cities and territories to sea level rise. The Declaration is a call to accelerate adaptation action addressed to the international community, and highlights four priority strategies: (1) mobilizing science and observation systems, (2) integrating societal issues within adaptation plans, (3) fostering of adaptive and hybrid solutions, and (4) increasing of public funding and private investments for adaptation to sea level rise.

• Scientific Article - Designing Coastal Adaptation Strategies to Tackle Sea Level Rise³

The article "Designing Coastal Adaptation Strategies to Tackle Sea Level Rise" is a synthesis of scientific literature and presents four archetypes of adaptation strategies to sea level rise. These are analyzed according to their governance modalities and characterized based on their degree of implementation complexity. This synthesis was co-written by scientists from the RTPi-Sea'ties, co-led by the OCP and CNRS, and was published in the Journal Frontiers in Marine Science, Ocean Solutions section in November 2021.

• The [Blue-Tinted White Paper, Investment Protocol: Unlocking Financial Flows for Coastal Cities Adaptation to Climate Change and Resilience Building](#)⁴ highlights the financial gaps and opportunities for coastal cities' adaptation and provides recommendations to unlock financial flows at scale.

• Policy Brief - Adapting Coastal Cities and Territories to Sea Level Rise⁵

The policy brief "Adapting Coastal Cities and Territories to Sea Level Rise" addresses the challenges faced by stakeholders in the field of adaptation and highlights the essential elements of a sustainable transition of coastal territories.

• Map of Solutions

The Map of Solutions is an interactive map listing hybrid responses implemented around the world to tackle the risks associated with sea level rise. It provides project leaders with concrete feedback, highlighting the outcomes, takeaways, and cautionary remarks to inspire and support coastal stakeholders in the implementation of adaptation strategies in their coastal cities and territories.

1/ Ocean & Climate Platform. (2022). *Adapting Coastal Cities and Territories to Sea Level Rise in Northern Europe: Challenges and Best Practices*. Ocean & Climate Platform. 39 pp. https://ocean-climate.org/wp-content/uploads/2022/04/SEATIES_Report_Adaptation_SLR_Northern-Europe_V2.pdf

2/ Ocean & Climate Platform. (2022). *Adapting Coastal Cities and Territories to Sea Level Rise in the Mediterranean Region: Challenges and Best Practices*. Ocean & Climate Platform. 48 pp. https://ocean-climate.org/wp-content/uploads/2022/10/Seaties_Rapport_Mediterranee_Final.pdf

3/ Bongarts Lebbe, T., Rey-Valette, H., Chaumillon, E., Camus, G., Almar, R., Cazenave, A., et al. (2021). *Designing Coastal Adaptation Strategies to Tackle Sea Level Rise*. Frontiers in Marine Science. 8:740602. <https://doi.org/10.3389/fmars.2021.740602>

4/ Bongarts Lebbe, T., Beguin Billecocq, I., Vegh, T., Sarkozy-Banoczy, S. (2022). *Investment Protocol: Unlocking Financial Flows for Coastal Cities Adaptation to Climate Change and Resilience Building*. Blue-tinted white paper. Race to Resilience, High-Level Climate Champions. <https://climatechampions.unfccc.int/wp-content/uploads/2022/09/Investment-Protocol-for-Coastal-Cities-Adaptation-and-Resilience.pdf>

5/ Palazot, S., Bongarts Lebbe, T., Deprez, A. (2021). *Adapting Coastal Cities and Territories to Sea Level Rise*. Ocean & Climate Platform. https://ocean-climate.org/wp-content/uploads/2021/11/Policy_Brief_AdaptationEN_V4-1.pdf

CITY OF SANTA CRUZ, CALIFORNIA

Santa Cruz has always been defined by its strong relationship to the Ocean. With a diversity of sandy beaches, cliffs and coves, world-class surf breaks, coastal trails and dazzling biodiversity, the Santa Cruz shoreline is a primary identity marker for many of the City's residents. Yet, rising tides, storms and erosion are posing critical threats to public safety, infrastructure, roads, and beach access. The storms of January 2023 reasserted the importance of adapting now to ongoing coastal changes which will be exacerbated in the future.

In collaboration with researchers, regional and international experts, communities, and community groups, the City of Santa Cruz is increasing its adaptive capacity through an adaptation pathways approach. The West Cliff Drive Adaptation and Management Plan includes a strong emphasis on coastal change monitoring to implement its adaptation pathways, and the Resilient Coast Santa Cruz Initiative⁶ is ongoing and iterative work centering the community's vision for a safe, resilient, and equitable coastline into adaptation planning. The City conducts targeted engagement and applies a hybrid approach to adaptation - combining protection measures with

6/ Resilient Coast Santa Cruz, Initiative of the City of Santa Cruz, California. <https://www.cityofsantacruz.com/ResilientCoast>

Nature-based Solutions and ecosystem restoration in the near-term, and studies potential other approaches to respond to future needs.

Transforming the Santa Cruz coastline will entail concerted and collaborative efforts. Exchanges between interested communities are critical for the emergence and scaling of adaptation solutions to sea level rise. By hosting the Sea'ties workshop "Adapting to Sea Level Rise in North America: U.S. West Coast" and becoming a signatory of the Sea'ties Declaration, the City of Santa Cruz reaffirms coastal adaptation as a critical priority as well as the City's commitment to local, regional, and international cooperation.



Matt Huffaker,
City Manager,
City of Santa Cruz, California

UNIVERSITY OF CALIFORNIA AT SANTA CRUZ

Climate change is putting people and nature at great risk in California and beyond, altering the coastline of the western U.S. through sea-level rise, erosion and extreme storms, and threatening to dramatically transform the environmental, social and economic fabric of our state.

We saw first-hand the incredible vulnerability of coastal regions at the start of the new year, when a series of atmospheric rivers took direct aim at Santa Cruz County, bringing a series of storms that flooded and damaged homes and businesses, destroyed roadways, forced mandatory evacuations in some areas, and caused widespread power outages. The University of California at Santa Cruz and the entire UC system have long worked to develop shared solutions and models of excellence to address complex and challenging issues facing the state and the globe. The UC system is partnering with government, nonprofit, for-profit and community organizations to build collective capacity to adapt to multiple climate change impacts such as sea-level rise, increasingly intense storms, stronger wave power, altered fisheries and marine biodiversity, and saltwater intrusion in aquifers near the coast. Our collaboration with the Sea'ties initiative, led by the Ocean & Climate Platform, fosters knowledge exchange and the development of scalable adaptation solutions.

Thanks to state funding, both the UC system and UC Santa Cruz have launched new programs to support UC researchers partnering with diverse stakeholders on climate action. For example, the UC system has launched the California Climate Action Research Initiative, a historic partnership between the university and the state of California to combat climate change, and will award \$80 million in research grants across the state. UC Santa Cruz is coalescing its expertise and partnerships via a

7/ Center for Coastal Climate Research News. <https://officeofresearch.ucsc.edu/cccr/research.html>

new Coastal Climate Resilience Center, launched in the last quarter of 2022, to tackle the most pressing challenges facing coastal ecosystems and human communities. These include coastal hazards such as sea-level rise, bluff and beach erosion and storms, as well as food security, biodiversity loss, freshwater supply, energy, and human health.

The center is working closely with our Coastal Science and Policy Graduate Program on new approaches to workforce development to be solution-focused, agile, and responsive to the priority needs of government, community, private sector and our nonprofit partners. The center is also engaging research teams like the Coastal Resilience Lab that are innovating solutions at the nexus of risk and climate adaptation. Examples of previous and ongoing research at UCSC are detailed [online](#). UC Santa Cruz and its partners across the globe are developing a suite of solutions, fostering implementation of these solutions and advancing the skills of the next generation of global leaders who will tackle complexities of climate change with the diverse approaches needed to ensure equitable, feasible, and effective implementation.

In the face of complex challenges posed by climate change impacts, collaborations and partnerships are essential to transition coastal cities to resilience. This report illustrates possible avenues for solutions emerging from diverse stakeholders and experiences, and is in sync with our core values, centering the human impacts of climate change. Together we can make a difference.

Cynthia Larive
Chancellor
University of California, Santa Cruz⁷



PURPOSE OF THIS BRIEF

This report draws on discussions held during the SeaTies workshop “Adapting coastal cities and territories to sea level rise in North America: U.S. West Coast”, held on September 12, 2022, at the Seymour Marine Discovery Center in Santa Cruz, California. This workshop was organized by the Ocean & Climate Platform in collaboration with the City of Santa Cruz, the University of California at Santa Cruz and the Santa Cruz Sister Cities Committee, with support from Ocean Visions, the Center for Sea Rise Solutions, Santa Cruz Works, the Central Coast Climate Collaborative, and the U.S. Embassy in France. It mobilized over 50 actors of coastal adaptation (elected officials, practitioners, scientists, NGOs, and consultants) from across California to discuss adaptation practices, challenges, and needs encountered in the region, through three thematic sessions: 1) Building on scientific knowledge and science-stakeholder networks to inform adaptation; 2) Equity and social justice: fundamental levers for adaptation and communities’ well-being; 3) Implementing hybrid and adaptive solutions for coastal infrastructure. The report draws on the findings from the workshop, complemented by 26 individual interviews held between 2021 and 2022, with experts working across the West and East Coasts of the U.S.

Intended for policymakers, city and county planners, and all actors involved in adaptation planning who pursue transformational change, this report provides an overview of current practices and remaining challenges for coastal cities in defining and implementing adaptation strategies to sea level rise, proposes solutions, and highlights leading practices developed across California, Oregon and Washington. This report is also inspired by leading practices from Alaska, but does not provide an in-depth analysis of the situation in this state, due to its many particularities. As part of a wider series of regional studies, it complements the conclusions of previous reports, dedicated to the Northern Europe⁸ and Mediterranean regions.⁹ This report addresses the need to develop and share locally relevant and actionable knowledge, ways to engage coastal communities meaningfully into adaptation planning, and opportunities to deliver transformative adaptation policies.

ACRONYMS AND ABBREVIATIONS

BEACON: Beach Erosion Authority for Clean Oceans and Nourishment

BIPOC: Black, Indigenous and People of Color

CBO: Community-based organization

CCC: California Coastal Commission

CRC: Climate Resilient Communities

CZMA: Coastal Zone Management Act

FEMA: Federal Emergency Management Agency

GHG: Greenhouse gasses

IPCC: Intergovernmental Panel on Climate Change

ITK: Indigenous Traditional Knowledge

LCP: Local Coastal Program

LDM: Local decision maker

NbS: Nature-based Solution

NOAA: National Oceanographic and Atmospheric Administration

OCP: Ocean & Climate Platform

OPC: Ocean Protection Council

OLU: Operational Landscape Unit

RCP: Representative Concentration Pathway

SDRCC: San Diego Regional Climate Collaborative

SBSTA: Subsidiary Body for Scientific and Technological Advice

SLR: Sea level rise

SLR Collaborative: California Sea Level Rise State and Regional Support Collaborative

TNC: The Nature Conservancy

USACE: U.S. Army Corps of Engineers

UCSB: University of California at Santa Barbara

UCSC: University of California at Santa Cruz

UNFCCC: United Nations Framework Convention on Climate Change

U.S.: United States

USGS: United States Geological Survey

8/ Ocean & Climate Platform. (2022). *Adapting Coastal Cities and Territories to Sea Level Rise in Northern Europe: Challenges and Best Practices*. Ocean & Climate Platform. 39 pp. https://ocean-climate.org/wp-content/uploads/2022/04/SEATIES_Report_Adaptation_SLR_Northern-Europe_V2.pdf

9/ Ocean & Climate Platform. (2022). *Adapting Coastal Cities and Territories to Sea Level Rise in the Mediterranean Region: Challenges and Best Practices*. Ocean & Climate Platform. 48 pp. https://ocean-climate.org/wp-content/uploads/2022/10/Seaties_Rapport_Mediterranee_Final.pdf

SUMMARY FOR POLICYMAKERS

Sea level along the U.S. West Coast could rise by 0.1-0.2 meters (4-8 inches) in the next 30 years and 0.6 meters (2 feet) by the end of the century. Under a high emissions pathway (RCP8.5), an additional 0.5 meters (1.6 feet) might occur by 2100.¹⁰ Combined with coastal hazards, sea level rise (SLR) poses threats to public safety and wellbeing, endangers coastal infrastructure and lifelines, and jeopardizes the economic prosperity of the region. While mitigation of climate change is a prerequisite to limit the magnitude of SLR, the phenomenon will continue over the next centuries to millennia, making adaptation to SLR a firm priority. Cities and counties along the U.S. West Coast are on the frontlines of responding to SLR, yet they face unique challenges and urgently need to accelerate their adaptation. Three key axes can be considered to accelerate coastal adaptation and achieve just and equitable outcomes:

1

MOBILIZING ACTIONABLE KNOWLEDGE TO ADDRESS LOCAL ADAPTATION NEEDS

A wealth of scientific data, scenarios and tools is available in the U.S. In addition, a diversity of actors (federal and state agencies, local governments, non-profit organizations) provides guidelines and resources aimed at facilitating coastal adaptation. However, cities and counties also need actionable, practice-oriented, and downscaled information that is relevant to their operational level. Locally relevant information can be generated through partnerships (e.g., between universities and cities, with state and federal actors, across jurisdictions, with communities), participatory science, and the appropriate use of local and Indigenous Traditional Knowledge. Tailored language, framing, and communication tools can also be mobilized to increase understanding of SLR issues and appropriation of adaptation options among communities, practitioners, elected officials and other stakeholders.

¹⁰/ Sweet, W.V., Hamlington, B.D., Kopp, R.E., Weaver, C.P., Barnard, P.L., Bekaert, D., et al. (2022). *Global and Regional Sea Level Rise Scenarios for the United States: Updated Mean Projections and Extreme Water Level Probabilities Along U.S. Coastlines*. NOAA Technical Report NOS 01. National Oceanic and Atmospheric Administration, National Ocean Service, Silver Spring, MD, 111 pp. <https://aambpublicoceanservice.blob.core.windows.net/oceanserviceprod/hazards/sealevelrise/noaa-nos-techrpt01-global-regional-SLR-scenarios-US.pdf>

2

ROOTING ADAPTATION STRATEGIES IN COMMUNITIES' VISIONS

Socially vulnerable populations are exposed to heightened coastal risks and can exhibit distinct vulnerabilities and barriers to adaptation. Adaptation to SLR is therefore conditional on achieving equity and social justice objectives. For this reason and because coastal communities are well positioned to know local risks and opportunities for action, community-driven adaptation – where communities are empowered into leadership roles – can foster community-wide resilience, facilitate the adoption of adaptation strategies, unlock co-benefits from adaptation measures, and enable the realization of communities' visions for the future. Meaningful engagement, essential to develop just, equitable and efficient strategies, requires time and increased funding. Capacity building within communities, stronger dialogue between local authorities and residents, the involvement of communities into knowledge generation and monitoring activities, and support to community organizing spaces such as “Community Resilience Hubs”, are ways to uphold meaningful engagement.

