Climate Change Data and Trends

Increasing levels of greenhouse gas emissions are warming our planet and driving climate change. How do scientists know this? This appendix provides a snapshot of some of the key data points and observed trends related to global climate change. References and links are provided to key sources of information, which provide more in-depth data, trends, and scientific analysis.

Global Average Temperature

The planet's average surface temperature has risen about 1.1°C since 1880, based on measurements made on land and at sea (Figure 1).[1] Most of that warming has occurred in the past 35 years, with polar regions experiencing greater warming than the more temperate regions.[2] Sixteen of the seventeen warmest years on record have occurred since 2001. Scientific research has shown this change is driven primarily by increased carbon dioxide and other human-made greenhouse gas emissions into the atmosphere.[3,4] Although the global atmospheric concentrations of carbon dioxide have varied over the millennia, since the industrial revolution in the mid-1700s it has increased to unprecedented levels (Figure 2).[5]

1 https://climate.nasa.gov/vital-signs/global-temperature/
2 https://www.climate.gov/news-features/understanding-climate/climate-change-global-temperature
3 https://climate.nasa.gov/evidence/
4 http://www.ipcc.ch/pdf/assessment-report/ar5/wg1/WG1AR5_SPM_FINAL.pdf
5 https://climate.nasa.gov/evidence/

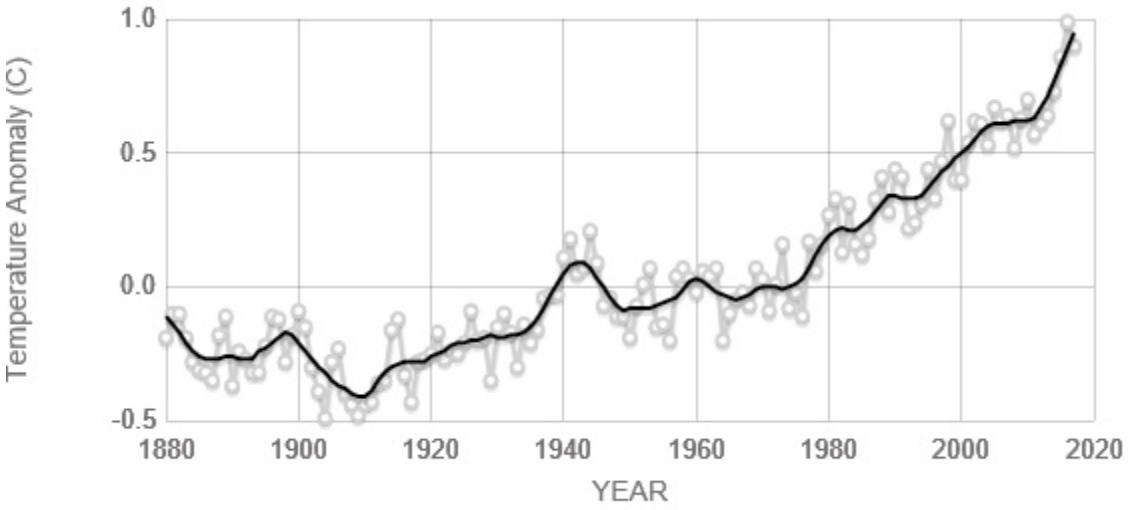

Figure 1. Global surface temperature change (land and ocean, compared to 1951-1980 average)

