

# COLLABORATIVE PLANNING FOR CLIMATE RESILIENCE

## An Integrated Science-based Framework for the San Diego Region



**American Planning Association**  
*Creating Great Communities for All*



**California-Nevada Climate Applications Program**  
A NOAA RISA team

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American Planning Association  
Regional and Intergovernmental Planning Division

and

Scripps Institution of Oceanography  
California - Nevada Climate Applications Program

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## I. Introduction

The impacts of climate change are causing increasing public concern about the resulting risks facing us. According to a recent report by the Pew Research Center, **sixty-three percent of American adults say global climate change is affecting their community, and sixty-five percent say the federal government is doing too little to reduce the effects of climate change.**<sup>1</sup> And, while significant efforts at all levels of government over the past twenty to thirty years have been aimed at reducing greenhouse gas emissions, far less attention has been paid to finding ways to adapt to the adverse impacts of climate change, both nationally and locally.

In the San Diego region, average temperatures are increasing, sea levels are rising, wildfire hazards are mounting, sporadic winter storms continue, and the possibility of a co-occurrence or a sequence of these events is becoming more likely. Scientists tell us that, due to our geographical location and unique physical setting, the San Diego region is susceptible to a host of threats to our quality of life and to our natural environment. San Diego's Mediterranean climate and coastline, which attract so many people to live and work here, also make the region vulnerable to the impacts of climate change. Science-based projections indicate that the ambient temperatures in our region will gradually increase, leading to greater wildfire risk by exposing San Diego's landscapes to longer dry periods; these may extend into the peak of the Santa Ana Wind season that historically has fanned the region's most devastating wildfires. This situation is made even worse by the increasing probability of multi-year droughts, resulting from both lack of precipitation and increasing evaporative demand directly connected with warming. And, although the San Diego region may become drier overall, the most extreme precipitation events are projected to become even more extreme, potentially leading to increased flooding and erosion along rivers and creeks and at beaches and cliffs.<sup>2</sup>

Against this backdrop, the primary purpose of this report is to promote collaborative and science-based climate resilience planning that will build on existing plans and related research, and that will broaden our vision to take on the new challenges we face as a result of climate impacts. The report sets forth a proposed *Framework* for climate resilience planning in the San Diego region, which will serve as the basis for evaluating and adapting to the impending threats posed by climate change, some of which are unique to our region and many of which are already being experienced in other regions across the United States.

Production of this report has been a collaborative effort led by urban planners from the American Planning Association's Regional and Intergovernmental Planning Division and research scientists from the Scripps Institution of Oceanography, San Diego State University, and other renowned research organizations that are focusing on climate change. The final report has also benefitted greatly from comments and suggestions made by over thirty external reviewers, representing a broad range of agencies, organizations, and interests. Our overriding goal has been to produce a report that identifies

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<sup>1</sup> "Two-Thirds of Americans Think Government Should Do More on Climate," Pew Research Center, 6/23/20.

<sup>2</sup> See: Kalansky, Julie, Dan Cayan, Kate Barba, Laura Walsh, Kimberly Brouwer, Dani Boudreau (University of California, San Diego). 2018. San Diego Region Report. California's Fourth Climate Change Assessment. Publication number: SUM-CCCA4-2018-009. [San Diego Region Report \(ca.gov\)](#)

practical ways for different sectors of the community to join together in solving one of the greatest challenges of our time.

The proposed *Framework* is built upon the foundation of the **Sustaining Places Initiative**, an urban planning research effort initiated and led by the American Planning Association (APA), the leading professional organization for urban planners in the United States. Launched by APA in 2010 at the United Nations Fifth World Urban Forum, it is based on the premise that the local Comprehensive Plan (also known as the General Plan) is the ideal vehicle for addressing the challenges to sustainability facing our communities. According to APA:

Planning for sustainability is the defining challenge of the 21st century. Overcoming deeply ingrained economic and cultural patterns that result in resource depletion, climate instability, and economic and social stress requires holistic problem solving that blends the best scientific understanding of existing conditions and available technologies with the public resolve to act. Planning processes allow communities to look past immediate concerns, evaluate options for how best to proceed, and to move towards a better future. The Comprehensive Plan has the legal authority to act as the vehicle for guiding community development, the scope to cover the necessary functions and facilities, and the history of practice to inspire public acceptance of its policies. Planning can provide the necessary analysis, the requisite communitywide reflection and education, and the momentum required to respond to these monumental challenges.<sup>3</sup>

As a result of its focus on the Comprehensive Plan as a primary vehicle for addressing sustainability challenges, APA identified a set of principles, processes, and attributes that, taken together, will lead to a *Comprehensive Plan for Sustaining Places*. These required Principles, Processes and Attributes are listed below.

### Principles

1. **Livable Built Environment.** Ensure that all elements of the built environment, including land use, transportation, housing, energy, and infrastructure, work together to provide sustainable, green places for living, working, and recreation, with a high quality of life.
2. **Harmony with Nature.** Ensure that the contributions of natural resources to human well-being are explicitly recognized and valued and that maintaining their health is a primary objective.
3. **Resilient Economy.** Ensure that the community is prepared to deal with both positive and negative changes in its economic health and to initiate sustainable urban development and redevelopment strategies that foster green business growth and build reliance on local assets.
4. **Interwoven Equity.** Ensure fairness and equity in providing for the housing, services, health, safety, and livelihood needs of all citizens and groups.
5. **Healthy Community.** Ensure that public health needs are recognized and addressed through provisions for healthy foods, physical activity, access to recreation, health care, environmental

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<sup>3</sup> Godschalk, David and William Anderson. 2012. *Sustaining Places: The Role of the Comprehensive Plan*. Planning Advisory Service Report 567. Chicago: American Planning Association. p. 7.

justice, and safe neighborhoods.

6. **Responsible Regionalism.** Ensure that all local proposals account for, connect with, and support the plans of adjacent jurisdictions and the surrounding region.

### Processes

1. **Authentic Participation.** Ensure that the planning process actively involves all segments of the community in analyzing issues, generating visions, developing plans, and monitoring outcomes.
2. **Accountable Implementation.** Ensure that responsibilities for carrying out the plan are clearly stated, along with metrics for evaluating progress in achieving desired outcomes.

### Attributes

1. **Consistent Content.** Ensure that the plan contains a consistent set of visions, goals, policies, objectives, and actions that are based on evidence about community conditions, major issues, and impacts.
2. **Coordinated Characteristics.** Ensure that the plan includes creative and innovative strategies and recommendations and coordinates them internally with each other, vertically with federal and state requirements, and horizontally with plans of adjacent jurisdictions.

Another key concept addressed in the **Sustaining Places Initiative** is that of an *Integrated Planning Process*, where integration occurs both *horizontally* and *vertically*<sup>4</sup>. In a regional/local planning context:

- *Horizontal integration* refers to the linking of related topics. In regional planning, for example, smart mobility efforts have expanded to include not only urban land use and transportation integration but also environmental resource protection, regional economic development, and social equity considerations. Similarly, local comprehensive plans typically include elements that represent these same types of topical areas and are integrated into a single plan document.
- *Vertical integration* primarily involves connecting planning processes at several geographic scales. For example, regional planning efforts typically connect with federal-level and state-level policymaking and guidance, as well as with local government plans, strategies, and implementing actions. This aspect of integrated planning is particularly important in dealing with planning topics like climate resilience, where scientific research, analysis, and forecasts conducted at the regional scale can be “downscaled” to the city or county level to develop evidence-based local plans, strategies, and implementing actions.

To summarize, our report sets forth a proposed Framework for Climate Resilience Planning in the San Diego Region, based on the following:

- The APA **Sustaining Places** Principles, Processes, and Attributes;
- An evaluation of key guidance documents and advisory reports from public agencies and professional organizations applicable to climate resilience and adaptation planning in the San Diego region.

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<sup>4</sup> Piro, Rocky, and Robert Leiter, with Sharon Rooney. 2017. *Emerging Trends in Regional Planning*, Planning Advisory Service Report 586. Chicago: American Planning Association. p. 13.



- Careful consideration of contemporary environmental justice and equity best practices.
- An evaluation of existing regional and local plans; an overview of current scientific research on climate impacts; and examples of how cross-sector planning and analysis can be conducted in ways that properly address complex climate resilience issues.

This *Framework* serves as the basis for laying out a *Conceptual Planning Process* that can be used by a planning manager to update a particular local or regional plan, or to develop a new plan that will address climate resilience and adaptation. The first step in this process is to design and implement a community engagement process that ensures authentic and ongoing participation by the community. This process should start with visioning and articulation of planning principles; identification of issues, opportunities, and challenges to be evaluated; and agreement on certain assumptions to be used during the process. Once this step is initiated, the planning manager can then proceed with the other important steps in the planning development process, including setting goals, collecting and analyzing data, formulating objectives, analyzing alternatives, selecting and adopting a preferred plan, and implementing the plan. It is also important that climate research and modeling be a core component of the planning process.

### Our Target Audiences

This report identifies four distinct “audiences” that need to work collaboratively to meet the challenges that we face:

- **Planners.** Urban planners are responsible for analyzing how our communities and our natural landscapes will be affected by the changing climate, and for developing plans and policies that allow us to respond effectively through processes that are inclusive, science-based, and cost-effective. To that end, they are charged with preparing the planning documents that will guide the responses of public agencies, non-governmental actors, and the general public to climate change impacts — those impacts already occurring and those expected in the future. For planners, this report provides guidance on how to engage a cross-section of partners and collaborators to frame and formulate science-based plans and recommendations to policymakers.
- **Scientific Researchers.** Whether in universities, private companies, or non-profit organizations, researchers perform the vital task of identifying and documenting climate change vulnerability and impacts, and then devising means of reducing or mitigating them to achieve climate resilience. This report provides researchers with guidance needed to collaborate with planners, grant makers, and other stakeholders in order to better communicate the need for applied research that can best inform solutions at the local and regional level. Additionally, collaboration with these groups can increase researchers’ understanding of planning and management challenges to help inform applied research questions and data frameworks.
- **Community Members and Organizations.** Environmental groups, community-based organizations, policy advocates, and other participants in the planning process rely on an understanding of existing plans, opportunities for input, and the work of scientific researchers to inform development of programs and outreach. This report describes how these participants can engage most effectively in the process of developing and implementing plans for climate resilience.
- **Policymakers.** At all levels of government, policymakers rely on the work of planners and

scientists, as well as communication with the community, as the basis for adopting programs, policies, and regulations addressing climate change impacts and achieving climate resilience. For policymakers, this report provides a guide to understanding these processes and attaining the desired results.

Ultimate success in meeting these challenges requires collaboration and communication between and among all these groups. That means understanding one another's roles and how to build effective relationships. It also requires high-level leadership and commitment in all the groups, whereby political, community, professional, and academic leaders deliver a consistent message about the importance of addressing these issues, while providing adequate resources and actively supporting collaboration at all levels.

### About Climate Resilience and Climate Adaptation

Although climate change poses difficult challenges to the San Diego region, science-based collaborative planning and applied research by key public agencies, research organizations, and other participants can make this region more resilient, thereby avoiding negative impacts to our natural environment, our economic base, and our overall quality of life. Local and regional planning processes laying the groundwork for climate resilience and adaptation in the region have already begun, but much more work is needed. In the short run, public agencies and other stakeholders are already in transition to living with an ever-evolving “new normal” in responding to the impacts of climate change. In the long run, significant changes will be required in land use, resource management, and other practices that underlie the region's vulnerability to climate-related impacts.

While most of the current climate planning efforts are aimed mainly at *greenhouse gas reduction*, this report focuses on planning for *climate resilience* and *climate adaptation*. The *California Adaptation Planning Guide (APG)* defines these terms as follows:

- **Adaptation** is an adjustment in natural or human systems to a new or changing environment (such as the increased frequency and intensity of climate-related hazards or other climate-related conditions). An adaptation adjustment moderates harm or exploits beneficial opportunities brought about by the change.
- **Resilience** is the capacity of any entity—an individual, a community, an organization, or a natural system—to prepare for disruptions, to recover from shocks and stresses, and to adapt and grow from a disruptive experience. A community's resilience is determined by its ability to survive, adapt, and thrive no matter what acute shock or chronic stressor it experiences.<sup>5</sup>

Our report also emphasizes the importance of incorporating *environmental justice*<sup>6</sup> into the climate resilience planning process. Although various agencies and organizations describe this concept in slightly different terms, the U.S. Environmental Protection Agency definition is widely accepted:

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<sup>5</sup> Governor's Office of Emergency Services, 2020. California Adaptation Planning Guide, p. 15  
<https://www.caloes.ca.gov/HazardMitigationSite/Documents/CA-Adaptation-Planning-Guide-FINAL-June-2020-Accessible.pdf>

<sup>6</sup> The term “climate justice” is also used to address environmental justice issues related to climate impacts. For example, see the discussion of “climate justice” in the San Diego Region Report).

The fair treatment and meaningful involvement of all people regardless of race, color, national origin, or income, with respect to the development, implementation, and enforcement of environmental laws, regulations, and policies, achieved when everyone enjoys (i) the same degree of protection from environmental and health hazards, and (ii) equal access to the decision-making process to have a healthy environment in which to live, learn, and work.<sup>7</sup>

In recent years, environmental justice has become an increasingly important consideration in urban planning and environmental analysis, recognizing the disproportionate vulnerability to long-term environmental impacts which certain communities have endured, often as a result of discriminatory planning, service delivery, and public investment. Historically, these have been communities of color, low-income communities, and tribal communities, as well as some rural areas. These concerns take on special urgency in the context of climate change because areas identified as *environmental justice communities* (also classified in many cases as *disadvantaged communities* per SB 1000)<sup>8</sup> are particularly vulnerable to climate impacts.

### Contents of this Report

Following this Introduction, the remaining sections of this report are organized as follows:

- **Section II — Key Guidance Documents and Advisory Reports** summarizes and analyzes key state and regional planning documents relating to climate change impacts and responses, along with statutory requirements, regulations, and policy guidelines pertaining to each. These include state requirements for responding to climate change in local and regional plans, as well as state reports describing the impacts of climate change and methods for addressing them. This section also discusses recent reports from the American Planning Association that describe various approaches to *Integrated Planning* in response to climate change.
- **Section III — Environmental Justice and Equity** recognizes that certain kinds of communities, having been subjected to discriminatory land use and financial practices and denied an equitable share of infrastructure and other public investment, are especially likely to feel the impacts of climate change, and therefore need and deserve greater assistance to be able to respond effectively. This topic must be viewed as an overarching consideration in designing and implementing plans for climate resilience, relying on “best planning practices.” This section also discusses the unique opportunities and challenges of collaborative planning with the eighteen tribal nations in the San Diego region.
- **Section IV — Designing a Framework for Climate Resilience Planning in the San Diego Region** includes three key components:
  - **A. Plans Requiring Climate Impact Analysis** describes local and regional plans that are required to address climate change impacts through climate impact analysis pursuant to state laws and other guidance.

<sup>7</sup> <https://www.epa.gov/environmentaljustice>

<sup>8</sup> See discussion in Section III of this report.

- **B. Future Impacts of Climate Change in the San Diego Region** summarizes current scientific findings regarding climate impacts that are likely to affect the region in the coming years.
  - **C. Examples of Cross-Sector Vulnerability Assessments and Adaptation Strategies** identifies and describes how collaboration across topical sectors can produce effective strategies for adapting to these impacts. This subsection also addresses the unique challenges that face us in the realm of *Compounding Extreme Events*, which scientists tell us will become more frequent and more damaging in the future as a result of climate change.
- **Section V — Proposed Framework** presents a science-based and collaborative approach through which planners, scientists, and other participants can evaluate and respond to future climate change impacts in the San Diego region. Viewed through the lens of environmental justice and equity, the framework is organized according to four focus areas: (i) infrastructure; (ii) natural resources; (iii) coastal resources; and (iv) public health and safety. For each of these focus areas, the proposed *Framework* allows us to identify plans which must be created or updated in response to federal and state laws, along with areas in which additional research should be performed.
- **Section VI — Essential Engagement and Collaboration** discusses the ways that participants should be identified and organized as individual planning processes are launched. Potential participants are identified as individuals who can speak for: (i) public agencies and service providers; (ii) research organizations; and (iii) community organizations and individuals, including education, advocacy, outreach groups, and the general public. This section also includes a discussion of how and when participants can become engaged in the planning process, and of the current and future roles of *boundary-spanning organizations*.
- **Section VII — Considerations for Planners Moving Forward** includes a discussion of several critical factors that should be considered in the planning process, including economic analysis, working lands, energy, and cross-border planning issues. This section also discusses technical planning considerations, such as the appropriate design and use of science-based predictive models, the use of scenario planning tools and techniques during the planning process, and performance monitoring systems that will ensure that plan goals and objectives are being met.
- **Section VIII — Report Summary** There is agreement in the San Diego region that because of the threats posed by climate change the time to act is now. Effective responses to these threats will rely on building consensus on the best pathways forward. These pathways should start from a well-formed Framework such as the one proposed in Section V of this report. This Framework can then serve as the basis for developing plans, strategies and implementing actions that will allow us to make our region more resilient. The actions that we take now will lead to a better future for us and for future generations.

## II. Key Guidance Documents and Advisory Reports

Over the past half century, the state of California has developed a body of planning and environmental laws intended to promote an integrated approach to addressing major issues such as climate change. Recognizing the complexity of these laws and the importance of providing clear explanations of them, the state has also developed:

- **Guidance documents**, which are produced by designated state agencies to explain planning and environmental laws and provide guidance on how these laws should be implemented by state, regional, and local governments, and
- **Advisory reports**, which include analyses of important issues and advice regarding how public agencies and other entities can best respond to these issues.

Designated state agencies, including the Governor’s Office of Planning and Research (OPR) and the Governor’s Office of Emergency Services (Cal OES), have been given legal responsibility for developing guidance documents pertaining to state planning laws and other related laws. Additionally, various state agencies produce advisory reports that focus on topical areas like water resources, land conservation, and public health and safety.

At the regional level, certain public agencies have also produced advisory reports intended to provide information on how plans for the San Diego region should be developed, including analysis of topical areas related to climate change. In addition, professional organizations like the American Planning Association (APA) produce reports that provide advice to urban planners and others at the national, state, regional, and local levels on important topical areas like climate resilience.

This section provides an overview of key guidance documents and advisory reports most relevant to those involved in climate resilience and adaptation planning for the San Diego region. In addition, this section concludes with a summary of overall findings and suggested actions. A list of documents and reports discussed in this section is shown in **Table 1**.

**Table 1: Key Guidance Documents and Advisory Reports**

Document	Agency/Organizations	Publication Date
<b>State Guidance Documents</b>		
<b>California Adaptation Planning Guide (APG)</b>	California Governor's Office of Emergency Services	2020
<b>California General Plan Guidelines (GPG)</b>	California Governor's Office of Planning and Research	2017
<b>State Advisory Reports</b>		
<b>Fourth California Climate Change Assessment: San Diego Region Report</b>	State of California / UC San Diego	2018 2018
<b>California Water Resilience Portfolio</b>	California Department of Water Resources	2020
<b>Advisory Reports from Regional Public Agencies</b>		
<b>SANDAG Regional Plan - Climate Change White Paper</b>	San Diego Association of Governments	2018
<b>San Diego Integrated Regional Water Management Plan (SDIRWM)</b>	San Diego County Water Authority	2020
<b>Advisory Reports from the American Planning Association (APA)</b>		
<b>Regional Water Planning for Climate Resilience</b>	APA Regional and Intergovernmental Planning Division Report	2019
<b>Planning for Infrastructure Resilience</b>	APA Planning Advisory Service Report	2020

## State Guidance Documents

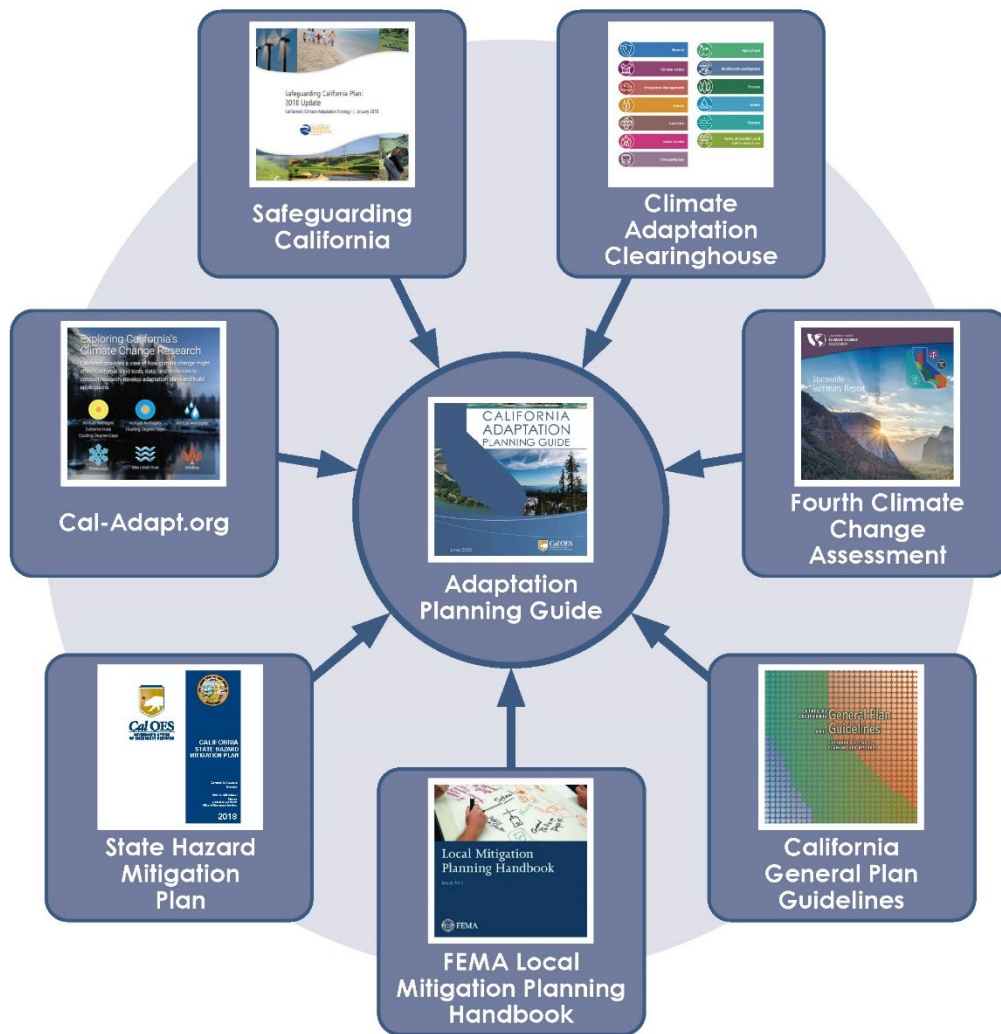
### California Adaptation Planning Guide

Cal OES, in partnership with OPR, recently completed a major update to the *California Adaptation Planning Guide (APG)*.<sup>9</sup> Senate Bill 246 (SB 246, 2015), required Cal OES to update the *APG* within one year of an update to the *Safeguarding California Plan* and established the Integrated Climate Adaptation and Resiliency Program (ICARP) at OPR. In response to this requirement, Cal OES produced an updated *APG*, the final version of which was published in June 2020. With the completion of this comprehensive update, the *APG* is now viewed as the single document that best integrates state and federal resources for climate adaptation and resilience planning by regional and local agencies in California (see **Figure 1**).

<sup>9</sup> Governor's Office of Emergency Services, California Adaptation Planning Guide (APG), p. 1.



Figure 1: State and Federal Resources Related to the APG



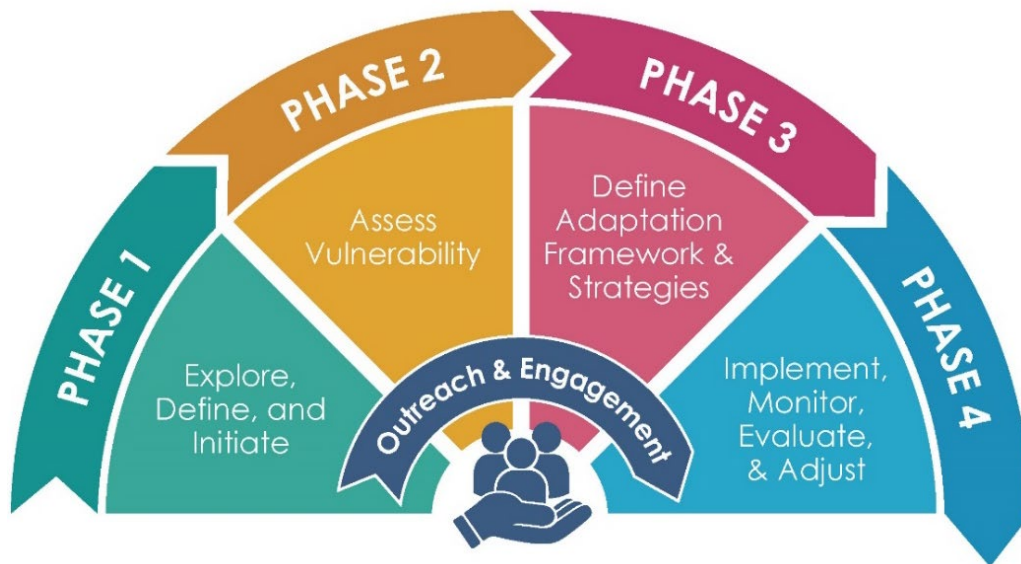
Source: APG, p. 3.

The 2020 update to the *APG* follows the requirements of SB 246 and explains the connections between climate adaptation, community resilience, public safety, and security; provides information and planning support for assessing climate vulnerabilities across sectors and regions; and supports tools to create and implement adaptation strategies that can be tailored to meet local needs. Since the development of the 2012 edition of the *APG*, the state has enacted new legislative requirements for local adaptation planning, which are summarized in the *APG* update. The updated *APG* also provides helpful resources to regional and local governments as they comply with these requirements, and provides recommendations and advice on community-level climate change adaptation planning, such as the preparation of vulnerability assessments and adaptation strategies. It also explains how these plans and processes can be integrated with other local and tribal government planning and operations.

The *APG* presents a four-step process that communities can use to plan for climate resilience. This process, which is illustrated in **Figure 2**, includes:

- **Phase 1, Explore, Define, and Initiate:** This phase includes scoping the process and project, such as identifying the potential climate change effects and important physical, social, and natural assets in the community. It also identifies the key stakeholders in the local government and throughout the community.
- **Phase 2, Assess Vulnerability:** The vulnerability assessment identifies how climate change could affect the community. This phase includes analysis of potential impacts and adaptive capacity to determine the vulnerability for populations, natural resources, and community assets.
- **Phase 3, Define Adaptation Framework and Strategies:** This phase focuses on creating an adaptation framework and developing adaptation strategies based on the results of the vulnerability assessment. The adaptation strategies are the community's response to the vulnerability assessment: *i.e.*, how the community will address the potential for harm identified in the vulnerability assessment, given the community's resources, goals, values, needs, and regional context.
- **Phase 4, Implement, Monitor, Evaluate, and Adjust:** In this phase, the adaptation framework is implemented, consistently monitored, and evaluated, and adjusted based on continual learning, feedback, and/or triggers.

