# THE CANADA COUNTRY STUDY:

## *Climate Impacts and Adaptation*

## *CANADIAN PRAIRIES SUMMARY*

Environment Canada

Canada

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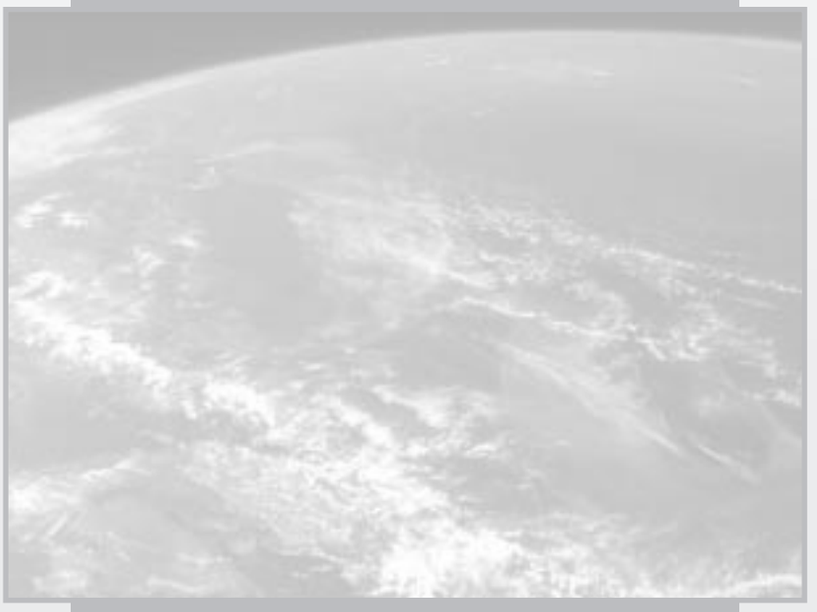

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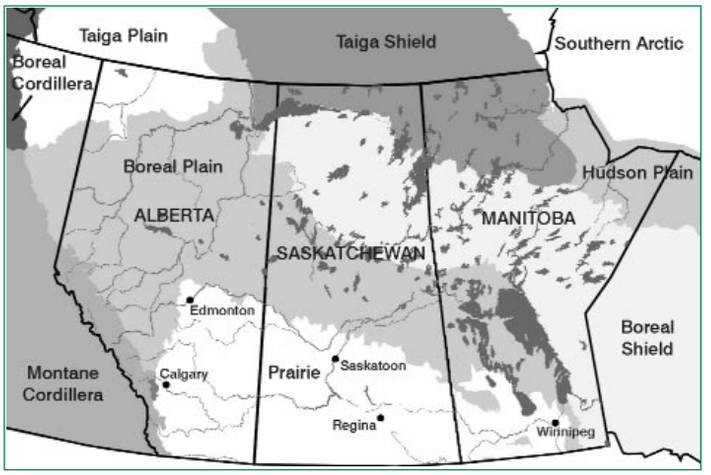
THE CANADA COUNTRY STUDY

# Climate Change in the Canadian Prairies

## Introduction

Nearly five million people live in Canada's prairie provinces of Alberta, Saskatchewan and Manitoba with over three million living in urban areas. While the labour force engaged in agriculture has grown in absolute terms in recent decades, there has been a large scale shift in orientation of the Prairie economy away from agriculture. However, in spite of the growth in the manufacturing and mining sectors, agriculture remains a dominant industry.




*Ecozones of the Prairie Provinces*

People living in this region are used to changing weather conditions, from one season to another and from year to year. But, in addition to natural variations in temperature and precipitation, there is growing concern over the long-term effects of climate change.

Over the next century, Canada's prairie provinces are expected to experience warmer temperatures, changes in the distribution and amounts of rain and snow and greater extremes in climate. Climate change will affect the economy, environment and many aspects of life.

*Spring 1997 flooding in southern Manitoba*

Environment Canada's 1997 report, *Responding to Global Climate Change in the Prairies, Volume III*, Canada Country Study, documents the potential effects of climate change on farming, forestry, water resources, wildlife, energy supply and demand, the insurance industry, as well as the general population. This document is a summary of those findings.

