PHASE 2: ASSESS VULNERABILITY

Phase 1 developed the scope, goals, and team for building a community's resilience to climate change. Phase 2 involves a vulnerability assessment that identifies and characterizes the climate hazards and other climate effects a community faces.

This guidance uses the latest and best available knowledge from state and federal resources about designing and completing vulnerability studies. The approach is designed to ensure that the resulting vulnerability assessment meets Safety Element requirements in California Government Code § 65302(g)(4), as updated by SB 379 and SB 1035. It is also designed so that users can easily integrate the vulnerability assessment into a local hazard mitigation plan (LHMP). This approach to a vulnerability assessment mostly aligns with FEMA's risk assessment process in Task 5 of *Local Mitigation Planning Handbook*, and the APG notes when this is the case. The Phase 2 vulnerability assessment is more in-depth than in other planning processes in order to create a more comprehensive assessment of vulnerability to climate change effects.

Phase 2 has four steps for completing the vulnerability assessment—exposure, sensitivity and potential impacts, adaptive capacity, and vulnerability scoring—and a final step for outreach and engagement (see Figure 9). This phase gives a better understanding of a community's major climate vulnerabilities, and which vulnerabilities to focus on in Phase 3. Steps 2.1 to 2.4 in this phase should be followed sequentially (see Figure 10). Step 2.5 provides options for outreach and engagement that can be integrated throughout the phase or as a step at the end of the phase.

Figure 9. Steps in Phase 2

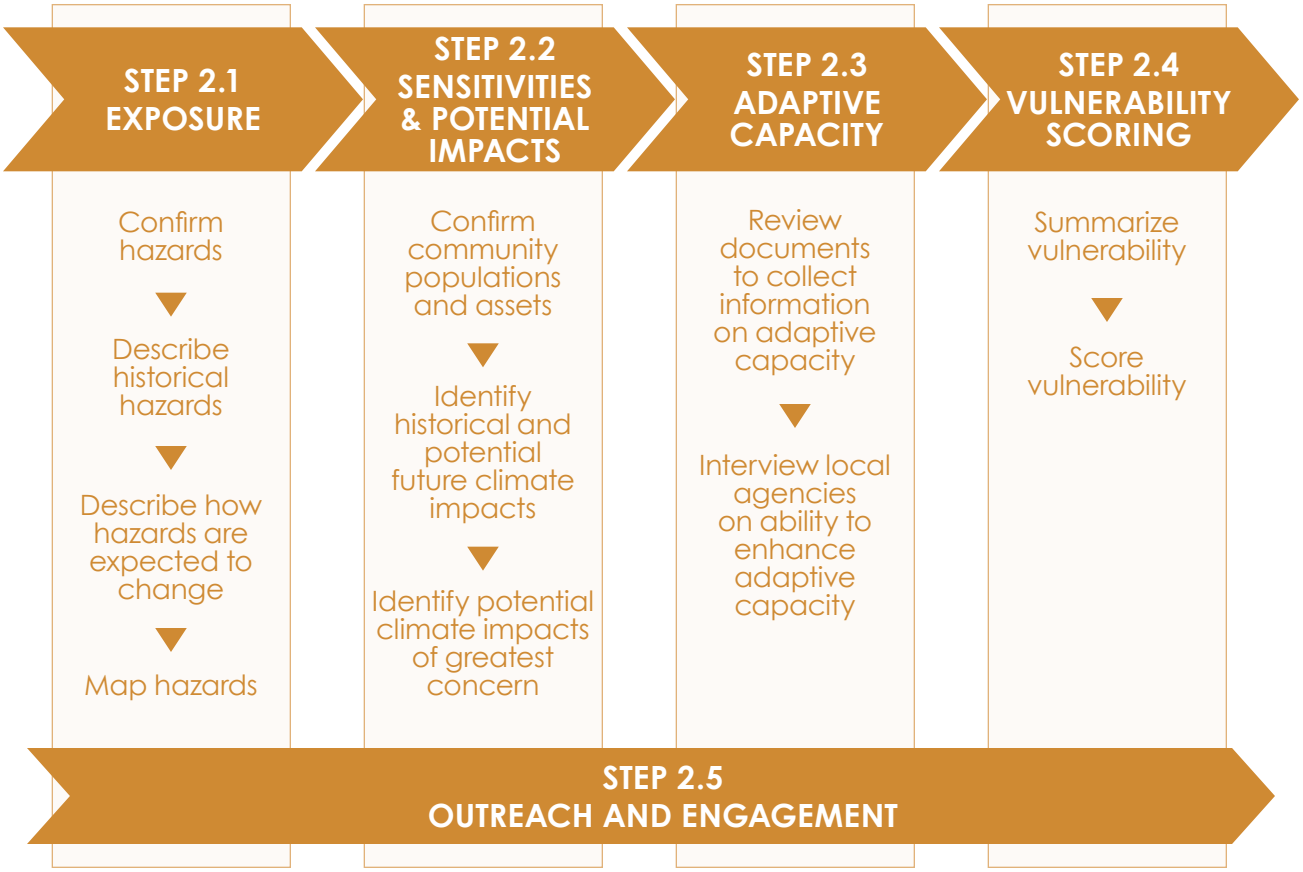
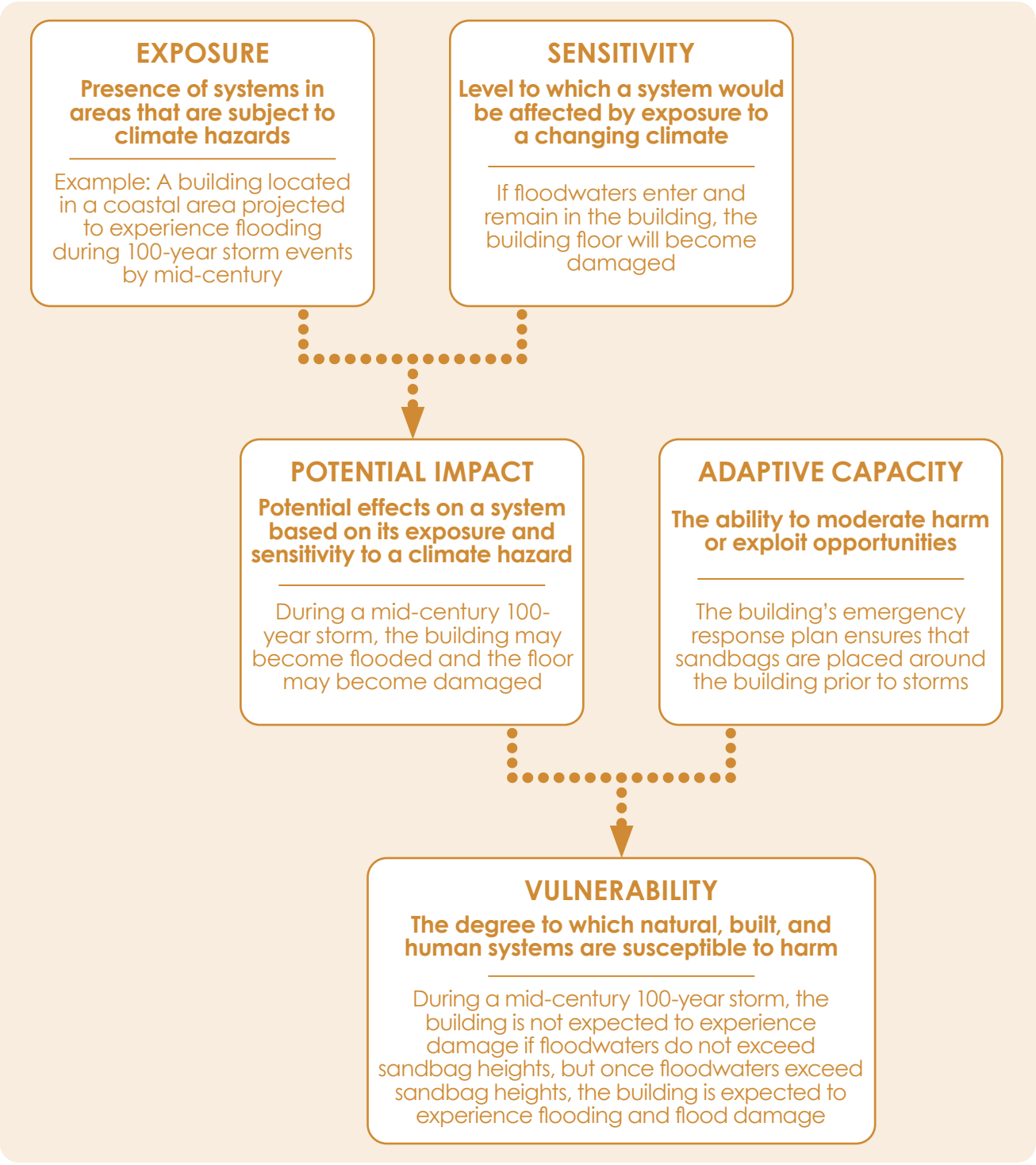