**Figure 2: Climate Adaptation Process**



*Source: APG, p. 2.*

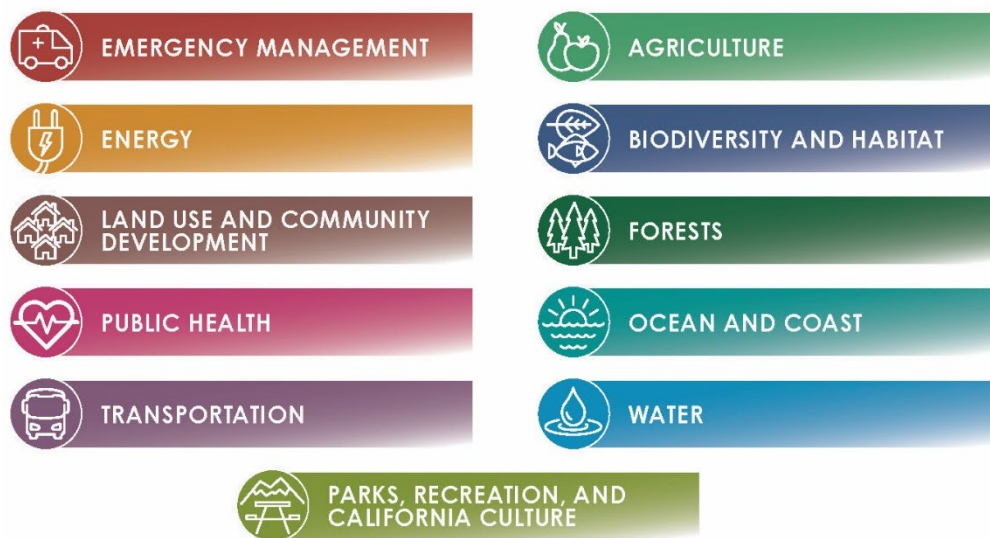
For regional planning agencies, the *APG* provides guidance regarding how regional scale planning issues can be properly addressed. The report includes a listing of regional planning documents that may need to

be analyzed to determine whether any of the predicted impacts in a particular region may necessitate review and/or updates to those plans.

For local governments, the *APG* also includes a listing of the types of local plans that may need to be reviewed in light of current scientific findings regarding the impacts of climate change on that city or county. These include not only local general plan elements, but also specialized local plans that may need to be updated to address relevant climate impacts.<sup>10</sup>

The *APG* also describes the way in which the state categorizes resilience policies according to eleven “climate adaptation sectors:” agriculture; biodiversity and habitat; emergency management; energy; forests; land use and community development; ocean and coast; parks, recreation, and California culture; public health; transportation; and water (see **Figure 3**). Five of the sectors (emergency management, energy, land use and community development, public health, and transportation) address vulnerabilities in *social systems and the built environment*. Five others (agriculture, biodiversity and habitat, forests, ocean and coast, and water) address vulnerabilities in *natural and managed resource systems*. The eleventh sector, “Parks, Recreation, and California Culture,” spans both categories.

**Figure 3: State Climate Adaptation Sectors**



Source: *APG*, p. 27.

For each of these sectors, the *APG* includes a “Sector Summary” that provides an overview of the important characteristics of the sector at a statewide level, along with a description of major vulnerabilities of that sector to climate change-related impacts.<sup>11</sup> In addition, Appendix D of the *APG*

<sup>10</sup> Refer to *APG*, p. 18 and 19.

<sup>11</sup> For further information, see *APG*, Appendix A

includes examples of possible local adaptation strategies in response to impacts identified for each sector.<sup>12</sup>

The *APG* also includes a discussion of how *equity and environmental justice* issues can be addressed in climate change adaptation planning.<sup>13</sup> It suggests that equity be viewed as multidimensional and having three main objectives: 1) procedural, 2) distributional, and 3) structural. The *APG* does not identify “equity and environmental justice” as a separate climate adaptation sector, but instead looks at it as an overarching topic that should be integrated into all eleven sectors as applicable.

### General Plan Guidelines

In 2017, OPR published the first major update to the *California General Plan Guidelines (GPG)* since 2003. In transmitting this document, the Director of OPR acknowledged that “a great deal has changed in California since 2003, and the *GPG* reflects that. Most importantly, climate change and its implications permeate almost every aspect of the Guidelines, as they must. One thing that has not changed is the importance of the general plan itself and the unique perspective each jurisdiction brings to the process and the plan vision.”<sup>14</sup>

The *GPG* views the general plan as more than the legal underpinning for land use decisions. It is also a vision of how a community will grow, reflecting contemporary community priorities and values while shaping the future. The *GPG* contains a flow chart that lays out the critical steps in developing a general plan. The flow chart includes not only the technical aspects of contemporary plan making, but also the procedural steps necessary to engage key stakeholders and community members in the planning process.

To assist local governments in preparing general plans and the public in participating in that process, OPR periodically revises the *GPG* (Gov. Code § 65040.2). For mandatory and common optional elements of the general plan, the *GPG* sets out each statutory requirement in detail, provides OPR-recommended policy language, and includes online links to city and county general plans that have adopted similar policies. Each chapter also contains a sample selection of policies.<sup>15</sup>

The term “element” refers to the topics that California law requires or permits to be covered in a general plan (Gov. Code § 65302). There is no mandatory structure or maximum number of elements. Once added into the general plan, each element, regardless of statutory requirement, assumes the same legal standing as and must be consistent with all other elements (Gov. Code § 65300.5). The general plan is the perfect space for innovation, reflecting the unique character of each city or county. The format and content of general plans can vary between jurisdictions. Local governments are required by law to adopt mandatory elements, but they have discretion to organize general plans by values (core concepts that the community wants to enhance or uphold), themes (overarching issues identified by the community as important), or challenges or goals (identified through community engagement processes or by the elements themselves).

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<sup>12</sup>For further information, see *APG*, Appendix D

<sup>13</sup>*APG*, pp. 28 and 29.

<sup>14</sup>Governor’s Office of Planning and Research, 2017 State of California General Plan Guidelines; p. i. [https://www.opr.ca.gov/docs/OPR\\_COMPLETE\\_7.31.17.pdf](https://www.opr.ca.gov/docs/OPR_COMPLETE_7.31.17.pdf)

<sup>15</sup>Governor’s Office of Planning and Research, 2017 State of California General Plan Guidelines; p. 1.

### *Mandatory and Optional General Plan Elements*

The *General Plan Guidelines* includes a description of the eight mandatory general plan elements (**Table 2**). In addition to the mandatory elements, the *GPG* discusses optional general plan elements, which may be included by a community as a matter of local concern or as particularly relevant to the community's physical development (Gov. Code § 65303). These may include air quality, health, public health, economic development, water resources, and other similar topical elements.

**Table 2: Mandatory General Plan Elements**

General Plan Element	Description
<b>Land Use</b>	Designates the type, intensity, and general distribution of uses of land for housing, business, industry, open space, education, public buildings and grounds, waste disposal facilities, and other categories of public and private uses.
<b>Circulation</b>	Correlates the land use element and identifies the general location and extent of existing and proposed major thoroughfares, transportation routes, terminals, and other local public utilities and facilities.
<b>Housing</b>	Assesses current and projected housing needs for all economic segments of the community and embodies policies for providing adequate housing and includes action programs for that purpose. By statute, this element is updated every eight years, according to a schedule set by the Department of Housing and Community Development (HCD).
<b>Conservation</b>	Addresses the conservation, development, and use of natural resources, including water, forests, soils, rivers, and mineral deposits.
<b>Open Space</b>	Details plans and measures for the long-range preservation and conservation of open space, including open space for the preservation of natural resources, the managed production of resources, agriculture, outdoor recreation, and public health and safety.
<b>Noise</b>	Identifies and appraises noise problems within the community and forms the basis for land use distribution determinations.
<b>Safety</b>	Establishes policies and programs to protect the community from risks associated with seismic, geologic, flood, and wildfire hazards, as well as from other concerns such as drought.
<b>Environmental Justice</b>	Identifies objectives and policies to reduce pollution exposure, improve air quality, promote public facilities, improve food access, advance access to housing, and increase physical activity in identified disadvantaged communities.

*Source: General Plan Guidelines, p. 17.*

The level of discussion given to each topical area in the general plan depends upon local conditions and the relative local importance of that topic. When a city or county determines that an element required by law is not locally relevant, the general plan may briefly discuss the reason for that decision but does not otherwise have to address that topic (Gov. Code § 65301). A jurisdiction may also choose to combine elements as appropriate for local context.



### *Guidance on Climate Adaptation Planning*

The *GPG* specifically addresses the need for climate adaptation planning, recognizing that planning agencies, emergency managers, private companies, and communities are all affected by climate change and need to plan for the increase in the frequency, geographic range, and intensity of natural hazards. As outlined in more detail in the Safety Element section of the *GPG*<sup>16</sup>, a jurisdiction can start the process of evaluating these hazards by using the resources in *Cal-Adapt*, the state's on-line tool for evaluating climate impacts. *Cal-Adapt* can be used in conjunction with the *APG*<sup>17</sup>. Together, they can guide creation of a general plan that meets statutory requirements for addressing climate adaptation, such as compliance with Government Code Section 65302(g)(4),

The *GPG* also emphasizes that the safety element may be viewed as the “home” for climate adaptation discussions in the general plan, but that climate change adaptation should be integrated throughout the other elements of a general plan to create internal consistency and support holistic consideration of this important topic. A general plan should also provide context for changes in the environmental setting that will occur over time. For additional information on requirements and recommendations regarding addressing climate risk, including policy recommendations, readers are referred to the safety element discussion referenced above.<sup>18</sup>

### *“Environmental Justice Element” Addendum*

In June 2020, OPR published an addendum to the *General Plan Guidelines* that provides detailed guidance regarding preparation of environmental justice elements<sup>19</sup>. This addendum includes:

- A brief history of environmental justice (EJ) in California
- A summary of Senate Bill 1000 (2016), which established EJ requirements for general plans under Government Code Section 65302(h);
- A summary of the regulatory and policy context related to EJ;
- Guidance for determining whether an EJ element or equivalent is required in a local jurisdiction, including identifying the location of *disadvantaged communities* (as defined in Gov. Code, § 65302, sub. (h)(4)(A)) as well as the nature of their environmental burdens, health risks, and needs;
- Guidance for community engagement when addressing EJ and disadvantaged communities; and
- Guidance for developing EJ goals, policies, and programs that address the unique and compounded health risks in disadvantaged communities and prioritize improvements and programs that meet the needs of those communities.

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<sup>16</sup> Governor's Office of Planning and Research, *2017 State of California General Plan Guidelines*, p. 141-163

<sup>17</sup> See discussion of 2020 California Adaptation Planning Guide in Section II.B of this report.

<sup>18</sup> *GPG*, p. 222.

<sup>19</sup> Governor's Office of Planning and Research, *General Plan Guidelines*, Chapter 4: Required Elements – Environmental Justice Elements; June 2020. [https://opr.ca.gov/docs/20200706-GPG\\_Chapter\\_4\\_EJ.pdf](https://opr.ca.gov/docs/20200706-GPG_Chapter_4_EJ.pdf)



This addendum provides important information to be considered by local governments that are required to prepare and adopt environmental justice elements.

## State Advisory Reports

### California's Fourth Climate Change Assessment and San Diego Region Report

In 2018, a major state-sponsored project brought together scientists, planners, and other key stakeholders to produce several reports that provide users with a common understanding of the threats that climate change poses to the state generally and to the San Diego region in particular. The primary statewide report that was produced through this effort was called *California's Fourth Climate Change Assessment (Fourth Assessment)*. In addition, for the first time, the state project also developed “regional reports” for several areas of the state. The *San Diego Region Report*<sup>20</sup> provided an overview of the region’s vulnerabilities to more frequent and intense heat waves, more frequent droughts, and more extreme precipitation events coupled with coastal flooding exacerbated by sea-level rise. It also discussed ways in which public agencies and other key stakeholders in the San Diego region could begin to prepare for and adapt to climate change impacts.

The *Fourth Assessment* provides a summary of the latest research on climate change impacts to the state and illustrates the ways in which the problems that arise because of climate change in nine regions of the state are interrelated and how the solutions are interconnected. These climate change projections are also included in the *Cal-Adapt* online toolkit<sup>21</sup>, which provides user-friendly graphs and climate change impact information for jurisdictions to use, based on the latest available scientific information.

The *San Diego Region Report* published in conjunction with the *Fourth Assessment* describes in detail the interconnected climate change challenges that the San Diego region will face in the coming years based on its unique microclimates, terrain, and socio-economic landscape.<sup>22</sup> The report concludes that:

San Diego County will be increasingly affected by climate change and has begun to prepare on multiple fronts for the panoply of climate change related impacts on San Diego County’s residents, development, infrastructure, and ecosystems. In future decades, San Diego County and adjacent regions will be confronted with, among others, increasingly warmer average temperatures, more frequent and likely more intense heat waves, more intense droughts, occasionally increased heavy rainfall events and floods, and continuing Santa Ana winds and wildfire threats. The impacts will play out in different ways across the complex terrain and differing climates within San Diego County. Communities along the 70 miles of coastline are (also) planning for substantial sea level rise, which will affect beaches, sea cliffs, real estate, infrastructure, and other amenities.<sup>23</sup>

<sup>20</sup> This report is also referred to as San Diego Summary Report.

<sup>21</sup> [www.cal-adapt.org](http://www.cal-adapt.org)

<sup>22</sup> Kalansky, Julie, Dan Cayan, Kate Barba, Laura Walsh, Kimberly Brouwer, Dani Boudreau (University of California, San Diego). 2018. San Diego Summary Region Report. California’s Fourth Climate Change Assessment. Publication number: SUM-CCCA4-2018-009. [San Diego Region Report \(ca.gov\)](http://San Diego Region Report (ca.gov))

<sup>23</sup> *San Diego Region Report*, p. 6.

The San *Diego Region Report* delineates “Climate Impacts and Adaptations” in the following areas:

- San Diego Coasts
  - State of the Science
  - Future Vulnerabilities to Sea Level Rise
  - San Diego Sea Level Rise Adaptation and Planning
- Lands
  - Land Use and Change
  - Natural Lands and Ecosystems
  - Agriculture
- Infrastructure and Services
  - Water
  - Energy
  - Transportation
  - Emergency Management
- Health and Vulnerable Communities
  - Public Health
  - Climate Justice
- Cross Border Climate Interaction and Adaptations
  - Cross-Border Climate Planning
  - Tijuana River Watershed

The report identifies a number of adverse impacts that climate change will have on the San Diego region’s natural and built systems, leading to degradation of water resources, water quality, infrastructure, and natural habitats, as well as increased risks from more extreme events such as flooding, wildfires, and heat waves. The report also highlights how some primary climate drivers — temperature, precipitation, wind, and marine-layer clouds — create climate-related impacts, sometimes in compound fashion such that risks are amplified. Considering San Diego’s coastal zone, the report provides a summary of the current understanding of the impacts of sea level rise and various adaptation strategies that public agencies can take to address these hazards. Highlighted in the report are adaptation efforts being conducted in the San Diego region, illustrating how community-involved regional and local planning is addressing sea level rise and other climate risks.

The report also contains a section on “Cross-jurisdictional and Cross-sector Climate Change Issues,” discussing some major issues that require collaborative resilience planning, policy development, and sustained commitments to achieve desired implementations. Referencing the *California Adaptation Planning Guide* and other state guidance documents, it highlights the need for local and regional governments to address these issues through updates to local general plans and other plans and policies.

Finally, it should be noted that recently enacted state legislation (Senate Bill 1320: 2020) establishes parameters for the next statewide climate change assessment, including updated regional reports. Recognizing benefits provided by the *Fourth Assessment* and the accompanying regional reports, along with additional insights offered herein, multi-dimensional regional teams such as those who produced these reports hopefully will be encouraged to contribute to forthcoming iterations of statewide climate assessment and adaptation planning.

### California's Water Resilience Portfolio

California Governor Gavin Newsom signed an executive order on April 29, 2019, directing three state agencies to develop a comprehensive strategy to build a climate-resilient water system and ensure healthy waterways through the 21st century. The executive order directed the Secretaries of the California Natural Resources Agency, the California Environmental Protection Agency, and the California Department of Food and Agriculture to identify and assess a suite of complementary actions to ensure safe and resilient water supplies, flood protection, and healthy waterways for the state's communities, economy, and environment. These agencies solicited extensive public input in preparing the *California Water Resilience Portfolio (Portfolio)*, which was released by the Governor on July 28, 2020.<sup>24</sup> The *Portfolio* integrates and builds on programs, policies, and investments already in place to create a climate-resilient water system.

It was recognized in developing the *Portfolio* that climate change projections for the state portend a future characterized by both longer, more intense droughts and stronger, wetter precipitation events. Resilience planning must incorporate a changing hydrology, so that California can manage its water when plentiful and adapt to drought conditions that will inevitably return. For example, the latest scientific analysis shows the Sierra Nevada snowpack – an historically reliable source of water for much of the state – will shrink in the coming decades. Additional storage — both above and below ground — will be needed to adapt to that change. Expanded stormwater capture, more flexible reservoir operations, more extensive water reuse, and better long-range forecasting tools will be critical to preparing for a more variable climate.

In developing the *Portfolio*, state agencies conducted an inventory and assessment of key aspects of California water, soliciting broad input from tribes, agencies, individuals, groups, and leaders across the state. An interagency working group considered the assessment and input from more than twenty public listening sessions and more than one hundred substantive comment letters.

The *Portfolio* incorporates the following principles:

- Prioritize multi-benefit approaches that meet multiple needs at once.
- Utilize natural infrastructure such as forests and floodplains.
- Embrace innovation and new technologies.
- Encourage regional approaches among water users sharing watersheds.

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<sup>24</sup> Department of Water Resources, California Water Resilience Portfolio. 2020. <https://waterresilience.ca.gov/about/>

- Incorporate successful approaches from other parts of the nation and the world.
- Integrate investments, policies, and programs across state government.
- Strengthen partnerships with local, federal, and tribal governments, water agencies, irrigation districts, and other stakeholders.

The *Portfolio* also makes recommendations for actions related to addressing climate change impacts. For example, it identifies several actions that state agencies can take to improve the ability of regions to anticipate weather and climate changes:

- Support regional decision making with watershed-scale climate vulnerability and adaptation assessments that include strategies to address risks to water supply, ecosystems, and water quality.
- Support California Water Plan planning-area scale analysis of future flood risk, water demand, supply reliability, and water for the environment for a range of climate and growth scenarios. Incorporate climate change forecasts into permitting processes.
- Support utilization of emerging technologies and partnerships to improve forecasts of precipitation, seasonal snowpack, and runoff at all time scales to support more efficient water management now and to help estimate the impacts of climate change on future flood and drought conditions.<sup>25</sup>

Overall, the *Water Resilience Portfolio* reflects the state's strong interest in proactive water planning and implementation by regional and local public agencies and stakeholders in the San Diego region. The San Diego Integrated Regional Water Management leadership team, discussed below, has already taken steps to express the region's support for the principles contained in the *Portfolio* and has engaged directly in some of the key early activities of the state agencies responsible for carrying out the recommended actions.

## Advisory Reports from Regional Public Agencies

### SANDAG Regional Plan – Climate Change White Paper

In 2018, the San Diego Association of Governments (SANDAG) produced a *Climate Change White Paper*, which included a discussion of recent scientific research, the new statewide greenhouse gas reduction targets, other new state laws and plans, and the status of local climate action plans (CAPs). It also included updated descriptions of SANDAG's climate-related plans and programs, as well as other collaborative activities underway to address climate change in the region.<sup>26</sup> The SANDAG White Paper was designed to inform preparation of the next update to *San Diego Forward: The Regional Plan*, which is now scheduled for adoption in late 2021. In February 2019, the SANDAG Board of Director's approved an action plan to create a bold new transportation vision entitled The Five Big Moves, with the goal of transforming the way people and goods move throughout the region. SANDAG is developing the 2021 Regional Plan to incorporate this new vision and to develop strategies directing investments in the

<sup>25</sup>[https://waterresilience.ca.gov/wp-content/uploads/2020/07/Final\\_California-Water-Resilience-Portfolio-2020\\_ADA3\\_v2\\_av11-opt.pdf](https://waterresilience.ca.gov/wp-content/uploads/2020/07/Final_California-Water-Resilience-Portfolio-2020_ADA3_v2_av11-opt.pdf) p. 26.

<sup>26</sup> San Diego Association of Governments, Climate Change White Paper, February 2018, p. 5. [meetingid\\_4688\\_23350.pdf](#) (sandag.org)

regional transportation network that will provide more travel choices, protect the environment, create healthy communities, and stimulate economic growth for the benefit of all San Diegans.<sup>27</sup>

The 2021 *Regional Plan* will include an analysis of how well the San Diego region has performed in relation to previous GHG reduction targets. These targets are set by the California Air Resources Board (CARB) with input from SANDAG, using a methodology that will be referenced in the Regional Plan. SB 375 (2006) requires that SANDAG demonstrate how it will be able to meet the new target, and if that is not possible, it will be required to explain why it is infeasible for the region to meet the target.

It is also important to note that the 2021 Regional Plan will be based on a new 2050 regional growth forecast, which will reflect predicted development and growth patterns for nineteen jurisdictions: the unincorporated County of San Diego and the eighteen incorporated cities. The combination of planned land use development patterns and a revamped regional transportation network plan are being designed to help the region reduce greenhouse gas (GHG) emissions by at least 19% from 2005 levels by 2035, as mandated by the California Air Resources Board in 2018. The adopted 2021 Regional Plan will also include a *Sustainable Communities Strategy* which is intended to guide efforts to meet or exceed the GHG targets, while maintaining quality of life in the San Diego region.

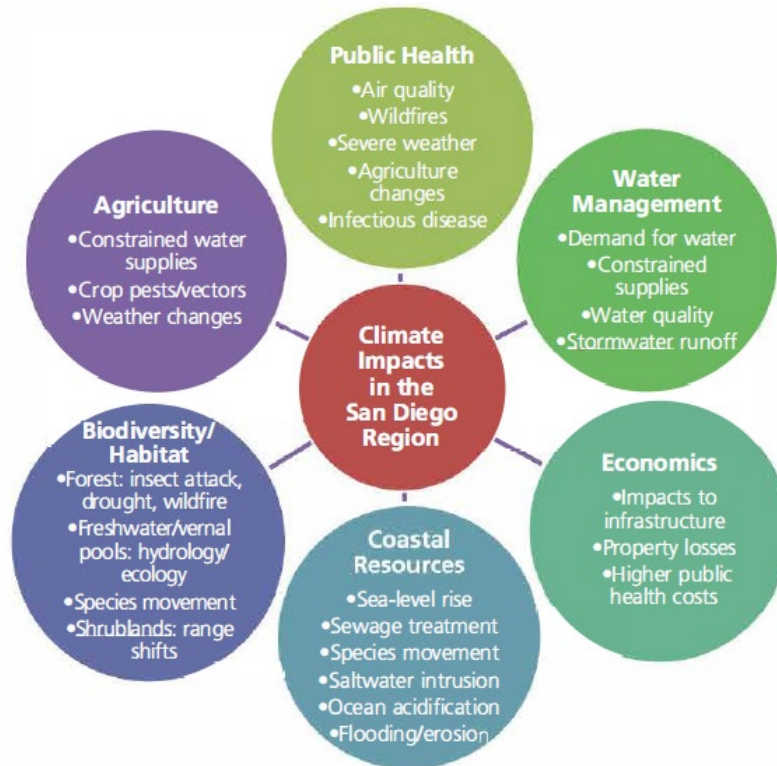
In its *Climate Change White Paper*, SANDAG acknowledges that, even with efforts to reduce GHG emissions, the San Diego region is experiencing ongoing, escalating impacts from regional and global climate change. These impacts, summarized in Figure 4, are far-reaching and will disrupt several sectors of the natural and built environment. The report explains that preparing the region for the effects of climate change requires measures to adapt to these changes and create resilient communities. In addition to highlighting the projected impacts of climate change on the region, the paper includes a summary of state policy guidance for decision-makers, planning resources for local and regional agencies, and technical tools to assist with climate change adaptation and resilience. It also summarizes adaptation planning efforts by SANDAG in the areas of transportation infrastructure, shoreline preservation, and habitat conservation.<sup>28</sup>

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<sup>27</sup> San Diego Forward: the 2021 Regional Plan – Fact Sheet, [https://www.sandag.org/uploads/publicationid/publicationid\\_1811\\_16978.pdf](https://www.sandag.org/uploads/publicationid/publicationid_1811_16978.pdf)

<sup>28</sup> SANDAG Climate Change White Paper, February 2018, p. 31-32.

**Figure 4: Future Climate Impacts in the San Diego Region**



*Source: SANDAG Climate Change White Paper, p. 7.*

### San Diego Integrated Regional Water Management Plan

The San Diego Integrated Regional Water Management (IRWM) Program was established in 2005 by the San Diego Regional Water Management Group (RWMG), comprised of the San Diego County Water Authority, the City of San Diego, and the County of San Diego. The RWMG published its first IRWM Plan in 2007 and since then has received approximately \$111.7 million in state voter-approved bond funding for seventy-two priority projects sponsored by public agencies and non-profit organizations, along with two IRWM Plan updates. The San Diego IRWM Plan helps improve collaboration in water resources management across the region and attempts to address the issues and differing perspectives of all the entities involved through mutually beneficial solutions. The *2013 IRWM Plan* was a comprehensive update of the *2007 Plan*. More recently, the *2019 IRWM Plan* updated the *2013 Plan* for compliance with the 2016 IRWM Guidelines developed by the California Department of Water Resources (DWR) pursuant to state Proposition 1, thereby maintaining the region's eligibility to receive state grant funds and incorporating recent planning efforts in the region.<sup>29</sup>

The *2019 IRWM Plan* incorporates additional planning studies completed by various water management organizations in the region and reflects revised statewide priorities and understanding of water resource

<sup>29</sup> Regional Water Management Group, 2019 San Diego Integrated Regional Water Management Plan, p. 1-3. [SDIRWM\\_Final\\_2019\\_IRWM\\_Plan\\_compiled\\_2Jul19.pdf\(sdirwmp.org\)](#)



management. It thereby builds upon and further strengthens the original plan. Since adoption of the *2013 Plan*, there have been numerous changes to water resource regulations and management priorities.

The *2019 IRWM Plan* includes the following:

- An update of the 2013 Plan, consistent with the Plan Standards in the Proposition 1 2016 Guidelines, including a more robust climate change adaptation strategy (as required by California Water Code Sec. 79742) and incorporation of stormwater plans completed in 2017 and 2019;
- A planning study in support of the Plan — the Stormwater Capture and Use Feasibility Study (SWCFS) — that provides a comprehensive analysis and understanding of stormwater resource capture and reuse opportunities for the region; and
- Updated descriptions of the conditions and needs of disadvantaged communities, economically distressed areas, underrepresented communities, and environmental justice communities in water resources management within the region.

It should be noted that the *2019 IRWM Plan* provides guidance to local and regional planners regarding relevant climate adaptation and resilience issues. Specifically, the Plan includes an updated list of Climate Change Vulnerability Issues (see **Table 3**) and prioritized listing of climate change management strategies (see **Table 4**). These issues are discussed further in **Section IV.A** of this report.

**Table 3: IRWM – Prioritized Climate Change Vulnerability Issues**

Priority Level	Category and Vulnerability Issue
Very High	Water Supply: Decrease in imported supply
High	Water Supply: Sensitivity due to higher drought potential Water Quality: Increased constituent concentrations Flooding: Increases in flash flooding and inundation (extreme weather) Ecosystem/Habitat: Decrease in available necessary habitat Sea Level Rise: Inundation of storm drains and sewer systems Ecosystem/Habitat: Decrease in ecosystem services Water Supply: Lack of groundwater and surface water storage* to buffer drought Ecosystem/habitat: Decrease in environmental flows (e.g., stream flows)
Medium	Water Demand: Crop demand would increase Water Demand: Industrial demand would increase Water Supply: Decrease in groundwater supply Water Quality: Increase in treatment cost due to water quality impacts to reservoirs Sea Level Rise: Damage to coastal recreation / tourism due to inundation Water Quality: Increased eutrophication
Low	Water Demand: Limited ability to conserve further Flooding: Increases in inland flooding Ecosystem/Habitat: Increased impacts to coastal species Sea Level Rise: Damage to ecosystem/habitat
Very Low	Water Demand: Limited ability to meet summer demand Water Supply: Invasive species can reduce supply available Water Quality: Decrease in recreational opportunity Sea Level Rise: Decrease in land Hydropower: Decrease in hydropower potential

Source: 2019 San Diego IRWM Plan, p. 7-46.