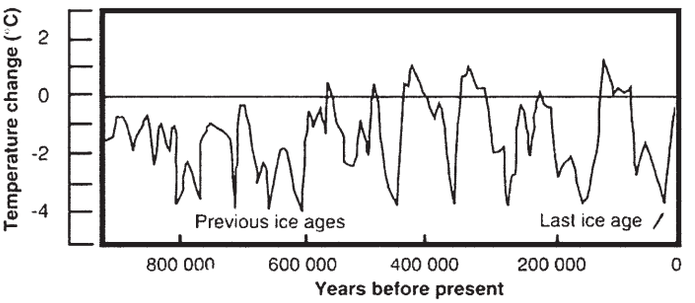
**The Canada Country Study is the first-ever national assessment of how climate change will affect Canadians over the next century. It brings together the knowledge and views of climate experts in government, industry and academic institutions, identifies gaps in research and recommends plans of action.**

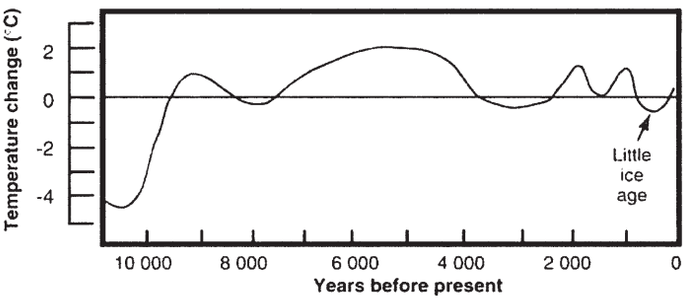
**This is one of two national and six regional reports summarizing the Canada Country Study findings.**

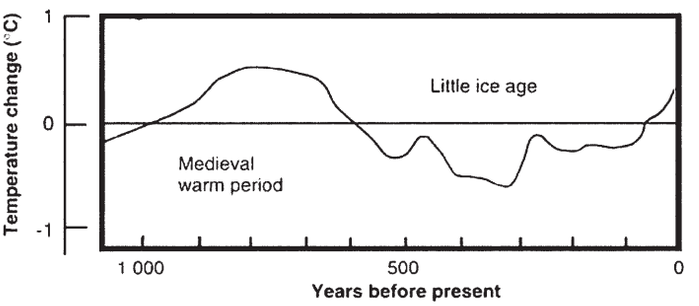
# Past Climates

Direct measurements of climate characteristics, such as temperature and precipitation, only exist for about the past hundred years for the prairies and are by themselves insufficient to detect climate trends longer than a few decades. However, some indirect data are available from the study of pollen records contained in sediments in lakes and wetlands, and from the analysis of tree rings, among other techniques. According to this research, the climate of the prairies has experienced major shifts in the last 9,000 years. Between about 9000 and 6000 years ago, the prairies were warm and dry, with temperatures warmer than at present. Soils were generally salty and the grasslands probably extended more than 80 km farther north than their present range. According to current climate models, these conditions may occur if the concentration of greenhouse gases, such as carbon dioxide, methane and water vapour, in the atmosphere doubles, as expected, over the next century.

Increased moisture and cooler temperatures occurred about 6000 years ago. This resulted in renewed ice accumulation in the Rockies. A warm period ended around the 12th Century, followed by a cooler period a few centuries later. During the late 19th Century, tree ring records have shown sequences of drought years interspersed with wetter intervals.



# Climate Change

Climate is naturally variable. From our own experiences we know that one summer is often warmer than another, or one winter is colder or snowier than another. Such variability is normal, and is related to changes in ocean currents or seasurface temperatures, volcanic eruptions, alterations in the sun's energy output, or other features of the climate system.

Over the past century, however, climates of nations around the globe, in general, have been getting warmer. In the last half a century, most parts of Canada have also experienced warmer temperatures and increased precipitation. These trends may reflect the growing influence of human activities on our planet.

