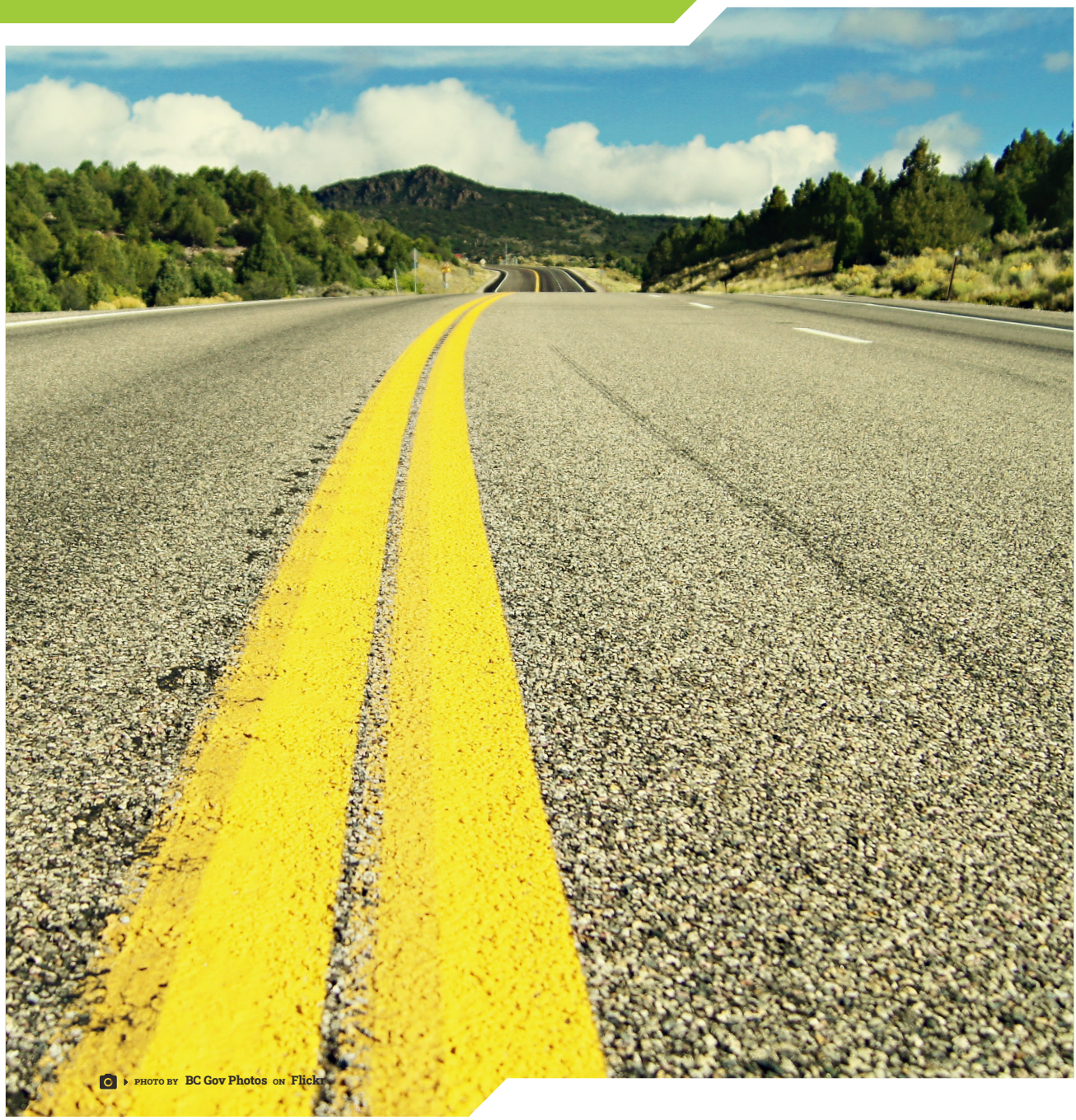
ClimateWest

April, 2022

A Snapshot of the Changing Prairie Climate



Prepared for ClimateWest
by the Prairie Climate Centre

Prairie Climate Centre

ClimateWest

Building Prairie Resilience

About ClimateWest

ClimateWest, launched in January 2021, is a central hub for climate services in Manitoba, Saskatchewan, and Alberta. ClimateWest's mandate is to support people, communities, businesses, and governments to address climate change risks and vulnerabilities through planning and action.

Why "climate services"? From acute challenges such as floods and fires to more gradual shifts in temperature and precipitation patterns, the Prairie region needs to prepare, invest, and build towards greater climate resilience. Yet several barriers often prevent insights about future climate change from shaping decision-making across communities and economic sectors. Breaking down these barriers is exactly what ClimateWest seeks to do.

ClimateWest delivers access to credible, useful, and timely climate information and data tailored to the Prairie region. ClimateWest invests in tools and training that build local capacity for the application of climate information in planning and action. ClimateWest also offers a public Help Desk as a free service to troubleshoot Prairie-focused queries about climate data and climate change adaptation. To learn more, and for the latest news about our work, please visit **www.climatewest.ca.**

Core to ClimateWest's operations are three leading Prairie-based climate research organizations which are ClimateWest's founding partners: the Prairie Adaptation Research Collaborative (PARC), the Prairie Climate Centre (PCC), and the International Institute for Sustainable Development (IISD).

These founding partners have a long-term commitment to collaborate under the banner of ClimateWest on climate adaptation initiatives in the Prairie region. ClimateWest's work marries their many strengths across research, communications, and capacity-building focused on climate risk and adaptation.

In addition, ClimateWest seeks to engage additional expertise, capacity, and knowledge across the region, including Indigenous leaders and elders, post-secondary institutions, research institutes, professional associations, non-profits, foundations, and private firms.

ClimateWest is also part of a growing network of regional climate service providers working closely with the Canadian Centre for Climate Services (CCCS) that also encompasses the Pacific Climate Impacts Consortium (PCIC), serving BC and the Yukon, and Ouranos, serving Quebec.

Acknowledgements

ClimateWest is a non-profit climate services hub focused on building the Prairie region's climate resilience through information access, training, and tools. The expertise and capacity of ClimateWest's three founding partners underpin the organization's work: the Prairie Adaptation Research Collaborative at the University of Regina, the Prairie Climate Centre at the University of Winnipeg, and the International Institute for Sustainable Development.

To learn more, and for the latest news about ClimateWest, please visit **www.climatewest.ca.**

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A Snapshot of the Changing Prairie Climate

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- The region is projected to warm much faster than the global average.
- Risks to ecosystems, communities, and economies will be substantial.
- The Prairies are projected to continue warming even if large-scale, international emission reduction efforts are made today.
- Along with global mitigation efforts, local adaptation to climate change will be essential for future prosperity in the Prairies.[1]

The region and its people are already seeing and experiencing the effects of climate change, and many aspects of life in the Prairies will continue to be impacted. This report builds on the research and synthesis of many others, especially the recently released Prairie Chapter of the updated National Assessment process.

The situation is growing ever more urgent, but there is yet time to improve our capacity to adapt and build resilience in the face of our changing climate. Much depends on the decisions and actions of governments, communities, businesses, and nonprofits, and their leaders. But citizens also have a role in helping drive adaptation, too. This report concludes with some practical steps that concerned Prairie dwellers can take across four areas:

- Advance local policies, planning and preparedness.
- Shape the conversation about the changing Prairie climate.
- Contribute to building local climate resilience.
- Share "citizen data" to advance reporting and research on climate change.

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1. Introduction

The Canadian Prairies is a hotspot for climate change not just within Canada, but across the world. The region is projected to warm much faster than the global average—a product of the region's northern latitude and continental geography—and the risk to ecosystems, communities, and economies will be substantial. The region and its people are already seeing and experiencing the effects of climate change, and many aspects of life in the Prairies will continue to be impacted in the following ways:

- An altered water cycle will increase the risk of both flood and drought.
- Forest fires will become larger and occur more frequently.
- Agriculture will be challenged by heat stress and more frequent drought.
- Wildlife will be impacted as the changing climate threatens habitats and as invasive species and pests migrate further north.
- Human health will suffer from longer and more frequent heat waves.
- Traditional ways of life will be interrupted or made impossible as the warming impacts local wildlife populations and transportation routes.

The long story short: virtually all ecological, economic, and social systems—meaning how we live with nature, how we make a living, and the way we relate to others on the Prairies—are dependent, either directly or indirectly, on a stable climate system and will therefore be affected by climate change.

Ultimately, the consequences of climate change in the Prairies will depend on how societies around the world can reduce greenhouse gas emissions, and how well local ecological, economic, and social systems can adjust to the changes. An often overlooked aspect of climate change is that the Prairies are projected to continue warming, even if large-scale, international emission reduction efforts are made today. This means that along with global mitigation efforts, local adaptation to climate change will be essential for future prosperity in the Prairies.

Reinforcing a system so that it better handles climate shocks and reduces the risk from the impacts of climate change are key parts of climate change preparedness. This may involve making changes such as updating engineering codes to account for changing weather patterns, planting crops that are more tolerant of heat and moisture stress, and making better emergency management plans to deal with more frequent and intense disasters. But before any such changes are determined, a crucial step of adaptation planning is to better understand the climate change risks. Only with those risks in focus can the best steps be identified in order to avoid or reduce their impact.

> The long story short: virtually all ecological, economic, and social systems on the Prairies are dependent, either directly or indirectly, on a stable climate system.

Why this report, and why now?

This report on climate change in the Prairies is designed to be an accessible, timely, and accurate snapshot for those who make Alberta, Saskatchewan, and Manitoba their home. It was not written for a technical audience. Rather, it's aimed at anyone seeking a serious orientation that covers many facets of the changing Prairie climate.

As with a photography snapshot that captures a moment in time, this report captures the present understanding of anticipated climatic changes and their implications across many parts of Prairie life. Also true to a snapshot, while rich in detail, this report remains a fairly high-level summary. You can read this report from start to finish in about the same time it takes to read a weekend newspaper. Or, should your interests lie in a specific area, you can use it as a reference tool, since each section stands alone.

We hope you will return to this report, and refer others to it, as you and your community consider what it means to be prepared for the future.

This report builds on the work of many others, especially the newly updated National Assessment process that brings together a scientific summary of the latest research and findings on climate change adaptation in Canada. The recently released Prairie Chapter of the National Assessment offers greater detail, and is relevant for those seeking more information after consulting this snapshot report.[2] Like the National Assessment, the contents of this report are grounded in trustworthy existing research and evidence.

The first three report sections take a deep dive to explore our changing climate across major phenomena:

1. **wildfires,**
2. **flood and drought, and**
3. **extreme weather events.**

The sections that follow explore what our projected climate holds for our way of life:

4. **agriculture,**
5. **ecosystems and wildlife,**
6. **health,**
7. **Indigenous communities,**
8. **transportation and infrastructure,**
9. **tourism and recreation, and**
10. **urban and rural communities.**

The vision of ClimateWest and its partners in creating this landscape report is to help communities across Alberta, Saskatchewan, and Manitoba better understand the risks for our region, our key sectors, and our way of life. The situation is growing every more urgent, but there is yet time to improve our capacity to adapt and build resilience in the face of our changing climate.

2. Background: The Canadian Prairie Provinces

The Canadian Prairie provinces (the Prairies for shorthand in this report) are very important to Canada and the world. The region is home to one of the world's largest contiguous food-producing regions, one of the world's last remaining undeveloped swaths of boreal forest, a significant volume of frozen peatland (an important storehouse of methane, a potent greenhouse gas), and some of the world's largest freshwater lakes—Lake Winnipeg (11th), Lake Athabasca (20th) and Reindeer Lake (23rd). It is also home to numerous endangered and threatened species; many intensive industries, such as mining, forestry, farming, and oil extraction; several of Canada's largest metropolitan areas; and a large Indigenous population actively practicing both modern and traditional ways of life.

Past

The Prairies' vast historical, cultural, and ecological significance is intimately linked with climate. The Prairies owe their largely flat profile to glaciers, which covered the landscape with massive amounts of ice that compressed the land over horizontal layers of ancient marine sediment. As the glaciers retreated around 12,000 years ago, they scoured the land and left behind deposits, creating the hills, lakes, and other landscape features found in the Prairies.

Following this last major shift in climate, the climate system entered a long period of relative stability—the Holocene. Rich grasslands thrived in the semi-arid environment in the south and under the stewardship of the land's first Indigenous peoples, who periodically burned the landscape to discourage the spread of shrubs and trees. These grasses led to the development of the rich, dark chernozemic soils that support today's intensive, industrial-scale farming activities.

Further north, colder and wetter conditions favoured the development of vast coniferous forests. Today, these forest ecosystems constitute one of the country's largest stores of terrestrial carbon and are home to abundant biodiversity and numerous keystone species—species vital to the function and health of an ecosystem. In northern Manitoba, the ground remains frozen year-round. This permafrost is important because it prevents huge volumes of methane from entering the atmosphere, and also provides structural stability for roads and buildings in this region.

