

Climate 2050 STRATEGIC FRAMEWORK

SEPTEMBER 2018

Revised July 2019



Metro Vancouver acknowledges the input and feedback that contributed to the development of this *Climate 2050 Strategic Framework*. Input came from a range of organizations and individuals including other orders of government, First Nations, industry and business associations, academics, Metro Vancouver's members, and many engaged residents, with particular note to the youth from across the region who provided an inspiring and motivating voice. The support and guidance of Metro Vancouver's Climate Action Committee is gratefully acknowledged.

The *Climate 2050 Strategic Framework* document is first published in 2018. Further content, resources, a history of current and past climate actions, and the next stages to develop the actions and supporting policies can be found at metrovancover.org, search 'Climate 2050'.

Metro Vancouver is a federation of 21 municipalities, one Electoral Area and one Treaty First Nation that collaboratively plans for and delivers regional-scale services. Its core services are drinking water, wastewater treatment and solid waste management. Metro Vancouver also regulates air quality, plans for urban growth, manages a regional parks system and provides affordable housing. The regional district is governed by a Board of Directors of elected officials from each local authority.

Member jurisdictions of Metro Vancouver include:

Village of Anmore	City of North Vancouver
Village of Belcarra	District of North Vancouver
Bowen Island Municipality	City of Pitt Meadows
City of Burnaby	City of Port Coquitlam
City of Coquitlam	City of Port Moody
City of Delta	City of Richmond
Electoral Area A	City of Surrey
City of Langley	Tsawwassen First Nation
Township of Langley	City of Vancouver
Village of Lions Bay	District of West Vancouver
City of Maple Ridge	City of White Rock
City of New Westminster	



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INTRODUCTION

Climate Change: The Challenge and Opportunity

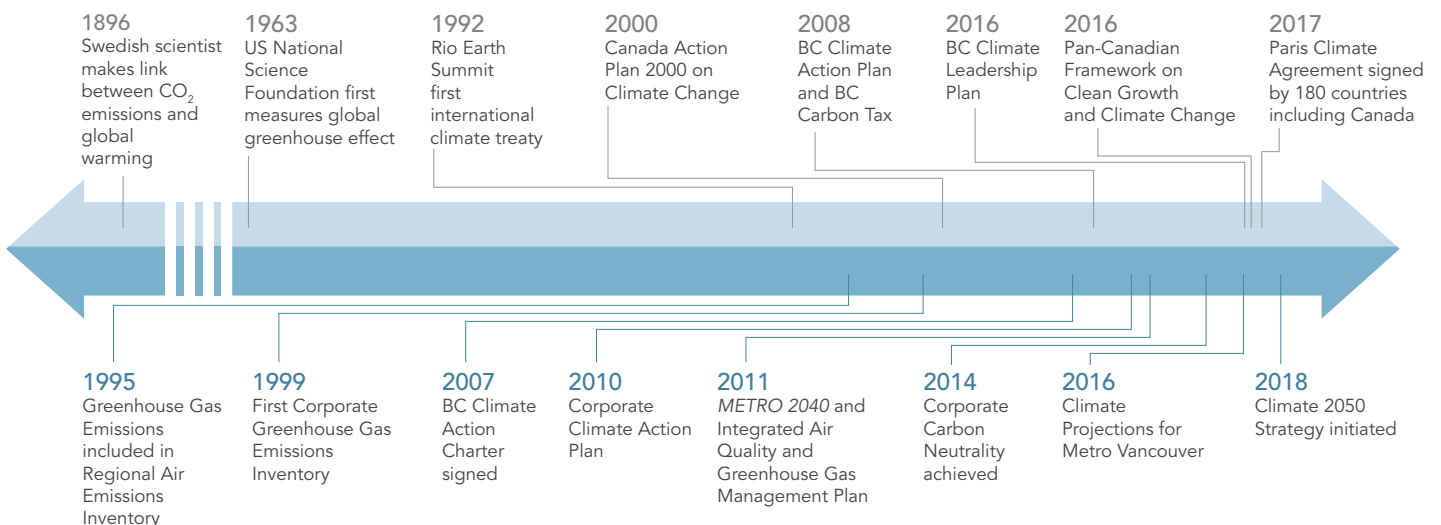
Climate Change is both a global and a local challenge, and it is already affecting our planet and our region in profound ways, making our summers hotter and drier, our winters warmer and wetter, and increasing the occurrence of extreme weather events. Furthermore, when climate change is viewed in the context of other challenges like affordability, equity, shifting jobs, economic insecurity, and the degradation of natural systems, it becomes clear that our response needs to be closely linked with other regional goals and initiatives.

Without strong action to reduce greenhouse gas emissions, both locally and globally, these trends will accelerate over the coming decades and it will become increasingly difficult and expensive to maintain the high quality of life

we experience in our region. At the same time, we need to ensure our ecosystems, infrastructure, and communities are resilient to the climate changes that have already been locked in due to past and current greenhouse gas emissions.

Every challenge that presents an opportunity and a robust, thoughtful response to climate change will create a more livable and sustainable region. Actions to adapt our communities and reduce greenhouse gas emissions can save money, create new businesses, improve air quality, protect nature, and provide many other benefits. Addressing this challenge effectively and taking advantage of these opportunities requires bold leadership and broad collaboration.

Global and Canadian Climate Action Milestones



Metro Vancouver Climate Action Milestones

Accelerating Early Success

Metro Vancouver and its 23 member jurisdictions have been enacting climate policy and taking climate action for over 20 years. For example, 18 years ago Metro Vancouver upgraded the energy system at Annacis Island Wastewater Treatment Plant to utilize more biogas to generate heat and electricity for the treatment processes. These upgrades significantly reduced the amount of natural gas used by the plant and its greenhouse gas emissions.

In 2008 the Metro Vancouver Regional District Board adopted a regional target of 80% reduction in greenhouse gas emissions below 2007 levels by 2050 and climate policies and actions are embedded in Metro Vancouver's management plans. For example, *Metro Vancouver 2040: Shaping Our Future (Metro 2040)*, the regional growth strategy, sets the framework for compact, complete communities that support a sustainable urban form and low carbon modes of transportation like walking, cycling and transit.

Within the water, liquid waste, and solid waste utilities, Metro Vancouver is reducing greenhouse gas emissions from its operations and recovering resources and energy from its waste streams, as well as planning improvements to the climate resilience of regional infrastructure. Actions in the *Integrated Air Quality and Greenhouse Gas Management Plan* enable policies and programs to support Metro Vancouver's member jurisdictions, businesses, and residents in reducing greenhouse gas emissions. In 2019, Metro Vancouver initiated development of a new Clean Air Plan in conjunction with Climate 2050 that will advance greenhouse gas reduction actions in the region.

Despite this progress, we need to do more if our region and planet are to continue supporting a high quality of life for future generations. In 2015, the Metro Vancouver Board of Directors directed staff to incorporate strategies and actions into all Metro Vancouver functions to mitigate and adapt to climate change, and to develop and implement

a regional climate action strategy, now called the *Climate 2050* strategy. In 2019, the MVRD Board amended this *Climate 2050 Strategic Framework*, committing to a carbon neutral region and associated interim target.

Climate Action Yields Many Benefits

Climate actions yield a range of benefits and opportunities that improve our quality of life. The adoption of electric vehicles reduces greenhouse gas emissions and other types of air pollution. Energy efficient homes and buildings are more comfortable and healthier. Protecting and enhancing natural areas and robust ecosystems increases our resiliency to climate change through flood control and heat reduction, while also providing increased support for biodiversity and human health and well-being. A region better prepared for climate risks like sea level rise, flooding and heat events is also better prepared for other major risks such as earthquakes.

The shift to a circular economy underpinned by renewable, low carbon energy is already generating thousands of new local jobs and businesses. New entrepreneurs and well-established businesses are creating new goods and services that turn waste into resources. Entrants into the market are offering new low carbon transportation options as well as products that support the building of energy efficient homes.

Continued local government leadership and investment in a resilient, low carbon future will contribute to additional economic opportunities in clean transportation, renewable energy, energy efficient buildings, recycling, local food, clean tech, and many other sectors.

Fairness, Equity and Affordability

Climate change will not affect everyone in the region to the same degree. Lower income and socially marginalized populations will have more difficulty coping with the impacts of climate change. Those with less financial resources will have fewer options to protect themselves when a major weather event occurs, and may have more difficulty recovering from impacts. They are more likely to have more difficulty adapting their homes to protect them from extreme weather events, less access to green spaces or air conditioning, and may have underlying health issues that can be exacerbated by extreme heat and air pollution.

Policies and programs to reduce greenhouse gas emissions and adapt to the changing climate must not exacerbate existing economic, social, or geographic disparities. The design of policies and programs should consider how low carbon options for transportation and buildings can be accessible to all Metro Vancouver residents. They should also strengthen relationships with First Nations including contributing to Reconciliation with First Nations peoples in the region.

Fairness, equity, and affordability will be central considerations in the development of goals, strategies and actions for the *Climate 2050* strategy.



Leadership, Collaboration, and Local Expertise

Metro Vancouver and other orders of governments play a role in establishing policies, delivering programs, and setting regulations, but effective climate action will require the efforts of all orders of government, combined with the energy, expertise and innovation of residents, businesses, academia and non-profit organizations. As a regional federation, Metro Vancouver has an important leadership role to innovate and demonstrate best practices, convene member jurisdictions to collaborate on joint initiatives, and liaise with other orders of governments.

Our region has become a hub for innovators, businesses, and professionals working on sustainability and climate change problems. *Climate 2050* will draw upon local and traditional knowledge from experts in the region, as well as global best practices. Such expertise will help develop solutions to local challenges and ideas that can contribute to climate action in other parts of the world.

