Climate Change in the Átl’ḵa7tsem / Txwnéwu7ts/ Howe Sound Region

“Our dependency on the earth to ensure life for all resources, animals and human beings has been taught through the generations.”

Kúkwpi Ta̋ya (CHIEF LEONARD ANDREW), Líl̓wat NATION
FROM “WHERE RIVERS, MOUNTAINS AND PEOPLE MEET”.
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Climate change refers to shifts in long-term (i.e., 30 years or greater) patterns of weather, including variations in temperatures, precipitation levels and/or extreme weather events. And while climate changes naturally over long periods, it is now clear that human activities have been responsible for the majority of warming experienced over the past 150 years[i].[1]

Increasing concentrations of greenhouse gases (GHG) in our atmosphere, most notably carbon dioxide (CO_2)[ii] – along with land use changes such as urbanization, affecting how much carbon natural systems can remove from the atmosphere – have been quickly changing Earth’s climate in recent times. GHGs do not interact with shortwave radiation (or light energy) coming from the Sun to Earth. The Earth converts this light energy into longwave radiation (or heat energy). When heat moves away from the Earth, GHGs absorb and quickly re-emit some of this outgoing longwave radiation. In other words, these gases trap heat and lead to a warmer planet. This phenomenon is known as the greenhouse effect, which is natural and essential for sustaining life as we know it on our planet.

i) The Intergovernmental Panel on Climate Change (IPCC) states that the level of likelihood of this statement being true is greater than 95%.

ii) Other GHGs emitted by human activities include methane, nitrous oxide and hydrofluorocarbons (HFCs).