The Prairies are projected to warm much faster than the global average.

Present

The Prairies are also no stranger to short-term climatic variations. Many Prairie residents will invoke the memories of severe drought in the 1980s and early 2000s, major flooding such as the 1997 Red River "flood of the century" in southern Manitoba, storms of all shapes and sizes—including tornadoes, blizzards, and "weather bomb" windstorms—and, in general, a highly variable climate system that's difficult to forecast. Consequently, the ecosystem and its inhabitants are uniquely adept at dealing with a wide range of climate conditions. There are few places on Earth where residents need to cope with -40°C days in the winter and +35°C days in the summer.

Despite this ability to cope—and even thrive—with climatic extremes, the Prairie region remains highly vulnerable to climate change. As more recent weather-related disasters have shown, changes in the frequency, intensity, and timing of weather extremes can have disastrous consequences.

The Calgary flood of 2013 cascaded out of control when unusually intense precipitation fell during late spring. The snow covering the mountains melted quickly when exposed to the rain, while the ground at higher elevations was still frozen and unable to absorb enough of the excess runoff.

In May 2016, the Fort McMurray wildfire was fanned by record-setting high temperatures caused in part by a very anomalous jet stream pattern, which itself may have been a manifestation of record warm Arctic temperatures.

And on October 11, 2019, Winnipeg, Manitoba, was hit with a remarkably early, heavy, and wet snowstorm that wreaked havoc on the city's treasured trees and that caused extensive and costly damage to the region's power grid.

These are the kinds of extremes that are likely to become more common in a changed climate.

Future

The Prairies are projected to warm much faster than the global average. Understanding future climate change and the potential impacts that are likely to occur in the Prairies is therefore a vital exercise. Even if actions are taken to reduce greenhouse gas emissions, the Prairies will experience a substantial and possibly even dangerous degree of climate change.

Figure 1 summarizes some key climatic changes projected for the Prairie region near the end of this century under high (RCP 8.5) carbon emission scenarios (see box on next page). Changes in temperature extremes best illustrate the profound climatic shifts expected for the region. The number of hot days (when the maximum temperature reaches or exceeds 30°C) is expected to triple or even quadruple across the southern Prairies. Conversely, the number of cold days (when the minimum temperature reaches -30°C or colder) will decrease across the entire region, most notably in the north, where communities may witness a huge reduction in the number of cold days under a high carbon scenario. This warming is also linked to a large increase in the length of frost-free period. Seasonal precipitation values are expected to change, too, with winters, springs, and falls projected to become wetter and summers (especially in the south) projected to become slightly drier, even though large rainstorms capable of causing localized flash floods are also projected to increase during the summer.

What are the implications of these climatic changes? On the surface, a warmer climate with a longer growing season may appear to greatly benefit agriculture. However, negative consequences are also likely for agriculture and other aspects of life in the region, such as more pests and crop diseases, more forest fires, more heat waves, and a greater risk of highly energetic storms. This report highlights the anticipated opportunities and risks associated with climate change in the Prairie provinces.

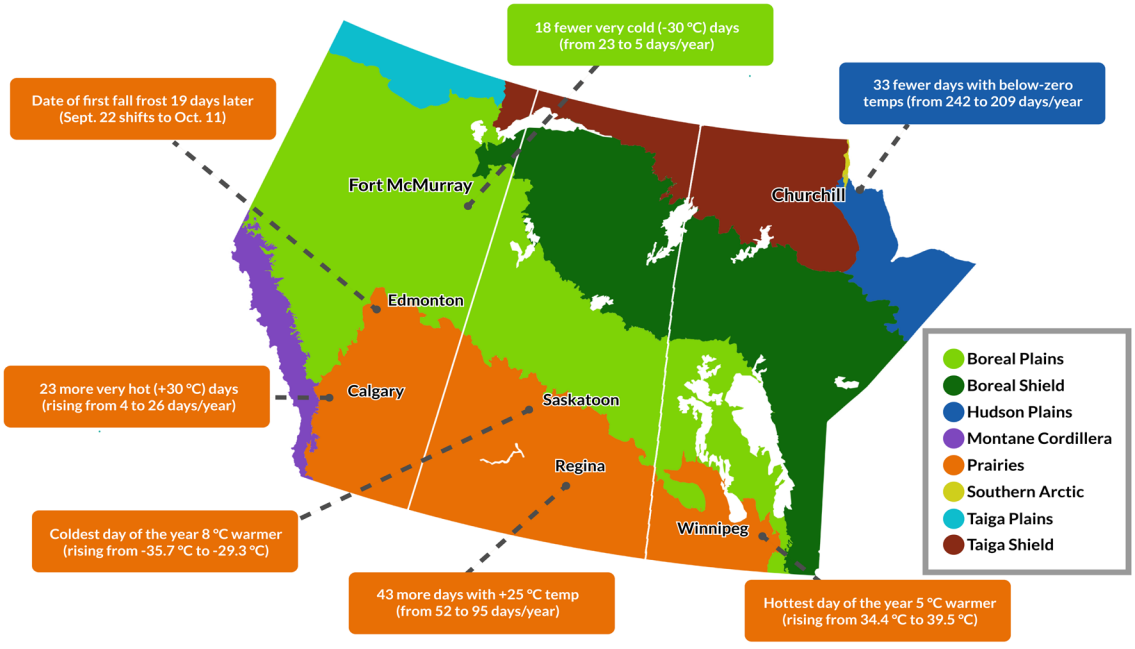

Figure 1 - Climate model projections of select climate variables for several cities in the Prairie provinces.
Note: Projections shown are from the mean of 24 climate models for the 2051–2080 period under a high carbon (RCP8.5) emission scenario, compared to the historical period 1976–2005. Map data: Ensemble of 24 CMIP5 models (BCCCAQv2 Statistically Downscaled Climate Scenarios) provided by the Pacific Climate Impacts Consortium, University of Victoria (pacificclimate.org)[3]

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What are "High" and "Low" Carbon emission scenarios?

The high and low carbon emission scenarios represent two possible future levels of global greenhouse gas emissions. These scenarios, also known as RCPs (representative concentration pathways), are used with climate models to project future climate based on the assumptions the scenarios make about the amount of greenhouse gases being released into the atmosphere through to the end of the century.

The low carbon (RCP 4.5) scenario assumes emissions will continue to rise until mid-century, before declining to a relatively low level and stabilizing by the end of the century. However, the concentration of CO2 in the atmosphere still ends up being much higher than today.

The high carbon (RCP 8.5) scenario assumes emissions will continue to rise at a similar pace as today, also known as "business as usual". This scenario results in the most severe climate change occurring.

Forest Fires:

What to prepare for in the future

1.

Hotter, drier conditions, increased evaporation creates drier fuel

2.

Longer fire season

3.

More lightning strikes igniting more fires

All across the Prairie region, the fire season is starting earlier and lasting longer.

Wildfires are one of the most important disturbances affecting Canadian forests.[4] Forest fires are natural events that help maintain the long-term health of a forest ecosystem by initiating regeneration, limiting invasive species, and revitalizing soils and vegetation. However, they are also very dangerous; they threaten human livelihood, buildings, and timber for harvest, and are extremely costly to control. Climate change is predicted to increase forest fire frequency in the Prairie provinces.[5] It's also predicted to increase their intensity and duration.[6]

Three main factors determine forest fire activity: fuel, ignition, and the right weather conditions.[7] Climate change is expected to affect each of these factors, as warmer temperatures, extreme heat, decreased summer precipitation, and more frequent lightning events become the new normal in the decades to come. Additionally, when these climatic conditions occur simultaneously, they produce the perfect recipe for severe, large-scale forest fires, and the downwind risk of community-wide evacuations, economic losses, and increases in smoke-related health issues.[8]

The availability and type of fuel is the first factor. As grasses, brush, and trees grow drier in warm weather, they are more likely to catch fire and stay burning longer. As temperatures increase due to climate change, vegetation dries even more quickly and more thoroughly. Less precipitation during the summer months also increases the risk of a drier landscape and the availability of dry material to burn.[9] The presence of all this dry fuel allows more fires to start and then burn extensive expanses of forest.

The second factor, ignition, is how the fires start. Lightning is the natural and main source of ignition for wildfires capable of destroying entire forests and severely damaging community infrastructure.[10] As the number of summer days above 30 °C is projected to triple or even quadruple in the majority of the Prairie region by the end of the century, the risk of severe thunderstorms will likely increase as well.[11] People are also a source of wildfire ignition. Through campfires and sparks from engines (among other things), human activities can start fires that quickly grow out of control. As the spring and fall seasons get warmer, it is expected that people will head into the backcountry earlier in the year and stay later. This increased outdoor activity may mean a higher risk of human-started forest fires.

Finally, wildfire activity is influenced by weather conditions. Hot, dry, and windy weather is ideal for spreading wildfires—as well as sending smoke hundreds if not thousands of kilometres from the wildfire site. Climate change will create higher temperatures conducive to weather that lets fires start, intensify, and spread. Warmer weather is also causing earlier snowmelt and later onsets of winter, thereby extending the fire season, or the span of time when the weather is warm enough and dry enough for fires to occur. All across the Prairie region, the fire season is starting earlier and lasting longer.[12]

As we look towards a future with more wildfires—ones that are also potentially larger and more intense—top priorities in the Prairies are to ensure the safety of communities and their residents while also protecting critical infrastructure and economic activity. FireSmart Canada, an association leading the way to promote fire-smart education and increase wildfire resilience in communities across Canada, recommends a number of practices for homeowners and farmers that reduce the risk and spread of wildfires. One recommended practice is to make conscious decisions about fire safety around properties, such as choosing fire-resistant construction materials and planting fire-resistant plants and shrubs instead of other, more flammable, alternatives. A number of fire-smart farming principles that focus on vegetation management can also apply to farm lands in order to protect lives, property, and crops, and to limit the spread of wildfires.[13,14]

Communities also play a role in reducing the impact of wildfires by adopting principles, best practices, and management strategies that focus on wildfire prevention, mitigation, and preparedness. Communities can put into place a number of actions, such as conducting wildfire hazard risk assessments, developing emergency response plans, planning land use with wildfire prevention in mind, and increasing public education and communication around wildfires.[15] When it comes to wildfire resiliency, a holistic approach will be key to reducing the impacts to health, communities, infrastructure, and the economy.

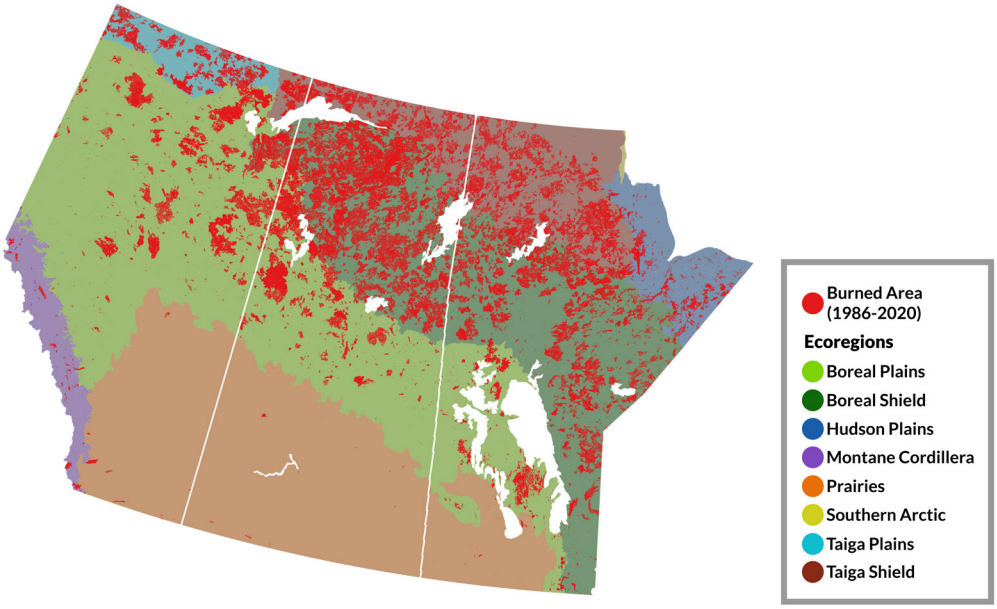


Figure 2. Areas burned by wildfire from 1986–2020
Note: Red shows burned areas. A large portion of the Prairie provinces outside of the Prairie ecoregion ex perience forest fires. Source: NRCAN [22]

Cultural Burning: An Adaptive Practice

Indigenous people have been using fire to shape the Prairie landscape since time immemorial. Traditionally practiced to encourage the growth of plants for subsistence, cultural burning is also a fire management practice that could help prevent devastating fires in a future with climate change.[16]

Using knowledge of the land, climate, and the behaviour of fire, Indigenous people in the Prairies set fires at deliberate times and locations under favourable conditions.[17] These smaller, generally low-burning and slow-moving fires help clear out undergrowth and deadwood, and prevent the build-up of natural wildfire fuels. Controlled burns also open up the land, creating new habitat for a variety of animals, including moose and elk, and encourage the growth of both fire-tolerant and culturally important plants that arrive shortly after fires, such as berries and medicines.[18]

For many centuries, fire management in Canada has focused on fire suppression, mainly to protect timber and watersheds, and therefore fires were seen only for their destructive properties.[19] Following that mentality, the practice of cultural burning was criminalized in Canada, and Indigenous people on the Prairies were persecuted for taking part in their own culture and heritage. As a result, the practice of burning became less common due to fear of punishment. This has led to the loss of culture, identity, and traditional knowledge for many Indigenous people.[20]

While cultural burning isn't as widely practiced as it once was, there is considerable desire on the part of Indigenous communities to re-establish the practice. Cultural burning plays an important for Indigenous culture and identity, while also helping reduce the impacts of large wildfires in the Prairies.[21]

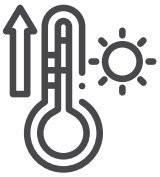
PHOTO BY Matthis ON Pexels

Drought and Flood:

What to prepare for in the future

1. 