3

DELIVERING TRANSFORMATIVE ADAPTATION POLICIES

Coordinating among jurisdictions and at scales that reflect geomorphic realities allows for the full consideration of local opportunities for action and the identification of risks of maladaptation. Concurrently, networks and communities of practice can accelerate the emergence and dissemination of knowledge and leading practices, build capacities, and facilitate collaborations. Given the long-range nature of SLR and high uncertainties surrounding future sea level evolutions, overcoming risk aversion and shifting from a “predict and act” paradigm to one of “monitor and adapt” in adaptation planning is key. The integration of different scenarios over sequenced time horizons in planning as well as monitoring of the coastline and implemented adaptation measures, that incorporates social and equity dimensions into evaluations, supports the design of flexible and phased adaptation strategies, such as under the Dynamic Adaptive Policy Pathways approach. Such an approach enables the timely implementation of transformative measures and supports the design of new models of coastal living. Among the many options available, it is essential to overcome the taboo of managed retreat, which in some areas may represent a long-term transformative option.



INTRODUCTION

The U.S. West Coast confronted with sea level rise

Stretching over 63,160 kilometers (39,246 miles),¹¹ the Pacific coast of the U.S. is home to 34 million inhabitants¹² as well as spectacular biodiversity. However, the landscapes and coastal uses that contribute to the attractiveness of the region are threatened by sea level rise (SLR). According to the [NOAA 2022 Sea Level Rise Technical Report](#),¹³ sea level along the U.S. West Coast could rise by 0.1-0.2 meters (4-8 inches) in the next 30 years and 0.6 meters (2 feet) by the end of the century. Under a high emissions pathway (RCP8.5), an additional 0.5 meters (1.6 feet) might occur by 2100. Concurrently, flooding is expected to occur 10 times more often by 2050 than it does today while El Niño events could raise coastal sea levels by an extra 0.1 to 0.3 meters (3-11 inches) for several winter months¹⁴ and drive stronger erosion.¹⁵ Critical habitats such as wetlands, sandy beaches and cliffs are receding and subject to coastal squeeze from development, which prevent their landward migration. Across the U.S., an estimated 233 federally protected species already under stress are imperiled by SLR¹⁶. SLR poses enormous challenges

for the coastal cities and towns distributed across Alaska, Washington, Oregon, and California – the most populous state in the U.S. While ambitious climate change mitigation policies are imperative and must remain a priority to limit the magnitude of SLR, the phenomenon of SLR will nevertheless continue in the coming centuries to millennia, underscoring the vital need for adaptation. Large cities such as Los Angeles, San Diego, San Francisco, Portland, and Seattle are not the only ones affected. Smaller cities face unique challenges and urgently need to accelerate their adaptation.

Disparities in vulnerability

Vulnerability to the impacts of SLR and storms is not shared equally across coastal communities in the region. In fact, it is exacerbated by factors linked to economic wealth, race and ethnicity, special needs, and other social factors, which influence individuals' and communities' ability to prepare for and cope with SLR. Socially vulnerable populations are overrepresented in coastal cities compared to inland cities, with low-income and BIPOC (Black, Indigenous and People of color) communities often residing in low-lying, flood-prone areas¹⁷. Although BIPOC communities represent about 40% of the total U.S. population, they constitute 53% of the population of coastal cities.¹⁸ These communities are among the hardest hit by SLR impacts (erosion, marine submersion) and extreme weather events due to greater exposure in low-elevation zones, lower levels of access to information and fewer financial resources to prepare, evacuate and recover after an extreme event. Heightened vulnerability of disadvantaged groups was exposed in the aftermath of hurricane Katrina which struck Louisiana and the Gulf Coast in 2005. Notably, lower levels of assistance were

11/ NOAA Office for Coastal Management, *Shoreline Mileage of the United States*. <https://coast.noaa.gov/data/docs/states/shorelines.pdf>

12/ United States Census Bureau. (2019). *Coastline America*. <https://www.census.gov/content/dam/Census/library/visualizations/2019/demo/coastline-america.pdf>

13/ Sweet, W.V., Hamlington, B.D., Kopp, R.E., Weaver, C.P., Barnard, P.L., Bekaert, D., et al. (2022). *Global and Regional Sea Level Rise Scenarios for the United States: Updated Mean Projections and Extreme Water Level Probabilities Along U.S. Coastlines*. NOAA Technical Report NOS 01. National Oceanic and Atmospheric Administration, National Ocean Service, Silver Spring, MD, 111 pp. <https://aambpublicoceanservice.blob.core.windows.net/oceanserviceprod/hazards/sealevelrise/noaa-nos-techrpt01-global-regional-SLR-scenarios-US.pdf>

14/ National Academies of Sciences, Engineering, and Medicine (2012). *Sea-Level Rise for the Coasts of California, Oregon, and Washington: Past, Present, and Future*. Washington, DC: The National Academies Press. <https://doi.org/10.17226/13389>

15/ Barnard, P., Hoover, D., Hubbard, D., Snyder, A., Ludka, B.C., Allan, J., et al. (2017). *Extreme oceanographic forcing and coastal response due to the 2015–2016 El Niño*. Nature Communications 8, 14365. <https://doi.org/10.1038/ncomms14365>

16/ Center for Biological Diversity. (2013). *Deadly Waters How Rising Seas Threaten 233 Endangered Species*. https://www.biologicaldiversity.org/campaigns/sea-level-rise/pdfs/SeaLevelRiseReport_2013_print.pdf

17/ Wing, O.E.J., Lehman, W., Bates, P.D., Sampson, C.C., Quinn, N., Smith, A.M., et al. (2022). *Inequitable patterns of US flood risk in the Anthropocene*. Nature Climate Change. 12, 156–162. <https://doi.org/10.1038/s41558-021-01265-6>

18/ Linsmayer, L., Croushore, L., Shrestha, J., Shah, S., Davis, M., Flemma, J., Johnson, A.E. (2022). *By the Numbers: Definition, Demographics, and Climate Risks of U.S. Coastal Cities*, Urban Ocean Lab. <https://urbanoceanlab.org/coastal-cities>

given to poorer neighborhoods, largely inhabited by BIPOC communities, compared to wealthier neighborhoods.¹⁹

The looming cost of inaction

Sea level rise, combined with coastal hazards, endangers coastal infrastructure – such as roads and highways, water and waste treatment plants, energy facilities, marinas, and public recreational trails²⁰ – threatening to disrupt essential lifelines, water supplies and evacuation routes²¹. SLR also compromises the socio-economic development of the region, which is otherwise heavily dependent on its coastline. Indeed, ocean-based activities largely contribute to the economy of the entire region. For instance, California displays the largest ocean economy in the U.S., valued at over \$44 billion per year²². In the San Francisco Bay Area alone, 104,000 existing jobs and the creation of 85,000 new jobs could be directly threatened by SLR in the next 40 years.²⁴ Strategic adaptation choices depend to an extent on the economic interests of the various sectors operating along the shoreline, including the real estate sector. Beachfront properties can have tremendous value and provide attractive investment opportunities, thus crystallizing opposition to certain adaptation strategies. In California alone, between USD 8 and 10 billions of existing property value is

19/ Babic, M. (2015). *Hurricane Katrina Showed That Even in the US, Disaster Hits the Most Vulnerable the Hardest*, Oxfam. <https://www.oxfamamerica.org/explore/stories/even-in-the-us-disaster-hits-the-most-vulnerable-the-hardest/>

20/ National Research Council. (2012). *Sea-Level Rise for the Coasts of California, Oregon, and Washington: Past, Present, and Future*. Washington, DC: The National Academies Press. <https://doi.org/10.17226/13389>

21/ Hummel, M. A., Berry, M. S., Stacey, M. T. (2018). *Sea level rise impacts on wastewater treatment systems along the U.S. coasts*. *Earth's Future*, 6, 622–633. <https://doi.org/10.1002/2017EF000805>

22/ Moser, S.C., Davidson, M.A., Kirshen, P., Mulvaney, P., Murley, J.F., Neumann, J.E., et al. (2014). Ch. 25: *Coastal Zone Development and Ecosystems. Climate Change Impacts in the United States: The Third National Climate Assessment*. Melillo, J.M., Richmond, T.C., Yohe, G.W., Eds., U.S. Global Change Research Program, 579–618. <https://doi.org/10.7930/JoMS3QNW>

23/ NOAA Office for Coastal Management, Bureau of Labor Statistics, Bureau of Economic Analysis, Economics: National Ocean Watch. <https://coast.noaa.gov/digitalcoast/data/enow.html>

24/ *Adapting to Rising Tides (2020). Adapting to Rising Tides Bay Area: Short Report Summary of Regional Sea Level Rise Vulnerability and Adaptation Study*. Bay Conservation and Development Commission (BCDC) and Metropolitan Transportation Commission/Association of Bay Area Governments (MTC/ABAG), San Francisco CA. https://mtc.ca.gov/sites/default/files/ARTBayAreaShortReport_Final_March2020_ADA-1.pdf

directly threatened by SLR and flooding by 2050²⁵. Despite this, West Coast coastal property value remains some of the highest in the world. In addition, only 4% of homeowners across the U.S. have flood insurance²⁶, making the financial ability of households to recover from an extreme sea-level event extremely challenging.

A multifaceted landscape of actors tackling sea level rise in coastal cities

Under the [Coastal Zone Management Act \(CZMA\)](#),²⁷ coastal management in the U.S., including the West Coast, is planned and regulated through a partnership of federal, state, and local authorities. Regulations from state to state may differ but throughout the West Coast cities and counties are on the frontlines of responding to SLR. Land use, planning and zoning fall under the responsibility of local governments, which are also in charge of developing and updating coastal adaptation plans, often in compliance with statewide goals. In California, the California Coastal Commission (CCC) reviews local government's Local Coastal Programs (LCP) on the outer coast for consistency with the California Coastal Act, while the San Francisco Bay Conservation Development Commission is an integral planning partner with San Francisco Bay communities²⁸. In Oregon, the Land Conservation and Development Commission examines Local Comprehensive Plans. Farther north, the Washington State Department of Ecology reviews cities' Shoreline Master Programs. Federal agencies such as the Federal Emergency Management Agency (FEMA), the U.S. Geological Survey (USGS), the U.S. Army Corps of Engineers (USACE) and the National Oceanic and Atmospheric Administration (NOAA) provide information and tools intended for decision makers to understand

25/ Legislative Analyst's Office (2020). *What Threat Does Sea-Level Rise Pose to California?* <https://lao.ca.gov/Publications/Report/4261>

26/ Santana, R., Philis M. (2022). *Lack of flood insurance leaves families with broken homes following Hurricane Ian*. PBS. Oct 7, 2022. <https://www.pbs.org/newshour/nation/lack-of-flood-insurance-leaves-families-with-broken-homes-following-hurricane-ian#:~:text=According%20to%20the%20insurance%20information,is%20only%20about%2018%20percent>

27/ NOAA. Coastal Management. Coastal Zone Management Act. <https://coast.noaa.gov/czm/act/>

28/ California Coastal Adaptation Planning Inventory. A project of the Ocean & Coastal Policy Center (OCPC) at UC Santa Barbara. <https://storymaps.arcgis.com/stories/5c3ec4198b564750886cc75b95a8e492>

risks and prepare their adaptation strategies. These federal resources are complemented by an array of guidelines developed by state agencies, counties, regional organizations and cities. These can differ substantially in the approaches they promote and be difficult to navigate for city officials. Thus, despite a general proactive attitude, coastal cities along the West Coast have different levels of preparations for the effects of SLR. While there is growing interest in Nature-based Solutions (NbS)²⁹, coastal armoring remains the primary response while managed retreat and relocation continue to be contentious topics³⁰.

Increasingly, coastal cities are seeking approaches that can deliver transformative change, through spatially diverse and long-term adaptation responses. Their decision-making needs to be informed by relevant and up-to-date knowledge, grounded in the visions of their communities. This report provides an overview of current practices and remaining challenges to define and implement adaptation strategies, shared during the Sea'ties workshop "Adapting coastal cities and territories to SLR in the U.S. West Coast" held in September 2022, as well as 26 preliminary interviews.

Three key topics are addressed in the following sections:

1. Although a wealth of scientific data is available in the region, these can be disconnected from local needs. Cities need locally relevant information, and producing actionable knowledge to initiate action is key. To this end, existing networks and cross-sector partnerships ought to be drawn on to enable mutual learning and knowledge sharing.
2. Rooting adaptation strategies in communities' visions is critical to achieve just and equitable adaptation. Indeed, coastal communities are well positioned to understand local risks, needs, and opportunities.
3. Coordination among cities and the phasing of adaptation measures facilitates SLR adaptation

29/ Bongarts Lebbe, T., Rey-Valette, H., Chaumillon, E., Camus, G., Almar, R., Cazenave, A., et al. (2021) *Designing Coastal Adaptation Strategies to Tackle Sea Level Rise*. *Frontiers in Marine Science*. 8:740602. <https://doi.org/10.3389/fmars.2021.740602>

30/ Anderson, R., Patsch, K., Lester, Charles, and Griggs, G. (2020). *Adapting to Shoreline Retreat: Finding a Path Forward*, Shore & Beach, Vol. 88, No. 4, <http://doi.org/10.34237/1008842>

over time and at scale. Unlocking co-benefits for cities and their inhabitants entails deploying transformative adaptation policies. Overcoming the taboo of managed retreat and relocation is also pivotal in ensuring that all options are considered for informed decision-making.



1 MOBILIZING ACTIONABLE KNOWLEDGE TO ADDRESS LOCAL ADAPTATION NEEDS

KEY MESSAGES:

- Locally relevant knowledge for SLR adaptation is best produced in-situ and in collaboration with local organizations and communities, which hold intimate understanding of the features and dynamics of their territory, as well as with relevant state and federal actors central to effective implementation.
- Collaborating with Indigenous and traditional knowledge holders is particularly relevant to the monitoring of coastal changes and supports the development of comprehensive adaptation strategies that are mutually beneficial to human communities and wider ecosystems.
- In a context of deep uncertainty, incorporating scenarios over sequenced time horizons into adaptation planning and monitoring actions over time are key to deployment of flexible adaptation strategies and addressing future, long-term impacts of SLR in a phased manner.

