4.14 CLIMATE CHANGE

Weather: the state of the atmosphere at a given place and time.

Climate: the weather conditions prevailing in an area or region over a long period of time.

Often the terms "global warming" and "climate change" are used interchangeably. Global warming refers to the warming of Earth's temperatures due to an increase in greenhouse gas concentrations. Increasing temperatures are a direct consequence of increasing greenhouse gas concentrations. Warming temperatures can cause disruptions to Earth's weather patterns. "Climate change" is the disruption of Earth's weather patterns because of warming temperatures. Warming temperatures are important to global climate, but a warmer Earth causes a series of complex changes to weather patterns.

Climate change itself is not a natural hazard; natural hazard mitigation planning does not typically include mitigation of climate change. However, climate change can affect the impacts of many other natural hazards. Specifically, changes in climate affect future risks to drought, flooding, dam failure, severe weather, wildfire, and avalanches. This section provides an overview of climate change and provides a basis for further discussion of changes in temperature and precipitation in Utah, especially in the section on drought (Section 4.7).

Climate change can be defined as the warming of the Earth and changes 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.

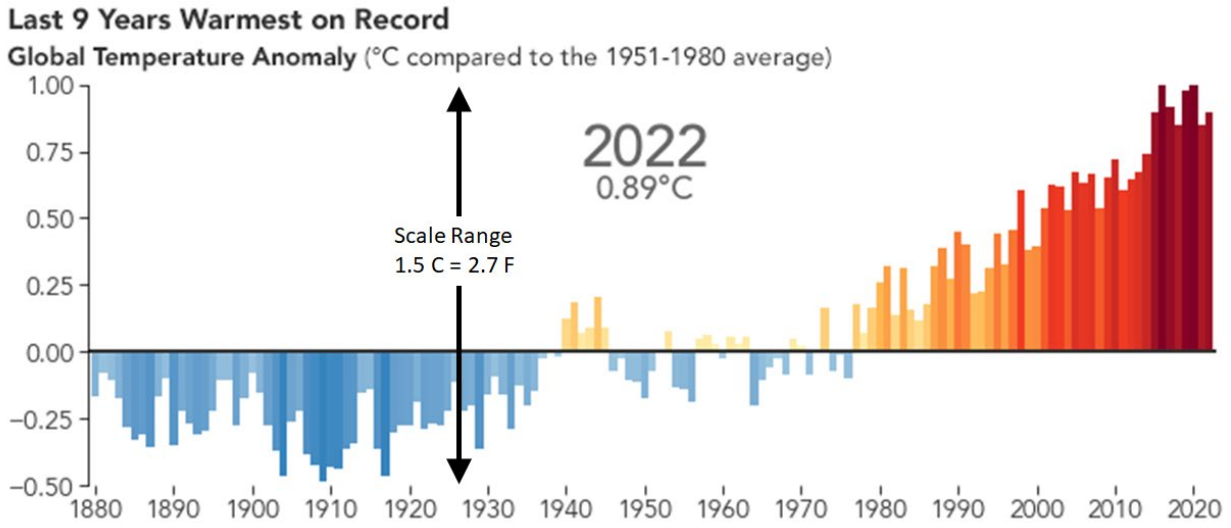
Greenhouse gases, such as carbon dioxide (CO2), methane (CH4) and nitrous oxides (N2O) trap radiation, or heat, near the earth's surface and cause air temperatures to warm. Greenhouse gases are an important part of our atmosphere; life would not exist on Earth without greenhouse gases. However, excess 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 and in Utah, but changes in other aspects of climate and natural hazards can affect the safety of Utah residents.

Climate change does not necessarily decrease precipitation. In fact, as temperature increases, evaporation increases, which drives more precipitation. How this plays out across an enormously complex climate system on Earth is not simple and changes are not uniform. Some locations are getting wetter, some locations are getting drier, snow is being replaced by rain in many places, and the frequency of extreme precipitation is increasing in some places. In some cases, changes to other aspects of weather, such as temperature, overshadow changes to precipitation with regard to hazards such as drought (see Section 4.7.6). Thus far, it is not getting discernably wetter or drier in Utah.