The traditional knowledge of the region's First Nations has accumulated over thousands of years, and can also be incorporated into planning processes that identify climate action priorities. Combining traditional knowledge and wisdom with new information, evidence and technologies can help Metro Vancouver develop more holistic strategies and actions that address the short term challenges while still considering the long term sustainability of our communities.



LOCAL GOVERNMENTS LEADING ON CLIMATE ACTIONS

While federal governments are building an international consensus on climate action, local governments are working together to respond to climate change. Provincial, national and international organizations are linking local governments together to share climate change information and best practices, reaffirm commitments, and advocate to other orders of government. Some of the leading organizations are described here:

C40 Cities Climate Leadership – A network of the world’s megacities that are committed to addressing global climate change, C40 supports cities to collaborate effectively, share knowledge and drive meaningful, measurable and sustainable action on climate change. C40 currently has 17 networks that cover the mitigation, adaptation and sustainability topics that are of highest priority to C40 cities and that have the potential for the greatest climate impact. c40.org

BC Municipal Climate Leadership Council (BCMCLC) – A group of Mayors and Councillors from large and small communities across BC who have volunteered to help other locally elected officials advance climate action through leadership that goes beyond politics as usual. The Council provides non-partisan education, support and mentoring for peers on the value of taking climate action in their communities. bcmclc.ca

Federation of Canadian Municipalities – Partners for Climate Protection Program is a network of 350 Canadian municipal governments that have committed to reducing greenhouse gases and acting on climate change. A five-milestone process guides members through the process of creating greenhouse gas inventories, setting reduction targets, developing local action plans, implementing actions, and monitoring and reporting on results. pcphub.fcm.ca

Climate Mayors – Climate Mayors (aka the Mayors National Climate Action Agenda) is a Mayor-to-Mayor network of US Mayors collaborating on climate. Cities are pursuing actions to achieve their emissions reduction objectives through undertaking community greenhouse gas inventories, setting targets to reduce emissions, and developing climate action plans. climatemayors.org



Global Covenant of Mayors for Climate and Energy – An international alliance of cities and local governments with a shared long-term vision of promoting and supporting voluntary action to combat climate change and move to a low emission, resilient society. This alliance serves cities and local governments by mobilizing and supporting ambitious, measurable, and planned climate and energy action in their communities. It emphasizes the importance of both climate change mitigation and adaptation, as well as increased access to clean and affordable energy. globalcovenantofmayors.org

Building Adaptive & Resilient Communities (BARC) Network – A network of Canadian communities, hosted by ICLEI Canada, which shares experience in responding to the impacts of climate change and strategies to protect the people, property, and prosperity of your community. icleicanada.org/programs/adaptation

VISION AND GUIDING PRINCIPLES

Vision Statement

Metro Vancouver demonstrates bold leadership in responding to climate change

Ensuring our infrastructure, ecosystems, and communities are resilient to the impacts of climate change.

Pursuing a carbon neutral region by 2050.

This vision statement will guide Metro Vancouver's response to climate change in each of its roles: delivering core services, planning for the future, and acting as a regional forum. It establishes Metro Vancouver's intention to develop specific goals, strategies, and actions for its own assets and operations, as well as recognizing the need to support its member jurisdictions, residents, and businesses to take their own climate action.



Guiding Principles

To guide the *Climate 2050* strategy, the following principles have been identified to reflect Metro Vancouver's mandate and role and the specific climate challenges of our region. These principles are based on the United Nations-Habitat principles for local-level climate action, which were established to encourage consistent and comparable approaches to developing effective climate action planning by local and regional governments around the world.¹

The *Climate 2050* strategy is:

- **Ambitious** – Demonstrate global and local leadership by ambitiously tackling our local climate challenges.
- **Dynamic** – Evolve our approach to respond to new information, support innovation, and take advantage of opportunities.
- **Evidence-based** – Inform decision-making with the most current scientific information, traditional knowledge, and local understanding to assess vulnerability and emissions.
- **Relevant** – Design actions to respond to Metro Vancouver's unique challenges and opportunities and deliver local benefits.
- **Comprehensive** – Undertake climate actions across Metro Vancouver's functions and support actions across sectors and communities.
- **Integrated** – Ensure actions are integrated with other municipal and regional policy priorities and are coordinated with Provincial and Federal initiatives.
- **Fair** – Seek solutions that equitably address the risks of climate change, fairly share the costs and benefits of action, and support a livable and affordable region, including responsibility to future generations.
- **Actionable** – Propose actions that can realistically be implemented given Metro Vancouver's mandate, finances and capacities; if necessary evaluate changes to mandate.
- **Inclusive & Collaborative** – Involve Metro Vancouver's members, strategic partners and communities in the planning and implementation of the *Climate 2050* strategy.
- **Transparent & Verifiable** – Follow an open decision-making process, and set goals that can be measured, reported, verified, and evaluated.

¹ The United Nations-Habitat principles were generated through a robust, global, multi-stakeholder process including climate action NGOs, academics, engineering and planning associations, and public agencies, and have been endorsed by multiple global organizations including ICLEI-Local Governments for Sustainability, UCLG (United Cities and Local Governments), and FCM (Federation of Canadian Municipalities), among many others. See: <http://e-lib.iclei.org/wp-content/uploads/2016/02/Guiding-Principles-for-City-Climate-Action-Planning.pdf>

CONCEPTUAL FRAMEWORK

Components of *Climate 2050 Strategy*

The purpose of the *Climate 2050* strategy is to guide climate change policy and action for Metro Vancouver for the next 30 years. The *Climate 2050* strategy is made up of three main components: *Climate 2050 Strategic Framework*, *Climate 2050 Roadmaps*, and *Online Reporting and Communication Tool*.

Climate 2050 Strategic Framework: The *Strategic Framework* sets the 30-year vision for Metro Vancouver's climate policies and actions, lays out guiding principles, and describes a dynamic and adaptive approach. The *Framework* includes summaries for each of the key Issue Areas that will become the *Climate 2050 Roadmaps* (see below).

Climate 2050 Roadmaps: The *Roadmaps* will describe the trajectory toward a resilient, low carbon region for each Issue Area. They will outline regional and corporate

goals, strategies, actions, and performance metrics. The *Roadmap* development process is designed to engage other organizations and stakeholders, and set priorities that may require strategic partnerships. The *Roadmaps* will evolve dynamically in response to new technologies and innovation, policies of other orders of government, measurement of performance, or other emerging factors.

Climate 2050 Reporting and Communication Tool: The *Climate 2050* strategy will be supported by an online reporting and communication tool. This hub will feature examples of current actions from both Metro Vancouver and its members, showcase best practices, engage the public and stakeholders, contain background and reference materials, and report on targets and measures.



The Roadmaps will guide the implementation of **climate action projects** under specific Issue Areas. Projects will be identified and approved through regular annual departmental work plans, budgets, and 5-year financial plans rather than a separate *Climate 2050* planning process. Staff will report to the Metro Vancouver standing committees and Boards to seek guidance and approval for any major climate projects.

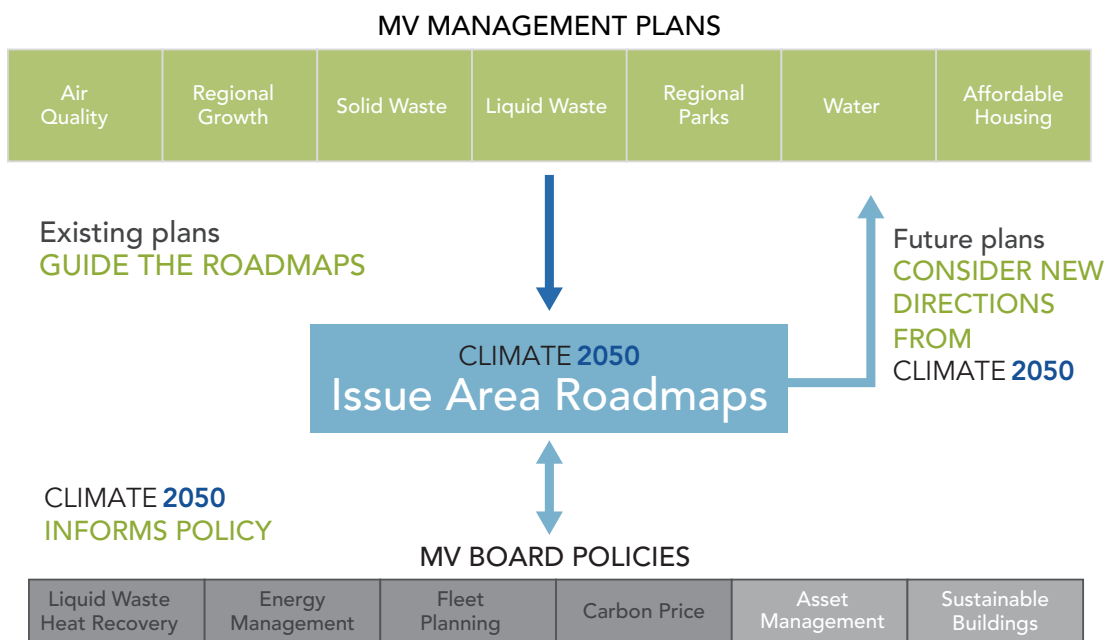
Throughout the document, several **cross cutting themes** are identified in the coloured call out boxes. Cross cutting themes are important topics that will be addressed by actions across Issue Areas.

ISSUE AREAS

Climate 2050 is organized around ten Issue Areas, intended to provide logical groupings of climate goals, strategies, and actions. They reflect the functions and responsibilities under Metro Vancouver’s mandate and the range of climate-related challenges and initiatives affecting the region. Each Issue Area may consider climate adaptation and greenhouse gas reductions and it is intended that climate strategies and actions may meet goals in more than one Issue Area. Issue Area descriptions can be found in Appendix 1.

