How to Obtain Detailed Climate Projection Data

INTRODUCTION

Information on how the climate change may change is useful for a variety of purposes. However, finding, retrieving and applying this information can seem daunting. This document provides information to help you access and make the best use of climate information.

This document describes four steps for obtaining climate data, including:

Step 1: Identify your climate data needs

Step 2: Determine climate data parameters

Step 3: Obtain climate data (including for disadvantaged communities)

Step 4: Contextualize uncertainty

STEP 1: IDENTIFY YOUR CLIMATE DATA NEEDS

Inputs

Determine what level of detail is necessary to achieve the goals of your analysis. If you aim to determine vulnerabilities at a broader level, you may require less detailed climate information; for example, it may only be necessary to understand general trends, such as the fact that heatwaves or intense precipitation events may increase, but it's not necessary to know exact temperature or precipitation values. On the other hand, if you intend to conduct an asset-specific engineering analysis to identify specific thresholds at which assets will experience impacts (e.g., once floodwaters exceed 1 ft. buses can no longer drive through the floodwaters) you may require much more detailed climate information.

If you have not yet assessed system vulnerabilities and you would like to understand which stressors are of greatest concern and which areas are most vulnerable, a broad analysis is likely more appropriate, and you may be able to use average projections for an area and the exposure maps in this document. If you aim to analyze and determine how to enhance the resilience of a small set of specific assets, it is likely more appropriate to conduct an asset-specific engineering analysis, and you will need detailed GIS maps.

If you are not sure, it may be helpful to start broad (e.g. general climate trends), then begin to work through your analysis and then refine your data needs, to make sure you're not spending unnecessary time or money obtaining unnecessarily detailed climate information.

Determine which climate variables should be included in your analysis. Consider which climate variables are most concerning for your transit system and transit riders, and decide which should be analyzed. As a starting point, take a look at the SCAG region exposure summary document below. It can also be helpful to review existing climate vulnerability assessments conducted for your agency's region.

Outputs:

After completing this step, you should know:

- What kind of climate information you need (i.e., do you need just average values for an area, or detailed GIS data of climate variables, and if so at what spatial resolution)
- Which climate variables you will analyze (e.g., sea level rise, average precipitation, extreme heat days, average temperature, etc.)

STEP 2: DETERMINE CLIMATE DATA PARAMETERS

Inputs

Identify appropriate parameters for your climate projection analysis, including time horizons and baseline, greenhouse gas (GHG) emissions scenarios, and global climate models.

Time Horizons and Baseline. Select appropriate time horizons based on existing planning process and/or the design-life of the infrastructure. For instance, if your infrastructure design-life is 50 years and will be built in 2020, you will want to select 2070[1] (and potentially a year between 2020 and 2070) as your target time horizon. Once you've selected the time horizon(s), pull climate data for a multi-decade (usually 20- or 30-year[2]) period centered on that time horizon to account for interannual variability. For instance, if you select 2070, consider using data for 2055 through 2084. Taking the average over multiple decades helps account for interannual variability in climate and reduces the effect of outlier years, ensuring that the projection represents the average over the chosen time period and is not overly skewed by an extreme year. This is particularly important for precipitation, which has high levels of interannual variability in California (i.e., there are large differences in the amount of precipitation during very wet years and very dry years).

It is also important to select an appropriate baseline period, or the historical time period against which the climate data for the future time horizon(s) is/are compared. Cal-Adapt uses 1961 – 1990 as the default baseline period. You may want to select a more recent baseline if you would like to compare projected changes in climate against more recent conditions (e.g., if you're concerned about how much sea levels will rise above present levels rather than historical levels). The baseline period should also ideally span 20 or 30 years, and the results for those years can be averaged together.

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[1] Note that when you select a target time horizon, you should avoid stating that your results are representative of that specific year. Rather, you should clarify that the results are representative of the 20- or 30-year time period centered on your time horizon; for instance, if your time horizon is 2070, state that the results are representative of 2061 – 2080 (if you pulled climate data for a 20-year period) or 2056 – 2085 (if you pulled climate data for a 30-year period). The time horizon year itself could be projected to be above or below average, and not represented of the longer-term climate. It is for this reason that you may sometimes hear climate projections referenced as "mid-century" or "late century" projected climate.

[2] FHWA. 2017. Chapter 4: Using Climate Information in Synthesis of Approaches for Addressing Resilience in Project Development. Federal Highway Administration (FHWA).

Greenhouse Gas (GHG) Emission Scenarios. For each time horizon, select a range of emissions scenarios, and include projections from upper-range emissions scenarios. Cal-Adapt offers a low emissions scenario (RCP 4.5) and a high emissions scenario (RCP 8.5). Under California's latest climate change assessment, the State recommended the use of RCP 8.5 for planning horizons before 2060, and RCP 4.5 and 8.5 beyond 2060. To be consistent with other California assessments, transit agencies may wish to follow these recommendations.

Climate Models. For each emissions scenario, obtain outputs from a range of climate models. Under California's latest climate change assessment, the State of California recommends the use of four models, including a warm/dry climate model (HadGEM2-ES), a cool/wet climate model (CNRM-CM5), an average climate model (CanESM2), and a complement model (MIROC5)[3]. Rather than simply averaging the results, consider the range of projections produced by these four models under a given time horizon and emissions scenario. This is particularly important for precipitation projections, which tend to vary more by model compared to temperature outputs.

Once you obtain the climate data, you will be able to calculate the range of potential changes in heat or precipitation for each time period.

