Climate Adaptation Policy Paper & Vulnerability Assessment

CITY OF FOWLER GENERAL PLAN UPDATE

APRIL 2020

CITY OF FOWLER
California

CLIMATE ADAPTATION POLICY PAPER & VULNERABILITY ASSESSMENT

GENERAL PLAN UPDATE

APRIL 2020

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PURPOSE

The purpose of this policy paper is to provide an overview of new general plan requirements, as outlined by Senate Bill (SB) 379, which require cities and counties to address the impacts of climate change in their communities. This paper will review the scientific context of climate change, the requirements of SB 379, and provide a vulnerability assessment: a five-step process that establishes the climate change exposures Fowler will face, summarizes likely impacts, and reviews risk and onset of each impact. The information in the vulnerability assessment will provide the basis for climate adaptation policy recommendations to be considered during the general plan update process.

BACKGROUND

SCIENTIFIC CONTEXT

The earth's climate has been warming for the past century. Scientific analysis of earth's historical climate shows that the climate system varies naturally over a wide range of timescales. In general, climate changes prior to the Industrial Revolution in the 1700s can be explained by natural causes. However, recent climate changes cannot be explained by natural causes alone.[1] It is understood that this warming trend is related to anthropogenic[2] releases of certain gases, known as greenhouse gases (GHG), into the atmosphere. GHGs absorb infrared energy that would otherwise escape from the Earth. As the infrared energy is absorbed, the air surrounding the Earth is heated. An overall warming trend has been recorded since the late 19th century, with the most rapid warming occurring over the past two decades.

Recent scientific analysis completed by the Intergovernmental Panel on Climate Change (IPCC) confirms that human influence on the climate system is clear, and recent anthropogenic emissions of greenhouse gases are the highest in history.[3] This has led to atmospheric concentrations of carbon dioxide, methane, and nitrous oxide that are unprecedented in at least the last 800,000 years. Their effects, together with those of other anthropogenic drivers, have been detected throughout the climate system and are extremely likely to have been the dominant cause of the observed warming since the mid-20th century.[3]

In recent decades, changes in climate have caused impacts on natural and human systems on all continents and across the oceans. Impacts are due to observed climate change, irrespective of its cause, indicating the sensitivity of natural and human systems to changing climate.[4] Some of these impacts include changes in

[1] (United States Environmental Protection Agency, 2017)
[2] Resulting from the influence of human beings.
[3] (Contribution of Working Groups I, II and III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change, 2014)
[4] (Contribution of Working Groups I, II and III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change, 2014)

extreme weather, precipitation, and melting snow which affect water resources, impact crop yields, and change wildlife geographic ranges and migratory patterns.[5]

Even after implementing measures to minimize how much the climate will change, communities around the world will experience new challenges due to the shifting climate. These impacts will vary from place to place, as will their intensity. In order to prepare for these changes, communities must determine what impacts they are most likely to face.

LEGISLATIVE CONTEXT (SENATE BILL 379)

In an effort to prepare for and mitigate climate change related impacts, new laws governing land use planning efforts have been enacted. SB 379 was passed in October of 2015 in reaction to increasing evidence that global climate change will have lasting impacts on the health and well-being of communities around the world.

SB 379 requires cities and counties to address climate change impacts either through their local hazard mitigation plan (LHMP) or general plan safety element. Jurisdictions must incorporate climate adaptation into their safety element once an LHMP is adopted on or after January 1, 2017, or, if they do not have an adopted LHMP, the safety element must be updated before January 1, 2022. These updates must include goals, policies, and objectives to address climate resilience in response to likely climate change vulnerabilities. These goals, policies, objectives, and implementation measures are based on a required vulnerability assessment. The vulnerability assessment will identify the risks that climate change poses to the jurisdiction by analyzing projected climactic shifts and the vital services, functions, and populations put at risk by those changes.

SB 379 REQUIREMENTS

Long range planning documents must integrate climate adaptation and resiliency strategies, including:

1. **A vulnerability assessment** that identifies the risks climate change poses to the local jurisdiction and the geographic areas at risk from climate change.
2. **A set of adaptation and resilience goals, policies, and objectives** based on the information specified in the vulnerability assessment.
3. **A set of feasible implementation measures** designed to carry out the goals, policies, and objectives identified in the adaptation objectives.

MITIGATION -VS- ADAPTATION

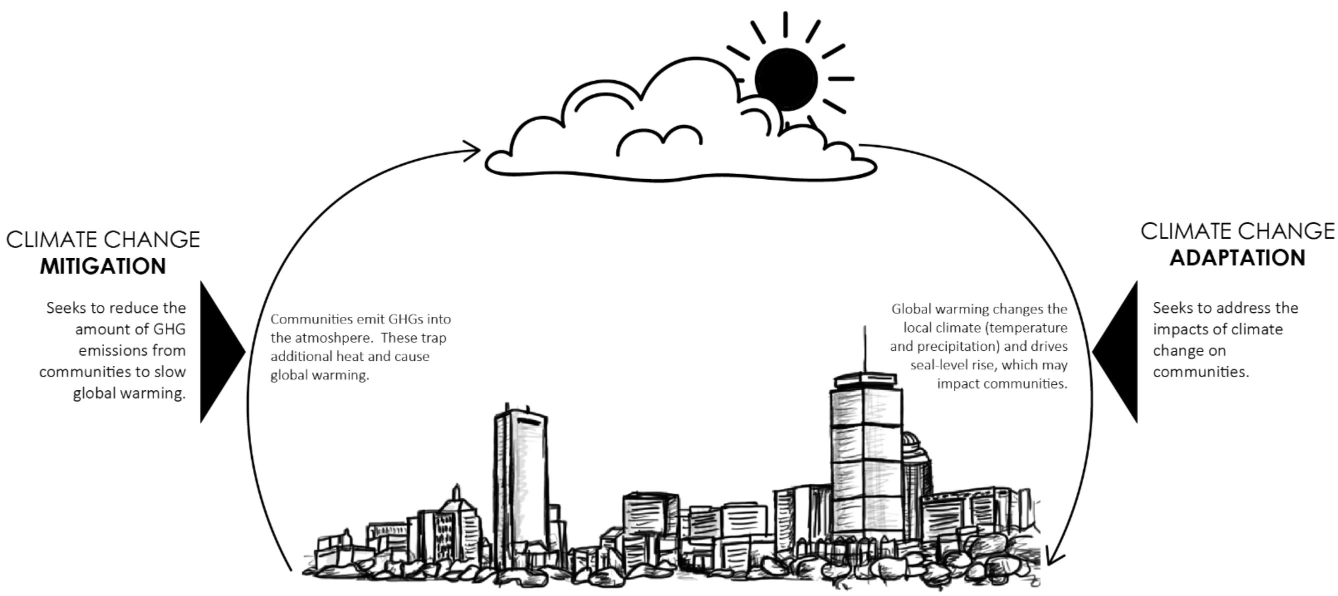
In the wake of new legislation pertaining to climate adaptation, it is necessary to distinguish the types of planning efforts undertaken to address climate change. Local planning efforts address climate change in two separate yet related ways. The first is through the reduction of greenhouse gas (GHG) emissions, also known as mitigation. The second is through adaptation planning, which is the subject of this policy paper. While these efforts are often pursued in parallel, there is a distinct difference between mitigation and adaptation. The purpose of mitigation is to slow the overall effects and consequences of climate change by reducing the amount of GHGs released into the atmosphere. Adaptation planning seeks to address the impacts of climate change on the vital structures, functions, and populations within a specific jurisdiction.

[5] (Contribution of Working Groups I, II and III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change, 2014)

Adaptation planning assesses climate change risks and provides coping strategies to help communities adapt to the changing environment regardless of how effectively GHG emissions may be curbed.