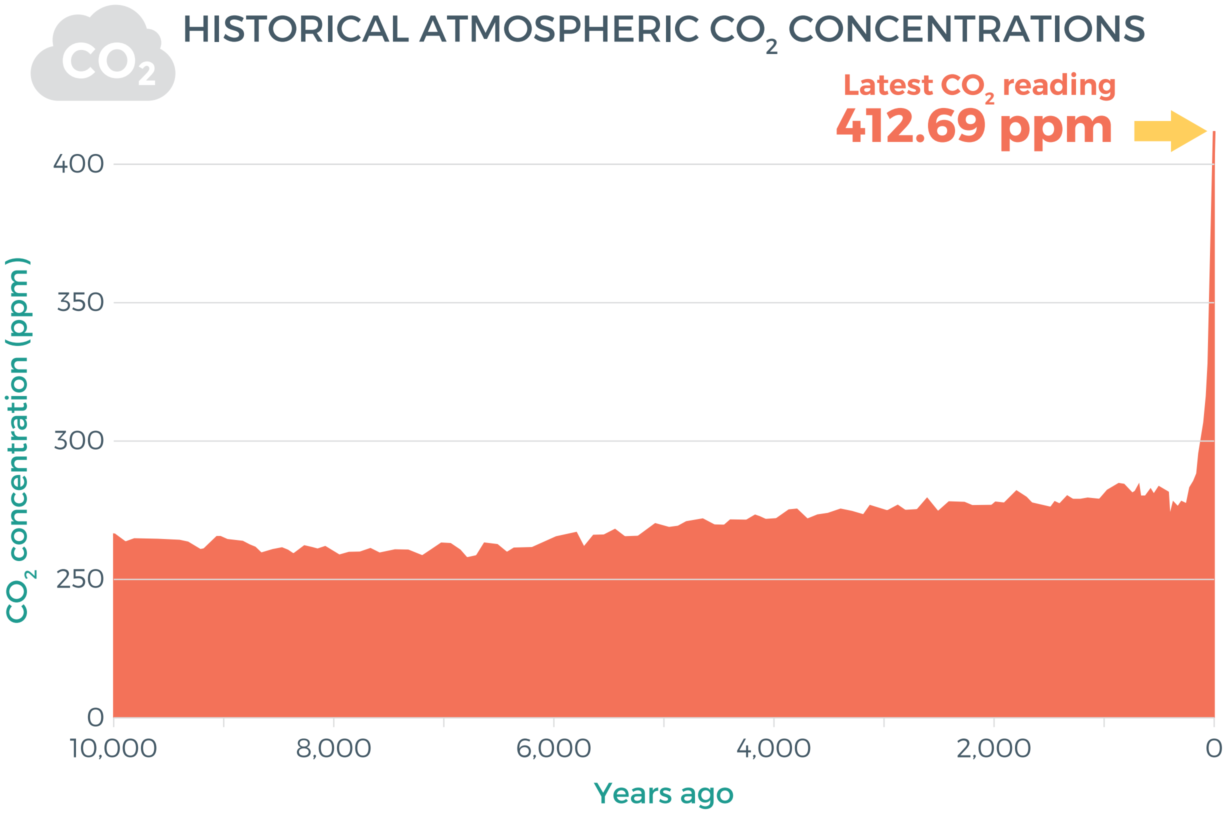

Figure 1. Historical atmospheric CO_2 concentrations from 10,000 years ago until present. Current levels are measured at the Mauno Loa observatory on Hawai’i. Go to https://scripps.ucsd.edu/programs/keelingcurve/ to see the real time concentration.

Recent (i.e., post-1950s) atmospheric CO_2 levels have increased dramatically compared to historical levels over the last 10,000 years (Figure 1). In 2016, CO_2 levels in the atmosphere surpassed 400 ppm and failed to return below this value. This is the first time this has occurred in the last 800,000 years[2], and likely the first time it has occurred since the Pliocene Epoch (between 2.6 and 5.3 million years ago).[3]

Many aspects of the climate system are highly complex and uncertain, and some are still not fully understood. However, the reality of anthropogenic[iii] climate change is simply scientific fact. A full discussion of energy budgets, GHGs, the greenhouse effect, positive feedback cycles[iv] and other relevant concepts can be found in excellent and readily available climate change resources (see Resources).

iii) Anthropogenic – human-caused.

iv) Positive feedback cycles – cycles that amplify the warming effects of increased GHGs. Common feedbacks include water vapour (which is a GHG that increases in concentration as air temperatures increase); albedo feedbacks (i.e., less snow and ice makes the earth less reflective allowing more heat to be absorbed by the oceans); forest fires; permafrost melting; and loss of ocean life.

Past climate change

Reliable global temperature information has been available since approximately 1880, at which point there were enough weather stations around the world to confidently estimate global temperatures. Older records exist (both human records and paleoclimate data[v]), but these involve greater uncertainties. Since pre-industrial times, average global temperatures have risen by approximately 1.0°C.[4] Northern areas, such as the Canadian Arctic, have warmed, and continue to warm, considerably faster compared to areas closer to the equator. Most inland areas have warmed faster than coastal areas in part because oceans are a large heat sink. For example, northeastern B.C. has experienced greater average temperature increases than Vancouver Island.

Average air temperatures in Canada have increased by approximately double the global average.[5] Since 1900, air temperatures in southwestern B.C. have increased by approximately 1.2°C, with winter temperatures

School strike for climate change, Vancouver, B.C., September 27, 2019. (Credit: Brett Vo)

v) Paleoclimate data – information about the climate at any given time in the past. These data can come from tree rings, ice cores, sediment samples, and other evidentiary sources.

(Figure 2, top) increasing faster than summer temperatures (Figure 2, bottom). Additionally, the rate of temperature increase has been occurring faster since 1951 (red lines in Figure 2) in both winter and summer.

Precipitation is much more variable compared to temperature because it can change considerably between nearby locations and can vary greatly from year to year. This makes it hard to discern clear trends. However, precipitation has generally increased globally over the past 100 years, partially because a warmer atmosphere holds more water vapour.[6] Specifically, in the Pacific Northwest, part of the difficulty in measuring precipitation changes is that there are major climatic cycles, namely the El Niño Southern Oscillation[vi] and the Pacific Decadal Oscillation[vii], that cause significant variations in precipitation levels.

Overall, data for B.C. indicate a precipitation increase of approximately 5%.[7] Historical trends in winter (Figure 3, top) and summer precipitation (Figure 3, bottom) show an increase in precipitation overall, but since 1951, there has been a decrease in winter precipitation (blue lines). There is low confidence in these trends because of such factors as noted above (e.g., annual and geographical variation). Climate change also affects the phase of precipitation: more rain and less snow have implications for snowpack, aquifers and stream flows.

Ocean temperatures are also increasing (see Ocean Warming, OWHS 2020). Thermal expansion[viii] and melting glaciers are driving sea level rise (see Shoreline Erosion, OWHS 2020). With increased atmospheric CO_2 concentrations, oceans are also becoming more acidic (see Ocean Acidification, OWHS 2020). Ocean acidification is a separate issue from climate change, but both are linked to increases in CO_2.

vi) El Niño Southern Oscillation (ENSO) – irregular, periodic variations in wind and sea surface temperatures over much of the Pacific Ocean, which impact climate in surrounding areas.

vii) Pacific Decadal Oscillation (PDO) – a recurring pattern of ocean-atmosphere climate variability centred over the Pacific basin.

viii) Thermal expansion – water increases in volume as it warms.