Increased frequency and intensity of heavy rain events

2. 

Decrease in summer rainfall, increase in drought

3. 

Increased risk of flash flooding

> It is not unlikely that floods and droughts could occur at the same time in different parts of the region, and sometimes one after the other in quick succession.

Water is essential for life, especially in the Prairies. Agriculture, hydroelectricity generation, forests, grasslands, lakes and rivers, recreation, and many other aspects of Prairie life are reliant on or affected by water. Too little water is a problem, but too much can also be a problem. For most of the southern Prairies, climate models project a decrease in precipitation during the summer but an increase in fall, winter, and spring.

Summer drought is always a serious concern, particularly for those whose livelihoods depend on moisture, such as farmers. With rising temperatures and lower summer precipitation, surface water losses to evapotranspiration will increase, as will the risk of drought and its substantial economic consequences. The drought of 1999–2005 was especially severe. Between 2001 and 2002, when the drought was at its worst, farmers in Alberta and Saskatchewan lost over $3 billion due to reduced crop production.[23] Statistics Canada reported this period as one of the worst droughts on record, and one of the worst harvests in Canadian history. In addition to low crop yields, there wasn't enough water to produce sufficient amounts of hay to feed livestock.

While the overall amount of rainfall during the summer is projected to decrease, the frequency and intensity of individual heavy rainfall events are likely to increase with climate change. Dumping large volumes of water in short periods of time, these events often cause flash flooding with dire consequences for rural and urban areas alike. In urban environments, storm water infrastructure may not withstand the severity, and streets may become impromptu rivers. More precipitation during winter and spring also increases the risk of flooding when the snow melts. Floods cause enormous amounts of disruption and economic losses, in both rural and urban areas, and can be devastating to communities.

Despite projections of increases in winter precipitation, the snowpack is expected to decrease due to a greater proportion of winter precipitation falling as rain with warmer winter temperatures. The decreased depth and shortened duration of the snowpack will result in earlier spring runoffs and peak flows.[24,25] Earlier spring melts, in turn, impact the hydrology of the Prairies. Water that is accumulated from the overwintering snowpack feeds into rivers and recharges groundwater. As such, a reduction in stored snowpack water and an earlier spring melt may reduce the availability of water

for drinking and irrigation during the drier summer months.[26] Similarly, the shrinking of glaciers in the Rocky Mountains also reduces the contribution of glacier melt to streamflow and poses a greater risk of water shortages.[27] With overall warming temperatures across the Prairies, it's expected that increased drying from evaporation will occur, further affecting water availability.

Summer is the season with the highest demand for water (i.e., water for hydroelectricity, agriculture, and municipal use), and without the accumulated water from snowmelt to recharge the baseflow, summer streamflow will significantly decrease. The resulting droughts carry serious consequences for the agriculturally-driven Prairie economy, especially since irrigation (a past adaptation to dry conditions) in the Western Prairies relies on sufficient streamflow to meet the needs of all water users.

In the future, as was the case in the past, the Prairies will be faced with flooding and drought. However, floods and droughts have serious potential to grow more frequent and more severe. It's also likely that floods and droughts could occur at the same time in different parts of the region, and sometimes one after the other in quick succession. This reality will make it difficult for communities and ecosystems to cope, as they will be given little time to recover from previous stress or damage. The impacts are costly: erosion and crop losses, significant property losses and insurance claims, compromised transportation infrastructure, damaged ecosystems, and widespread societal stress.

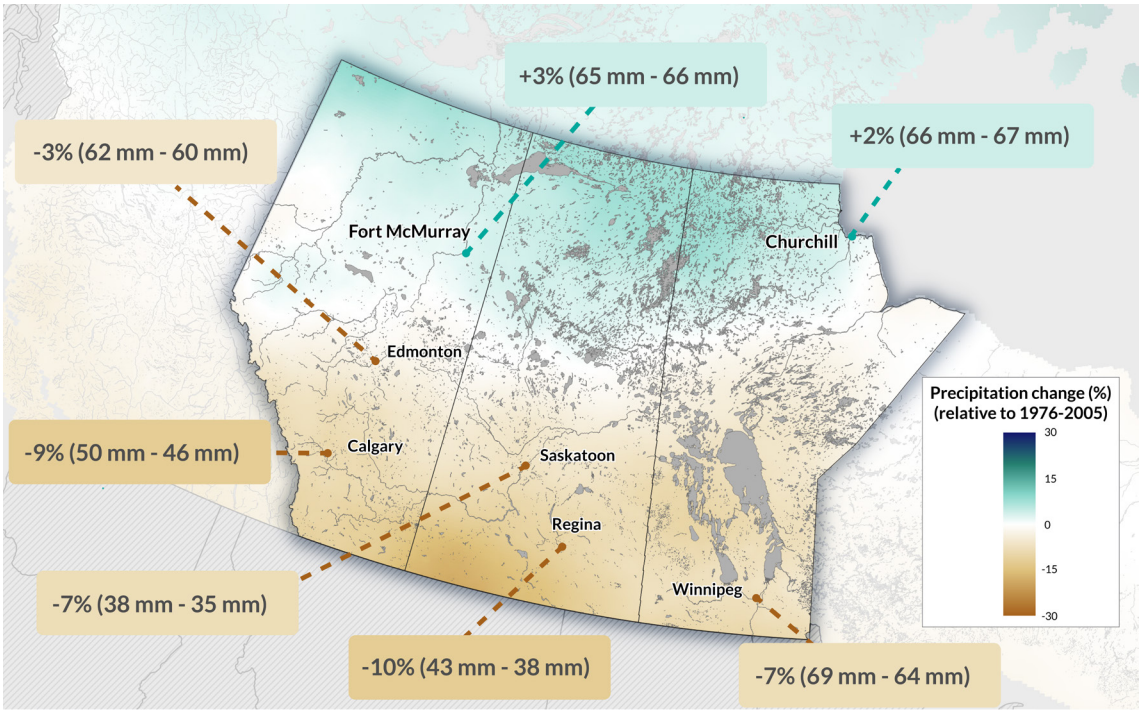
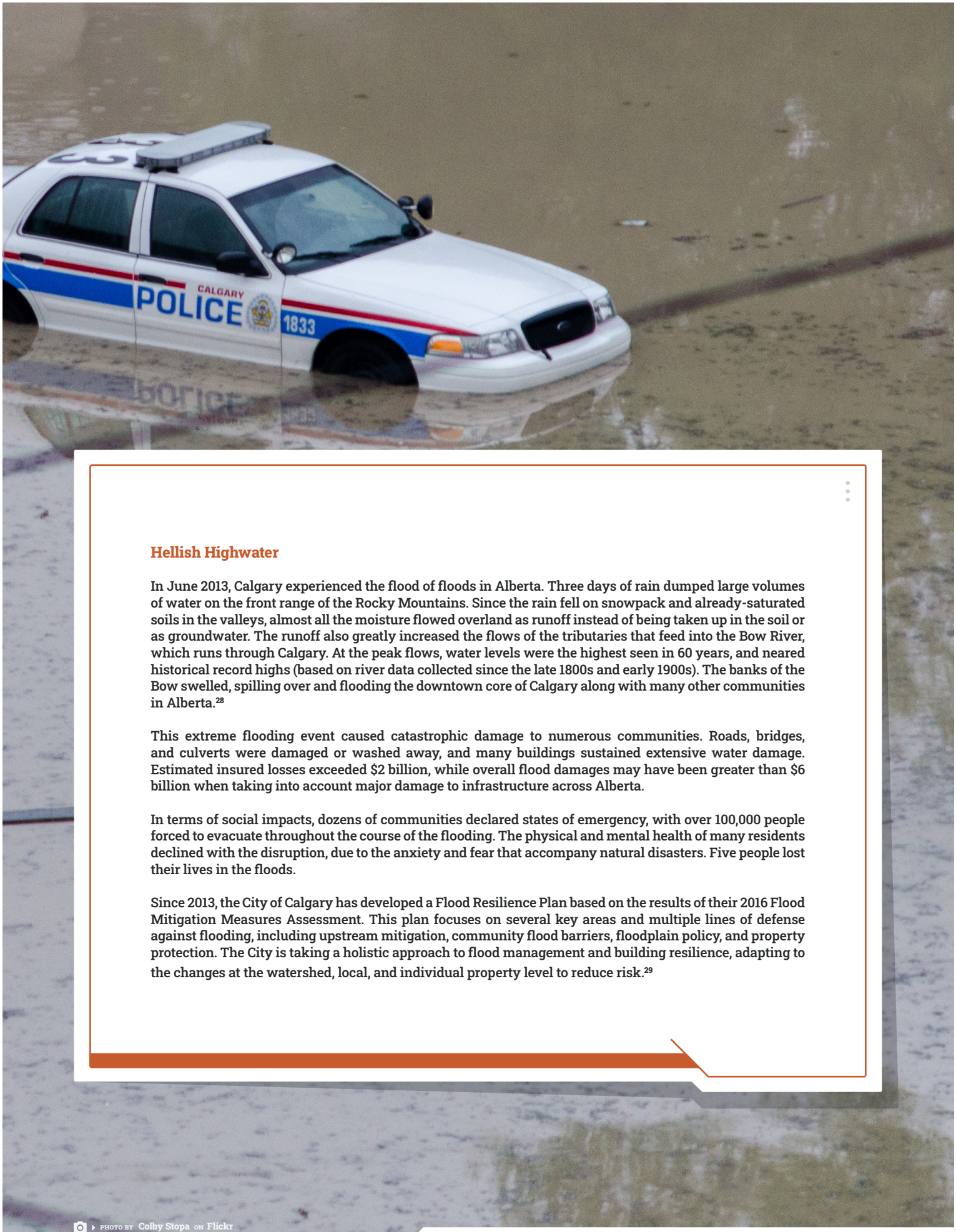


Figure 3 – *Projected percent change in August precipitation (2051–2080) at RCP 8.5 relative to the baseline period 1976–2005*



Hellish Highwater

In June 2013, Calgary experienced the flood of floods in Alberta. Three days of rain dumped large volumes of water on the front range of the Rocky Mountains. Since the rain fell on snowpack and already-saturated soils in the valleys, almost all the moisture flowed overland as runoff instead of being taken up in the soil or as groundwater. The runoff also greatly increased the flows of the tributaries that feed into the Bow River, which runs through Calgary. At the peak flows, water levels were the highest seen in 60 years, and neared historical record highs (based on river data collected since the late 1800s and early 1900s). The banks of the Bow swelled, spilling over and flooding the downtown core of Calgary along with many other communities in Alberta.[28]

This extreme flooding event caused catastrophic damage to numerous communities. Roads, bridges, and culverts were damaged or washed away, and many buildings sustained extensive water damage. Estimated insured losses exceeded $2 billion, while overall flood damages may have been greater than $6 billion when taking into account major damage to infrastructure across Alberta.

In terms of social impacts, dozens of communities declared states of emergency, with over 100,000 people forced to evacuate throughout the course of the flooding. The physical and mental health of many residents declined with the disruption, due to the anxiety and fear that accompany natural disasters. Five people lost their lives in the floods.

Since 2013, the City of Calgary has developed a Flood Resilience Plan based on the results of their 2016 Flood Mitigation Measures Assessment. This plan focuses on several key areas and multiple lines of defense against flooding, including upstream mitigation, community flood barriers, floodplain policy, and property protection. The City is taking a holistic approach to flood management and building resilience, adapting to the changes at the watershed, local, and individual property level to reduce risk.[29]

PHOTO BY Colby Stopa ON Flickr

Extreme Weather:

What to prepare for in the future

1.

Hotter summers conducive to warm-season extreme weather events

2.

Milder winters, more rain-on-snow events

3.