A diversity of regional SLR scenarios is available across the U.S. West Coast, emanating from federal and state agencies and articulating short, mid, and long-term horizons – NOAA notably produced long-term horizons out to 2150.³¹ State agencies translate these scenarios and other scientific content into guidelines for local decision makers (LDMs). However, the multiscale governance system in place in the U.S. results in a multiplicity of agencies providing guidelines and resources. These can conflict in language and approaches and their profusion can be difficult to navigate for LDMs. Thus, while the U.S. West Coast is well resourced in data and tools, they can be fragmented across several platforms and LDMs are not always aware

of them. For instance, the Oregon Coastal Atlas³² provides various climate, topographic and bathymetric data for the state’s coastline. Similarly, Cal-Adapt³³ provides coastal data and SLR scenarios tailored to California. Information relevant to planning is made available by other actors, such as the Ocean Protection Council in California, a state agency dedicated to protecting the ocean and coasts of California through research and policy. And while the U.S. Climate Resilience Toolkit³⁴ centralizes a great diversity of digital tools, planning frameworks and funding sources into a useful one-stop shop, it cannot substitute for locally-relevant data.

City and county managers and elected officials need information that is readily actionable and relevant to the specificities, challenges and opportunities faced in their areas to design and deploy tailored adaptation

31/ Sweet, W.X., Hamlington, B.D., Kopp, R.E., Weaver, C.P., Barnard, P.L., Bekaert, D., et al. (2022). *Global and Regional Sea Level Rise Scenarios for the United States: Updated Mean Projections and Extreme Water Level Probabilities Along U.S. Coastlines*. NOAA Technical Report NOS 01. National Oceanic and Atmospheric Administration, National Ocean Service, Silver Spring, MD, 111 pp. <https://oceanservice.noaa.gov/hazards/sealevelrise/sealevelrise-tech-report.html>

32/ Oregon Coastal Atlas. <https://www.coastalatlus.net/index.php/tools>
33/ Cal-Adapt. <https://cal-adapt.org/>
34/ U.S. Climate Resilience Toolkit. <https://toolkit.climate.gov/>

strategies. Academics, practitioners, and communities can be mobilized on applied projects through cross-sector partnerships to generate locally relevant and operational knowledge. In parallel, continuous monitoring of the shoreline and a paradigm shift in policy making are needed to develop flexible and dynamic adaptation strategies that are responsive to knowledge evolutions.

1.1. Generating locally relevant knowledge

Downscaled information that incorporates site-specific geophysical, ecological, and socio-economic aspects is essential to understand local, compounding interactions associated with SLR, to establish priorities for action and guide decision-making. In this regard, coastal and ocean observatories provide useful data on parameters such as bathymetry or beach topography which enable the monitoring of the shoreline at scale. For instance, the [NVS Beach and Shoreline Changes](https://nvs.nanoos.org/BeachMapping)³⁵ database compiles observations conducted by the States of Washington and Oregon across their coastlines. Participatory science, which makes communities' contribution to research more systematic, is also relevant to building local knowledge informed by on-site data generation. Meanwhile, it can also ignite interest in adaptation planning. Tools and technologies that are easy to use, such as smartphone apps, photographs and sensors can support citizens' involvement in data collection. Projects such as [iFlood](https://iflood.org/),³⁶ the [California King Tides Project](https://www.coastal.ca.gov/kingtides/)³⁷ and [CoastSnap](https://www.coastsnap.com/)³⁸ invite the public to engage with the coastline and report on its changes through submitting photographs.

Complementing scientific data with other types of knowledge, such as traditional knowledge, that stem from the multigenerational, lived experience of communities is useful in building place-based and responsive knowledge bases. **Indigenous Traditional Knowledges (ITK) are increasingly recognized as particularly relevant to the monitoring of shoreline evolution and SLR impacts assessments.** For instance, Inupiat

residents in Shishmaref, Alaska, have identified cyclical patterns of coastal erosion.³⁹ Likewise, a [Climate Change Impact Assessment](http://www.puyallup-tribe.com/tempFiles/PuyallupClimateChangeImpactAssessment2016_FINAL_pages.pdf)⁴⁰ produced by the Puyallup Tribe, in Washington State, and Cascadia Consulting Group incorporated global and regional climate models, climate and non-climate stressors with tribal knowledge to understand how climate change could affect issues of local importance. In California, the [Tribal Marine Stewards Network](https://tribalmsn.org/)⁴¹ coordinates several coastline monitoring initiatives and applies ITK into management practices across the state. Ultimately, ITK supports more comprehensive and holistic adaptation planning, as exemplified by the Swinomish Indian Tribal Community, in Washington State, which develops climate change adaptation strategies that combine science and traditional knowledge with the aim to be mutually beneficial to human communities and wider ecosystems.⁴²

Because ITK typically differs from academic scientific knowledge in language and conceptual frameworks, it can be difficult for users trained in Western scientific contexts to understand. Increasing literacy of ITK and representation of Native Americans among city and agency staff is key in appropriately working with ITK. To enhance appreciation for, understanding of and ability to use ITK, the Climate and Traditional Knowledges Workgroup has developed [Guidelines for Considering Traditional Knowledges in Climate Change Initiatives](https://climatetkw.wordpress.com/).⁴³ Concurrently, Indigenous leadership and guidance in applying ITK should be sought, compensated and given influence.

39/ Marino, E. (2015). *Fierce Climate, Sacred Ground: An Ethnography of Climate Change in Shishmaref, Alaska*, University of Alaska Press <https://www.jstor.org/stable/j.ctv21fqh5x>

40/ Puyallup Tribe of Indians. (2016). *Climate Change Impact Assessment and Adaptation Options*. A collaboration of the Puyallup Tribe of Indians and Cascadia Consulting Group. http://www.puyallup-tribe.com/tempFiles/PuyallupClimateChangeImpactAssessment2016_FINAL_pages.pdf

41/ Tribal Marine Stewards Network <https://tribalmsn.org/>

42/ Institute for Tribal Environmental Professionals at Northern Arizona University. (2013). *The Swinomish Tribe and Tsleil Waututh First Nation: Correlation and Climate Sensitivity of Human Health and Environmental Indicators in the Salish Sea*. http://www7.nau.edu/itep/main/tcc/Tribes/pn_tsleil

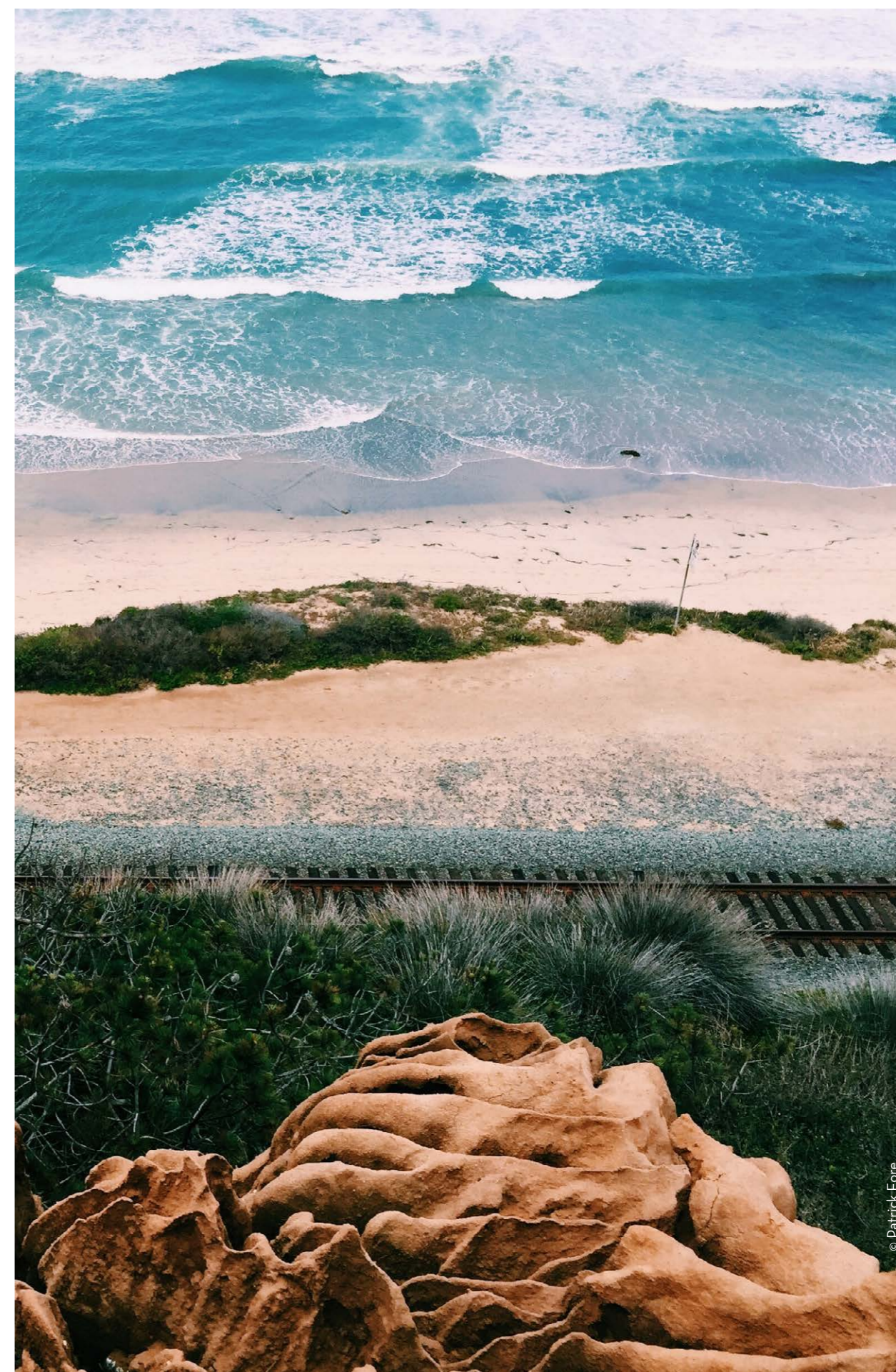
43/ Climate and Traditional Knowledges Workgroup (CTKW). (2014). *Guidelines for Considering Traditional Knowledges in Climate Change Initiatives* <https://climatetkw.wordpress.com/>

35/ NVS Beach and Shoreline Changes. Coordinated by the Northwest Association of Networked Ocean Observing Systems. <https://nvs.nanoos.org/BeachMapping>

36/ iFlood. <https://iflood.org/>

37/ California King Tides Project. <https://www.coastal.ca.gov/kingtides/>

38/ Coastsnap. <https://www.coastsnap.com/>



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California Coastal Dune Science Network - Sharing knowledge among scientists and practitioners to improve understanding of dune restoration.

The [California Coastal Dune Science Network](#) was established as a collaborative effort to expand understanding of coastal dunes and their role in building a resilient, transitional, and adaptive coast for future generations. Across California, many coastal communities are experimenting with restoring or building dunes to address contemporary and future flooding and erosion impacts. These projects are being tested at various coastal settings, some significantly more urbanized than others. They also involve a wide range of techniques derived from engineering, ecological restoration, and coastal processes science.

The Network fosters knowledge sharing across these sites and disseminates information and lessons learned through collaborative workshops, reports, and video case studies. This collective learning about nature-based dune and resilience projects has enabled the Network to identify the most essential ingredients for dune success and to categorize dune resilience approaches into three types. The next phase of the Network's efforts will focus on how best to define and evaluate resilience within the range of dune project types. This includes information about which approaches are best suited for specific coastal conditions, coastal hazard vulnerabilities, and supporting short and long-term resilience of dune ecosystems.



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1.2. Operationalizing knowledge and resources

Operationalizing knowledge and resources entails the production of practice-oriented information - in other words, information that is intelligible to LDMs, relevant to their scale of action and readily actionable to support the identification of risks, goal setting, and wider planning and monitoring of adaptation strategies. As such, including social dimensions into vulnerability assessments is fundamental to ensure the development of strategies attuned to local needs and specificities. Visualization tools that overlay social and economic data onto projected SLR exist, such as the [Coastal County Snapshots](#)⁴⁴ and [Sea Level Rise Viewer](#)⁴⁵ developed by NOAA, or the [Hazard Exposure and Reporting Analytics \(HERA\)](#)^{46,47} developed by USGS and based on its Coastal Storm Modeling System. Such tools should be informed and complemented by inputs from community groups. Indeed, information on occupation and activities along the shoreline at a neighborhood level support a better understanding of cities' socio-ecological systems and are essential for accurate vulnerability assessments. For instance, visualizations of the [Sea Level Rise Explorer](#)⁴⁸ developed by Virtual Planet Technologies were co-designed with a broad range of stakeholders, who also tested the technology prior to the launch of the products. Team members included residents from each city covered, which is reported as a key success factor for both the accuracy and consistency of elements displayed in the visualizations and users' experience.⁴⁹

44/ NOAA Office for Coastal Management, Coastal County Snapshots. <https://www.coast.noaa.gov/digitalcoast/tools/snapshots.html>