SOURCE: CLIMATE.NASA.GOV

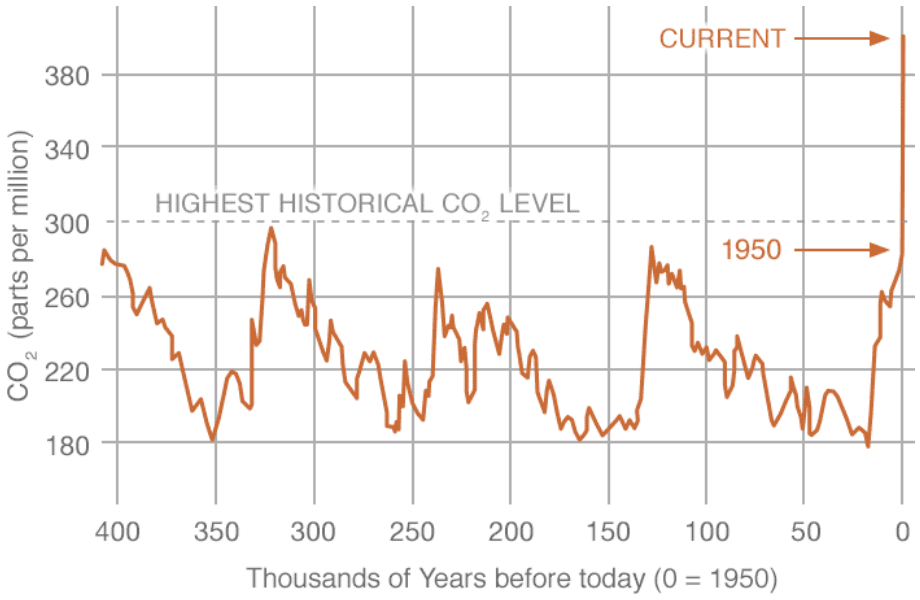

Figure 2. Global atmospheric concentrations of carbon dioxide over the past 400,000 years

(CREDIT: VOSTOK ICE CORE DATA/J.R. PETIT ET AL.; NOAA MAUNA LOA CO2 RECORD.)

Changing Global Climate System

Scientists have projected that increasing global temperatures would cause a number of significant changes to the global climate system. Some of these changes, such as declining global snow and ice cover and rising sea levels, are happening gradually as temperatures rise. Other changes are a consequence of amplified climate instability, for example the increasing frequency and intensity of extreme weather events such as heat waves, heavy precipitation, and storms. Below is a description of three of the expected changes to earth systems caused by rising global temperatures: sea level rise, decreased snow and ice cover, and extreme weather events.

SEA-LEVEL RISE

As the climate warms, sea levels are rising worldwide (Figure 3).[6] Higher global temperatures contribute to sea-level rise in two ways. First, as ocean temperatures increase, seawater expands and the overall volume of oceans increases. Second, higher temperatures accelerate the melting of glaciers and ice caps, also increasing the volume of the oceans.

Globally, sea levels have risen at an average rate of 1.8 mm per year from 1961 to 2003 and approximately 20 cm since 1880. Sea levels are expected to rise by an additional 30 to 120 cm by the year 2100.[7]

Coastal regions face several risks from rising seas. Higher sea levels will flood unprotected low lying areas such as islands and coastal river deltas. Wave action combined with higher sea levels will make more land vulnerable to coastal erosion.[8] Moreover, in the next several decades, storm surges and high tides combined with sea level rise will further increase flooding risk. In some coastal areas, groundwater and/or surface water will be contaminated with sea water as sea levels rise. This could impact the water available for irrigation and drinking water.

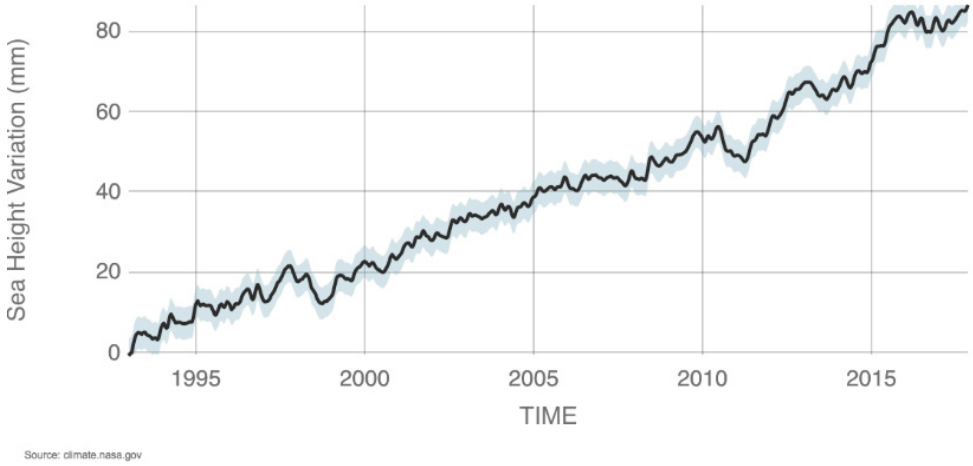

Figure 3. Sea Level Rise from 1993 to Present

6 https://climate.nasa.gov/vital-signs/sea-level/
7 https://climate.nasa.gov/evidence/
8 https://www.ipcc.ch/pdf/assessment-report/ar5/wg3/ipcc_wg3_ar5_summary-for-policymakers.pdf