Utah's snowpack provides an interesting case of how changes in precipitation are playing out in complex ways. While Utah is not receiving less precipitation, some of what would normally fall as snow is now falling as rain. This effectively reduces the snowpack depth and length of the snowpack duration. This is discussed with regard to water supply implications in the drought section (4.8). The economic impact of a declining snowpack is briefly discussed below in 4.14.3.

Figure 4-132 below displays global temperature anomalies compared to the 1951-1980 average, indicating an increasing trend in temperatures starting in 1975. Temperatures have not warmed uniformly across the earth's surface; in general, temperatures have warmed much more in polar areas and less at lower latitudes, especially over oceans. Continental regions, those far from the ocean, like Utah, have generally warmed more than the global average. Additional variability exists, for example northern Utah has warmed more than southern Utah since about 1960.

Figure 4-132. Global Temperature Anomalies (1880-2022)

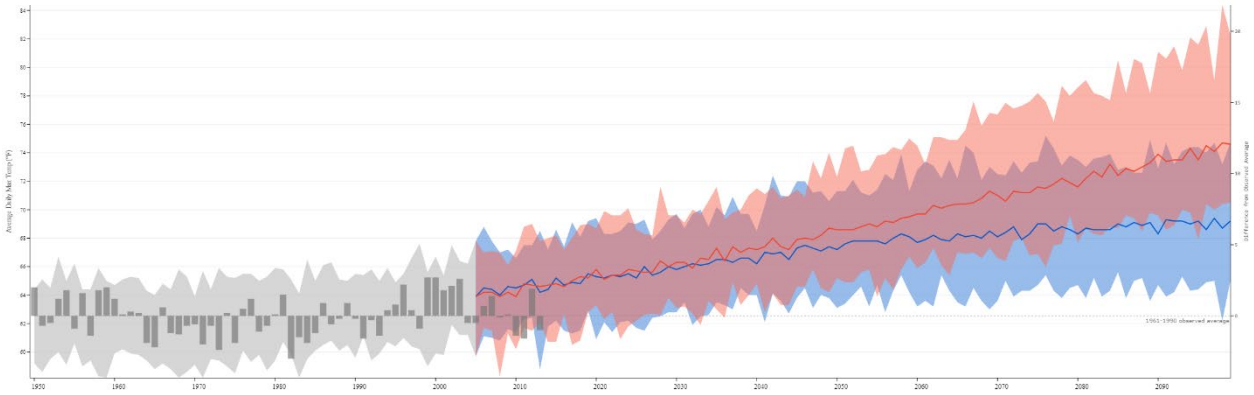


Source: NASA, https://earthobservatory.nasa.gov/world-of-change/global-temperatures

Figure 4-133 through Figure 4-138 display trends in past and future average annual temperature in six counties (Iron County, Cache County, Duchesne County, Salt Lake County, Washington County, and Garfield County) between 1922-2022. Overall, Utah warmed faster than the United States as a whole, warming 2.5°F since 1922 compared to 1.7°F across the entire United States. In all six counties, average temperatures have increased over the past century. The greatest average temperature increase was recorded in Garfield County (3.3°F increase) and the smallest increase in average temperature was recorded in Cache County (2.1°F increase).