Weather whiplash events could become more frequent

Climate change does not mean extreme winter weather events are a thing of the past.

The Prairies currently experience many types of hazardous weather conditions, including blizzards, freezing rain, lightning, hail, intense rainfalls, severe winds, and tornadoes. These severe weather events are often disastrous, with serious implications for people, infrastructure, and the environment. With climate change, many of these weather events may become more frequent and intense in the coming decades.

As summers become hotter in the Prairies, severe warm-season weather events such as hail storms and tornadoes may increase in frequency and intensity. Warmer surface temperatures tend to drive greater atmospheric instability—the kind of instability that often results in severe thunderstorms.[30]

While climate change is creating warmer, wetter, and generally milder winters for the Prairies, that does not mean extreme winter weather events are a thing of the past. Climate change influences large-scale atmospheric circulation patterns, such as the jet stream.[31] The weakening of the jet stream, which brings colder air down from the Arctic or carries warmer air further north, can lead to sudden shifts in weather conditions in the Prairies.

A rapid shift between cold and warm weather (frozen to unfrozen), or wet to dry, is known as a weather whiplash. These types of events occur over short periods of time (days to weeks), with temperature or precipitation that is unusual for that region or time of year. For winter weather whiplash, these events also usually include temperatures that fluctuate above and below freezing. Winter heatwaves, rain-on-snow events, and sudden out-of-season snow storms are all examples of winter weather whiplash.[32] These events can cause extensive damage to vegetation and infrastructure, especially when they are unexpected.

Take, for example, the early fall snow storm from October 10 to 12, 2019, that wreaked havoc on southern Manitoba right before Thanksgiving. The storm dumped large amounts of snow on the province over a three-day period. As much as 75 cm fell in the western Red River valley region, and a record 34 cm of snow fell in Winnipeg, the largest October snowfall on record.[33]

The early season storm hit while the tree canopy was still green and full of leaves. Bombarded by driving winds, trees buckled and snapped under the weight of the heavy wet snow that clung to the leaves and branches, taking out power lines, blocking roads, and damaging cars and homes.

In Winnipeg, over 30,000 trees were lost to the storm, or nearly 10% of the city's trees.[34] Major power outages were experienced across southern Manitoba, with an estimated 250,000 people losing power over the course of the storm and its aftermath. The province saw a record daily peak of 150,000 people without power, the largest in the history of Manitoba Hydro.[35] Damages were extensive and costly, with $100 million in hydro repairs and over $10 million in clean-up costs for the City of Winnipeg alone.[36] Farmers also experienced heavy losses as crops were left out on the field, unable to be harvested due to wet conditions.[37]

These storms are unusual, but serve as an example of the type of events that may become more frequent in the Prairies with climate change. Further research needs to be conducted in order to better understand how climate change may affect the occurrence of these storm-producing conditions. As well, anticipating the strategies and policies needed in the event of extreme weather events will help reduce communities' vulnerability by allowing them to better prepare and protect themselves.[38] Adaptation can also involve implementing better warning systems and more efficient disaster response strategies.

Global Increase in Natural Disasters?

To the average person, it may seem like highly destructive natural hazards, such as Hurricane Katrina and Hurricane Sandy, have been occurring more frequently in the last decade or so. While climate change may be partly responsible, other factors also contribute to this trend, including greater media coverage, as well as increasing settlement in previously uninhabited areas.[39]

Attributing a natural disaster solely to climate change is difficult, if not impossible. Studies that look at this connection are known as attribution studies. However, instead of trying to answer the question "Was this event caused by climate change?", researchers tend to focus on questions such as:

- Would these events occur as often without climate change?
- Would this event have been as extreme without climate change?
- Would this event have been as likely to happen without climate change?

For example, an attribution study looking at the Fort McMurray fire determined that human-made climate change made the event one and a half to six times more likely to occur.[40] So while we can't claim that climate change caused the Fort McMurray fire, we can say that climate change made that event more likely to happen.

Attribution studies are an area of climate change research that continues to expand as we strive to learn more about the relationship between climate change and extreme weather events.

PHOTO BY Joanne Francis ON Unsplash

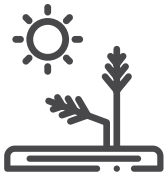
Agriculture:

What to prepare for in the future

1.

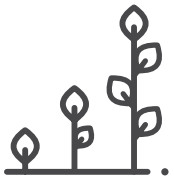
Favourable conditions for pests and disease, both new and established

2.



More heat stress and variable water supply

3.



Longer growing season

The good news is that adjusting to different conditions is nothing new for farmers in the Prairies.

When picturing the Prairies, vast fields of wheat and pastures are some of the images that come to mind, and for good reason. Agriculture comprises a major portion of the landscape and economy in the Prairie provinces. Additionally, over 80% of all farmland in Canada is found in the Prairies, with over half of all Canadian farm income generated in the three provinces.[41,42] Many aspects of agriculture hinge on the weather and climate. How hot or cold it is, how much or little it rains, and the timing of both are all critical. In a sector that is so closely linked to the weather and climate, farmers and farm communities will likely face many challenges in a changing climate.

Climate change will have both positive and negative impacts on agriculture in the Prairie provinces. A range of direct and indirect impacts can occur through changes in temperature and precipitation, and based on the timing of those changes. For example, crop yields depend on many complex factors, including available heat, the risk of frost, the availability of water, and even the concentration of carbon dioxide in the atmosphere. Extreme weather events, such as severe storms, drought, or flooding, also greatly impact crops and livestock, causing damage that can be widespread and costly.

Increasing temperatures associated with climate change will shrink the length of the winter, resulting in a longer growing season. This could present opportunities in agriculture for increased crop yields and increased survival rates, and growth (weight gain) of livestock through the winter. Likewise, warmer temperatures could be beneficial for some crop varieties in the Prairies, such as corn.[43]

However, too much heat can be a problem, as well. An increase in the number of really hot days in the future may leave crops exposed to damaging temperatures and cause heat stress in livestock. Increased summer heat may also lead to more exposure to summer storms and extreme weather that can cause widespread damage to crops and livestock.

Indirect impacts on agriculture

- More pests
- New diseases
- New invasive species
- Changes in insects and soil characteristics
- Changing water availability for irrigated agriculture
- Change in global agricultural production capacity

Any farmer will tell you that sunny skies won't mean much for crops and livestock without moisture. Across the southern Prairies, spring, fall, and winter months are projected to experience greater amounts of precipitation than at present, while summer months (especially July and August) may experience less. In general, climate change will likely cause precipitation patterns to shift from what we are used to and to become more variable. The impacts of such changes could be devastating if there isn't sufficient soil moisture for crops during key parts of their growing cycle, or sufficient river flow for irrigation water.

A decrease in precipitation over the summer months, combined with higher temperatures, could more often lead to periods of heat stress and water scarcity. When moisture does arrive, it may be too much at once. Extreme rainfall events, which are likely to happen more often in the future, can impact soil and water quality through erosion and runoff. Flooding is also damaging to crops and livestock, and can put agriculture-dependent infrastructure at risk.

Since crops are affected by so many factors, modelling crop performance under various warming scenarios has led to conflicting results. Several leading international research bodies, including the Food and Agriculture Organization of the United Nations Organization (FAO) and the Intergovernmental Panel on Climate Change (IPCC), have warned that increasing temperatures may lead to crop yield reductions. In contrast, some modelling-based research has suggested that temperate cropland could become more productive in the future—mainly because of an increase in photosynthesis from higher concentrations of CO_2 in the atmosphere—and an increase in the length of the growing season.[44]

An increasing understanding of crop-specific critical threshold temperatures and the negative effects of prolonged heat exposure on crop yields makes clear that agricultural systems still face climate risk, despite the assumed benefit of higher CO_2.[45] Furthermore, increased temperatures favour the spread of crop pests, harm pollinator populations, and can lead to more energetic storms with crop-damaging potential.

The net effects of climate change on agriculture will ultimately depend on the severity of climate change and how well farmers and the agricultural sector adapt. The good news is that adjusting to different conditions is nothing new for farmers in the Prairies. Adaptive farming practices such as zero tillage and shelterbelts have already been adopted by many farmers as ways of reducing erosion during dry periods.[46]

Farmers also have the ability to plant different crops or different crop varieties to adapt to changing growing conditions. For example, maize and soybeans are more accustomed to high temperatures compared to canola and wheat. Access to information, effective technology, support from government policies, and the availability of financial resources are all factors that will help farmers adapt.[47]

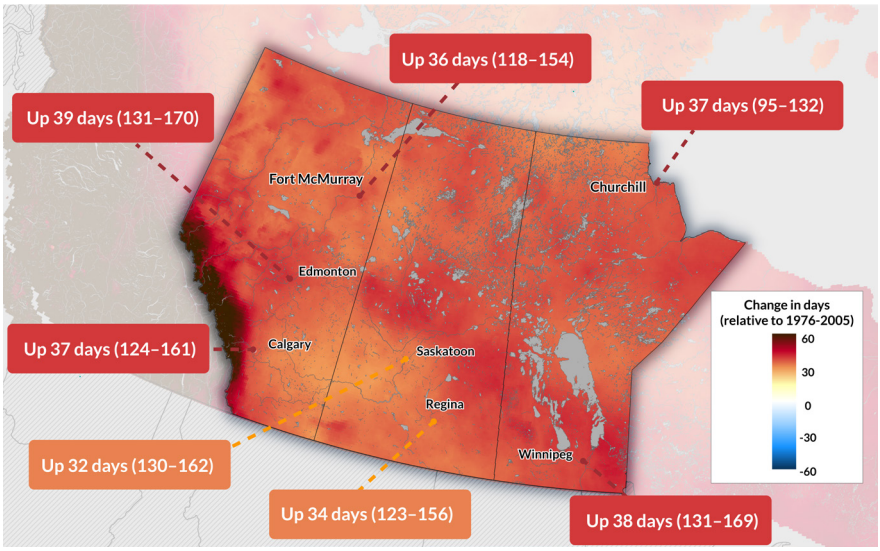


Figure 4 – *Change in the average number of consecutive days per year when temperatures are above 0°C (frost-free season) (RCP 8.5, 2051–2080) relative to the baseline period (1976–2005)*

PHOTO BY Priscilla Du Preez ON Unsplash

Canola's Climate Crux

Canola is among the leading crops in terms of volume on the Canadian prairies. In 2021, over 12 million metric tonnes of canola were harvested in Canada, the vast majority coming from Saskatchewan and Alberta.[48] Canola production alone contributes over $29 billion per year to the Canadian economy and employs 207,000 Canadians.[49] Canola seeds are often turned into canola oil, which is then exported around the world.[50]

Certain varieties of canola, particularly those varieties currently grown in Canada, do very well in cool climates. When temperatures hit 30 °C, canola suffers.[51] Prolonged exposure to these temperatures can damage an entire crop. During canola's delicate flowering stage, temperatures above 30 °C can greatly reduce yields.[52] Climate models project an enormous increase in the number of days above 30 °C in the future. In central Saskatchewan and Alberta, where the majority of the country's canola is grown, the number of these hot days is expected to triple in the coming decades if global emissions continue to rise at their current rate, under a business-as-usual scenario (RCP 8.5).

Ecosystems and Wildlife:

What to prepare for in the future

1. 

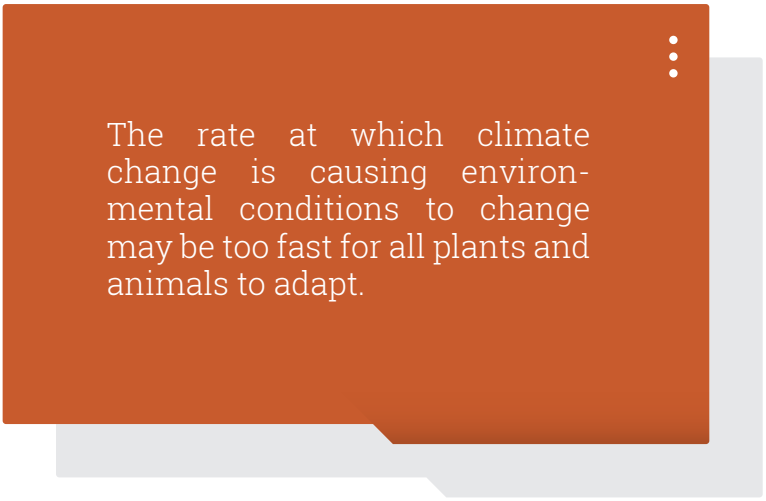
Vegetation zones and ecosystem shifting northward

2. 

Loss of alpine habitat

3. 