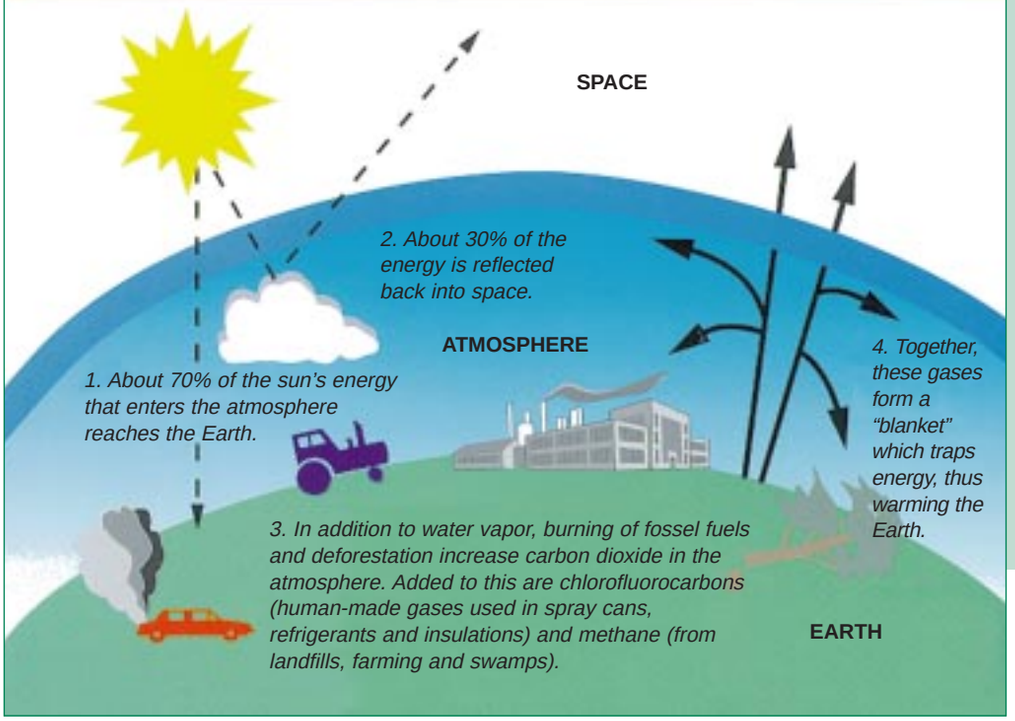
The concentrations of greenhouse gases, mainly carbon dioxide, methane and water vapour, which occur naturally in the atmosphere, are being altered through the burning of fossil fuels (coal, oil, natural gas), deforestation, and industrial and agricultural processes. These gases warm the atmosphere, and the climate and environment respond. Each climatic response triggers others, and we are still learning about some of these responses. So, it is difficult for scientists to accurately predict how much climate will change, or how those changes will affect us, especially at a regional or local level.

Greenhouse gas emissions will continue to increase over the next century. If the world continues along its present course, the concentration of greenhouse gases in the atmosphere will double before the end of the 21st century. In response, the average global temperature is expected to rise by one to four degrees Celsius. To get an idea of how significant this change could be, consider that the global temperature during the last Ice Age was only four to six degrees cooler than today.

While climate changes and impacts in Canada will mirror global ones, significant regional variations are anticipated, owing to the large size of the country. Here are some of the changes we're already experiencing:

- warming across most of Canada this century, with largest changes occurring in the northern prairies and Mackenzie Basin;
- increased precipitation in almost all regions of the country over the last half a century;
- sea level rises along portions of the coast;
- increases in insured losses caused by extreme weather events.

## How the Greenhouse Effect Works




Source: World Resources Institute, *Changing Climate: A Guide to the Greenhouse Effect* (World Resources Institute, Washington, D.C., 1989).

# How Climate Change Will Affect the Canadian Prairies

Climate change will significantly affect the economy and environment of this large and diverse region. Sheltered by the Canadian Rockies to the west, and affected by air masses from the Arctic and the United States, the region's climate is already as variable as its geography. The importance of climate, landscape and natural resources is apparent in the economic dominance of agriculture in this region, which is also rich in energy sources, mining and forestry.

Over the next century, most parts of Canada, including the Prairies, will experience more of a warming trend than the global average. It also is expected that warming will be greatest in winter and spring. Climate models suggest that current precipitation patterns will change as the climate warms. The southern Prairies could experience longer, warmer and drier summers.

The region's sensitivity to climate varies from one sector to another, as previously experienced during periods of droughts that occurred in the 1930s and 1980s and major floods at other times. Some economic sectors are more sensitive than others and will need to adapt to changing climate.