Figure 10. Vulnerability Assessment Steps Defined



Step 2.1: Exposure

The goal of this step is to characterize the community's exposure to current and projected climate hazards. Materials prepared for this purpose include:

- A final list of climate change effects of concern.
- An overview of major historical hazard events and the consequences to the community.
- A description of how each identified climate change effect is projected to change over the analysis period.
- Map of projected change in each identified climate change effect.

Climate change–related effects will likely change as the climate warms. The impact to a community depends in part on that community's exposure.

STEP 2.1A: CONFIRM HAZARDS AND OTHER EFFECTS

Phase 1 identified a list of climate change effects. Talking to colleagues and engaging with community members can garner additional details for this list. (See Step 2.5, Outreach and Engagement, for ideas on stakeholder interviews and storytelling.) They can also validate the initial list and potentially add new effects. Tables 5 and 6 can be helpful when exploring examples of relevant climate change effects.

The regional assessments in the most recent *California Climate Change Assessment* have information about what effects are relevant in different communities. The different regional reports provide an overview of current and projected climate change effects throughout California and point to additional detailed studies on specific climate change effects and impacts.

Describing Hazards for Local Hazard Mitigation Plans

To integrate the assessment into an LHMP, this exposure step can be integrated with the hazard descriptions in the FEMA risk assessment.

STEP 2.1B: DESCRIBE HISTORICAL HAZARDS

The historical record of the hazards in a community provides context for assessing the projected changes in hazards and other climate change–related effects. It is important to describe the histories of these hazards, including when they occurred, the areas where they occurred, and their magnitude (e.g., depth of flooding, area burned, temperature). Table 8 shows an example from San Diego County's 2017 LHMP that inventories the history of wildfires in the county.

TABLE 8. EXCERPT OF WILDFIRE HISTORY FROM SAN DIEGO COUNTY'S LHMP

FIRE	LOCATION	DATE	ACRES BURNED
Conejos Fire	Cleveland National Forest	July 1950	62,000
Laguna Fire	Laguna Mountains	October 1970	190,000
Harmony Fire	Carlsbad, Elfin Forest, San Marcos	October 1996	8,600
La Jolla Fire	Palomar Mountain	September 1999	7,800
Viejas Fire	Alpine	January 2001	10,353
Pines Fire	Julian, Ranchita	July 2002	61,690
Cedar Fire	Pine Hills, Ramona, Poway	October 2003	280,278
Mataguay Fire	Cleveland National Forest	July 2004	8,867
Harris Fire	Potrero	October 2007	90,440
Bernardo, Poinsettia & Cocos Fires	Rancho Bernardo, Carlsbad, San Marcos	May 2014	26,000

Source: San Diego County OES, 2017, Multi-Jurisdictional Hazard Mitigation Plan, https://www.sandiegocounty.gov/content/dam/sdc/oes/emergency_management/HazMit/2017/County-HazMit-Plan-2017-Sections-1-7-with-Appendixes-BOS-Approved.pdf.