These parallel planning efforts are also handled through two different regulatory landscapes. Mitigation is often dealt with through environmental compliance documents regulated by the California Environmental Quality Act (CEQA), while adaptation planning is addressed through long range planning documents such as local hazard mitigation plans (LHMPs), general plans, or climate action plans.

Figure 1: Climate Change Mitigation -vs- Adaptation



(California Emergency Management Agency, California Natural Resources Agency, 2012)

CLIMATE ADAPTATION PLANNING PROCESS

The primary resource outlining best practices for climate adaptation planning is the California Adaptation Planning Guide (APG). The APG was developed by the California Emergency Management Agency (CEMA) and the California Natural Resources Agency (CNRA) in order to help guide climate adaptation planning at the local level. The guide is a four-part series which introduces the basis for climate adaptation planning, provides a step-by-step process for conducting local vulnerability assessments, and outlines strategies for creating local adaptation plans. The APG breaks down climate adaptation planning into nine distinct tasks categorized into two phases, as shown in **Figure 2: Adaptation Planning Development**.

Figure 2: Adaptation Planning Development

(California Emergency Management Agency, California Natural Resources Agency, 2012)

Phase one of this process is conducting a vulnerability assessment. The vulnerability assessment will identify:

1. ***Exposure*** the community will experience due to the effects of climate change.
2. ***Sensitivity*** of key community structures, functions, and populations that are potentially susceptible to each exposure.
3. ***Potential Impacts*** likely to occur to the structures, functions, and populations within a community due to climate change exposures.
4. ***Adaptive Capacity*** of the community, or its ability to cope with and address projected impacts.
5. ***Risk and Onset***, including necessary adjustments to address the likely occurrence and timing of the projected impacts.

These first five steps are covered in this paper and inform its structure.

Phase two of the planning process is known as adaptation strategy development. This process includes steps six through nine:

6. ***Prioritize Adaptive Needs*** based on the findings in the vulnerability assessment.
7. ***Identify Strategies*** to address the highest priority adaptation needs.

8. ***Evaluate and Prioritize*** those strategies based on the projected onset of the impacts, cost, co-benefits, and feasibility.
9. ***Phase and Implement*** adaptation strategies and develop a monitoring system to assess effectiveness.

As noted in the **Purpose** section above, climate adaptation strategies identified during phase two (steps six through nine) will be addressed during future stages of the general plan update process. The adaptation strategies will result in climate adaptation policy recommendations to be considered in the general plan update. The information contained in phase one, the vulnerability assessment, will provide the data and research basis for those recommendations

UNDERSTANDING THE EFFECTS OF CLIMATE CHANGE

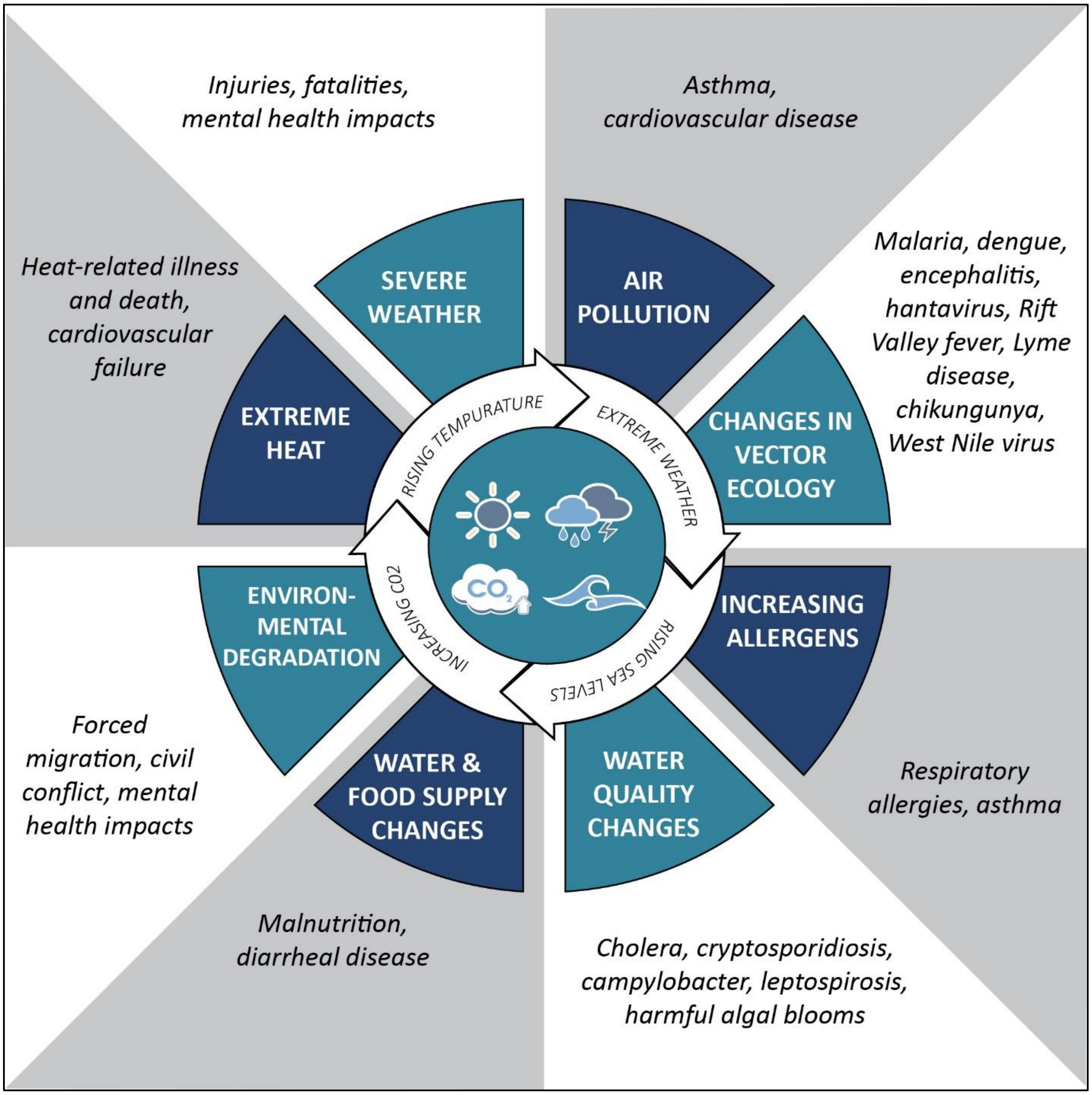
The discussions in this report provide descriptions of both primary and secondary effects of climate change. Primary effects result from direct exposures such as temperature and precipitation changes, sea level rise, and the occurrence of severe storms. Secondary effects occur as a result of primary effects, and may include phenomenon such as heat waves, changed seasonal patterns, and coastal erosion. A list of primary effects and commonly associated secondary effects may be seen in **Table 1: Primary Versus Secondary Effects of Climate Change.** Public health impacts must also be evaluated in order to determine and prioritize the adaptive needs of a community. The relationship between associated health effects of climate change is illustrated in **Figure 3: Associated Effects of Climate Change on Human Health**.

Table 1: Primary Versus Secondary Effects of Climate Change[6]

Primary Impact	Associated Secondary Impacts
Sea level rise	Inundation or long-term waterline change
	Coastal Erosion
	Extreme high tide
	Saltwater intrusion
Changed temperature/precipitation patterns/severe storms	Changed seasonal patterns
	Wildfire
	Drought
	Reduced Snowpack
	Heatwaves
	Landslide

[6] (California Emergency Management Agency, California Natural Resources Agency, 2012)

Figure 3: Associated Effects of Climate Change on Human Health



(Federal Centers for Disease Control)

METHODOLOGY AND DATA SOURCES

In California, Cal-Adapt provides climate change predictions downscaled to the most appropriate jurisdictional level, producing data for a number of potential exposure types under different climate scenarios. Nationwide and regional climate reports predicting potential climate change effects were used to supplement Cal-Adapt data and additional state and local documents were utilized to help determine the effects of climate change in Fowler.