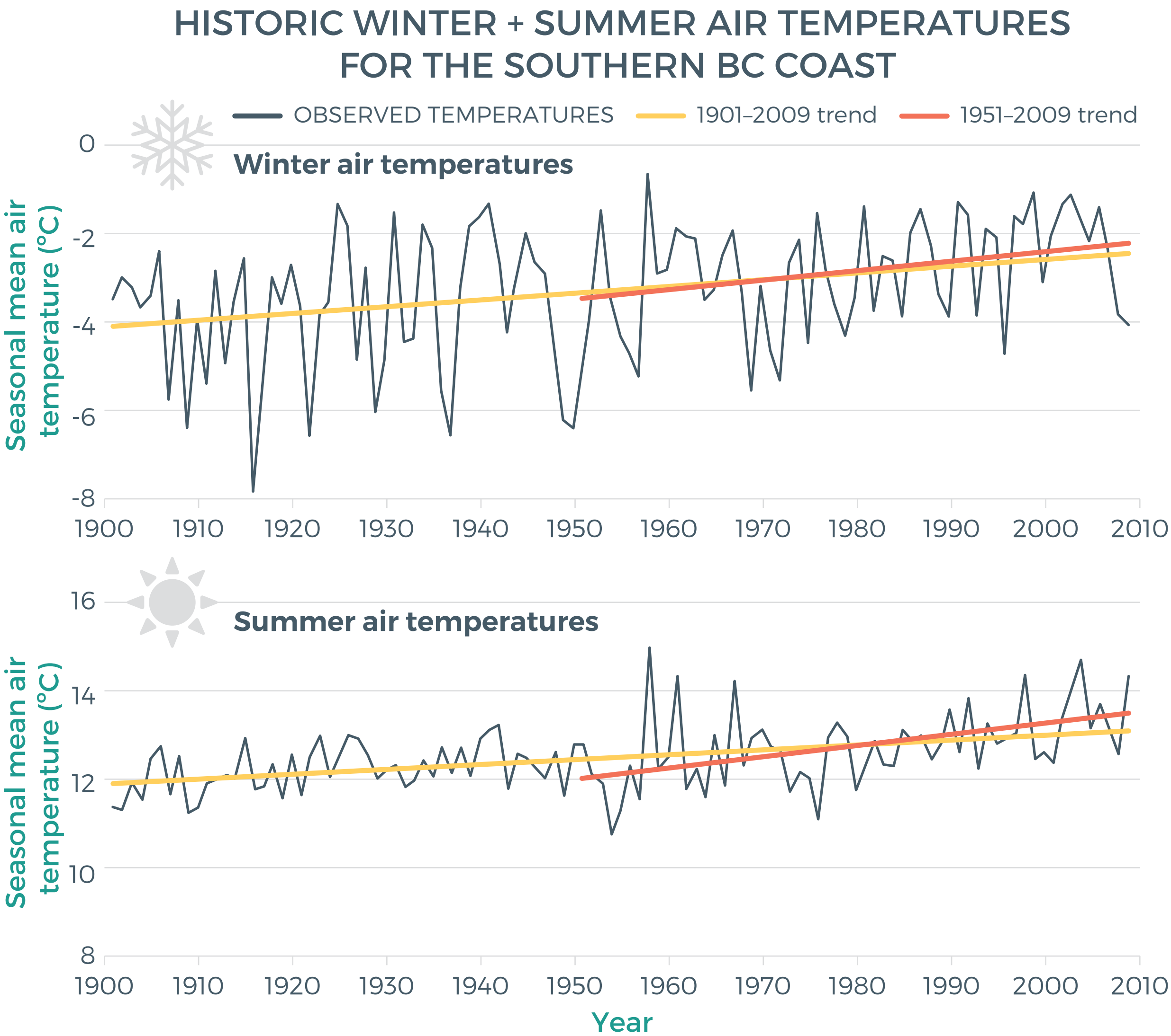

Figure 2. Historical winter (top) and summer (bottom) air temperature time series for the south coast region of B.C., which includes Átl’ḵa7tsem/Txwnéwu7ts/Howe Sound. (Adapted with permission from PCIC, 2013).