New invasive species and pests



Climate change has already brought significant threats to species and ecosystems around the globe.[53] Over long periods of time, species evolve and adapt to changing environmental conditions, but the rate at which human-made climate change is causing environmental conditions to change may be too fast for all plants and animals to adapt.[54] This will inevitably lead to the extinction of some species and potentially the deterioration of entire ecosystems.[55]

In the Prairie provinces, climate change will cause natural vegetation zones to shift northwards over time as the temperature increases in higher latitudes, becoming more suitable for plants otherwise constrained by cold.[56] The southern boundary of the boreal forest is expected to experience major changes in tree species representation, and the aspen parkland region will see a general reduction in tree cover and an invasion of grassland vegetation.[57] Other ecozones will shrink in size, and potentially disappear altogether. For example, in mountainous regions, the suitable temperature range for alpine vegetation will be confined to higher and higher elevations as the climate warms, eventually disappearing. This means places such as Banff National Park may look considerably different in the future, with the loss of iconic glaciers and alpine cover being replaced by evergreen forests.[58]

The range and distribution of many animal species will also change as temperatures increase. In many cases these will change before the vast shift in vegetation, as most animals are mobile and can react more readily to their environment. A recent report showed the Prairie provinces will be a hot spot for bird species loss due to changes in their habitat range. With a 3° C increase due to climate change, some locations in the boreal plains region could see up to 106 bird species move to more suitable habitats during the breeding season.[59]

However, not all species may be able to cope with the disturbances caused by climate change. Increased competition, habitat loss and fragmentation, and changes in food or predation are all additional pressures that species might face. How a species copes will greatly depend on whether it is a generalist that can survive across a range of environments and diets or a specialist that requires specific habitat conditions and food sources.

Climate change will likely change the landscape of diseases and parasites as well. New diseases and parasites may arrive as the climate becomes more suitable for their growth, as their ranges extend, or as infected host species move into new areas. Additionally, diseases and parasites that are already known in the

region may become more prevalent and dangerous as changing climate conditions improve their ability to survive and thrive. This has large implications, as parasites such as ticks and mosquitos that carry dangerous diseases could become more common in some parts of the Prairies.

Trees and other plants are also at risk from introduced diseases carried by pests. The habitat range of pest species is mainly determined by the availability of the host tree species and the suitability of the climate.[60] Therefore, habitat ranges could expand as temperature changes, as long as host trees are available. Diseases and pest outbreaks both affect the health of forest ecosystems. According to the National Forestry database, insects damaged 20.3 million hectares of forests across Canada in 2014 alone.[61]

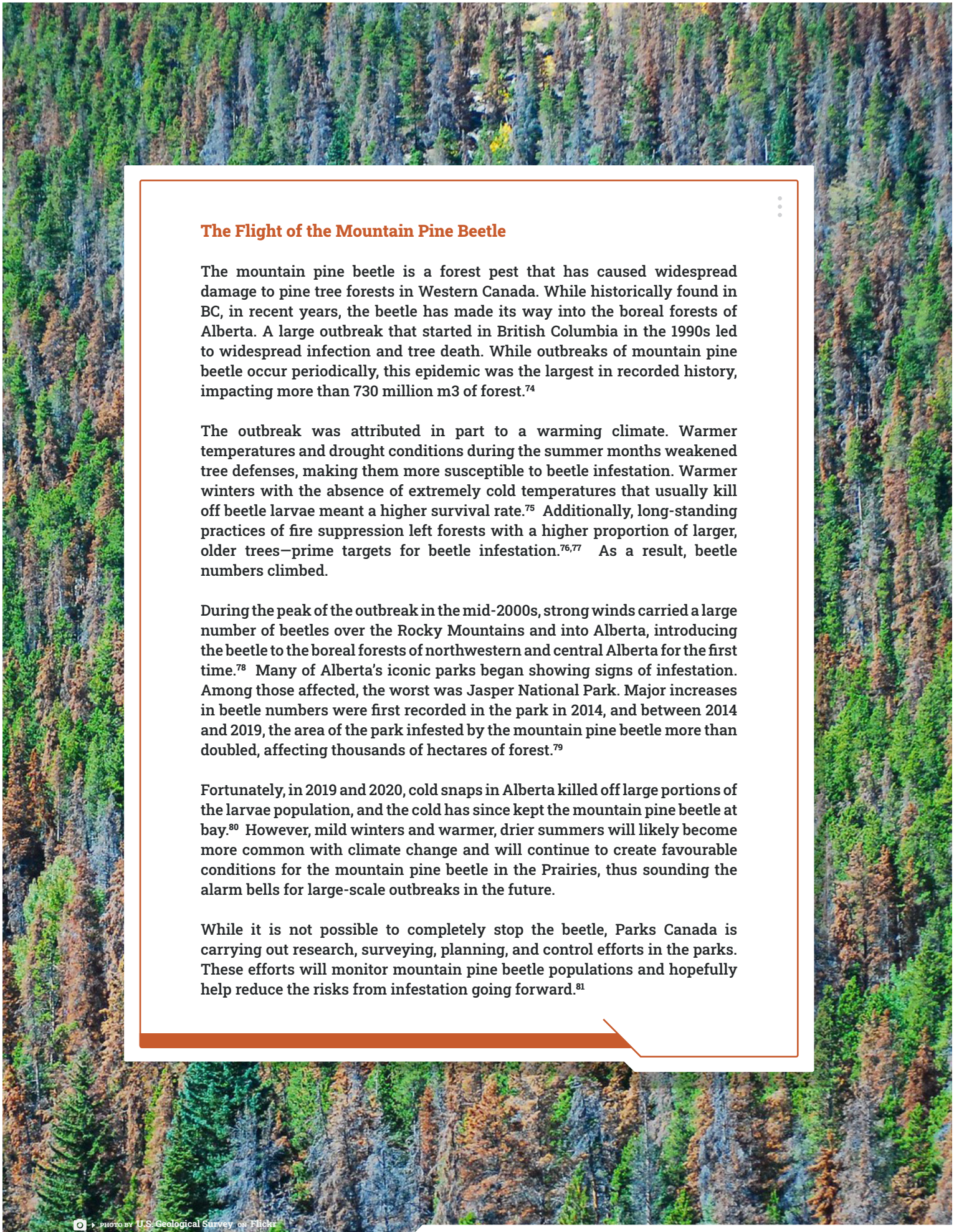
Warmer temperatures throughout the year means some pests become active earlier in the spring and stay active later into the fall, leading to an extended feeding and growing period.[62] For some pests, such as the emerald ash borer, an invasive insect responsible for threatening ash tree populations across Eastern Canada and Manitoba, a longer growing period allows them to reach maturity faster, speeding up reproduction cycles and leading to larger population sizes.[63,64]

With milder winters, pests that usually die over the winter could survive at a higher rate.[65] Increased survivability can cause pest numbers to grow considerably year to year, as has been the case with the mountain pine beetle. Warm, dry summers followed by mild winters were the main drivers behind large-scale outbreaks of the beetle in the mid-2000s that first ravaged pine forests in British Columbia before hopping over the Rocky Mountains into Alberta.[66,67] The fear is with a warmer climate, further outbreaks could lead to mountain pine beetle populations expanding further west into the boreal forests of all three Prairie provinces.[68]

Though the Prairie economy is mainly driven by agriculture, forestry is also an important sector. There are approximately 97 million hectares of forest ecosystem covering the Prairie provinces.[69] As climate change brings warmer temperatures and extends the growing season, the viability of forests may be promoted. However, disturbances such as droughts, floods, pests, and forest fires can severely affect the growth and productivity of forests, limiting wood supply and in turn impeding the timber industry.[70]

Forest ecosystems will adapt to climate change on their own. However, since they bring so much value to our society, it may be beneficial to help facilitate their adaptation.[71] Sustainable forest management strategies that study the long-term effects of climate change on forest ecosystems are key in enhancing the adaptive capacity of forests in the Prairies.

Reducing fossil fuel emissions to mitigate and reduce the effects of climate change will undoubtedly provide some help in protecting and conserving biodiversity. However, there are other mitigation and adaptation strategies that can be implemented to further protect Prairie species and ecosystems. Land protection, habitat restoration, captive breeding and releasing, and species translocation are some strategies that have the potential to restore populations and species at risk.[72,73] Paired with adequate monitoring and reviewing policies, these approaches could extensively protect species from extinction and ecosystems from collapse.



The Flight of the Mountain Pine Beetle

The mountain pine beetle is a forest pest that has caused widespread damage to pine tree forests in Western Canada. While historically found in BC, in recent years, the beetle has made its way into the boreal forests of Alberta. A large outbreak that started in British Columbia in the 1990s led to widespread infection and tree death. While outbreaks of mountain pine beetle occur periodically, this epidemic was the largest in recorded history, impacting more than 730 million m3 of forest.[74]

The outbreak was attributed in part to a warming climate. Warmer temperatures and drought conditions during the summer months weakened tree defenses, making them more susceptible to beetle infestation. Warmer winters with the absence of extremely cold temperatures that usually kill off beetle larvae meant a higher survival rate.[75] Additionally, long-standing practices of fire suppression left forests with a higher proportion of larger, older trees—prime targets for beetle infestation.[76,77] As a result, beetle numbers climbed.

During the peak of the outbreak in the mid-2000s, strong winds carried a large number of beetles over the Rocky Mountains and into Alberta, introducing the beetle to the boreal forests of northwestern and central Alberta for the first time.[78] Many of Alberta's iconic parks began showing signs of infestation. Among those affected, the worst was Jasper National Park. Major increases in beetle numbers were first recorded in the park in 2014, and between 2014 and 2019, the area of the park infested by the mountain pine beetle more than doubled, affecting thousands of hectares of forest.[79]

Fortunately, in 2019 and 2020, cold snaps in Alberta killed off large portions of the larvae population, and the cold has since kept the mountain pine beetle at bay.[80] However, mild winters and warmer, drier summers will likely become more common with climate change and will continue to create favourable conditions for the mountain pine beetle in the Prairies, thus sounding the alarm bells for large-scale outbreaks in the future.

While it is not possible to completely stop the beetle, Parks Canada is carrying out research, surveying, planning, and control efforts in the parks. These efforts will monitor mountain pine beetle populations and hopefully help reduce the risks from infestation going forward.[81]

PHOTO BY U.S. Geological Survey ON Flickr

Health:

What to prepare for in the future

1.

Extreme heat increasing heat-related stresses

2.

More wildfire smoke, more respiratory problems

3.

New and growing insect-borne diseases

Better planning and preparedness by municipalities may be one of the best ways to protect against health risks.

The changing climate in the Prairies is having many impacts, including increasing temperatures, risks from extreme weather events, and new, emerging infectious diseases. These impacts will be felt most strongly at the local level, as they will put the health of individuals and Prairie communities at risk. Some of these impacts are already being felt. Climate change challenges our well-being directly and indirectly by affecting our physical, mental, and emotional health, as well as collective community health.

Many Prairie dwellers may rejoice to learn that climate models project a substantial decrease in the frequency of extreme winter cold in the near future. However, the flip side of this shift—more hot days in the summer—can in many ways lead to increased health problems, especially for those unaccustomed to prolonged exposure to heat. When the temperature climbs above 30 °C for several days in a row, many effects on human health are observable. People are at risk of heat exhaustion when living spaces are without air conditioning and when outdoor occupations and activities offer no escape from high temperatures. In severe cases, this can lead to heat stroke and death. The effects of heat are made much worse when the humidity is high and when nighttime temperatures fail to fall below 20 °C, no longer providing a cool reprieve from daytime temperatures.

In southern Ontario and Quebec, where this type of oppressive heat is currently much more common compared to the Prairies, many large cities have designated cooling centres that open when a heat wave is declared. A heat wave is defined differently depending on the area, but in general, it is a number of days in a row when temperatures remain dangerously high. Currently, Prairie dwellers in need of respite from the heat often congregate in malls, libraries, and other public spaces to cool down. While air conditioning systems may be a short-term measure to deal with more frequent days above 30 °C, it will increase household costs and energy consumption. It is therefore not an accessible strategy for everyone. Better planning and preparedness by municipalities, for example with the provision of cooling centres, may be one of the best ways to protect against the health risks of hotter weather and heat waves.

Oppressive heat can impact everyone, though some people are more vulnerable. Individuals with underlying health conditions, reliant on caregivers, or with minimal access to resources, are among those whose health risks from heat are amplified. In other words, many people in our communities, including children, people who are sick, the elderly, the disabled, and marginalized people, are at risk from heat.

Another climate change impact that poses a health risk to people in the Prairies is the increase in forest fires. While danger comes directly from flames and heat, forest fire smoke also worsens air quality, generating an immediate and prolonged effect on respiratory health. While people with pre-existing health and respiratory problems are most vulnerable, everyone breathes, and therefore everyone can be affected by wildfire smoke. Smoke from wildfires travels very far distances. Fires burning in British Columbia, Ontario, or even farther away, can impact air quality in the Prairies.

When natural disasters such as forest fires and floods affect communities, it's not uncommon to see the mental health of residents suffer. Stress, anxiety, and depression are often exacerbated after such events, as people fear for the safety of their family, their property, and the community. Prolonged disruption of human activities, such as the forced evacuation of a community, can also contribute to these challenges. The effects of these stresses can often linger long after the events have passed.