Relationships to Other Plans and Policies

Climate 2050 will be closely linked to Metro Vancouver’s other plans and policies. The *Climate 2050 Roadmaps* will build on climate actions that have already been adopted in the existing Metro Vancouver management plans while also proposing new directions that can be considered in future management plans. The *Roadmaps* may suggest revisions or the development of new Board and Corporate policies that guide organizational decision-making regarding climate issues.



ROLES AND RESPONSIBILITIES

Metro Vancouver's role in climate change

Metro Vancouver has three broad roles in the region: **deliver core services, plan for the future, and act as a regional forum.** Through each of these roles, Metro Vancouver has responsibilities related to climate change.

Changes in weather patterns and rising sea level will require investments to prepare and adapt core regional services and infrastructure, including drinking water supply, liquid waste management, air quality management, and regional parks. Through its core services, Metro Vancouver also has opportunities to generate and use renewable energy from its facilities.

Metro Vancouver is considering climate change when it plans for the future of our region. Included in this planning role is the management and regulation of air contaminants, including greenhouse gas emissions. With its members, Metro Vancouver helps to plan for compact, complete communities that are foundational to enabling low carbon solutions. Metro Vancouver is also evaluating how climate change will affect future development and growth in the region.

Metro Vancouver has approval authority over key funding sources in the Federal Gas Tax and the Sustainability Innovation Funds, which can enable greenhouse gas and climate adaptation projects in corporate operations and the region.

In its role as a regional forum, Metro Vancouver builds and facilitates collaborative processes which engage the public and build partnerships to address significant regional issues like climate change. Metro Vancouver will continue to engage its members and other partners to develop the *Climate 2050 Roadmaps* and implement joint climate action projects.

AUTHORITY AND MANDATE

Metro Vancouver's authority and mandate to address climate change flows from several areas of Provincial legislation and policy. The *Green Communities Act* (Bill 27) requires regional growth strategies to include targets for reducing greenhouse gas emissions and proposed policies and actions for achieving those targets. Under the *Environmental Management Act*, Metro Vancouver has the delegated authority to provide the service of air pollution control and air quality management and may, by bylaw, prohibit, regulate and otherwise control and prevent the discharge of air contaminants, including greenhouse gas emissions. Also under the *Environmental Management Act*, Waste Management Plans are regulatory instruments that can address strategic and operational requirements that are specific to a local government's solid waste and liquid waste services such as responding to climate impacts and reducing greenhouse gas emissions.

In 2007, Metro Vancouver signed the BC Climate Action Charter, making the voluntary commitment to take actions to pursue carbon neutrality in its corporate operations and reduce community-wide emissions by creating more complete, compact and energy efficient rural and urban communities.

Roles and Responsibilities of Others

The **Federal Government** has jurisdiction over policies to set standards and regulate the design and manufacture of many products that directly or indirectly contribute greenhouse gas emissions (e.g., vehicles, appliances, buildings, industrial and commercial equipment). It is responsible for regulating emissions for Federal undertakings, including ports, airports and rail corridors, and shipping lanes.

In 2016, the Federal Government adopted the *Pan-Canadian Framework on Clean Growth and Climate Change* as the national climate change plan. The *Framework* set a national carbon price to help drive down greenhouse gas emissions, and established several funding mechanisms, including the Clean Energy Fund, the Green Infrastructure Fund, the Clean Growth Program, and the Low Carbon Economy Fund.

First Nations in the Metro Vancouver region provide services to their communities that will be impacted by climate change. Some First Nations in the region have adopted sustainability and/or land use plans that include a response to climate change such as protection and restoration of marine, coastal, and terrestrial ecosystems.

The **Provincial Government** has a significant influence on greenhouse gas emissions through policy and regulation in the areas of energy, transportation, buildings, forestry and industry. Funding for large infrastructure projects such as roads, bridges, transit, and dikes are critical for preparing for climate impacts, and project design can reduce emissions.

Since 2008, the Province has enacted climate change legislation including a carbon tax. It has established a *Climate Solutions and Clean Growth Advisory Council* to provide strategic advice to government on climate action and clean economic growth. In July 2018 the Province released intentions papers on: Clean Transportation; Clean, Efficient Buildings; and A Clean Growth Program for Industry as the first step towards developing a new long-term clean growth strategy for BC.

Member Jurisdictions are responsible for land-use policy and for investments in transportation, sewer, water, and other infrastructure. They are also responsible for enforcing the BC Building Code and can adopt the BC Energy Step Code to encourage lower carbon buildings. Members also have a key role in preparing for the impacts of climate



change, including investments in stormwater infrastructure and dikes, and responding to emergencies such as flooding in their communities.

Many members have adopted climate action plans and they are taking many actions to ensure their communities are adapting to climate change and reducing greenhouse gas emissions. They are using their land-use planning authority to encourage the growth of compact communities and investments in walking and cycling infrastructure consistent with the provisions of *Metro 2040*. All of the municipalities in Metro Vancouver have shown leadership by signing the BC Climate Action Charter for local governments.

TransLink is responsible for long-term investments in regional transit as well as road and bridge infrastructure that enable low carbon transportation options. It is also responsible for regional transportation demand management programs that encourage residents to choose low carbon forms of transportation. Through its management of, and investment in, the transit fleet TransLink can also reduce greenhouse gas emissions from transit vehicles. In 2018, TransLink started the development of a new long range (30 year) Regional Transportation Strategy.

Energy utilities in the region (e.g. BC Hydro and Fortis BC) are responsible for energy supply and distribution. They are responsible for programs and infrastructure investments that will increase the supply of low carbon energy to the region. They administer energy conservation incentives to encourage residents and businesses to reduce their energy demand and indirectly reduce greenhouse gas emissions. Energy utilities ensure that the energy infrastructure both inside and outside the region is resilient to the impacts of climate change.



REGIONAL CLIMATE IMPACTS AND GREENHOUSE GASES

Climate Change Projections for Our Region

Climate change impacts are already evident in our region, and will become more marked in the near future. Even if global greenhouse gas emissions were cut drastically tomorrow, our region – and the rest of the globe – will inherit the impacts of the previous 150 years of human generated greenhouse gas emissions, and the climate will continue to change.

Metro Vancouver’s Climate Projections Report² provides details of the projected impacts of climate change in this region. There is confidence in the projections through to the 2050s. However, projections to 2080 and beyond are more uncertain, because the impacts in the latter part of this century are highly dependent on how successful the global community is at reducing greenhouse gas emissions in the next couple of decades. This underscores the importance of taking action now.

Climate change is projected to drive changes to weather patterns. The “new normal” for the region may be very unlike the past. Climate projections for the 2050 timeframe are described below.

- **More extreme precipitation events:** more rain will fall during the wettest days of the year and the frequency of extreme rainfall events will increase.
 - **Decreased snowpack:** the deep spring snowpack in the mountainous watersheds is expected to decrease by over 50% compared to present day.
 - **Sea level rise:** in addition to these weather-related changes predicted in our region, warming global temperature is projected to bring at least 1 metre of sea level rise by 2100, which will impact coastal communities in our region.
- **Warmer temperatures:** with increasing daytime and nighttime temperatures, there will be more hot summer days and fewer winter days with frost or ice.
 - **Longer summer dry spells:** summer rainfall will decline by nearly 20%, with increased likelihood of extended drought periods.
 - **Wetter fall and winters:** although on average the total annual rainfall is expected to increase by just 5%, there will be a large increase in rainfall during fall and winter.



Last glacier in Metro Vancouver Watersheds

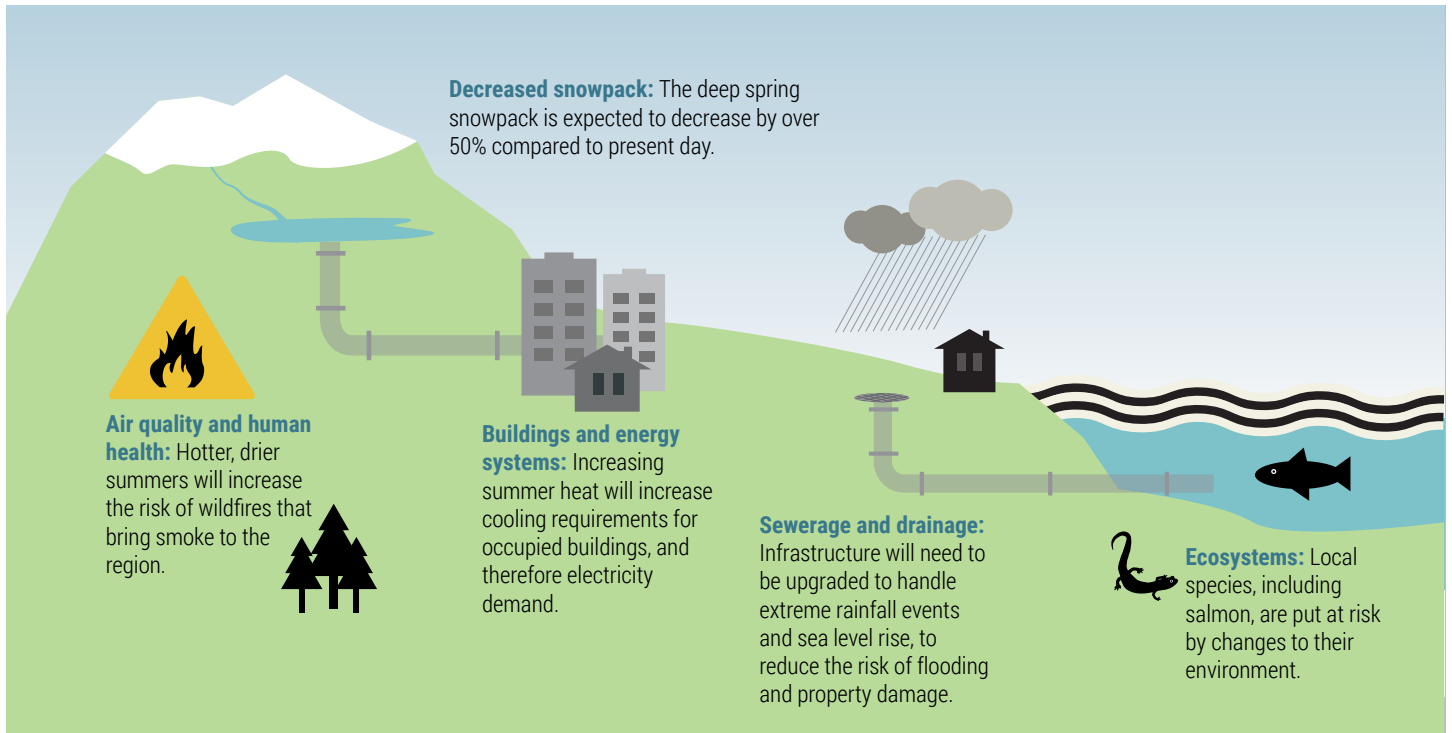
² Climate Projections for Metro Vancouver, 2016. Available at: metrovancover.org (search: climate projections 2016)

Anticipated Impacts on Regional Systems and Services

Across our region, changing weather patterns and sea level rise are expected to impact many regional services and lead to new concerns. Adaptation responses, including significant investment by the public and private sectors, will be required to upgrade our infrastructure, protect our ecosystems, and prepare for the impacts of climate change.