A historical hazard inventory is a good tool for giving the community a solid context and engaging the public to gain a better understanding of broader impacts on the community. The lived experience of community members can help build support for future adaptation actions. See Step 2.5, Outreach and Engagement, for more information.

Existing documents, such as LHMPs and previous local or regional climate vulnerability assessments, may provide enough information about historical hazard trends and events to complete this step. For greater detail, whether qualitative or quantitative, consider these sources for:

- **Coastal and storm hazards.** Sea level and storm historical data are available through the National Oceanic and Atmospheric Administration's sea level trends and storm events databases.
- **Temperature.** The U.S. Climate Resilience Toolkit's Climate Explorer has local data for both historical and projected data related to temperature trends.
- **Precipitation and snowpack.** The California Department of Water Resources provides historical data on annual precipitation and snow water equivalents by region through the California Data Exchange Center.
- **Drought.** The National Drought Mitigation Center has historical records for drought events by county through the U.S. Drought Monitor.
- **Wildfires.** The California Department of Forestry and Fire Protection (CAL FIRE) has fire incident perimeter data online dating back to 1950, and historical reports on wildfire statistics.

Different Levels of Detail for Different Plans

Exposure assessments have varying levels of detail. An LHMP effort should collect data for location, extent, and previous occurrences for each hazard. For other reporting efforts, such as a safety element, a qualitative description of the community's hazard history may be more appropriate.

Another helpful list of historical hazard resources for flooding and fires is in the Safety Element Completeness Checklist in OPR's *General Plan Guidelines*.

STEP 2.1C: DESCRIBE HOW CLIMATE HAZARDS AND OTHER CLIMATE CHANGE EFFECTS ARE PROJECTED TO CHANGE

Building on the historical characterization, develop projections for how each local hazard is expected to change over the identified time horizon. For each climate change effect, characterize the projected change in magnitude, frequency, seasonal timing, duration, inter-annual variability, and geographic extent.

The Step 2.1b historical inventory may reveal trends in climate hazards and other climate change effects that serve as useful context. Existing literature may also have more information about general projected trends—such as local LHMPs, previous local or regional climate vulnerability assessments, the latest *California Climate Assessment*, or resources in the Adaptation Clearinghouse.

Projection data is also accessible through Cal-Adapt. Cal-Adapt and other sources present a range of projection scenarios and climate models for different effects. Considering a range of scenarios and models can help staff think through variations in the severity of climate change effects and account for projection uncertainties. Data outside of Cal-Adapt may be more helpful for some climate change effects, such as information on heat-related public health rates, which can be accessed from the California Heat Assessment Tool (CHAT).

SELECTING CLIMATE CHANGE PROJECTION PARAMETERS

Cal-Adapt and other resources provide climate projections for an array of greenhouse gas (GHG) emissions scenarios, climate models, and time frames. These different scenarios, models, and time frames present a wide range of results. Therefore, when retrieving projections, it is helpful to select the appropriate parameters for local circumstances.

Selecting emission scenarios. GHG emissions scenarios reflect different projections for how global emissions and atmospheric GHG concentrations may change over time. The latest scenarios are representative concentration pathways (RCPs), and Cal-Adapt provides projections for a low emissions scenario (RCP 4.5) and a high emissions scenario (RCP 8.5). The Governor's Office of Planning and Research (OPR) recommends that agencies use RCP 8.5 for analyses considering impacts through 2050 because there are minimal differences between emissions scenarios during the first half of the century.[1] For analyses considering impacts beyond 2050, OPR recommends selecting warming scenarios on a case-by-case basis. For a more conservative approach to a given community element, consider using only RCP 8.5. For a less conservative approach, use both RCP 4.5 and RCP 8.5. Which approach will be most useful in selecting emissions scenarios depends on a given community element's risk and criticality.

Regional Variations in Climate Change Effects

Phase 1, Step 3 of this guide presented some of the common variations in hazards and other climate change–related effects in California communities. Climate change–related effects vary significantly throughout California, mirroring our state's diverse climate, topography, and ecology. For example, the consequences of climate change that are important for coastal communities, like sea-level rise, may not be relevant for inland communities. Communities in northern California may be less exposed to drought than those in southern California. Regional reports from the California Climate Change Assessment are helpful resources for more information about region-specific effects of climate change.

Selecting climate models. For each GHG emissions scenario, retrieve projections from a range of global climate models (GCMs), which vary based on the different modeling assumptions. The most current GCMs come from the Coupled Model Intercomparison Project, version 5 (CMIP-5), developed to support the Intergovernmental Panel on Climate Change. Though using all 32 CMIP 5 GCMs is ideal for a comprehensive assessment, there are subsets of 10 and 4 GCMs that closely simulate California's climate and can be used in studies that cannot accommodate all 32 models.[2, 3] Cal-Adapt's default settings provide outputs for these subsets of 10 and 4 models, depending on the hazard.[4] Considering a range of climate model outputs—in addition to an ensemble average—can be helpful in getting a fuller picture of potential future conditions. State guidance, including from the *Safeguarding California Plan* and the California Ocean Protection Council, recommends evaluating a range of future climate scenarios appropriate for planning decisions and respective risk aversion level. For example, high-end scenarios (e.g., H++ scenario for sea-level rise) are recommended for use with high-stakes decisions where underaccounting for projected changes could lead to significant financial or environmental impacts or public health and safety consequences.

