# CLIMATE CHANGE

Climate change, itself, is not a natural hazard. Natural hazard mitigation planning does not typically include a plan for climate change. However, climate change can affect and amplify the impacts of many other natural hazards. Specifically, changes in climate will affect future risks to drought, flooding, severe weather, landslide, wildfire, avalanche and dam failure. In order to appropriately prepare for natural hazards, this plan will consider the impact of climate change on natural hazard risk. This section will give an overview of climate change by providing a historical context to changes in temperature and precipitation in Utah, future projections of temperature and precipitation and the impacts of climate change on key natural hazards.

Climate change can be defined as the warming of Earth and changing of weather patterns because of changes in the composition of the atmosphere. Climate change is occurring due to changes in the concentrations of greenhouse gases in the atmosphere. Greenhouse gases, such as carbon dioxide ($CO_2$), methane ($CH_4$) and nitrous oxides ($N_2O$) trap radiation, or heat, near the earth's surface and cause air temperatures to warm. Greenhouse gases are an important part of our atmosphere; life would not exist on Earth without greenhouse gases. However, excess amounts of greenhouse gases in our atmosphere have caused rapid warming of air temperatures since the middle of the twentieth-century. Warming temperatures, alone, have a significant impact on life on Earth, but the rapid increase in greenhouse gases in the atmosphere can impact many other aspects of climate that affect the safety of Utah residents.

Warmer temperatures cause more rain to fall on Earth because warmer air holds more water vapor than colder air. Here in Utah, more rain could be a positive aspect of climate change. However, increased precipitation (rain or snow) from climate change does not occur uniformly in time or space. That means that climate change will make the world wetter overall, but that increase in rainfall may happen in some places but not others *and* rain will fall more intensely. So, some locations will get wetter, some locations will get drier and *all* locations will experience more intense, or extreme, precipitation. Climate change will cause precipitation to fall more intensely during some storms, but there will also be longer dry periods between storms.[1] This concept will likely be especially true in Utah, as Utah's climate is generally very dry and some areas of Utah are prone to strong thunderstorms that can cause flash floods. Climate change, caused by changes in the concentrations of greenhouse gases in the atmosphere, will cause temperatures to increase, but it will also cause changes in weather. The typical weather patterns of Utah may not be the weather patterns of the future. Climate change will certainly bring increased temperature to Utah, but it will also bring changes in precipitation. The change in precipitation will affect the type of precipitation that falls (rain or snow), how much falls, when it falls and how intensely it falls. Changes in precipitation amount, intensity and timing will greatly impact future natural hazard risk in Utah.

Global air temperatures have increased by approximately 1.8°F (degrees Fahrenheit) since 1850.[2] Temperatures have not warmed uniformly across the earth's surface; in general temperatures have warmed more over land and less over oceans. Continental regions, those far from the ocean, like Utah, have generally warmed more than the global average. However, even in Utah, there is variation in the amount of warming that has occurred. In northern Utah, temperatures have warmed by approximately 2°F since 1900.[3] Most warming in northern Utah, and throughout the state, has occurred since about 1960. There is a trend in rapid temperature warming in Utah since 1960. Many other parts of the country or world have seen temperatures consistently rise since 1900, but in Utah, the trend of rising temperatures is present since 1960. The southwestern United States is a region of great variability in temperature and precipitation. While temperatures have consistently risen in most Utah locations since 1960, no trends in precipitation have been observed. Precipitation in Utah is generally low and highly variable; there have been no long-term trends in precipitation. Thus far, it is not getting wetter or drier in Utah; precipitation remains extremely variable. Figure 1 shows historical temperature and precipitation for Logan and Duchesne, Utah. Since 1910, annual average temperatures in Logan have not significantly warmed. However, since 1960, temperatures have warmed slightly, at a rate of 0.25°F per decade. In Duchesne, temperatures have warmed sharply in the twentieth century; increasing from an average annual temperature of 43°F to nearly 48°F. Gaps in data for Duchesne make strong conclusions on temperature change impossible, but temperatures have generally warmed by 0.4°F per decade since 1910. Average annual precipitation for Logan was 18.2 inches in Logan and 9.4 inches in Duchesne; no long-term trends in precipitation were observed. In Logan the most significant droughts of record occurred in the 1930s, 1950-1965 and the early 2000s. Drought most significantly impacted Duchesne in the early 1930s and 1950-1965.