The following list highlights critical areas of concern.

- **Drinking water supply and demand:** Reduced snowpack and hotter, drier summers could strain the existing water supply during times of the year when temperatures are high and water is in greatest demand. The risk of landslides affecting water quality in supply reservoirs may increase due to more frequent extreme precipitation events and higher risk of wildfires in the watersheds.
- **Sewerage and drainage:** Wastewater treatment facilities will be impacted by higher influent volumes and sea level rise, both of which increase the energy required for pumping. Increasing rainfall intensity means drainage systems will be more likely to experience flooding. Sewers near the Fraser River and the ocean will be impacted by sea level rise. Infrastructure will need to be upgraded to maintain current expectations of drainage and flood protection.
- **Ecosystems and agriculture:** As the climate shifts, it will disrupt the complex natural systems that have evolved over time. The plants, trees, and animals within the ecosystems that have historically thrived in our region will be impacted or could be displaced entirely. Sea level rise may flood some coastal parks and natural areas. Shifts in weather patterns will also impact agricultural crops and the region's food security.
- **Air quality and human health:** Increases in the number, extent and duration of wildfires in BC will impact air quality in Metro Vancouver. Higher temperatures also have the potential to increase the formation of air contaminants like ground-level ozone. Increased frequency of extreme heat events can cause heat stress in vulnerable populations, especially in a region that has historically moderate temperatures.
- **Buildings and energy systems:** Increasing summer heat will increase cooling requirements for occupied buildings, leading to higher electricity demand. This in turn will impact the provincial energy infrastructure, which is designed for peak winter demand. Energy efficiency and passive cooling will become increasingly important in buildings, and the business case to build and retrofit to high efficiency standards will improve.
- **Transportation, recreation and tourism:** Warmer winters and less frost may improve road safety and present more opportunities to walk or cycle year round. However, warmer temperatures will mean less snow in the local mountains, which is a concern for the winter sport recreation and tourism industries.
- **Communities and infrastructure – flood risk:** sea level rise, storm surge, more extreme rainfall and changes in river hydrology all combine to increase the risk of flooding in Metro Vancouver communities. Most dikes were built in the 1970s and 1980s, and they were not designed to withstand the level of floods now projected. A major flood in this region could have direct and indirect losses estimated at \$20-30 billion, four to five times the losses from the Alberta floods of 2013. Flooding presents a risk to people, homes, businesses and infrastructure.



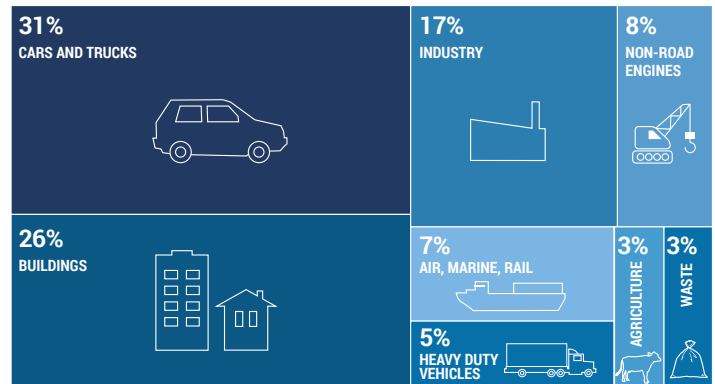
MEASURING RESILIENCE TO CLIMATE CHANGE

Local governments are developing methods and approaches to measure progress towards more climate-resilient infrastructure, and a more resilient region. Vulnerability assessments provide baseline data on ecosystems, infrastructure, and communities, but other indicators are needed to understand our region's resilience to climate changes. Metro Vancouver has already assessed the vulnerability of some of its infrastructure and services to specific risks such as flooding and drought events. Additional vulnerability assessments could help in prioritizing actions that aim to protect ecosystems, infrastructure, and communities from other climate risks such as extreme heat and wildfires. Through the *Climate 2050 Roadmap* process, Metro Vancouver will work with partners to develop appropriate indicators and measures of regional climate resilience.

Regional Sources of Greenhouse Gas Emissions

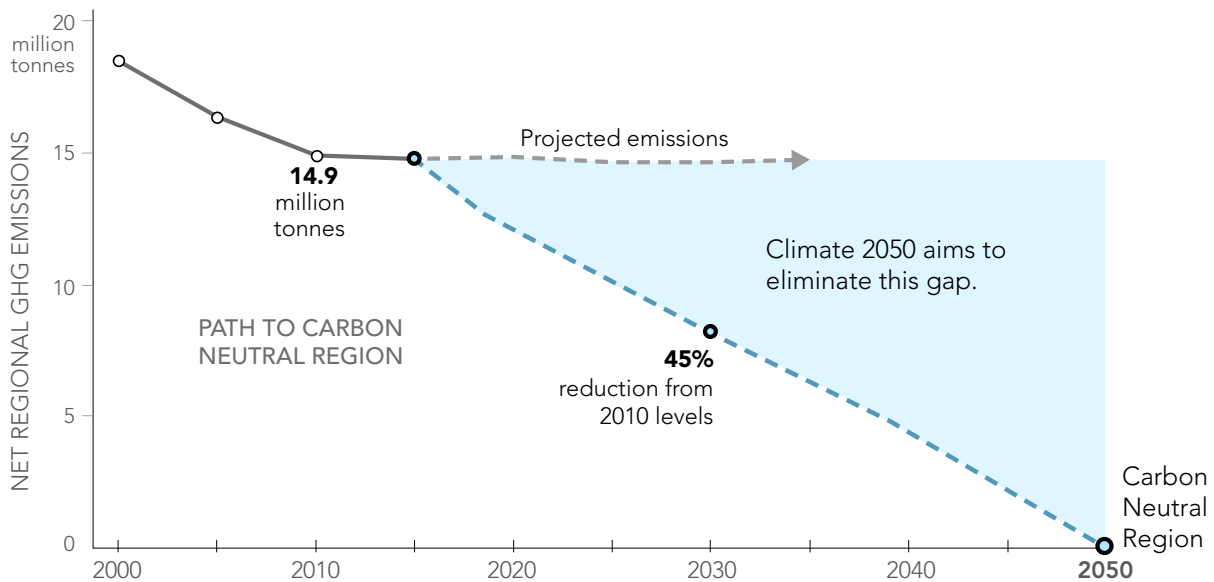
Metro Vancouver has influence on the activities of residents and businesses that produce greenhouse gas emissions, particularly through its planning and policy functions, and through its role as a regional forum for its member jurisdictions. Less than 1% of regional emissions is directly associated with the corporate activities of Metro Vancouver and its member jurisdictions.

Metro Vancouver compiles periodic emissions inventories to quantify greenhouse gas emissions from the various sources across the region. Between 2007 and 2015, regional greenhouse gas emissions dropped by almost 12%. The reduction in emissions is due to a number of factors including improvements in buildings and vehicle energy efficiency, switches to lower carbon energy sources such as electricity and renewable fuels, and shifts in types and volumes of industrial activity in the region.



Above is a summary of how different sources contributed to the regional "carbon footprint" (approximately 14.7 million tonnes of greenhouse gases in 2015). Transportation and buildings continue to contribute the greatest share of greenhouse gas emissions in Metro Vancouver's emission inventory.

Regional Greenhouse Gas (GHG) Emissions Trend: How Are We Doing?