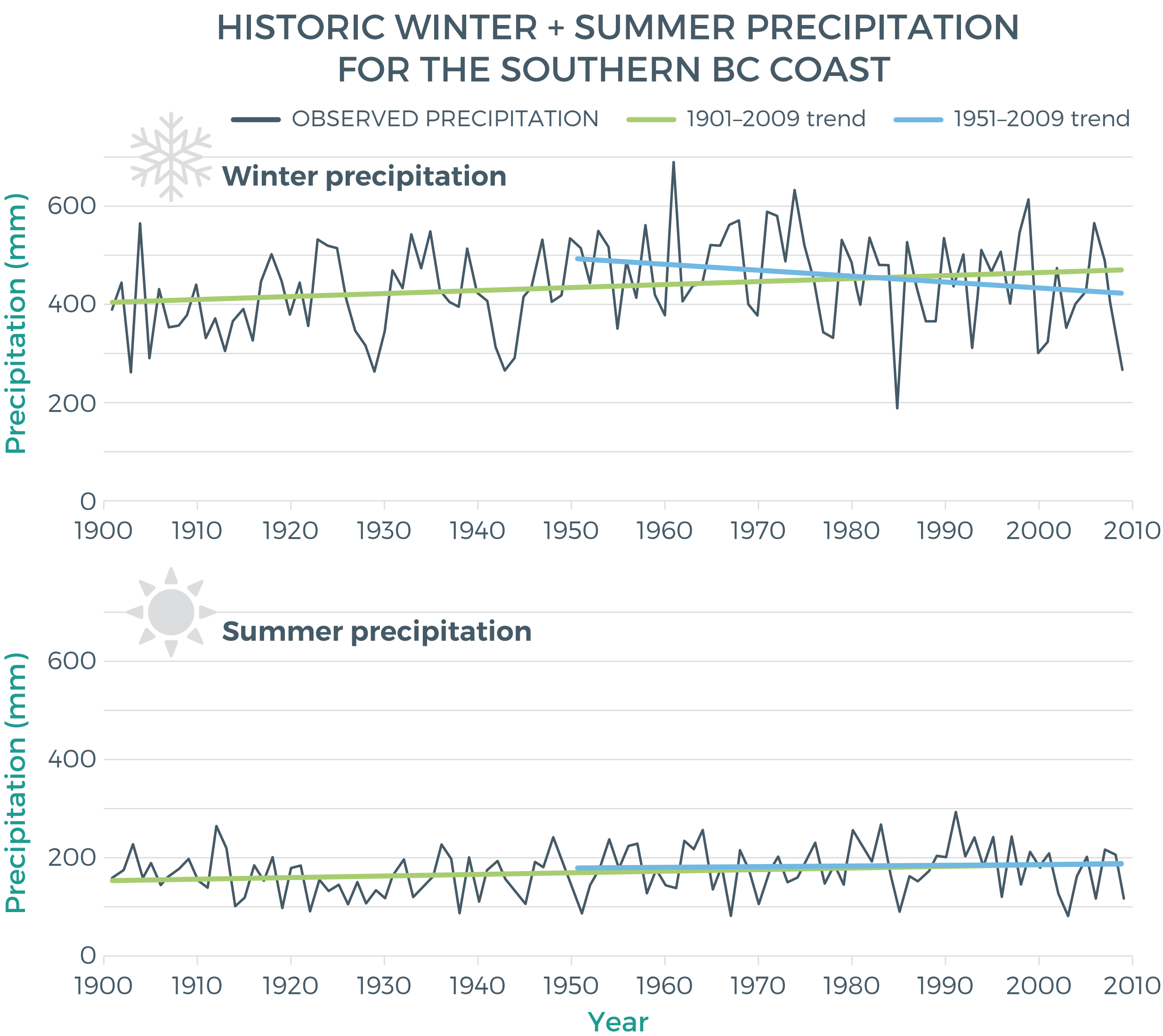

Figure 3. Historical winter (top) and summer (bottom) precipitation for the South Coast region of B.C., which includes Átl’ḵa7tsem/Txwnéwu7ts/ Howe Sound. (Adapted with permission from PCIC, 2013).

Future climate change

Projecting future climate changes is a complex and uncertain undertaking. The best tools available for projecting future climates are global climate models (GCMs). These are mathematical representations of the global climate system based on well-established physical and chemical principles. They are now so comprehensive they require super-computing capacities to run.