The potential effects of climate change on agriculture, forests, the insurance industry, the environment, and the region's water supply are of greatest concern. Extremes in temperatures, changes in length of seasons and the increased risk of droughts will force these sectors to find ways of adapting to climate change. Recreation and tourism, energy production and other sectors will also be affected, but more moderately.

## Agriculture

Agriculture is a key industry on the prairies, where farmers are only too familiar with the economic hardships brought on by extreme weather conditions. Between 1933 and 1937, for example, precipitation decreased by almost 50 per cent in the region. As a result, prairie wheat and corn production fell by 32 and 50 per cent, respectively.

In the late 1980s, precipitation again fell by 40 per cent and mean temperatures increased as much as five degrees Celsius above normal temperatures. Yields in grain and specialty crops decreased 29 and 40 per cent, respectively. Crop exports fell by $4 billion. Livestock production also decreased due to a drop in feed and pasture land, and increased stress to animals re-sulted from dust storms, drought and grass fires. In Manitoba and Saskatchewan, net farm income fell by more than half, resulting in lower farm employment.

*Drought of the 1930's*

Clearly, because of its direct dependence on climate, the agricultural sector in the prairies is highly sensitive to global warming. Average potential crop yields may fall by 10 to 30

percent due to higher temperatures and lower soil moisture. Increases in temperature will lengthen the growing season but the extra heat may enhance insect infestations.

A warmer climate will increase demand for irrigation and result in more competition with other water users. Water management policies and allocation systems will have to be reviewed and revised. Climate conditions may allow agricultural production to expand northward, but this will depend greatly on how well the industry can adapt and on the quality of the soils in more northern areas.

## Forests

*Raging forest fire*

Flowering, pollination, seed formation, germination and seedling survival are climate sensitive. Soil nutrients and plant communities are also sensitive to climate. During the drought of the1980s, tree growth within the boreal forest decreased and seedling mortality, insect outbreaks, fire damage and suppression costs all increased.

A net loss in area of the western Canadian boreal forest is expected under global warming conditions. This is primarily due to less favourable moisture conditions along the southern forest boundary and increases in disturbances such as fire, insects and disease. Also, the composition, structure and function of the boreal forest will change. Forest fire fighting costs may increase. Social and economic competition for old growth forests will challenge national and provincial governments, industry and interest groups to resolve conflicts relating to forest resource use. Forests may produce more greenhouse gases by releasing carbon dioxide from drier organic soils, plant decomposition and burning.

Not all effects of climate change will be negative, however. Tree growth in the central and northern areas of the boreal forest may increase, especially on favourable sites. Economic opportunities may arise for replacing lumber with manufactured construction products.

## Insurance

The financial security of the insurance industry, which compensates people and businesses for damage from natural hazards, is highly sensitive to climate. Climate change and greater variability in weather in the prairies may increase the risk of exposure to damaging wind, rain and hail storms, drought and flooding.

The possibility of more frequent and intense extreme weather events will challenge the insurance industry's financial capacity to provide coverage. Insurance premiums for property and crop damages in the prairies may increase or industry and government may decide to change crop insurance. Greater personal responsibility to deal with natural disasters, such as flooding, drought or wind storms, may be required. Changes within the insurance industry may affect the financial survival of agriculture and other sectors which are sensitive to extreme changes in climate.

*Windstorm damage*

Generally, the insurance industry responds to a growing number of claims by increasing deductible amounts or premium rates, or by withdrawing the availability of insurance. The potential for greater claims resulting from climate change and variability is already driving the insurance industry to adopt measures to reduce its potential financial liability.

## Water Supply and Demand

The water supply on the prairies is very sensitive to climate change and the amount of runoff from rain and snow. Large areas of the prairies do not drain into streams or rivers. These closed drainage basins are highly sensitive to short-term variations in temperature and precipitation.

Agriculture and other industrial activities that depend on water supplies are stressed when faced with water shortages. Rising temperatures already are creating longer ice-free periods on lakes and rivers. As a result, more moisture evaporates and there is less surface water available for use. These and other factors create challenges for managing water supplies in the prairie region.