It is also important to retrieve climate projections for the appropriate time frame. After selecting the historical baseline and future time horizon of interest, pull climate data for a multi-decade period (usually 20 or 30 years) centered on the year of interest. For example, if the year of interest is 2050, consider pulling projections for 2040 to 2060 or 2036 to 2065. Cal-Adapt uses 1961 to 1990 as the default baseline period; 1986 to 2005 is another common baseline period. Multidecade averages account for interannual variability and appropriately characterize the climate norm for the selected historical context and future time horizon.[5]

Accessing Climate Hazard Projection Data with Cal-Adapt

Cal-Adapt is an online resource that provides quick and easy access to downscaled climate project data. An array of climate models and emissions scenarios offer climate projections for the major stressors facing California, including:

- Temperature averages and extremes
- Precipitation averages and extremes
- Sea-level rise
- Wildfires
- Drought

Cal-Adapt provides users with easily accessible projections and more detailed downloadable data to support a range of needs.

STEP 2.1D: MAP HAZARDS AND OTHER CLIMATE CHANGE–RELATED EFFECTS

Mapping climate projection data helps with visualizing the populations and assets that are projected to be exposed to the effects of climate change. Depending on a community's needs and staff capacity, some mapping options are printed maps, free computer mapping tools like Google Maps, or dedicated Geographic Information Systems (GIS).

In cases where mapping is not particularly informative, other methods for visualizing climate trends can be relevant to a community. For example, consider projecting the frequency of heat waves (i.e., multiple extreme heat days over a given threshold) over the Step 2.1c time horizons, and see how this frequency changes over time. Cal-Adapt includes a variety of visualizations to inform an exposure analysis and has downloadable data to allow visualizations in other software (e.g., Excel charts).

In some cases, quantitative datasets are not available for relevant hazards. In this case, it is still useful to provide a narrative description of how (and whether) exposure varies across the community, and the degree to which community assets are projected to be exposed. For example, although there are spatial datasets showing today's inland flooding and landslide risks, there are not widely available spatial datasets related to future inland flooding and landslide risks. For these hazards, it is still useful to explain how risks may change in the future due to changes in climate.

For more detailed mapping, GIS data sources for climate hazard projections include:

- **Coastal hazards.** Sea the Future is a good resource for understanding the various sea level rise and flood visualization tools available. While there are a number of options, all with their own benefits and limitations, organizations may wish to consider two in particular. The US Geological Survey's Coastal Storm Modeling System (CoSMoS) has maps of coastal flooding under various sea level rise scenarios, storm conditions, and erosion. In the San Francisco Bay Area, the Adapting to Rising Tides (ART) program has detailed sea level rise mapping for several different scenarios. Unlike other sea level rise mapping programs, CoSMoS and ART programs provide both sea level rise and coastal storm scenarios on a simple online platform without the need for specialized software. Both also provide detailed information that is not always available from other mapping sources.
- **Temperature, precipitation, hydrologic variables, and wildfires.** Cal-Adapt's downloadable data is available in NetCDF, TIFF, and other formats.

If the planning team has GIS capabilities, it can overlay these climate change effect projections with community assets. Consider mapping climate change effects with utility assets, transportation assets, hospitals, telecommunication assets, public spaces, populations, and other assets. Another option is to map climate change effects with indices of social vulnerability—such as CalEnviroScreen and Healthy Places Index—to learn more about projected exposure in disadvantaged communities.

Step 2.2: Sensitivity and Potential Impacts

The goal of Step 2.2 is to characterize past and potential future climate impacts to community populations and assets. Materials produced in this step include:

- A final list of community populations and assets that are sensitive to the community's climate change effects.
- A list of historical and potential future climate impacts to community elements.
- A list of potential climate impacts of greatest concern.

Describing Hazards for Local Hazard Mitigation Plans

To integrate the vulnerability assessment into an LHMP, this exposure step can be incorporated into the FEMA risk assessment when identifying community assets.

STEP 2.2A: CONFIRM COMMUNITY POPULATIONS AND ASSETS

Create a list of community elements exposed to the relevant climate hazards. The community elements screening in Step 1.3 of Phase 1 should be helpful with completing this step.

Depending on the outcomes of Step 2.1, consider limiting the scope to critical community elements. A broad scope of assets can dilute the focus of the vulnerability assessment and create less-actionable outcomes. A more limited scope allows more concentrated effort on later steps—such as Phase 3 and Phase 4—that focus on mitigating impacts. Revisit Phase 1 to consider the resilience goals in identifying critical community assets. These goals can help inform criteria for identification, such as a focus on enhancing safety or mitigating impacts to the community economy.

STEP 2.2B. IDENTIFY CLIMATE IMPACTS TO COMMUNITY POPULATIONS AND ASSETS TO DETERMINE WHICH ARE SENSITIVE TO CLIMATE CHANGE EFFECTS

Projected impacts from climate hazards should be the primary concern in a vulnerability study. Climate change will exacerbate many hazards, so future climate impacts have the potential to be more severe than historical ones. Climate change will also generate impacts that may be entirely new to some communities. However, examining historical climate impacts is useful for establishing context and better understanding present-day vulnerability. As a result, in this step, consider both historical and projected impacts by collecting information on past impacts and augmenting this with more forward-looking information. Specifically:

1. Conduct desk research on historical climate impacts.
2. Conduct desk research on potential future climate impacts.
3. Engage stakeholders in order to deepen understanding of past and potential future impacts, such as with stakeholder interviews and participatory asset mapping.
4. Summarize findings on potential future climate impacts.

Finding Impact Data for Specific Incidents

Impact data for some historical incidents is available through public data sources, including:

- U.S. Energy Information Administration (EIA) Electric Power Monthly for electricity outages
- CAL FIRE's Incident Reporting Collection
- Cal OES's Hazardous Material Spill Notifications

1. Desk Research on Historical Climate Change Effects

Building on the data and analysis from in Step 2.1b, collect information on how climate-related effects have historically impacted specific community assets and the community as a whole—for example, by reviewing existing reports and databases. Publicly available data often has impact data for specific events. For example, the EIA publishes electricity outage duration, power loss, and customers impacted as part of the Electric Power Monthly reports.[6] If reports and databases are not available, stakeholders may be able to fill in historical information. Revisiting the example in Step 2.1b and Table 8, San Diego County collected information on the facilities impacted and lives lost in historical wildfire events as part of their LHMP (Table 9).