DECREASED SNOWPACK/SNOW COVER

Snow and ice cover helps regulate the climate by reflecting incoming solar energy back into space. Over the next century, water contained in glaciers, ice caps and annual snowpack are expected to continue to decline. With less snow cover and a decrease in the amount of reflected sunlight, the ground absorbs four to six times as much heat.

Monitored snowpack levels in western North America are decreasing, with record lows observed throughout the United States (Figure 4).[9] Since 1955, average snowpack has declined on average by 14 percent including areas in California, Oregon, and Washington, with some sites recently experiencing snow-free periods for the first time ever.[10] Glaciers have been retreating at least since the 1960s and mountain snow cover has declined on average in both the Northern and Southern hemispheres.[11]

The decline of glaciers and annual snowpack will reduce freshwater availability in regions supplied by meltwater, where more than one sixth of the world population currently lives. Rapid melting snowpack can also lead to springtime flooding and lower river and reservoir levels in the late summer. Changes in melting patterns and reduced stream flow will also affect hydro-electric power generation that is reliant on the water that is supplied through melting snowpack.

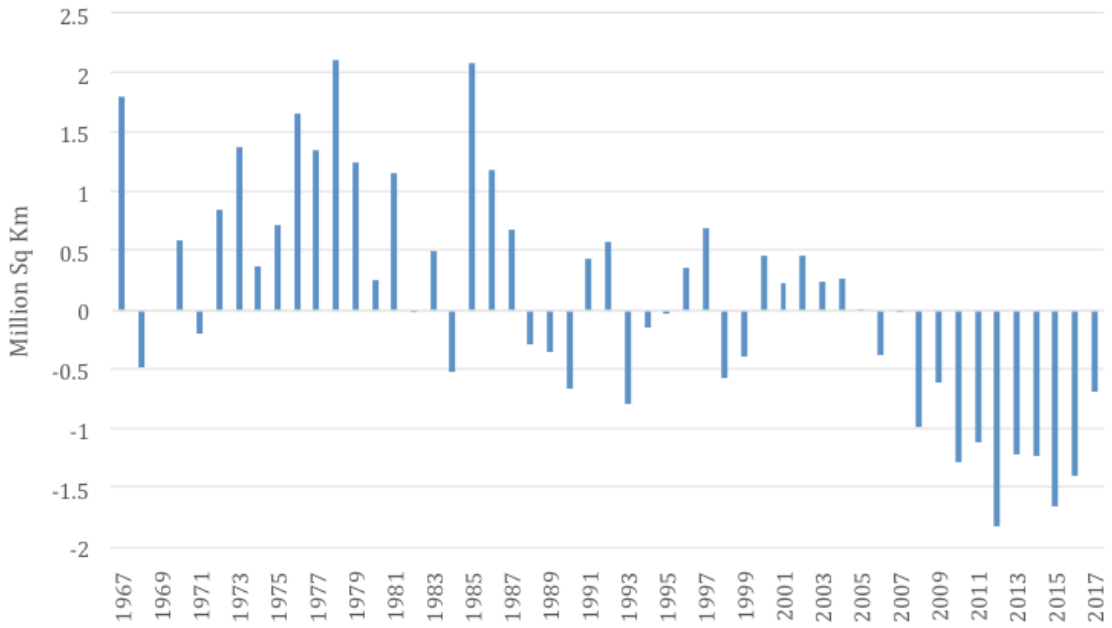

Figure 4 North American snow cover compared to 1981-2010 average

SOURCE: RUTGERS UNIVERSITY GLOBAL SNOW LAB12

9 https://climate.rutgers.edu/snowcover/chart_anom.php?ui_set=1&ui_region=namgnld&ui_month=6
10 https://blog.epa.gov/blog/2015/06/the-importance-of-snowpack/
11 http://nsidc.org/cryosphere/sotc/snow_extent.html
12 https://climate.rutgers.edu/snowcover/chart_anom.php?ui_set=1&ui_region=namgnld&ui_month=6