CAL-ADAPT

This policy paper primarily considers peer-reviewed climate change data from Cal-Adapt, a web-based, interactive visualization tool that synthesizes climate research into a series of charts, maps, and data points of observed and projected climate variables for California. Cal-Adapt was developed by UC Berkeley's Geospatial Innovation Facility and funded and advised by the California Energy Commission and California Strategic Growth Council. Cal-Adapt is particularly useful for identifying localized climate change predictions. Most climate change data exist on a global scale and are brought to the local level through a process called downscaling. Cal-Adapt downscales for several boundaries related to environmental, census, and planning regions. This report uses the incorporated and census designated place boundary of Fowler whenever downscaling is appropriate.

Cal-Adapt uses two climate change scenarios, called Representative Concentration Pathways (RCP). RCP 4.5 is a moderate scenario where GHG emissions are curbed and peak in 2040. RCP 8.5 assumes emissions continue as usual and rise throughout the 21st century. Because Cal-Adapt considers both scenarios to be equally likely, both are discussed in this report. Cal-Adapt combines several models to form its pathway predictions. How the climate will change depends on human action and feedback loops, so averaging models helps to account for this uncertainty. More information about the models can be found on the Cal-Adapt website. The charts used in this report to demonstrate trends and the variation between scenarios use only the average simulation for ease of reference.

SUMMARY REPORTS

This report also considers analysis from climate change experts. While Cal-Adapt can provide powerful insight to how the climate will change in a particular place, it cannot explain how those changes will impact the structures, functions, and populations of that place. To better understand the potential impacts on these features in Fowler, Cal-Adapt data was supplemented with national and state summary documents, which provided additional analysis on how these exposures may impact Fowler and the region.

The Fourth National Climate Assessment first identifies climate change impacts the United States is likely to face. It then narrows its scope to discuss what will impact various regions. Fowler is located in the Southwest region, consisting of California, Nevada, Utah, Colorado, Arizona, and New Mexico. The regional predictions of climate change impacts outlined in the Fourth National Climate Assessment help to bridge the gap between how the climate will change, as documented through the Cal-Adapt tool, and what impacts it will have on life in the Southwest region.

This vulnerability assessment also considers documents produced by California State agencies. California's Fourth Climate Change Assessment Statewide Summary Report identifies which climate changes California is most susceptible to and which populations are likely to be affected. Other reports provide more specialized analysis for specific regions, such as the Climate Change and Health Profile Report for Fresno County, prepared by the California Department of Public Health.

VULNERABILITY ASSESSMENT

As described in the above section titled **Climate Adaptation Planning Process**, Fowler must conduct a vulnerability assessment to:

1. Determine what effects of climate change are likely to occur in Fowler;
2. Identify sensitive structures, functions, and populations within the City;
3. Determine likely impacts;
4. Evaluate current capacity to adapt to the shifting climate; and
5. Assess the risk and onset of the impacts likely to occur.

The topics in the following sections include these five steps and, together, make up the vulnerability assessment for the City of Fowler.

EXPOSURE ASSESSMENT

The City of Fowler, located in the southern San Joaquin Valley, will be exposed to a variety of natural hazards that are likely to become more frequent and severe due to climate change. Primarily, Fowler will face temperature and precipitation changes, but severe weather and wildfire will also be of concern.

The following exposures are divided into primary and secondary effects, while the individual topics addressed in each category are primarily organized around those identified in the Cal-Adapt tool.

RELATIVE CONCENTRATION PATHWAYS (RCP)

Cal-Adapt uses two climate change scenarios, called Representative Concentration Pathways (RCP). **RCP 4.5** is a moderate scenario where GHG emissions are curbed and peak in 2040. **RCP 8.5** assumes emissions continue as usual and rise throughout the 21st century. Both scenarios are considered equally likely and thus are both discussed in this report.

Where possible, each exposure was evaluated under both the RCP 4.5 and RCP 8.5 Scenarios.

Primary Effects of Climate Change

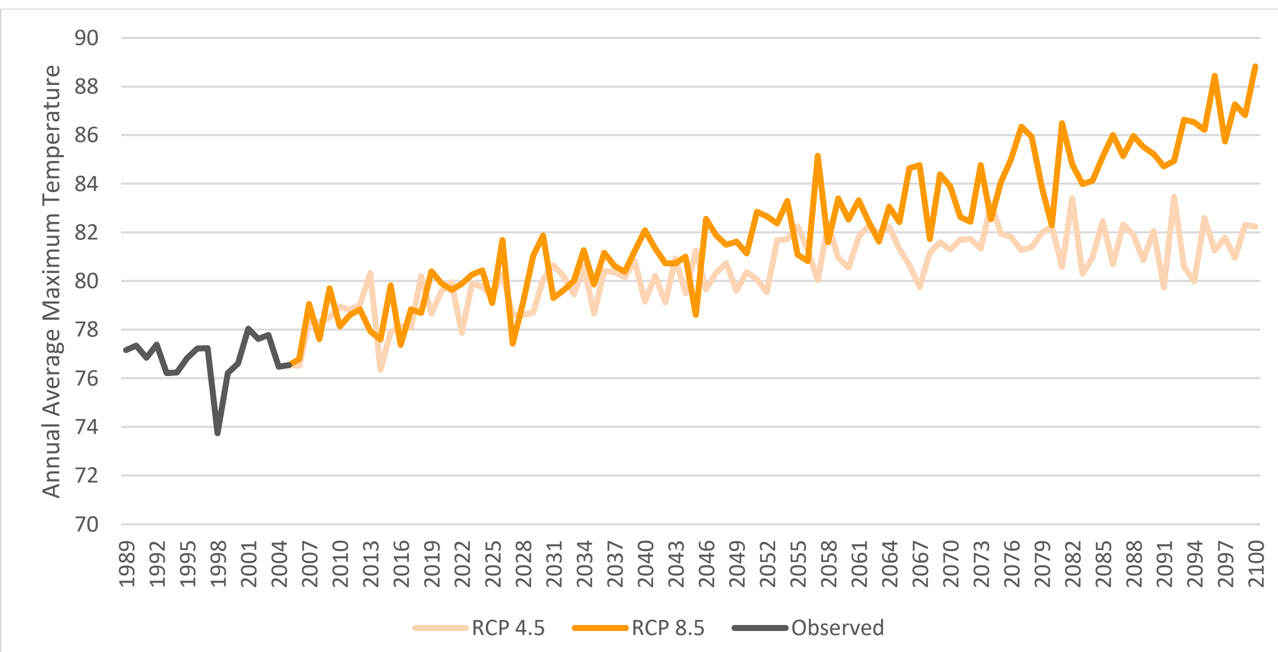
Sea Level Rise

Fowler is in the San Joaquin Valley of California, deeply inland and surrounded by mountain ranges. Thus, it is unlikely to experience direct effects from sea-level rise. However, secondary effects of rising sea levels, such as population change, shifting job markets, and increased need for healthcare, may still affect Fowler. Although sea-level rise cannot be ignored as an impact for California, Fowler itself has low exposure to this effect of climate change.

Temperature Increase

Between 1961 and 1990, the average annual temperature in Fowler was approximately 76.5°F. The average temperature is expected to rise significantly in the coming decades. Between 1961 and 1990, the average annual temperature was approximately 76.5°F. The overall increase will depend on how much carbon is released into the atmosphere. In a low-emissions scenario, average annual maximum temperature will likely rise to around 82°F by 2099. If emissions are not curbed, it is likely that annual average maximum temperature in Fowler will increase to around 85°F.[7] **Figure 4: Predicted Annual Average Maximum Temperature in Fowler** demonstrates the expected increases in average maximum temperature for both scenarios. There is a high certainty that Fowler will be exposed to increasing average temperature.