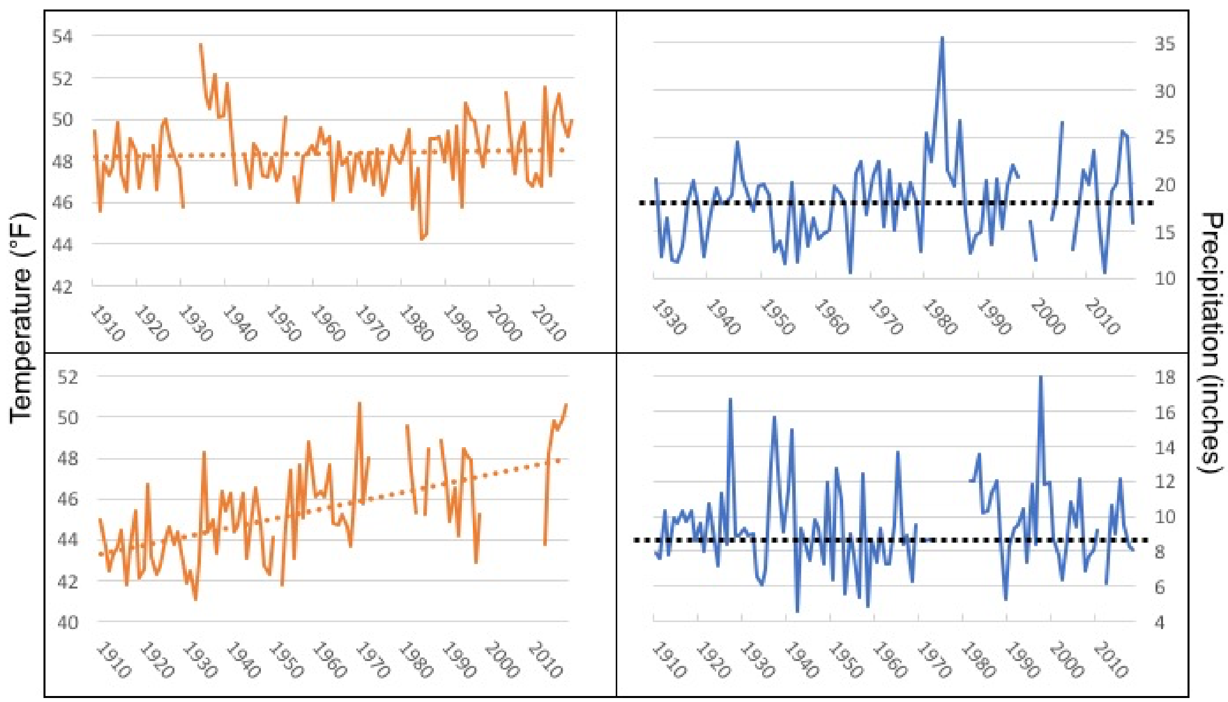

**Figure 1**. Historical temperature (left panels) and precipitation (right panels) in Logan (top panels) and Duchesne (bottom panels). Temperatures and precipitation are annual averages. Gaps in data represent years where not enough data existed to calculate an annual average. Dashed orange line (left panel) shows trend in temperature; the dashed black line (right panel) shows average precipitation. Data was obtained from the NOAA weather service office in Salt Lake City, UT; NOWData; https://w2.weather.gov/climate/xmacis.php?wfo=slc

Figure 2 shows historical temperature and precipitation for Cedar City and St. George, Utah. Since 1950, annual average temperatures in Cedar City were variable and show only a slight warming trend. In St. George, annual average temperatures have steadily increased since 1895. Annual average temperatures in St. George have increased by 0.5°F per decade. No long-term trends in precipitation were observed. Precipitation was highly variable with a long-term average of 10.8 inches in Cedar City and 8 inches in St. George. The most significant periods of drought in the historical record were 1950-1965 and the early 2000s for Cedar City. In St. George, the most significant droughts occurred in the 1930s, 1950s and early 2000s.