As climate change affects seasonal temperature and precipitation patterns, various insects and pests that often carry diseases and bacteria harmful to humans may be introduced or become more prevalent in the Prairies, such as ticks and mosquitos. In general, with longer and hotter summers, these insects have more time to reproduce and spread, and with warmer winters, fewer insects die between seasons. Put the two together, and climate changes increases the survival rates of these insects, and therefore increases the risk of certain vector-borne infectious diseases.

The bottom line is that the health of every person in the Prairies will be affected by a changing climate. Extreme heat, poor air quality, natural disasters, and diseases spread by ticks and mosquitos are harmful to all, not just those considered the most vulnerable. It's crucial that individuals, municipalities, and provincial governments work together to protect our collective health.

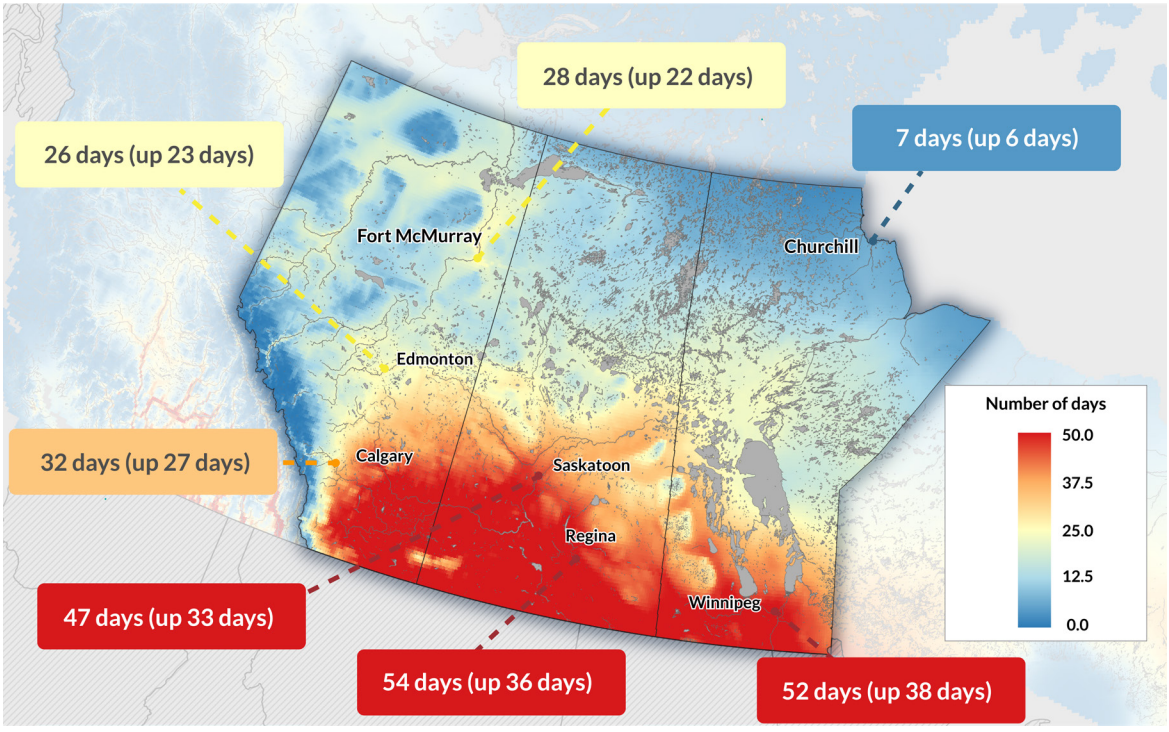


Figure 5 – *The projected average number of days where maximum temperatures reach at least 30 °C (RCP 8.5, 2051–2080) in the Prairies*

PHOTO BY Jachan Devol ON Unsplash

Bad Bites: Ticks, mosquitoes and disease

In the past 10 years, the incidence Lyme disease has increased across Canada from 150 cases in 2009 to over 2,000 cases in 2017.[82] Lyme disease is transmitted to humans through the bite of the black-legged tick. As climate change helps create promising conditions for more human-tick encounters, the incidence of Lyme disease may continue to rise.

Warmer summers and winters provide the right conditions for ticks to grow larger, reproduce more often, and have a higher survival rate. A warming climate also means that ticks are spreading farther north and westward from their known range in Southern Ontario and the eastern half of the United States. Mild weather in the spring and fall encourage people to be active outdoors longer. Animals that are hosts for ticks, such as rodents, birds, and deer, are also likely to be more abundant, carrying ticks with them to new locations. Being aware while outside, wearing appropriate clothing, avoiding wooded areas, and checking for ticks after outdoor activities are all ways to help reduce the risk of tick bites and contracting Lyme disease.

Mosquitoes are bothersome pests that we know all too well in the Prairies. West Nile virus is a disease that is carried by mosquitos and is transmissible to humans and livestock. In Canada, it is mainly the *Culex* mosquito species that transmits the disease.[83] While not all mosquitos carry the disease, the number of cases in Canada has risen in the past 20 years by 10%.[84] Eighty-six cases of West Nile virus were reported in the Prairie provinces in 2018.[85]

Standing water is the ideal habitat for mosquito eggs and larvae. In simple terms: more rainfall, more standing water, more mosquitos.[86] Hotter temperatures also means mosquitos grow faster from their immature stages of development to adulthood, arriving much faster at the stage where they can start reproducing.[87]

Changes in rain patterns and higher temperatures throughout the year will also likely increase the range of these mosquitos, as has already been observed in Canada.[88] More mosquitos found in more places could result in a higher rate of transmission of West Nile and a greater health risk.

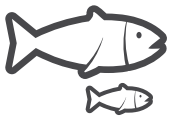
New species of mosquitos moving north into Canada, such as the invasive *Aedes* species, is a growing concern with climate change, as they may bring novel, harmful diseases to Canada and the Prairies.

As with Lyme disease, the best way to protect your health is to take steps to prevent getting bitten: wear light-coloured clothing that covers your arms and legs, use bug sprays and other mosquito deterrents, and reduce the amount of time spent in shady areas, especially near tall grasses and swamp land. Getting rid of sources of standing water also reduces areas for mosquito breeding.

Indigenous Communities:

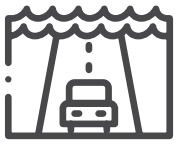
What to prepare for in the future

1.



Threats to practicing traditional ways of life

2.



Greater risks for many modes of transportation

3.

Compounded impacts of colonialism and climate change

> The historical observations of climate conditions based on Traditional Knowledge adds significant value to climate change adaptation planning.

The Prairie provinces are home to many Indigenous people, a large segment of whom live in remote communities. The close relationship that Indigenous people have with the land—economically, culturally, and spiritually—and the existing inequities Indigenous populations often face makes them particularly exposed to the effects of climate change.[89] Additionally, colonization has left a legacy of many negative, long-term impacts on Indigenous people, which are likely to be exacerbated in the face of climate change.

Hunting, trapping, and fishing are closely connected to Indigenous culture and identity, and are the main source of affordable, healthy, fresh foods in many Indigenous communities of the Prairie provinces.[90] As climate change brings modifications to temperature, seasonality, and precipitation, the migration and travel patterns of many animal species will change, which can challenge hunting practices.[91]

Besides traditional foods derived from the land, additional sources of nutrition are often very expensive due to transportation costs. Several communities' access to food, medical supplies, and other equipment depends on temporary, seasonal roads available only during the winter. With warmer temperatures and a longer frost-free period, the winter road season is predicted to shrink, making food security even more challenging. Where air transportation is the only alternative to winter roads, the delivery of fresh and healthy food becomes more expensive, resulting in an increased consumption of processed food. As hunting, trapping and fishing become less productive, and the price of healthy food increases, cases of diet-related illnesses, such as diabetes, coronary heart disease, and obesity, may drastically increase, especially in northern remote First Nation communities.[92]

Due to the long-lasting impacts of colonialism, many Indigenous people face barriers and socio-economic inequalities that increase their risk and reduce their resiliency to the impacts of climate change. Some of these inequalities can be expressed through certain economic indicators. For example, rates of unemployment are higher among Indigenous people compared to non-Indigenous people, and are even higher in the Prairie provinces compared to other provinces.[93] Higher unemployment, and many other connected implications such as low income, can make it more difficult to endure and rebound from the impacts of climate change, such as extreme weather events like flooding or wildfires.

Many Indigenous communities throughout the Prairie provinces experience seasonal flooding, in part due to natural geographical location, but also as a result of human-made infrastructure and decision-making. As climate change continues to impact spring runoff, water levels, and water quality, communities will continue to face evacuations, long-term displacement, boil-water advisories, and their associated health impacts more frequently.

Similarly, many Indigenous communities are evacuated each year due to wildfires. Over the past 30 years, Indigenous people were 33 times more likely to be evacuated if they were living on a First Nations reserve than off.[94] The location of communities plays a large role in this, as over 60% of all First Nations reserves in Canada are situated close to, or in, the wildland-urban interface, making them more exposed to the risks of wildfires and other natural disasters.[95]

While Indigenous Peoples disproportionately experience the impacts of climate change, they play an integral role in mitigation and adaptation. Indigenous Knowledges encompass an understanding of seasonal patterns in temperature, precipitation, and winds for localized areas.[96] This familiarity with unique local climates has been passed down through generations in Indigenous communities and is highly valued knowledge. As a result, Indigenous Peoples have been some of the first to see, acknowledge, and record that the climate is changing. The detailed knowledge of local and historical observations of climate conditions based on Traditional Knowledge adds significant value to climate science and climate change adaptation planning.[97]

Climate change adaptation needs to be led by communities for well-grounded and effective planning and preparedness in the face of changing climate.

Indigenous Climate Atlas

In 2022, the Climate Atlas of Canada team — in partnership with the Assembly of First Nations (AFN), Métis National Council (MNC), and numerous Indigenous collaborators — launched Indigenous-focused data, knowledge, and resources developed by, with, and for Métis, First Nations, and Inuit communities. This launch made public climate data for all 634 First Nations communities, all 53 Inuit communities, and projects across the Métis homeland as well as new videos and resources to support Indigenous-led climate solutions. Check out www.climateatlas.ca/indigenous for more information.

PHOTO BY Landon Parenteau ON Unsplash

Infrastructure and Transportation:

What to prepare for in the future

1. 

Unstable permafrost

2. 

Potholes and cracks

3. 

Road and bridge washouts

One of the often underappreciated aspects of climate change is that the extremes are expected to change much faster than the averages.

Climate change impacts infrastructure in many different ways. In severe cases, acute failure of a structure occurs when environmental stresses exceed design capacities, such as when a culvert is destroyed during a flash flood. Infrastructure projects can also gradually grow more susceptible to failure due to increasing rates of infrastructure decay. Climate change even has the potential to affect groundwater and permafrost distribution, thereby altering the surface stability of many built infrastructure projects. Ultimately, climate change can impact most of the structures we rely on in order to live in the Prairies.