Figure 4: Predicted Annual Average Maximum Temperature in Fowler[8]



[7] (Geospatial Innovation Facility and California Energy Commission, 2020)
[8] (Geospatial Innovation Facility and California Energy Commission, 2020)

Changing Precipitation

The San Joaquin Valley region as a whole will experience declines in annual precipitation of 1-2 inches by the year 2050 and as much as 3.5 inches by 2100. Areas of higher elevation are expected to experience precipitation declines up to 10 inches.[9] Under the RCP 4.5 scenario, the City of Fowler's expected minimum precipitation rates may decline from 6.7 inches per year to 2.1 inches from 2020 to 2040 and 3.3 inches per year through the last half of the century. Under the 8.5 RCP scenario, minimum precipitation rates may decline to 4.6 and 3.0 inches per year from 2020 to 2040 and 2040 to 2099, respectively. While minimum precipitation rates are likely to decline, maximum precipitation rates may increase, leading to relatively stable average precipitation under both scenarios. A summary of these scenarios can be seen in **Figure 5: Annual Average Precipitation under the RCP 4.5 Scenario** and **Figure 6: Annual Average Precipitation under the RCP 8.5 Scenario** below.

Figure 5: Annual Average Precipitation under the RCP 4.5 Scenario

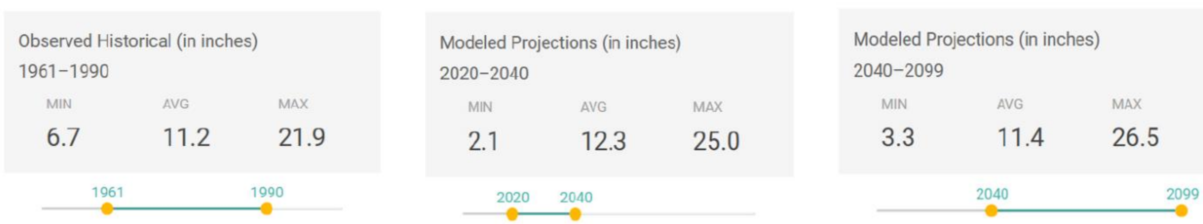
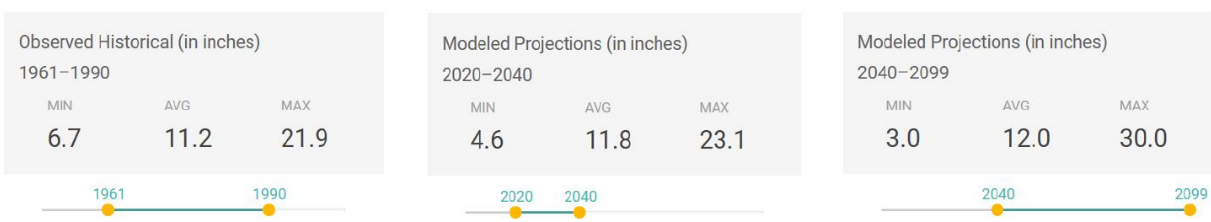


Figure 6: Annual Average Precipitation under the RCP 8.5 Scenario



Secondary Effects of Climate Change

Drought, Snowpack and Water Supply

The state of California has seen temperatures increase steadily since 1895, with accelerated warming rates since the 1970s.[10] As winter temperatures increase, freezing elevations[11] have risen by approximately 500 feet and winter chill time has decreased.[12] These warming trends have led to more and more mountain

[10] (California Department of Water Resources, n.d.)
[11] The freezing elevation is the altitude at which the temperature is at 0 °C (32°F).
[12] (California Department of Water Resources, n.d.)

precipitation falling as rain instead of snow, decreasing snowpack and causing snowmelt to occur earlier in the year.[13]

In very dry years, the possibility of drought will become a more frequent reality. Drought is a gradual phenomenon, occurring slowly over a period of time, and is defined based on impacts to water users.[14] California's extensive system of water supply infrastructure can mitigate the effects of a short-term dry period, but the changing climate will stress jurisdictions' ability to meet their longer-term water needs.[15] In addition, as precipitation decreases, soil is more likely to become parched. Parched soil absorbs less water, increasing runoff and stressing water storage infrastructure, which may lead to dam failure and worsened drought conditions.

Extreme Heat

Both the frequency and severity of extreme heat events are increasing.[16] Intense heat is a hazard on its own, but it also increases the risk of other extreme weather such as wildfire or drought. Historically, the City of Fowler experienced, on average, four extreme heat days each year.[17] That number is expected to rise to 30 extreme heat days per year by 2099 in RCP 4.5 and to 46 extreme heat days per year in RCP 8.5 as shown in **Figure 7: Extreme Heat Days under the RCP 4.5 Scenario** and **Figure 8: Extreme Heat Day under the RCP 8.5 Scenario**. Future predictions are charted in **Figure 9: Predicted Annual Extreme Heat Days in Fowler**.

[13] (Fresno County, Amec Foster Wheeler, 2018)
[14] (California Department of Water Resources, n.d.)
[15] (Fresno County, Amec Foster Wheeler, 2018)
[16] (Center for Disease Control)
[17] From 1950-2000, where an extreme heat day is one when the maximum temperature is above 103.9°F, the 98th historical percentile of daily maximum/minimum temperatures based on observed historical data from 1961-1990 between April and October; (California Department of Water Resources, n.d.)

Figure 7: Extreme Heat Days under the RCP 4.5 Scenario

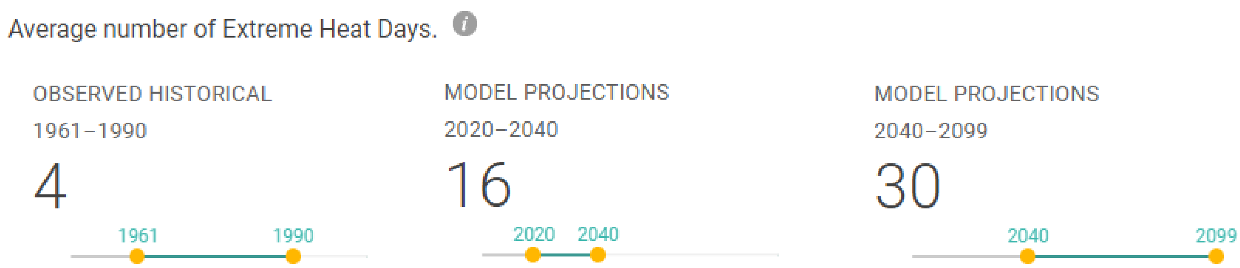
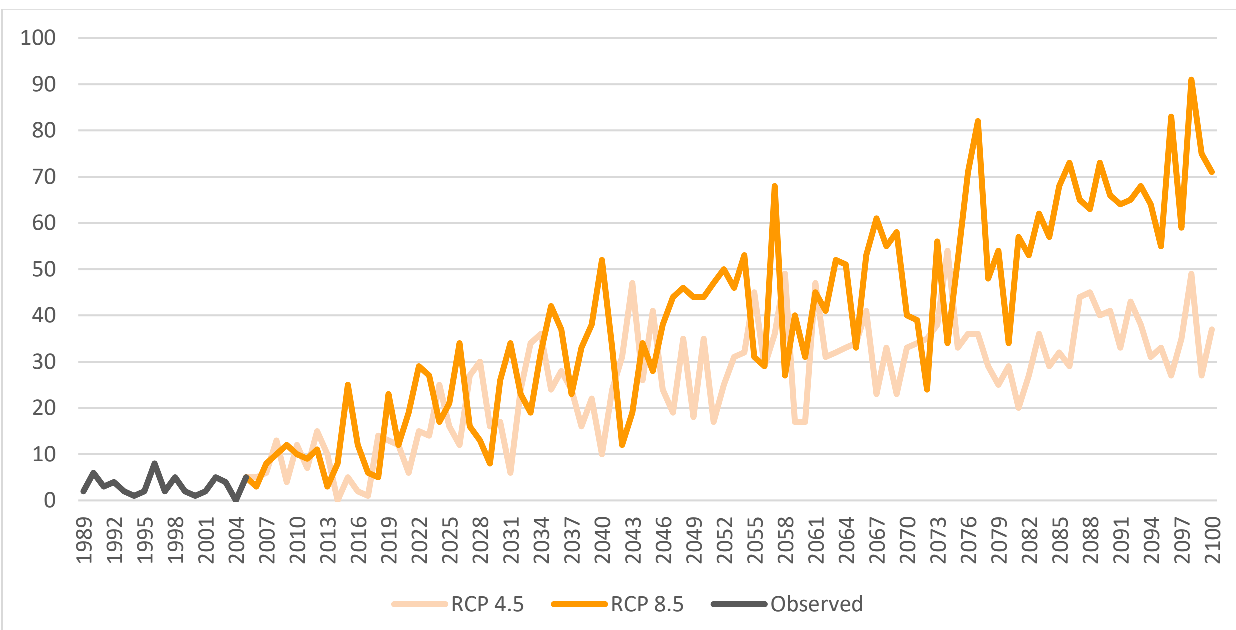