## The Natural Environment

The effect of climate change on prairie plant and animal communities will depend greatly on their sensitivity, not just to warmer temperatures, but also to increased solar radiation, higher salt levels, and changes in water chemistry.

Prairie wetlands are especially sensitive to climate variability and climate change. They provide habitat for more than half of North America's waterfowl. In addition, many of Canada's rare, threatened or endangered species survive in habitats found only in wet environments. Agricultural practices in the prairies have already destroyed many of the region's wetland areas and have deteriorated many others. Those that haven't been destroyed are highly sensitive to climate change and will experience a decrease in bird and wildlife populations.

*Prairie Wetland*

A warmer climate will affect the timing and amount of water flows in rivers and receiving wetlands and lakes. As well, it would affect the water quality and groundwater systems interconnected to wetlands. Increased evaporation could change many semi-permanent wetlands from open water conditions to vegetated areas. As a result, the plant and animal communities that thrive there will be affected.

Changes in water temperature and greater variation in flood and drought conditions will change plant communities and affect animal and wildlife survival. Cold water fish species, such as trout, will be reduced. If food production in warm shallow lakes declines, warm water fish species, such as perch, will also be affected. Managing, maintaining and restoring water environments will be a major challenge.

## Energy

Demand for energy is highly sensitive to climate. While energy used for heating and transportation will decrease during the warmer winters expected with global warming, it will increase for summer cooling, pumping of water for irrigation, and grain drying and harvesting. Electrical energy production will be most

*Hydroelectric Generating Station*

affected. Hydroelectric generation capacity would decline if streamflows are reduced. This could lead to a greater dependency on thermal power production, creating higher greenhouse gas emissions from higher fossil fuel consumption. Cooling ponds for thermal plants will experience temperature increases, reducing their efficiency.

As a result, the cost of energy production will increase and its availability for long-term export will decrease. In planning future investments, operators of existing conventional electrical generation and delivery systems will be challenged by the uncertainty of water supply.

Climate change, however, may create an increased demand and favorable economic conditions for some alternative energy sources. Opportunities will increase for applying solar energy, and perhaps wind power, technologies to a range of agricultural, domestic and commercial activities.

*Summer recreation*

## Recreation and Tourism

Recreation and tourism in the prairie region is also sensitive to climate change. People participate more in outdoor activities when climate conditions are favorable and much less when there are extremes in temperatures, precipitation and storm activity. The effects of climate change on other economic sectors may also affect the amount of disposable income people have to spend on recreation and tourism.

Recreational lakes may experience lower water levels and increased water temperatures,

*Winter recreation*

which may result in reduced fish populations. Algae increases at warmer temperatures and this may make some lakes unsuitable for swimming and other water-related activities. Cold water fish species, such as trout and pickerel, may not survive in warmer water. Increased variability in snow and rain also may alter conditions, reducing fish populations that sport and commercial fisheries rely on.

Climate change will also affect the financial security of the region's guiding and lodging industry. In a warmer climate, the number of large game animals may decline and with them the number of hunters who support this industry.

Winter outdoor recreational activities such as ice fishing and skiing will have a shorter season. Concerns about ice thickness and early spring break-up may result in fewer opportunities for ice-fishing. The service industry and facilities catering to outdoor winter activities may experience economic hardships.

# Can We Adapt and How?

Although there is increasing confidence in the results of models used to predict climate change and variability, there is uncertainty about the timing and distribution of future rain and snow patterns at the local and regional levels. We need to learn more about how local and regional water supplies will be affected by climate change and variability. Many information gaps need to be addressed to improve our understanding and to

design appropriate ways of adapting to a warmer climate and greater extremes in weather conditions.

By expanding our research of past climate conditions and by developing climate models that more accurately predict local changes in climate and precipitation, we will enable communities and economic sectors to make more informed decisions about the future.

## Agriculture

More farmers practising conservation farming and abandoning marginal land would improve soil conservation, soil moisture and habitat for animals and wildlife. Growing native plants, or new varieties of grains which are more resistant to higher temperatures and drought, may improve yields.

*Centre pivot irrigation system*

Developing herbicides that perform effectively under drought conditions would reduce weeds and increase crop yields. Producers might also respond to climate change by increasing the variety of crops grown, switching from grain to livestock production and investing in irrigation systems. More farmers may pursue off-farm careers as a way of supplementing or replacing farm-generated income.