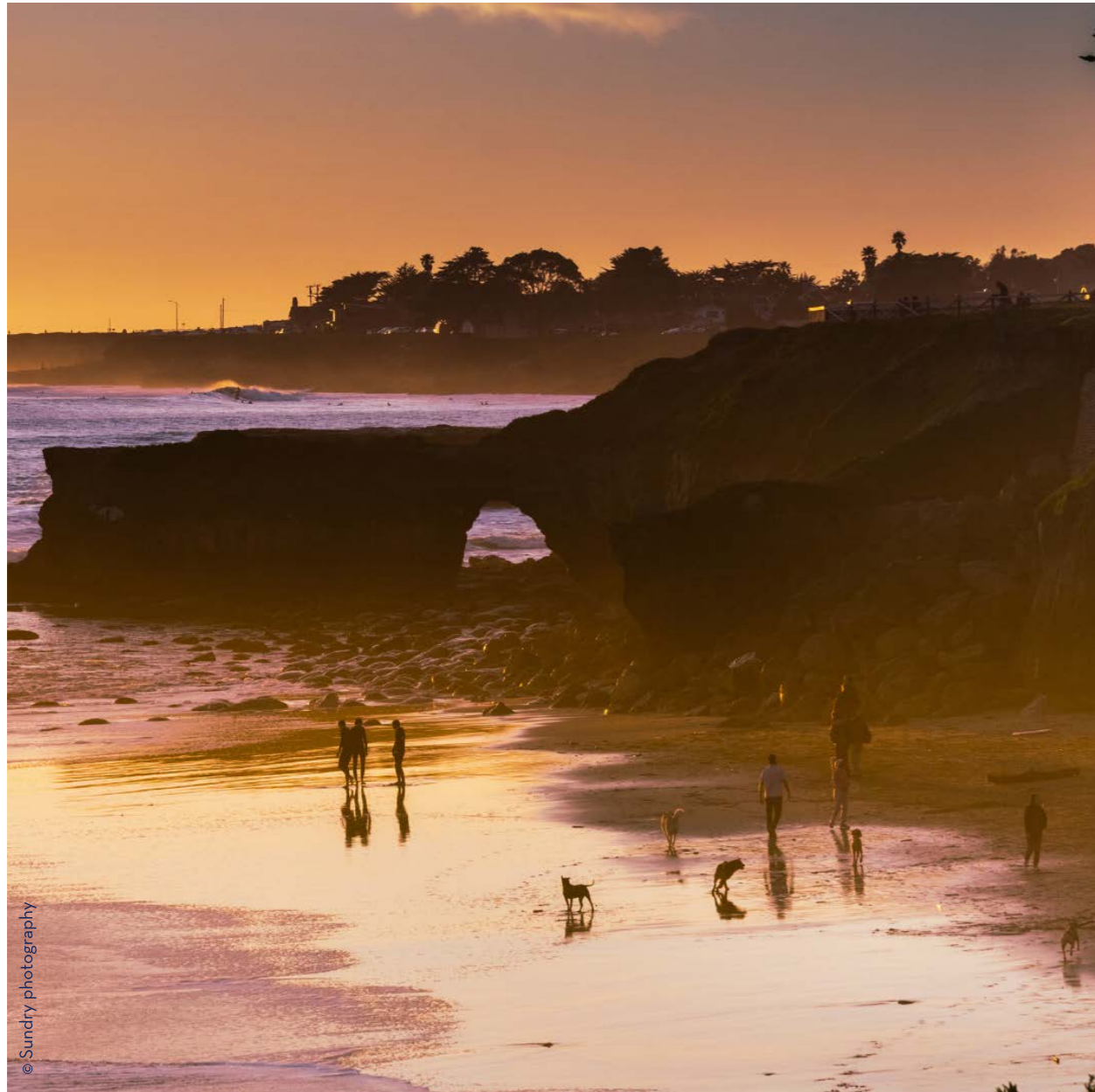
45/ NOAA Office for Coastal Management, Sea Level Rise Viewer. <https://coast.noaa.gov/digitalcoast/tools/slr.html>

46/ Hazard Exposure and Reporting Analytics (HERA) <https://www.usgs.gov/apps/hera/>

47/ USGS, Coastal Storm Modeling System (CoSMoS). [https://www.usgs.gov/centers/pcmsc/science/coastal-storm-modeling-system-cosmos#:~:text=The%20Coastal%20Storm%20Modeling%20System%20\(CoSMoS\)%20is%20a%20dynamic%20modeling,i.e.%2C%20beach%20changes%20and%20cliff](https://www.usgs.gov/centers/pcmsc/science/coastal-storm-modeling-system-cosmos#:~:text=The%20Coastal%20Storm%20Modeling%20System%20(CoSMoS)%20is%20a%20dynamic%20modeling,i.e.%2C%20beach%20changes%20and%20cliff)

48/ Virtual Planet Technologies LLC. Sea Level rise explorer - Santa Cruz, CA. <https://virtualplanet.tech/santa-cruz>

49/ Calil, J., Fauville, G., Muller Queiroz, A. C., Leo, K. L., Newton Mann, A. G., Wise-West, T., et al. (2021). Using Virtual Reality in Sea Level Rise Planning and Community Engagement—An Overview. *Water*, 13 (9), 1142. <https://doi.org/10.3390/w13091142>



Partnerships between local authorities and universities, or even with state agencies, allow for the integration of multiple perspectives and enable mutual learning: public officials can support research by documenting decision-making processes and outcomes of specific management practices and co-develop with academics the research questions attuned to their needs. For instance, the City of Santa Cruz, California, and the University of California at Santa Cruz (UCSC) have partnered for several years, through intensive applied projects that involve students into the city's work. Notably, students completed a SLR vulnerability assessment for the campus section of the Santa Cruz coastline. Such collaborations can also leverage local and traditional knowledge. The [Los](#)

[Angeles County Vulnerability Assessment](#)⁵⁰ integrated the intersection of social, structural, and natural resources vulnerability with coastal risks to identify areas of high vulnerability. Conducted in partnership with University of Southern California (USC) Sea Grant, a network of 34 university-based programs, the analysis involved local stakeholders in the definition of vulnerability criteria and climate-driven risks, as well as in the prioritization of adaptation areas⁵¹. Researchers at the Ocean and Coastal Policy Center of the University of California

50/ County of Los Angeles. (2021). *LA County Climate Vulnerability Assessment*. <https://ceo.lacounty.gov/wp-content/uploads/2021/10/LA-County-Climate-Vulnerability-Assessment-1.pdf>

51/ Fleming, C.S., Regan, S.D., Freitag, A., Burkart, H. (2020). *Assessing the Geographic Variability in Vulnerability to Climate Change and Coastal Hazards in Los Angeles County, California*. NOAA Technical Memorandum NOS NCCOS 275. Silver Spring, MD. 172 pp. <https://doi.org/10.25923/mgca-hc06>

at Santa Barbara⁵² developed a [statewide inventory of SLR adaptation planning activity in California](#),⁵³ funded by OPC, to support knowledge transfer and evaluation of adaptation strategies and priorities.

The involvement of stakeholders from different sectors can provide in-depth multidisciplinary expertise while accelerating the uptake of knowledge into business practices. For instance, the UCSC Coastal Resilience Lab, in partnership with insurers, disaster risk agencies, the World Bank and the Nature Conservancy (TNC), is advancing knowledge about the myriad benefits generated by reefs and wetlands for adaptation and coastal health. Based on these findings, the Lab is developing groundbreaking methodologies to incorporate marine and coastal ecosystems into national economies and risk industry models (cf. case study 1).

Pilot projects can be highly effective in generating operational knowledge. Serving as testing labs that can demonstrate viability, they enable rapid expansion of regional and local expertise. **Connecting practitioners involved in these pilots and sharing their findings (new knowledge acquired, techniques and tools used or created, positive and negative outcomes and lessons-learned) are powerful ways to accelerate collective learning.** Along the U.S. West Coast, several pilots are being deployed to bridge knowledge gaps about ecosystem functioning, natural infrastructure, monitoring, reporting, and evaluation practices. For instance, the California Coastal Conservancy together with partners collected knowledge on natural infrastructure for coastal adaptation by examining several pilot projects across the state. The report [Case Studies of Natural Shoreline Infrastructure in Coastal California](#)⁵⁴ compiles information about the different projects, i.e., permitting requirements, planning, implementation and performance, and provides technical guidance for decision makers to deploy natural shoreline infrastructure.

Since local authorities and especially small and me-

52/ University of California at Santa Barbara, Ocean and Coastal Policy Center. <https://ocpc.msi.ucsb.edu/>

53/ Ocean & Coastal Policy Center (OCPC) at UC Santa Barbara, California Coastal Adaptation Planning Inventory. <https://storymaps.arcgis.com/stories/5c3ec4198b564750886cc75b95a8e492>

54/ Judge, J., Newkirk, S., Leo, K., Heady, W., Hayden, M., Veloz, S., et al. (2017). *Case Studies of Natural Shoreline Infrastructure in Coastal California: A Component of Identification of Natural Infrastructure Options for Adapting to Sea Level Rise (California's Fourth Climate Change Assessment)*. The Nature Conservancy, Arlington, VA. 38 pp. https://coastalresilience.org/wp-content/uploads/2017/11/tnc_Natural-Shoreline-Case-Study_hi.pdf

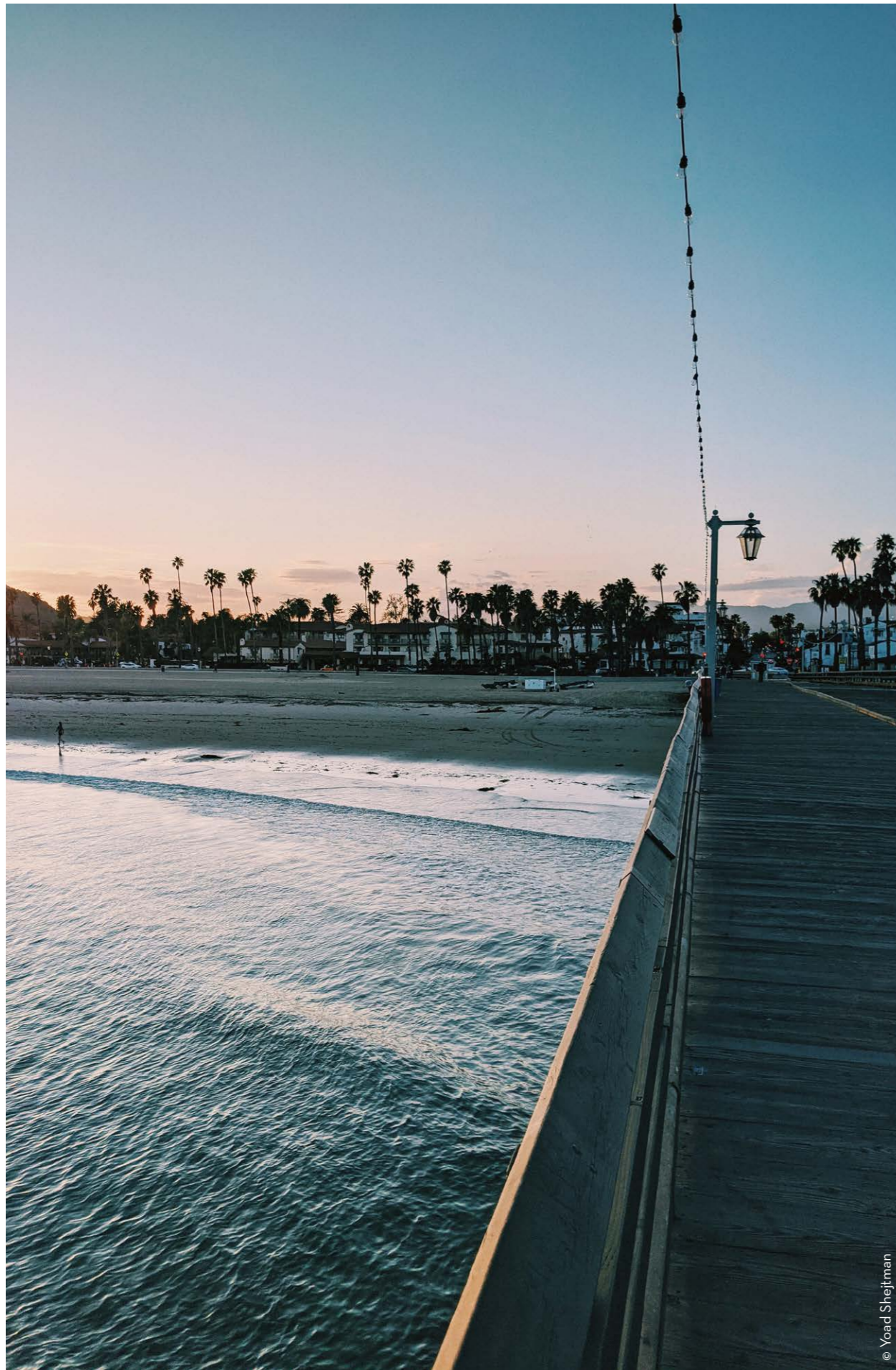
dium-sized cities do not systematically have in-house experts of coastal adaptation, access to scientific data is not the only factor in its uptake. A high degree of technicality in language or methodology can interfere with the use of scientific information. Thus, adjusting wording and terminologies to local capacities and priorities can help overcome political division and inertia. Framing issues differently, in line with local socio-political contexts, can also be efficient. Emphasizing specific aspects over others, based on the understanding of the targeted audience's motivations behind engagement can strengthen communication outcomes and catalyze productive dialogue.⁵⁵ Relying on positive and action-based storytelling can contribute to building LDMs and other stakeholders' agency to understand and use adaptation options at their disposal.⁵⁶ Likewise, drawing on palpable, near term events such as erosion and storms can prompt LDMs and populations to consider impacts of SLR and plan for long-term adaptation. Boundary-spanning organizations, such as the [NOAA Sea Grant](#)⁵⁷ network, provide useful translation, interpretation, and technical assistance to help communities understand scientific information and how best to apply it to local SLR challenges. Several sea grant staff developed the [Application Guide](#) to help local communities understand the 2022 Sea Level Rise Technical Report⁵⁸ and how to apply it to planning.

55/ Badullovich, N., Grant, W.J., Colin, R.M. (2020). Framing climate change for effective communication: a systematic map. *Environmental Research Letters*, 15, 123002, <https://doi.org/10.1088/1748-9326/aba4c7>

56/ De Meyer, K., Coren, E., McCaffrey, M., Slean, C. (2020) Transforming the stories we tell about climate change: from 'issue' to 'action'. *Environmental Research Letters*, 16, 015002, <https://doi.org/10.1088/1748-9326/abcd5a>

57/ NOAA Seagrant. <https://seagrant.noaa.gov/>

58/ Sweet, W.V., Hamlington, B.D., Kopp, R.E., Weaver, C.P., Barnard, P.L., Bekaert, D., et al. (2022). *Global and Regional Sea Level Rise Scenarios for the United States: Updated Mean Projections and Extreme Water Level Probabilities Along U.S. Coastlines*. NOAA Technical Report NOS 01. National Oceanic and Atmospheric Administration, National Ocean Service, Silver Spring, MD, 111 pp. <https://oceanservice.noaa.gov/hazards/sealevelrise/sealevelrise-tech-report.html>



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1.3. Facilitating planning in a context of uncertainty

Beyond the need for locally relevant and actionable knowledge, two of the main challenges in formulating adaptation strategies lie in the risk aversion of elected officials and how they can address uncertainty. Future rates and magnitude of SLR are impossible to predict with precision, notably due to their dependence on GHG emissions trajectories, future ice-sheet dynamics and climate sensitivity.^{59,60,61} Thus, scenarios for future SLR can differ substantially. **Incorporating scenarios over sequenced time horizons into adaptation planning can increase long-term resilience, easing conversations about future needs and helping overcome the electoral cycle horizon while remaining tangible for policy makers operating on shorter timescales.**

For instance, the OPC [2018 State of California Sea-Level Rise Guidance](#)⁶² (currently under review) distinguishes low risks, medium risks, and extreme scenarios – the last foreseeing a rise of over 3 meters (10 feet) along the state’s shores by the end of the century – to accommodate for several timeframes, expected lifespan of projects, and propensity to risk. Concurrently, near-term, regional observation-based trajectories from satellite altimetry can provide ongoing assessments of the possible trajectories of future SLR.⁶³

59/ Climate sensitivity refers to global temperature rise following a doubling of CO₂ concentration in the atmosphere compared to pre-industrial levels. It cannot be directly measured and estimations beyond our century are particularly complex, notably due to feedback effects and the long timescales for some changes to manifest to their full extent.