**Table 4: IRWM – Climate Change Management Strategies**

Tier 1		
<ul style="list-style-type: none"> <li>• Urban water use efficiency</li> <li>• Crop idling for water transfers</li> <li>• Education</li> <li>• Gray water use</li> <li>• Rainfed agriculture</li> <li>• Conveyance – Regional/local</li> <li>• System reoperation</li> <li>• Conjunctive management &amp; groundwater storage</li> <li>• Recycled municipal water</li> <li>• Drinking water treatment and distribution</li> </ul>	<ul style="list-style-type: none"> <li>• Groundwater/aquifer remediation</li> <li>• Pollution prevention</li> <li>• Salt and salinity management</li> <li>• Urban runoff management</li> <li>• Flood risk management</li> <li>• Agricultural lands stewardship</li> <li>• Economic incentives</li> <li>• Ecosystem restoration</li> <li>• Land use planning and management</li> <li>• Recharge area protection</li> </ul>	<ul style="list-style-type: none"> <li>• Water-dependent recreation protection</li> <li>• Watershed/soils/forest management</li> <li>• Water-dependent cultural resources and practices preservation</li> <li>• Increase urban forest management</li> <li>• Building water facilities in coordination with land use/sea level rise planning</li> </ul>
Tier 2		
<ul style="list-style-type: none"> <li>• Conduct emissions inventory and target</li> <li>• Increase use of renewable energy courses</li> <li>• Surface storage – Regional/local</li> </ul>	<ul style="list-style-type: none"> <li>• Protective infrastructure</li> <li>• Sediment management</li> <li>• Protect water facilities through the relocation or removal of vulnerable structures</li> </ul>	<ul style="list-style-type: none"> <li>• Protect resources and facilities by constructing seawalls or levees</li> <li>• Protect/restore/create coastal wetlands</li> </ul>
Tier 3		
<ul style="list-style-type: none"> <li>• Water meters installation</li> <li>• Treatment and distribution efficiency</li> <li>• Water transfers</li> </ul>	<ul style="list-style-type: none"> <li>• Localized treatment</li> <li>• Shift water use to off-peak hours</li> <li>• Optimize sewer systems</li> </ul>	<ul style="list-style-type: none"> <li>• Desalination</li> <li>• Indirect potable reuse/Potable reuse</li> </ul>

Source: 2019 San Diego IRWM Plan, p. 7-47.

## Advisory Reports from the American Planning Association

### Regional Water Planning for Climate Resilience

Some of the key findings of the *San Diego Region Report* were discussed further in a report published by the Regional and Intergovernmental Planning Division of the American Planning Association (APA) in 2019. *Regional Water Planning for Climate Resilience*<sup>30</sup> explores the connections between regional water planning and climate resilience at a national level. That report includes a “case study” of the San Diego region, providing an overview of the existing planning framework for integrated water management in the region, focusing on the connections between water resource management, water quality, and habitat conservation. The report discusses ways in which this planning framework can help address climate change impacts and adaptation needs through integrated water management strategies and actions. In addition, it describes the existing regional planning framework for management of natural hazards like floods and fires, along with the need to address climate change impacts through hazard mitigation planning. The case study concludes with recommendations for how public agencies and other key stakeholders should collaborate in preparing for climate change impacts on these systems.

<sup>30</sup> Rooney, Sharon, editor. 2019. *Regional Water Planning for Climate Resilience*, APA Regional and Intergovernmental Planning Division Policy Handbook, Chicago, American Planning Association.

## Planning for Infrastructure Resilience

In 2019, the American Planning Association also published a Planning Advisory Service (PAS) report on *Planning for Infrastructure Resilience*.<sup>31</sup> As stated in the report introduction:

In some communities, the planning, design, and maintenance of infrastructure, public facilities, and other public investments can occur in isolation from planning departments and planners. Similarly, climate adaptation, climate risk assessment, and hazard mitigation may also be isolated from the work of community planning. In contrast, other communities may have processes that seek to integrate long-term planning with infrastructure development and climate adaptation goals. This report is intended to support planners, floodplain managers, and other local practitioners across this wide spectrum with guidance suited to addressing the real challenges of planning for long-term resilience of infrastructure.

While this report is focused on planning for infrastructure resilience as it pertains to water-related systems and facilities, many of the findings and recommendations in the report are applicable to other types of infrastructure that can be adversely affected by climate change. **Table 5** lists some of the types of infrastructure that need to be considered in climate resilience planning.

**Table 5: Infrastructure Needs in Climate Resilience Planning**

Infrastructure Sector	Infrastructure Type
Water, wastewater, and stormwater	Water and wastewater treatment plants, distribution systems, drainage, retention
Transportation	Roads, bridges, public transit, airports, ports
Public facilities	Community centers, schools
Energy	Electric grid of municipal utility
Parks and open space	Public parks, bike paths
Health and emergency management services	Fire and police stations, emergency operations centers
Coastal protection	Groins, jetties, seawalls, dams

Source: *Planning for Climate Resilience*, p.15.

Overall, the APA report on infrastructure resilience planning has been useful in the preparation of this report and should be considered as a valuable resource for planners as they prepare and implement their road maps.

<sup>31</sup> Joseph DeAngelis, Haley Briel, and Michael Lauer. 2019. Planning for Infrastructure Resilience. Planning Advisory Service Report 596. Chicago: American Planning Association. p. 13. [https://planning-org-uploaded-media.s3.amazonaws.com/publication/download\\_pdf/PAS-Report-596-rev-2.pdf](https://planning-org-uploaded-media.s3.amazonaws.com/publication/download_pdf/PAS-Report-596-rev-2.pdf)

## Section Summary

After reviewing the guidance documents and advisory reports discussed in this section, the following observations have been made that will help frame our proposed approach to climate resilience planning in the San Diego region:

1. Climate change poses serious future risks to the San Diego region in relation to the natural environment, built environment, and social and economic considerations, all of which are already well documented through the research findings contained the *San Diego Region Report* and the supplementary reports that are included. In particular, the *Ecosystems* report<sup>32</sup> provides a thorough analysis of the risks to the region's already fragile natural environment.
2. The state's two updated guidance documents for climate adaptation and resilience planning, the *Adaptation Planning Guide* and *General Plan Guidelines*, are valuable resources and should be carefully considered by local and regional agencies and stakeholders in developing plans and implementing strategies. However, it should be recognized that these two statewide documents do not provide specific guidance on many of the regional and local climate resilience issues that have been identified for the San Diego region.
3. The state's categorization in the *APG* of eleven *climate adaptation sectors* provides a useful structure for organizing climate resilience plans and strategies at the regional level, and they can also provide guidance to local governments regarding how to organize topical discussions and recommendations within General Plan elements. In addition, it will be important to understand the connections among these sectors. This issue will be explored further through the cross-sector examples that are provided in Section IV.C of this report.
4. The guidance documents and advisory reports reviewed here provide a wealth of useful information for planning project managers and others who wish to determine whether a particular local or regional plan meets current requirements for climate resilience and adaptation planning, and if not, what statutory, procedural, and other requirements must be met. However, there is currently no single entity that is responsible for working directly with a regional or local planning manager who is initiating a plan review or development of a new plan, to determine what the specific requirements are for that particular plan, and how those requirements can best be met. This may suggest the need for a single entity (either a public agency or possibly a non-governmental organization) to be assigned this "liaison" responsibility. In addition, OPR and Cal OES should also consider designating a staff member who would be the primary point of contact for public agencies and other entities in the San Diego region, and who could provide definitive interpretations of state planning laws as requested.
5. From an environmental justice and equity perspective, it would be useful for SANDAG to conduct analyses of specific regional economic impact topics, such as higher personal costs for air conditioning and weatherization, and cumulative economic impacts of new VMT reduction measures on housing costs and availability.

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<sup>32</sup> Jennings, Megan K. et al. 2018. San Diego County Ecosystems: Ecological Impacts of Climate Change on a Biodiversity Hotspot. [https://www.energy.ca.gov/sites/default/files/2019-12/Biodiversity\\_CCCA4-EXT-2018-010\\_ada\\_0.pdf](https://www.energy.ca.gov/sites/default/files/2019-12/Biodiversity_CCCA4-EXT-2018-010_ada_0.pdf)



### III. Addressing Environmental Justice and Equity in Climate Resilience Planning

Achieving environmental justice and equity goals is an increasingly important consideration in the planning field. It is particularly important that necessary changes be made rapidly and effectively to address the disproportionate impacts of climate change on certain communities and demographic groups. This is expressly recognized by the American Planning Association, which has issued a *Planning for Equity Policy Guide*<sup>33</sup> to aid planners in navigating the challenges of achieving equity in the planning process, with a section specifically focused on environmental justice.

In different localities, environmental inequities have taken such forms as discriminatory land use policies, degraded air quality, exposure to hazardous and toxic materials, lack of reliable and clean water supply, frequent flooding, extreme heat from lack of shade, insufficient health services, food scarcity, inadequate recreational open space, limited public transportation, and depressed economic opportunity. Such conditions in large part are the consequences of discriminatory decisions made in the past by planners, public officials, and financial institutions, *e.g.*, decisions to locate undesirable land uses in communities least able to resist, to deny private investment capital to communities of certain racial or ethnic composition, or to underfund public infrastructure serving these communities.

None of this is accidental, but rather is the manifestation of political and economic conditions which have excluded certain groups and certain communities. Overcoming that history will require extraordinary efforts to open decision-making processes and access to resources. The plans discussed in this report provide important opportunities to rectify those prior discriminatory and damaging decisions and to provide for meaningful engagement by the impacted communities. The planning framework presented here, with an overarching focus on environmental justice, builds on and supplements important work already undertaken by others.

These concerns take on special urgency in the context of climate change, since geographical areas identified as *environmental justice communities* (often coterminous with but potentially going beyond designated *disadvantaged communities*) are particularly vulnerable to climate-related impacts. Their locations may subject them to more frequent and/or more intense impacts. That may be exacerbated by inadequate financial resources resulting from discriminatory housing and employment practices, and by underrepresentation in the public decision-making process. These conditions pose additional challenges for the affected communities to achieve the necessary level of resilience in which to thrive. Consequently, public planning and implementation takes on even greater importance for environmental justice communities than for the region in general.

Long-standing legal requirements support the increased focus on environmental justice. Provisions of the United States Constitution (14<sup>th</sup> Amendment) and the California Constitution (Article I, Section 31) mandate equal treatment in actions conducted by or required by government agencies. Legislation such as the federal Civil Rights Act of 1964 has amplified those requirements.

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<sup>33</sup> <https://www.planning.org/publications/document/9178541/>

Executive Order 12898, signed by President Bill Clinton in 1994 and titled “Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations,” was more specific, directing all federal agencies to make environmental justice a part of their respective missions. More recently, President Joseph Biden signed Executive Order 14008, establishing both an Interagency Council and an Advisory Council on Environmental Justice to guide policy decisions in this area.

California law has advanced this principle considerably and has applied it explicitly to climate change planning. California statutes require fair treatment of all people in environmental policy, planning, and implementation (Government Code Section 65040.12(e)) and inclusion of an *environmental justice element* in local general plans for jurisdictions containing environmentally disadvantaged communities (Government Code Section 65302(h)).

On a regional level, SANDAG has established a Social Equity Group comprised of representatives of communities (including tribal communities) that traditionally have been underrepresented in the planning process. This group is charged with identifying necessary steps to meet equity goals in SANDAG’s forthcoming 2021 Regional Plan.

The California Environmental Protection Agency (CalEPA) has programs in place to ensure compliance with state environmental justice requirements by its various units. Through its California Communities Environmental Health Screening Tool<sup>34</sup> (commonly referred to as CalEnviroScreen), the Office of Environmental Health Hazard Assessment produces maps that local jurisdictions can use to identify disadvantaged communities, based on a scoring system of environmental, economic, and social considerations. However, a challenge in relying exclusively on CalEnviroScreen to identify communities of concern and secure state funding to assist them is that the indicators used to map those communities do not necessarily take into account the potential effects of adverse climate change impacts such as extreme heat, flooding, wildfires, and drought.

Other mapping tools that place a greater emphasis on disproportionate environmental impacts may identify other communities of concern that are not designated as disadvantaged communities through CalEnviroScreen. For example, a more climate-sensitive approach is utilized in the City of San Diego’s Climate Equity Index,<sup>35</sup> which includes such factors as vulnerability to flooding; fire and heat risk; access to healthy food; and mobility indicators such as walkability, bikeability, and access to public transit.

This report describes a variety of measures being taken by state and regional agencies to facilitate implementation of state environmental justice requirements, including by directing increased levels of resources to the communities in question. Using a broader, more environmentally oriented set of criteria such as those identified in the City of San Diego index helps identify more communities that are at risk of harmful climate change impacts and provides added support to local jurisdictions pursuing state funding to address those conditions.

A key document in integrating state and federal resources for climate adaptation and resilience planning by local agencies is the *California Adaptation Planning Guide*, described in detail in Section II of this

<sup>34</sup> <https://oehha.ca.gov/calenviroscreen>

<sup>35</sup> [https://www.sandiego.gov/sites/default/files/2019\\_climate\\_equity\\_index\\_report.pdf](https://www.sandiego.gov/sites/default/files/2019_climate_equity_index_report.pdf)



report. In addition to providing local and regional governments the information and tools to pursue the necessary planning and implementing actions, it discusses how equity and environmental justice issues can be addressed in climate change adaptation planning.<sup>36</sup> It suggests that equity be viewed as multidimensional and having three main objectives:

1. **Procedural Equity** — creating processes that are transparent, fair, and inclusive in developing any program, plan, or policy; ensuring that all people are treated openly and fairly; and increasing civic engagement opportunities of communities that are disproportionately impacted by climate change.
2. **Distributional Equity** — fairly distributing resources, benefits, and burdens; prioritizing resources for communities that experience the greatest inequities and most disproportionate impacts and have the greatest unmet needs.
3. **Structural Equity** — making a commitment to correct past harms and prevent future unintended consequences; addressing the underlying structural and institutional systems that are the root causes of social and racial inequities; and including adaptation strategies to eliminate poverty, create workforce development, address racism, increase civic participation, protect housing availability, increase education, and provide healthcare.

The *APG* does not identify “equity and environmental justice” as a separate climate adaptation sector, but instead treats it as an overarching topic that should be integrated as applicable into all eleven of its adaptation sectors.

The environmental justice-related requirements and programs discussed in the *APG* and the kinds of adaptation strategies identified therein are more likely to be effective if proper attention is given to procedural equity ahead of any policy or program decisions. That begins with planners and public officials acknowledging the past inequities and the role their agencies may have played in perpetuating them, whether intentionally or not. Responses to current conditions need to be designed to address local conditions, based on an understanding of both the vulnerabilities and the underutilized assets of the communities in question. Residents of these communities, as well as local leaders and institutions, must have the opportunity to be integrally involved in planning to improve climate resilience. This is especially true for members of tribal communities, many of whom live off-reservation and some of whom have no recognized geographical communities. Ensuring procedural equity includes restructuring the policies and procedures governing allocation of funding for infrastructure and other resources, and continually reevaluating these policies and procedures to determine whether such changes are having the desired beneficial effects.

Given the social and economic constraints that disproportionately affect disadvantaged communities, agencies need to make extraordinary efforts to engage with the residents and ensure that climate resilience planning considers their input and priorities. This may require extensive efforts to gain residents’ trust through:

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<sup>36</sup> California Adaptation Planning Guide, p. 29

- respectful and transparent interaction;
- holding meetings at times and in locations convenient for the residents (including virtual meetings by teleconference) and having them co-hosted by respected community leaders;
- facilitating participation by providing childcare, transit vouchers, and food;
- tailoring communications methods to the circumstances of the particular community;
- providing financial resources to enable residents to conduct their own research into community needs and priorities; and
- allowing more time than usual for the process to be completed.

In the end, it also may require agencies to accept community preferences for what issues to prioritize and what adaptation strategies to implement, even if those run counter to the preferences of agency policy makers and planners. All of this represents a challenge to planning professionals, many of whom are accustomed to carrying out public engagement in less intensive ways. Yet, without such extensive efforts, carried out consistently over a long period of time, the symbiotic goals of environmental justice and regional resilience are unlikely to be achieved.

Ensuring distributional equity requires providing disadvantaged communities with greater resources and relieving them of more burdens in order to balance the inequities imposed on them historically, *i.e.*, establishing a “level playing field.” This may take the form of new or upgraded educational facilities, larger investments in storm drainage systems to avert flooding, added tree cover and shade structures to reduce ambient temperature, and/or relocation of facilities threatened by sea level rise.

Consideration of structural equity may mean removing existing hazardous land uses and avoiding locating new ones in such communities, along with improving the social and economic conditions, *e.g.*, high unemployment and poor educational opportunities, that contribute to making these communities more vulnerable in the first place.

Local governments in some other parts of the country are experimenting with achieving environmental equity through creation of *resilience districts* encompassing disadvantaged communities. Seattle, Portland, and New Orleans are notable examples. Such districts promote involvement of local residents and businesses in the planning process with the goals of enhancing political power and economic wealth for people of color, low-income households, and other impacted populations. They typically concentrate resources to improve infrastructure, health, housing, and other conditions key to climate change resilience. The efforts underway in those cities merit consideration by local jurisdictions in the San Diego region.

The approach described in Sections VI and VII, by which planning agencies can develop pathways to guide development of climate change resilience plans, incorporates these equity considerations as overarching principles. Plans that effectively address the conditions and needs of environmental justice communities will better serve the needs of the region as a whole.

## IV. Designing a Framework for the San Diego Region

As one of the worldwide leaders in climate planning, California has already taken aggressive actions to address the impacts of climate change. The laws and policies enacted at the state level provide guidance and direction to several state agencies regarding their responsibilities. At the same time, these state laws and policies place specific responsibilities on regional and local governments to address future impacts of climate change through climate resilience and adaptation planning.

In order to design a framework for the important climate resilience planning that lies ahead, this section of the report discusses the following:

- **A** — an overview of local and regional government plans and programs for the San Diego region that will require review and possible updates to address climate change impacts.
- **B** — an overall assessment of the future impacts of climate change in the San Diego region, based on current scientific research.
- **C** — examples of how vulnerability assessments and adaptation strategies can be developed to address key impacts of climate change that cut across multiple sectors.

### A. Plans Requiring Climate Impact Analysis

An important aspect of designing a climate resilience planning Framework is the identification of those regional and local plans that should be analyzed by responsible public agencies regarding their compliance with California planning laws regarding climate resilience and adaptation planning. The results of this analysis should then be used to determine whether: (i) the public agency is required to amend its plan to comply with applicable laws and regulations; or (ii) the public agency is required to prepare and adopt a new plan in order to comply with these requirements. As discussed in **Section II** of this report, the *California Adaptation Planning Guide* and the *California General Plan Guidelines* provide official guidance from the State on these requirements<sup>37</sup>.

In addition, we have identified certain regional plans that are required to be updated periodically, and for which a climate impact analysis should be conducted. Certain regional plans are *multi-tiered*; *i.e.*, they include *subregional plans* that apply to defined geographic subareas within the boundaries of the regional plan. In this report, we have included multi-tiered regional plans in the San Diego region for hazard mitigation, water quality improvement, and habitat conservation.

Finally, in this section, we provide an overview of *tribal collaboration planning* in the San Diego region. Collaborative planning efforts involving local and regional governments and tribal governments operate under a specific set of federal and state laws and are vitally important in dealing with shared challenges and opportunities related to climate resilience and adaptation.

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<sup>37</sup> Many city or county general plans include *community plans* that cover a smaller community area within the city or county. For purposes of this report, we have focused on the citywide or countywide general plans rather than individual community plans.

### Local Hazard Mitigation Plans

The *California Adaptation Planning Guide (APG)* describes the Local Hazard Mitigation Plan (LHMP) as an excellent example of an existing regional planning process that requires local governments (either individually or through a multi-jurisdictional process for a particular region) to plan for mitigation of natural hazards. These plans are now required to consider potential climate change effects as they are developed and updated, and climate change should be integrated into the assessment of hazards risk. In addition, the *LHMP* should address both *current hazards* and future hazards occurring as a result of climate change.

Natural hazards comprise only one area that may be affected by climate change. According to the *APG*, if a city or county has adopted a *LHMP* pursuant to the federal Disaster Mitigation Act of 2000, that plan can be an appropriate document for codifying climate-related adaptation strategies related to the mitigation of natural or human-caused hazards such as wildfire, flooding, coastal storms and erosion, drought, and heat emergencies.

In 2014, the San Diego County Office of Emergency Services (SD County OES) initiated an update of the *San Diego County Multi-jurisdictional Hazard Mitigation Plan (MJHMP)*, which serves as the *LHMP* for the County, all eighteen cities, and certain special districts. The MJHMP is a multi-tiered plan, with both a *countywide component* and individual *local components* for the unincorporated area, the eighteen cities, and certain special districts.

The result of this effort was the *2018 San Diego County Multi-jurisdictional Hazard Mitigation Plan (MJHMP)*.<sup>38</sup> This plan identifies several specific types of hazards that are already occurring or are expected to occur, such as threats to regional and statewide sources of water supply, dangers from sea level rise, threats from wildfires, and effects of extreme heat events, all of which will worsen in the future because of climate change. The *MJHMP* is intended to meet the requirements of the federal Disaster Mitigation Act of 2000, which requires all local governments to adopt such a plan to qualify for hazard mitigation funding.

The 2018 *MJHMP* includes a generalized “vulnerability assessment,” but this assessment does not include a quantitative analysis of future impacts from climate change. It also discusses emerging hazards posed by climate change, but again does not include a quantitative analysis of those impacts during the covered time horizon.

The 2018 *MJHMP* identifies the following climate-related hazards:

- Increased temperatures
- Precipitation pattern changes
- Extreme heat
- Wildfire
- Flooding
- Heat waves
- Drought
- Sea level rise

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<sup>38</sup> County of San Diego Office of Emergency Services, 2018. San Diego County Multi-jurisdictional Hazard Mitigation Plan. [2018 Hazard Mitigation Plan.pdf \(sandiegocounty.gov\)](#)

However, it is important to note that the 2018 *MJHMP* update was produced prior to the completion of the *San Diego Region Report* and the *Ecosystems Report*. Therefore, much of the regionally specific climate change hazard information and analysis contained in those reports was not available to be included in the 2018 *MJHMP*. Therefore, it should not be used as the basis for the climate impact analysis that will be needed for future updates of safety elements, environmental justice elements, and other elements of local general plans.

The next update to the *MJHMP* is scheduled for completion and adoption in 2023. SD County OES has already begun working on this update and will be deciding how to address climate change-related impacts in the next iteration of the plan. For example, the *Cal-Fire Wildfire Hazard Severity Zone Maps*, which were used in the analysis and formulation of policies in the current *MJHMP* and most local *general plan safety elements*, have not been updated since 2008 and do not include consideration of current scientific research findings regarding the impact of climate change on frequency and severity of wildfires in San Diego County. It will be critical that the San Diego County OES address these issues in the 2023 *MJHMP* update and that regional agencies that are responsible for planning and financing needed infrastructure be included in the process.

### SANDAG Regional Plan

The *Sustainable Communities and Climate Protection Act* (SB 375, 2006) supports the state's climate action goals of reducing greenhouse gas emissions through coordinated transportation and land use planning in regional transportation plans (RTPs), to achieve more sustainable communities. Under this statute, the California Air Resources Board sets regional targets for GHG emissions reductions from passenger vehicle use. These targets are then implemented in the sustainable communities strategy (SCS) of each metropolitan planning organization (MPO). SANDAG is one of eighteen MPOs in California and is responsible for regional transportation planning in the San Diego region.

SB 375 establishes the primary statutory GHG-reduction requirements for MPOs, focusing on reducing vehicle miles traveled and promoting compact urban development. Each SCS combines transportation and land use elements to demonstrate attainment of the GHG reduction targets if feasible. Through the implementation of the strategies and implementing actions contained in the *RTP/SCS*, SB 375 seeks a significant decrease in GHG emissions and an improved quality of life for the region.

The California Transportation Commission is required by law to adopt up-to-date guidelines for the preparation of RTPs by all eighteen MPOs. The current guidelines are contained in the *2017 Regional Transportation Plan Guidelines for Metropolitan Planning Organizations*. This document also includes a section (Section 6.30) that specifically addresses *Adaptation of the Regional Transportation System to Climate Change*<sup>39</sup> and provides an overview of climate adaptation issues pertinent to regional transportation planning. It also includes references to state laws and executive orders relevant to climate adaptation planning and identifies resources to be considered by MPOs in their respective adaptation planning.

In 2019, the California Department of Transportation (Caltrans) completed a *Climate Change Vulnerability Assessment* for its own transportation facilities in District 11 (San Diego and Imperial

<sup>39</sup> California Transportation Commission, *2017 Regional Transportation Plan Guidelines for Metropolitan Planning Organizations*; pp. 158-161.

Counties).<sup>40</sup> Similar studies are being performed for each of the twelve Caltrans districts. The introduction to the *District 11* report explains that:

Climate change and extreme weather events have received increasing attention worldwide as potentially one of the greatest challenges facing modern society. Many state agencies—such as the California Coastal Commission (CCC), the California Energy Commission (CEC), branches of the University of California, and the California Department of Water Resources (DWR)—have developed approaches for understanding and assessing the potential impacts of a changing climate on California’s natural resources and on the built environment, and for conveying this information to the public and decision-makers. Caltrans is doing its part by undertaking the current set of studies to better understand the vulnerability of California’s State Highway System to future changes in climate. These studies have three objectives:

- Understand the types of weather-related and longer-term climate change events that will likely occur with greater frequency and intensity in future years,
- Identify Caltrans assets vulnerable to various climate-influenced natural hazards, and
- Develop a method for prioritizing candidate projects, taking financial constraints (among other things) into consideration.<sup>41</sup>

The Caltrans *District 11 Climate Vulnerability Assessment* provides valuable data and analysis that should be considered in the preparation and adoption of the *2021 SANDAG Regional Plan*. In addition, the summary report for the *Caltrans - District 11 Climate Vulnerability Assessment* includes a discussion regarding the importance of considering *evacuation planning* as a key function of the State Highway System in relation to climate-related hazards. The report states:

Among the things that Caltrans must consider when planning for climate change is the role of the State Highway System when disaster strikes. The State Highway System is the backbone of most County-level evacuation plans and often provides the only high-capacity evacuation routes from rural communities. In addition, state highways also serve as the main access routes for emergency responders and may serve as a physical line of defense (a firebreak, an embankment against floodwaters, etc.). As climate-related disasters become more frequent and more severe, this aspect of State Highway System usage will assume a greater importance that may need to be reflected in design. The upcoming studies of climate change adaptation measures will take these factors into account when identifying measures appropriate to each situation.<sup>42</sup>

Many of the findings and recommendations discussed here were summarized in the *SANDAG Regional Plan Climate Change White Paper* (see discussion in **Section II**). As discussed in the White Paper, SANDAG is required to meet a number of different statutory requirements in preparing and adopting the *2021 Regional Plan update* to replace the 2015 Regional Plan, and some of the key issues being addressed in that document are tied directly to the projected impacts of climate change on the region’s

<sup>40</sup>[Caltrans Climate Change Vulnerability Assessments 2019.](#)

<sup>41</sup>[Caltrans Climate Change Vulnerability Assessment Summary Report District 11, 2019.](#) p. 1.

<sup>42</sup><https://dot.ca.gov/-/media/dot-media/programs/transportation-planning/documents/2019-climate-change-vulnerability-assessments/d11-summary-report.pdf>, p. 1.



transportation system. Scheduled for adoption in late 2021, the update will serve among other things as an update to the RTP/SCS pursuant to SB 375 and other relevant legislation and agency guidance.<sup>43</sup>

#### Regional and Subregional ("Watershed Management Area") Water Quality Plans<sup>44</sup>

The State's Porter-Cologne Water Quality Control Act (California Water Code, Div. 7) requires that Regional Water Quality Control Boards (RWQCBs) adopt water quality control plans ("basin plans") for water basins and watersheds within their jurisdictions. These plans are used to determine water quality standards for certain surface water bodies and groundwater resources. The Region 9 RWQCB (also known as the San Diego Water Board) is responsible for the *Water Quality Control Plan for the San Diego Basin* (Basin Plan). The Basin Plan is subject to periodic review and amendment as needed, and the San Diego Water Board is currently considering updating it to explicitly address climate change impacts to water quality.<sup>45</sup>

The agency implements management plans to modify and adopt standards under provisions set forth in the federal Clean Water Act (CWA) (Section 303(c)) and the California Water Code (Section 13240). In addition to enforcing Basin Plan requirements, the RWQCB issues water quality certifications under CWA Section 401. The Region 9 Municipal Separate Storm Sewer System Permit (Order R9-2013-0001, as amended by Order No. R9-2015-0001) (*MS4 Permit*) regulates the conditions under which storm water and non-storm water discharges into and from municipal separate storm sewer systems are managed. The eighteen cities, County of San Diego, San Diego County Regional Airport Authority, and San Diego Unified Port District, along with certain Orange County and Riverside County jurisdictions (collectively known as the *MS4 co-permittees*), operate under this MS4 Permit governing their discharges of storm water and non-storm water into waters of the United States.