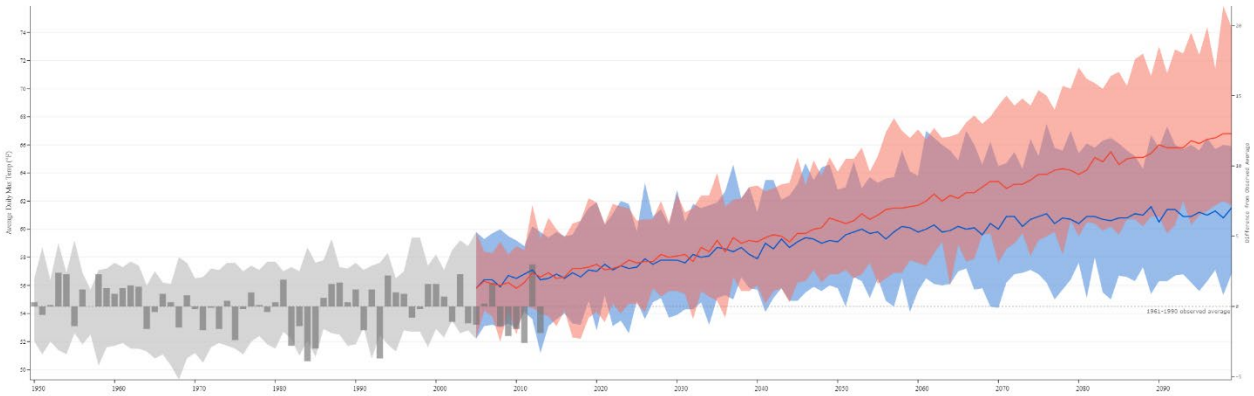
One point of providing figures for six counties is to communicate the degree of variability in warming across the state; there are subtle differences between counties, with an overall trend of undeniable warming. An additional point is that the next 70 years will look different from the past 70 years. Put into numbers, for all six locations, temperatures are projected to warm by 4-6˚F by 2050, depending on the greenhouse gas emissions scenario used in the projection. By 2100, temperatures are projected to warm by 6-10˚F depending on 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.

Figure 4-133 Iron County Projected Changes in Average Daily Maximum Temperature (1950-2100)



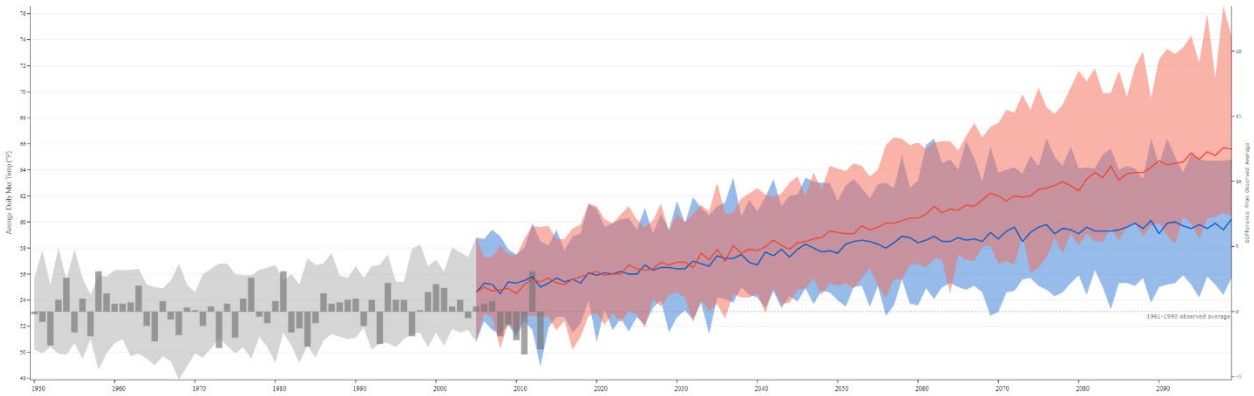
Source: The Climate Explorer, https://crt-climate-explorer.nemac.org/

Figure 4-134 Cache County Projected Changes in Average Daily Maximum Temperature (1950-2100)



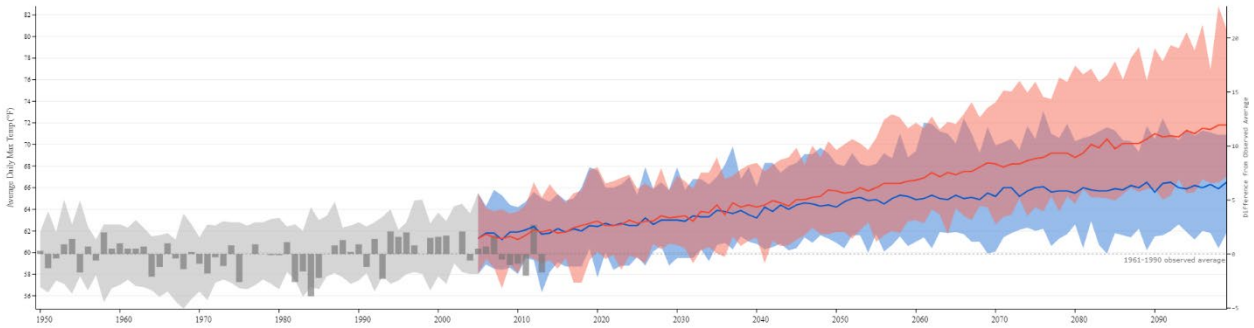
Source: The Climate Explorer, https://crt-climate-explorer.nemac.org/