60/ IPCC. (2019). *Sea Level Rise and Implications for Low-Lying Islands, Coasts and Communities*. In: IPCC Special Report on the Ocean and Cryosphere in a Changing Climate [Pörtner, H.-O., Roberts, D.C, Masson-Delmotte, V., Zhai, P., Tignor, M., Poloczanska, E., et al. (eds.)]. Cambridge University Press, Cambridge, UK and New York, NY, USA, pp. 321-445. <https://doi.org/10.1017/9781009157964.006>

61/ IPCC. (2021). The Earth’s Energy Budget, Climate Feedbacks, and Climate Sensitivity. In *Climate Change 2021: The Physical Science Basis. Contribution of Working Group I to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change* [Masson-Delmotte, V., Zhai, P., Pirani, A., Connors, S.L., Péan, C., Berger, S., et al. (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA, pp. 923-1054. <https://www.ipcc.ch/report/ar6/wg1/>

62/ California Ocean Protection Council. (2018). *State of California Sea-Level Rise Guidance*, 2018 Update. http://www.opc.ca.gov/webmaster/ftp/pdf/agenda_items/20180314/Item3_Exhibit-A_OPC_SLR_Guidance-rd3.pdf

63/ Hamlington, B.D., Chambers, D.P., Frederikse, T., Dangendorf, S., Fournier, S., Buzzanga, B., Nerem, R.S. (2022). *Observation-based trajectory of future sea level for the coastal United States tracks near high-end model projections*. *Communications Earth & Environment* 3, 230. <https://doi.org/10.1038/s43247-022-00537-z>

Designing policies for the future is crucially informed by scientific models, trajectories, and continuous monitoring of the coastline. It also entails the incorporation of social, political, economic, and wider climatic and environmental uncertainties. These uncertainties expose the inadequacy of the "predict and act" paradigm in which many LDMs are still entrenched for dealing with coastal change and long-term planning. **Adherence to the principle of “monitor and adapt” – through coastal monitoring, evaluation of adaptation measures, community response, and thresholds above which alternative adaptation pathways are activated – is a powerful enabler to deploy phased action.** Approaches such as the Dynamic Adaptive Policy Pathways⁶⁴ can integrate uncertainties with a defined risk tolerance (physical and socio-economic) which triggers action based on coastal evolution.

64/ Bonjean Stanton, M.C., Roelich, K. (2021). *Decision making under deep uncertainties: A review of the applicability of methods in practice*. *Technological Forecasting and Social Change*, Volume 171, 120939, ISSN 0040-1625, <https://doi.org/10.1016/j.techfore.2021.120939>

65/ Marjolijn, H., Kwakkel, J.H., Walker, W.E., ter Maat, J. (2013). *Dynamic Adaptive Policy Pathways: A Method for Crafting Robust Decisions for a Deeply Uncertain World*. *Global Environmental Change* 23, no. 2 (2013): 485-98. <https://doi.org/10.1016/j.gloenvcha.2012.12.006>

UCSC Coastal Resilience Lab – Valuing risk reduction services provided by coastal ecosystems



SUMMARY

The Coastal Resilience Research Lab at UCSC informs the case for the protective value of nature as a cost-effective strategy to help reduce risk to people and property. In many cases, a mix of natural and built solutions can be optimized to both save money and provide benefits in coastal protection, fish production, carbon sequestration, and recreation. By focusing on how decision makers plan, finance and insure new development and infrastructure investments, this work will transform adaptation approaches to current and future risks.

CLASSIFICATION

- Risks:** Submersion, erosion, storms
- Typology of solutions:** Research to action project, Nature-based Solutions, soft protections, capacity building and knowledge sharing activities
- Geographical location:** The lab works across the USA and globally.
- Typology of actors:** University, regional institution, state services, NGOs, local and regional authorities, companies and professional organizations, federal authorities

OBJECTIVES

The main goal of the Coastal Resilience Lab is to advance innovative solutions for building coastal resilience that benefit both people and nature. To meet this goal, the Lab collaborates with many partners including:

- (1) Public and private risk managers to value nature and identify incentives to insure ecosystems and to invest in them in hazard mitigation and disaster recovery efforts.
- (2) Engineering firms and agencies to design and calculate the benefits of natural solutions by updating engineering models to include wetlands, forests and floodplains, engineering firms will be able to include nature in the designs they offer their clients; and
- (3) Development Banks to value the benefits of nature in national economics.



ACTIVITIES

The Lab, in collaboration with TNC and IH Cantabria, is working internationally to quantify and build tools to assess the role that mangroves, coral reefs, oyster reefs and wetlands play in reducing risks and providing coastal protection. This work aims to incorporate nature into disaster risk reduction, coastal development, and climate adaptation strategies to address flooding, erosion, and storms. Meanwhile, several projects are deployed along the U.S. West Coast of the U.S. In collaboration with USGS and with support from OPC, the Lab leads a quantitative evaluation of the socio-economic benefits of nature-based adaptation options in San Mateo County. The lab is also working alongside USACE to examine gaps and opportunities between Nature-based Solutions and risk science, risk models, and risk transfer tools globally, nationally, and within California. This work will allow for the development of approaches that fill these gaps and improve the incorporation of nature-based adaptation into risk assessments and finance.

RESULTS

The work of Lab has demonstrated that:

- The significant flood reduction benefits provided by coral reefs, mangroves, and marshes can be rigorously and globally valued
- The restoration of these habitats can provide cost-effective defense
- This knowledge supports innovative habitat restoration solutions on the ground
- Insurance and Ecosystem-based Adaptation can be aligned.

The Lab has published multiple peer-reviewed papers and reports on coastal risks and nature-based defenses – all available on the Lab’s website.

KEY TAKEAWAYS



- Factors of success include that:
- Public disaster recovery funds are used to restore natural defenses
 - Natural defense benefits are used in risk models to inform incentives for risk reduction
 - Innovative new products such as reef and resilience insurance are expanded to reduce risk with natural defenses
 - The natural defense values of habitats are included in national economic indicators and development bank financing.
- In delivering these outcomes, the aim is to ensure that billions of dollars in public and private risk and recovery funding are invested in cost effective natural defenses and to build coastal resilience, naturally.



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2 ROOTING ADAPTATION STRATEGIES IN COMMUNITIES' VISIONS

KEY MESSAGES:

- ☞ Socially vulnerable groups are hit the hardest by the impacts of SLR. Placing equity at the heart of adaptation action thus provides the opportunity to accelerate social reform and achieve greater justice as a legacy of coastal adaptation.
- ☞ Community-driven adaptation is best suited to develop strategies that meet the needs of coastal communities and enable the realization of their aspirations for the future while avoiding maladaptation.
- ☞ Meaningful engagement takes time and can make the development of adaptation strategies harder to predict. Yet moving at the speed of trust is key to strengthening relationships between local decision makers and communities to shape resilient and prosperous futures for coastal cities.

The intersection of socio-economic inequalities and vulnerability to SLR is strong in the United States,⁶⁶ imparting a clear social justice objective to adaptation. Indeed, about 18% of Americans exposed to high flood risk by the end of the century fall within the “high social vulnerability” category.⁶⁷ **Along the West Coast, groups such as low-income households or BIPOC communities are more likely to be exposed to floods - with impacts on their livelihoods and health,⁶⁸ and can exhibit distinct vulnerabilities and barriers to adaptation.** For instance, non-federally recognized Native American tribes can see their access to funding as well as their authority in planning and implementing

adaptation strategies limited. Over the past decades, discussions around environmental and climate justice have gradually permeated policymaking under the influence of activists and community organizing. Yet, “colorblind adaptation”, characterized by insufficient consideration of socio-economic and racial factors, often results in policies that benefit some populations while abandoning others.⁶⁹ This abandonment can manifest in the form of disinvestment or forced displacement. To yield true resilience, adaptation planning must be attuned to structures of inequalities, and thus address all three dimensions of climate justice: recognition,⁷⁰ procedure⁷¹ and distribution.⁷²

66/ EPA. (2021). *Climate Change and Social Vulnerability in the United States: A Focus on Six Impacts*. U.S. Environmental Protection Agency, EPA 430-R-21-003. https://www.epa.gov/system/files/documents/2021-09/climate-vulnerability_september-2021_508.pdf

67/ Moser, S.C., Davidson, M.A., Kirshen, P., Mulvaney, P., Murley, J.F., Neumann, J.E., et al. (2014). Ch. 25: Coastal Zone Development and Ecosystems. *Climate Change Impacts in the United States: The Third National Climate Assessment*. Melillo, J.M., Richmond, T.C., Yohe, G.W., Eds., U.S. Global Change Research Program, 579-618. <https://doi.org/10.7930/JOMS3QNW>

68/ Toxic Tides Project. <https://sites.google.com/berkeley.edu/toxictides/home?pli=1>

69/ Hardy, D., Milligan, R., Heynen, N. (2017). *Racial coastal formation: The environmental injustice of colorblind adaptation planning for sea-level rise*. *Geoforum*, 87, 62-72. <https://doi.org/10.1016/j.geoforum.2017.10.005>

70/ Acknowledging and respecting the legitimacy of rights, and different identities, values, worldviews, and knowledge systems.

71/ Giving everyone the opportunity to participate in and influence decisions that will affect them.

72/ Making sure everyone receives a fair share of benefits from marine resources and activities.

2.1. Community-driven adaptation

The Climate Justice Alliance defines just transition as a “vision-led, unifying and place-based set of principles, processes, and practices”, aimed at redressing inequalities and traditional power dynamics,⁷³ insisting that frontline communities should be in leadership positions in decision-making. Applied to adaptation planning, this means shifting from habits of conducting unidirectional public outreach to adopting institutionally embedded mechanisms to develop community-driven solutions towards resilience. **A community-driven approach relies on collective visioning, a process that engages communities in imagining a desirable future and pathways leading to it.** Reflecting core community values and priorities, visioning relies on consensus – while recognizing the diversity of perspectives on the matter – to create a shared vision for change. It can also support risk-readiness among residents, by enhancing familiarity with the issue, increasing social cohesion and civic engagement, and prompting organizational readiness.⁷⁴

The understanding of communities’ local experiences and aspirations for the future is a prerequisite to unlock co-benefits while avoiding maladaptation. For instance, “green gentrification”⁷⁵ must be carefully considered since inadequate adaptation strategies may further segregate vulnerable groups to unsafe areas, outside of their existing neighborhoods, which are turned into “privatized islands of resilience”⁷⁶. Adaptation must be prepared in manners that incorporate other community priorities relating to environmental, housing, transportation, and health policies, and help meet communities’ existing needs. In addition, tensions exist between communities living on or near the coast

73/ Climate Justice Alliance. <https://climatejusticealliance.org/just-transition/>

74/ Urban Sustainability Directors Network. (2017). *Guide to Equitable, Community Driven Climate Preparedness Planning*. https://www.usdn.org/uploads/cms/documents/usdn_guide_to_equitable_community-driven_climate_preparedness_high_res.pdf

75/ Anguelovski, I., Connolly, J.J.T., Cole, H., Lamarca, M.G., Triguero-Mas, M., Baró, F., et al. (2022). *Green gentrification in European and North American cities*. *Nature Communications* 13, 3816. <https://doi.org/10.1038/s41467-022-31572-1>

76/ Solman, P., Connelly Holmes, R. (2022). *How ‘Green Gentrification’ Is Pricing out Longtime East Boston Residents*. PBS NewsHour, June 6, 2022. <https://www.pbs.org/newshour/show/how-green-gentrification-is-pricing-out-longtime-east-boston-residents>

and inland populations that desire access to and along the coast. Thus, engagement that is strictly limited to local communities may potentially result in the exclusion of disadvantaged inland populations. The aspirations of inland communities should be given greater consideration while planning for SLR adaptation, when this is relevant, as to avoid locals-only bias to outcomes.

To ensure the continuity of vision-led planning, community visions already established for related sectors should be integrated. In line with this, the city of Seattle adopted the [Duwamish Valley Action Plan](#),⁷⁷ anchored by a pre-established community vision for resilience in the South Park and Georgetown neighborhoods. Similarly, the [Islais Creek Adaptation Strategy](#) – the long-term plan for the Islais creek in San Francisco,⁷⁸ is grounded in a community vision that resulted from a two-year engagement effort. The plan aligns with both the [Plan Bay Area 2050](#)⁷⁹ – which encompasses interrelated sectors of economy, transportation, and environmental issues for the nine-county San Francisco Bay Area, as well as the [San Francisco Estuary Blueprint](#)⁸⁰ – relating to the long-range resilience of the San Francisco Bay and delta, and the [Waterfront Resilience Program](#) of San Francisco⁸¹ dedicated to the adaptation of the San Francisco waterfront managed by the Port of San Francisco.