Figure 8: Extreme Heat Days under the RCP 8.5 Scenario

Figure 9: Predicted Annual Extreme Heat Days in Fowler[18]



Flooding

Natural floods are usually caused by weather events and can pose a substantial threat to property and human safety. Floods may also be caused by structural failures at reservoirs and dams. In some instances,

[18] (Geospatial Innovation Facility and California Energy Commission, 2020)

climate change will affect the likelihood of a structural failure due to a combination of drought and severe storm events. In addition to facing more intense rain events with higher than normal maximum precipitation, Fowler will also experience drought conditions which can contribute to parched soil, where the ground is less able to absorb water during storms and floods. Together, these phenomena may contribute to increased runoff during storm events and a decreased ability to contain stormwater, further stressing water storage infrastructure and increasing the likelihood of failure.

With the changing climate causing an increase in severe weather events, flooding may pose a greater risk than it has historically. A small portion of the City of Fowler is within the 100-year floodplain designated by FEMA. Due to its location primarily outside of flood zones, Fowler has little to no exposure to climate-related flood risks. The greatest risk for flooding in Fowler remains the Pine Flat Dam, located approximately 23 miles northeast of Fowler. Although increased drought conditions and other climate change effects have the potential to stress dam infrastructure, it is not anticipated that climate change would greatly impact the likelihood of the Pine Flat Dam failing.

Severe Weather

Severe weather includes any destructive weather event, such as fog, hail, and severe thunderstorms. The Fresno County Multi-Jurisdictional Hazard Plan identified the most common severe weather events as:

- Fog;
- Heavy rain, thunderstorms, hail, lightning, and wind; and
- Tornados.[19]

Fog

Fog occurrence in Fowler can be expected to decrease as a result of climate change. Already, warming temperatures have resulted in a significant drop in the number of fog days being recorded.[20] Fog limits visibility, which poses a distinct threat to drivers and pedestrians. While fewer fog days may be good for public safety, the warmer temperatures indicated by the decrease in fog may result in reduced agricultural productivity from many orchard crops.[21] Fowler is already exposed to fog that threatens public safety, but climate change is expected to decrease its occurrence. Decreased fog is a secondary effect of rising temperature, which is covered in the **Extreme Heat** section of this report.

Storms

Storms are characterized by heavy rain and are often accompanied by strong winds, lightning, and hail. These storms will likely increase in both frequency and severity. The number of rainy and snowy days in Fresno County is expected to increase from 25-40 days annually to 35-55.[22] These storms will carry greater amounts of precipitation and reach extreme levels more frequently as the climate continues to change. Fowler is likely to be exposed to more intense storms due to climate change.

[19] (Fresno County, Amec Foster Wheeler, 2018)
[20] (Fresno County, Amec Foster Wheeler, 2018)
[21] (Fresno County, Amec Foster Wheeler, 2018)
[22] (Fresno County, Amec Foster Wheeler, 2018)

Tornados

Historically, most tornados in Fresno County have been minor, registering as F0 or F1 on the Fujita scale.[23] Tornados can form in storms that have a certain type of wind shear, though meteorologists are unsure why only some of these storms generate tornados. An increase in the frequency of severe storms would increase the potential for tornado-generating conditions.[24] In 2007 the Fujita Scale was revised to reflect more accurate wind speed estimates. This is known as the Enhanced Fujita Scale. Should the County experience a tornado that registers as a four or five on the Enhanced Fujita scale, severe property and crop damage would occur. Loss of life would also be likely. Older and poorly constructed homes would experience the most damage and put those residents in the most risk for injury or death.[25] Fowler is likely to be exposed to more storms with tornado-generating strength, but exposure to tornados is not a primary climate change concern for the City.

FUJITA SCALE

The Fujita Scale determines tornado strength based on structural damage. The Enhanced Fujita Scale was implemented in 2007 and uses the same potential damage to produce more accurate wind speed predictions.

F0	Broken branches, sign damage
F1	Roof damage, mobile homes and cars shifted
F2	Roof torn off, cars lifted off ground, large trees uprooted
F3	Roof and some walls missing, most trees uprooted, cars thrown
F4	Houses leveled, large missiles generated and thrown 100+ yards
F5	Strong homes leveled, trees debarked, complete destruction

Wildfire

Wildfires occur primarily in areas with abundant fuel, so heavily forested areas are especially at risk. Although there is a threat of wildfire throughout Fresno County, the City of Fowler is at low risk and has not historically experienced fires.[26] Cal-Adapt models do not predict Fowler will experience wildfire in either RCP 4.5 or RCP 8.5. Still, fires may occur in areas with little risk and climate change is likely to increase the occurrence of wildfire throughout the state. Drought, rising temperatures, and a lengthening fire season will all increase the risk of wildfire in Fowler. Not only can drought increase the risk of fire, water shortages may also limit Fowler's ability to fight wildfires. Additionally, increased wind due to climate change, coupled with hot, dry conditions, can worsen fire risk.

Fowler is much more likely to be exposed to the indirect effects of wildfire, such as the release of smoke and air pollution capable of traveling long distances. As fire occurrence in the rest of the state increases, smoke and ash will likely cause Fowler to experience greater air pollution and decreased air quality. The San Joaquin Valley has experienced decreased air quality due to large fires burning in all parts of California.[27] Though Fowler is unlikely to be directly exposed to a wildfire, the City will be exposed to the effects of fires elsewhere in the state.

[23] (NOAA, 2014)
[24] (Fresno County, Amec Foster Wheeler, 2018)
[25] (Fresno County, Amec Foster Wheeler, 2018)
[26] (Fresno County, Amec Foster Wheeler, 2018)
[27] (San Joaquin Valley Air Pollution Control District, 2018-19)

Streamflow

Climate change is expected to cause streamflow to vary more frequently between extremely high and low flows. Because Fresno County and the San Joaquin Valley are located in a primarily arid climate, most streamflow in the region occurs in channelized and controlled streams. It is not expected that streamflow would vary to the extreme levels that it might in a natural stream, as it is already heavily controlled by man-made systems. Therefore, Fowler is unlikely to be exposed to changes in streamflow due to climate change.

SENSITIVE COMMUNITY ASSETS AND POTENTIAL IMPACTS

The next step in completing a vulnerability assessment is to create an inventory of sensitive community assets potentially affected by climate change exposures. Once an inventory of these assets is completed, likely impacts can be analyzed.