TABLE 9. EXCERPT OF HISTORIC WILDFIRE IMPACTS FROM SAN DIEGO COUNTY'S LHMP

HEADING	LOCATION	DATE	ACRES BURNED	STRUCTURES DESTROYED	STRUCTURES DAMAGED	DEATHS
Conejos Fire	Cleveland National Forest	July 1950	62,000	Not Available	Not Available	0
Laguna Fire	Laguna Mountains	October 1970	190,00	382	Not Available	5
Harmony Fire	Carlsbad, Elfin Forest, San Marcos	October 1996	8,600	122	142	1
La Jolla Fire	Palomar Mountain	September 1999	7,800	2	2	1
Viejas Fire	Alpine	January 2001	10,353	23	6	0
Pines Fire	Julian, Ranchita	July 2002	61,690	45	121	0
Cedar Fire	Pine Hills, Ramona, Poway	October 2003	280,278	5,171	63	14
Mataguay Fire	Cleveland National Forest	July 2004	8,867	2	0	0
Harris Fire	Potrero	October 2007	90,440	255	12	5
Bernardo, Poinsettia &Cocos Fires	Rancho Bernardo, Carlsbad, San Marcos	May 2014	26,000	65	19	0

Source: San Diego County OES, 2017, Multi-Jurisdictional Hazard Mitigation Plan, https://www.sandiegocounty.gov/content/dam/sdc/oes/emergency_management/HazMit/2017/County-HazMit-Plan-2017-Sections-1-7-with-Appendixes-BOS-Approved.pdf

In addition to mortality/morbidity and property damage, impacts from future climate change may include:

- Loss of service from critical utilities (e.g., energy, water, and wastewater).
- Disruptions to essential facilities (e.g., hospitals, schools, emergency services).
- Damage to facilities from coastal and inland flooding.
- Loss of housing (e.g., loss of areas available for housing, loss of existing limited housing stock, including affordable housing generally and specifically in communities experiencing significant housing shortages).
- Disruptions to a transportation system that can affect accessibility to some areas, or that can adversely affect drive or ride times (e.g., a landslide or flood that temporarily closes off access to an area; increased transit time on buses during precipitation events; floods or wildfires that shut down transit stops or lines).
- Impacts to local community health (e.g., number of hospital visits related to hazard events, air quality index ratings during wildfires, fatalities).
- Degradation or loss of natural assets, local ecosystems, and biological communities, including those that provide ecosystem services. For example, the *Karuk Tribe Climate Change Vulnerability Assessment* evaluated the impacts of high intensity fire on traditional foods and cultural use species important for health, sustenance, and well-being.

2. Desk Research on Potential Future Climate Impacts

Identify potential future climate impacts to the community by reviewing existing local, regional, and/or state reports. These might include:

- Climate vulnerability assessments that the community has conducted in the past.
- Climate vulnerability assessments produced by local colleges or universities, the Alliance of Regional Collaboratives for Climate Adaptation (ARCCA), nonprofits, or other reputable organizations.
- The most recent *California Climate Change Assessment* reports, including the regional report.

3. Interview Stakeholders on Historical and Potential Future Climate Impacts

This substep presents a good opportunity to talk one-on-one with appropriate stakeholders to explore past climate impacts and think through potential future climate impacts. The best stakeholders to engage in this substep are those most familiar with the assets, services, and resources that are most important to the community. Stakeholders may include asset managers and operators, people who run key community services (e.g., emergency services, water and wastewater, utilities, fire, police), and others. Asset and service managers often have a more detailed understanding of past climate

impacts than what has been documented in reports, and they have a wealth of knowledge around asset sensitivity and adaptive capacity.

A preliminary approach is to engage staff within the local government. However, it is also important to engage individuals outside of local government—community organizations and members, critical services not owned by local government, etc.—to create a fuller understanding of potential climate impacts and help build momentum for adaptation. Questions for these interviews could include:

- What services have been impacted by the climate hazard? Are these services disrupted? How might impacts to services change given projected changes in climate?
- What facilities have been damaged, destroyed, or otherwise impacted by the climate hazard? How might impacts to facilities change given projected changes in climate?
- Have populations been impacted physically or mentally by the climate hazards? How might impacts to populations change given projected changes in climate?
- Have there been additional downstream disruptions that result from the loss of critical services (e.g., electrical disruptions impacting hospital service)? How might impacts arising from interdependencies change given projected changes in climate?
- How have impacts varied across the community? Which populations have been most affected? Which populations might be most impacted in the future?
- Did the climate hazard create economic losses? How might economic losses change given projected changes in climate?
- Have community ecological or cultural resources been impacted? How might impacts to these resources change given projected changes in climate?

Combining Interviews

Before arranging the Step 2.2b interviews, review Step 2.3b to determine whether it makes sense to combine the two interviews. If the interviewees for the two steps would be the same, it might be best to minimize the burden on interviewees and improve efficiency by combining the interviews. However, if the interviewees are not the same, are willing to be engaged more than once, and/or the project team has enough time, it may be more appropriate to keep the two sets of interviews separate.

For more guidance on engaging stakeholders in assessing vulnerability, identifying assets, and understanding potential climate impacts, see Phase 2, Step 2.5 on Outreach and Engagement.

4. Summarize Findings on Potential Future Climate Impacts

Using the information developed through substeps 1 through 3, summarize the findings on potential future climate impacts. This summary should include information on whether existing and/or planned community assets are already exposed to climate-related hazards and/or may be exposed to them in the future. This might be a bulleted list of potential impacts and consequences or a more detailed report.

The project team may go beyond a narrative describing potential future climate impacts and develop quantitative estimates of potential future climate impacts. If a hazard or other climate change-related effect is projected to increase in magnitude or frequency and has impacted the community in the past, it could be beneficial to extrapolate data from the historical impact inventory to estimate impacts under a future climate change scenario. See Step 2.1d for recommendations on how to visualize hazard projections over time using Cal-Adapt and other tools.