Once a model has been established and tested, different scenarios can be run to provide estimates of future climate conditions, for example, average and extremes in temperatures and precipitation levels. The scenarios run in these models differ primarily in how many GHGs humans emit and therefore give different projections of climatic conditions. Models may (and do) differ in how they represent various processes (such as how clouds form). Such slight mathematical nuances account for the differences in projections for the same scenarios (illustrated by the shaded areas in Figure 4).

Some predicted results from the Intergovernmental Panel on Climate Change (IPCC) have come from multiple GCMs and consider two emissions scenarios. Based on this work, the future projected changes in temperature until the year 2100, relative to the baseline average (1986 to 2005), are shown (Figure 4). The Representative Concentration Pathway (RCP) 2.6 scenario (Figure 4, blue line) envisions a world with significant global efforts to reduce GHG emissions. By contrast, RCP 8.5 (Figure 4, red line) is “business as usual” scenario, where humanity continues to rely heavily on fossil fuels and there is little international cooperation regarding climate change.[8]

The evidence is clear that global warming is happening and will continue; however, how much warming will occur in the coming decades depends on us (Figure 4). It is impossible to state definitively what is a “maximum acceptable” level of warming. Many scientists and governments believe that 1.5°C is a maximum “safe” acceptable threshold, while some maintain that 2°C is appropriate. However, changes beyond 2°C will result in impacts that are very damaging, and adaptation will be either difficult or impossible. Even a 1.5°C increase in average temperatures will lead to substantial stress on many ecosystems, impacts on resources and huge consequences for many people around the world. Unfortunately, the most vulnerable human populations are typically the least wealthy. Perhaps ironically, it is these people who have the lowest carbon footprints and have contributed the least to climate change.

How climate change is expected to continue specifically in the B.C. South Coast region has been analyzed with outputs from a suite of 30 GCMs, run using multiple emissions scenarios.[7] The median[ix], or average, values (and the 10th to 90th percentile[x] range of pro-

ix) Median – when data points are arranged in order, the median value is that which falls in the middle.

x) 90th percentile – larger than 90% of the datapoints; 10th percentile – larger than 10% of the data points.

jections) are shown below for both temperature and precipitation. Future projections indicate that the region will:

- warm by approximately **1.7°C** (from 1.1 to 2.5°C) in the 2050s, compared to the 1961–1990 baseline;
- become **6%** wetter annually in the 2050s, compared to the 1961–1990 baseline. Increases are projected for winter of 11%, while decreases are projected for summer of 2%.

Not surprisingly, precipitation falling as snow in winter is projected to decrease substantially due to warmer temperatures.

When thinking about projected changes, it is important to consider and plan for a range of potential future scenarios. This helps decision makers prepare for uncertainty, and also encourages people to build resilience into their systems.