The *MS4 Permit* sets forth specific requirements to protect water quality and designated beneficial uses of waters from adverse impacts caused by or contributed to by *MS4 Permit*-regulated discharges. The permit requires each jurisdiction covered under the *MS4 Permit* to implement a *Jurisdictional Urban Runoff Management Program* (JURMP) to control the contribution of pollutants to the discharges subject to the permit. The goal of the JURMP is to implement water quality improvement strategies and runoff management programs that effectively prohibit non-storm water discharges and reduce pollutants in storm water discharges to the maximum extent practicable.

The *MS4 Permit* also requires that the co-permittees jointly develop *Water Quality Improvement Plans* (WQIPs) for each of the eleven Watershed Management Areas in the San Diego region (see **Figure 5**). The WQIPs are required to identify the highest priority water quality conditions within each watershed, and specify goals, strategies, and implementing actions that will address those priorities, including numeric goals and action levels, and requirements for water quality monitoring and assessment. The co-permittees are required to implement strategies through their JURMPs to achieve the goals of the WQIPs for which they are responsible. Co-permittees must implement storm

<sup>43</sup> It should be noted that in June 2021, SANDAG released a draft 2021 Regional Plan for initial public review and comment.

<sup>44</sup> It should be noted that portions of this section are taken directly from the APA report on Regional Water Planning for Climate Resilience and have been updated, as necessary.

<sup>45</sup> Correspondence from David Gibson, Executive Officer, San Diego Regional Water Quality Control Board, dated March 30, 2021.

water management requirements and controls, which include storm water best management practices (BMPs) during construction and post-construction periods. These may include low impact development BMPs for development and significant redevelopment to reduce pollutants in storm water runoff from sites through more natural processes such as infiltration and biofiltration. Co-permittees also must comply with hydromodification management requirements to mitigate the potential for increased erosion in receiving waters due to increased runoff rates and durations often caused by development and increased impervious surfaces.

**Figure 5: San Diego County Watershed Management Areas**



Source: 2019 San Diego IRWM Plan, p. 1-1.

One way that regional and sub-regional water quality plans can directly address climate change is in the design and analysis of stormwater conveyance systems. In the past, these systems were typically engineered to convey 50- or 100-year design storms. Extreme storms will become more common because precipitation is becoming more variable due to climate change. In other words, what used to be a 100-year storm may, in the future, be a 50- or 25-year storm. References to stormwater conveyance capacities should be explicit about whether they are based on historical or future storms frequency.<sup>46</sup>

For the first time, the current *MS4 Permit* also allows each of the co-permittees to establish an *alternative compliance program*. Where such a program is established, a *priority development project (PDP)* may be allowed to participate in this program in lieu of implementing the “onsite structural BMP performance requirements” of the permit. The program would allow the developer of

<sup>46</sup> Correspondence from David Gibson, Executive Officer, San Diego Regional Water Quality Control Board, dated March 30, 2021.

a PDP to fund or implement an authorized offsite stormwater mitigation project (or portion thereof) that meets certain criteria specified in the permit. Such projects may include:

- stream or riparian area rehabilitation;
- retrofitting existing infrastructure to incorporate storm water retention or treatment;
- groundwater recharge projects;
- water supply augmentation projects; and
- land purchases to preserve floodplain functions.

These types of projects reflect a nature-based or "green infrastructure" approach to reducing polluted runoff and hydromodification and can often provide "co-benefits" to the community that are not available through structural BMPs. Since the current *MS4 Permit* was approved in 2013, both the County of San Diego and City of San Diego have been pursuing development of alternative compliance programs but have made limited progress.

In addition to pursuing alternative compliance programs, local jurisdictions in the region have begun to allow use of "green infrastructure" projects to restore and implement natural systems that provide flood control, water quality functions, and other community co-benefits. For example, "green street" projects, which include storm water capture and filtration elements in addition to other community co-benefits, are being promoted in the San Diego region through streamlined regulatory review and incentive funding programs. While the upcoming updates to WQIPs should focus primarily on an evaluation of progress toward meeting applicable water quality standards, they should also evaluate progress by local jurisdictions in implementing alternative compliance programs and pursuing other opportunities for use of "green infrastructure" solutions to specific water quality problems.

The current watershed management area WQIPs were adopted in 2015.<sup>47</sup> WQIPs are required to be reviewed and updated (if needed) every five years at a minimum through the *Report of Waste Discharge* (ROWD). Estimating the completion dates for the updates is difficult since some WQIPs require an update prior to the 5th year and, since the permit is administratively extended, some updates are due after the five-year ROWD date.<sup>48</sup>

Subsequent to adoption of the current WQIPs, the state provided recommendations in the *California Water Resilience Portfolio* on how regional and local entities should address the impacts of climate change. Climate change resilience planning could become a mandatory component of each updated WQIP. In addition, SDRWQB staff will be evaluating the recommendations in the *2019 IRWM Plan* regarding climate impacts and priority adaptation strategies that should be addressed in the next update of the WQIPs.

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<sup>47</sup> The WQIP for the Carlsbad Watershed Management Area was accepted by the Water Board in 2016.

<sup>48</sup> Correspondence from Kelly Dorsey, San Diego Regional Water Quality Control Board, dated 3/17/21.

### Regional Urban Water Management Plan<sup>49</sup>

The metropolitan region encompassing the City of San Diego and urbanized portions of San Diego County lies within a semi-arid zone. The region historically has imported the largest percentage of its water through the Metropolitan Water District of Southern California, primarily from the Sacramento-San Joaquin River Delta and the Colorado River. Both sources are strongly affected by climate variability and their principal watersheds have endured recent droughts compounded by unusual warming. This warming has been attributed in part to climate change<sup>50</sup> and substantially greater warming is expected.<sup>51</sup> Climate model projections indicate that further warming will reduce the natural water storage that has historically been held in the Sierra Nevada and Rocky Mountains snowpack and that continued intermittent drought will be made worse by increased evaporative losses, collectively resulting in increasingly diminished runoff and river flows.

The San Diego County Water Authority (SDCWA) is the wholesale water agency serving twenty-four retail water agencies in the San Diego region. For more than twenty-five years, the SDCWA and SANDAG, under a memorandum of understanding, have ensured that regional water demand projections are linked with official regional growth forecasts and that water supply is a component of the region's official growth management plans. This linkage has occurred primarily through the SDCWA's state-mandated *Urban Water Management Plan*, an important tool for long-term planning efforts to meet future water demand and for tracking progress toward water conservation targets.

In 1983, the California Legislature enacted the *Urban Water Management Planning Act* (Water Code, Division 6, Part 2.6). It requires that every urban water supplier that provides water to 3,000 or more customers, or that delivers more than 3,000 acre-feet of water annually, ensures the appropriate level of reliability to meet the needs of its customers during normal, dry, and multiple dry years. The statutes prescribe the contents of the *Urban Water Management Plan (UWMP)*, as well as how urban water suppliers should adopt and implement the plans. Plan updates are required every five years, and updates maintain the SDCWA's eligibility for certain state grants.

UWMPs are important tools for reporting water agencies' long-term planning efforts to meet future demands and track progress toward achieving state-mandated water conservation targets. They also support state laws linking approval for large developments to water supply availability. In the early 1990s, following a previous severe drought, the SDCWA focused the update of its UWMP on greater diversification of water resources and increased water conservation. Through this and subsequent updates, the plan now quantifies the regional mix of existing and projected local and imported supplies necessary to meet retail water demand that SDCWA forecasts over the next 25 years. The amount of locally available water has increased over the years as recycled wastewater is being used for landscape irrigation, and brackish groundwater is being demineralized and distributed,

<sup>49</sup> Portions of this section are taken directly from the San Diego Case Study in the APA report on *Regional Water Planning for Climate Resilience* and have been updated, as necessary.

<sup>50</sup> Barnett TP, Pierce DW, Hidalgo HG, Bonfils C, Santer BD, Das T, Bala G, Wood AW, Nozawa T, Mirin AA, Cayan DR, Dettinger MD. Human-induced changes in the hydrology of the western United States. *Science*. 2008 Feb 22;319(5866):1080-3. doi: 10.1126/science.1152538

<sup>51</sup> Pierce, D. W., J. F. Kalansky, and D. R. Cayan, (Scripps Institution of Oceanography). 2018. Climate, Drought, and Sea Level Rise Scenarios for the Fourth California Climate Assessment. California's Fourth Climate Change Assessment, California Energy Commission. Publication Number: CNRA-CEC-2018-006.

In addition, several new water sources for the region have recently been brought online. In 2016, the SDCWA agreed to purchase desalinated seawater from a new, privately owned desalination plant in the City of Carlsbad. In addition, the SDCWA has secured additional water allocations from the Imperial Irrigation District, including water transfers that provide 200,000 acre-feet of water per year. Also, canal-lining projects will conserve an additional 80,000 acre-feet of water per year.

The available water supply within the region is being increased further through *potable reuse* projects. First, the City of San Diego Public Utilities Department, the sole retail water supplier within the City, has completed the demonstration phase and commenced construction of the Pure Water potable reuse (or advanced wastewater treatment for reuse) project<sup>52</sup>, which will add a largely "drought-proof" component to the water supply, planned eventually to produce eighty-three million gallons per day, representing fifty percent of the city's need, by 2045.<sup>53</sup> Two other significant potable reuse projects also are underway in the San Diego region:

- Padre Dam Municipal Water District is constructing the East County Advanced Water Purification Program, a surface water augmentation project (also known as reservoir augmentation). It is projected to meet thirty percent of East County's current drinking water demand when completed in 2025.
- The City of Oceanside's Pure Water project will recharge the Mission Basin Aquifer with full advanced-treated water from the San Luis Rey Water Reclamation Facility. It is projected to meet thirty-two percent of Oceanside's demand and is scheduled for completion in late 2021.

At the same time, through major investments in storage and transmission infrastructure, the SDCWA has significantly improved its ability to distribute water throughout the region and to manage water shortages during drought years. However, the cost of producing a reliable supply of potable water will continue to increase, and certain types of local sources may have environmental impacts that will need to be addressed.

### *Considerations for the Next UWMP Update*

The most recent update to the UWMP was adopted in 2016, and the next update is due to be completed in 2021. One major area of concern raised by several environmental organizations is the way in which SDCWA forecasts the demand for retail water in the draft 2021 UWMP. In a comment letter, they stated their concern as follows:

We submit this letter to express our concern that the current version of the Draft Plan makes an inflated prediction about water needs in the region, which will improperly justify over-investment of ratepayer dollars in facilities, supplies, and projects of severe environmental consequence over the next two decades.<sup>54</sup>

It will also be important to ensure that the next UWMP update fully addresses the climate change vulnerability issues identified in the 2019 *IRWM Plan* that could adversely affect future water supply

<sup>52</sup> [www.sandiego.gov/water/purewater](http://www.sandiego.gov/water/purewater)

<sup>53</sup> "Construction Can Start on Pure Water Sewage System," David Garrick, San Diego Union-Tribune, March 8, 2021.

<sup>54</sup> Letter to SDCWA from San Diego County Surfrider Foundation, San Diego Coastkeeper, Climate Action Campaign, Environmental Center of San Diego, and San Diego Audubon Society, undated.



in the region (see **Table 4**) along with the guidance given to regional water agencies in the *California Water Resilience Portfolio*.

### Regional and Subregional Habitat Conservation Plans

Enactment of the federal *Endangered Species Act* (ESA) has led to numerous efforts by state, regional, and local authorities to protect and restore plant and wildlife habitat, and to avoid extinction, fragmentation, or reductions in range. The San Diego Region's *Multiple Species Conservation Program* (MSCP) represents one of the most robust such efforts in the nation.

To address conflicts over rapid urban development and diminishing open space in California and to assist the federal government in implementing the ESA, the State Legislature enacted the *Natural Community Conservation Planning Act (NCCP Act)* in 1991. The NCCP Act provided for a regional planning process focused on protection of biological communities rather than single species, through regional plans that protect multiple sensitive plant and animal species within those areas while allowing development in less-sensitive areas. Federal and state wildlife agencies, local governments, landowners, and environmental groups all were involved in developing these plans.

The San Diego region's MSCP<sup>55</sup> spans eleven cities, including the City of San Diego, as well as unincorporated portions of central and southwest San Diego County. The participating local governments agreed to permanently preserve sufficient sensitive habitat areas to protect eighty-five animal and plant species. Since then, they have made significant progress in acquiring and maintaining the 172,000 acres to be preserved.

Implementation of the MSCP has required a major financial commitment. Much of the cost has been covered by developer land transfers and mitigation associated with granting development entitlements. The MSCP financing plan has also relied on significant funding being obtained from federal and state grant programs for acquisition of additional land. In addition, a portion of the necessary funding has come from a sales tax increase approved through the SANDAG-sponsored *TransNet* ballot measure<sup>56</sup> in 2004, which provided funding for the SANDAG *Environmental Mitigation Program (EMP)*. The EMP was established by SANDAG in 2008 to fund land acquisitions and regional management and monitoring within those areas covered by adopted MSCP subregional plans and other conserved lands in San Diego County. However, subregional plans for the northern and eastern portions of the unincorporated County have not been adopted except by the City of Carlsbad, and additional funding for the implementation of existing and future subregional plans has not materialized, with a 2016 SANDAG sales tax ballot measure for this purpose failing.

The future of the San Diego region's habitat conservation plans has significant implications for water resource planning, as does the way multiple entities and agencies seek to manage the conservation reserves and surrounding lands. For example, uncertainty over establishment of the remaining proposed preserve areas may complicate planning by SDCWA to meet future water needs, as the agency cannot be certain whether and how much of those areas will actually be protected or will become available for new development. Similarly, the RWQCB cannot plan with certainty for the

<sup>55</sup>[www.sandiego-county.gov/pds/mscp](http://www.sandiego-county.gov/pds/mscp)

<sup>56</sup>[www.sandag.org/transnet](http://www.sandag.org/transnet)



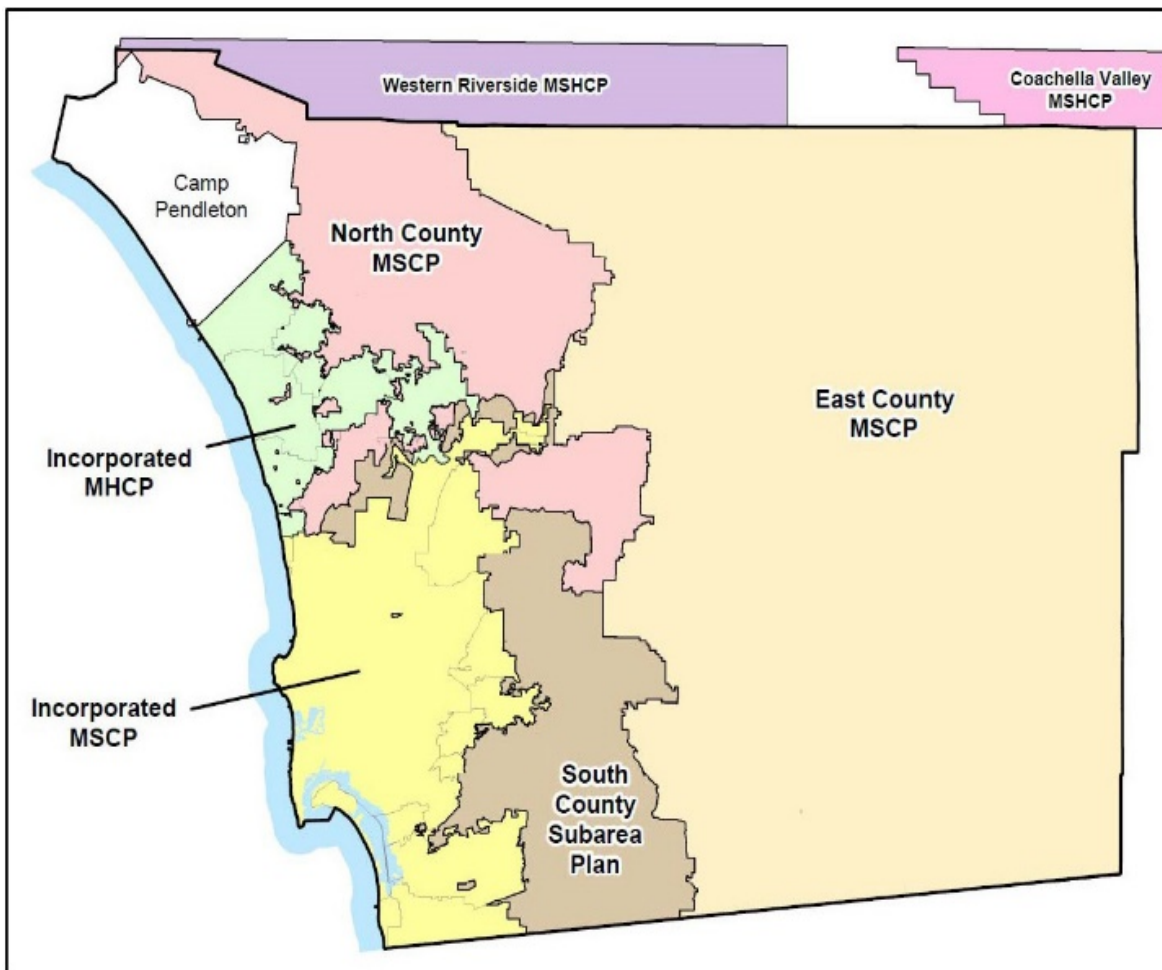
amounts and types of flows which may impact water bodies in the region and will need to be regulated.

From a broader perspective, climate change will have significant impacts on many aspects of the San Diego region's unique ecological systems. *The San Diego County Ecosystems* report, which was produced in conjunction with the *San Diego Region Report*, observed that "the diverse ecosystems, habitats, plants, and animals in the San Diego County region will be impacted by climatic shifts in multifold ways due to current and future variability, along with other factors including habitat loss and fragmentation, land use shifts, and changing fire regimes."<sup>57</sup>

#### *Current Status of Subregional Habitat Plans*

The San Diego Region's *Multiple Species Conservation Program* is comprised of four distinct Subregional Planning Areas (see **Figure 6**).

**Figure 6: San Diego MSCP Subregions**



*Source: County of San Diego*

<sup>57</sup> Jennings, Megan K. et al. 2018. *San Diego County Ecosystems: Ecological Impacts of Climate Change on a Biodiversity Hotspot*.

The following is the status of plans for each of these Subregional Planning Areas.

#### *South County Multiple Species Conservation Program*

This program was approved in 1998 and covers eighty-five species, with the goal of acquiring or permanently protecting 98,379 acres in the unincorporated southern area of the County. In addition, the cities that were included in the program (including San Diego, Chula Vista, and Poway) were required to acquire and manage additional lands in conjunction with their adoption of subarea plans. A subarea plan for Santee is currently under preparation.

#### *San Diego (North County) Multiple Habitat Conservation Program (MHCP)*<sup>58</sup>

This program, adopted in 2003, encompasses the boundaries of the cities of Carlsbad, Encinitas, Escondido, Oceanside, San Marcos, Solana Beach, and Vista. Its goal is to conserve approximately 19,000 acres of habitat, of which roughly 8,800 acres (forty-six percent) are already in public ownership, and protect more than eighty rare, threatened, or endangered species. A subarea plan has been prepared for the City of Carlsbad, which has entered into implementing agreements with the California Department of Fish and Wildlife and the U.S. Fish and Wildlife Service. The City of Solana Beach does not require a subarea plan. Subarea plans covering the other cities have not been adopted, and it remains uncertain whether those cities will decide to participate.

#### *North County MSCP*

For several years, the County was developing the North County MSCP Plan to achieve many of the same environmental and economic benefits realized through the adopted South County Plan. However, work on this plan stalled a few years ago. In fall 2020, the San Diego County Board of Supervisors directed its staff to restart work on the North County Plan.

#### *East County MSCP*

This plan would extend the MSCP into the eastern portion of the unincorporated County. According to the County<sup>59</sup>, budget constraints and staffing reductions have slowed progress on this subregional plan significantly.

### County of San Diego Public Health and Climate Change Planning

Since 2015, the Public Health Services (PHS) Department, in the County of San Diego Health and Human Services Agency, has been collaborating with the California Department of Public Health (CDPH) Office of Health Equity, to implement a program funded by the US Centers of Disease Control and Prevention (CDC). Funding from this CDC program, known as *Building Resilience Against Climate Effects (BRACE)*, has also facilitated creation of a state version of this program, known as *California BRACE (CalBRACE)*. The goal of the CalBRACE project is to enhance CDPH's capability to plan for and reduce health risks associated with climate change. CalBRACE joined fifteen other states and two cities across the United States in climate adaptation planning efforts from a public health perspective. San Diego County was one of eleven counties funded to implement climate change activities in California. Through the CalBRACE efforts, CDPH has provided the County of San Diego with a *Vulnerability*

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<sup>58</sup> <https://wildlife.ca.gov/Conservation/Planning/NCCP/Plans/San-Diego-MHCP>

<sup>59</sup> <https://www.sandiegocounty.gov/content/sdc/pds/mscp/ec/overview.html#:~:text=The%20East%20County%20>

*Assessment* and a *Regional Profile Report*<sup>60</sup>, as well as technical assistance to support creation of a local narrative on the public health impacts of climate change.

During the spring of 2020, PHS and its partner organizations were planning a summit, convening of local partners to provide input on a draft *San Diego County Climate Change and Public Health Plan*, using the template created in partnership with the state and the *Four Twenty Seven*, a climate risk data firm. The global COVID-19 pandemic temporarily delayed those efforts, as the County declared its local health emergency on February 14, 2020. Currently PHS is planning to update the draft *San Diego County Climate Change and Public Health Plan* and has been in discussions with [Community Action Partnership](#) and [Community Health Improvement Partners](#) to add public health and climate change to the curriculum for the [Resident Leadership Academy](#).

Eventually, these living documents will feed into a potential virtual convening of stakeholders for the purposes of obtaining input regarding the draft plan. In the meantime, PHS remains focused on the COVID-19 pandemic, health equity, racial equity, and social justice, while providing support to partners in the County Land Use and Environment Group and Office of Emergency Services.

CDPH has further requested that the County provide a public health perspective on the federal- and state-mandated San Diego County MJHMP update and the current County General Plan updates, which now include a safety element update and a new environmental justice element that addresses climate change and health equity issues, per changes made to the federal and state guidelines for those documents. During the last five years, because of the CalBRACE collaborations and previous collaboration with San Diego County OES, PHS is in a position to provide this support.

### Port Master Plan

The Port of San Diego, along with other ports and harbors across California, is required to develop a Port Master Plan (PMP) that is certified by the California Coastal Commission as consistent with the California Coastal Act. The current PMP was adopted in 2008<sup>61</sup> and is currently being updated. Similar to local coastal programs (see below), the draft PMP update includes a sea-level rise vulnerability assessment and will include land use plans and strategies for implementing phased adaptation and land use policies to address short and long-term sea-level-rise impacts.

### Local General Plan Safety Elements

The state laws that require general plan safety elements to be updated in order to address climate resilience issues have become somewhat complex in recent years. The Governor's Office of Planning and Research has produced the *Fire Hazard Planning Technical Advisory*, a final draft of which was issued in November 2020.<sup>62</sup> This includes a section on Local General Plan Safety Elements, which includes guidance on the overall requirement for local governments to update their safety elements to address climate adaptation and resilience issues (see pp. 16 – 21.) The document also discusses the requirements for local governments to make specified findings before approving a tentative map or tentative parcel map for an area located within certain designated fire hazard areas (see pp. 21-22). Given the complexity of

<sup>60</sup> [CDPH Climate Change and Health Profile Reports \(ca.gov\)](#)

<sup>61</sup> [Port-Master-Plan.pdf \(windows.net\)](#)

<sup>62</sup> [OPR Fire Hazard Planning Technical Advisory](#)

these requirements, it is strongly advised that local government staffs seek assistance from OPR staff in interpreting these guidelines as they may apply to a particular city or county.

### Local General Plan Environmental Justice Elements

The *Planning for Healthy Communities Act* (SB 1000, 2016) requires that all local jurisdictions in California with disadvantaged communities incorporate environmental justice policies into their general plans, with the goal of reducing health risks in those communities and promoting civic engagement by their residents in the public decision-making process.

In June 2020, the Governor’s Office of Planning and Research published an expanded set of guidelines for Environmental Justice Elements<sup>63</sup> (see discussion in **Section II**) which was incorporated into the *2017 General Plan Guidelines*. OPR interprets SB 1000 to trigger the requirement for a local government to prepare and adopt an environmental justice element if the following two criteria are met:

1. The city or county determines that it contains a *disadvantaged community*; and
2. The jurisdiction adopts or revises two general plan elements concurrently on or after January 1, 2018.

Therefore, in order to determine whether a local government is required to prepare and adopt an environmental justice element, it is necessary for city or county staff to conduct an evaluation of whether the city or county meets both of these criteria. With regard to the first criterion, it is important to look at the definition of “disadvantaged communities” in the law (Government Code Sec. 65302(h)). This definition requires a local government not only to look at the CalEnviroScreen designations, but also to evaluate whether there is “an area which is a low-income area that is disproportionately affected by environmental pollution and other hazards that can lead to negative health effects, exposure, or environmental degradation.” With regard to the second criterion, since the County of San Diego and the 18 cities within the County are all currently required by law to prepare revisions to their Housing Elements and Safety Elements during 2021, it appears that this criterion is applicable. Because there is limited experience by local governments in interpreting this law, it is recommended that city or county staff contact OPR for assistance further guidance on in this matter.

Regardless of whether a jurisdiction creates a separate environmental justice element or incorporates environmental justice policies into other general plan elements, the jurisdiction must, at minimum, address the following concerns:

- Pollution Exposure and Air Quality
- Public Facilities
- Food Access
- Safe and Sanitary Homes

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<sup>63</sup> [https://criteria.www.opr.ca.gov/docs/20200706-GPG\\_Chapter\\_4\\_EJ.pdf](https://criteria.www.opr.ca.gov/docs/20200706-GPG_Chapter_4_EJ.pdf)

- Physical Activity
- Community Engagement
- Improvements and Programs that Address the Needs of Disadvantaged Communities.

While many climate-related public health planning issues are being identified in local communities, a general plan public health element is not a mandatory element. Therefore, counties and cities may decide to include public health policies in their environmental justice elements.

### Local Coastal Programs

The *California Coastal Act*, enacted in 1976, is the primary law regulating land use in the defined coastal zone, and also established the California Coastal Commission. The coastal zone encompasses approximately 1.5 million acres of land and stretches from three miles at sea to an inland boundary that varies from several blocks in urban areas to five miles in less developed areas. Local coastal programs (LCPs) are prepared by local governments to guide future development and protection of coastal resources within a defined section of the coastal zone. LCPs typically include a land use plan, an inventory of sensitive coastal resources, and strategies to implement the plan for the short and long-term conservation and use of coastal resources (*e.g.*, zoning ordinances, zoning district maps). They must be certified by the California Coastal Commission as consistent with the Coastal Act, thereby providing the local governments with authority to approve development permits within the coastal zone that concur with the LCP.

Starting in 2014, state grant funds were made available to local governments to support updating LCPs. The County of San Diego and many coastal cities in the San Diego region (Oceanside, Carlsbad, Solana Beach, Del Mar, City of San Diego, Imperial Beach) were awarded these funds to support steps towards LCP updates, including assessing sea-level-rise flooding and erosion-vulnerability, developing adaptation strategies, updating the land use plan, and developing an implementation plan<sup>64</sup>.

During this time, global down-scaled sea-level-rise projections significantly improved and these models are now coupled with regionally specific data on coastal beach, wave, and nearshore conditions. These advances have resulted in more localized projections of sea-level rise and coastal storm-associated flood risks, beach erosion and loss, and cliff retreat that all can be used at the regional and local planning scale. Research in this area of sea-level rise and coastal hazard risks is continually being enhanced, so local planners should consult with regional academic institutions on best-available science to help inform their LCP updates.