Created by Metro Vancouver, updated 12/19

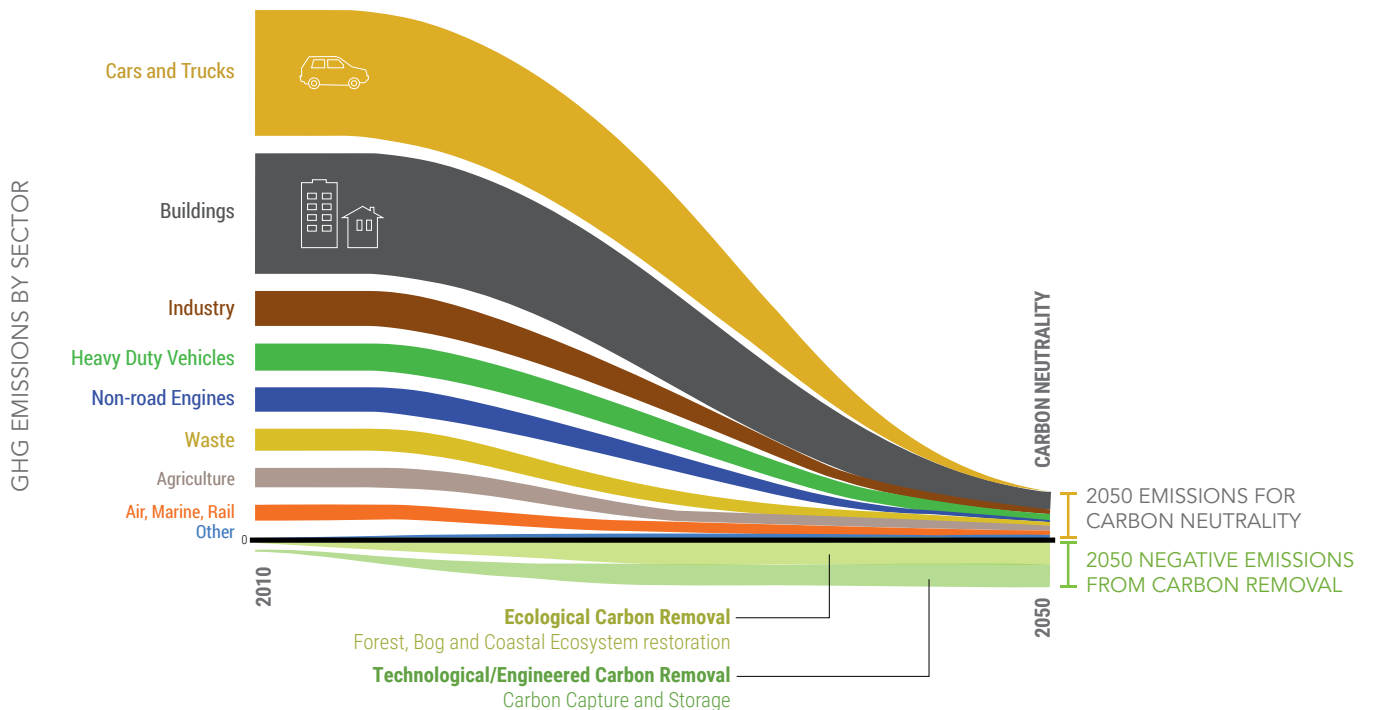
Creating a Carbon Neutral Region

Creating a carbon neutral region by 2050 will require unprecedented greenhouse gas reductions across most sectors. Many sectors must become “zero emissions”, and any remaining greenhouse gas emissions will need to be balanced with ecological and technological carbon removal approaches. The graphic below illustrates how a carbon neutral region can be achieved by a combination of deep emissions reductions in all sectors and some carbon removal.

To define the path toward a carbon neutral region, and continue to build on existing actions and accelerate new ones, an interim target of a 45% reduction from 2010 levels, by 2030, is established.

As part of the development of the *Climate 2050* Roadmaps, further analysis will be completed for each of the emissions sources to understand the pathways to deep emissions reductions including costs and benefits. Collaboration with other orders of government, partner organizations and key stakeholders will be critical to identify effective actions to reduce emissions in each sector.

HOW CAN WE CREATE A CARBON NEUTRAL REGION BY 2050?



TOWARDS 2050: NEXT STEPS

Dynamic Approach: a living, breathing strategy

Recognizing the magnitude of the climate challenge, the urgency for action, and the evolving science and data, policy responses need to be adaptive. A dynamic approach is needed for the *Climate 2050* strategy.

Climate 2050 Roadmaps will be developed for each issue area. Together they describe how Metro Vancouver – in collaboration with others – will achieve a low carbon, resilient region. They are intended to be flexible and will be revised if significant opportunities arise that can accelerate progress towards the goals. Their five year planning horizon synchronizes with Metro Vancouver’s annual budget and work plan cycles and five year financial plans.

Roadmap Structure

Each *Roadmap* will provide a summary analysis of the current conditions and potential challenges for each Issue Area. The *Roadmaps* will include regional and corporate goals for each Issue Area that help visualize the changes necessary for a particular issue area to achieve a low carbon, resilient region. The goals will align or be incorporated into the goals of management plans for each of Metro Vancouver’s functions.

The *Roadmaps* will describe the strategies and actions necessary to achieve the goals for each Issue Area. The *Roadmaps* are intended to align with the relevant management plans and will reflect existing priorities. Through gap analyses and engagement with the public and stakeholders, new directions will likely be identified as part of the *Roadmap* process. As a result, the final list of strategies and actions in the *Roadmaps* will be a combination of strategies and actions already in existing plans and new directions that can be implemented directly,

or adopted as part of the new management plans and other policies.

Finally, performance metrics will track progress towards the overall *Climate 2050* vision, breaking the tasks in each *Roadmap* into measurable and manageable sections. These performance metrics will be designed to provide a picture of progress by issue area and more broadly towards the *Climate 2050* vision.

Roadmap Development Process

Metro Vancouver will work with its members and other stakeholders to develop *Climate 2050 Roadmaps* for each of the Issue Areas described below. The first *Roadmaps* will be developed over 2019 and 2020. The *Roadmap* development process coincides with the planned review of several existing management plans.

Roadmap development process will consist of three types of activities, as described below:

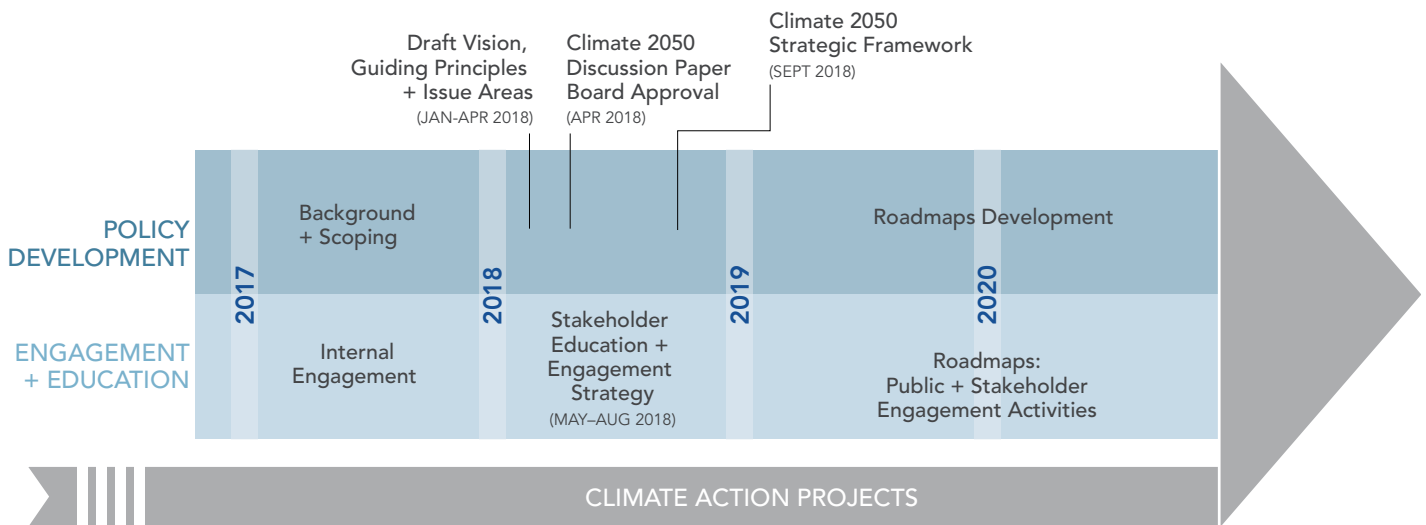
- **Research and analysis** that will include gathering existing information and conducting analyses to support the development of evidence to understand the impacts of proposed actions.
- **Goal and performance** metric setting that will be informed by goals and strategies adopted in existing management plans, but adapted to specifically describe the desired outcomes for each Issue Area and how they will contribute to the overall *Climate 2050* vision. They will include quantifiable measures to track progress toward the goals.

- **Action Planning** that will include a process to develop actions drawn from Metro Vancouver’s existing management plans and through an engagement process, identify new directions that can be implemented directly or adopted as part of future management plans. Actions will be evaluated to ensure alignment with *Climate 2050 Guiding Principles*.

Over the next two years, Metro Vancouver will engage the public and stakeholders to support the above activities at key stages of the *Roadmap* development process, in alignment with Metro Vancouver’s Public Engagement Policy and Guide. The intention is to draw on the interest and expertise of the region’s residents and businesses.

Once completed, the *Climate 2050* strategy will provide a comprehensive view of the path towards a low carbon, resilient region, Metro Vancouver’s contribution, and how Metro Vancouver is tracking our progress over time. Metro Vancouver aims to demonstrate bold leadership in responding to climate change, while working closely with its member jurisdictions, the public, stakeholders and partners. We will ensure that our infrastructure, ecosystems, and communities are resilient to the impacts of climate change, while pursuing a carbon neutral region by 2050.

CLIMATE 2050 STRATEGY TIMELINE



APPENDIX 1

Issue Areas

THE TEN ISSUE AREAS ARE:





Nature and Ecosystems

Metro Vancouver is a region with a rich and diverse natural environment that provides important ecosystem services including clean air and water, pollination, flood control, and cooling of urban areas. Furthermore, many aspects of the region's ecosystems hold cultural significance to First Nations, and healthy ecosystems provide the basis for local food security and prosperity for us all. Soil, forests, wetlands and other ecosystems also contribute to the regulation of the global climate by removing and storing carbon dioxide from the atmosphere.

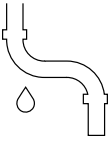
However, the health of our region's ecosystems is deteriorating and vulnerable to further degradation, especially with a changing climate. Many species and ecosystems in the region are at risk of being impacted or displaced entirely due to climate change because they cannot adapt fast enough. This is a complex issue and our understanding is incomplete, but protecting and enhancing natural areas and their connectivity will be essential in helping species and ecosystems adapt to climate change.