The impacts a community will face are the combination of climate change exposures and how those exposures affect sensitive community assets. Understanding both concepts is key to evaluating climate change impacts at a community level.

Sensitive Community Assets

When inventorying sensitive assets, the APG suggests sorting each asset into one of three categories:

1. **Structures.** Structures include critical infrastructure such as roads, communications systems, and utility systems including potable water, wastewater, natural gas, fuel, and electric power. Critical structures also include hazardous materials facilities and high potential loss facilities. These structures house toxic, flammable, explosive, and/or radioactive materials, and may include nuclear power plants, dams, military installations, industrial buildings, and other structures which critically impact the environment, public health, or safety in the event of damage.

2. **Functions.** The essential functions of a community include services that maintain government continuity and public safety, including emergency operations like healthcare, police, fire services, evacuation shelters, and schools. These functions are always important to the health and welfare of a community but are especially critical following climate-related hazard events.

3. **Vulnerable populations.** Often, the populations most sensitive to climate change exposures are those experiencing high levels of social vulnerability. Social vulnerability refers to the characteristics of a person or group that influence their capacity to anticipate, cope with, resist, or recover from the effects of climate change. Characteristics which inform social vulnerability include age, health, income, linguistic isolation, mobility, and more. These characteristics often align with indicators used in environmental justice analysis, or the establishment of Disadvantaged Communities (DACs) as defined by SB 1000. As a result, populations identified as Disadvantaged Communities may also be considered the most sensitive to climate change.

In order to aid jurisdictions in identifying sensitive community assets, the APG has provided sensitivity checklists outlining the structures, functions, and populations which should be evaluated. These checklists can be seen in **Figure 10: Fowler's Sensitive Community Assets** below.

Figure 10: Fowler's Sensitive Community Assets

Items which are marked with an "x" exist within the Fowler planning area.

POTENTIALL SENSITIVE FUNCTIONS	*POTENTIALL SENSITIVE STRUCTURES*	*POTENTIALL SENSITIVE POPULATIONS*
☐ Government continuity ☒ Water/sewer/solid waste ☒ Energy delivery ☒ Emergency services ☒ Public safety ☒ Public health ☒ Emotional and mental health ☒ Business continuity ☒ Housing access ☒ Food security ☒Mobility/transportation/access ☒ Quality of life ☒ Social services ☐ Ecological function ☐ Tourism ☒ Recreation ☒ Agriculture, forest, and fishery productivity ☒ Industrial operations	☒ Residential ☒ Commercial ☒ Industrial ☒ Institutional (schools, churches, hospitals, prisons, etc.) ☒ Parks and Open Space ☒ Recreational facilities ☒ Transportation facilities and infrastructure ☐ Marine Facilities ☒ Communication Infrastructure ☐ Dikes and levees ☒ Water treatment plant and delivery infrastructure ☒ Wastewater treatment plant and collection infrastructure	☒ Seniors ☒ Children ☒ Individuals with disabilities ☒ Individuals with compromised immune systems ☒ Chronically ill individuals ☒ Individuals without access to lifelines (e.g. car or transit, telephones) ☒ Non-white communities ☒ Low-income, unemployed, or underemployed communities ☒ Individuals with limited English skills ☒ Renters ☒ Students ☐ Seasonal Residents ☒ Individuals uncertain about available resources because of citizenship status

Potential Impacts as a Result of Local Exposures

Extreme Heat

Decreased Public Health

Exposure to extreme heat can pose a serious health threat, causing discomfort and fatigue and, in severe cases, hospitalization and death.[28] Specifically, heat can compromise the cardiovascular and respiratory systems and especially impacts populations with other health conditions or that do not have access to cool spaces.[29]

The populations most likely to be impacted by extreme heat include:

[28] (Center for Disease Control)
[29] (Katharine Burgess, 2019)

- Seniors
- Children
- Individuals without access to lifelines (e.g., car or transit, telephones)
- Low-income, unemployed, or underemployed communities
- Individuals with limited English skills
- Individuals who work outdoors

Infrastructure Damage and Impaired Services

Rapid changes in temperature and extreme heat can compromise the integrity of road infrastructure, causing physical damage such as road buckling.[30] When temperatures reach certain levels, people are also unwilling to use alternative modes of transportation, such as biking or walking, putting additional stress on roadway and public transit infrastructure. Additionally, extreme heat puts stress on utility infrastructure due to the high energy demand associated with air conditioning and other cooling needs. Increased health needs due to high temperature can also put stress on emergency response and medical functions.

The economy of the San Joaquin Valley is primarily based on agricultural production. Increased temperatures will vary the growing season and the types of crops that can be grown in the region. Additionally, higher temperatures may increase water demand for both agricultural and urban use. With less water available and increased demand, California cities will have trouble meeting their water needs.

The functions and structures most likely to be impacted by extreme heat in Fowler include:

- Energy delivery
- Emergency services
- Public health
- Mobility/transportation/access
- Transportation facilities and infrastructure
- Agriculture, forest, and fishery productivity
- Water treatment and delivery infrastructure

Severe Weather

Severe weather associated with climate change can cause significant damage to property and crops. Storms also pose a threat to people who are unable to find adequate shelter. Extremely wet events, especially in arid climates like the San Joaquin Valley, can overstress water infrastructure and cause flooding and property damage.

The populations, functions, and structures most likely to be impacted by storm events in Fowler are:

- Individuals experiencing homelessness

[30] (Katharine Burgess, 2019)

- Public safety
- Built structures
- Water collection and storage infrastructure

Wildfire

Wildfires pose significant threat to property and human safety. Should a fire burn through Fowler, built structures and agricultural activities as well as public safety would be at risk. Though fire risk is increasing in California as a whole, it is unlikely to impact Fowler directly. Fowler is primarily at risk from the indirect effects of wildfire, such as air pollution and smoke. Smoke carries particulate matter, carbon monoxide, nitrogen oxides, and volatile organic compounds, all of which can significantly reduce air quality.[31] Exposure to smoke can negatively impact the respiratory and cardiovascular systems, increase hospitalizations, and agitate medical issues such as asthma.

The air quality in the San Joaquin Valley is already poor. It exceeds federal and State standards for both particulate matter at 2.5 microns and ozone, as well as State standards for particulate matter at 10 microns.[32] Wildfire smoke contains both particulate matter and ozone. Wildfire smoke is becoming increasingly impactful on Fowler's air quality and it can be expected that individuals *not* already predisposed to health risks from poor air quality would begin to be affected. Particulate matter and ozone can cause several health effects including coughing, wheezing, chest pain, headaches, nausea, fatigue, and, on a prolonged timeline, dementia. Individuals whose jobs require them to spend more time outside or do intense physical labor are significantly more likely to be impacted by poor air quality.

The populations and functions most likely to be impacted by wildfire in Fowler are:

- Seniors
- Children
- Individuals with compromised immune systems
- Individuals who are chronically ill
- Outdoor workers
- Business continuity

Drought, Snowpack and Water Supply

The expected reduction in snowpack coupled with more frequent extreme heat events indicate that climate change will decrease water supply while increasing demand throughout California. Regulations and water rights further limit the availability of water when conditions in the mountains change resulting in reduced snowpack. Drought especially impacts agricultural and urban functions, as both of those uses rely on large amounts of water. Other secondary impacts of drought, such as wildfire, dust storms, and flash floods, can pose serious risk to health and property.

[31] (Centers for Disease Control and Prevention, 2019)
[32] (City of Fowler, 2019)

Decreased Public Health

Dust storms associated with drought carry particulate matter that degrades air quality and can increase the incidence of coccidioidomycosis, or valley fever.[33] Drought is also associated with increased risk of disease from both groundwater and surface water sources, especially for those with chronic health conditions.[34] While air quality issues are especially impactful for people with respiratory illnesses, those with immune disorders are more likely to be affected by decreased water quality.