One of the often underappreciated aspects of climate change is that the extremes are expected to change much faster than the averages. In more concrete terms: instances of extreme rainfall and temperature are expected to increase dramatically even though the average temperature increase across the Prairies will be comparatively small. Extreme events such as flooding and wildfires often cause catastrophic damage to infrastructure. The Fort McMurray wildfire in 2016 and the Calgary flood in 2013 are the first and second costliest disasters, not only in the Prairies but in the history of Canada.[98]

Costs from the impacts of extreme weather, measured in catastrophic insured losses, have been rising in Canada over the past 35 years.[99] This increase in claims is linked to climate change and compounding factors such as aging infrastructure, loss of natural areas that mitigate risk, and outdated standards and building practices.[100]

There is growing concern that some engineering codes, which are premised on a stable climate, inadequately account for climate change and need an overhaul. These codes dictate operating requirements for various types of infrastructure, including specifications of maximum wind, rain intensity, temperature thresholds and other environmental stressors that the structure is likely to experience during its lifetime. Engineers understand that historical climate is becoming less representative of future climate conditions and have adjusted their practice, taking into account future climate when possible. Engineers Canada has a national guideline that outlines how engineers should strive to integrate climate change into their practice to reduce the impacts of climate change on engineered systems.[101]

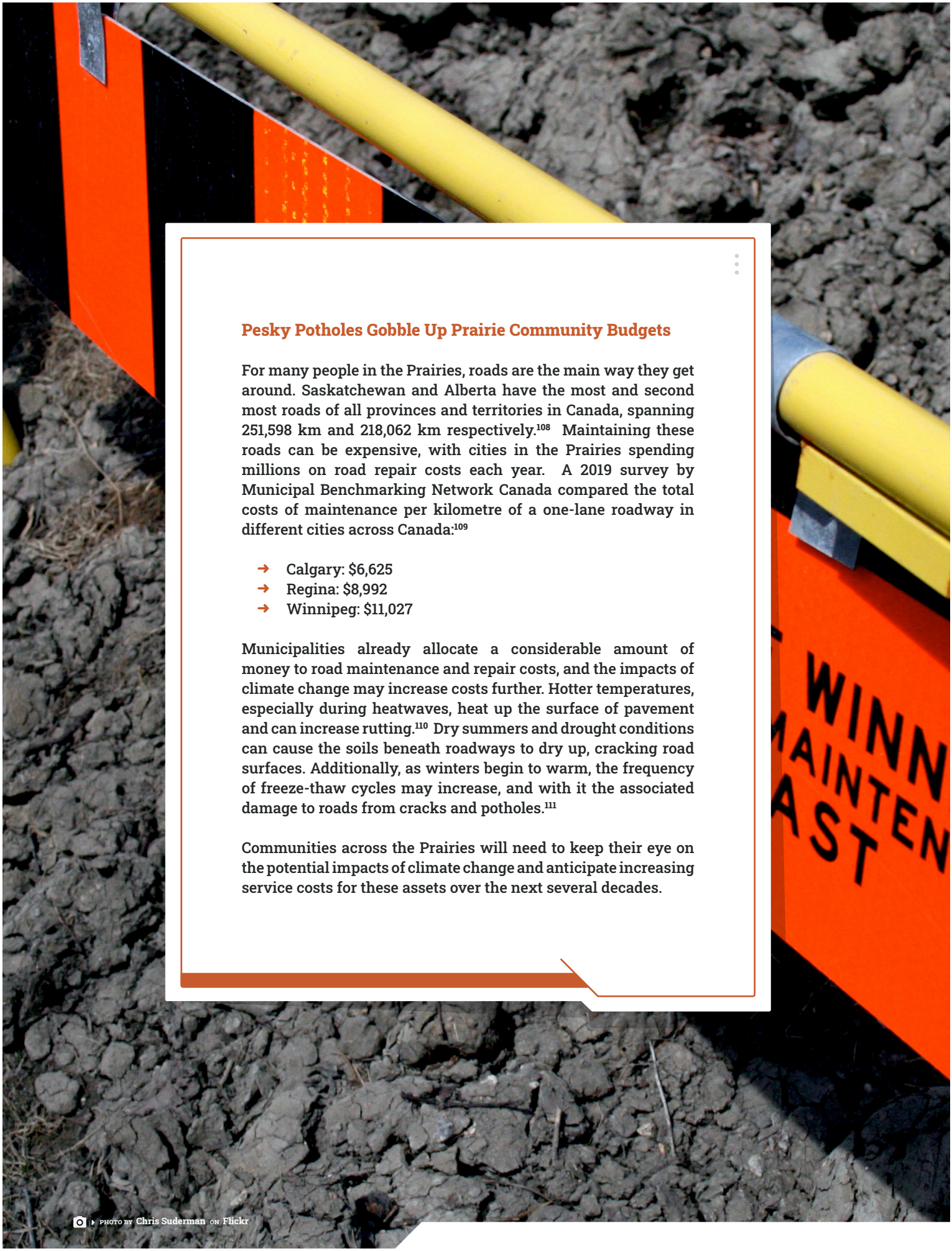
Due to the vastness of the Prairies, and how spread out communities are from each other, close to half of Canada's roads are found in the Prairie provinces.[102] Previous extreme flooding has damaged and completely washed out roads and bridges, effectively closing transportation routes and cutting off communities. Poor roadway drainage also contributes to flooding during heavy precipitation events. One important factor that determines whether a roadway can endure extreme rain events is whether culverts are sized to handle large volumes of water.[103]

However, climate extremes are not the only element of climate change that can damage roads. As temperature fluctuates above and below 0° C, melting snow and ice can penetrate road surfaces and then freeze, causing cracks, bubbles, and potholes in roadways and bridges. The number of freeze-thaw cycles is expected to increase with climate change in the Prairies, along with the associated costs of future road repairs.[104]

In the Northern region of the Prairies, buildings, roads, and railways are built upon permafrost—ground that remains permanently frozen throughout the year. Each summer, a thin layer of permafrost thaws (the active layer). Northern infrastructure projects are therefore required to have relatively deep and well-insulated foundations to ensure they will not be affected by the seasonal melting and that heat from the surface is not allowed to transfer to the frozen ground below. This method of building is expensive and is one of the major reasons why so few northern communities have access to permanent all-weather roads. The loss of permafrost due to climate change will likely make infrastructure projects even more expensive in the North unless new construction techniques are developed.

Some remote communities that do not have permanent road access all year round use winter roads for the delivery of food, fuel, construction equipment, and other vital goods that are too large or heavy to fly in. Winter roads are made of ice and snow, and require continuous cold temperatures for months. Of the three Prairie provinces, Manitoba has the most winter roads, which operate for a short window between mid-January and mid-March.[105] As winters get warmer, the length of time winter roads are open and safe to drive on will become shorter. Costs to build and maintain the roads will increase, making it more expensive to transport goods to those communities.[106] The continued shortening of the winter road season is already having dramatic impacts on these communities, which also rely on these routes for communication and access to traditional hunting grounds.[107]

Planning and building for a future with climate change in mind is an important step for reducing costs from damaged or failing infrastructure, and avoiding the interruption of important transportation networks. Effective actions include updating building codes and other regulations so they take into account a future with climate change. Likewise, governments can create policies that ensure engineers and planners consider climate change in their designs. By preparing for the worst, we can reduce our vulnerability.



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Pesky Potholes Gobble Up Prairie Community Budgets

For many people in the Prairies, roads are the main way they get around. Saskatchewan and Alberta have the most and second most roads of all provinces and territories in Canada, spanning 251,598 km and 218,062 km respectively.[108] Maintaining these roads can be expensive, with cities in the Prairies spending millions on road repair costs each year. A 2019 survey by Municipal Benchmarking Network Canada compared the total costs of maintenance per kilometre of a one-lane roadway in different cities across Canada:[109]

- Calgary: $6,625
- Regina: $8,992
- Winnipeg: $11,027

Municipalities already allocate a considerable amount of money to road maintenance and repair costs, and the impacts of climate change may increase costs further. Hotter temperatures, especially during heatwaves, heat up the surface of pavement and can increase rutting.[110] Dry summers and drought conditions can cause the soils beneath roadways to dry up, cracking road surfaces. Additionally, as winters begin to warm, the frequency of freeze-thaw cycles may increase, and with it the associated damage to roads from cracks and potholes.[111]

Communities across the Prairies will need to keep their eye on the potential impacts of climate change and anticipate increasing service costs for these assets over the next several decades.

Tourism and Recreation:

What to prepare for in the future

1. 

Travel restrictions from forest fires

2. 

Poorer quality of snow and ice due to warmer winters

3. 

Reduced winter tourism season

> The long-term effects of climate change will put a great deal of pressure on the tourism industry as it operates today.

The Canadian Prairie provinces are home to some of Canada's top tourist destinations. Places such as Churchill, Manitoba, and Banff, Alberta, as well as provincial and federal parks, numerous towns and festivals, and many other attractions in between draw both Canadian and international tourists to the region. It's no surprise, then, that many people's livelihoods depend on recreation and tourism, and that these sectors are a vital component of the Prairie economy. Tourism in the Prairies is most prominent in the summer, when activities such as camping, hiking, swimming, boating, and fishing are common—not to mention many outdoor summer festivals. In the winter, skiing, snowmobiling, snowshoeing, and polar bear viewing are some of the top attractions. As the climate changes in the coming decades, the length and quality of the tourism and recreation seasons may change.

Temperature, humidity, precipitation, and extreme weather are all elements that affect the level of comfort a tourist experiences while travelling. Not surprisingly, very warm temperatures can be uncomfortable, and even dangerous, especially when participating in strenuous outdoor activities. The number of days reaching at least 30 °C in the Prairies is projected to triple or even quadruple by the end of the century. This increase in hot summer days may dissuade some tourists from travelling to the Prairies and persuade more Prairie residents to travel outside the region. Regardless, outdoor activities in extreme heat will require adequate hydration and other precautions.

As summer temperatures warm and if summer precipitation decreases in the coming decades, the level of lakes and streams may also decrease, resulting in fewer opportunities for swimming, boating, fishing, canoeing, white water rafting, and other aquatic activities.[112] Additionally, these conditions create a higher risk of forest fires, which means that fire bans and travel bans in national and provincial parks will be on the rise in the coming decades; this may discourage people from camping.

Ecotourism is rapidly growing in the global tourism market, as well as within Canada, yet climate change threatens its viability.[113] With increasing risks of fire and the spread of diseases and pests within forests, loss of forest flora and fauna may be inevitable.[114] For example, the alpine treeline is predicted to migrate to higher elevations as temperatures warm in higher latitudes, resulting in the fragmentation and loss of alpine wildlife habitat.[115] Jasper National Park in Alberta, one of the top

tourist attractions in the Prairie provinces, has already experienced an upward migration of its treeline. This change in vegetation can lead to a change in wildlife distribution patterns, negatively impacting ecotourism as well as the fishing and hunting industries.[116]

With the winter season lasting approximately four months, winter recreation and tourism are also a key slice of economic activity in the Prairies. Banff and Jasper, with world-class downhill skiing and snowboarding nearby, are big attractions. And as with many outdoor winter pastimes, these activities require a certain quantity and quality of snow. While winter precipitation is projected to increase in the coming decades, with warming temperatures more of this precipitation may fall as rain instead of snow, making it difficult to maintain adequate snow on ski hills. Artificial snowmaking could become an adaptive strategy.[117] However, this could increase costs and reduce profitability for the ski industry. Ice fishing, snowmobiling, and other activities on ice can also become dangerous as warm temperatures reduce the thickness of ice.[118]

While it seems as though climate change will severely and negatively impact the tourism and recreation sector, milder winters and warmer summers may attract visitors to the Prairies. Thus, there is an uncertainty regarding the effects of climate change on tourism and recreation. However, we can predict that the long-term effects will put a great deal of pressure on the tourism industry as it operates today. Finding ways to take advantage of the opportunities created by climate change may be the best long-term strategy for tourism in the Prairies.

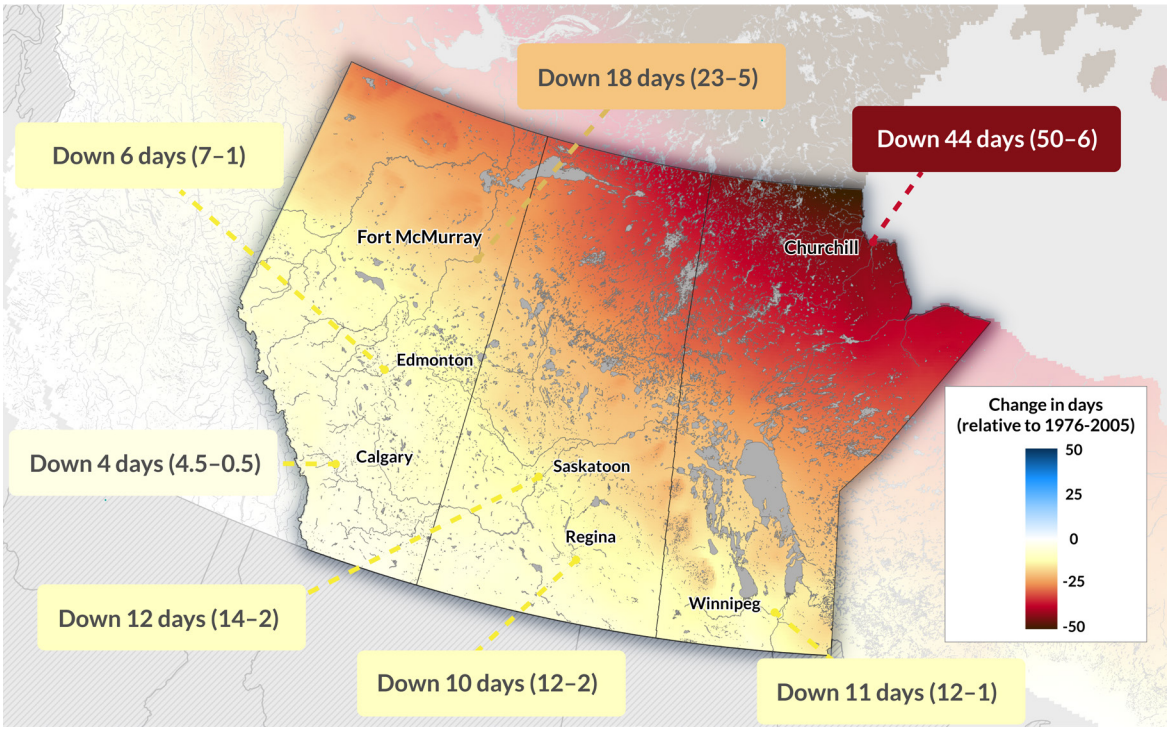


Figure 6 – Change in the number of -30°C days (2051–2080, RCP 8.5) relative to the 1976–2005 baseline.