The *State of California Sea-level Rise Guidance*<sup>65</sup>, updated in 2018 by the California Ocean Protection Council, provides guidance for state agencies and local governments to help them understand and select projected sea-level-rise ranges based on planning time horizons and risk probabilities. This guidance was developed based on sea-level-rise projection science summarized in the *Rising Seas Report (2017)*, which outlines probabilistic rates of sea-level rise depending on future greenhouse gas emissions, Antarctic ice sheet melting, and model uncertainty. Building on these two reports, the California Coastal Commission

<sup>64</sup> Status of LCP updates: <https://www.coastal.ca.gov/lcp/grants/>

<sup>65</sup> [http://www.opc.ca.gov/webmaster/ftp/pdf/agenda\\_items/20180314/Item3\\_Exhibit-A\\_OPC\\_SLR\\_Guidance-rd3.pdf](http://www.opc.ca.gov/webmaster/ftp/pdf/agenda_items/20180314/Item3_Exhibit-A_OPC_SLR_Guidance-rd3.pdf)



released an updated version of its *Sea Level Rise Policy Guidance*<sup>66</sup> with more detailed prescriptions for how to incorporate the new *Rising Seas Report* science and state guidance into LCP updates. The Commission also published a *Draft Sea-level Rise Adaptation Guidance for Residential Development* (2019)<sup>67</sup> and is working on a companion critical infrastructure guidance document to provide local governments with additional information on potential land use policy tools and phases for adapting development and infrastructure to short-term and long-term sea-level-rise risks. In addition to these guidance documents, a *Coastal Plan Alignment Compass*<sup>68</sup> was created by several state and federal agency partners to help public agency planners identify when local hazard mitigation plans, adaptation plans, general plans and LCPs can complement and support one another. Estuaries (bays and lagoons) may best be suited for a separate planning exercise and start with integrating climate change impact considerations and regional planning with the existing management for these sensitive ecosystems. The Tijuana Estuarine Research Reserve and the Batiquitos Lagoon already have included sea-level-rise projections and climate scenarios into their management plan update process. On the open coast, planning should also align with regional sediment management planning being led by SANDAG.

### San Diego Region Tribal Planning Collaboration

The boundaries of San Diego County overlap the ancestral lands of four Indigenous groups in southern California: the Cahuilla, Cupeño, Luiseño, and Kumeyaay (also known as Iipai-Tipai or Diegueño). Their ancestral lands are depicted in **Figure 7**.

**Figure 7: Map of Ancestral Lands in Southern California**



Source: Megan Jennings, CWC Project

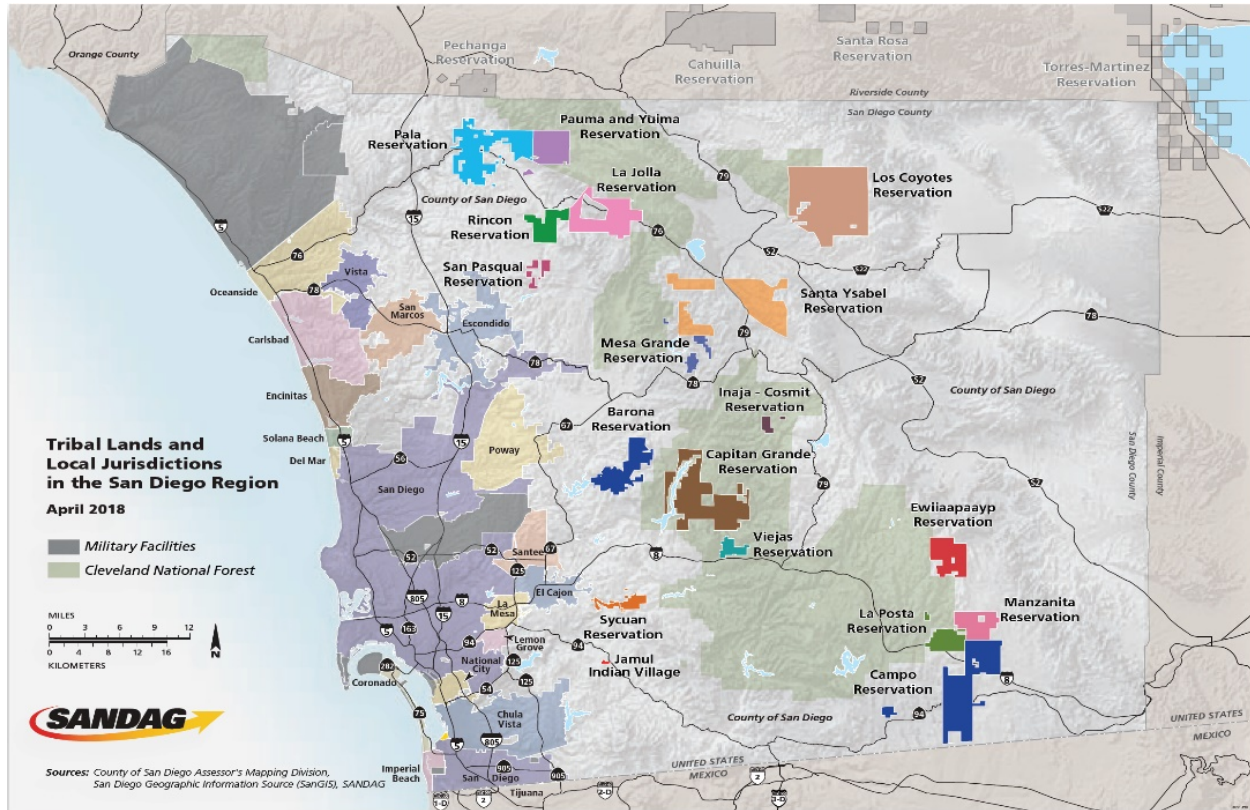
<sup>66</sup> [https://documents.coastal.ca.gov/assets/slr/guidance/2018/0\\_Full\\_2018AdoptedSLRGuidanceUpdate.pdf](https://documents.coastal.ca.gov/assets/slr/guidance/2018/0_Full_2018AdoptedSLRGuidanceUpdate.pdf)

<sup>67</sup> <https://www.coastal.ca.gov/climate/slr/vulnerability-adaptation/residential/>

<sup>68</sup> <https://resilientca.org/topics/plan-alignment/compass/>

Today, there are eighteen federally recognized sovereign tribal nations within San Diego County, more than in any other county in the United States. **Figure 8** shows the areas of their reservations or trust lands.

**Figure 8: Tribal Lands and Local Jurisdictions in the San Diego Region**



Source: SANDAG

For local and regional planning efforts, formal government-to-government consultation with tribal nations is required by federal and state laws (Section 101(d)(6)(B) of the National Historic Preservation Act, and provisions of the California Government and Public Resources Codes) when ground-disturbing activities may affect cultural, historic, or sacred resources or when proposed activities or plans may affect the lands within tribal reservations or ancestral territories. More specifically, Government Code Section 65352.3 (SB 18, 2004) requires tribal consultation prior to amending or adopting general or specific plans or designating open space, and Public Resources Code Section 21080.1(a) (AB 52, 2014) requires consultation with interested tribes on projects subject to the California Environmental Quality Act.

Although AB 52 was developed in consultation with tribes, its requirements are only a first step in ensuring that the consultation process captures and addresses the full range of concerns tribal governments and tribal members may have about planning and activities that directly or indirectly affect their reservations and ancestral lands, as CEQA applies only to activities that require discretionary approval from one or more public agencies. Development activities carried out by right, as well as some

planning processes, potentially including climate planning, would thus be outside the scope of the statutory consultation requirement. Additionally, AB 52 requires the Native America Heritage Commission to compile a list of tribes and give notice to them of formal consultation opportunities. Tribes that are not federally recognized may not be on the list, in which case they may be left out of the consultation processes. Cultural and institutional change is necessary to ensure that dialogue and collaboration among local jurisdictions and tribes go beyond statutorily required consultations, to address tribal needs and concerns from a broader perspective.

Tribal communities are among the most susceptible to climate change impacts, as many face increased health risks, food and water insecurity, and the threat of wildfire on reservation lands. In addition to the need to acknowledge and address the disproportionate effects of climate change on tribal communities, much can be learned from the long history of local traditional knowledge and the important cultural tradition of land stewardship among Indigenous peoples. An example of this is *The California Wildfire and Forest Resilience Action Plan*<sup>69</sup> integrating cultural burning and other forest health practices. Considering and integrating historical information and traditional practices can have substantial benefits for climate adaptation planning, not the least of which is the recognition of the ancestral history and cultural significance of land within the San Diego region.

Relying strictly on the formal consultation process as the primary means of gathering tribal input and addressing concerns often fails to establish the necessary relationships to understand concerns in the early phases of planning. Limiting interaction to the statutorily required minimum misses the opportunity to promote the collaborative design of projects and plans to incorporate Indigenous perspectives and concerns from the outset. Focusing on cultural resources as strictly defined by law ignores the broad and complex range of places and natural resources that hold cultural significance for tribal communities. For example, the exclusions from consultation requirements may result in failure to consider impacts on traditional gathering places or on populations of plants that are culturally important as food, medicine, or basket-weaving material, located on ancestral homelands outside reservation boundaries.

As discussed in **Section III**, tribal communities present some special challenges for meaningful interaction, as the majority of tribal members in this region live off-reservation and a long history of abuse by surrounding communities engenders a level of distrust. For local and regional public agencies, establishing effective communication and developing more inclusive collaborative practices with San Diego's tribal communities can strengthen relationships and develop into sustained and meaningful engagement. That, in turn, can improve climate resilience and adaptation planning, especially cross-jurisdictional efforts, with the integration of traditional knowledge and acknowledgement of the importance of Indigenous culture and history for the region.

SANDAG, the Climate Science Alliance, and the Southern California Tribal Chairman's Association have all made commitments for sustained and meaningful engagement. SANDAG has committed over the years to engaging tribal governments in the regional transportation planning process and other regional planning processes that it leads<sup>54</sup>, while acknowledging that, for the most part, government-to-government

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<sup>69</sup> <https://fmtf.fire.ca.gov/media/cjwfpckz/californiawildfireandforestresilienceactionplan.pdf>



relations between tribes and regional planning agencies, local governments, and counties are voluntary. The Climate Science Alliance has a Tribal Working Group that began in 2015 and now convenes bi-monthly, with members representing more than twenty tribes and multiple tribal organizations in Southern California. Collectively, the Tribal Working Group identifies ways to safeguard lands and cultures from the threat of climate change. The Southern California Tribal Chairmen’s Association, a consortium of twenty federally recognized tribes, coordinates and administers numerous grant programs for its members and the Southern California Native American community. These activities exemplify agencies and organizations improving collaboration and engagement with the tribal nations, leading to enhanced regional climate resilience.

### Section Summary

This section of the report has provided an overview and analysis of existing and required plans that are currently being produced by regional and local government agencies for the San Diego region. Each of these plans will require reviews and possible updates to address climate change impacts. A summary of local and regional plans that will require review and possible updates is shown in **Table 6**.

**Table 6: Summary of Plans in Section IV.A**

Plan	Responsible Public Agencies
<b>Regional and Subregional Plans</b>	
San Diego County Multi-jurisdictional Hazard Mitigation Plan (MJHMP) and Local Hazard Mitigation Plans	San Diego County Office of Emergency Services (SD County OES); County of San Diego; cities; designated special districts
San Diego Forward: The Regional Plan (RTP/SCS)	San Diego Association of Governments (SANDAG)
Regional and Subregional Water Quality Plans: <ul style="list-style-type: none"> <li>Water Quality Control Plan for the San Diego Basin (Basin Plan)</li> <li>Watershed Management Area Water Quality Improvement Plans (WQIPs)</li> </ul>	San Diego Regional Water Quality Board; County of San Diego; cities; special districts
Urban Water Management Plan (UWMP)	San Diego County Water Authority (SDCWA)
Regional and Subregional Habitat Conservation Programs: <ul style="list-style-type: none"> <li>San Diego Multiple Species Conservation Program (MSCP)</li> <li>MSCP Subregional Planning Area Programs</li> </ul>	US Fish and Wildlife Service; California Fish and Wildlife Service; County of San Diego; cities; SANDAG
San Diego County Climate Change and Public Health Plan	San Diego County Public Health Services Department
San Diego Port Master Plan	San Diego Unified Port District
<b>Local Governments and Programs</b>	
Safety Element	County of San Diego; cities
Environmental Justice Element	County of San Diego; cities
Multi-jurisdictional Hazard Mitigation Plan – Local Plans	County of San Diego; cities; designated special districts
Local Coastal Programs (LCP) and related general plan elements	California Coastal Commission; County of San Diego; cities in State Coastal Zone

## B. Future Impacts of Climate Change in the San Diego Region

Community adaptation to climate change is best conducted with an awareness of the existing local climate, along with spatially specific climate projections. The *San Diego Region Report*<sup>70</sup> and the *San Diego County Ecosystems Report*<sup>71</sup> describe the important climate variables in San Diego, focusing on the interactions between different climate variables and the projected future changes.

In summary, over the next several decades, San Diego County will likely experience substantial warming, sea level rise, a precipitation regime with continued Mediterranean seasonality but with even greater variability, increasing dryness, and continued dry wind weather episodes that will heighten wildfire danger (**Table 7**). Projections of climate change in the region include warming by 4-9°F on average, and with this associated warming trend heat waves are expected to increase in intensity and frequency. With a 6°F temperature increase, the number of heat wave days is projected to increase between 20-50%. At the same time, sea level rise is projected to rise substantially faster than the modest historical rates already observed (about 0.6 ft of rise observed over the last century). Estimates of sea level rise yield increases of approximately 1 ft by mid-21st century. However, as global climate continues to warm, it is estimated that by late-21st century sea levels will likely rise to 3 ft and potentially much higher.

Overall changes in annual precipitation are uncertain but most climate models agree that there will be fewer wet days, but with more intense precipitation received when wet days do occur. Annual extreme precipitation is projected to increase between 10-25% throughout San Diego County. Extreme drought is also projected to increase, resulting from more dry years as well as higher temperatures which further dry out the landscape during dry periods. The extended dry periods and a longer dry season increase the wildfire risk as the fire season will extend into the dominant Santa Ana wind season when the wind events are the strongest. The most catastrophic wildfires in San Diego have occurred under Santa Ana wind conditions.

How all of these climate change drivers will affect different sectors is highlighted in **Table 7**, and further supported by **Appendix A-1**. Important to note in **Table 7** and explained in more detail in Appendix A-1, is that health impacts from climate change effect the most vulnerable, including those that lack resources, are socially isolated, have preexisting or underlying health conditions, and are uninsured. Further, the most devastating climate events are those associated with extremes, such as flooding, heat, drought, and wildfire. When extreme climate events such as these co-occur or occur sequentially, often referred to as compounding extreme events, they can lead to major social, environmental, and economic impacts.

Compounding events<sup>72</sup>, also referred to as correlated or complex extremes, are weather related climate extremes that occur sequentially or simultaneously or both, amplifying impacts and potentially overwhelming systems<sup>73</sup>. One example of sequential compound events is demonstrated by the Thomas Fire and the Montecito debris flow. The very wet winter of 2017 fostered fuel growth which then dried

<sup>70</sup> Kalansky, Julie, Dan Cayan, Kate Barba, Laura Walsh, Kimberly Brouwer, Dani Boudreau (University of California, San Diego). 2018. *San Diego Summary Report*. California's Fourth Climate Change Assessment. Publication number: SUM-CCCA4-2018-009.

<sup>71</sup> Jennings, Megan K. et al. 2018. *San Diego County Ecosystems: Ecological Impacts of Climate Change on a Biodiversity Hotspot*.

<sup>72</sup> <https://www.annualreviews.org/doi/10.1146/annurev-earth-071719-055228>

<sup>73</sup> <https://www.nature.com/articles/s43017-020-0060-z>



out during unprecedented hot summer in California. A bone-dry fall marked with unprecedented heat wave activity extended the fire season into December — the primary season for Santa Ana winds. Ignitions during strong Santa Ana wind conditions occurring on the dry landscape led to the largest wildfire in California's history at the time, the Thomas Fire. In San Diego County, the Lilac Fire had also ignited during the same Santa Ana wind event. The Thomas Fire, however, burned for over a month, spread by back-to-back Santa Ana winds common in December. The smoke impacts on coastal air quality and health were further compounded by excessive coastal heat common under Santa Ana winds. When rains finally came in January, high intensity precipitation led to deadly debris flows. Increased heat extremes and precipitation volatility associated with climate change make the possibility of such compound extremes more likely in the future.

The next section, cross-sector examples, highlights how planning for compounding hazards helps to prevent an underestimation of climate hazards. The compounding hazards that are highlighted are simultaneous coastal and terrestrial flooding, sequential and simultaneous heat waves and wildfire, and finally drought and wildfire. Compounding events give scientists and planners a better understanding of the complex relationships among the various sectors which can lead to significant climate change-related events that are projected to occur more frequently in the future.

**Table 7: Climate Drivers of Change**

Climate Drivers of Change	Projected Shift	Confidence in Shift	Ecological Impacts	Water Resource Impacts	Public Health and Safety Impacts*	Infrastructure Impacts
<b>Warming Temperatures</b>	Increasing	Very High Confidence	<ul style="list-style-type: none"> <li>Shift in species' ranges</li> <li>Interruption in ecosystem processes</li> <li>Degradation of ecosystem integrity</li> </ul>	<ul style="list-style-type: none"> <li>Degradation of water quality impacts</li> <li>Increased water demand</li> </ul>	<ul style="list-style-type: none"> <li>Increased hospitalizations</li> <li>Increased premature deaths and maternal and child health issues</li> <li>Increased potential for vector borne diseases</li> </ul>	<ul style="list-style-type: none"> <li>Increased energy demand, potentially leading to reduced electrical distribution</li> <li>Increased need for air conditioning</li> </ul>
<b>Heat Waves</b>	Increase in frequency, duration, and severity. Becoming more humid and accentuated at night.	Very High Confidence	<ul style="list-style-type: none"> <li>Negative physiological impacts on fauna</li> <li>Increased mortality</li> <li>Decreased reproductive rates</li> </ul>	<ul style="list-style-type: none"> <li>Increased water demand and consumption</li> </ul>	<ul style="list-style-type: none"> <li>Increased hospitalizations</li> <li>Increased Premature deaths and maternal and child health issues</li> <li>Increased job loss and productivity especially for those that work outdoors</li> <li>Decreased recreation</li> </ul>	<ul style="list-style-type: none"> <li>Increased potential for road damage, rail buckling</li> <li>Increased need for air conditioning, day and night</li> <li>Increased peak energy demand potentially leading to reduced electrical distribution</li> </ul>
<b>Greater Precipitation Volatility</b>	Increasing	High Confidence	<ul style="list-style-type: none"> <li>Increased risk of vegetation mortality and wildfire</li> <li>More toxic runoff to coastal zone</li> <li>Reduced reproductive success</li> <li>Degraded habitat structure in terrestrial and aquatic environments from extreme flows and drought</li> </ul>	<ul style="list-style-type: none"> <li>Greater challenges for water resource management</li> <li>Potentially large swings in outdoor irrigation and water demand</li> </ul>	<ul style="list-style-type: none"> <li>Increased toxic runoff in the coastal zone impacting health</li> </ul>	<ul style="list-style-type: none"> <li>Similar to flooding</li> </ul>

Climate Drivers of Change	Projected Shift	Confidence in Shift	Ecological Impacts	Water Resource Impacts	Public Health and Safety Impacts*	Infrastructure Impacts
<b>Flood</b>	General Increase	High Confidence	<ul style="list-style-type: none"> <li>• Most significant impacts to riparian environments</li> <li>• Less stabilizing vegetation and increased erosion can increase allochthonous input</li> <li>• Increased contaminations of coastal bays, estuaries and ocean waters</li> </ul>	<ul style="list-style-type: none"> <li>• Greater contaminates in inland rivers and streams</li> <li>• Increased sedimentation</li> <li>• Greater probability of debris flows</li> </ul>	<ul style="list-style-type: none"> <li>• Safety hazards related to flooding</li> <li>• Safety hazard related to cliff erosion</li> <li>• Negative impacts on mental health</li> <li>• Decreased water quality</li> <li>• Increased in the spread of toxic materials</li> </ul>	<ul style="list-style-type: none"> <li>• Increased damage to wastewater and stormwater systems</li> <li>• Increased damage to and loss of buildings, including housing</li> <li>• Increased damage to transportation and energy infrastructure</li> </ul>
<b>Drought</b>	General Increase	High Confidence	<ul style="list-style-type: none"> <li>• Changes in ecosystems resulting from potential structural shifts.</li> <li>• Increased mortality of trees and other native vegetation</li> <li>• Increased opportunity for invasive species and wildfire</li> <li>• Decrease in base flow leading to loss of vegetation in riparian habitats</li> </ul>	<ul style="list-style-type: none"> <li>• Drought causes water shortages, increased demand for developed water supply</li> <li>• Drying of soil moisture conditions</li> <li>• Limited water supply for communities reliant on groundwater</li> </ul>	<ul style="list-style-type: none"> <li>• Increased frequency of dust storms</li> <li>• Potential to decrease local food security</li> <li>• Negative economic impacts and mental health among agriculture workers</li> </ul>	<ul style="list-style-type: none"> <li>• Need for increased water storage</li> <li>• Possible need to retrofit landscaping in public areas such as parks to more drought tolerant vegetation</li> <li>• Investments for water reclamation projects for agriculture areas are needed</li> <li>• Water conservation can reduce liquid in sewer systems causing increase debris and maintenance needs</li> </ul>

Climate Drivers of Change	Projected Shift	Confidence in Shift	Ecological Impacts	Water Resource Impacts	Public Health and Safety Impacts*	Infrastructure Impacts
<b>Fire Frequency</b>	General Increase	Confident	<ul style="list-style-type: none"> <li>Vegetation type conversion from shrubland systems to non-native grasses and from forests to shrublands or grasslands</li> <li>Direct and indirect negative impacts to habitat for sensitive flora and fauna</li> <li>Impacts to water quality and quantity with increased post-fire erosion and sedimentation</li> </ul>	<ul style="list-style-type: none"> <li>Sedimentation, degraded water quality</li> <li>Decreases soil permeability, leading to higher runoff and less groundwater recharge</li> <li>Higher peak flows and flooding risks</li> </ul>	<ul style="list-style-type: none"> <li>Wildfire smoke including fine particles (PM2.5 more dangerous to health than similar levels of pollution from other sources)</li> <li>Exposure to mudslides, debris flows</li> <li>Evacuation and potential mental health impacts</li> </ul>	<ul style="list-style-type: none"> <li>Increased damage to the built environment</li> </ul>
<b>Santa Ana Winds</b>	Decrease in Fall and Spring	Modest Confidence	<ul style="list-style-type: none"> <li>Impacts fire cycle, and severity of burn</li> </ul>		<ul style="list-style-type: none"> <li>Fewer out of season heat waves when individuals are not acclimated or not as well prepared.</li> </ul>	
<b>Variable Marine Layer Clouds</b>	Unknown	More Research Needed	<ul style="list-style-type: none"> <li>Provides moisture to coastal species, e.g. Torrey Pines</li> </ul>	<ul style="list-style-type: none"> <li>Reduces evapotranspiration and improves soil moisture conditions</li> </ul>	<ul style="list-style-type: none"> <li>Reduces heat waves impacts on health, especially along the coast</li> </ul>	
<b>Sea Level Rise</b>	Increase	High Confidence	<ul style="list-style-type: none"> <li>Increased beach and cliff erosion</li> <li>More frequent and severe coastal flooding</li> <li>Increased saltwater incursion into freshwater systems affecting flora and fauna</li> </ul>	<ul style="list-style-type: none"> <li>Increased damages to water infrastructure</li> <li>Storm water system more frequently overwhelmed from the ocean.</li> <li>Negative effects on fresh water conveyed through Bay/Delta</li> </ul>	<ul style="list-style-type: none"> <li>Public safety concerns resulting from flood and erosion of cliffs</li> </ul>	<ul style="list-style-type: none"> <li>Increased maintenance on roads, trains, electrical system infrastructure</li> <li>Storm water system more frequently overwhelmed from the ocean.</li> </ul>

## C. Examples of Cross-Sector Vulnerability Assessments and Adaptation Strategies

**Section IV.A** provides an overview of the plans that require climate information integration and **Section IV.B** provides a summary of the projected climate change impacts which are expected to have adverse impacts on the San Diego region. These are fundamental building blocks needed to construct an overall *Framework* for future climate resilience planning and applied research in the San Diego region. However, it is important to test some of our findings and principles through examining current efforts in working across sectors to develop and implement adaptation strategies. This section includes three examples of cross-sector vulnerability assessments and coordinated planning approaches. The examples in this section illustrate how these planning and research building blocks, when taken together, can work to form a framework to guide planning efforts.

### Cross Sector Example 1: Urban Flooding

#### Background

Urban flooding in San Diego occurs when stormwater and/or coastal water overwhelm natural and built drainage systems. The most devastating floods often occur when coastal flooding and stormwater flooding occur at the same time as a result of a large storm producing significant rainfall, high coastal waters and powerful waves.<sup>74</sup> An example of this is the Feb 23, 1998 El Nino storm that brought high winds, large waves, and heavy rainfall resulting in power outages, catastrophic and widespread flooding, evacuations and swift water rescues, debris flows, agricultural losses and damaged homes, roads, bridges, and railroads. Flooding damages were estimated to be approximately \$31.6 M in San Diego County.<sup>75</sup>

Many southern California extreme precipitation events are atmospheric rivers (ARs), corridors of concentrated moisture in the atmosphere, driven by high winds coming across the Pacific. These events can result in heavy volumes of stormwater flowing into the region's watersheds that drain to the ocean or estuaries in San Diego's coastal region. Climate projections indicate that ARs will become more extreme in the future.<sup>76</sup>

Southern California's coastal floodplains and river mouth drainages regions are also vulnerable to ocean-driven coastal flooding from the ocean side, when coincidental high waves and high tides increase wave run up and wave overtopping of shoreline features. In addition, strong wave energy can also move sediment into lagoons and estuaries, building barrier berms and blocking water exchange between the lagoon and the ocean<sup>77</sup>, thus increasing the risk of flooding around the lagoons and estuaries. As sea levels rise, even small wave events and high tides these events are likely to cause more frequent flooding and result in permanent inundation of some estuaries and floodplain areas.<sup>78 79</sup>

<sup>74</sup> <https://doi.org/10.3390/geosciences8120450>

<sup>75</sup> [https://journals.ametsoc.org/view/journals/wcas/11/3/wcas-d-18-0071\\_1.xml](https://journals.ametsoc.org/view/journals/wcas/11/3/wcas-d-18-0071_1.xml)

<sup>76</sup> <https://doi.org/10.1038/s41598-019-46169-w>, <https://doi.org/10.3390/geosciences8120450>

<sup>77</sup> Harvey, M., Giddings, S.N., Stein, E.D. et al. Effects of Elevated Sea Levels and Waves on Southern California Estuaries During the 2015–2016 El Niño. *Estuaries and Coasts* 43, 256–271 (2020). <https://doi.org/10.1007/s12237-019-00676-1>

<sup>78</sup> <https://www.mdpi.com/2077-1312/6/2/59>

<sup>79</sup> <https://data.pointblue.org/apps/ocof/cms/index.php?page=flood-map>



Stormwater flooding and coastal flooding events combine to increase flood depth and coverage. Inland riverbanks and drainage systems can become overwhelmed from the storm water and high coastal water and sedimentation in lagoons can block drainage systems designed to discharge coastal waters further exacerbating flooding inland. The widespread flooding caused by both coastal and storm water flooding has the potential to cause more damage, stress infrastructure and require more emergency services, leading to a longer recovery, than if caused by one type of flooding alone. An important challenge is to integrate plans that include adaptation strategies to address flooding events arising from both coastal inundation and storm water flooding. Representation from both coastal and inland jurisdictions with support from scientists who can model the confluence of coastal and inland and urban watershed flooding is critical to informing the development of targeted adaptation strategies to build regional resilience to all flooding events.