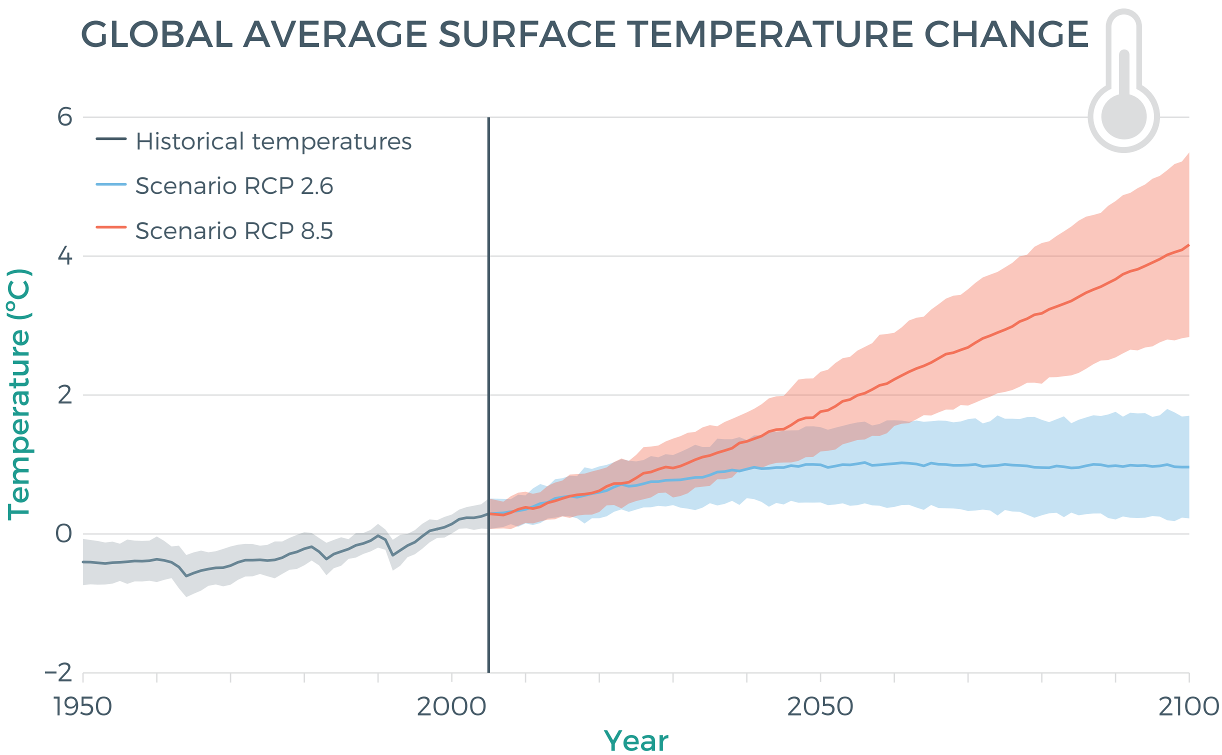

Figure 4. Past (1950–2005) and projected future (2005–2100) temperature changes using a suite of GCM models and two emissions scenarios (RCPs 2.6 and 8.5) relative to the 1986–2005 baseline (from IPCC 2013). In 2100, the RCP 2.6 scenario is approximately 1.5°C above preindustrial temperatures, whereas the RCP 8.5 scenario is 3°C higher, being approximately 4.5°C above preindustrial temperatures. These two scenarios represent substantially different futures with severe global implications. The two scenarios do not start to differ significantly for another 20 to 30 years, around 2050. This is because there are already a lot of GHGs in the atmosphere that will continue to warm the climate for some time, regardless of what action is taken. However, after 2050, the consequences of our actions become apparent as these two scenarios diverge significantly. The shaded areas around the blue and red lines account for differences in projections for the same scenario because of different models used.

Wildfire smoke at the Sea to Sky Gondola. (Credit: Tracey Saxby)

Extreme weather

Climate change does not just mean shifts in averages, but also how often extreme events may occur, and how extreme they may be. Extreme events may include very warm weather, heavy precipitation events, floods and droughts, as well as wildfires (which relate to changes in temperature and precipitation). Projecting shifts in extremes is complex, but a recent study focused on climate change and health includes extensive projection information for the Lower Mainland.[9] Two noteworthy results for the Vancouver area include:

- the number of summer days above 30°C are projected to increase from two days currently to 12 days in 2050;
- the wettest day of the year is expected to deliver 11% more precipitation than it does currently.

Climate change impacts

The changes discussed above will have far-reaching impacts both globally and on local scales, such as in the Átl’ḵa7tsem/Txwnéwu7ts/Howe Sound region. It is important to remember that an “impact” does not necessarily have to be negative. However, there will likely be more negative than positive impacts associated with climate change because both human and natural systems are designed for a current particular set of conditions, such as temperature and precipitation. The impacts of changes to climate depend heavily on the local and regional contexts. What infrastructure is there currently, and how important is it? How resilient are established systems, biological, physical and social? How much capacity do people have to adapt to change?

Recently, researchers and the District of Squamish partnered to explore what the impacts of climate change will be in the municipality.[10] The near-term (i.e., urgent) and long-term (i.e., not urgent but important to consider) impacts in Sḵwx̱wú7mesh/Squamish are summarized below (Table 1). Although the study did not encompass the entire Átl’ḵa7tsem/Txwnéwu7ts/Howe Sound area, the results are likely to represent the regional impacts. The focus of this work was the Squamish Municipality, so many ecological impacts may be underrepresented or missing.

Wildfire smoke in Squamish. (Credit: Tracey Saxby)

Table 1. Overview of impacts in the District of Squamish. Summarized from Picketts and Hamilton (2016)[10].