Some climate change effects could impact a community in the future that have not impacted it in the past. In this case, other communities in the region that have experienced these climate hazards can shed light on their potential impacts.

STEP 2.2C. IDENTIFY POTENTIAL CLIMATE EFFECTS OF GREATEST CONCERN

The research in Step 2.2b compiled information about the historical and potential future climate impacts that pose the greatest risk to the community. That information can be used to develop a subset of priority climate impacts that are the most important to the community.

Phase 1 may have already identified these priority effects based on the community's key resilience goals and concerns. Or interviews and engagement with community stakeholders may have made them apparent. Revisiting the conclusions from Step 2.1c about how hazard conditions are projected to change and using the regional reports from the most recent California Climate Change Assessment can help identify the effects of greatest concern and inform the list of priority impacts.

The outcomes from Step 2.2b can also help determine which impacts pose the greatest risk. Consider these questions when evaluating Step 2.2b results:

- Which climate impacts might result in loss of life or significant human health impacts?
- Which impacts might create disruptions or damages to essential facilities (see Phase 1, Step 1.3)?
- Which impacts might generate significant losses for the local economy?
- Which impacts may create significant environmental impacts, such as release of hazardous materials?

- Are impacts of climate change effect short but acute, long term, or both?
- Could two or more impacts interact to result in a more severe impact (e.g., wildfires followed by extreme precipitation creating landslides)?

Answering these and other questions can help identify the specific impacts that most concern a particular community, that is, the priority climate impacts, and the vulnerability assessment can move forward.

Step 2.3: Adaptive Capacity

The goal of Step 2.3 is to characterize a community's current ability to cope with climate impacts to community populations and assets. Materials prepared in this step:

- A matrix describing the community's existing capacity to adapt to each of the priority climate impacts based on existing policies, plans, and/or programs.
- An enhanced version of the same matrix describing factors that enhance local agencies' adaptive capacity.

Describing Adaptive Capacity for LHMPs

If integrating a vulnerability assessment into an LHMP, this step can be integrated into the FEMA risk assessment when summarizing vulnerability.

Adaptive capacity is the ability to moderate the potential damages or take advantage of the opportunities from climate change. Many communities have adaptive capacity in the form of policies, plans, programs, or institutions. Understanding this adaptive capacity entails identifying existing resources and assessing the community's ability to cope with potential climate impacts. This information on adaptive capacity will feed into Step 2.4, Vulnerability Scoring.

Adaptive capacity focuses on existing capacity to cope. Phase 3 will focus on developing new adaptation strategies and building up future capacity to manage climate impacts.

Adaptive Capacity for Extreme Heat

Nearly all communities in California will experience an increase in extreme heat events in the future. Extreme heat can affect vulnerable populations, causing heat stress and respiratory illnesses, which would be considered impacts of extreme heat. Adaptive capacity looks at the existing resources available to help vulnerable populations adapt, such as cooling centers, air-conditioned schools and public facilities, and water fountains at sports fields. Larger-scale weatherization programs and other upgrades to housing can further protect populations, including vulnerable populations living and working in older buildings. These efforts increase the ability of the community to adapt to extreme heat conditions; therefore, they increase the adaptive capacity of vulnerable populations.

STEP 2.3A: REVIEW DOCUMENTS TO COLLECT INFORMATION ON ADAPTIVE CAPACITY

The goal of this step is to identify and review documents that might outline policies, plans, or programs that already help manage climate impacts or will in the future. The information reviewed could come from local, state, regional, tribal, and federal entities, including:

- Public health and safety agencies
- Environmental regulation agencies
- Fire protection agencies
- Flood protection agencies
- Offices of emergency services
- Special districts (e.g., fire protection, sewer, sanitation, water supply, electricity, parks, recreation)

Documents produced by these agencies that may have relevant information are listed below. OPR's Adaptation Clearinghouse is also a useful database to search for the latest government policies, plans, and programs that enhance adaptive capacity. The most relevant documents for review vary based on the end product of the planning process and the priority climate impacts.

Local Plans

- Climate Adaptation Plans
- Climate Action Plans
- Local Hazard Mitigation Plans
- General Plans / Comprehensive Plans
- Area and Specific Plans
- Sustainable Community Plans (SB 375)
- Local Coastal Programs
- Downtown Plans

Local and Regional Sector-Specific Plans

- Urban Water Management Plans
- Integrated Regional Water Management Plans (IRWMPs)
- Transit and Regional Transportation Plans
- Public Health and Safety Plans, such as Community Health Assessments
- Emergency Services Plans
- Fire Management Plans
- Community Wildfire Protection Plans
- Floodplain Management Plans
- Open Space and Land Management Plans

Local Nongovernment Programs

- Nonprofit adaptation-related programs
- College or university adaptation-related programs

Local Standards, Ordinances, and Programs

- Climate Adaptation Program
- Hazard Mitigation Programs
- Emergency Management Programs
- Capital Improvement Program
- Zoning Code
- Building Code
- Fire Code
- Tree Ordinance
- Urban Heat Island Ordinance
- Floodplain Ordinance
- Stormwater Management Program

Regional Strategies

- Council of Government (COG) Adaptation Plan
- Association of Government (e.g., ABAG, SCAG) Adaptation Plan

State Strategies

- Safeguarding California
- Cal OES State Hazard Mitigation Plan
- CAL FIRE California Fire Plan
- CA DWR Climate Action Plan

Federal Programs

- Building Resilient Infrastructure and Communities (BRIC) Program
- FEMA Hazard Mitigation Grant Program
- HUD Community Develop Block Grant Disaster Resilience Program

A helpful way to coordinate the information in each document is to create a matrix that summarizes:

1. Strategies that might help manage climate impacts. Is the strategy already implemented, is implementation in progress, or is it planned? Does it have components that address social vulnerability? Strategies that help manage impacts might include emergency response plans, evacuation plans, zoning requirements related to hazards and other effects of climate change, building code requirements related to hazards, asset engineering standards related to hazards, water conservation policies, etc.
2. The extent to which existing strategies manage today's climate impacts. This may require input from interviewees under Step 2.3b.
3. The extent to which existing strategies are expected to manage potential future climate impacts. This may require input from interviewees under Step 2.3b.
4. Opportunities to build on the strategies and strengthen their ability to manage present and potential future climate impacts.