Natural areas and greenspaces will play a key role in assisting the region's communities to adapt to climate change. Soils and vegetation capture rainwater, protect the foreshore, and moderate the impacts of extreme weather events, reducing the need for built infrastructure. Trees provide shading in urban areas, which reduces the energy needed to cool buildings and gives relief to residents during extreme heat events. Maintaining tree canopy and managing urban forests so they are resilient to the impacts of climate change will mean they are able to continue to provide these adaptation benefits. Incorporating green infrastructure such as rain gardens, bioswales and green roofs into development projects will increase resilience and help to mitigate environmental impacts, particularly in more urban areas.

MARINE AND INTERTIDAL ECOSYSTEMS

Our rich marine and coastal areas provide important habitat for fish and wildlife including endangered killer whales, salmon, and hundreds of species of resident and migratory shorebirds. The ocean has spiritual, cultural and ceremonial value for local First Nations, and it provides traditional foods. Salt marshes and seagrasses can store carbon and mitigate flooding in coastal communities. However, these complex intertidal and marine ecosystems are particularly vulnerable to climate change. With rising seas and storm surge, intertidal wetlands will be lost as they are unable to move higher due to sea walls and other man-made structures. In marine environments, warmer temperatures, increased run-off from more extreme rainfall events, and changes in ocean chemistry will alter ecological processes. Federal, provincial, and local governments, First Nations, researchers and conservation groups will need to work together to improve understanding and better protect marine and coastal environments from a changing climate.





Infrastructure

Local government infrastructure is foundational to the region's economy and its residents' quality of life. The reservoirs, pipes, pumps, treatment plants, roads, power lines, dikes, and other built infrastructure provide essential services such as drinking water, sewage treatment, stormwater drainage, solid waste disposal, transportation, and energy to residents and businesses. The region's water, wastewater and drainage infrastructure is vulnerable to anticipated climate change impacts such as more frequent extreme precipitation events that will increase localized flooding and may overwhelm sewer systems, and heat and drought that will challenge the drinking water system.

Incorporating climate change into local government infrastructure planning, design and operation can help maintain these essential services in the face of climate impacts. By considering climate change, local governments can invest in actions that improve infrastructure and contribute to the overall resilience of the region. By jointly considering climate risks and other physical risks such as seismic events, local governments are able to find cost efficiencies and more effective approaches to infrastructure upgrades, and sustain long-term levels of service.

The construction, maintenance and operation of infrastructure all contribute to greenhouse gas emissions in the region. Innovation in infrastructure design, upgrades, and operations can significantly reduce associated greenhouse gas emissions.

WATER

Climate change will affect the quantity and quality of water in the region, which has implications for many of the Issue Areas. It will increase the likelihood that there is too much or too little water (see section on Climate Impacts). Water-related actions will be central to our climate change response and be included under a number of Issue Areas. Managing water demand, protecting and restoring streams, lakes, bogs, and coastal estuaries, and protecting communities against sea level rise and flooding will be important components of creating a region resilient to the impacts of climate change.





Human Health and Well-Being

Climate change will affect the health of people living and working in this region. Direct health impacts will come from air and water deterioration, wildfires, flooding, extreme heat, as well as from increased pathogens and disease incidence associated with climate change. Some of the most significant climate change impacts may be indirect, such as compromised food security, chronic stress, displacement due to flood or fire risk, loss of livelihood, and adverse mental health effects. The health burden of climate change will not be felt equally. For example, the very young, the elderly, or people with underlying health issues can be more vulnerable to heat or smoke exposure, and lower income and homeless people will likely have fewer options to protect themselves from extreme weather events and fewer resources to recover from their impacts. Lower income neighbourhoods tend to have fewer green spaces or air conditioned community spaces which provide relief in extreme heat events.

All orders of government will need to enact policies and implement projects to reduce the long term exposure to these health risks, as well as to increase capacity to respond to more frequent emergency situations (see inset box). Working closely with the local health authorities and the Provincial government, local governments can take actions that will reduce health risks due to climate change. Examples include: improving our system of air quality advisories and education about wildfires, planning for building cooling systems, supporting access to local food for low income residents, greening neighbourhoods that house vulnerable people, and ensuring neighbourhoods are prepared for flooding events.

There are health co-benefits from some of the climate actions that reduce greenhouse gas emissions. For example, walkable communities with increased green spaces promote physical activity and social connections. Reducing vehicle emissions improves air quality and noise pollution. More energy efficient, well ventilated buildings can improve indoor air quality and create more comfortable homes.

EMERGENCY MANAGEMENT

Climate change will increase the need for local governments, residents, and businesses to be better prepared for and respond to emergencies like wildfires, flooding, storms and droughts. Local governments can help mitigate risks to health and safety and build resilience through increased emergency management planning and response services.

In some cases, better planning may alleviate some of the damage, and in others, a coordinated response will improve outcomes and recovery. Communities resilient to climate change-related emergencies will be more resilient to other emergencies.





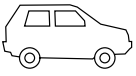
Buildings

Buildings generate greenhouse gas emissions from burning fossil fuels, (primarily natural gas), for space and water heating. The region's greenhouse gas emissions from buildings are second only to transportation, accounting for approximately one quarter of all regional greenhouse gas emissions.

Improving energy efficiency and switching to low carbon energy systems (e.g., district energy, electric heat pumps, solar, renewable natural gas) can reduce greenhouse gases from buildings. Trees can be used to reduce the energy required to heat and cool buildings. Local governments can influence building energy efficiency and the use of low carbon energy systems by adopting the BC Energy Step Code. They can also deliver programs that encourage building and home owners to improve energy efficiency and switch to low carbon energy sources. Buildings are long-lived assets (50 years or more) so energy efficiency requirements and programs to reduce emissions from buildings will have a long-term impact on greenhouse gas emissions.

Climate change will increase the incidence of extreme heat events, average summer temperatures and the need to cool buildings. Governments, utilities, and building owners need to consider how this will impact building design and energy use, and in response, modify policy and planning for energy demand, and building management. Increased risk of flooding due to climate change needs to be considered in the design and siting of new buildings and the retrofit of existing buildings. Also see the Land-Use and Growth Management Issue Area for further discussion of land-use planning for climate impacts.





Transportation

Transportation emissions come from the movement of goods, materials and people, whether by land, air, or sea. In this region, transportation is the single largest source of greenhouse gas emissions, accounting for approximately 45% of the regional total.

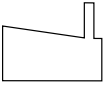
The dominant emission contributors in the transportation sector are cars and light trucks. Today, there are 1.4 million cars and trucks operating across the Metro Vancouver region, which emitted more than 4.7 million tonnes of greenhouse gases in 2015. In addition, heavy duty vehicles, trains, ships, and airplanes accounted for about 1.8 million tonnes of greenhouse gas emissions.

Today, about 70% of personal trips in the region are made by vehicles, compared to 13% by walking and cycling, and 14% by transit. Significant effort is needed to shift trips to non-vehicular modes and transit, both of which have

lower emissions. This transition will require infrastructure investments and changes to land-use policy, so that walking, biking and transit becomes the most convenient way of getting around for most personal trips. It will also mean transitioning almost all remaining personal vehicle trips to low carbon emission vehicles. Reducing emissions from the heavy duty vehicles, air, marine and rail sectors will require transition to low carbon fuels such as renewable diesel, renewable natural gas, and electricity.

Some transportation infrastructure will be impacted by climate impacts such as sea level rise and more frequent flooding. Special attention will need to be given to adapting this infrastructure to ensure that people, goods and services can continue to get around without disruption.





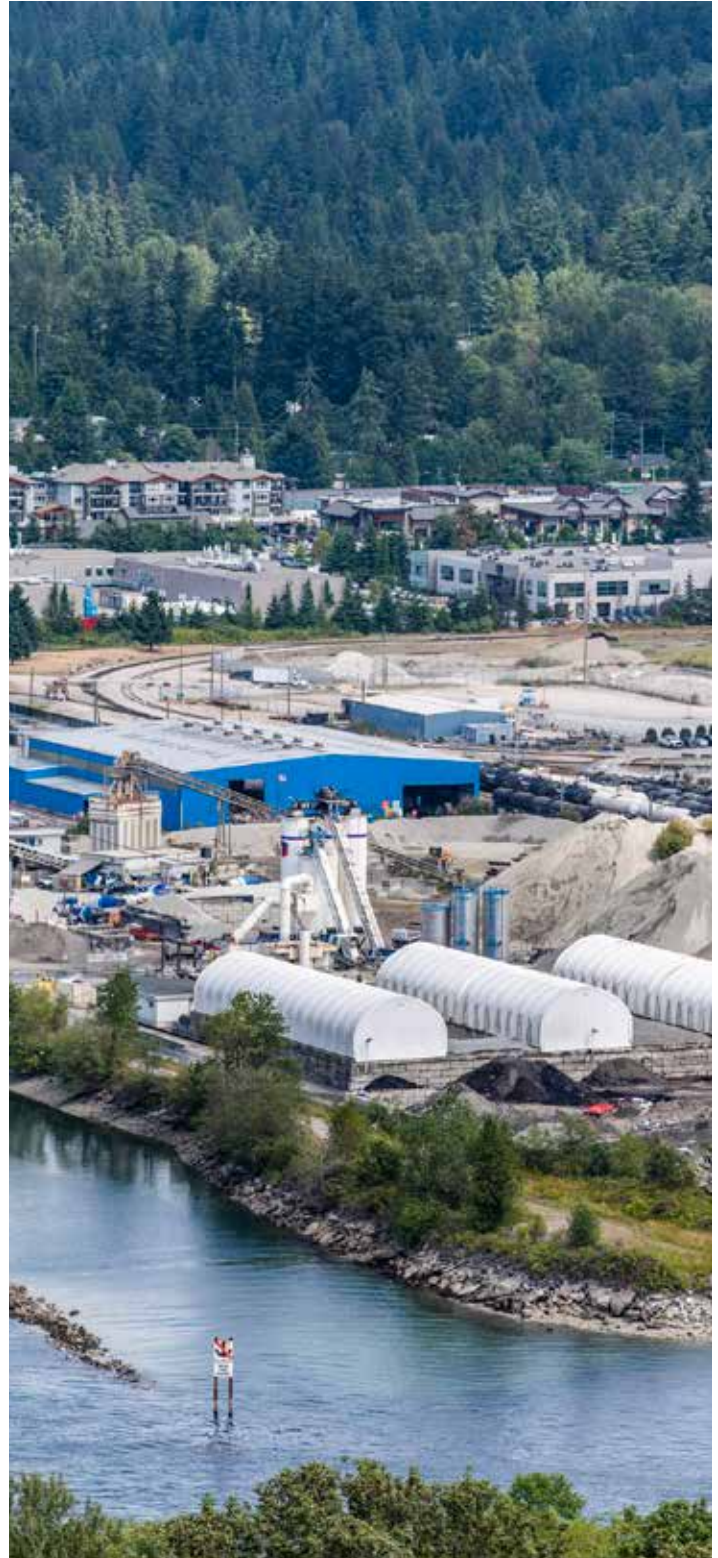
Industry

The region's relatively small but diverse manufacturing sector (e.g., cement production, food processing, metal fabrication, chemical manufacturing, forest products, and petroleum refining), in addition to the construction industry, combine to contribute approximately 23% of the region's total greenhouse gas emissions.