Figure 4-135 Duchesne County Projected Changes in Average Daily Maximum Temperature (1950-2100)



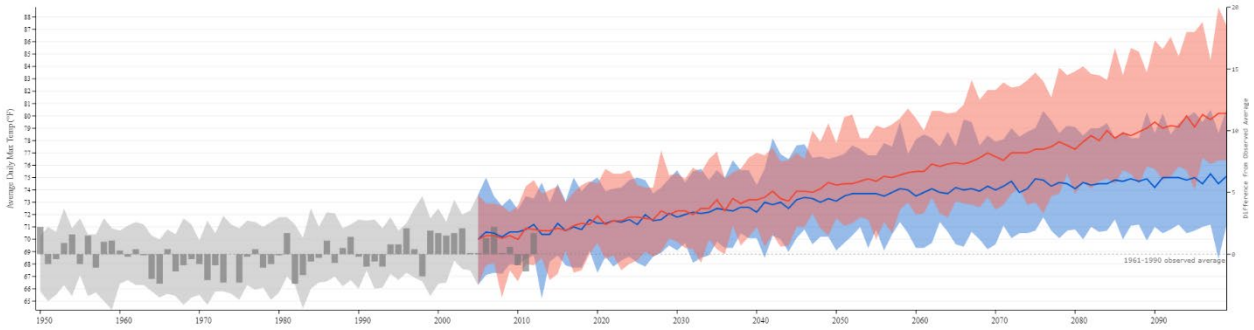
Source: The Climate Explorer, https://crt-climate-explorer.nemac.org/

Figure 4-136 Salt Lake County Projected Changes in Average Daily Maximum Temperature (1950-2100)



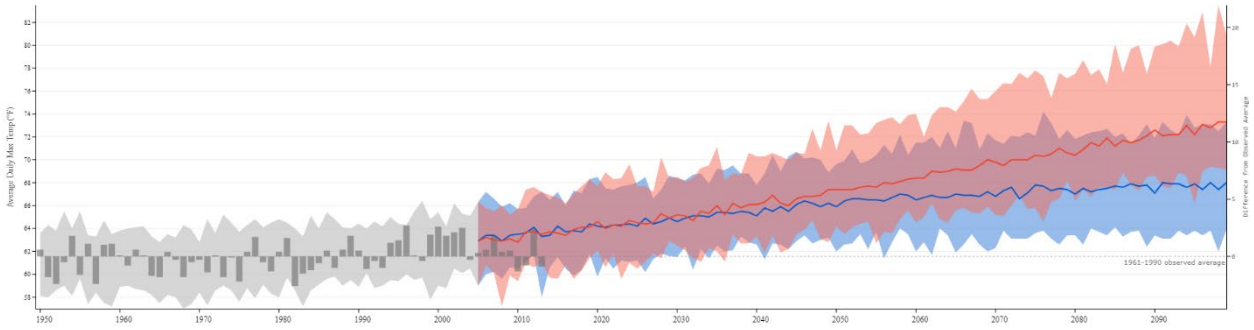
Source: The Climate Explorer, https://crt-climate-explorer.nemac.org/

Figure 4-137 Washington County Projected Changes in Average Daily Maximum Temperature (1950-2100)



Source: The Climate Explorer, https://crt-climate-explorer.nemac.org/

Figure 4-138 Garfield County Projected Changes in Average Daily Maximum Temperature (1950-2100)



Source: The Climate Explorer, https://crt-climate-explorer.nemac.org/

4.14.1 Impacts To Hazards

Describing the past and future trend in air temperature is merely the starting point in a deeper discussion on how climate change affects hazards. Each chapter in the HIRA expands on the basic discussion provided here and puts climate change into context for how it affects hazards facing Utahns. In some cases, such as earthquake (Section 4.9), climate change is not a

significant factor. In other cases, such as drought (Section 4.8) and wildfire (Section 4.13), the effects are quite significant and considerable discussion is provided.