The populations most likely to be impacted by drought in Fowler are:

- Individuals with compromised immune systems
- Individuals who are chronically ill
- Individuals who work in conditions where they are exposed to dust

Infrastructure Damage and Impaired Services

Groundwater levels in the Fowler area have dropped from approximately 33 feet below ground surface in 1967 to about 60 feet below ground surface in 2019, with large swings in the water table occurring in response to hydrologically wet and dry periods.[35] During hydrologically dry periods there is less surface water available, causing increased reliance on ground water. Historic trends in water depths indicate that groundwater levels may fall more drastically in drought conditions.[36] The City of Fowler currently relies solely on groundwater to serve its municipal functions. As climate change exposures increase the likelihood of drought, there may be a need to address chronic lowering of groundwater levels.

Drought not only decreases the availability of water; it decreases its quality as well. Negative impacts to water sheds may arise as drought-fueled wildfires lead to increased landslides, mudslides, or sediment in run-off that reduce water quality. In addition, higher water temperatures and levels of sediment decrease water oxygen levels, which can kill aquatic life and put drinking water availability into question.[37] Lack of surface water for irrigation can reduce farm productivity, a major economic driver for the San Joaquin Valley. Furthermore, it can cause food insecurity as the San Joaquin Valley produces food for the rest of the country.

The functions and structures most likely to be impacted by drought and snowpack and water supply changes in Fowler include:

- Public health
- Food security
- Agriculture, forest, and fishery productivity
- Water treatment and delivery infrastructure

[33] (Centers for Disease Control and Prevention, 2019)
[34] (Centers for Disease Control and Prevention, 2020)
[35] (Provost & Pritchard Conulting Group, 2019)
[36] (Provost & Pritchard Conulting Group, 2019)
[37] (Centers for Disease Control and Prevention, 2020)

ADAPTIVE CAPACITY

Adaptive capacity is the ability of a community to address climate change impacts. In order to determine Fowler's adaptive capacity, it is necessary to evaluate the extent to which potential impacts are already being addressed. This is done through a review of climate change related policies, plans, and programs, that are either in place or can be easily implemented. Once complete, adaptive capacity is rated as either low, medium, or high to indicate level of preparedness. High capacity indicates that adaptive measures are already implemented, and low capacity indicates that a community is unprepared for the impacts it may face.

For the purposes of this effort, a document review has been completed wherein local planning documents were reviewed for responsiveness to the most likely impacts facing Fowler. A list of documents, their applicability to the City of Fowler, and the year they were completed can be found in **Table 2: Planning Documents, Standards, Ordinance, and Programs Addressing Climate Change.** The most likely climate change impacts facing Fowler include decreased public health, infrastructure damage, and impaired public services as a result of:

- Drought, reduced snowpack, and reduced water supply;
- Extreme heat;
- Severe weather; and
- Wildfire.

A more detailed description of these impacts may be reviewed in the section above, entitled **Sensitive Community Assets and Potential Impacts.**

Table 2: Planning Documents, Standards, Ordinance, and Programs Addressing Climate Change

Document Type	Applicable (yes/no)	Title and Year Completed	Agency
Planning Documents			
General Plan	Y	2025 General Plan, 2004 *(update currently underway)*	City of Fowler
Climate Action Plan	N		
Climate Adaptation Plan	N		
Area and Specific Plans	N	Central Fowler Revitalization Plan (Downtown Plan), 2007	City of Fowler
Local Hazard Mitigation Plans	Y	Fresno County Multi-Jurisdictional Hazard Mitigation Plan, 2018	Fresno County
Local Coastal Plan	N	*Not Applicable	
Urban Water Management Plan	N	*Not Required	
Ground Water Sustainability Plan	Y	South Kings Groundwater Sustainability Plan, 2019	South Kings Groundwater Sustainability Agency
Integrated Regional Water Management Plan	Y	Kings Basin Integrated Regional Water Management Plan, 2016	Kings Basin Water Authority

Document Type	Applicable (yes/no)	Title and Year Completed	Agency
Transit Plan	Y	Fresno County Regional Long Range Transit Plan 2019-2050, 2019	Fresno Council of Governments
Sustainable Community Plans (SB 375)	Y	Regional Transportation Plan, Sustainable Communities Strategy, 2018	Fresno Council of Governments
Regional Transportation Plans	Y	Regional Transportation Plan, Sustainable Communities Strategy, 2018	Fresno Council of Governments
Standards, Ordinance and Programs			
Capital Improvement Program	Y	Currently Underway	
Zoning Code	Y	City of Fowler Zoning Ordinance, 2009	City of Fowler
Building Code	Y	California Building Standards Code, 2019	California Building Standards Commission
Fire Code	Y	California Fire Code, 2019	California Building Standards Commission
Tree Ordinance	N		
Stormwater Management Plan	N		
Floodplain Ordinance	Y	Fowler Municipal Code, Chapter 8, 2009	City of Fowler

Planning Documents

General Plan[38]

A general plan is a comprehensive, long-range planning document that forms the basis of land use decisions and envisions how a community will grow. It addresses issues that impact the entire city, such as how land is used, the locations of roads and parks, safety, noise, and more. Every other planning document adopted by the city must be consistent with the goals and policies of the general plan.

Fowler's operating General Plan was adopted in 2004 and establishes a planning horizon of 2025. Topics covered include land use, circulation, housing, economic development, environmental resources management, and public facilities elements. Since its adoption, the General Plan has been revised and amended but not comprehensively updated. The General Plan is currently in the process of being comprehensively updated.

As part of the update process, existing General Plan policies have been reviewed for consistency with new legislative requirements and current community needs. Currently, there are no policies that deal directly with climate change resiliency. There are some policies that emphasize sustainability, growth management, and active transportation, all of which have co-benefits with climate adaptation needs. While there are some policies relevant to climate adaptation, they do not directly address climate change exposures and impacts most relevant to Fowler. Focused climate change adaptation policies will need to be developed as part of ongoing update efforts.

[38] (City of Fowler, Land Use Associates, 2004)

Local Hazard Mitigation Plans[39]

The Local Hazard Mitigation Plan (LHMP) is intended to reduce the long-term risk of environmental hazards such as severe weather or drought. Fresno County has a multi-jurisdictional plan which addresses hazards at a more regional scale and Fowler contributed an annex to that document which examines more local impacts. The plan identifies which hazards pose a risk to the County, what the impacts of such hazards would be, and how to mitigate and lessen the impacts of hazards. With the risk of many of these hazards increasing due to climate change, the mitigation measures identified in the LHMP are closely related to the beneficial actions of climate adaptation planning. The LHMP is identified as a document that can be used to implement SB 379; however, while it includes mutually beneficial measures, it does not directly address the necessary actions Fowler will need to take to address climate change.

Groundwater Sustainability Plan[40]

In 2014, the California Sustainable Groundwater Management Act (SGMA) was signed into law in order to provide a statutory framework for sustainable local management of groundwater basins. SGMA requires certain governments and water agencies to bring groundwater basins into balanced levels of pumping and recharge. The City of Fowler falls within the South Kings Groundwater Sustainability Agency (SKGSA) boundary. As part of a critically over-drafted sub basin, the SKGSA's goal is to ensure sustainable management by the year 2040. The primary planning document outlining sustainable management practices is the Groundwater Sustainability Plan (GSP). Climate change related impacts are a consistent consideration throughout the South Kings GSP. Sustainable water management practices in the face of changing seasonal patterns, reduced snowpack, flooding, and drought potential are covered within the South Kings GSP. It is also important to note that GSPs must be consistent with local general plans.