Polar Bear Economics

The town of Churchill in Manitoba relies on the tourism sector as a main driver of its economy. Every year, it's estimated that between 6,000 and 10,000 tourists visit during the polar bear viewing season, which lasts for 40 to 60 days, from mid-October to the end of November.[119] The survival of polar bears in Churchill is dependent on the extent, duration and thickness of sea ice cover on Hudson Bay.[120] As temperatures warm and the frost-free period extends, the formation of ice will occur progressively later and the ice break-up will start earlier in the year. Churchill currently experiences approximately 50 days per year below -30 °C (1976–2005 average, Climateatlas.ca), and this number could be reduced to about six days per year by the end of the century if carbon emissions and climate change continue at their current rates. This will drastically impact the polar bear population, in turn hurting the tourism industry that is heavily dependent on polar bear viewing.

PHOTO BY Ucumari Photography ON Flickr

Urban and Rural Communities:

What to prepare for in the future

1. 

Impacts on water availability

2. 

Damage to infrastructure

3. 

Impacts on community health

Many communities face the challenge of dealing with large climate change impacts on a small budget.

Communities in the Prairies are on the frontlines when it comes to addressing the risks of climate change. At the local level, they face the direct and indirect consequences of climate change—many already highlighted earlier in this report. Communities are uniquely positioned to address these risks, as their actions can have a profound impact on the lives of their members. Each community has different strengths and vulnerabilities, and therefore faces different risks associated with climate change.

A sometimes underappreciated aspect of climate change is its potential to alter availability and access to natural resources. Communities across the Prairie provinces depend on natural resources for energy, food, recreation, and much more. Many natural resources have multiple uses within the community. Water, for example, is used for drinking, irrigation, intensive livestock operations, industrial processing, and hydroelectricity production. As climate change modifies the availability of resources, particularly water, communities may face economic instability. This is particularly true for communities that lack economic diversification.

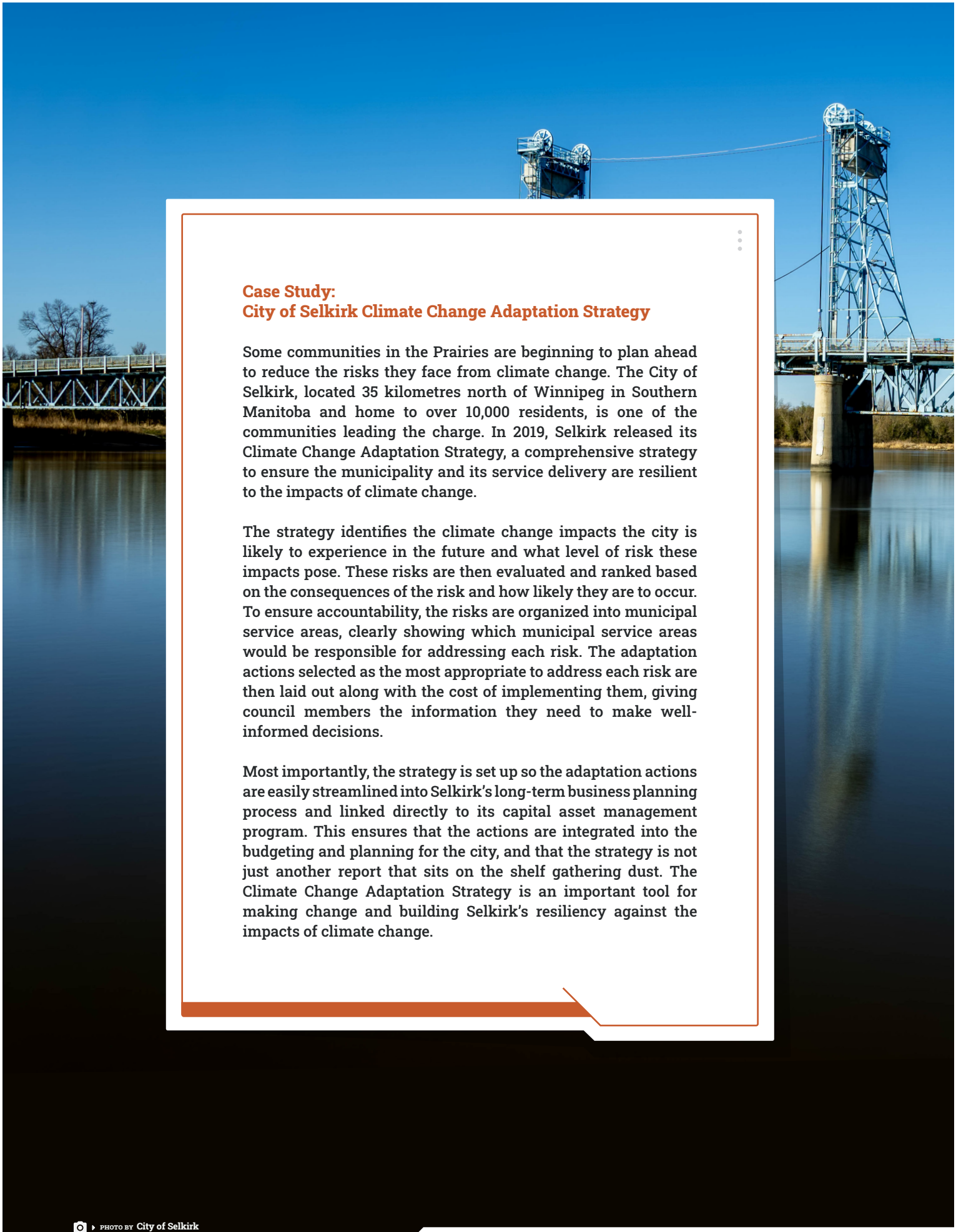
Climate change is anticipated to alter the frequency and intensity of weather-related disasters. Communities can anticipate added costs, either for repairs to damaged infrastructure post-event or for upgrades to prepare infrastructure for more intense weather events. In Winnipeg, Manitoba, the Red River Floodway is designed to protect the city from floods by diverting excess water away from the city's core. The Province of Manitoba upgraded the Floodway in 2010 to accommodate floods with a longer return period. The move was costly and somewhat controversial; some local residents fear that the Floodway has the potential to exacerbate flooding outside the city.

Many smaller communities face the challenge of dealing with large climate change impacts on a small budget—they lack the resources to build their own floodways or undertake planned relocations, for example. Smaller infrastructure upgrades can be employed to reduce the risk of damage and disruption from flooding. These include larger culverts to handle increased amounts of water, higher ring dikes (a dike that encircles the town and can be closed off to keep flood waters out) and the installation of backwater valves to reduce the chances of basement flooding.

Better emergency plans can also make a community more resilient to the impacts of climate change. The 2016 evacuation of Fort McMurray, where 80,000 residents were forced to flee due to a massive wildfire, serves as an example of how vital emergency management plans can be. Fort McMurray's emergency equipment was stressed to its limits—even maintaining adequate water pressure for firefighters was a constant challenge. However, the fact that so few people were injured and most of the city remained unburned is testament to the work of the emergency planners and first responders. The city was put to the test again in the spring of 2020 when ice jams in the Athabasca and Clearwater Rivers forced water over their banks, causing a one-in-100-year flood.[121] In this case, the city was less prepared, as flood defense construction was not yet complete.

In Southern Ontario, urban heat warning systems are in place to help communities deal with the effects of heat waves, which generally strike the region a few times each summer. Climate model projections show that heat waves are likely to become more common across the southern Prairies, too, and therefore it's important that communities have strategies in place to deal with prolonged periods of hot and muggy weather.

The adaptive potential of a community depends on its ability to understand, plan for, and reduce the impacts of climate change.[122] One way communities across the Prairies are improving their adaptive capacity is by developing climate change adaptation plans. Climate change adaptation planning is a process in which communities identify the risks they may face from climate change based on likely local climate impacts, and their own strengths and vulnerabilities in their community. They then determine what actions would best help them adapt in order to reduce those risks from climate change.



Case Study:
City of Selkirk Climate Change Adaptation Strategy

Some communities in the Prairies are beginning to plan ahead to reduce the risks they face from climate change. The City of Selkirk, located 35 kilometres north of Winnipeg in Southern Manitoba and home to over 10,000 residents, is one of the communities leading the charge. In 2019, Selkirk released its Climate Change Adaptation Strategy, a comprehensive strategy to ensure the municipality and its service delivery are resilient to the impacts of climate change.

The strategy identifies the climate change impacts the city is likely to experience in the future and what level of risk these impacts pose. These risks are then evaluated and ranked based on the consequences of the risk and how likely they are to occur. To ensure accountability, the risks are organized into municipal service areas, clearly showing which municipal service areas would be responsible for addressing each risk. The adaptation actions selected as the most appropriate to address each risk are then laid out along with the cost of implementing them, giving council members the information they need to make well-informed decisions.

Most importantly, the strategy is set up so the adaptation actions are easily streamlined into Selkirk's long-term business planning process and linked directly to its capital asset management program. This ensures that the actions are integrated into the budgeting and planning for the city, and that the strategy is not just another report that sits on the shelf gathering dust. The Climate Change Adaptation Strategy is an important tool for making change and building Selkirk's resiliency against the impacts of climate change.

PHOTO BY City of Selkirk

4. Conclusion

Climate change is altering Prairie life in many, many ways, and will continue to do so for decades to come. As this report lays out, disturbance and disruption will not be limited to wildlife and ecosystems. Rather, every aspect of our society—the economy, the built environment, human health, and social relations—will be significantly altered by the changing climate. This challenge requires a whole-of-society response, for which momentum is building.

Yet the current response to climate change remains somewhat lopsided: mitigation via carbon emission reductions tends to dominate the focus of many leaders across public institutions, businesses, and advocacy groups. To be clear, mitigation remains vital to reduce climate change's worst-case scenario—namely, the most severe risks and impacts. However, a mitigation focus often overlooks or under-emphasizes the value of adaptation—that is, building the capacity to better cope with anticipated climate risk and impacts. As this report highlights, the anticipated risks are very real to the Prairies, as are some opportunities.

Planning and preparing for the changes to come is not optional. **It is our collective responsibility.**

5. What Comes Next

Just as climate change is a complex, multi-faceted phenomenon, so too must be our societal response.

Effective climate change measures within a Prairie context requires a diverse set of actors to engage and work together to understand risks and vulnerabilities faced by our ecosystems, communities, and livelihoods. Together, we must also identify strategies that can address climate change impacts. This work takes leadership, resources, technology, and collaboration.

Also critical for adaptation action is access to credible and timely information and tools specific to the Prairies. It's here that ClimateWest—comprised of leading climate organizations across the region—is focused on helping to facilitate climate resilience-building across different sectors.

If you are wondering what a Prairie dweller can do to support climate change adaptation, here are some starting points. Keep in mind there are many more activities specific to location, vocation, and other factors.

Climate Adaptation: Starting points for citizens

1 Advance local policies, planning and preparedness:

- If you sit on a board or are a member of a local organization, ask if climate risk is something your organization needs to consider and learn more about.
- Be in touch with your local councillors, mayors, reeves, band council or similar local leaders to find out how future climate considerations are shaping decision-making, including long-term infrastructure investments, local economic resilience, and reducing the vulnerabilities of various groups of people.
- Consider how you, your home, and your neighbourhood could be better prepared in the event of an extreme weather event.

2 Shape the conversation about the changing Prairie climate:

- Share this report with people who are involved in any of the sectors or industries mentioned in this report.
- Speak up about changing local weather patterns and climate to help make climate change locally relatable.
- Encourage the consideration of climate adaptation and climate resilience to complement efforts to reduce emissions.
- Where climate change is a topic that's discussed (e.g. on social media, at school, at community forums, council meetings), help amplify local voices and the perspectives of the people who are most vulnerable to climate change.

3 Contribute to building local climate resilience:

- Plant pollinator gardens to support biodiversity.
- Set up community gardens or greenhouses to improve food security.
- Support local conservation efforts to protect habitat and natural infrastructure.
- Retrofit homes or build new structures informed by future climate.
- Check in with neighbours and vulnerable people when faced with extreme weather, from heat to storms to weather whiplash.

4 Share citizen data to advance reporting and research:

- Farm and ranch operations can volunteer to be Agroclimate Impact Reporters with Agriculture and Agri-Food Canada. A monthly survey about local weather and impacts informs a host of applications, including the drought monitor.
- Citizens anywhere can join the CoCoRaHS network, which seeks rainfall and precipitation data. This public data source is used by many, including governments, to supplement their monitoring of weather conditions.
- Seek out one of the many other citizen-data monitoring initiatives offered locally, including lake and river water quality monitoring and wildlife observation, and find out how you can contribute.

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ClimateWest is committed to improving access to regionally relevant climate data in friendly formats for audiences. One such example are the maps included in this report, which focus on temperature and precipitation changes.

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