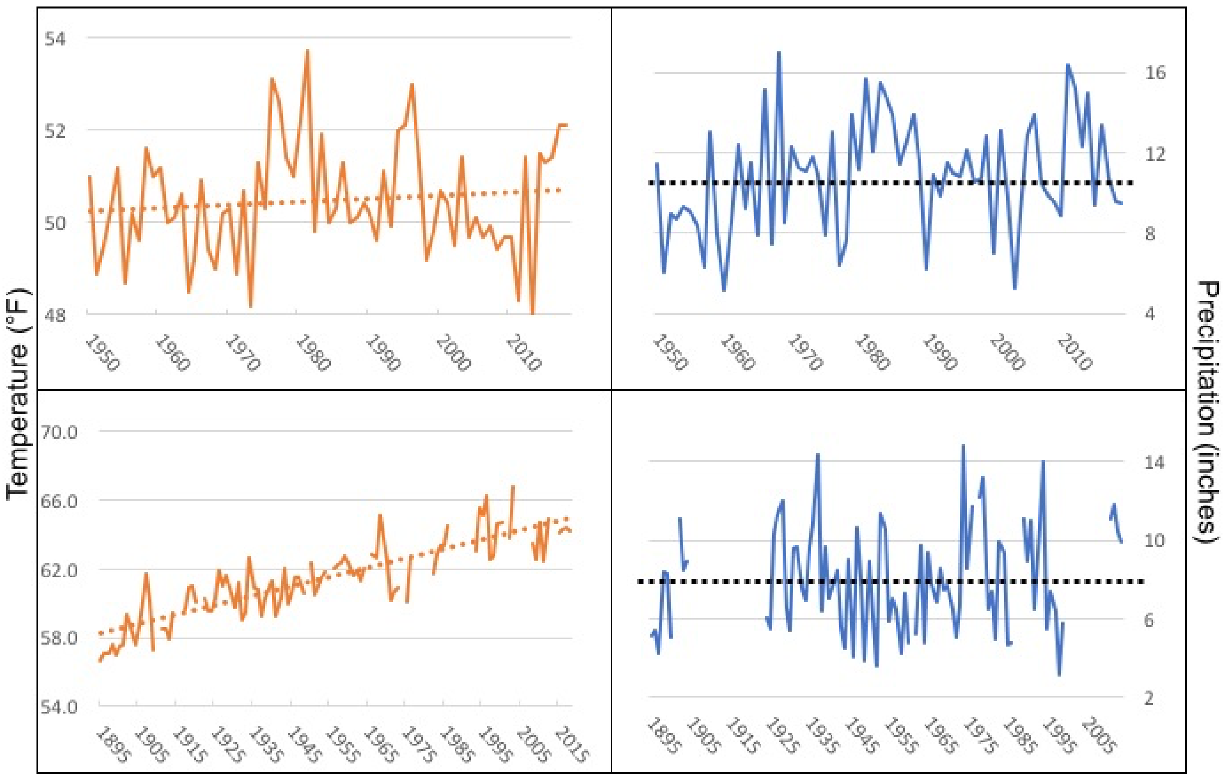


**Figure 2**. Historical temperature (left panels) and precipitation (right panels) in Cedar City (top panels) and St. George (bottom panels). Temperatures and precipitation are annual averages. Gaps in data represent years where not enough data existed to calculate an annual average. Dashed orange line (left panel) shows trend in temperature; the dashed black line (right panel) shows average precipitation. Data was obtained from the NOAA weather service office in Salt Lake City, UT; NOWData; https://w2.weather.gov/climate/xmacis.php?wfo=slc

Figure 3 shows the historical record of annual average temperatures and annual precipitation for Boulder and Salt Lake City. Temperatures in both Salt Lake City and Boulder have warmed significantly throughout the historical record. Salt Lake City temperatures have warmed at a rate of 0.4°F per decade since 1930; annual average temperatures in Boulder have warmed at a rate of nearly 0.5°F per decade since 1955. As with other locations in Utah, precipitation was highly variable and no long-term trends were observed. Long-term average precipitation in Salt Lake City was 15.2 inches and 11 inches in Boulder.