STEP 2.3B. INTERVIEW LOCAL AGENCIES ON THEIR CURRENT ABILITY TO ENHANCE ADAPTIVE CAPACITY

The goal of this step is to identify and interview local agencies about their adaptive capacity. The findings from Step 2.3a may help to identify local agencies that could or do affect adaptive capacity. Arrange an interview to elicit information on their existing and planned efforts to manage climate impacts now and in the future, particularly the priority climate impacts. If appropriate, this interview can be combined with the Step 2.2b interviews.

Interview questions might include:

- Are there existing programs and policies that help the community manage climate impacts?
- How effective are they in managing present-day climate impacts?
- Based on projected changes in climate, do you think they will be effective in managing future climate impacts?
- Are there planned programs and policies that will help the community manage climate impacts?
- How effective do you believe they will be in managing present-day climate impacts? Future climate impacts?
- What are the barriers to managing climate impacts in the community? Are they related to institutional governance, attitudes and motivations, resources and funding, politics, leadership, expertise and technology, or other areas?

The findings from the interviews about adaptive capacity should be summarized in the matrix from Step 2.3a. These summaries can serve as a starting point for developing adaptation strategies in Phase 3.

Step 2.4b scores vulnerability, including assigning a score to adaptive capacity, but this can also be done as part of this step.

Step 2.4: Vulnerability Scoring

The goal of this step is to identify priority climate vulnerabilities based on systematic scoring. Materials prepared in this step are:

- A table summarizing vulnerabilities.
- A table showing the vulnerability score for each of the major climate vulnerabilities.

Vulnerability scores are based on the combination of potential impact and adaptive capacity and help identify the major climate vulnerabilities to address in Phase 3. The scoring process is qualitative, and the APG guidance ensures that the scoring process is transparent and can use inputs from multiple sources.

Although the APG discusses a quantitative scoring process for this step, it is possible to evaluate vulnerability in a more qualitative manner. Some organizations may find it beneficial to instead convene stakeholder groups and identify key priorities through facilitated discussion. This approach may be appropriate for situations where stakeholder input is particularly emphasized, where assessments need to be completed quickly, or where the information available is simply not conducive to a more systematic scoring approach.

STEP 2.4A. SUMMARIZE VULNERABILITY

For each of the climate change–related effects of concern to the community, produce a table that describes vulnerability and consequence:

- **Population and community assets.** The populations and assets associated with the potential impact and its location(s) (see Step 2.2).
- **Exposure.** The projected severity of the climate change effect in the area of the population and community assets (see Step 2.1).
- **Sensitivity and potential impact.** How the population and community assets might be affected given its projected exposure to climate change effect(s) and the broader implications for the community from the potential impacts of these effects, including consequences for public safety, human health, ecosystem services, continuity of public services, costs to the local government or borne by the public, and/or any other key metrics identified in Step 2.2 or Phase 1.
- **Adaptive capacity.** Existing ability to manage the potential impacts (see Step 2.3).

STEP 2.4B. SCORE VULNERABILITY

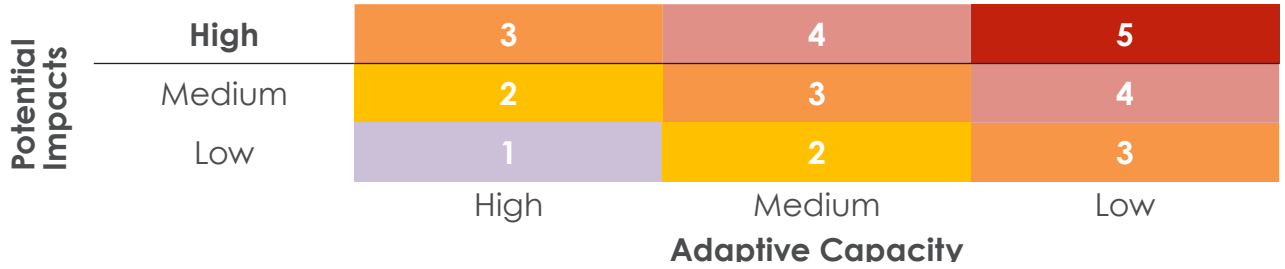
For each population and asset at risk for each climate change–related effect described in the table from Step 2.4a, score potential impact and adaptive capacity, then use these scores to determine an overall vulnerability score. This scoring can help clarify which effects pose the greatest threats and should be prioritized in adaptation planning. For instance, in the Los Angeles County Metropolitan Transportation Authority's *Metro Climate Action and Adaptation Plan 2019*, Metro scored the relevant climate change effects to identify the greatest vulnerabilities and prioritize transportation assets for adaptation actions.

To score potential impact and adaptive capacity, use the rubric in Table 10 as a guide, but adjust the scoring system to the circumstances. For example, if using three scoring levels is not enough, the system can expand to four, five, or more levels. Criteria can be customized to reflect the goals specific to the community, such as quantifiable metrics related to safety, costs, or other factors. Different inputs can help with the scoring process, depending on the project team's capacity and stakeholder engagement. The scoring process is based on the team's judgment, so it is a good idea to seek a broad range of inputs, including the opinions of community members and any scientific studies that assess climate change impacts.