There is no one-size-fits-all approach to meaningful engagement. **Instead, purposeful and effective engagement must be tailored to communities’ preferences and address barriers to engagement.** The Greenlining Institute created a [guidebook with practical steps to prioritize social justice and operationalize equity](#)⁸² in policies and grant programs. The guidebook goes over

77/ City of Seattle. (2018). *Duwamish Valley Action Plan, Advancing Environmental Justice & Equitable Development in Seattle*. http://greenspace.seattle.gov/wp-content/uploads/2018/06/DuwamishValleyActionPlan_June2018.pdf

78/ San Francisco planning. (2021). *Islais Creek Adaptation Strategy*. <https://sfplanning.org/project/islais#about>

79/ Metropolitan Transportation Commission (MTC) and Association of Bay Area Governments (ABAG). (2021). *Plan Bay Area 2050*. <https://www.planbayarea.org/finalplan2050>

80/ San Francisco Estuary Partnership (2022) *2022 San Francisco Estuary Blueprint* (Comprehensive Conservation and Management Plan for the San Francisco Estuary). <https://www.sfestuary.org/estuary-blueprint/>

81/ Port of San Francisco. *Waterfront Resilience Program of San Francisco*. <https://sfport.com/wrp>

82/ Mohnot, S., Bishop, J., Sanchez, A. (2019). *Making Equity Real in Climate Adaptation and Community Resilience Policies and Programs: A guidebook*. The Greenlining Institute. <https://greenlining.org/publications/making-equity-real-in-climate-adaptation-and-community-resilience-policies-and-programs-a-guidebook/>

all stages of planning, implementation and monitoring to ensure that equity progress is a clear outcome of adaptation strategies.

2.2. Empowering communities into leadership roles

Community-driven adaptation implies that communities are empowered and institutionally integrated into all stages of the policymaking process. Building capacity is an essential step in fostering informed community participation and awareness raising campaigns must be attuned to the groups they are intended for, in language and media. Several constituencies have tested innovative communication tools, such as the City of Santa Cruz, California. The immersive [Sea Level Rise Explorer](#)⁸³ displays SLR scenarios at different time horizons and for different neighborhoods of the city. Several types of solutions are proposed, as well as the timing of their implementation in response to sea level evolution. In addition to the virtual reality experience, the Sea Level Rise Explorer allows viewers to provide feedback on their preferred solutions. Similarly, Marin County in California uses [Game of Floods](#),⁸⁴ a board game that places communities in charge of adaptation planning. The game facilitates the consideration of local assets and encourages the combination of different types of solutions to develop an adaptation plan.

Education programs that embrace a “train the trainer” approach can also be impactful by devolving to community members the roles of raising awareness and formulating adaptation solutions. The Sacred Place Institute developed a [climate justice program](#)⁸⁵ to build the capacity of Native Nations and Indigenous Peoples with regards to resilience and adaptation to the effects of climate change. Focusing on historically disadvantaged groups is also a priority. In line with this, the Cascadia Coastal Hazards and Resilience Training, Education and Research, or [CHARTER program](#), provides formal and informal training, education and research opportunities to undergraduate, graduate and postdoctoral students

83/ Virtual Planet Technologies LLC. *Sea Level rise explorer* - Santa Cruz, CA. <https://virtualplanet.tech/santa-cruz>

84/ County of Marin. *Game of Floods*. <https://www.marincounty.org/depts/cd/divisions/planning/csmart-sea-level-rise/game-of-floods>

85/ The Sacred Place Institute. <http://www.sacredplacesinstitute.org/>

who identify as BIPOC, Latinx, LGBTQ+, first generation, and/or low-income.⁸⁶

Effective community engagement necessitates stronger dialogue between LDMs and communities along with recurring opportunities for community involvement throughout the lifespan of an adaptation strategy. Residents and grassroots groups can be involved in community-led vulnerability assessments as well as community-based monitoring. For instance, Climate Resilient Communities (CRC) leads a [marshland restoration project](#)⁸⁷ in East Palo Alto, California, which involves community members in the restoration of a tidal marsh. As reported by CRC, the ethnically diverse community of East Palo Alto is particularly vulnerable to flooding which contributes to mold in homes and exacerbates respiratory illnesses within the community.⁸⁸ Moreover, residents have less access to natural areas than the general population of the region. The marshland restoration project thus provides an opportunity to increase knowledge and experience of the living world, fosters a sense of ownership for local open space and positions community members as champions for implementing adaptation measures. By paying residents to engage with their environment in meaningful and restorative ways and for the benefit of their community, CRC directly contributes to overcoming inequities and underrepresentation of local communities in volunteering.

Organizing spaces such as “Community Resilience Hubs” can strengthen resilience within communities and fast track the dialogue between LDMs and communities. At the intersection of coordination and resource sharing, these hubs can directly build capacities in their communities. They can also provide a space to facilitate exchanges between municipal authorities and resident-led community networks and build relationships between these groups.⁸⁹ Although such hubs are not yet widespread on the U.S. West Coast, the [Strategic](#)

86/ The Cascadia Coastlines and Peoples Hazards Research Hub. *Cascadia CHARTER Fellowship Program*. <https://cascadiacopesub.org/cascadia-charter-fellowship-program/>

87/ San Francisco Bay Restoration Authority. *Baylands Habitat Restoration and Community Engagement*. <https://www.sfbayrestore.org/projects/baylands-habitat-restoration-and-community-engagement-east-palo-alto>

88/ Climate Resilient Communities. *East Palo Alto*. <https://www.climatecommunities.org/east-palo-alto>

89/ Lou, Z. (2020). *Resilience Before Disaster - The Need to Build Equitable, Community-Driven Social Infrastructure*. *Asian Pacific Environmental Network (APEN), Service Employees International Union (SEIU) California, SEIU 2015 BlueGreen Alliance (BGA)*. <http://apen4ej.org/wp-content/uploads/2020/10/Resilience-Before-Disaster-FINAL-UPDATED.pdf>

[Growth Council](#)⁹⁰ of California and organizations such as [NorCal Resilience Network](#)⁹¹ provide funding as well as training programs for their establishment. The city of San Leandro, in the San Francisco Bay area, has also developed a [Climate Resiliency Mini Grant Program](#) to support resilience hubs and the non-profit Coastal Quest established the Bay Area Coastal Resilience Small Grants to support start-ups and community-based organizations (CBOs) in reinforcing community resilience.

BOX 2

San Diego Regional Climate Collaborative - Elevating regional leadership for equitable adaptation

The San Diego Regional Climate Collaborative's (SDRCC) mission is to connect the region to advance solutions that both mitigate and adapt to the effects of climate change. SDRCC envisions a region that is prosperous and resilient, committed to maintaining a high quality of life, and fosters a green and growing economy with an equitable and unified approach. SDRCC achieves this vision by supporting projects and programs that leverage strategic partnerships, focus on developing and implementing regionally responsive research, and elevate the San Diego region's capacity and leadership for climate action. SDRCC collaborated with the San Diego Association of Governments (SANDAG) to develop an Equity-First Approach to Climate Adaptation that provides high-level recommendations for adaptation practitioners to engage communities, identify inequities related to climate impacts, and advance equity-first adaptation initiatives. In tandem with the report, SDRCC developed training curricula and workshop modules for practitioners that build organizational capacity, an understanding of equity-first adaptation, and detailed community engagement best practices. SDRCC currently offers technical assistance and training opportunities to its members and working groups to accelerate equity-first adaptation practices across the region.

90/ Strategic Growth Council. Community Resilience Centers. <https://sgc.ca.gov/programs/community-resilience-centers/>

91/ NorCal Resilience Network. Resilience Hub Initiative. <https://norcalresilience.org/resilient-hub-initiative/>

2.3. Committing time and resources to long-term, meaningful engagement

Building or restoring trust is fundamental to making engagement appealing to community members - in particular for groups that have been historically disempowered. A sort of "consultation fatigue" may exist in communities that are solicited but do not see the results of their interactions with local authorities, researchers, or NGOs. Meaningful engagement can make the development of adaptation strategies slower and harder to predict. Yet, it provides legitimacy and increases public acceptance of the resulting adaptation strategies. It also has the potential of saving expenditures and time if consensus is reached across stakeholders before an adaptation plan or project moves to a wider public consultation period. Because of this, LDMs should not bypass it, nor ignore communities' potential reluctance to proposed measures. Instead, it is essential to move at the speed of trust.

Therefore, elected representatives and city officials should engage with their communities in a transparent and consistent manner over the long-term. This is particularly crucial considering the long-range nature of SLR and the imperative to address it in conjunction with many other issues affecting coastal areas. Being clear about the terms of engagement and demonstrating impacts of involvement by sharing outcomes is key in avoiding disappointment and disengagement. Providing opportunities for participation that are conscious of time, mobility, language, and financial constraints is also essential to ensure that as many community members, including hard-to-reach groups, can participate. For instance, offering interpretation (such as in Spanish or Mandarin) can facilitate community engagement. Increasingly, providing stipends to CBOs and individuals, often on an hourly basis, is seen as leading practice in facilitating community engagement and justice by enabling participation from a wider range of community members in the decision-making process.

The financial costs of meaningful engagement are often underestimated, hindering the provision of fair and inclusive opportunities for communities to take part in the elaboration of adaptation strategies. In line with this, the City of Santa Cruz, California,



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financially compensates stakeholders residing in its Beach Flats area and encourages them to take up leadership roles. Funding agencies and philanthropies such as the [Oregon Community Foundation](#)⁹² providing grant programs for community engagement are a good step forward. Nonetheless, these funding mechanisms - most often aimed at small non-profits and schools - remain too limited to cover the full costs

92/ Oregon Community Foundation. 2023 Community Grant Program. <https://oregoncf.org/grants-and-scholarships/grants/community-grant-program/>

of required action. **Unlocking dedicated, increased funding for cities and grassroots organizations to engage with communities is key to sustain meaningful engagement in the long run.**

East Palo Alto Rain Garden Project – Centering communities in resilience-building



SUMMARY

Climate Resilient Communities, in collaboration with HighTide Intelligence, Grassroots Ecology, and FreshApproach received a grant from the California Coastal Conservancy to install 25 rain gardens and water cistern systems for low-income homeowners in East Palo Alto, all at no-cost. This project emerged out of an extensive community engagement process including extended focus groups with residents, door-to-door solicitation and surveying, and several community workshops, all to assess East Palo Alto’s vulnerability to climate change and community priorities for response. Rain gardens were suggested by the community as a Nature-based Solution to the harms of climate change that offers multiple compounding benefits.

CLASSIFICATION

-  **Risks:** Submersion; stormwater flooding; erosion
-  **Typology of solutions:** Nature-based Solutions; capacity-building; knowledge sharing activities; research to action project
-  **Geographical location:** East Palo Alto, California, USA
-  **Budget:** \$1,000,000
-  **Typology of actors:** Community-based organizations; NGOs; local and regional authorities
-  **Project duration:** 2022-2025

OBJECTIVES

- Reduce stormwater and riverine flooding impacts with decentralized Nature-based Solutions by creating more permeable opportunities for water to naturally be absorbed.
- Prevent displacement by improving property values and reducing risks of catastrophic loss during flood events. Property owners without mortgages often bear the risk of flooding without flood insurance, which has historically fueled displacement in East Palo Alto.
- Promote household resilience by creating food and water sovereignty to a community disproportionately burdened by the high costs of fresh food and water allocations.
- Determine the potential for scaling rain gardens through rigorous modeling and conduct a cost-benefit analysis to advocate for project expansion.

RESULTS

- 10 Garden Ambassadors trained and employed
- 25 rain gardens and water cistern systems installed
- 500 residents engaged through educational workshops and outreach activities
- 1 journal article or white paper outlining best practices
- Modeling results making the case for widespread, decentralized, Nature-based Solutions to climate change



KEY TAKEAWAYS

- (1) The East Palo Alto Rain Garden Project has been community-led from the start, bringing a diverse set of community voices into conversation about their priorities for climate adaptation at the local level, which facilitated buy-in and the recruitment of participants.
- (2) Residents strongly support this project, in part because of the immediate and tangible impacts it will provide. In addition to workforce development, a key community priority - residents recognize the tremendous value this project can play in reducing displacement.
- (3) Project management and administration has been very coherent, due in large part to strong, pre-existing relationships between collaborators. Shared goals of community resilience and commitment to local communities unified the team around the project.

ACTIVITIES

Widespread community education, outreach and public engagement are key components of this project, which will raise awareness about the benefits of Nature-based Solutions. Several modeling exercises will be conducted to ensure optimal placement of gardens at household level as well as the scaling necessary to impact flood risk at community level. Native plants and edible species will form a plant palette specific to the conditions of each site and garden ambassadors will be recruited and trained to install and maintain nature-based infrastructure and water cistern systems. Continuing employment and upkeep of the gardens will provide opportunities for 10 community members to develop transferable skills and earn prevailing wages.





3 DELIVERING TRANSFORMATIVE ADAPTATION POLICIES

KEY MESSAGES:

- Coordinating among cities reflects geomorphic realities and enables the development of adaptation strategies that take full consideration of local opportunities for action and the possible negative impacts of adaptation options.
- Considering social objectives and integrating several policy domains into adaptation planning are key in designing new models of coastal living to build cities that are not only safer but more equitable, inviting and where communities can thrive.
- Reframing the debate around managed retreat is urgently needed. When anticipated, consented to, and phased, it can yield transformative results for coastal communities in the form of social, health, economic, political, and environmental benefits.

The U.S. West Coast has long been proactively managing its coastline with consideration of erosion, storms, and SLR. Washington, Oregon and California were among the first states to establish their coastal management programs - in 1976, 1977 and 1978 respectively, in line with the National Coastal Zone Management Program established by the Coastal Zone Management Act (CZMA).⁹³ Recently, financial resources dedicated to climate-related programs, including adaptation action, substantially increased in the region, notably with the Inflation Reduction Act of 2022 providing \$369 billion at federal level; or the \$715 million from the California state budget allocated to the State Coastal Conservancy.⁹⁴ Nevertheless, discrepancies among coastal cities in political will and levels of advancement remain. In California, for example, about two-thirds of outer coast communities have completed vulnerability

assessments while only one-third have completed adaptation plans.⁹⁵ Protection-based approaches best suited to address near-term risks persist as the primary response across the region. **However, SLR-related impacts are long-term threats with high uncertainty requiring holistic and hybrid systems of solutions, as well as flexibility to address multiple priorities and needs in changing conditions.** Dynamic and transformative policies require stronger coordination among stakeholders across jurisdictions, rely on the phasing of strategies to advance adaptation in the face of uncertainty and include exploring all options, including managed retreat.