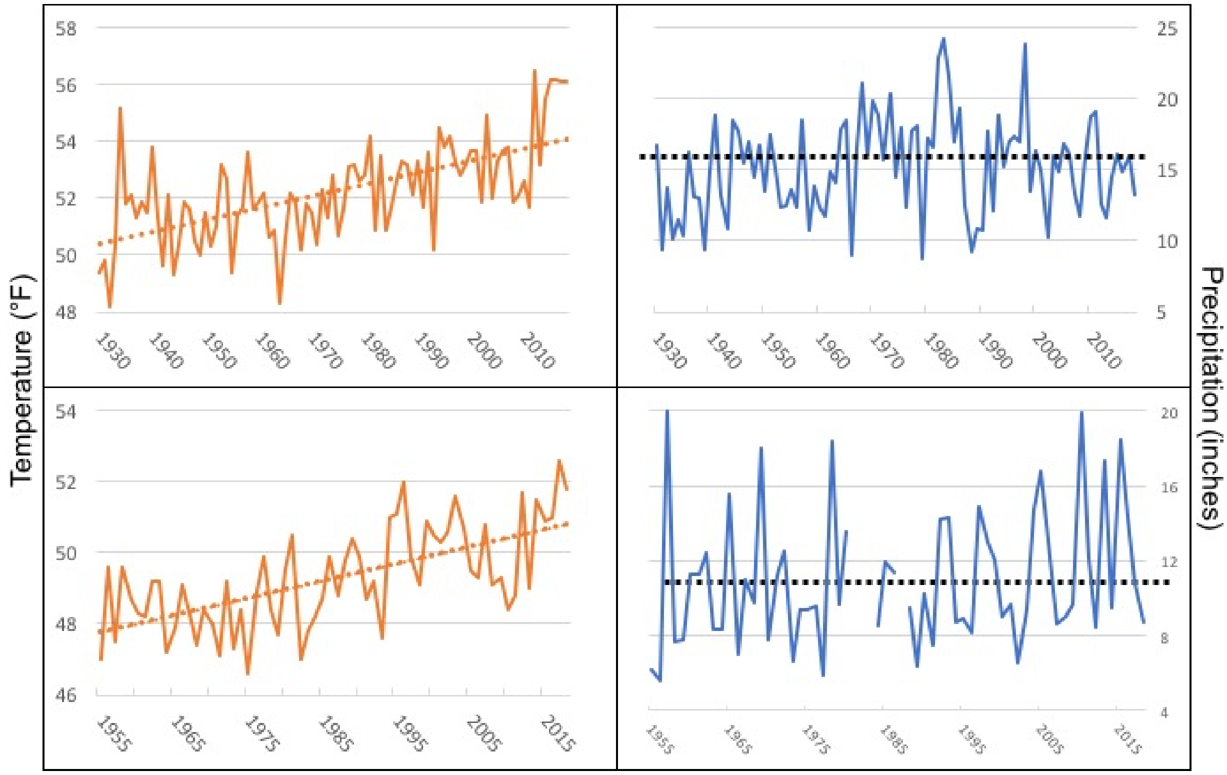


**Figure 3**. Historical temperature (left figures) and precipitation (right figures) in Salt Lake City (top panels) and Boulder (bottom panels). Temperatures and precipitation are annual averages. Gaps in data represent years where not enough data existed to calculate an annual average. Dashed orange line (left panel) shows trend in temperature; the dashed black line (right panel) shows average precipitation. Data was obtained from the NOAA weather service office in Salt Lake City, UT; NOWData; https://w2.weather.gov/climate/xmacis.php?wfo=slc

Four of six locations in Utah described in Figures 1-3 showed strong warming trends over the historical period. The warming trend that is clear in the historical record is projected to continue throughout the twenty-first century. Figure 4 shows future projected changes in temperature and precipitation in Logan, Salt Lake City and St. George. For all three locations, temperatures are projected to warm by 3-4°F by 2050 depending on emissions scenario. By 2100, temperatures are projected to warm by 5°F under a moderate emissions scenario and 10°F under a high emissions scenario. There is a high level of certainty that temperatures will continue to increase in the twenty-first century; the only question is how *much* temperatures will increase. Global climate models used to project future changes in temperature all agree that temperature will increase for all regions of Utah. These global climate models do not agree about changes in precipitation. In general, precipitation will increase in the northwestern United States and it will decrease in the southwestern United States.[4] The geographical location of Utah sits in between these two continental-scale changes. Consequently, it is likely that northern Utah will see a slight increase in precipitation and southern Utah will see a slight decrease in precipitation. However, global climate models do not give a clear projection of how precipitation will change in Utah.