TABLE 10. POTENTIAL IMPACT AND ADAPTIVE CAPACITY SCORING RUBRIC		
SCORE	**POTENTIAL IMPACT**	**ADAPTIVE CAPACITY**
Low	Impact is unlikely based on projected exposure; would result in minor consequences to public health, safety, and/or other metrics of concern.	The population or asset lacks capacity to manage climate impact; major changes would be required.
Medium	Impact is somewhat likely based on projected exposure; would result in some consequences to public health, safety, and/or other metrics of concern.	The population or asset has some capacity to manage climate impact; some changes would be required.
High	Impact is highly likely based on projected exposure; would result in substantial consequences to public health, safety, and/or other metrics of concern.	The population or asset has high capacity to manage climate impact; minimal to no changes are required.

After scoring the potential impact and adaptive capacity for each population and asset for the relevant climate change-related effects, use the matrix in Figure 11 to determine overall vulnerability scores based on the potential impact score and adaptive capacity score.

Figure 11. Vulnerability Score Matrix



Record a description of each population and asset and the associated potential impact, adaptive capacity, and vulnerability scores for all of the climate change-related effects and associated vulnerabilities in a table such as the example in Table 11.

TABLE 11. EXAMPLE TABLE OF DESCRIPTIONS AND VULNERABILITY SCORES

VULNERABILITY DESCRIPTION	VULNERABILITY SCORE		
	POTENTIAL IMPACT	ADAPTIVE CAPACITY	VULNERABILITY
Rain-induced mudflow preventing entry to emergency operations center	Medium	Medium	3
Wildfire inhibiting provision of key public services	High	Low	5

These scores will be used to determine which vulnerabilities are most pressing and should be prioritized for adaptation action in Phase 3 to help manage climate vulnerability.

Step 2.5: Outreach and Engagement

The goal of outreach and engagement in Phase 2 is to collaborate with community members both within the organization and externally to identify neighborhood strengths, assets, and climate change effects. Vulnerability assessments should be driven by community priorities and reflect knowledge from different population groups and neighborhoods. Outreach and engagement in this phase ensures that community members have opportunities to share their expertise and provide valuable, on-the-ground understanding of climate vulnerabilities.[7]

TARGETED STAKEHOLDER INTERVIEWS OR FOCUS GROUPS

As noted in Step 2.2b, stakeholder interviews are important opportunities to tap local knowledge, experience, and expertise, and understand historical climate impacts. The core planning team should identify long-standing, respected members of the community to connect with. Some examples might be heads of local governmental agencies, residents from past planning processes, leaders of environmental partner organizations, directors of youth or college programs, and managers of hospitals or public health clinics. When selecting interviewees, make sure that they are from diverse groups and can provide different geographic perspectives. Refer to "Interview Stakeholders on Historical and Potential Future Climate Impacts" in Step 2.2B.

STORYTELLING TIMELINES

Developing a historical hazard inventory through personal narratives is an effective way to engage with the community. The lived experience of community members can create social cohesion and help build support for future adaptation actions. Create an interactive timeline with drawings, written stories, and photos as an outreach activity to learn about past climate disasters and what the responses were. Find a way to summarize best practices learned from each climate disaster and future ideas on preparing for climate change. More information on creating a storytelling timeline is in the Pacific Institute's climate survivor workbook and in the *Regional Resilience Toolkit*. The *Regional Resilience Toolkit* offers a Storytelling Framework and Best Practices to Tell A Story.

PARTICIPATORY ASSET MAPPING

Participatory asset mapping can help residents understand the data behind the vulnerability assessment and projections as well as give an opportunity to realize how it will impact them. Planners can present the data through visual boards and get comments through in-person workshops, and/or present the data through GIS platforms that allow residents to map their own content via their personal computers. Co-creating asset maps helps accurately capture local organizations, places,

structures, or institutions that are vulnerable to climate change impacts and can support climate resilience. More information on setting up participatory asset mapping is in the Advancement Project's Healthy City toolkit, *Participatory Asset Mapping*.[8]

Asset Mapping Example:

The Map Your Future project from Bay Localize is training youth to prepare for the local impacts of climate change by helping to map climate vulnerabilities and develop resilience efforts. Youth mappers are trained to identify local impacts of climate change and community efforts that build climate resilience. The program gives preference to participants from low-income communities of color and low-income youth with barriers to employment (e.g., no high school diploma, history of incarceration, at-risk), who suffer the highest rates of unemployment.[9]

Extensive facilitation guides and templates are available from Bay Localize online.[10] Additional information about the Map Your Future project is also available.[11]

COMMUNITY-BASED PARTICIPATORY RESEARCH

Partnering with an academic institution or educational nonprofit organization is another way to include students or residents as project researchers. Engage the researchers to understand the project themselves and then have them popularize technical information about local climate impacts to make it more accessible to the broader community. For example, researchers could co-create fact sheets related to natural hazards or conduct parts of the vulnerability assessments, such as interviewing several local small businesses to assess post-disaster capacity.

If funding is available, partnering with community-based organizations to do a supplemental analysis about vulnerability in lower-income communities and communities of color could be ideal. One example is *Mapping Our Future: A Work Plan for Public Engagement and Equity in Climate Adaptation Planning in the San Francisco Bay Area*. Based on survey results and a workshop with input from more than 400 residents, the report describes the local climate vulnerabilities based on income, race, health conditions, age, living conditions/location, occupation, language barriers, and related factors. This project was a way for community-based organizations to play a leadership role in climate adaptation planning.

More information is available online: http://www.baylocalize.org/files/EquityReportFinal041213v11.pdf.

When partnering with outside organizations (no matter the type), local agencies should ensure ownership of the final outputs of your project.

Phase 2 Wrap-Up

The vulnerability assessment is the process that provides participants with the details of how the community may be harmed by climate change. Through this analysis, communities can identify the most vulnerable populations and assets, and which climate-related effects may be most damaging. This can be the most technical and data-intensive phase of adaptation planning, but there are many existing reports and datasets that can help streamline the process. Community engagement during this phase can help refine the analysis and make sure it more accurately reflects specific conditions. Using the results from the vulnerability assessment, communities can develop an adaptation framework and strategies, following the process discussed in Phase 3.