IMPACT	DESCRIPTION OF IMPACT AND POTENTIAL ADAPTATION ACTIONS
NEAR TERM PRIORITIES	
Sea level rise (SLR)	The B.C. Government recommends that communities plan for 1 m of SLR by 2100. This level does not consider storm surge flooding. Adaptation approaches relate to protection (e.g., dikes), accommodation (e.g., flood-proofing buildings), retreating (e.g., relocating away from vulnerable areas) and avoiding (e.g., not developing vulnerable areas).
Increased forest fires	Forest fires are increasing in frequency and size in Canada and B.C. due to increased temperatures, changing precipitation and other factors. Adaptation approaches relate to enhanced understanding, identifying high hazard areas and making properties more 'fire smart'.
Extreme precipitation	Climate change is intensifying the hydrological cycle, resulting in more extreme precipitation events that are outside of a normal range. Adaptation approaches relate to infrastructure design and maintenance, and determining if design standards must be changed to account for projected shifts.
LONG TERM PRIORITIES	
Changing river flows	It is difficult to understand the relationship between climate change and river flows (flooding has been increasing in some but not all rivers). More research is needed to determine how to proceed.
Water supply vulnerability	Climate change affects water supply in terms of both quantity and quality. Water conservation is an excellent strategy to address both adaptation and mitigation.
Economic development	Climate has important links to natural resource operations, agriculture, recreation and tourism. Both positive and negative impacts may arise.
Food security	Climate change interacts with food security through ecological impacts (e.g., salmon populations), temperature change (e.g., growing seasons and water demands) and extreme events (e.g., droughts).
Health	Climate change poses both long-term health risks (e.g., air quality and disease vectors) and short-term health risks (e.g., heat waves and fires).

Climate change responses

It is important to consider how climate will change and what can be done to prepare for, adjust to and avoid these changes. There are three principle human responses to climate change:

1. **Climate change adaptation** is fundamentally a process of managing the risks and opportunities brought by climate change and preparing for uncertainty. Adaptation can happen reactively but is generally more effective, less costly and less risky when proactive measures are taken.
2. **Climate change mitigation** focuses on how humans can decrease their long-term effect on the climate. This is accomplished primarily by reducing GHG emissions and enhancing Earth’s natural abilities to sequester GHGs.
3. **Geoengineering**, or direct interference with (aka manipulation of) the climate system to either lower atmospheric GHG concentrations or reduce incoming solar radiation.

We are now at a point in time where the negative impacts of climate change cannot be avoided solely through effective mitigation. *(Recall from Figure 4 that there is a level of continued change that will occur regardless of even the most ambitious GHG reductions.)* Therefore, climate change adaptation is required. That being said, adaptation on its own is not sufficient: there is simply no way that certain systems can adapt to high levels of change. For example, a community may be able to accommodate 1 m of sea level rise, but many areas just could not withstand 3 m of sea level rise. Beyond certain thresholds, a significant percentage of plant and animal species will also face extinction.

Geoengineering is still in its infancy, but it may emerge as another response to climate change alongside significant mitigation and adaptation options. Even strong proponents of geoengineering caution people not to view this response as a panacea – it may only help us to avoid some impacts as we strive to meet ambitious mitigation targets. Moreover, it carries with it a “moral hazard,” that is, society continues to burn fossil fuels and emit carbon dioxide (thus, for example, exacerbating ocean acidification as CO_2 dissolves in seawater) even while geoengineering activity – such as reflecting sunlight back to space — is put in place to lower Earth’s average temperature.

What can you do?

A detailed overview of recommended actions relating to climate change is included in *The path to zero carbon municipalities* (OWHS 2020).

Resources

This list is not intended to be exhaustive. Omission of a resource does not preclude it from having value.

Natural Resources Canada is leading a national assessment of climate change in Canada. The recent "Canada's Changing Climate Report" (Bush and Lemmen 2019) is available from: https://www.nrcan.gc.ca/sites/www.nrcan.gc.ca/files/energy/Climate-change/pdf/CCCR_FULLREPORT-EN-FINAL.pdf

The Intergovernmental Panel on Climate Change (IPCC) is a United Nations body that summarizes and synthesizes the state of knowledge about climate change globally. Find their full assessments and other reports at: https://www.ipcc.ch/

The Pacific Institute for Climate Solutions (PICS) has many educational and informative resources about climate change in B.C. that can be accessed here: https://pics.uvic.ca/

The Pacific Climate Impacts Consortium provides practical climatic information about climate change, models, variability and impacts, available from: https://www.pacificclimate.org/

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