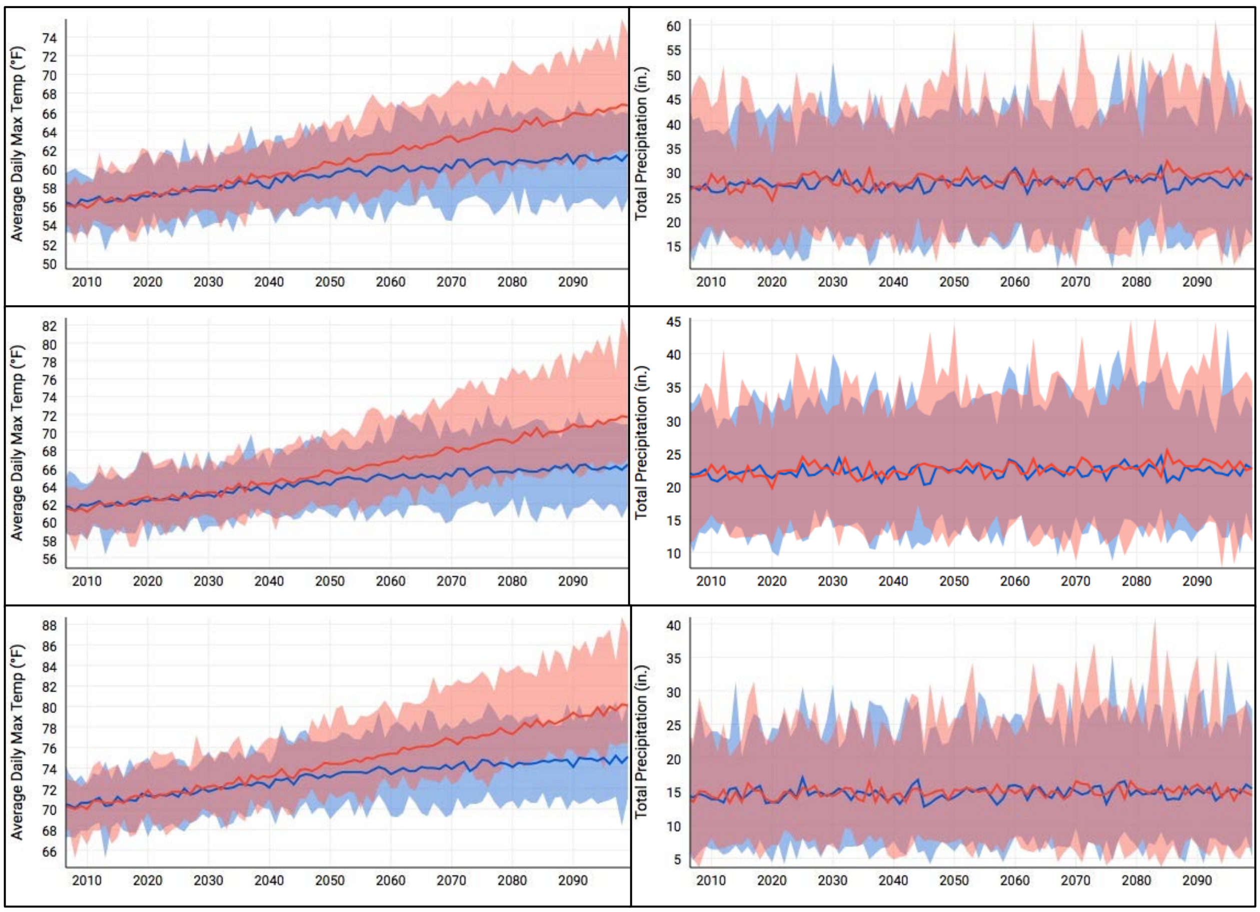


**Figure 4**. Projected changes in average daily maximum temperature (left figures) and projected changes in precipitation (right figures) for Logan (top figures), Salt Lake City (middle figures) and St. George (bottom figures). The blue line represents average projected temperature for a moderate emission scenario, blue area represents the range of climate models, the red line represents the average projected temperature for a high emission scenario, and red area represents the range of climate models. The moderate emissions scenario is the Representative Concentration Pathway, or RCP4.5, and the high emissions scenario is RCP8.5.[5]

It is certain that temperatures will increase through much of the twenty-first century. Increasing temperatures, alone, will have several important impacts to natural hazards in Utah. Higher temperatures will increase the incidence of drought. In the future, years with "normal" precipitation will act like drought years when temperatures are hotter than historical average temperatures. Higher temperatures will increase the risk of wildfire. Higher temperatures in the shoulder season lengthen the fire season, dry soils, increase the dryness of dead wood and increase transpiration from plants; all of these factors lead to an increased risk of wildfire. Severe weather is likely to increase because climate change will cause an increase in extreme weather patterns; these extreme weather patterns can be related to both drought and floods. Extreme precipitation and warming temperatures will likely cause a greater incidence of floods. Warmer temperatures will likely cause a greater incidence of rain-on-snow events that cause mid-winter flooding. In general, climate change will increase the incidence of extreme precipitation. Increases in extreme precipitation associated with monsoonal rainfall will increase the risk to flooding in much of Utah. Overall, climate change will impact weather and climate hazards such as drought, flood and extreme weather and also impact other hazards such as wildfire, landslide, avalanche and dam failure.

**Literature Cited**


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