EXTREME WEATHER EVENTS

Climate change is increasing the frequency and intensity of extreme weather events. Climate-change-related risks from extreme weather events are already considered moderate to high with 1°C of warming and those risks are expected to increase as temperatures continue to rise.[13] International agencies that are tracking extreme events are already observing an increase (Figure 5).[14] Scientists are increasingly able to evaluate the contribution of climate change to specific extreme events.[15]

Although there has been a slight increase in the frequency or duration of droughts over the last 50 years, scientists expect climate change to increase the intensity and duration of droughts to increase after 2050, especially if global GHG emissions do not decline.[16] [17] Less snow and a lack of moisture in the ground increases the likelihood and prevalence of wildfires and dry spells. Longer dry spells and drought in the summer months also increase wildfire risk.

Scientists are studying how the frequency and severity for floods will change due to climate change.[18] Globally, the amount of damage caused by extreme weather events, including flooding, is increasing dramatically – both from the number of events and the increasing value of the built environment.[19] In BC, flood risk is exacerbated by sea level rise, particularly during events such as king tides and storm surges.

Climate-related weather extremes and shifting temperature patterns can put stress on ecosystems, disrupt food production and water supply, damage infrastructure and urban settlements, lead to loss of life, and have consequences for population health.[20] These interrelated challenges pose a particular threat to cities with aging infrastructure such as water and sewage systems, roads, bridges, and energy grids. Governments, including municipalities, are spending more on climate change adaptation to protect essential services, with costs rising from $4 billion globally in 2010 to $25 billion in 2014.[21]

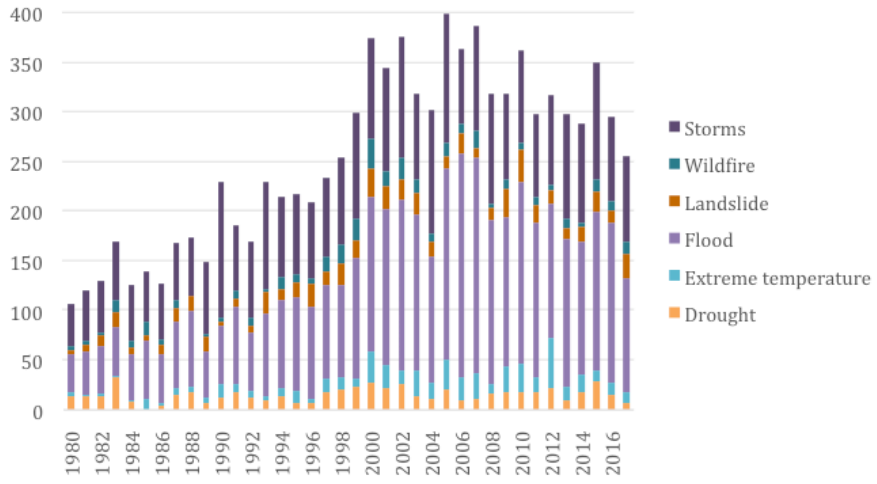

Figure 5. Reported Extreme Weather-related natural disaster events 1980-2017[22]

DATA SOURCE: EMDAT (2017): OFDA/CRED INTERNATIONAL DISASTER DATABASE

13 http://www.ipcc.ch/pdf/assessment-report/ar5/wg2/ar5_wgII_spm_en.pdf
14 https://ourworldindata.org/natural-catastrophes
15 https://e360.yale.edu/features/pinning-wild-weather-on-climate-change-scientists-are-upping-their-game Yale Environment 360
16 https://rmets.onlinelibrary.wiley.com/doi/pdf/10.1002/joc.3875
17 https://svs.gsfc.nasa.gov/cgi-bin/details.cgi?aid=4270
18 https://www.earth-syst-dynam-discuss.net/esd-2017-59/esd-2017-59.pdf
19 http://www.iisd.org/sites/default/files/publications/adaptation_can_infrastructure.pdf
20 http://www.ipcc.ch/pdf/assessment-report/ar5/wg2/ar5_wgII_spm_en.pdf
21 https://nca2014.globalchange.gov/report/sectors/urban
22 https://ourworldindata.org/natural-catastrophes