### Vulnerabilities

*Water:* More intense urban flooding places strains on stormwater drainage infrastructure. High waves, elevated sea-levels, and sedimentation in lagoons and estuaries prevent gravity-driven conveyance of stormwater into ocean areas, which can cause storm drains to back up, exacerbating flooding impacts. Additionally, infrastructure such as reservoirs, sewage pipelines, and water treatment facilities located in or near floodways, will lead to increased risk of damage from flooding, erosion, and sedimentation. Flooding also increases pollutants in coastal waters degrading water quality.

*Energy:* Energy infrastructure (electric transmission lines, natural gas pipelines, etc.) is susceptible to damage from urban flooding, the sedimentation that accompanies flooding, and erosion of the foundation material supporting such infrastructure. This will result in increased maintenance costs and/or replacement costs for damaged infrastructure and may also lead to interruptions in service.

*Transportation:* Transportation infrastructure such as roads, bridges, and major freeways may all be vulnerable to future flooding events that lead to road closures during the event and costly maintenance and repair. In particular, the types of infrastructure that will be most vulnerable to flooding are those that are built in floodplains, exposed to wave overtopping, built with soil (earthen dams or embankments) or those that interface with soil (roads and bridges)<sup>80</sup>. Road closures from flooding or debris flows can impair their functionality by impeding evacuation routes, and limiting accessibility for emergency responders. SANDAG developed a report on sea level rise and transportation that discusses these vulnerabilities from coastal flooding in more detail.<sup>81</sup>

*Emergency Management:* The Emergency Management sector will need to evaluate and plan for the increased risk to life and property from intensified flooding. It is particularly important that emergency management planners address potentially severe flooding events that include both coastal and stormwater flooding, leading to widespread impacts and potential hazards. In addition, physical displacement, loss of income, lack of insurance to recover and impacts from mold should all be considered.

<sup>80</sup> AghaKouchak, Amir, Elisa Ragno, Charlotte Love, and Hamed Moftakhari. (University of California, Irvine). 2018. *Projected changes in California's precipitation intensity-duration-frequency curves*, in California's Fourth Climate Change Assessment, California Energy Commission. Publication Number: CCA4-CEC-2018-005. [energy.ca.gov/sites/default/files/2019-11/CCA4-CEC-2018-005\\_ADA.pdf](https://www.energy.ca.gov/sites/default/files/2019-11/CCA4-CEC-2018-005_ADA.pdf)

<sup>81</sup> [https://www.sandag.org/uploads/projectid/projectid\\_510\\_28075.pdf](https://www.sandag.org/uploads/projectid/projectid_510_28075.pdf)



*Public Health:* Heavy precipitation events can lead to a concentrated level of pollutants in stormwater flows to coastal floodplains and coastal waters. These pollutants are either absorbed in estuaries or reach coastal waters where they can disperse alongshore. These stormwater flows and other flood related discharge into coastal waters lead to high levels of fecal bacteria and associated pathogens in coastal California.<sup>82</sup> The region's water quality regulators and public health sector will need to be prepared for poor water quality resulting from urban flooding as well as the potential mental health impacts of flooding such as increasing levels of post-traumatic stress disorder, anxiety, and depression.

*Land Use and Community Development and Parks, Recreation, and California Culture:* More intense coastal flooding should be considered when upgrading, developing or zoning low lying areas or regions in the floodplains. Additionally, as waterfront infrastructure or shoreline protection structures are removed or degraded, coastal land areas directly behind these structures will be increasingly at risk for flooding. Future flooding of coastal accessways, parks and recreation areas will also need to be considered as coastal areas provide a significant source of recreational and economic value to the region (e.g., beach parking, coastal trails, bikeways) and protect sensitive coastal habitats that have already been significantly diminished by urban development. Historic and cultural sites along the coast may also be at risk for flooding, requiring careful consideration for long-term preservation and potential relocation.

*Agriculture:* Significant flooding can cause direct agricultural losses from loss of crops. In addition, this can lead to topsoil loss and sediment erosion. Flooding can also negatively impact soil function by impacting soil microbial composition and nutrient cycling within the soils. Frequent flooding can eventually lead to the loss of agriculture from areas cause by repetitive damages.

*Habitat and Biodiversity:* Riparian habitats are sensitive to increase erosion caused by flooding. Coastal wetland habitat and species are sensitive to both freshwater and coastal flooding due to impacts on water chemistry, circulation and tidal exchange conditions needed for survival. Beach habitats are expected to be lost as sea-levels rise and storm event flooding increases and permanently inundates these ecosystems.

### Examples of Integrated Flood Adaptation Planning

The *Multi-jurisdictional Hazard Mitigation Plan (MJHMP)*, which serves as the San Diego Region's *Local Hazard Mitigation Plan*, should be viewed as the guiding document for adaptation to extreme flooding events resulting from climate change impacts and the increasing probability of simultaneous flooding from coastal and storm water. Participation in the update of this plan by local government including SANDAG, San Diego County OES and others, is important to facilitate the use of the *MJHMP* to support the required general plan safety element updates. Local Coastal Program (LCP) flooding vulnerability assessments and prescribed adaptation strategies can inform MHMP risk summary and potential mitigation actions. In addition, involving planners from SANDAG and incorporating information from the agency's Regional Transportation Infrastructure and Sea Level Rise Assessments will help to identify regional vulnerabilities from coastal flooding. Further reviewing recent efforts like those in the City of Imperial Beach to enhance a coastal flooding alert system as a hazard mitigation

<sup>82</sup> <https://www.sciencedirect.com/science/article/abs/pii/S0048969719313166?via%3Dihub>

strategy that can evolve with climate change and sea level rise may provide guidance to other local agencies in addressing this need.

*Water Quality Improvement Plans (WQIPs)*, which are led by the San Diego Regional Water Quality Control Board and the local MS4 Copermittees, should serve as the guiding documents to address stormwater planning and water quality issues that arise from flooding. New stormwater best management practices will be important in augmenting existing drainage infrastructure for climate adaptation strategies. The most low-impact, cost-effective solution to ensuring waterways can convey expected increased extreme precipitation while preserving existing reaches of natural waterways, both upstream of the built environment and in naturally-lined streams that drain primarily impervious land surface. Floodplain restoration projects, in conjunction with distributed bioretention and biofiltration projects like “green streets” and other types of *green infrastructure* will further improve the ability of natural features to remove pollutants and infiltrate stormwater back into the groundwater system. Proactive watershed master planning will ensure compliance with the existing regulatory structure, reduce the need for additional mitigation when updated permits are put in place, better prepare municipalities and local agencies for future impacts forecast by climate experts, and aligns goals for water resource management with those of sustainable resource use outlined in city and county general plans and climate action plans.

At the local government level, updated WQIPs will provide guidance in the updates of key local general plan elements, such as safety elements, open space elements, conservation elements, and environmental justice elements. In addition, updated WQIPs will support the required updates to Jurisdictional Urban Runoff Management Plans (JURMPs) by all the local governments in the San Diego Region. Additionally, updates to local Master Drainage Plans and Capital Improvement Programs will help to address increased precipitation events and flooding frequency/intensity.

*The Integrated Regional Watershed Management (IWRM) Plan* is a collaborative effort aimed at developing long-term water supply reliability, improving water quality, and protecting natural resources. The IWRM plan was last updated in 2019 and included an analysis of climate change impacts to the region’s water resources and goals for using future funding priorities to address these impacts. Future updates of this plan provide a valuable mechanism for 1) coordinating and integrating existing water planning efforts within a regional climate change and coastal flooding vulnerability context; 2) identifying specific regional and watershed-based priorities for flood mitigation and adaptation projects; and 3) aligning funding support for regional efforts to address future flooding risks.

*Lagoon and estuary climate adaptation and resilience* plans identify potential management responses to projected sea-level rise and coastal flooding impacts to these sensitive coastal ecosystems. These include the Batiquitos Lagoon Resiliency Plan, the Tijuana River Estuarine Research Reserve’s Climate Understanding and Resilience in the River Valley Project, and Mission Bay wetland restoration plans underway. In addition, the Southern California Wetland Recovery Project, an interagency group of wetland managers and scientists across Southern California, can also serve as a valuable partner for funding and supporting wetland restoration and research plans that address future coastal flooding impacts to these resources.

## Cross Sector Example 2: Extreme Heat and Wildfire Smoke

### Background

The summer and fall of 2020 provided a remarkable example of how extreme heat and wildfire smoke can jointly affect the San Diego Region. Coastal southern California experienced 10 heat waves between May and October. Summertime heat waves such as these impact health at lower temperatures along the coast compared to inland valleys and desert regions due to lack of necessary physiological and technological (access to air conditioning) acclimation.<sup>83</sup> In addition, there have been well documented impacts of urban development on heat, commonly referred to as urban heat island effect. Research has shown certain adaptation strategies are effective in reducing the urban heat island effect which will ultimately help reduce the severity of heatwaves in populated urban centers.<sup>84</sup>

In addition to extreme heat, numerous large fires burned in Southern California in the summer and fall of 2020. Fire events such as the El Dorado Fire and Valley Fire produced smoke that caused poor air quality and resulted in public health hazards. The particulates generated by wildfires exacerbate cardiovascular and respiratory medical conditions multifold compared to similar levels of ambient air pollution from other sources.<sup>85</sup>

The warming trend is already and will certainly continue to increase the intensity and frequency of heatwaves throughout San Diego. Further increases in wildfire activity in California have been partially attributed to the warming and drying of fuels, which are accentuated during heat waves. Together, the temperature projections and recent research on wildfire risk underscore the importance of planning for more extreme heat events, more wildfire smoke, and the probability of the co-occurrence of these two public health hazards.

### Vulnerabilities

*Water:* Extreme heat can cause harmful algal blooms leading to poor water quality. The impact of wildfire particulates on water quality remains an outstanding research question.

*Energy:* High energy demand on extreme heat days can put a strain on the system and possibly cause outages. In rural areas, outages can highlight existing disparities (telemedicine, fuel availability, etc.) across vulnerable populations. Fires can damage energy infrastructure, and cause power outages which can lead to lack of cooling centers and air purification system outages which aid in smoke pollution removal.

<sup>83</sup> Guirguis K., R. Basu, W. K. Al-Delaimy, T. Benmarhnia, R.E.S. Clemesha, I. Corcos, J. Guzman-Morales, B. Hailey, I. Small, A. Tardy, D. Vashishtha, J.G. Zivin, and A. Gershunov, 2018, Heat, disparities, and health outcomes in San Diego County's diverse climate zones, *GeoHealth* doi:10.1029/2017GH000127. <https://agupubs.onlinelibrary.wiley.com/doi/10.1029/2018GL079249>

<sup>84</sup> Matei Georgescu, Philip E. Morefield, Britta G. Bierwagen, Christopher P. Weaver, *Urban adaptation can roll back warming of emerging megapolitan regions*. *Proceedings of the National Academy of Sciences* Feb 2014, 111 (8) 2909-2914; DOI: 10.1073/pnas.1322280111. <https://www.pnas.org/content/111/8/2909>

<sup>85</sup> Aguilera, R., T. Corringham, A. Gershunov and T. Benmarhnia, 2020: Wildfire smoke impacts respiratory health much more than fine particles from other sources: observational evidence from Southern California. *Nature Communications*, <https://www.nature.com/articles/s41467-021-21708-0>.

*Transportation:* Railways are subject to buckling during extreme heat. Individuals may change their mode of transportation if they are able, (i.e., drive or take public transit to work instead of bike) to avoid being in the smoke or extreme heat.

*Emergency Management:* The Emergency Management sector will need to evaluate and plan for the increased health risk from extreme heat, smoke and the cooccurrence with public health emergencies. There may be a need for new tools and strategies to integrate public notification systems and enhanced coordination across agencies.

*Public Health:* The health impacts of extreme heat have been well documented in the literature and understanding of the impacts on health resulting from different types of heat waves (humid versus dry heat waves, long duration heat waves, winter heat waves) as well of the seasonality of such events is emerging. Similarly, the negative health impacts of wildfire smoke in Southern California are becoming more evident from recently published research. Vulnerable populations include the elderly and children, people with preexisting medical conditions and those with fewer resources or who are uninsured.<sup>86</sup> Furthermore, it has been shown that urban heat islands increase heat-health risks.<sup>87</sup>

*Land Use and Community Development and Parks, Recreation, and California Culture:* Extreme heat and smoke cause people to stay indoors affecting recreation and California culture.

*Agriculture:* Wildfire smoke and heat has indirect impacts on workers, including displacement and the inability to work because of air quality. These lost workdays due to displacement and poor air quality make it more difficult to find temporary labor when it's needed. Extreme heat can damage crops and create losses. Livestock, horticultural businesses and more that thrive and require outdoor living are impacted and must be monitored for health and welfare during extreme heat events and exposure to wildfire smoke.

*Habitat and Biodiversity:* Extreme heat may cause increased mortality, decreased reproductive success and potential for exceeding heat thresholds for some species like the California Spotted Owl with known temperature thresholds. Limited research is available on extreme heat and smoke impacts on various species and habitat interactions due to the ethical issues of experimenting on fauna.

*Forests:* Extreme heat leads to drying of fuels, increasing the fire risks in San Diego's forests. Forest vulnerabilities to multiple or out of season heatwaves is unknown.

### Examples of Integrated Extreme Heat and Smoke Adaptation Planning

The *Multi-jurisdictional Hazard Mitigation Plan (MHMP)* and the forthcoming *San Diego County Public Health and Climate Adaptation Plan* are central to identifying the most vulnerable populations and developing mitigation strategies to reduce public health impacts from extreme heat and smoke. Integrating environmental justice into these plans is also critical as the people most vulnerable to extreme heat and smoke are often those with fewer resources, often resulting in less access to air conditioning

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<sup>86</sup> Benmarhnia, T., Deguen, S., Kaufman, J. S., & Smargiassi, A. (2015). Vulnerability to heat-related mortality. *Epidemiology*, 26(6), 781-793.

<sup>87</sup> Schinas, L. H., Benmarhnia, T., & De Roos, A. J. (2018). Modification of the association between high ambient temperature and health by urban microclimate indicators: a systematic review and meta-analysis. *Environmental research*, 161, 168-180.

and/or air purification. In addition, working with the energy sector on providing adaptations, such as making air conditioning and air filtration more widely available is fundamental to planning for these extremes. Further collaborating and incorporating planning efforts to reduce fire risk, discussed in the third cross sector example (below), should be incorporated in both the *MHMP* and the San Diego County *Public Health and Climate Adaptation Plan*. SANDAG should also consider extreme heat and wildfire smoke events in transportation planning and can potentially use the Public Health and Climate Adaptation Plan to support integrating adaptation strategies to account for these extremes. Like flooding, a well-developed *MHMP* and *Public Health and Climate Adaptation Plan* can support updates to required local general plans, including safety elements and environmental justice elements.

The Tribal Climate Health Project<sup>88</sup> lead by the Pala Band of Mission Indians is an example of coordination between jurisdictions that support climate resilience planning across the region. The project developed curriculum, a resource clearinghouse, and tools and templates to assist tribes and their partner agencies in assessing vulnerability and implementing adaptation strategies related to climate and health. In addition, the project made it easier for tribes to access health and other data to support their climate resilience efforts. Learning from the project and utilizing the tools and curriculum developed as part of this project can support advancing adaptation planning in the region.

### Cross Sector Example 3: Wildfires and Land Use

#### Background

Wildfires are a natural ecosystem process that have strongly influenced the distribution and composition of highly diverse plant communities in the entire Southern California region, including San Diego County. The native vegetation, in turn, regulates hydrological functioning, stores atmospheric carbon, fixes nitrogen, and provides critical habitat to faunal species. The structure, composition, and geographical range of plant communities are typically modified by changes in the fire regime (size, frequency, interval, intensity, and seasonal timing) and by the direct impacts of extreme climatic conditions. In recent decades, areas throughout Southern California have experienced a rise in human-caused ignition including those generated by electrical power infrastructure, which are now the dominant cause of fire starts in Southern California.<sup>89</sup> The increasing pace of anthropogenic climate change along with the propagation of volatile invasive grasses and forbs<sup>90,91</sup>) in many areas throughout southern California have contributed to uncharacteristically high fire frequency. This shift in fire regime<sup>92</sup> has been exacerbated at times by periods of long-term extensive drought<sup>93</sup>

While warming temperatures and a changing precipitation regime have increased wildfire risk and are likely to heighten the risk in the future, fire ignitions in San Diego are almost entirely caused by people or

<sup>88</sup> <http://tribalclimatehealth.org/about/>

<sup>89</sup> Keeley JE, Syphard AD (2018) Historical patterns of wildfire ignition sources in California ecosystems. *International Journal of Wildland Fire* 27:781-799.

<sup>90</sup> Merriam, K. E., J. E. Keeley, and J. L. Beyers. 2006. *Fuel breaks affect nonnative species abundance in California plant communities*. *Ecological Applications* 16:515-527.

<sup>91</sup> Brennan, T. J., and J. E. Keeley. 2015. Effect of mastication and other mechanical treatments on fuel structure in chaparral. *International Journal of Wildland Fire* 24:949-963.

<sup>92</sup> Syphard, A. D., T. J. Brennan, and J. E. Keeley. 2018. Chaparral landscape conversion in southern California. Page in E. C. Underwood, H. D. Safford, J. E. Keeley, and N. A. Molinari, editors. *Valuing Chaparral: Ecological, Socio-Economic, and Management Perspectives*. Springer.

<sup>93</sup> Keeley, J. E., and P. H. Zedler. 2009. Large, high-intensity fire events in southern California shrublands: debunking the fine-grain age patch model. *Ecological Applications* 19:69-94.

infrastructure related to development<sup>94</sup>. Thus, land use and development planning that emphasizes climate resilience is a fundamental adaptation strategy to reduce fire risk and preserve the diversity of habitats in San Diego.

### Vulnerabilities

*Water:* Water quality issues arise as a result of increased sedimentation from burn areas and impacts the hydrologic systems from the burning of the soils and changes in vegetation. The extent of these impact to the hydrological system remains an open research question.

*Energy:* Energy infrastructure in fire-prone locations may be damaged and cause outages.

*Transportation:* Roads closures near active wildfires may have a serious impact on evacuation routes. Growth of fine fuels, particularly the conversion to weedy herbaceous vegetation, along roads can act as an ignition point for fires.

*Emergency Management:* The Emergency Management sector will need to account for increased fire risk that results not only from higher temperatures and increases drought but also the conversion of woody shrubland to invasive grasses. Invasive grasses and forbs are more flammable than woody shrubs which increases the probability of a fire igniting and spreading, making firefighting more challenging.

*Public Health:* Beyond the immediate safety of those affected by fires, the Public Health sector will need to address the public health impacts beyond the immediate safety of those affected by the fire resulting from smoke exposure as discussed in the cross- sector example above.

*Agriculture:* Fire poses both direct and indirect challenges to agricultural producers in Southern California. The direct impacts of fire include losses in property and equipment, as well as crop losses with significant impacts particularly for orchards and vineyards that take years to establish. Wildfires can also result in power outages that can then hinder the ability to water crops. In addition, producers are struggling with the ability to secure insurance for property and equipment, and coverage for the direct loss of revenue if producers are not able to salvage crops or start over in time to meet market demand.

*Land Use and Community Development and Parks, Recreation, and California Culture:* Communities developed at the wildland-urban interface, which are often low-density developments, are particularly vulnerable to loss of life and property in wildfires. Recreational activities can be a source of ignitions for wildfires but are also affected by burned landscapes. Park landscapes can change drastically after fires and have even required closures in the interest of public safety and to protect the landscape, allowing for post-fire recovery. Further, wildfire suppression response contributes to destruction of cultural sites as bulldozers and fire equipment move across the landscape. Indigenous land stewardship in the San Diego region often included use of fire in ceremonial practice and as a management tool, but fire risk near wildland urban interface communities and environmental regulations such as air quality issues have limited this practice in the recent past.

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<sup>94</sup> Syphard, A. D., and J. E. Keeley. 2015. Location, timing and extent of wildfire vary by cause of ignition. *International Journal of Wildland Fire* 24.1: 37-47



*Habitat and Biodiversity:* Altered fire regimes in the San Diego region can cause vegetation *type conversion*, the conversion of woody chaparral and coastal sage shrublands to weedy herbaceous vegetation<sup>95</sup> or the conversion from native coniferous forests to shrublands or exotic grasslands (Franklin 2010). Combined with persistent habitat loss and degradation, genetic connectivity and bottlenecks have been attributed to wildfire events (Barr et al., 2015).

*Forests:* Fire can destroy forests and it can take decades for a forest to return to its previous developed state. Reforestation can be increasing challenging cause increase in heat and drying and changes to the precipitation regime.

### Examples of Integrated Wildfire Adaptation Planning

The *San Diego County Multiple Species Conservation Program* and the MSCP subregional planning areas throughout San Diego are heavily reliant on wildfire prevention and mitigation to protect sensitive species and maintain ecosystem integrity. Therefore, the impact of increasing fire frequency and fire-induced vegetation type conversion that can degrade habitat should be given careful consideration in the development or updating of habitat conservation plans (HCPs) in accordance with State's Natural Community Conservation Planning Act (NCCP). Specifically, restrictions and guidance for addressing the impacts of increasing fire frequency on ecosystems must be integrated into the implementing agreements for these HCPs and NCCPs and reflected accordingly in the safety, open space and conservation elements of local general plans. Currently, SANDAG's San Diego Management and Monitoring Plan staff is assessing and developing a wildfire management approach to guide scoping of fire management tasks scheduled for completion in FY22/23. This would include the preparation of a Fire Ignition Reduction Plan with specific recommendations to prevent wildfire ignitions affecting Conserved Lands, supporting the development of a regional Resource Avoidance Area Map integrated into fire agency's Wildland Fire Decision Support Systems, and preparation of Preserve Fire Management Plans for Conserved Lands. In addition to this, *SDG&E Fire Prevention Plan*, hardens the electrical system to prevent ignitions and focuses of readiness and public awareness of fire risk to mitigate impact of wildfire. Further, the Connecting Wildland and Communities project contributes to an improved understanding of needs for protecting habitats and species from the impacts of wildfire and increasing fire frequency and severity. Research from this project, and other connectivity projects that consider climate change, should be incorporated to the MSCP plans.

For example, evaluating areas most prone to frequent fires in relation to possible shifts in vegetation communities and impacts on important habitat elements should be addressed in HCPs or NCCPs. This could entail highlighting at-risk areas for protection and identifying alternative lands to meet conservation targets (e.g., pre-approved mitigation areas under San Diego's MSCP or MHCP) if habitat degradation renders an area degraded beyond a threshold that would support listed species or their habitats. This type of land replacement was, in fact, required when the City of Chula Vista, a permitted jurisdiction under San Diego County's MSCP Sub-Area Plan, evaluated an area initially identified for conservation that was observed to have the potential for decreased habitat quality after a series of fire events. That led to reconsideration of the suitability of those lands for conservation of listed species and the identification of

<sup>95</sup> Syphard, A. D., T. J. Brennan, and J. E. Keeley. 2019. Extent and drivers of vegetation type conversion in Southern California chaparral. *Ecosphere* 10.7: e02796.

replacement lands necessary to meet plan requirements. Although smaller-scale HCPs are generally not designed proactively for advanced mitigation, similar strategies and adaptation actions can be integrated into plans and addressed in the regulations under implementing agreements.

In addition, general plan environmental justice elements can identify actions to protect species and habitats with cultural value for tribal nations and neighbors of local jurisdictions. Indeed, all lands within local jurisdictions are the traditional lands of Indigenous people and protection of the resources therein can facilitate the protection of important cultural values and practices for tribal nations that are adjacent to local government jurisdictions.

Coordinating efforts between the development of the updated *Multi-jurisdictional Hazard Mitigation Plan (MJHMP)*, the *CAL FIRE Vegetation Management Plan* (prepared and adopted per SB 1704), and HCPs will also be important. Planning for fuel management to protect life and property in the built environment may conflict with adopted plans such as HCPs that are designed to protect the quality and integrity of habitat for protected species. Working collaboratively to achieve common objectives to protect species and reduce fire risk is an important component to climate resilience planning for the region. Local general plan safety elements, currently mandated to be updated by all local governments, often set forth requirements establishing defensible space by clearing vegetation around structures. In addition, many communities in the wildland-urban interface may opt to prepare Community Wildfire Protection Plans under the 2003 Healthy Forest Restoration Act, in coordination with federal, state, and local governments, to protect entire communities through fuel management regulations. Cross sector coordination and assembling strategic and scientifically-based information for species and vegetation is critical to guide these fuel management planning efforts, as inappropriate fuel treatments can lead to degradation of adjacent wildlands and can actually result in a greater probability of ignition in fuel zones where light, flashy fuels such as grasses replace woody shrubs and native forbs.

## V. Proposed Framework

The previous sections of this report laid the foundation for a proposed Framework for climate resilience planning in the San Diego region. This foundation includes:

- The required principles, processes, and attributes of “Comprehensive Planning for Sustaining Places,” and the related concept of “vertically and horizontally integrated plans,” both of which have been developed through the American Planning Association and its affiliate organizations over the past decade;
- The guidance documents and advisory reports produced by the State of California, regional planning agencies, and professional organizations, which set forth parameters for conducting state-of-the art local and regional planning for climate resilience;
- An analysis of best practices for ensuring that all of our plans are viewed through the lens of Environmental Justice and Equity; and
- Other components that are needed to design a Framework that is responsive to the needs of planners in the San Diego region, including:
  - An evaluation of existing plans and required new plans that will need to address climate resilience and adaptation needs in the coming years;
  - Science-based research on the projected impacts of climate change on our natural systems, built environment, and social systems; and
  - Examples of how cross-sector analysis and vulnerability assessments can lead to solutions to many of the challenges that we face.

This report shows that the San Diego region faces a host of climate-related extreme events, along with the gradual deterioration of many of its critical systems and services. Therefore, a collaborative and science-based planning approach is needed to respond to these predicted climate impacts. The proposed *Framework* shown in **Table 8** identifies *planning focus areas* (groups of related topics) that are tailored to the San Diego region. For each of these focus areas, plans that require climate impact analysis at both a regional / subregional scale and/or a local scale are identified.

*Environmental Justice and Equity* is shown in **Table 8** as an overarching consideration affecting all the planning focus areas. This is discussed in detail in **Section III**. Planning for *Environmental Justice and Equity* should be based on sound analytical processes that will identify the disproportionate impacts of climate change on disadvantaged communities in the San Diego region. At the same time, planners should develop strategies to properly mitigate these climate impacts and should identify opportunities to address existing deficiencies in these areas as soon as possible. Building relationships and working with tribal communities and other communities that are frequently not part of the climate resilience conversation is also an important part of the process.

**Table 8: Proposed Framework**

Environmental Justice and Equity		FOCUS AREAS			
REGIONAL & SUBREGIONAL SCALE		Infrastructure	Natural Resources	Coastal Resources	Public Health & Safety
		SANDAG Regional Plan	San Diego County Urban Water Management Plan  San Diego Basin Plan and Subregional Water Quality Improvements Plan  MSCP Subregional Habitat Conservation Plans		San Diego County Multi-jurisdictional Hazard Mitigation Plan  San Diego County Climate Change and Public Health Plan
LOCAL SCALE		Environmental Justice Element	Environmental Justice Element	Environmental Justice Element  Local Coastal Program and related General Plan Elements	Environmental Justice Element  Safety Element  Local Government Hazard Mitigation Plan

The following is a brief description of each of the *focus areas*:

1. **Infrastructure** – Planning for this focus area will address the impacts of climate change on regional infrastructure, such as transportation, energy, stormwater, wastewater, water delivery, and parks and recreation facilities. The primary analysis and planning activities for this focus area should occur at a *regional* level, while recognizing the importance of local government participation in this work. The SANDAG Regional Plan appears to be the one existing regional-scale plan that is already addressing regional infrastructure needs in the areas of transportation and other regional facilities that may be affected by climate change.
2. **Natural Resources** – Planning for this focus area will include evaluation of the impacts of climate change on the region’s water supply, water quality, and sensitive habitats. The analysis

and planning for water quality should occur primarily at a regional and *subregional* level, utilizing the geographic boundaries of the Watershed Management Areas for which water quality improvement plans have been developed by the San Diego County MS4 Permit co-permittees. The evaluation of climate impacts on sensitive habitats should also occur at the *Subregional* level, utilizing the geographic boundaries for the Subregional Habitat Conservation Plans that are called for in the regional Multiple Species Conservation Program.