In the Metro Vancouver region, industrial facilities generate greenhouse gas emissions from burning natural gas, propane and fuel oil to produce heat for industrial processes, using diesel fuel in non-road engines, and other smaller sources. Industrial chemical processes such as cement production also produce a significant amount of greenhouse gas emissions. Reducing emissions from the various industrial sectors will require targeted approaches that are appropriate to those sectors, such as encouraging or requiring a switch to low carbon fuels like renewable natural gas.

RESEARCH AND INNOVATION

Many proven technologies exist in the market today to dramatically reduce greenhouse gas emissions and help build more resilient ecosystems, infrastructure, and communities. However, climate change still poses difficult technical and economic challenges to achieving a carbon neutral region and protecting against climate change impacts like sea level rise and extreme weather events. These problems will require the development of new technologies and approaches. Actions to support research and innovation will be an important part of the *Climate 2050 Roadmaps*.





Energy

Residents and businesses use energy to heat buildings and water, fuel vehicles, and power industrial processes. Using fossil fuel energy such as gasoline, diesel, propane, and natural gas results in greenhouse gas emissions. In this region, there are many opportunities to generate renewable and low carbon energy, and switch away from fossil fuels.

Switching from fossil fuel-based energy sources to low carbon electricity and fuels is essential to decarbonize our region's energy system. Investing in local low carbon energy systems such as renewable natural gas, waste heat recovery, solar, and heat pumps can support business development, job creation and energy self-sufficiency while reducing greenhouse emissions. Eliminating sources of energy waste (e.g., heated/cooled air leakage from buildings) and improving energy efficiency (e.g., through equipment upgrades and process improvements) should be an integral part of reducing energy-related emissions. Grid electricity in British Columbia is primarily generated by hydroelectric dams.

Recovering energy from waste streams produces a renewable and clean energy that can replace fossil fuel use or electricity. Metro Vancouver currently produces renewable natural gas at several of its wastewater treatment plants, which displaces the use of fossil fuels for operation of these facilities. There is potential to produce additional renewable natural gas or other biofuels at Metro Vancouver facilities. There are also opportunities to capture more waste heat from its utility processes, solid waste management facilities, and liquid waste collection system. Recovered heat can be used to generate electricity, or in district energy systems that provide energy to buildings for space heating and water heating. Through its policies and programs, Metro Vancouver can also support other projects in the region that generate renewable, low carbon energy.





Land-Use and Growth Management

The Metro Vancouver region is growing rapidly. Our population is increasing by 30,000 residents each year and it is anticipated that the regional population could reach 3.6 million people by the year 2050. The location of new homes, businesses and institutions strongly influences both greenhouse gas emissions and exposure to risks associated with climate change.

Land use decisions determine where residents live, work and play. Metro Vancouver and its member jurisdictions are working to reduce greenhouse gases by focusing growth in a network of transit-oriented urban centres, and building compact, complete communities that offer amenities close to home. This focused growth reduces emissions by supporting low carbon transportation such as walking, cycling and public transit. Actions in this Issue Area will be complementary to those contained in the *Transportation* Issue Area.

Where and how the region accommodates growth also determines how much residents, businesses and infrastructure are exposed to physical risks associated with climate change, such as flood risk from rising seas and rivers. Land use planning is an important tool for directing growth away from higher risk areas and natural areas that can alleviate negative impacts, thereby increasing community resilience to flooding. For buildings and other infrastructure that remain in flood-prone areas, protection such as dikes may need to be built or upgraded to mitigate increasing climate risk (see *Infrastructure* Issue Area), and additional resources may need to be allocated to emergency response planning (see *Emergency Management* inset box, pg 27).

LAND-BASED CARBON INVENTORY

As the region urbanizes, areas that were once forests, bogs, or agricultural land are changing to residential, commercial, or industrial uses. Often when these changes occur, greenhouse gases are released into the atmosphere through soil disturbance and decomposition or burning of wood and other plant material. In this process, local carbon sinks (e.g., trees, soil, bogs, and estuaries) are disturbed or lost entirely. Our current emissions inventory approach does not capture the potentially significant changes in emissions associated with land development in the region.

A land-based carbon inventory would provide a better understanding of the impact that land-use changes are having on the region's ability to sequester carbon and inform *Climate 2050* actions to protect local carbon sinks.





Agriculture

The combination of mild climate, fertile soils and demand for locally produced food has enabled a thriving agricultural industry that contributes to the region's food security. Uncertainty around the supply of food is emerging in many parts of the world due to a changing climate and limited fresh water resources. Protecting agricultural land and enhancing local food production are a priority for resilience in the region.

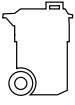
Climate models predict there will be both positive and negative consequences for agriculture. Rising average temperatures shifts the types of crops that can be grown and decreases heating costs for greenhouses. At the same time, rising temperature will introduce and exacerbate pest and disease problems, and increase irrigation demand. Changes in seasonal precipitation patterns could limit water supply during the growing season, putting increased stress on crops and livestock.

Heat waves can damage crops and increase the need for cooling of livestock barns and expanded use of refrigerated crop storage, which leads to higher costs and energy use. Rising sea levels can limit access to irrigation water from the Fraser River, and storm surges may require dike upgrades and other coastal flood protection measures to prevent agricultural land from flooding during the growing season.

Agricultural activities are also a source of greenhouse gas emissions. Around 3% of the regional greenhouse gas emissions come from agriculture, primarily methane from livestock and manure, nitrous oxide from the application of fertilizer and soil management, and carbon dioxide from burning fossil fuels to heat greenhouses and operate farm equipment. The good news is that agricultural soils can play a substantial role in carbon sequestration, which has the added benefit of maintaining soil productivity over the long term.

Securing local food production means that some of the food consumed by residents is available year round and during emergency situations. Equally important is the role agricultural land plays in providing ecosystem services. Nutrient and organic matter recycling on farmland supports regional efforts to recycle organic waste. Agricultural land also provides important habitat for migratory birds and other wildlife. Both agricultural land and natural areas can help communities manage river water levels and extreme precipitation events through groundwater infiltration and flood management.





Waste

Fossil fuels are used to manufacture, transport, and ultimately dispose of all the goods we consume, and when waste is disposed in a landfill it produces methane, a potent greenhouse gas. The actions we take in this region have a significant influence on the lifecycle greenhouse gas emissions related to the goods consumed in the region.

Much of our waste can be reduced, reused, or recycled, so we need to ensure that waste is always considered a potential resource. Transitioning to a circular economy helps to further reduce waste (and associated emissions), because the circular economy concept aims to retain the value of products, materials, and resources in the economy through non-linear business models, maximized product lifespans, and closed production and consumption loops. For example, preventing methane emissions through source reduction, composting, or capturing methane at digestion facilities and landfills are effective greenhouse gas reduction strategies. The captured gas can be upgraded to renewable natural gas, and used to replace fossil-based natural gas (see also Energy Issue Area). Policies incentivizing or requiring the reuse, recycling, and recovery of energy from waste materials can generate new business and create new economic opportunities.



CONSUMPTION-BASED EMISSIONS INVENTORY

Metro Vancouver has been preparing sector-based emissions inventories (as described above) since 1985. But sector-based inventories only account for emissions that are released directly in the region, mostly related to fossil fuel use for transportation and building heat. They don't account for the lifecycle greenhouse gas emissions associated with the goods and services consumed in the region, because they are not emitted directly in the region. A consumption-based inventory attributes the greenhouse gas emissions associated with the full lifecycle of goods and services including emissions from the production, transport, wholesale and retail, use, and disposal.

Since greenhouse gases have the same impact on the global climate regardless of where they are emitted into the atmosphere, Metro Vancouver will explore conducting a consumption based inventory to measure the full emissions impact of choices made in the region. Evaluated together, these different inventory approaches can provide a more complete picture of the region's greenhouse gas emissions and offer insights into the most effective actions to reduce global emissions.