Integrated Regional Water Management Plan[41]

Integrated Regional Water Management (IRWM) practices began in 2002, with the passing of the Regional Water Management Planning Act (SB 1672). In some ways, IWRM is considered the precursor to SGMA. IRWM seeks to build collaborative water management solutions across jurisdictional boundaries. The City of Fowler lies within the Kings Basin IRWM Plan (IRWMP) Area. The IRWMP for this area covers many interrelated water management topics, including predicted impacts from climate change, a vulnerability assessment for the Kings Basin, proposed adaptation measures, and monitoring plans. The information contained within this report is a valuable resource for predicting the effects of climate change on Fowler's water resources.

Downtown Plan (Central Fowler Revitalization Plan)[42]

The Central Fowler Revitalization Plan was adopted in 2007 as a method of creating a set of guiding design principles to revitalize Fowler's downtown commercial core. The primary focus of this document is economic development, coupled with urban design principles to facilitate economic development. The design concepts discussed within the Central Fowler Revitalization Plan focus on connectivity, walkability,

[39] (Fresno County, Amec Foster Wheeler, 2018)
[40] (South Kings Groundwater Sustainability Agency, 2019)
[41] (Kings Basin Water Authority, 2018)
[42] (Local Government Commission, Opticos Design, 2007)

and community character. While these concepts may parallel some adaptive strategies, this document does not incorporate climate change discussions, nor does it address climate resiliency as a primary goal.

Transit Plan[43]

Fowler is currently served by Fresno County Rural Transit Authority which has a long-range plan that considers transit operations through 2050. Environmental responsibility is identified as a goal for the transit system and several projects intended to increase the environmental sustainability of the system have been proposed. However, these projects focus on mitigating greenhouse gas emissions rather than adapting to predicted changes.

Regional Transportation Plan[44]

The Fresno Council of Governments' Regional Transportation Plan (RTP) looks at all types of transportation, travel, and goods movement in Fresno County. The most recent version of this plan was adopted in 2018 and looks forward to 2042. The plan also includes a Sustainable Communities Strategy that integrates land use and transportation planning to meet greenhouse gas emission reduction targets. The Policy Element of the RTP outlines several goals, objectives, and policies related to curbing emissions and mitigating climate change. However, it does not contain policies for adapting to predicted changes in the climate.

Sustainable Community Plans (SB 375)[45]

The Fresno Council of Governments' Regional Transportation Plan includes a Sustainable Communities Strategy (SCS) that fulfills the requirements of SB 375. The goal of the SCS Element is to increase sustainability through land use and transportation planning. The strategy identifies ways climate change will affect the transportation system and the need to prepare transportation infrastructure for those changes. However, it has not yet identified specific policies related to mitigating the effects of climate change on transportation infrastructure.

Standards, Ordinance, and Programs

Capital Improvement Program

Fowler is in the process of drafting and approving a Capital Improvement Program, which is anticipated for adoption by July 1, 2020. The program, once implemented, will assist in prioritizing capital improvement projects, many of which will support Fowler's adaptation to the effects of climate change.

Zoning Code[46]

Fowler's Zoning Code implements the General Plan through regulating allowed uses and development standards such as setbacks, building height, lot coverage, fencing, and parking requirements. Fowler's Code does not prescribe additional efficiency, safety, or green building requirements above what is required from the California Building Code, nor does it implement design standards with the intent of reducing the effects of climate change. However, Fowler's Zoning Code is currently in the early stages of a comprehensive

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[43] (Fresno Council of Governments, 2019)
[44] (Fresno Council of Governments, 2018)
[45] (Fresno Council of Governments, 2018)
[46] (City of Fowler, 2017)

update process. At this time, it is not anticipated that climate change related design standards will be part of this comprehensive update.

Building Code[47]

The California Code of Regulations, Title 24, also known as the California Building Standards Code, is published in its entirety every three years by order of the California Legislature. The purpose of building codes is to protect the health, safety, and welfare of the public through regulating how structures are built. Building codes also establish energy efficiency standards. In addition to typical code requirements, the state of California adopted the California Green Building Standards Code (CALGreen) as part of Title 24 in the year 2007. CALGreen is the first of its kind in the United States, and mandates green building standards. Adoption of CALGreen was primarily an effort to meet the goals of Assembly Bill 32 (AB 32), also known as the Global Warming Solutions Act. Passed in 2006, AB 32 established a program to reduce GHGs to 1990 levels by the year 2020.

While the CALGreen Code is an integral part of California's effort to reduce GHG emissions that contribute to climate change, it does not focus on safety measures geared towards resilience in the face of an already changing climate. A local jurisdiction may establish more restrictive building standards as necessary to adjust to local climactic, topographic, or geological conditions. At this time the City of Fowler has not adopted such regulations.

Fire Code[48]

The City of Fowler enforces the California Fire Code, last updated in 2019. The Code covers fire prevention and resistance standards. While the policies may relate to or attempt to mitigate the impacts of the increased fire risk associated with climate change, the Code does not directly mention climate change.

Floodplain Management Ordinance[49]

Fowler's Floodplain Management Ordinance will be a useful tool for preparing for the effects of increased flooding due to climate change. While the ordinance does not mention climate change or increasing risk factors, the requirements for construction within floodplains will help protect those buildings from damage due to flooding.

Summary and Recommendations

While some of Fowler's adopted planning documents, standards, ordinances, and programs address aspects of climate change, there are improvements that can be made to increase preparedness, specifically in response to the effects that will be most impactful to the health, safety, and welfare of the community. **Table 3: Summary of Adaptive Capacity** below summarizes the most relevant potential local effects of climate change in Fowler, as well as associated levels of preparedness based on the document inventory above. Recommendations on how to improve Fowler's adaptive capacity will be reflected in the climate adaptation strategies identified during future stages of the general plan update process.

[47] (California Building Standards Commission, 2019)
[48] (California Building Standards Commission, 2019)
[49] (City of Fowler, 2017)

Table 3: Summary of Adaptive Capacity

Effects of Climate Change in Fowler	Level of Preparedness
Extreme heat	Low
Severe weather	Low
Wildfire	Low
Drought, reduced snowpack and water supply	Medium

RISK AND ONSET

The fifth step of a vulnerability assessment is determining the risk and onset of potential climate change effects relevant to Fowler. The APG defines risk as the probability that a certain effect will occur. An assessment of risk considers both the certainty of the science projecting climate change effects and the certainty of local sensitivity. Climate change effects with higher probability are considered more of a risk, and therefore a higher priority for action. In comparison, onset predicts *when* the effect is likely to occur. Estimates of timeframe are not precise; however, it is possible to categorize the onset of climate change effects in the following terms:

- **Current:** Effects already happening
- **Near-term:** 2020-2040
- **Mid-term:** 2040-2070
- **Long-term:** 2070-2100

An evaluation of both risk and onset is critical to help communities with the second phase of the adaptation process, prioritizing their adaptive needs. In doing so, jurisdictions will be able to consider what impacts require the most immediate action. The International Panel on Climate Change (IPCC) continuously releases reports on climate change science, including estimations of risk and onset. Using this information will help Fowler determine adaptive priorities moving forward. Below, **Table 4: Summary of Risk and Onset** provides an overview of the predicted risk and onset of climate change exposures and associated impacts. Anticipated onset included in these tables are sourced from Cal Adapt data. For a more detailed summary of anticipated exposures, including minimums, maximums, and averages during each timeframe for both RCP 4.5 and 8.5, please see the above section entitled **Exposure Assessment .**

Table 4: Summary of Risk and Onset

Exposure	Risk[1]	Onset
Temperature Change	High	Near Term
Precipitation Change	Medium	Near Term
Extreme Heat	High	Near Term
Drought	Medium	Near Term
Reduced Snowpack	High	Near Term
Severe Weather	Medium	Near Term
Wildfire	Medium	Near Term

[1] Risk has been estimated from probability based on global models provided by the IPCC.

(California Emergency Management Agency, California Natural Resources Agency, 2012); (Geospatial Innovation Facility and California Energy Commission, 2020)

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