3. **Coastal Resources** – Planning for this focus area will be conducted primarily at the local government level, due to the requirements of the California Coastal Act. Coastal resource planning will need to consider the unique climate challenges facing the San Diego coast and its coastal communities due to sea level rise, which will cause more frequent and extreme coastal flooding and will exacerbate coastal erosion of the beaches, cliffs, and bluffs. Estuaries (bays and lagoons) may best be suited as a separate planning exercise and should start with integrating climate change impact considerations and regional planning with the existing management for these sensitive ecosystems. The Tijuana Estuarine Research Reserve and the Batiquitos Lagoon have already evaluated sea-level rise projections and have developed climate scenarios that are being used in their management plan update process. On the open coast, planning should also align with regional sediment management planning being led by SANDAG.
4. **Public Health and Safety** – Planning for this focus area will occur primarily at a regional scale, through the *San Diego County Multijurisdictional Hazard Management Plan* and the *San Diego County Climate Change and Public Health Plan*. Through the lens of Environmental Justice and Equity, planning for this focus area should include recommendations on ways to deal with the impacts of climate change on emergency management services, along with life safety and property protection issues related to existing and future development. At the same time, public health concerns such as poor air quality, extreme heat, and vector-borne diseases, should also be addressed.

For each focus area, responsible public agencies at the federal, state, regional, and local levels should be directly involved in the climate resilience planning process, with designated lead agencies that will manage the planning process. At the same time, it will be necessary to identify the specific types of scientific research that will be needed to support the planning for each focus area. In addition, the public agencies will need to identify other organizations and individuals who should participate in the planning process.

With regard to local government plans, **Table 8** lists the general plan elements that will need to be reviewed and updated.<sup>96</sup> Preparation of updates to Safety Elements and new Environmental Justice Elements (where required by SB 1000) should be carefully coordinated related regional and subregional planning efforts. In addition, the Local Coastal Programs for the County of San Diego and the cities that are wholly or partially located within the Coastal Zone will need to be reviewed and updated to address climate resilience and adaptation issues. This is already occurring in some local jurisdictions.

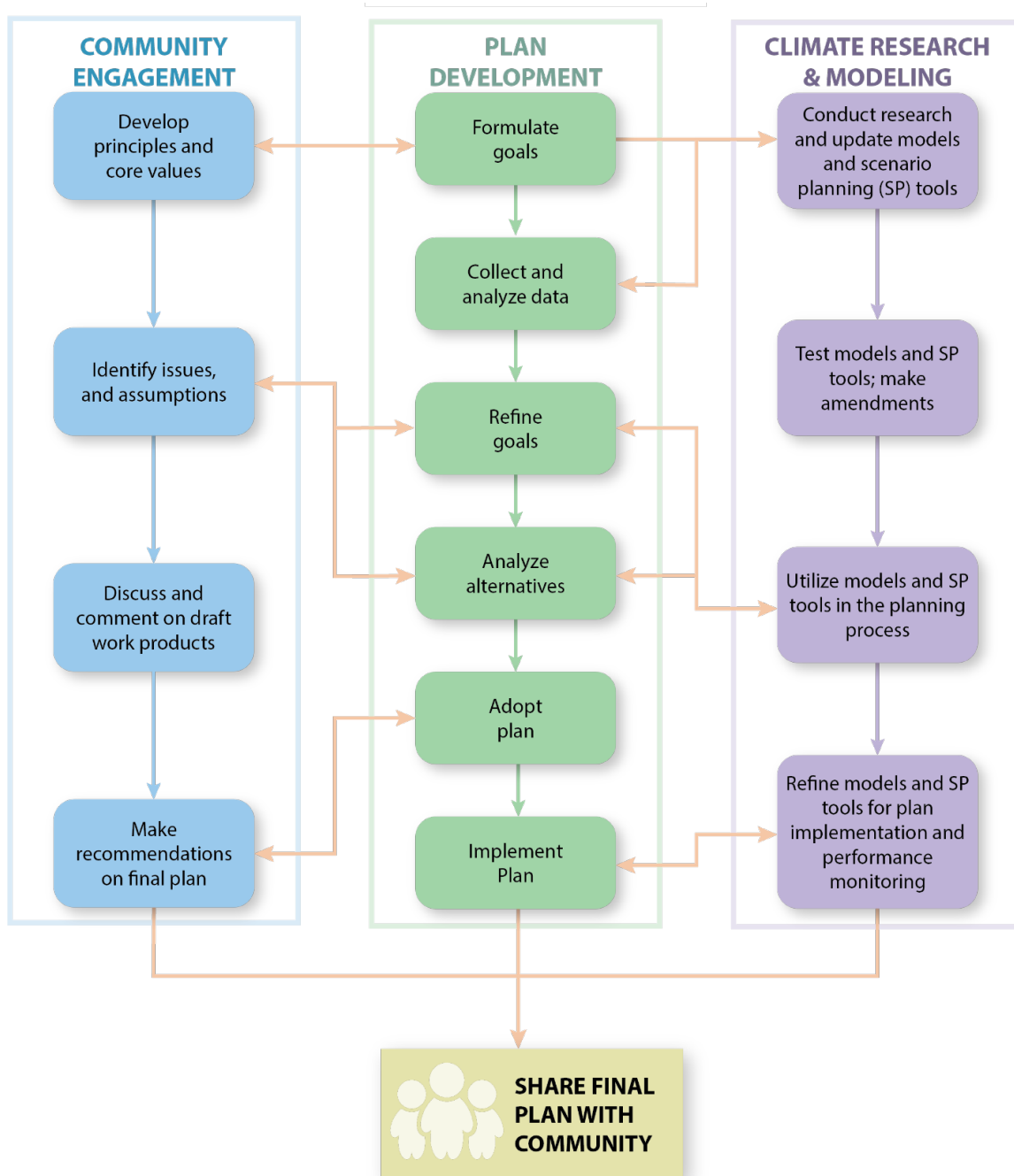
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<sup>96</sup> It should be noted that in the future State law could require that climate impact analyses be conducted for general plan elements other than those listed in Table 8. In addition, when a city or county conducts a comprehensive update of its general plan, each of the mandatory elements would be required to include a climate impact analysis, pursuant to CEQA and / or other existing laws and regulations.

### Using this Framework to Guide the Planning Process

This proposed Framework can help to guide the planning process for the development of individual plans and plan elements. For each plan, it will be important for the planning manager to initially lay out a flow chart that shows all of the steps that are needed in order for the public agency to ultimately adopt the plan and to decide on a set of implementation actions. The *Conceptual Planning Process* diagram shown in **Figure 9** lays out an example of this process.

**Figure 9: Conceptual Planning Process**





This diagram starts with the same basic steps for Plan Development as are described in the *California General Plan Guidelines*.<sup>97</sup> However, the diagram also lays out two parallel processes that are also important:

- Community engagement, and
- Climate research and model development

These processes should be initiated at the same time and should continue to run in parallel with the plan development process, with several points of interaction that are illustrated through the arrows in the diagram. These same basic steps should be included not only in a local general plan process but in relevant and needed in regional and subregional planning processes, recognizing that there may be some variations.

**Figure 9** can be used as a *template* from which a work program, schedule and budget for a particular plan can be prepared. In addition, the template can be used in the future for other plans that may be identified as needing to be prepared or updated to address climate resilience and adaptation issues. **Section VI** of this report will discuss the parameters for designing and implementing an effective community engagement process, while **Section VII** will discuss other important considerations in developing such plans.

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<sup>97</sup> California General Plan Guidelines, p. 17.

## VI. Essential Engagement and Collaboration

Previous sections of this report have discussed the components that are necessary to develop a **framework** for integrated and science-based climate resilience planning. With a framework in place, the next critical step is creating a process to develop and implement a plan. This section and Section VII provide overall guidance and specific examples of how public planning agencies in the San Diego region can establish an effective process for developing their plans.

Section V, **Figure 9**, provides a similar framework as what is proposed in the *General Plan Guidelines* which sets forth basic steps that can be applied to almost any regional, subregional, or local planning process. A well-designed process for plan development includes a clear set of goals and identifies necessary resources to support engagement and collaboration. The process also includes specific strategies and a timeline to ensure that all relevant and interested agencies, organizations, Tribal Nations, and community members can participate in the planning process. An approach that builds strong, lasting partnerships among public agencies, community organizations, service providers, and research organizations to solve the shared challenges of planning for climate resilience is vital.

It is clear that many agencies and organizations are already working together to advance climate resilience planning in the San Diego Region. Others have indicated they wish to initiate new efforts or expand current efforts or have learned that they are required by law to update their plans to address climate impacts. The following is a discussion of important groups that need to be considered for how and when they can support the planning process. In addition to the planning agencies, researcher groups, and community groups, this next section also includes a discussion of *boundary-spanning organizations*, which have become an important catalyst in climate resilience planning. Climate adaptation and resilience planning requires collaboration and engagement throughout the planning process which enables the leveraging of information, methods, and assessments to assure that equitable and effective adaptation strategies are implemented throughout the region.

### Public Agencies and Other Service Providers

A *Public Agency* is a municipal unit of government, such as a state, county, city or district, that is created or established by law, and that provides certain types of public services within its jurisdiction. Examples include federal, state, county and city agencies, and other local agencies such as the San Diego Unified Port District or local water agencies. A *Private Sector Service Provider* is a company that owns and operates a system that provides a public service, normally under an agreement with a public agency. Examples include SDG&E, and telecommunication companies.

Public agencies are often the responsible entity for developing and implementing the plans that are discussed in this report. The cross-sector examples in **Section IV.C** highlights the importance of collaborating and partnering with other agencies in the planning process. Climate change impacts do not stop at jurisdictional boundaries, thus planning for resilience requires multi-agency and cross-jurisdictional collaboration that is based on an assessment of the relevant public agencies that should be part of the planning process. Further, collaborating early in the planning process with other agencies,

facilitates the leveraging and incorporation of data, research and methods that other agencies have developed for adaptation planning.

### Tribal Nations

Engaging with Tribal Nations is necessary to build regional resilience to climate change. Including Tribal Nations in the planning process enables the integration of traditional knowledge and acknowledgement of the importance of Indigenous culture. Further, several of the Tribal Nations have experience developing climate vulnerability assessments, adaptation plans, and frequently collaborate to support climate resilience planning in region. Tribal Nations bring deep knowledge of the region and experience that can enhance plans. The importance of sustained and early engagement and collaborations with Tribal Nations is discussed in more detail in **Section IV.A**.

### Research Organizations

Research organizations currently engaged in building resilience are primarily institutions of higher learning with established Centers that actively engage with government and non-governmental organizations, including public policy organizations to develop and conduct basic and applied research relating to climate change. Research efforts increasingly include social science disciplines such as economics and sociology. Results are disseminated through collaborative engagement with planners as well as through teaching, publication, presentations, and technology transfer.

Research organizations are a critical component of climate resilience planning. The research community provides information about how climate is changing and the future impacts that the region should be anticipate in the planning the process. Researchers can assess the impacts of adaptation approaches through continuous monitoring and analysis. For climate resilience to move forward however, climate research should be co-produced with those using the information in decision making. This requires regular conversations that convey the research results, understanding of how the planning community can integrate the results, and what other research questions need to be addressed for planning. Further, partnerships between researchers and planning agencies can lead to funding opportunities that specifically seek to fund co-produced, applied science. One such example of this is the *Connecting Wildlands and Communities* (CWC) project<sup>98</sup> funded by California’s Strategic Growth Council. *CWC* brings together an interdisciplinary team of researchers with climate adaptation practitioners working in urban and environmental planning for regional and local governments, natural resource management, and tribal governments to integrate science into climate resilience and adaptation planning. Central to the CWC project’s engagement is the Climate Science Alliance, a boundary-spanning organization that is discussed below.

### Boundary-Spanning Organizations

“Boundary-spanning organizations<sup>99</sup>” work at the boundary between science researchers and decision makers to foster more comprehensive information exchange process. As it relates to climate science, boundary-spanning organization encourage multi-jurisdictional, multi-disciplinary interactions between

<sup>98</sup> <https://www.climatesciencealliance.org/cwc>

<sup>99</sup> <https://doi.org/10.1007/s11625-018-0550-9>

the groups leading to climate informed decision making. An important role of boundary-spanning organizations is the ability to convene multiple groups providing a platform to link internal networks of regional and local governments and decision makers with researchers, other external actors. These organizations help ensure scientific credibility and legitimacy in decision making, translate and communicate science, build trust among partners, and are able to educate and influence a broad spectrum of community entities to garner support for action. Additionally, with their unique understanding of a region and strong networks, boundary spanning organizations can work with agency or organization leads to stage engagement and collaborative opportunities at relevant points in the plan development timeline. These opportunities are facilitated at key points over the life of a project to ensure the highest potential for ideas, leveraging of resources and data gathering, along with fostering relationships and increasing support and ownership in implementation. Boundary spanning organizations also work with academics, businesses and foundations to identify funding opportunities and support partnerships in plan and project development. As boundary spanning organizations are relative newcomers to the planning community, two examples of boundary-spanning organizations in the San Diego region, the Climate Science Alliance and the San Diego Regional Climate Collaborative, are discussed below to provide more context about how these organizations support climate resilience planning.

The Climate Science Alliance (Alliance)<sup>100</sup> leverages over 350 partnering organizations, agencies, and individuals in Southern California to accelerate climate adaptation projects and processes that are visioned, led, and implemented by local communities through a just and equitable framework. The mission of the Climate Science Alliance is to safeguard natural and human communities in the face of a changing climate. The Climate Science Alliance has hosted the last three San Diego Climate Summits that brought together a diversity of groups interested in building a more climate resilient region. The Alliance has a Tribal and Baja working group that provide opportunities for partners to share expertise and knowledge in order to bridge the gap between research and applications within these two communities.

The San Diego Regional Climate Collaborative (SDRCC)<sup>101</sup> serves as a network for public agencies to advance climate change solutions by partnering with academia, non-profit organizations, and business and community leaders, thereby raising the profile of regional leadership, shared expertise, and leveraged resources. One such example of this is the Regional Adaptation Needs Assessment/Holistic Implementation of Adaptation and Transportation Resilience Strategies (HIATRS)<sup>102, 103</sup>. SDRCC partnered with San Diego Association of Governments, Tijuana River National Estuarine Research Reserve and The San Diego Foundation to gauge the climate adaptation planning and implementation capacity and challenges within the San Diego region. HIATRS will use the results of the Regional Adaptation Needs Assessment to develop tools such as guidance on how to incorporate economics and equity into adaptation planning. Another example is the San Diego Coastal Exchange. SDRCC and Resilient Cities Catalyst partnered to develop the San Diego Coastal Exchange, which convened global experts and key leaders in the region to explore innovative design options that address coastal resilience challenges and identify a set of viable projects and policies that are ripe for further advancement. The

<sup>100</sup> <https://www.climatesciencealliance.org/>

<sup>101</sup> <https://www.sandiego.edu/soles/hub-nonprofit/initiatives/climate-collaborative/>

<sup>102</sup> The Regional Adaptation Needs Assessment - <https://digital.sandiego.edu/npi-sdclimate/13/>

<sup>103</sup> San Diego Association of Governments - [projectid\\_510\\_28191.pdf\(sandag.org\)](https://projectid_510_28191.pdf(sandag.org))

Exchange has now moved into the implementation phase, which consists prioritization of projects, unification of the varied regional participants, and attraction and generation of funding.

### Community Education, Advocacy and Outreach Groups

These groups are often issue-based and recognize the impacts of climate change integral to their mission and goals. There are numerous groups in the San Diego region, each with a unique mission and purpose. Generally, they use climate information to inform, educate and/or advocate across their membership and constituencies and provide an invaluable link to foster individual, organizational and collective change to advance climate resilience. Included in this group are Community Based Organizations (CBO) and Foundations. CBOs are organizations that have been proven to be effective in representing a community or significant segments of the community. CBOs are a crucial link between planning agencies and the community members. They are the appropriate starting point for equitable and representative engagement. For any climate planning and implementation plan to be successful, the community must be the driver of the process. Foundations are an increasingly important source of climate planning leadership and funding given local and statewide budgetary constraints. Foundations may restrict grant applications to CBOs or other non-profits, increasing the importance for local jurisdictions to cultivate CBO relationships. A regularly updated list of the education, advocacy, outreach groups and CBOs in the region would assist planning agencies in the identification of organizations to engage in the development of plans and projects.

### Summary

Meaningful and effective engagement and collaboration throughout the planning process results in information sharing, identifies efficiencies, and helps ensure equitable adaptation planning. Sustained engagement and collaborations can also lead to partnerships and trust that can contribute to implementation, as plans are completed and reviewed. This can also lead to future funding opportunities to further climate resilience. It is important to assess and identify successful engagement practices across the region in order to learn from our experience and avoid mistakes. Regular evaluations of the engagement process to identify successful components and areas for improvement would benefit the entire region. Planning for a climate resilient region requires significant investment; collaborations can lower this barrier and lead to more effective region-wide planning.



## VII. Considerations for Planners Moving Forward

The previous section provided an overview of the ways to ensure that a robust community engagement process is given a high priority when launching a climate resilience plan. Section VII discusses other factors that are essential components in advancing the climate resilience planning process. While each jurisdiction and agency has its own unique responsibilities, geographic boundaries, and constituencies, successful planning for climate resilience will normally consider a common set of topics and processes. These factors are described below with the understanding that planners would customize them according to their local priorities.

### Economic Analysis

The San Diego region already has felt some harsh examples of wildfire, flooding, heat waves and habitat loss, with the massive costs to public and private sectors. Remedial and preventive actions to avoid climate change impacts are expensive, so it is vital that governments in the region evaluate costs of possible future climate impacts to assess the value of taking those actions. The economic costs of climate change continue to accumulate so they should be documented on an ongoing basis.

Related considerations involve the methodology and the analytical models used to perform economic analyses. Public agencies that are preparing climate resilience plans should ensure that the methodologies and models used to evaluate economic impacts are based on sound economic principles and best practices. To the extent possible, planners should also use consistent methods, models, and input data. When properly designed and used, scenario planning tools can accurately predict how different planning scenarios will financially impact communities, both regionally and locally. For example, an evaluation of how insurance industry practices in response to changes in wildfire and flooding risks affects the local and regional economy would provide valuable information to planners and policymakers. Further, insurance agencies may have unique data sets that could support these types of robust economic analyses, although this data can be difficult to access.

Economic analyses should also be done in a way that is sensitive to environmental justice and equity considerations, including evaluation of costs and benefits at both the individual level (e.g., weatherizing individual homes) and at the agency level (e.g., creating a community weatherization grant program). Leveraged efforts will save public agencies from each having to develop their own tools, could therefore result in better conceived methodologies and facilitate cross-jurisdiction collaboration and analysis. For example, SANDAG has a research unit that develops and maintains such analytical tools and works with university research organizations and other experts to ensure that its models reflect sound economic principles and best practices and that they will provide useful and accurate results. As mentioned in Section VI, through the Holistic Implementation of Adaptation and Transportation Resilience Strategies (HIATRS) project, SANDAG, the San Diego Regional Climate Collaborative (SDRCC), and others are developing a regional economic guidance document to help local jurisdictions consider the costs and benefits of different adaptation strategies.

## Use of Predictive Models and Scenario Planning Tools

Predictive models and scenario planning tools are vital in conducting meaningful climate resilience planning. As noted above, accurate predictive models are essential for conducting economic impact analysis. Similarly, it is important for climate resilience planners to develop and use sound environmental impact models, such as the science-based hydrologic models that are being enhanced through the CWC Project with the assistance of science experts and experienced environmental planners. In addition, accurate predictive models that address other critical elements of the climate resilience planning process, such as social equity impact analysis, will need to be designed and maintained. The results from these models can then be individualized by a jurisdiction to meet the needs for a specific plan. A couple of examples of environmental impact models include The Coastal Storm Modeling System (CoSMoS) for evaluating impacts of sea level rise and the Climate Resilient Connectivity data base that hosts GIS data showing landscape connectivity for habitat preservation. Additional environmental impact models are needed to address other impacts of climate change, and others may be needed to synthesize certain related impacts into a single layered model.

Another important input into many facets of climate resilience planning is regional growth forecasting. SANDAG has produced growth forecasts of population, housing, employment, income, and land use in the San Diego region since 1971. These growth forecasts help regional and local public agencies develop plans for necessary facilities and services. For example, the San Diego County Water Authority uses the SANDAG growth forecasts in developing and updating its Urban Water Management Plan.

To summarize, effective climate resilience planning will almost always require the use of scenario planning tools and techniques. These tools and techniques allow the users to incorporate uncertainty and triggers into their planning process. It will be important to identify the types of scenario planning tools that allow for fair comparisons of alternative planning scenarios in terms of their social, environmental, and economic impacts. Two local examples of scenario planning efforts are the Tijuana River National Estuarine Research Reserve's *Climate Understanding and Resilience in the River Valley* and the Climate Science Alliance's *Batiquitos Lagoon Resiliency Plan*. Both efforts gathered experts and community members to envision possible future climate scenarios and how those scenarios could impact natural systems, infrastructure improvements and social/cultural resources.

## Plan Implementation and Funding Sources

This report identifies several regional, subregional, and local plans which need to be prepared, updated, and implemented to effectively address the climate change impacts anticipated for the San Diego region. That planning itself is costly, and public agencies will need to obtain adequate funding and other resources to produce plans that are science-based and are developed through a robust community engagement process.

The implementation of these plans, which will often involve a multitude of adaptation strategies and implementing actions, will be far more costly. These costs should be quantified in the economic analyses described above, from which the costs of large investments necessary to make the San Diego region resilient to climate change impacts can be compared with costs, likely even greater, of impacts that could

occur in absence of such planning. The County of San Diego, the cities within the County, and regional agencies such as SANDAG need to scour all levels of government for available resources.

The *California Adaptation Planning Guide (APG)* includes a discussion of *Implementation Funding* that provides some general parameters for identifying funding sources for implementing actions.<sup>104</sup> Much of this funding may come from federal and state public agencies. An example of federal funding is FEMA's hazard assistance grants like "Building Resilient Infrastructure and Communities". An example of state funding available for climate resilience and community transformation, particularly for partnership projects, is funding from the California Climate Investments program, which includes projects such as the Community Fire Planning and Preparedness Program and the Climate Ready Program.

To provide funding for some climate resilience planning and implementation public agencies may need additional taxes, assessments, and/or fees, which will require development of strong public support for these actions. Agencies and organization could work to include funding in bond measures and legislation for climate resilience planning, though much of this would need to be approved by the voters. Aggressive leadership will be needed from elected officials, the business community, and other community leaders to develop new funding for climate resilience. One such example is the Waikiki Beach Special Improvement District<sup>105</sup> where business owners pay for groin improvements to retain sand.

San Diego is unique to many jurisdictions because it shares an international border. Cross-border climate and social issues are interwoven into San Diego regional impacts and resilience strategies; international collaboration is required to build regional climate resilience. Area authorities should collaborate with Mexican counterparts in devising a funding plan to support the cross-border climate planning and implementation.

### Performance Monitoring

To achieve success, the regional climate resilience planning process should couple its objectives and implementation actions with a set of performance measures and performance targets. To track progress will require a well-designed performance evaluation system. *Section 4.2* of the *APG* provides an overview of Monitoring, which is considered an essential part of Plan Implementation. Performance monitoring should be an on-going process and should include an evaluation of the findings of the monitoring to improve the plan and its implementation. One of the leading organizations in the San Diego region that specializes in performance monitoring is the Equinox Project<sup>106</sup>, and is a valuable resource that can be consulted in developing a performance monitoring system for climate resilience plans in the San Diego region.

### Other Topics Not Addressed in this Report

It is important to note here that there were three major topics that were covered in *the San Diego Region Report* but were not covered in depth in this report:

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<sup>104</sup> APG, pp. 144 – 145.

<sup>105</sup> <https://www.wbsida.org/>

<sup>106</sup> <https://www.sandiego.edu/soles/hub-nonprofit/initiatives/dashboard/>

- Agriculture (pp. 58 -59)
- Energy (pp. 66 – 71); and
- Cross-border Climate Interactions and Adaptation (pp. 86-90).

The main reason that we did not conduct an in-depth analysis of these three topics in this report was because our focus was on topics where public agencies are already required to update their plans to address climate resilience and/or where public agencies have already decided to develop plans that address climate resilience, such as San Diego County Public Health. We acknowledge that these three topics will warrant further evaluation in the future and may lead to future modifications to the Framework.

### Section Summary

The topics discussed in this section are common to nearly all climate resilience planning efforts for the San Diego region. A critical step in the planning process for an individual plan should be discussion and evaluation of these topics by all participants in the planning process. At the same time, additional topics may be identified and evaluated. By convening an advisory group and working with other agencies, organizations and Tribal Nations, as discussed in **Section IV**, and engaging them early and throughout the planning process, public agencies can obtain insights from participants and leverage their experience and knowledge that will be valuable throughout the process of preparing and adopting the plan. *Boundary-spanning organizations* can also provide resources that will support resilience building throughout the region.

## VIII. Report Summary

The San Diego region is already experiencing climate change, the magnitude and impacts of which will likely intensify, so unified regional and local planning is needed. The breadth and complexity of physical, biological, and social structure in the region require a holistic approach to avoid the worst impacts and adapt to unavoidable ones. This report, therefore, presents an integrated approach to planning using a science-informed, community-based sustainability framework. Integral to this is a planning process based on well-established best practices that can be used for both regional and local climate resilience planning. Allied with this framework, the report suggests actions that can be taken as soon as possible to improve existing planning activities.

### Conclusions

- Climate change impacts include intensified and more frequent heatwaves; less frequent precipitation, but wetter extreme storms; drier landscapes and more frequent drought; increased coastal and inland flooding; and enhanced volatility between wet and dry years, punctuated by more extensive wildfires, more extreme wet days, and more frequent sea level extremes.
- These impacts underscore the need for planning to address various forms of extreme events that will occur in our region that will have dramatic impacts on the built environment, social and economic systems, and the natural environment. Planning must also deal with the possible occurrence of future “compounding extreme events,” — e.g., extreme heat and wildfires — which would multiply the direct impacts of climate change.
- This report has laid out a proposed planning framework for the San Diego region based on guidance from federal, state, regional, and local agencies, as well as professional organizations. This framework is organized around four topical areas: infrastructure, natural resources, coastal resources, and public safety and health. Each of these topical areas can be viewed at both the regional and local scales. Such a framework is needed for public agencies and organizations across geographic scales and sectors in the San Diego region to collaborate on strategies and actions that cut across topical sectors and use science-based research and analysis to achieve effective solutions for combatting the impacts of climate change.
- Environmental justice and equity must be integrated into planning for climate resilience and adaptation, both at regional and local scales. The impacts of change on communities of color, low-income communities, some rural areas, and other disadvantaged communities should be identified as early as possible in the planning process through strong collaboration efforts. Local and regional agencies then need to devise specific strategies and actions for alleviating such impacts and ensuring long-term resilience, including allocation of additional resources where needed.
- The planning process processes and support systems required to implement effective regional and local strategies and actions for climate resilience are not always well understood by many of the agencies and organizations that are responsible for updating plans and implementing them. Thus, there is a need to clarify scientific information, forecasting models, and scenario planning tools and techniques to produce plans that reflect a collaborative and science-based approach.



- Interdisciplinary research and cross-jurisdictional integration of regional and local plans are valuable ways to obtain information and guidance on how to adapt to the projected impacts of climate change. By applying research and scenario planning tools at the regional scale, local governments can avoid duplication of effort in developing local plans and implementing actions. For example, for the eighteen cities and the unincorporated areas in the County of San Diego, planners can utilize the latest scientific knowledge and best regional planning practices to inform local plans.
- Collaborating with public agencies, private service providers, tribal governments, and community organizations is critical to producing a successful climate resilience plan. Meaningful engagement leads to long-term partnerships, leveraging of expertise, opportunities for funding, and other resources that are needed to build resilience.
- Effective performance monitoring is vital in order to learn from successful and unsuccessful outcomes and make necessary adjustments to subsequent strategies and actions.
- Tribal nations in San Diego County are critical players in climate resilience planning. Beyond what is required by law, meaningful engagement with them is needed to build regional climate resilience. This process will provide better understanding of how climate change is impacting tribal nations and how regional adaptations may benefit or harm them.
- *Boundary-spanning organizations*, which are designed to connect planners, scientists, researchers, community educators and advocates, and policymakers, are a vital resource in planning and implementing climate resilience and adaptation solutions.
- Scientific understanding of climate change and impacts is advancing rapidly, and regionally tailored results are vital to inform climate resilience planning. The San Diego Region Report and the San Diego Ecosystem Report identified research needs that are important to address in relation to these future impacts.
- Although much progress has been made, there are some gaps in our understanding of which public agencies are responsible for determining the legal requirements, completion deadlines, science research needs, and best planning practices for regional and local plans that are required to address the impacts of climate change.
- Many of the findings and conclusions in this report may be applicable to other regions that are vulnerable to significant climate change impacts and should be considered in developing climate resilience plans for those regions.