Current farm assistance policies do not cover climate change factors. Governments and agriculture agencies might consider adopting new policies that encourage farmers to look at ways of adapting to climate change.

*Landscape near Lake Athabasca*

## Forests

Forest management practices should guard against disturbances to forest growth and soil fertility. Plant and animal life should be protected and forests should be thinned to restore and maintain tree vigor.

The forest products industry has an important role to play in adjusting to climate change. The industry can adapt by salvaging dying trees and replanting areas with better-adapted trees, or relocating operations to areas where trees become more abundant. The industry can lead the way to improving forest health and productivity. A range of options are available that will help forests adapt. These include simulating natural processes, varying the ages of trees within a forest, using a variety of trees, changing harvesting practices to protect soil and maintain productivity, and developing ways to combat the effects of forest fires.

More research is needed to better understand the contribution of forests and fires to increasing carbon dioxide concentrations in the atmosphere and to identify the socio-economic sensitivities of the forest industry to climate change.

## Insurance

In 1996 the insurance industry requested more research and substantial reductions in greenhouse gas emissions under the United Nations Environment Program Insurance Initiative. The industry wanted to participate in

climate change negotiations and asked that a framework of political, social and economic measures promoting sustainable development be established.

More directly, insurance companies are examining their risk and re-investment strategies. Insurance companies are lobbying for improved building codes to reduce energy demand and to better withstand extreme weather events that affect crops, property and personal health.

## Water Supply and Demand

The expected future of water supplies in a warmer and more variable climate is unclear. The prairie region needs to prepare for a water future different from what it currently has. It will have to address new supply issues, develop new strategies for responding to water shortages and determine how to best adapt to new environmental conditions.

Warmer summer temperatures, increased evaporation and reduced soil moisture will increase the demand for water for irrigation in the southern prairies. Increased demand for groundwater for agricultural and domestic uses may also occur.

Other water-based industries, including thermal and hydroelectric power plants, food processing, and oil and gas recovery and processing, will challenge the way water is managed and allocated. The need to protect fish and other water-dependent forms of wildlife will compete with the social and economic needs of the region. Transboundary water quantity and quality will need to be monitored to ensure that provincial and international agreements are respected.

Implementing water conservation practices in irrigation agriculture, water-based industries and in homes and businesses could be adopted. Energy conservation practices could also reduce water demand for hydroelectric power generation.

## Energy

Energy supply and demand patterns are directly affected by climate change. Implementing energy conservation practices and alternative technologies may reduce the amount of energy used, the reliance on fossil fuels such as oil and gas, and the demand for water in hydroelectric power generation. Improving building design and reducing transportation needs will also help decrease energy demand.

## Recreation and Tourism

Climate change will directly influence the public's participation in hunting, fishing, and other outdoor recreational activities. People will adapt to changing conditions by using alternative locations, reducing or stopping participation, and substituting activities. For example, greater opportunities may be created in the future for substituting natural outdoor environments with indoor facilities for skating, tennis, golf and other sports.

The recreation industry may have to look at new ways of attracting users. New technologies may extend participation in some activities. The industry will need to adapt and be flexible in locating facilities. People may need to adapt by hunting different species, or by traveling to alternative facilities and sites.

*Solar powered water pumping system*

# Taking Action

Socially, economically and environmentally, the prairies are an important region of Canada. Millions of people live and work in this region of almost 200 million hectares. Climate change will affect farming, forestry, water resources, energy supply and demand, recreation and the insurance industry, as well as other social and economic activities and the natural environment. As an example, the prairie grasslands ecosystem is one of the most endangered habitats in Canada. How flexible the prairies and other regions will be to climate change and future climate variability depends largely on how we respond and adapt.

How will climate change affect me and my family? Are decisions being made today helping to reduce the risks of climate change? Will the rate of change permit enough time to adapt? How can we become more flexible and adaptable to climate change?

These, and other questions, about climate change on the prairies will be addressed during the second phase of the Canada Country Study. The study will challenge governments, industry, the university community, non-governmental organizations and individuals to work together to better understand the consequences of climate change and how adaptive strategies may be implemented.

*Peace River, northern Alberta*