APPENDIX 2

GLOBAL CLIMATE CHANGE DATA AND TRENDS

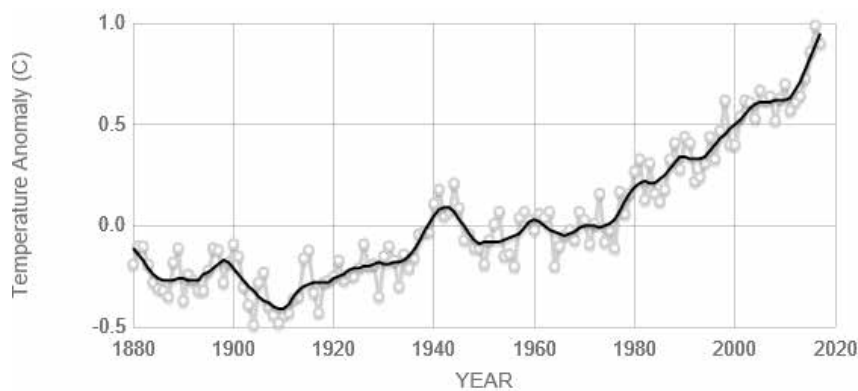
Increasing levels of greenhouse gas emissions are warming our planet and driving climate change. How do scientists know this? This appendix provides a snapshot of some of the key data points and observed trends related to global climate change. References and links are provided to sources of information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



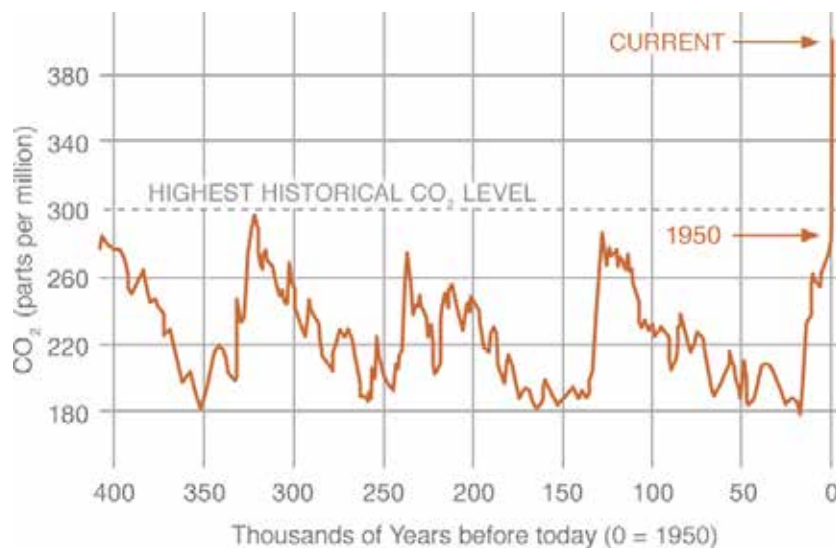
Watershed staff measure snowpack eight times a year in the remote wilderness behind the North Shore Mountains. They go to five different sites, taking samples to determine the quantity of stored water for our reservoirs.

Global Average Temperature

Human-induced warming reached approximately 1°C above pre-industrial levels in 2017, increasing at 0.2°C per decade according to Global Warming of 1.5°C, a special report by the Intergovernmental Panel on Climate Change (IPCC)¹. Both past and future warming in Canada is, on average, about double the magnitude of global warming. Northern Canada has warmed and will continue to warm at more than double the global rate.^{2,3} 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. 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.⁴



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



Global atmospheric concentrations of carbon dioxide over the past 400,000 years³

1 IPCC, 2018: Summary for Policymakers. In: Global Warming of 1.5°C. <https://www.ipcc.ch/sr15/>

2 Government of Canada, Canada's Changing Climate Report, 2019 <https://changingclimate.ca/CCCR2019/>

3 IPCC, 2013: Summary for Policymakers. In: Climate Change 2013: The Physical Science Basis https://www.ipcc.ch/site/assets/uploads/2018/02/WG1AR5_SPM_FINAL.pdf

4 NASA Global Climate Change – Evidence <https://climate.nasa.gov/evidence/>

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,

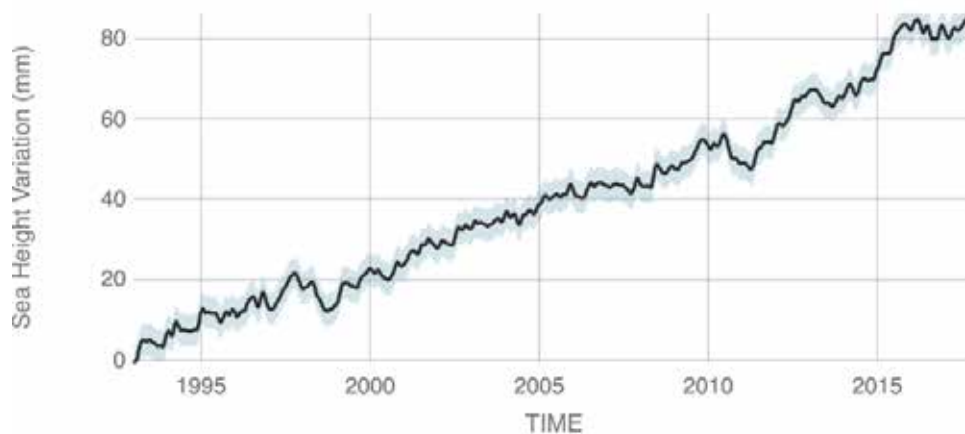
for example the increasing frequency and intensity of extreme weather events such as heat waves, heavy precipitation, and storms. Below is a description of three of the expected changes to earth systems caused by rising global temperatures: sea level rise, decreased snow and ice cover, and extreme weather events.

SEA-LEVEL RISE

As the climate warms, sea levels are rising worldwide.⁵ 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.

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. 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.



Sea Level Rise from 1993 to Present⁴

5 NASA Global Climate Change – Vital Signs <https://climate.nasa.gov/vital-signs/sea-level/>

Decreased Snowpack / Snow Cover

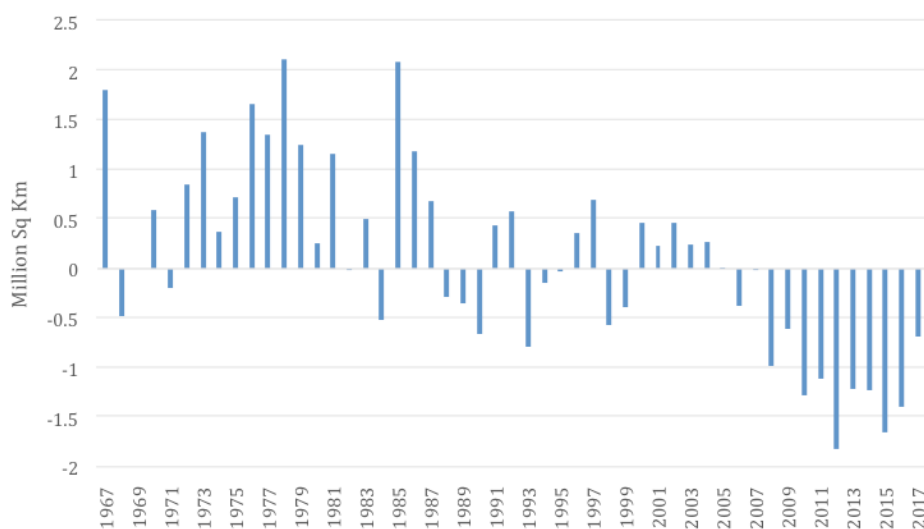
Snow and ice cover helps regulate the climate by reflecting incoming solar energy back into space. Over the next century, water contained in glaciers, ice caps and annual snowpack are expected to continue to decline. With less snow cover and a decrease in the amount of reflected sunlight, the ground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

Monitored snowpack levels in western North America are decreasing⁶. Data from 1981–2015 shows the proportion of days within each month that snow was present on the ground is decreased by 5% to 10% across most of Canada during most seasons². Glaciers have been retreating at least since the 1960s and mountain snow cover has declined on average in both the Northern and Southern

hemispheres⁷. Over the past three decades, the proportion of Canadian land and marine areas covered by snow and ice have decreased, and permafrost temperatures have risen².

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. Rapidly 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.

North American snow cover compared to 1981-2010 average⁶



⁶ Rutgers University Global Snow Lab – North American Snow Cover Anomalies <https://climate.rutgers.edu/snowcover/index.php>

⁷ National Snow & Ice Data Center – State of the Cryosphere <https://nsidc.org/cryosphere/sotc>

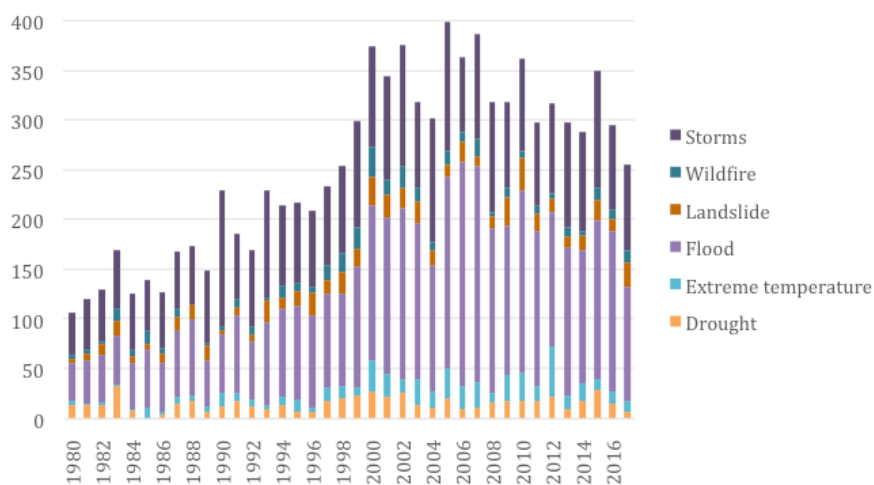
Extreme Weather Events

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. International agencies that are tracking extreme events are already observing an increase.⁸ Scientists are increasingly able to evaluate the contribution of climate change to specific extreme events.

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. 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. 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. 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. 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 2014.⁹



Reported Extreme Weather-related natural disaster events 1980-2017 ²

⁸ EMDAT (2017): OFDA/CRED International Disaster Database <https://ourworldindata.org/natural-disasters>

⁹ US Global Change Research Program – National Climate Assessment <https://nca2014.globalchange.gov/report/sectors/urban>