4.14.2 Impacts on Vulnerability of State Assets

The impact of climate change on the vulnerability of state assets is difficult to predict with specificity due to uncertainty. However, some general conclusions can be drawn with respect to certain hazards, notably wildfire. With wildfire season expansion and changes in intensity of fire behavior the assets noted at-risk to wildfire in Section 4.13.7 are specifically acknowledged. Assets at risk to flooding noted in Section 4.8.7 may be subject to extreme events in the future. Asset exposure to avalanches is already low and not expected to grow in vulnerability. Asset risk from geologic hazards and earthquake is not anticipated to be affected significantly by climate change. Very few state assets are directly at risk from drought. Due to uncertainty, it is difficult to predict if asset vulnerability to severe weather or dam incidents may be altered by climate change. Vulnerability of state assets to space weather events is not expected to increase from climate change.

4.14.3 Impacts To Health

The health impacts from a changing climate and how it impacts Utah residents have been documented in the Utah Department of Health "Climate Change and Public Health in Utah" plan.[37] This plan addresses environmental and health indicators, and the effects climate change is having on them and how our community design is compacting climate change effects.

The 2020 "Climate Change, Water Resources, and Potential Adaptation Strategies in Utah" report by the Utah Department of Natural Resources[38] discusses some of the direct and indirect impacts of climate change to local public health in Utah. The report notes that an increase in temperature can reduce air quality in Utah and across the United States because some atmospheric chemical reactions occur quicker in warmer conditions. This results in heat waves accompanied by increased ground-level ozone. Additionally, the 2020 report noted that heat stress is one of the leading weather-related causes of death in the United States and is a recurrent health issue for urban residents.

Some of the health impacts of ozone exposure include higher rates of respiratory disease, increased asthma prevalence, increased heat related disease, and premature death from heart and lung disease. From the Health Plan, "Ozone can have negative effects on human health. Increased levels of ozone can irritate the respiratory system and cause coughing, sore throat, and chest discomfort. Additionally, if ozone pollution gets deeper into the lungs, it can damage the lining of the lungs. Other health effects include lower resistance to infectious diseases and allergen sensitivity".

4.14.4 Impacts To Utah's Economy

Park City was early in identifying climate change as a threat to economic prosperity. The city commissioned a research study completed in 2009[39] that documented how climate change will likely impact the city as well as the skiing industry. The study found that projections of decreasing snow levels threaten the length and quality of the ski season. The study went on to

37 Spencer M, Stembridge ESB, and Phillips LU. Climate Change and Public Health in Utah. Salt Lake City: Utah Department of Health, 2012.
38 Khatri, K. B., & Strong, C. (2020). Climate change, water resources, and potential adaptation strategies in Utah. Salt Lake City, UT: Division of Water Resources, Utah Department of Natural.
39 Park City Foundation. (2009) Climate change in Park City: An assessment of climate, snowpack, and economic impacts. Prepared by Stratus Consulting, Inc., Report #SC11855. Accessed 12/4/2023 at http://www.parkcitygreen.org/Documents/2009-Climate-Change-in-Park-City-Report.aspx.

predict a $120 million impact to the economy by 2030. This prediction remains plausible given that in 2009 the ski industry created 20,000 jobs and generated $1.3 billion of economic activity annually in Utah.

Climate change will impact Utah's agricultural economy as well. The livestock industry in Utah relies on open grazing, which is predicted to be reduced in capacity. At the same time, increased heat will further stress livestock. As a result, livestock production will decline.

Hotter summers and especially reduced snowpack and runoff make the availability of irrigation water less reliable. This has evidently been occurring in Utah for some time. A 2011 paper *Ranching and Multiyear Droughts in Utah*[40] found that "75% of Utah ranch operations reported major reductions in water supply, forage, and cattle productivity." According to a Utah State report, agriculture accounts for 15% of Utah's economy, accounting for $21 Billion a year.