93/ Office for Coastal Management, NOAA. Coastal Zones Management Programs. <https://coast.noaa.gov/czm/mystate/#oregon>
94/ Legislative Analyst's Office. (2022). *The 2022-23 California Spending Plan: Resources and Environmental Protection*. <https://lao.ca.gov/Publications/Report/4633>

95/ Ocean and Coastal Policy Center at UC Santa Barbara, *California Coastal Adaptation Planning Inventory*. <https://storymaps.arcgis.com/stories/5c3ec4198b564750886cc75b95a8e492>
96/ Bongarts Lebbe, T., Rey-Valette, H., Chaumillon, E., Camus, G., Almar, R., Cazenave, A., et al. (2021). *Designing Coastal Adaptation Strategies to Tackle Sea Level Rise*. *Front. Mar. Sci.* 8:740602. <https://doi.org/10.3389/fmars.2021.740602>

3.1. Coordinating among agencies, cities, and networks

Adapting to the cumulative effects of SLR at scale generally requires expanding the geographical scope of decision-making. Indeed, SLR does not abide by municipal boundaries and neither do the impacts of adaptation measures. **Planning for adaptation in coordinated, place-based and cross-jurisdictional ways, makes it possible to take full account of local opportunities for action and to understand the possible negative impacts of adaptation options, both in-situ and in neighboring areas (e.g., impact of dykes on sediment flows).**

Bridging the disconnect that can exist between state objectives, regional plans and local implementation is crucial in developing sound adaptation strategies. In an attempt to overcome this challenge, California passed the bill “[SB-1 Coastal resources: sea level rise](#)”⁹⁷ in 2021. This bill establishes the California Sea Level Rise State and Regional Support Collaborative (SLR Collaborative), which will be tasked with advancing coastal resilience in coordination with state priorities under the leadership of the OPC. Networks such as this SLR Collaborative can promote coordination by encouraging the collective definition of local and regional priorities and regulatory changes. In this respect, the consortium [Bay Adapt](#)⁹⁸ is working to mobilize governments, organizations and leaders in adaptation planning to collectively define principles and goals, with the objective to create a cohesive strategy across the nine counties of the Bay Area in California.

Networks and communities of practices are useful in building regional capacity and accelerating action by providing a space for the exchange of informal advice, know-how and returns on experiences. Members can pool knowledge, information and resources, and form collaborations to initiate projects across jurisdictions. For instance, the [Alliance of Regional Collaboratives for Climate Adaptation](#)⁹⁹ brings together practitioners from eight different partnerships from across California. The collaborative notably creates tailored “learning sessions”, provides up-to-date policy resources such

97/ SB-1 Coastal resources: sea level rise (2021-2022). https://leginfo.ca.gov/faces/billTextClient.xhtml?bill_id=20210220SB1
 98/ Bay Adapt. <https://www.bayadapt.org/>
 99/ Alliance of Regional Collaboratives for Climate Adaptation. <https://arccacalifornia.org/>

as bill trackers, and grant trackers, as well as toolkits to facilitate the planning and implementation of adaptation action across the California’s counties and cities of the State. Washington Sea Grant has also developed the [Washington Coastal Hazards Resilience Network](#)¹⁰⁰ to boost coordination and collaboration among state, federal and academic and tribal experts planning to respond to coastal hazards.

BOX 3

San Francisco Estuary Institute - Operational Landscape Units

The San Francisco Bay shoreline is both fundamentally interconnected yet locally distinct in its landscapes, demographics, and land uses patterns – rendering it vulnerable to SLR in multiple ways and making adaptation possible only through coordination across jurisdictions. To facilitate this process and best appraise where nature-based approaches can be applied across the Bay, the [San Francisco Estuary Institute](#) produced an “Operational Landscape Units” (OLUs) framework that divides the Bay shoreline into 30 distinct OLU. OLU are connected geographic areas defined through their shared physical characteristics (typologies of landscapes, watershed boundaries, mudflat width, population density, etc.) and are best managed as a coherent unit to provide desired ecosystem functions and services. Recognition of the interconnectedness and feedback loops between OLU means their management should be done with consideration of the wider Bay system. Based on the OLU framework, SFEI produced the [San Francisco Bay Shoreline Adaptation Atlas](#), which supports the definition of locally relevant adaptation strategies that work with natural processes.

100/ Washington Coastal Hazards Resilience Network. [www.wacoastalnetwork.com](http://wacoastalnetwork.com)

BOX 4

Coastal Quest - Working with partners across jurisdictions to facilitate and fund adaptation planning and action

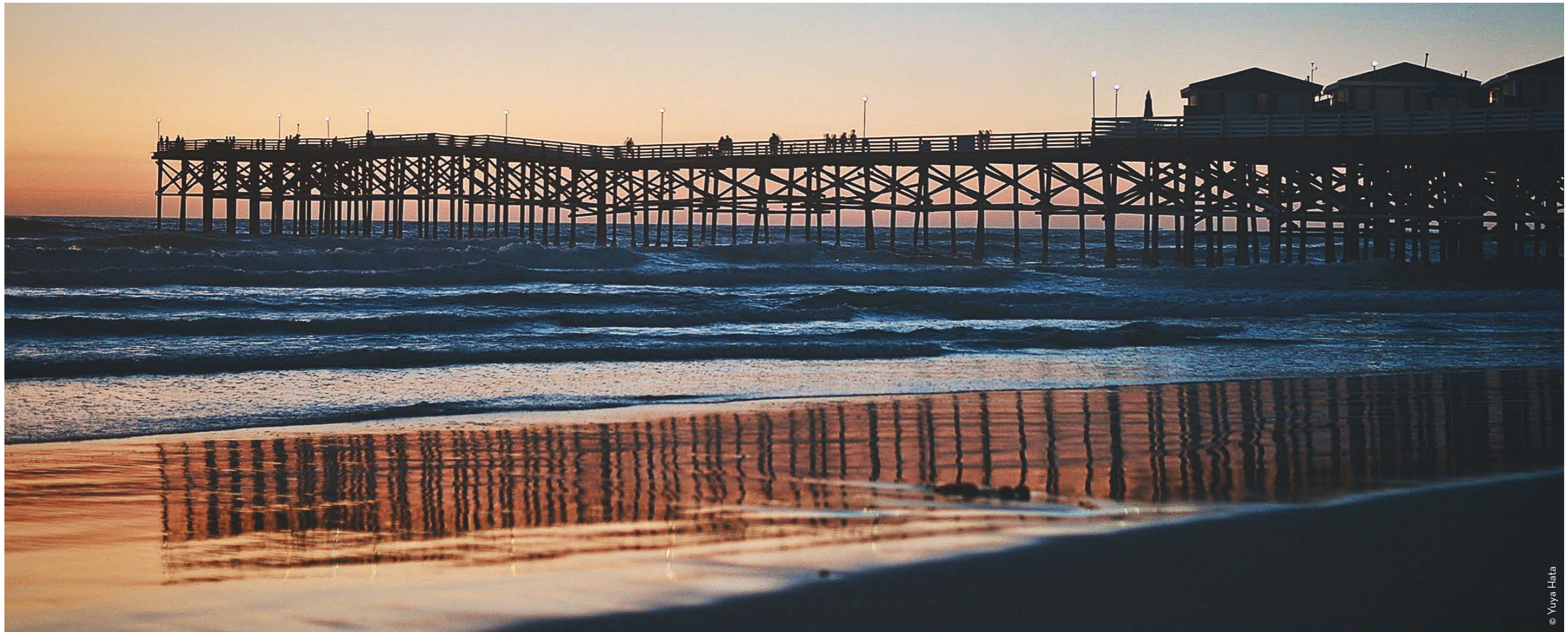
[Coastal Quest](#) partners with state agencies, county and city governments, as well as CBOs to design, fund, and implement equitable, multi-benefit solutions to improve coastal resilience and help coastal communities adapt to climate hazards like SLR. Coastal Quest facilitates the development of coordinated adaptation action plans across jurisdictions that are grounded in science and community input, helping find and secure funding for both planning and execution. In 2022 Coastal Quest helped over 20 government agencies and CBOs across California identify coastal resilience priorities and secure over \$4 million to advance on-the ground solutions. In the San Francisco Bay Area, the organization raised over \$1.5 million in grants to support governments and CBOs develop collaborative, community-led adaptation strategies and advance long-term, cross-jurisdictional planning. In Southern California, Coastal Quest is piloting an early, multi-scale study in partnership with California State Parks. The team raised over \$1.2 million in blended funding to assess SLR vulnerability for the coastal state parks in San Diego’s coastal district, and to identify options for adaptation. The pilot study follows a holistic approach to vulnerability assessments that accounts for state park’s diverse assets, leverages cutting edge data on hazards and park visitation trends and includes a comprehensive outreach and engagement process to collect input from stakeholders including community members, California Tribes, governments, and NGOs.

3.2. Deploying adaptation strategies through a phased approach

Sea level rise operates on timescales that far exceed those of electoral terms and political agendas and is characterized by great uncertainty. **Avoiding lock-ins and maladaptation in the long run involves designing adaptive strategies, such as Dynamic Adaptive Policy Pathways,¹⁰¹ to enable the articulation of short-term tactical measures and longer term action over several phases, continuous reviewing and changing trajectories whenever necessary.** Pathways can integrate environmental change and community vision into multiple trajectories with transitions from one to another that are not associated with predefined timescale but are instead initiated by collectively chosen triggers. In its [2021 Sea-Level Rise Adaptation Plan](#),¹⁰² the City of Santa Barbara, California, enshrined a phased approach to planning, based on monitoring and trigger-based actions, given the degree of infrastructure work needed and the number of parcels affected. Nearest-term priorities are action oriented, e.g., relocating major sewer lines under the beach, raising harbor walkways, and changing floodplain building regulations to factor in SLR. Meanwhile, mid and longer term priorities focus on decision-making structures, reconsider protection measures, and elaborate on the relocation of the wastewater system and portions of the harbor at 0.45 meter (1.5 feet) SLR. This phased approach in the deployment of solutions tailored to evolving priorities has so far facilitated commitment from the city to near- and mid-term action and eased discussions on the needs and options for the longer term.

Tools exist to co-develop alternative futures and facilitate decision-making. For instance, [ENVISION](#)¹⁰³ is a scenario modeling tool produced by Oregon State University and Sea Grant. It incorporates landscape feedback as well as the simulation of community values and “multiagent modeling;” i.e., decisions made by LDMs. This supports the definition of pathways by quantifying the potential

101/ Marjolijn, H., Kwakkel, J.H., Walker, W.E., ter Maat, J. (2013). *Dynamic Adaptive Policy Pathways: A Method for Crafting Robust Decisions for a Deeply Uncertain World*. *Global Environmental Change* 23, no. 2 (2013): 485-98. <https://doi.org/10.1016/j.gloenvcha.2012.12.006>
 102/ City of Santa Barbara. (2021). *City of Santa Barbara Sea-Level Rise Adaptation Plan*. <https://santabarbaraca.gov/sea-level-rise-adaptation-plan-and-vulnerability-assessment>
 103/ ENVISION. <http://envision.bee.oregonstate.edu/>



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impacts of each scenario associated with climate change trajectories and decision-making options. However, these tools tend to be very technical and could be made more accessible to simplify installation and use by end-users in charge of decision-making.

Defining the metrics of success and evaluating adaptation responses over time is key in ensuring that chosen policies remain suitable – and if they are not, in deciding when to transition to another set of actions. **Evaluation criteria should not only account for technical and cost efficiency but also be tied to strategic, pre-defined objectives, collectively chosen through community visioning and early engagement.** Community access to the shoreline, improved housing units, satisfaction of inhabitants with the participatory process and chosen measures, and degree of engagement of communities in the decision-making process are examples of social metrics that can guide the evolution of governance

frameworks and practical pathways.

Anticipated long-term planning with interim milestones can ease the transition to ambitious measures that may not yet be suited nor feasible, but which could yield transformative results for communities at large as well as wider ecosystems. In some areas, managed retreat could be necessary in the long-term and prove to be transformative. Indeed, when proactively anticipated, prepared with clear social justice objectives, and consented to, managed retreat has the potential to transform both societal perceptions about SLR risks and adaptation as well as the economic, political, health, and social dynamics at play.¹⁰⁴

104/ Siders, A.R., Ajibade, I., Casagrande, D. (2021). *Transformative potential of managed retreat as climate adaptation. Current Opinion in Environmental Sustainability*, Volume 50, Pages 272-280, ISSN 1877-3435 <https://doi.org/10.1016/j.cosust.2021.06.007>

3.3. Enabling managed retreat

Defending coastal communities through armoring could cost the U.S. \$400 billion over the next 20 years and would require the construction of over 80,467 kilometers (50,000 miles) of coastal barriers,¹⁰⁵ with additional maintenance costs and potential negative impacts. Notably, seawalls lead to the passive erosion of beaches, and can alter longshore drifts and sediment flow, with repercussions on important activities for coastal economies, identities, traditional uses, and access. Protection-based measures can also give rise to a false sense of security, resulting in greater development along the shoreline and lower

105/ LeRoy, S., Wiles, R. (2019). *High Tide Tax, The Price to Protect Coastal Communities from Rising Seas*. The Center for Climate Integrity Resilient Analytics. https://www.climatecosts2040.org/files/ClimateCosts2040_Report.pdf

preparedness of inhabitants, businesses, and cities at large against the risks posed by SLR. **Meanwhile, the Intergovernmental Panel on Climate Change (IPCC) underlines that preventing the establishment of people, dwellings, infrastructure, and activities in vulnerable areas, or facilitating their relocation, are the only measures that can remove coastal risks, while others only delay impacts.**¹⁰⁶ It is therefore critical to consider managed retreat as a potential long-term option in certain areas.

106/ IPCC, (2022). *Climate Change 2022: Impacts, Adaptation, and Vulnerability*. Contribution of Working Group II to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change [Pörtner, H.-O., Roberts, D.C., Tignor, M., Poloczanska, E.S., Mintenbeck, K., Alegría, A., et al. (eds.)]. Cambridge University Press. Cambridge University Press, Cambridge, UK and New York, NY, USA, 3056 pp., doi:10.1017/9781009325844. https://www.ipcc.ch/report/ar6/wg2/downloads/report/IPCC_AR6_WGII_FrontMatter.pdf



In addition, delaying retreat where it is necessary only makes it more expensive. Costs are difficult to estimate and are context specific. For instance, Kivalina, Alaska, is making concerted efforts to relocate its 400 residents. Attempts to determine the costs of this relocation, in the particular context of the town, have estimated that they are increasing each year, potentially ranging from USD100 to 400 million.¹⁰⁷ For many reasons, the issue of managed retreat remains a heavily polarized and contentious one¹⁰⁸ leading to heightened political conflict, notably over concerns regarding potential tax revenue loss for cities. For instance, in Pacifica, California, disagreement over the topic resulted in the replacement of the mayor who supported managed retreat.¹⁰⁹ Frequently, political and social unrest result in the exclusion of the option from the list of possibilities.