## Future Actions and Research Needs

Readers of this report will have gained a wider appreciation of the myriad plans and studies addressing climate change impacts in the San Diego region that have been completed, are underway, or must be updated. They will have been presented with a framework for assisting the region and its people in adapting to those changes that cannot be avoided and for making the region more resilient to such changes in the long term, with special emphasis on advancing environmental justice. They also will have been shown the importance of collaboration among public agencies, scientific research institutions, non-

governmental organizations, community representatives, and others in continuing to build on all these efforts.

This report is by no means intended to be a final word on the subjects discussed. As climate change and its impacts become increasingly severe, constant follow-up work is needed. Without intending to define or limit the extent of such work, it can be observed that important areas for additional study and implementation include:

- Refining the tools that planners, scientists, and others can utilize in these continuing efforts.
- Enhancing the capacity of public agencies and non-governmental organizations to conduct research and formulate policies relating to climate change and to climate resilience planning.
- Identifying further research and analysis needed to create effective adaptation responses and resilience plans.
- Increasing meaningful collaboration with tribal nations and communities that are especially impacted by climate change, with particular focus on disadvantaged communities.
- Developing financial and other resources to support the work of sustainability professionals and to fund the adaptation and resilience programs that the region requires.
- Analyzing legal, economic, and other obstacles to implementation of effective climate resilience plans.
- Learning from the experience of other regions and collaborating with them in formulating the best practices for climate resilience research and planning.
- Using the Framework set forth in this report when conducting a comprehensive update to a local general plan, recognizing that all of the mandatory elements of such plans will be affected either directly or indirectly by the impacts of climate change over time.

## Appendix A-1

### Assessment of Future Impacts of Climate Change in the San Diego Region

Community adaptation to climate change should best be conducted with an awareness of the existing local climate, along with spatially specific climate projections. This section summarizes and updates findings of the San Diego Region Report (Kalansky et al., 2018) and the San Diego County Ecosystems Report (Jennings et al., 2018) which have recently synthesized the current state of the science and understanding of the impacts from climate variability and future climate change in the region. The section will be organized by key climate-related phenomena: temperature, precipitation, Santa Ana winds and wildfires, coastal low clouds, and sea level. The section concludes by discussing compounding extreme events.

#### Warming Temperature

As has been projected across California (Pierce et al., 2018), models indicate that temperature in San Diego will warm progressively through the 21st Century. By the end of the 21st Century, the projected warming ranges from 4°F to 9°F, with magnitude depending greatly upon global greenhouse gas emissions. Warming is projected to be greater in late summer and early fall than in other months of the year, and this monthly difference is more pronounced for minimum daily temperatures and under a non-mitigated greenhouse gas emission scenario (RCP 8.5). Because the oceans warm more slowly than land masses, temperature increases along the coast are projected to be about 1°F less than other locations throughout the region.

The most severe impacts of rising temperature will likely result during occurrences of weather patterns that cause extreme heat. Heat waves have impacts on human health, ecosystems, agriculture, energy demand, and infrastructure. By the end of the century, similar to the average temperature change, the hottest day of the year is projected to increase by 4-9°F depending on the greenhouse gas emission scenario. The frequency, or the probability of a heat wave occurrence, does not necessarily follow background warming however (Guirguis et al., 2018). For example, under 6°F of warming, nighttime frequency of heat waves is projected to increase by approximately 51% in the coastal zone, while that of day time heat waves is only projected to increase by 23% (Jennings et al., 2018). Unlike the coasts, the local mountains, such as Cuyamaca have a similar increase (~30%) in the probability of nighttime and daytime heat waves. This contrast is a result of differences in the number of days of extreme temperature (long warm tails). Relative to background warming, which is projected to be stronger inland than at the coast, scientists (Gershunov & Guirguis, 2012) have projected more intense future heat waves along the coast compared to inland areas. In San Diego, as in the rest of California, coastal low clouds modulate temperatures by providing a cooling effect (Iacobellis & Cayan, 2013) while their absence can boost heat waves relative to normal temperatures (Clemesha et al., 2018). This relationship has an impact on projections of heat waves; however, the sensitivity of coastal low clouds to climate change is complicated and is an area of active research at present.

The San Diego Region Report highlighted that the most vulnerable populations to health impacts from extreme events, such as heat waves, are those who lack resources or are uninsured, are socially isolated,

or whose health is already compromised. For example, cardiovascular and respiratory illnesses are exacerbated by heat and air pollution (Analitis et al., 2014) and psychiatric illness has been shown to triple the risk of death from extreme heat (Bouchama et al., 2007). Heat waves increase morbidity and mortality as was seen with the July 2006 heat wave in California, which exhibited unprecedented magnitude and unusually high humidity levels (Gershunov et al., 2009). The 2006 extreme heat wave resulted in over 600 excess deaths (Ostro et al., 2009), over 1200 excess hospitalizations for cardiovascular and other diseases (Guirguis et al., 2014), and over 16,000 excess emergency-department visits (Knowlton et al., 2009). In addition, recent research since the San Diego report has shown heat waves in the week prior can cause preterm birth (Ilango et al., 2020) and significant increases in renal hospital admissions for urinary tract infection, septicemia (blood poisoning), urinary stones, and composite kidney disease (Malig et al., 2019).

Throughout California and in San Diego, the effect of high apparent temperature, a combination of hot temperatures and high humidity, can have a greater impact in mortality (heat-related deaths) in coastal areas than inland areas (Basu, 2009). Guirguis et al. (2018, 2014) found that higher daily rates of heat wave-related hospitalization in coastal areas was caused by a lack of air conditioning, while residents in inland areas more often did have air conditioning. Building on this, McElroy et al. (McElroy et al., 2020), examined heat wave definitions (length, threshold percentiles and nighttime versus daytime temperature) and found that residents in climatologically warmer inland and desert climate zones in San Diego had more hospitalizations during heat waves that had high nighttime warming, as compared to residents in the coastal zone. Both of these studies underscore the need for heat warning systems that account for differences in the climate zones throughout San Diego.

In Southern California, high temperatures also have great impacts on energy and transportation. A study of Los Angeles, which examined vulnerabilities of energy infrastructure at the neighborhood level, estimated losses up to 20% of peak demand safe operating electrical system capacity during projected extreme temperature at the end the century. High temperatures in neighboring San Diego County are expected to have similar impacts. Possible adaptations identified for the Los Angeles case, including higher density housing and reduction of sunlight absorbed (increasing albedo) are relevant for the San Diego region (Burillo et al., 2018, 2019). Data relating to temperature impacts on transportation in Southern California is limited, but studies elsewhere indicate that high temperatures must be included as design criteria in order to avoid damage to roads and rail lines (Markoff et al., 2018).

Research is advancing on effective adaptations to help combat the impact of heat. As Guirguis et al. (2018) showed, access to air conditioning can help prevent hospitalizations during extreme heat events. People living in hotter areas within cities have suffered an overall 6% higher risk of mortality/ morbidity compared to those in cooler areas, and those living in less vegetated areas had 5% higher risk compared to those living in more vegetated areas (Schinasi et al., 2018). In Los Angeles, increases in roof albedo, through light-colored reflecting roof surface treatments, reduces near-surface air temperature (Mohegh et al., 2018). With respect to infrastructure, the increase of solar energy generation in San Diego will help to offset increased electricity demand during hot sunny days, although this local source of energy will not help to satisfy nighttime energy needs for air conditioning on hot nights, and will be less effective during,

cloudy, hot and often humid days. The addition of batteries can extend solar power ability to provide energy during nighttime and on cloudy days.

### High Volatile Precipitation

Precipitation in Southern California has the highest year-to-year variability of any place in the continental U.S (Dettinger et al., 2011). In the San Diego region this variability is exemplified by the unusually wet water years of 2005, 2011, and 2017 and the droughts of 2001-2004, 2007-2010 and 2012-2016. As is the case for Northern California (Dettinger & Cayan, 2014), the high year-to-year variability in San Diego County is driven by extreme precipitation events, wherein days with precipitation at or exceeding the 95th percentile account for 80% of the year-to-year variability in annual total precipitation (Jennings et al., 2018). The heaviest events mostly occur in winter, although the region occasionally experiences high rainfall events from tropical storms or convective rainfall patterns during late summer and early fall. Large spatial variability adds to the complexity of the climate regime in the region. Mean annual precipitation ranges widely in San Diego County, between approximately 8-36 inches with most differences resulting from topographic influences - most precipitation on the west and south facing slopes and least in the rain shadow of the local mountains.

Model projections indicate that precipitation in California will become even more variable in future decades. While days with measurable precipitation become less frequent in Southern California (Pierce et al., 2013; Polade et al., 2014), extreme precipitation events will intensify (Polade et al., 2017). By the end of the century, the average wettest day every five years is projected to increase by 10-30%. Driving the precipitation regime change are atmospheric rivers, which are transports of moisture from the tropics over the Pacific Ocean in long, thin streams of moisture, like rivers in the sky. Precipitation from atmospheric rivers is projected to increase in the future, while precipitation from other forms of precipitation is projected to decrease. This tendency is particularly evident for the most extreme events — model projections suggest the strongest increases in the wettest 1 % of days, nearly all of which are found to be atmospheric rivers (Gershunov et al., 2019). Atmospheric rivers are projected to be associated with floods, annual maximum flow events, 8% more often in the end of the century as compared to 1950-2000 (Cao et al., 2020). Historically atmospheric rivers have caused the greatest flood damages to property in California and elsewhere along the West Coast as compared to other types of storms (Corringham et al., 2019). Also, coastal runoff created by atmospheric rivers has been shown to result in fecal pollution in coastal waters (Aguilera et al., 2019). In future decades, projected increases in precipitation from atmospheric rivers will likely increase both the flood damages and water pollution as a result of the extreme precipitation.

The average of several climate models project that Southern California will be drier in the future. However, the models project a range of changes in annual precipitation, due to differences in the representation of atmospheric circulation changes across different global climate models, and to the highly variable nature of the San Diego precipitation (Gershunov et al., 2019). Drought, both interannual and annual, impacts ecosystems and enhances wildfire risk. The recent 2012-2016 drought may be an early form of future droughts in California, not only having diminished annual precipitation amounts, but also featuring temperatures exceeding historical levels. This combination of warming and drying results in greater evaporative demand from plants and the land surface, which exacerbates the drought (McEvoy



et al., 2020; Williams et al., 2015). While reductions of annual precipitation are somewhat uncertain, the increase in temperature is baked into the future because of greenhouse gas accumulation in the atmosphere. The strong likelihood of warming continuing through future decades would indicate that enhanced evapotranspiration and landscape drying are quite certain. Because of this, future projections of drought that incorporate the evapotranspiration as well as precipitation project more multi-year droughts relative to projections of drought that only include precipitation (Kalansky et al. 2018; McEvoy et al., 2020).

Ecosystems have adapted to the high variability of San Diego's hydroclimate, but this variability is projected to increase. The recent 2012-2016 drought showed that certain species were more susceptible to multi-year droughts than others (Venturas et al., 2016). Meanwhile, recurrent drying, along with persistent warming since 1999 has pushed the Southwest toward "mega drought" (Williams et al., 2020). Extreme drought has the potential to intensify and change community composition and structure of ecosystems. Drought has severe consequences because it operates at spatial scales larger than other disturbances such as fire (Jennings et al., 2018). Adding to impacts caused by interannual drought, the seasonal drought that is characteristic of the Mediterranean climate is projected to become longer with reduced precipitation in the shoulder seasons, spring and fall. Such a shift toward a narrower precipitation season would stress some plant communities because spring features the largest increases in biomass for many plants due to the availability of moisture as well as the longer daylight hours (Parker et al., 2016). Thus, the projected spring drying has the potential to limit the growth of plants during their primary growing season. The largest impact of fall drying might likely be the increased occurrence of dry live and dry fuels during the season when Santa Ana wind occur, which would intensify the fall wildfire season.

### Growing Threats of Wildfire from Warmer Climate and Santa Ana Winds

Santa Ana conditions erase the presence of the North Pacific air mass that usually blankets San Diego County. Santa Ana events typically last a few days and often carry strong and gusty winds from east or northeast directions that produce extreme dryness. Santa Anas bring some of the highest winds experienced by many parts of San Diego County. Peaking in early winter, Santa Ana winds originate in the elevated Great Basin as cool air masses and are pushed southwestward by a synoptic pressure gradient creating offshore winds throughout San Diego (Hughes & Hall, 2010). Clear skies are typically associated with Santa Ana wind events as the offshore winds blow air pollution offshore (Aguilera et al., 2020a). Some Santa Anas are quite cool, owing to their origins from cold dry Great Basin air masses, but the majority of Santa Anas are warm. In fact, hot, dry Santa wind events have accounted for many of the extremely warm (99th percentile) days within the September through May period: 90% of the warm extremes in winter, 30% in fall and 40% in spring. These non-summer heat waves increase hospitalizations for dehydration, renal failure, and stroke (McElroy et al., 2020).

San Diego's highest wildfire risk occurs during Santa Ana winds. In recent years, the region suffered some of California's largest conflagrations, including the September 1970 Laguna fire (175,425 acres burned), the October 2003 Cedar fire (273,246 acres burned) and the October, 2007 Witch (197,990 acres burned) and Harris (90,440 acres burned) fires, all fanned by Santa Ana winds. The Santa Ana season typically commences in October, when vegetation is driest. An ignition of parched vegetation under this strong, gusty, dry wind causes wildfires that are extremely difficult if not impossible to control. This

explains the timing of the peak of the traditional southern California wildfire season — October — when the Santa Ana season starts and before the first rainstorms of winter. During fires under Santa Ana conditions, air pollution (particulate matter under 2.5 microns - PM<sub>2.5</sub>) increases throughout San Diego and PM<sub>2.5</sub> from wildfire is up to 10 times more harmful than air pollution from other sources (Aguilera et al., 2020b) (Aguilera R, et al. 2021, in review) In addition to the personal safety, infrastructure and public health hazards posed by wildfires, San Diego ecosystems are also sensitive to too frequent fires. A growing risk in a warmer, fire-prone climate is the conversion of woody chaparral and coastal sage shrublands to grasses and other weedy herbaceous vegetation (Syphard et al., 2018), or the conversion from native coniferous forests to shrublands or exotic grasslands (Franklin, 2010).

Climate model projections of Santa Ana winds indicate that their activity could decrease in the warmer future. In the second half of the century under a non-reduction of greenhouse gas emission scenario (RCP 8.5). Santa wind frequency is projected to decrease by between 8-20% and winds speeds between 5-10% relative to a historical period of 1950-1999. Further the Santa Ana activity is projected to decrease more in the shoulder seasons, fall and spring, relative to winter (Guzman-Morales & Gershunov, 2019). The decrease in Santa Ana wind activity in the fall may help mitigate future wildfire risk resulting from drier autumns and more frequent multi-year droughts. On the other hand, projected delays in the wet season (Pierce et al., 2013) would extend the presence of dry vegetation into the December peak of Santa Ana wind activity (Guzman-Morales et al., 2016) which will always see more frequent Santa Ana winds than October ever did (Guzman-Morales & Gershunov, 2019). December fires could occasionally be fanned by back-to-back Santa Ana wind events and have the potential to grow to unprecedented proportions. These were the antecedent conditions that led to the Lilac Fire in San Diego and one of the largest fires in California history, the Thomas Fire, which burned in Ventura and a Santa Barbara. The Thomas Fire continued to burned throughout most of December 2017 and into January 2018, when its smoldering remains were finally put out by the first significant rain of the season — an atmospheric river, which caused deadly debris flows. A later start of the wet season is already apparent in the observations, while a decrease in Santa Ana wind activity has not yet emerged from the natural variability (Williams et al., 2019).

### Variable Marine Layer Clouds

Coastal low stratus clouds, also described by scientists as Marine Layer Clouds (MLC), or in Southern California as “May gray” and “June gloom,” are a defining, often persistent, and highly variable aspect of coastal California summer climate. MLC in San Diego are common in late spring and early summer when cool moist air near the ocean surface and sinking warm air above cause a temperature inversion which traps low level moisture and creates optimal conditions for these blanketlike stratiform clouds. When present, MLC shield the coast from summertime heat and are an important weather pattern to the coastal ecosystems in San Diego (Jennings et al., 2018) and as important modulators of coastal expressions of summertime heat waves (Clemesha et al., 2018). The stability of the lower atmosphere and ocean temperatures are important in the development of MLC, but there are additional drivers that interact on various spatial and temporal scales (Clemesha et al., 2016, 2017; Schwartz, 2015). Because global climate models are coarse-grid calculations and only poorly resolve the high gradient atmosphere-ocean structure along the California coast, and because the controls that govern the presence of coastal stratus are a balance of competing large and smaller scale processes, MLC appear to be poorly predicted. These

factors and interactions need to be better understood to provide credible predictions of any future changes in MLC along San Diego County's coastal zone under future climate change.

### Sea Level Rise and Coastal Storms

The coast is an important part of San Diego's landscape, culture and economy. It is also one of the more vulnerable landscapes in San Diego as many of its beaches, cliffs, and estuaries are already experiencing erosion and flooding, and these hazards are expected to accelerate in frequency and intensity with climate change.

Over the last century sea level has risen about 0.6 ft over much of the Central and Southern California coast. Global sea level provides an important indicator of the state of the warming climate, but regional sea-level rise varies across coastal communities because processes that cause sea-level rise interact differently and vary across coastal regions (Hamlington et al., 2020). Between 1980 and 2000, sea level along San Diego was relatively stable, even decreasing slightly as stronger wind stress gradients over the eastern Pacific suppressed the global rise along North America. Since 2000, sea level has been increasing as the wind systems relaxed once again (Bromirski et al., 2011, 2012; Hamlington et al., 2016). For the San Diego region, sea-level rise models project similar ranges in elevated sea-levels until 2050 (approximately 0.6 to 1.3 feet). In the second half of the century, sea-level rise is expected to accelerate significantly, but there is greater uncertainty as to how extreme this rise will be at the end of the century (0.9 to 4 feet) with the possibility that it is much higher (Griggs et al., 2017). This is related to unknown global greenhouse gas emission reductions and uncertainties about how rapid ocean warming will impact ice sheet melting (Griggs et al., 2017; Kalansky et al., 2018)

Given the increase rate of sea level rise, in the near term the greatest impacts from sea level rise are mostly likely to occur during events that combine high tides, El Nino and both locally and distantly generated wind-driven waves. For example, the generally elevated sea levels along the California coast during the super El Nino of 1982-83 were heightened by large winter storms and high waves during high tide periods, causing enormous coastal damage along the San Diego County shoreline (Flick, 1998). The next period of unusually high tides will occur in 2021 from 16.8 and 4.4-year lunar tidal cycles, and will produce peak monthly tides about 0.5 ft higher than years in between cycle peaks (Cayan et al., 2008; Zetler & Flick, 1985). Hazardous coastal storm events are expected to become more severe as global sea level rises. San Diego's long history of coastal monitoring and research are now being used more to advance our understanding of how extreme events as repetitive stressors are increasing San Diego's coastal vulnerabilities. Recent improvements in coastal wave forecasting (Crosby et al., 2016, 2017) coupled with enhanced wave runup modeling are improving coastal flood forecasting capabilities for San Diego communities by defining the incident wave conditions and tide levels that result in site-specific flooding.

A long history of coastal monitoring and analysis by San Diego researchers (Ludka et al., 2019) has led to improved wave forecasts, improved understanding of sediment processes, including beach nourishment (addition of sand to the beaches) and cliff erosion, and improved understanding of local estuarine dynamics and ecosystems. Beach processes and sediment budgets are typically characterized within a particular littoral cell, a series of sand sources (such as rivers, streams, and eroding coastal bluffs) that provide sand to the shoreline, sand sinks (such as coastal dunes and submarine canyons) where sand is

lost from the shoreline, and alongshore transport that moves sand along the shoreline. Over the years, human activity, such as damming rivers, has limited the amount of sand that enters the littoral cell. For example 60% (40% dammed and 20% urbanized and not dammed) of the Oceanside Littoral Cell watershed no longer generates beach sand (Young et al., 2010). Beach sand levels and waves have been monitored at selected San Diego beaches for as long as 17 years (Torrey Pines, Imperial beach, Solana beach, and Cardiff beach) including two energetic El Nino winters that showed significant beach degradation (Ludka et al., 2019). These observations have led to a better understanding of seasonal beach sand level changes, areas of chronic erosion (Doria et al., 2016; Yates et al., 2009, 2011) and coastal impacts associated with El Niño events (Barnard et al., 2017; Doria et al., 2016; Ludka et al., 2015, 2016, 2018; Young, 2018).

Cliff erosion is a natural coastal process for much of northern San Diego County. In San Diego, between 1998 and 2009 the mean cliff top retreat was 0.46 ft/yr (Young, 2018). San Onofre State Beach is a cliff erosion hot-spot in San Diego County due to extensive deep-seated landslide (Adam P Young, 2015). Other areas in north San Diego County, such as Encinitas and Del Mar, have also experienced a number of significant cliff failures in recent years. Researchers are advancing understanding of how wave-cliff impacts and rainfall contribute to both upper and lower coastal cliff erosion providing insight into how increasing sea levels, and storm driven waves and rainfall may further accelerate this erosion (Young et al., 2021)

Additionally, beach nourishment, or the addition of sand, is an important part of the sediment supply to beaches throughout the San Diego region, beginning at the end of World War II. SANDAG spent \$44 million in 2001 and 2012 on non-opportunistic nourishment by placing 3.5 million cubic yards of sand on beaches throughout the County and north San Diego County has developed a 50-year, \$160 million plan for beach nourishment (Diehl, 2015). The impacts of beach nourishment are complex as there are several physical processes that interact to determine the impacts on flooding, erosion, and ecosystems. Successive beach monitoring during the nourishments provides insight into how site-specific sediment transport processes, sand grain size, timing of the nourishment and the intensity and frequency of storm-driven wave energy can affect the success of a nourishment (Ludka et al., 2016, 2018, 2019).

### Compounding Extreme Events

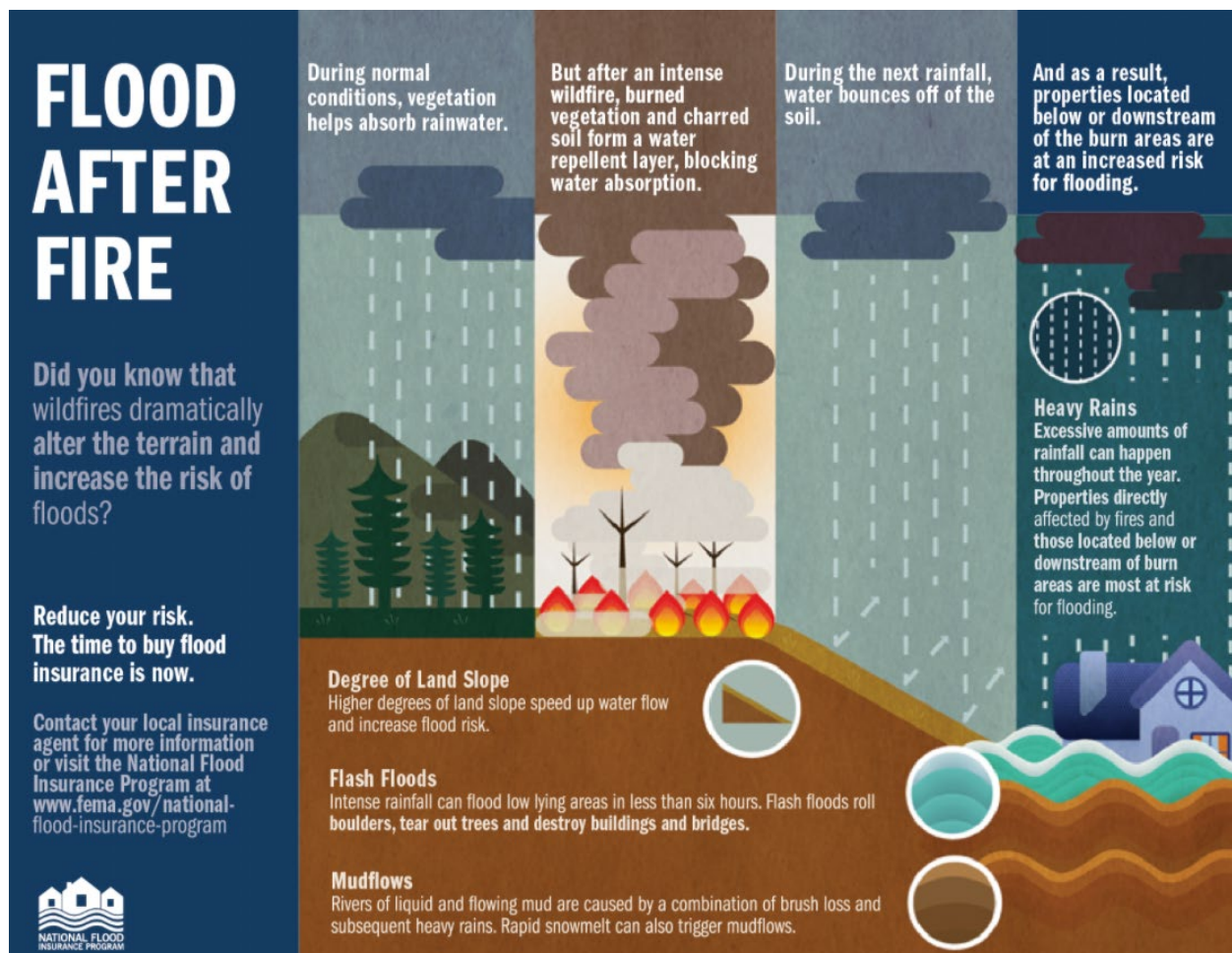
One major concern, both historically and in the future, is a sequence of hazards or “compounding extreme events.” For example, the largest fire in California history, the Thomas Fire, led directly to the subsequent Montecito debris flows. These debris flows, which were unleashed from barren landscape that was burned off by the Thomas Fire, serve as a clear example of a devastating sequence of climate related events. The December 2017 Thomas fire, which burned 281,893 acres, occurred several months after a very wet winter (more than 22 inches November through May as an average over South Coast Climate Division) and immediately followed an extremely dry September through November that delivered only about 0.3 inches of precipitation. When a strong Santa Ana wind event occurred in early December, the dry landscape provided the fuel for a devastating wildfire that was fanned by strong Santa Ana Winds. The conditions allowed the Thomas fire to grow to the largest wildfire in California’s modern history. The first measurable rainfall occurred on January 8. During the storm, high intensity rainfall resulted in devastating post-fire debris flows in Montecito and Carpinteria, resulting in 23 deaths, 246 structures



destroyed, and 167 structures damaged. This sequence of devastating events has the potential to become more frequent given the projections of a drier fall season, extending the annual seasonal drought into the main Santa Ana wind season and therefore increasing the likelihood that an extreme Santa Ana wind event occurring over a dry landscape could provide fuel for the fire. Further post fire debris flows. The Federal Emergency Management Agency (FEMA) has actually given the name “flood after fire dynamic” to this type of compounding extreme event. (See Figure A-1)

Another possible compounding event that could heighten the potential for increased frequency and severity in the future is the combination of a storm causing both terrestrial and coastal flooding. As sea level rises, and extreme precipitation becomes more extreme, the combination of costal and storm water flooding has the potential to have devastating impacts on property, infrastructure and water quality.

**Figure A-1: Flood After Fire Dynamic**



Source: FEMA



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