The agriculture industry is sensitive to a variety of factors that are influenced by climate change. Pests, irrigation water availability and quality, shorter cool-weather periods, and rapid changes in seasonal timing of crop development are all examples of how climate change affects agriculture.

4.14.5 Climate Change and the ESHMP

This ESHMP is designed to address natural hazard concerns. The plan only addresses climate change indirectly, as if affects natural hazards. This commonly takes form as climate change adaptation. Examples include actions taken to reduce wildfire, most drought actions, and some severe weather actions.

4.14.6 Climate Change Plans and Legislation Addressing Impacts in Utah

One study and one plan were mentioned previously; The Utah Department of Health's "Climate Change and Public Health in Utah" and Park City Green study in 2009. In this section we will discuss other plans and Legislation that has passed.

In 2018, the Utah Legislature passed, and Governor Herbert signed, H.C.R. 7 Concurrent Resolution on Environmental and Economic Stewardship. H.C.R. 7 recognizes the impacts of changing climate and encourages resilient ecosystems that can better adapt and the reduction of emissions through incentives and the support of growth in technologies and services that enlarge the economy.

The Utah Climate Action Network works to build partnerships between 20 public and private organizations, including Salt Lake City, Salt Lake County, Park City, Alta Ski Area, West Valley City and the University of Utah to address climate change in Utah. The Climate Network holds quarterly meetings and is working to bring these groups together to fully address climate change and its impacts on Utah.

Salt Lake City completed the Climate Positive Plan 2040 in 2016. The plan establishes a baseline of where the city is and outlines transformational steps to reach their long-term climate and energy goals. Salt Lake City is a leader in addressing climate issues and innovative in their solutions and goals. Those goals include:

- 100 x 2032: 100% Renewable Energy for Community Electricity Supply by 2032
- 80 x 204 0: 80% Reduction in Community Greenhouse Gas Emissions by 2040

40 Coppock, D. L. (2011). Ranching and multiyear droughts in Utah: production impacts, risk perceptions, and changes in preparedness. Rangeland Ecology & Management, 64(6), 607-618.

Salt Lake City has implemented city operations solutions such as Net Zero construction that requires all new city buildings over 10,000 square feet must meet Net Zero Energy standards, and Clean Vehicle Fleet, replacing old vehicles with clean hybrid or electric vehicles.

The US Forest Service rolled out their Climate Change Vulnerability & Adaptation Plan in the Intermountain Region plan in the spring of 2018. The nearly 1,000-page document addresses climate change for the intermountain West, that includes all of Nevada, Utah, and southern Idaho. The plan focuses on USFS lands, but relevant because of the extent of these lands in the Intermountain Region and Utah.

The US Global Change Research Program (USGCRP) delivered the fourth report of The National Climate Assessment in 2018.[41] The report is mandated to be delivered to Congress and the President every four years and must integrate, evaluate, and interpret findings of USGCRP, and analyze the effects of the global change on the natural environment, agriculture, energy production and use, land and water resources, transportation, human health and welfare, human social systems, and biological diversity and analyze global climate change, projecting trends for the next 25 to 100 years.

The League of Women Voters in Utah developed a study on Utah's Transition to Clean Energy in April 2020. The study was developed to inform the League members to advocate for clean energy and reduce greenhouse gas emissions that contribute to the warming of our planet. The study reported that Utah has warmed by 3 degrees Fahrenheit, which is greater than national and global averages. The article emphasizes that Utah has potential to mitigate greenhouse gas emissions due to the State's abundant solar and geothermal resources that offer clean-energy alternatives and the state's superior outdoor environment attracts the workforce needed to problem-solve the transition to clean energy.

In addition to the above-mentioned climate change plans and legislation, the Utah Legislature requested the creation of "The Utah Roadmap" to improve air quality, address causes and impacts of climate change, and assist in legislative policy making. This roadmap is a plan created by the Kem C. Gardner Policy Institute with the assistance of a 37-person Technical Advisory Committee and was published on January 31, 2020. The plan identifies recommendations for the State of Utah to reduce greenhouse gas emissions and prioritizes 59 of the previous 200 policy options with the greatest potential to impact Utah's air quality and changing climate.

41 NCA 5 was released in late 2023, after this chapter had been drafted.