The great costs of removing and relocating assets and who pays for it are a fundamental point of contention with social justice implications. Since the 1980s, FEMA has offered buyouts for storm-damaged homes to convert them to natural open spaces. This program, intended to incentivize homeowners to relocate in post-disaster recovery, is useful but does not deter individuals from moving to or staying in vulnerable areas. In fact, the real estate market in California has substantially increased over this period, with homes in the areas most at risk recording the greatest increase in value.¹¹⁰ In addition, property taxes limitations in place in California restrict annual increase in value assessments. As a result, it can be cheaper for California residents to remain in their home than moving to another house of the same value, especially in coastal cities where increase in property value is the highest. This in turn limits incentives to mobility.¹¹¹ The coastline simply remains

too financialized, and properties retain too much economic value pitting interest groups against the very reality of SLR.¹¹²

In the short term, better risk information should be readily accessible through mandatory disclosure of properties' risk status and flood history, as well as community-level information about future risks. Concurrently, new development in flood-prone areas should be further restricted through strengthened setback zones for both residential and commercial buildings, such as hotels. In line with this, the [bluff policy of Isla Vista](#) in Santa Barbara County¹¹³ requires different actions from homeowners depending on the proximity of buildings to the bluff face. These short-term measures can be easily enacted to facilitate managed retreat at longer term horizons. Special consideration must be given to less affluent households while planning for relocation, to ensure that affordable homes remain available locally, in particular since housing availability is already a challenge in some areas of the West Coast. To this end, the not-for-profit community planning firm [Buy-In Community Planning](#)¹¹⁴ uses geospatial data and participatory planning to help local governments design buyout programs that are transparent, efficient, and equitable.

Focusing on shared community spaces, amenities, infrastructure and commercial projects is critical, could help alleviate some of the opposition around retreat, and is often a priority. Indeed, retreat provides opportunities for greater public access to the coastline as well as the preservation or restoration of natural areas.¹¹⁵ For instance, the CCC and Caltrans conducted the relocation of several sections of state highways

in California,¹¹⁶ enabling shoreline restoration and the creation of visitors' facilities. Identifying community values and priorities is key to provide personalized information about the potential benefits of managed retreat, introduce the time horizon at which such an option could be considered and best initiate discussion on the matter. Against the dichotomous terms of armoring versus retreat, other terminologies such as "corrective shoreline planning", "managed realignment", "planned relocation", and "community-led relocation" can better frame its coordinated aspect.¹¹⁷ In Marina, California, community and state pressure along with enforcement action succeeded in phasing out industrial sand removal and introduced the consideration of a seawall ban, while the definition of triggers to relocate public buildings and infrastructures is underway. In San Francisco, a dispute over the relocation of the highway near south Ocean Beach was settled through an interagency effort spanning several years.¹¹⁸

No matter the adaptation strategy selected, proactive community visions ought to be centered and leveraged. It is critical that adaptation strategies remain flexible to integrate uncertainties and ensure the ability of cities and counties to respond to future SLR. For this reason, it is important to ensure that managed retreat is not automatically ruled out of the field of possibilities. **When anticipated, consented to, and integrated in phased and flexible manners in adaptation planning, managed retreat provides opportunities to rethink the intersection of built and natural spaces and to conceive better amenities and urban spaces for coastal communities.**

Beach Erosion Authority for Clean Oceans and Nourishment (BEACON) - Surfers' Point Living Shoreline and Managed Retreat Project

[BEACON](#) is a California Joint Powers Agency bringing together the counties of Santa Barbara and Ventura as well as the coastal cities of Santa Barbara, Goleta, Carpinteria, Ventura, Oxnard and Port Hueneme. Involved in coastal studies and management projects within its jurisdiction, BEACON has assisted its Surfers Point Working Group project partners in coordinating planning the "Surfer's Point Living Shoreline and Managed Retreat Project" in Ventura through a phased approach. The Surfers Point project has rejected traditional rip-rap protection in favor of a nature-based Living Shoreline cobble, beach and dune restoration as well as a Managed Retreat project that is restoring a cobble beach and dune habitat ecosystems, and maintaining coastal access while moving public access and recreation improvements out of the hazard zone. To complete Phase 2 of the project, remaining portions of a damaged oceanfront bike line and a parking lot will be relocated out of the hazard zone and reconfigured to provide better urban services. Including transportation and stormwater facilities (e.g., EV charging stations will be added to the new parking lot). Concurrently to the managed retreat element, soft-nature-based ecosystem restoration will create a resilient 'living shoreline'. Long-term monitoring of the Phase 1 section of the project constructed in 2011 has demonstrated successful performance of the living shoreline restored coastal dune and beach system in providing protection against storms and winter extreme events. A Surfers Point Working Group was established for community consultation regarding the project's goals and design as well as stakeholders' involvement throughout the entire process. Local champions, with leadership by the Surfrider Foundation Ventura Chapter have been instrumental in attaining public support for the living shoreline and managed retreat project elements while ensuring the project meets the needs of recreational users of Surfer's Point.

107/ U.S. Climate Resilience Toolkit. Relocating Kivalina. <https://toolkit.climate.gov/case-studies/relocating-kivalina>

108/ Siders, A.R. (2019). *Managed Retreat in the United States*. One Earth, Volume 1, Issue 2, Pages 216-225, ISSN 2590-3322. <https://doi.org/10.1016/j.oneear.2019.09.008>

109/ Xia, R. (2019). 'The California Coast Is Disappearing under the Rising Sea. Our Choices Are Grim.', Los Angeles Times, July 7. <https://www.latimes.com/projects/la-me-sea-level-rise-california-coast/>

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113/ County of Santa Barbara. (2020). *Isla Vista Bluff Policy Update*. <https://content.civicplus.com/api/assets/3bf7414c-99ff-4012-a78a-366afe681da8>

114/ Buy-In Community Planning. <https://buy-in.org/>

115/ Lester, C., Griggs, G., Patsch, K., Anderson, R. (2022). *Shoreline retreat in California: Taking a step back*. Journal of Coastal Research, 38(6), 1207-1230. Coconut Creek (Florida), ISSN 0749-0208. <https://doi.org/10.2112/JCOASTRES-D-22A-00010.1>

116/ Ketchum, J., Grove, T. (2021). "Partnering Transportation and Coastal Zone Management Agencies: The California Example of Success." Joint Caltrans and California Coastal Commission presentation for the Congressional Briefing, Protecting Coastal Roads: Using Nature Based Solutions to Protect Transportation Infrastructure from Sea Level Rise and Flooding, September 9, 2021. <https://dot.ca.gov/-/media/dot-media/programs/environmental-analysis/documents/env/ct-ccc-presentation-narrative-a11y.pdf>

117/ Bragg, W.K., Gonzalez, S.T., Rabearisoa, A., Stoltz, A.D. (2021). *Communicating Managed Retreat in California*. Water, 13, no. 6, 781. <https://doi.org/10.3390/w13060781>







118/ San Francisco Planning. (2022). *Ocean Beach Climate Change Adaptation Project*. Draft Environmental Impact Report. Public Hearing, January 6, 2022. <https://sfgov.org/countyclerk/sites/default/files//NOA-OceanBeachClimateChangeAdaptationProject-120821.pdf>

Resilient Coast Santa Cruz - Cross-sector collaboration for long-term resilience.

SUMMARY

Resilient Coast Santa Cruz (Resilient Coast) is an initiative of the City of Santa Cruz aiming to address coastal adaptation for the long-term resilience of the City's coastline. Informed by scientific work and community vision, Resilient Coast utilizes an adaptation pathways approach supported by immersive and interactive tools, such as virtual reality used to facilitate community engagement

CLASSIFICATION

-  **Risks:** Sea level rise; stormwater flooding; erosion
-  **Typology of solutions:** Planning and policy documents, Nature-based Solutions; knowledge sharing activities; Research to action project; soft protections; hard protections; coastal monitoring
-  **Geographical location:** Santa Cruz, California, USA
-  **Budget:** Over \$600,000 in grant funds have been invested since 2019 in Resilient Coast Santa Cruz; the City now budgets \$20,000 annually to operate its coastal monitoring network and approximately \$500,00 annually to implement solutions. It has over \$2.5M currently pending in grant funding to implement solutions.
-  **Typology of actors:** Local and regional authorities; state services; research institutes and universities; community-based organizations; NGOs; companies and professional organizations
-  **Project Duration:** Resilient Coast Santa Cruz 1.0 took place between 2019 and 2022. Resilient Coast Santa Cruz 2.0 started in 2022 and is anticipated to conclude in 2024.

OBJECTIVES

Resilient Coast aims to build awareness, increase adaptive capacity and strengthen the long-term resilience of the 4 miles long Santa Cruz shoreline in the face of ongoing erosion, SLR and storms. Through cross-sector collaboration and community engagement, it integrates community priorities (such as public access to the coastline, preservation of habitats, and transportation needs) and visions into the development of adaptation pathways.

ACTIVITIES

Through Resilient Coast, the community developed adaptation pathway approaches for its beaches and blufftop locations. The proposed pathways articulate several potential adaptation options over different time horizons, including living shorelines, hard protection, increased pump capacity, and managed retreat for certain coastal facilities and infrastructure in the longer term. Resilient Coast led to the production of the West Cliff Drive Adaptation and Management Plan and complementary policies in the City's Local Coastal

Program (currently being amended). Physical, social, and ecological triggers are under development, as well as a coastal change monitoring network composed of a tidal gauge, monitoring cameras, drone imagery and CoastSnap community science stations.

RESULTS

- The City had over 1,500 touchpoints with the community during Resilient Coast 1.0 through over 50 traditional and nontraditional engagement activities.
- The monitoring network consists of 1 tidal gauge, 9 cameras, 4 Coast Snap community science stations, and drone imagery along with data sources, which will be all brought into a publicly available dashboard providing triggers, threshold tracking and alerts, as well as shoreline change analytical tools.
- The January 2023 bomb cyclone event caused nearly \$10M in damages to West Cliff Drive, forcing the City to take one-lane of traffic out of service and test a one-lane, one-way scenario (i.e., incremental managed retreat), a concept that previously had mixed community support.
- Through engagement activities, frontline neighborhood residents produced a family emergency planning guide distributed throughout the neighborhoods.

KEY TAKEAWAYS



- Spending time building relationships with frontline community leaders and residents by sharing meals, designing meetings with them, and compensating them for their time helped establish trust and gain sustained engagement.
- Leveraging academic partnerships added capacity to the City to focus long-term on frontline communities and evaluate the efficacy of our engagement efforts.
- Elected officials serving as project champions demonstrated the importance of this work and brought attention to the initiative.
- The commitment of twelve different federal, state, and local agencies, higher education institutions and NGOs brought together all the expertise and knowledge necessary to design a sophisticated coastal change monitoring network.



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RESOURCES

Presentations made at the Sea'ties Workshop Adapting Coastal Cities to Sea Level Rise in North America - U.S. West Coast

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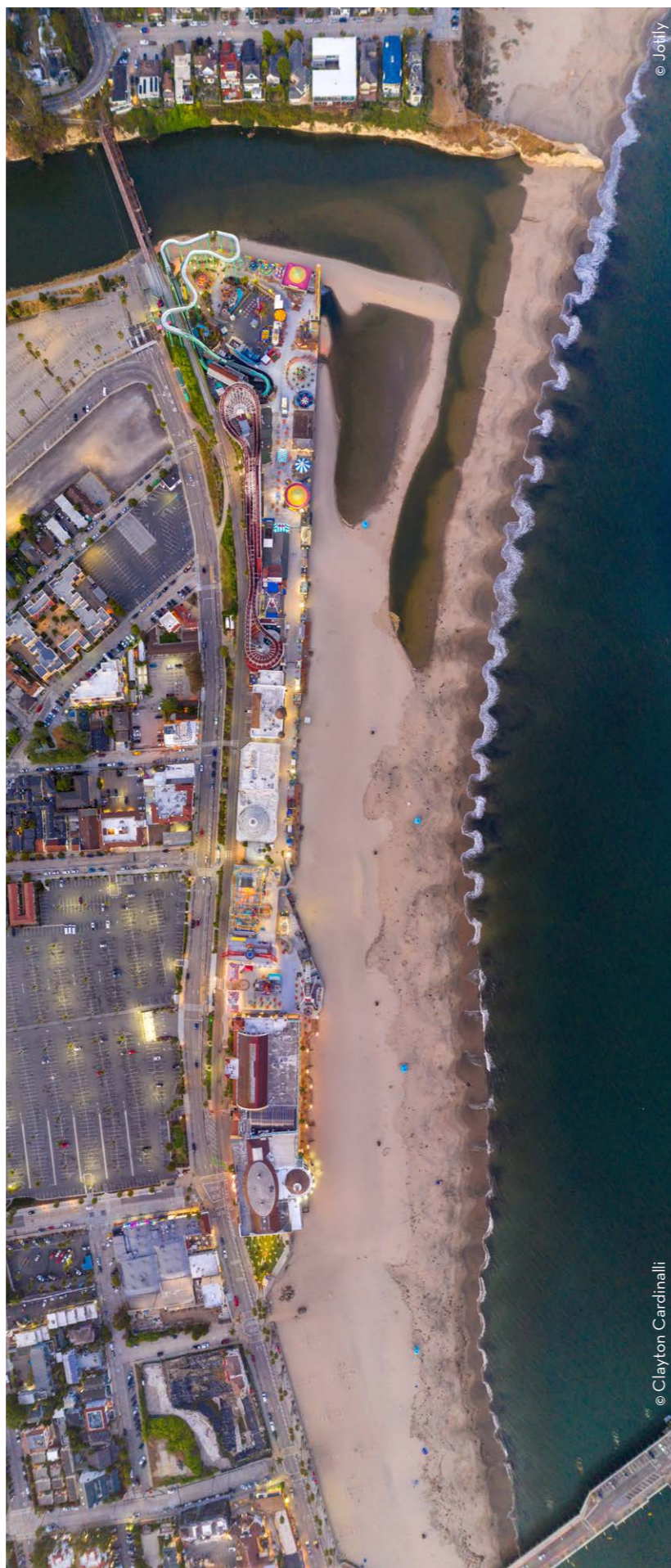
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SHARING SOLUTIONS WITH COASTAL
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