For more information, see Chapter 4: Using Climate Information of the Federal Highway Administration's Synthesis of Approaches for Addressing Resilience in Project Development.

Outputs:

After completing this step, you should know:

- The baseline period that you will use to obtain historical climate data
- The future time horizons that you will use to obtain projected climate data
- The emissions scenarios that you will use to obtain projected climate data
- The climate models that you will use to obtain projected climate data

STEP 3: OBTAIN CLIMATE DATA

Inputs

General

Once you have determined your climate needs and data parameters, you have the information necessary to obtain climate data. The State of California recommends that practitioners obtain climate data from Cal-Adapt[4], the State's web platform for accessing and visualizing climate data. This website provides visualization tools and data for a variety of climate variables that are relevant to transit agencies, including:

- **Annual Averages** of maximum temperature, minimum temperature, and precipitation
- **Extreme Heat Day** thresholds, frequency, and timing
- **Sea Level Rise** inundation location and depths during 100-year storm events
- **Wildfire** annual averages of area burned

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[3] California Energy Commission. 2018. Cal-Adapt. http://cal-adapt.org/
[4] California Governor's Office of Planning and Research. Chapter 8: Climate Change in General Plan Guidelines: 2017 Update.

Cal-Adapt also provides downloadable GIS data on the following variables relevant to transit agencies:

- **Maximum temperature, minimum temperature, and precipitation**
- **Sea Level Rise** inundation location and depths during 100-year storm events
- **Wildfire** annual averages of area burned

Cal-Adapt enables the user to specify climate data parameters, including time horizons (any period between 2006 and 2099) and baseline period (any period between 1950 and 2005), emissions scenarios (RCP 4.5 and RCP 8.5), and climate models (10 total, including the four recommended above).

Other useful sources of climate information and guidance include:

- Federal Highway Administration CMIP Climate Data Processing Tool
- UCLA's Center for Climate Science
- Cal-Adapt Guidance on Using Climate Projections
- State of California Sea-Level Rise Guidance: 2018 Update

Obtaining information on disadvantaged communities

Disadvantaged communities can contain a greater proportion of low-income and transit-dependent populations that have fewer resources available to adapt to disruptions in transit service. As a result, when analyzing transit system vulnerability, it can be useful to analyze climate projections overlaid by information on disadvantaged communities. Cal-Adapt offers an option to download climate projection data aggregated by census tract that includes CalEnviroScreen 2.0 data on disadvantaged communities. To download this data, follow the steps below:

- From the main page, select the climate stressor data that you'd like to download (e.g., temperature annual averages, extreme heat, precipitation annual averages, etc.)
- Scroll down and above the map, select Change Location
- Under **Select Boundary:** select Census Tracts with CalEnviroScreen 2.0 data
- In the map, select the census tract of interest
- Click UPDATE CHART

These steps will produce data on the census tract ID, projected climate information, and CalEnviroScreen 2.0 score and percentile rank. Census tracts in the 75^{th} percentile and upward are considered disadvantaged.[5] With this data, your agency can determine the magnitude of projected climate impacts within disadvantaged communities, and use this information to inform resilience decisions and investments.

Outputs

After completing this step, you should have the climate data needed for your analyses.

[5] California Office of Environmental Health Hazard Assessment. 2018. SB 535 Disadvantaged Communities. https://oehha.ca.gov/calenviroscreen/sb535

STEP 4: CONTEXTUALIZING UNCERTAINTY[6]

Inputs

There is some uncertainty regarding exactly how the climate may change in the future. Decision makers may at first be reluctant to make investments to protect against future changes that are uncertain. However, it is important to remember that uncertainty is manageable, and that transit agency decisions are routinely made based on uncertain models and assumptions. For instance, transit investments are often made based on traffic modeling, which relies on assumptions about population growth, land use change, and other uncertain variables. There is no reason that the uncertainty surrounding climate projections should be the reason that action is not taken today.

Uncertainty in climate projections is caused by three main sources, each of which can be managed if different ways. The three sources are:

1. **Climate model uncertainty**, or scientists' ability to understand and model climate processes. There is no one perfect climate model, and models have different strengths and weaknesses. To manage climate model uncertainty, it is important to consider outputs from a range of climate models, as described in Step 2. Notably, climate model uncertainty varies by climate variable. Typically, uncertainty is larger for precipitation-dependent projections and smaller for temperature-dependent projections. As a result, it is more important to consider a range of climate models when precipitation is the greatest concern.
2. **GHG emission uncertainty**, or the ability to predict future human GHG emissions. GHG emission projections are used as inputs to climate models, and vary based on assumptions about economic activity, energy sources, population growth, and other factors. To manage GHG emission uncertainty, it is important to consider multiple emissions scenarios, as described in Step 2.
3. **Natural variability in the climate system**, or natural year-to-year variations, that mean that any given year may not be representative of overall trends. To manage uncertainty caused by natural variability, average climate projections over two or three decades, as recommended in Step 2. Twenty- and 30-year averages temper the effect of outlier years while indicating overall trends.

Outputs

After completing this step you should better understand the uncertainty in your climate data, and should have interpreted your climate data in a way that manages uncertainty. Specifically, you will have considered outputs from multiple climate models and emission scenarios, and from an appropriate time frame.

[6] Based on FHWA. 2017. Chapter 4: Using Climate Information in Synthesis of Approaches for Addressing Resilience in Project Development. Federal Highway Administration (FHWA).