Climates do change

If you don't like the climate... wait a while Warming and cooling trends are part of the Earth's normal climatic cycles. Temperatures vary within a given year, from one year to the next, and on longer time scales, over decades, centuries, and millennia. In fact, there have been frequent changes in climate, with repeated swings from colder to warmer conditions. Past changes in climate have had significant impact on human development. At the peak of the last ice age (about 16 000 years ago), most of Canada was covered After the Ice Age: Turning up the heat in the last 10 000 years the 1980s and 1990s the last 1000 years The global climate warmed rapidly at the end of the During the Medieval Warm Period, between about AD Over the past 140 years, Earth's atmosphere has warmed. Since the 1980s this warming trend has last ice age. By about 4000 BC, the Prairies were increased. Scientists are concerned that we are warm and dry, and prairie grasslands probably comparatively warm — this is the time when Vikings extended more than 80 km farther north than they do travelled to Greenland and Newfoundland. During a entering a period of unprecedented global warming caused by human activity. todau. Later, increased moisture and cooler subsequent cooling trend called the Little Ice Age, the temperatures caused renewed glacier ice Vikings abandoned their settlements, Europe accumulation in the Rockies. experienced colder weather, and the glaciers in the Rockies expanded again. By AD 1860, temperatures & ...the last 140 years began to rise again. ...the last 1000 years in the last 10 000 years 1000 1200 1400 1600 1800 2000 4000 BC for 2080-2100 relative to 1975-1995 A much different future Temperature change (°C This map shows predicted summer surface air temperature

change for the northern hemisphere that could occur in the

next century. The greatest differences are predicted to occur

in the Arctic and the interior of North America.

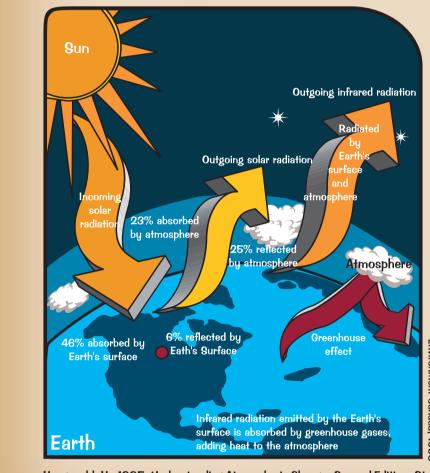
last 1000 years, and the 1990s was the warmest decade of that century. Folland, C.K., Karl, T.R., and Vinnikov, K., 1990: Observed

climate variations and change: in Climate Change: the Mann, M.E., Bradley, R.C., and Hughes, M.K., 1999: IPCC (Intergovernmental Panel on Climate Change)

Northern hemisphere temperature during the past Scientific Assessment, Cambridge University Press, millenium: inferences, uncertainties, and limitations; in London, United Kingdom, p. 195-238.

Why is the climate changing NOW?

Earth's solar energy budge About one third of the incoming short-wave radiation from the Sun is reflected back into space by the atmosphere and the Earth's surface. The remainder is absorbed by the Earth and its atmosphere. The heattrapping quality of the atmosphere, the so-called 'greenhouse effect', is caused by gases such as carbon dioxide (CO₂) and water vapour that absorb long-wave radiation emitted by the Earth. The greenhouse effect is essential for maintaining temperatures within a range that is tolerable for most life on Earth.



Did you know?

The twentieth century was the warmest century of the

380 - CO concentrations

Global CO₂ concentrations in the atmosphere have ncreased 30% since the start of the Industrial Revolution in the 1700s. The cause of the rapid buildup of CO₂ is human activities: burning fossil fuels (coal, oil, and natural gas), agricultural practices, and deforestation. Scientists predict that atmospheric CO₂ concentrations will double from pre-industrial levels in the next 40 to 60 years.

The carbon balance balanced by removals

Hengeveld, H., 1995: Understanding Atmospheric Change, Second Edition, State of the Environment Report Number 95-2, Environment Canada, p. 26.

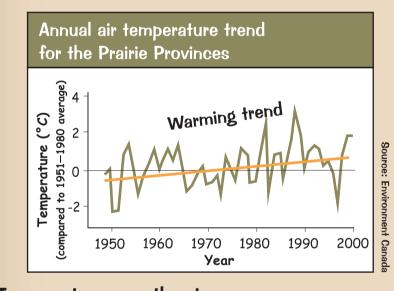
Greenhouse gases: Carbon occurs in the atmosphere and oceans mainly in the form of CO2 the big three Huge amounts of carbon are also stored within the Earth in fossil fuels and sedimentary rocks, and on the Earth's surface in vegetation and soils. Before the Industrial Revolution atmospheric concentrations of CO₂ and other greenhouse gases did not vary much because additions were 🦼 and cattle, landfills, wetlands house gases, aside (H₂O), are carbon dioxide (CO₂), methane (CH₄), and nitrous oxide (N2O). Methane and nitrous oxide absorb more long-wave radiation than CO2, but CO2 has the greatest impact because it is much more

500 0 km 500

Houghton, J.T., Meira Filho, L.G., Callander, B.A., Harris, N., Kattenberg, A., and Maksell, K. (Ed.), 1995: Climate Change: the Science of

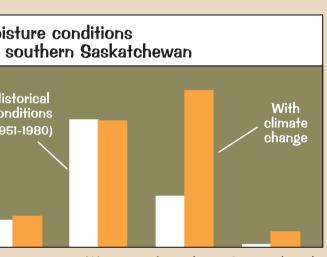
How are climates changing in the Prairies?

Most climate change projections for the Prairies show an increase in temperature under global warming. Some scientists believe that a small increase in precipitation could occur, while others predict a decrease. According to the Canadian Global Climate Model, the southern Prairies could experience serious summer deficiencies in soil moisture by the end of this century. However, not all parts of the Prairies will experience the same effects. While most climate change projections suggest that the semiarid regions of the Prairies can expect an increase in the frequency of drought, some suggest that no major change in drought frequency will occur in southern Alberta.



Temperatures on the rise According to Environment Canada, air temperatures in the Prairie Provinces have warmed historically. The yearly average temperature has warmed by about 1.2°C over about the last 50 years – but winter temperatures have warmed by about 3°C, and summer temperatures have only warmed by about 0.2°C. Since 1948, seven of the top ten warmest years on the Prairies

Wetter or drier? Analysis of drought risks for southern Saskatchewan under several climate change scenarios indicates that the frequency of drought and severe drought could increase dramatically. During dry summers, higher temperatures under warmer climates will create increased evaporation and inten<mark>sify</mark> drought conditions. Conversely, there may also be wetter periods when temperatures are cool. Overall, this suggests that soil moisture conditions could become more variable.



Moisture conditions for southern Saskatchewan

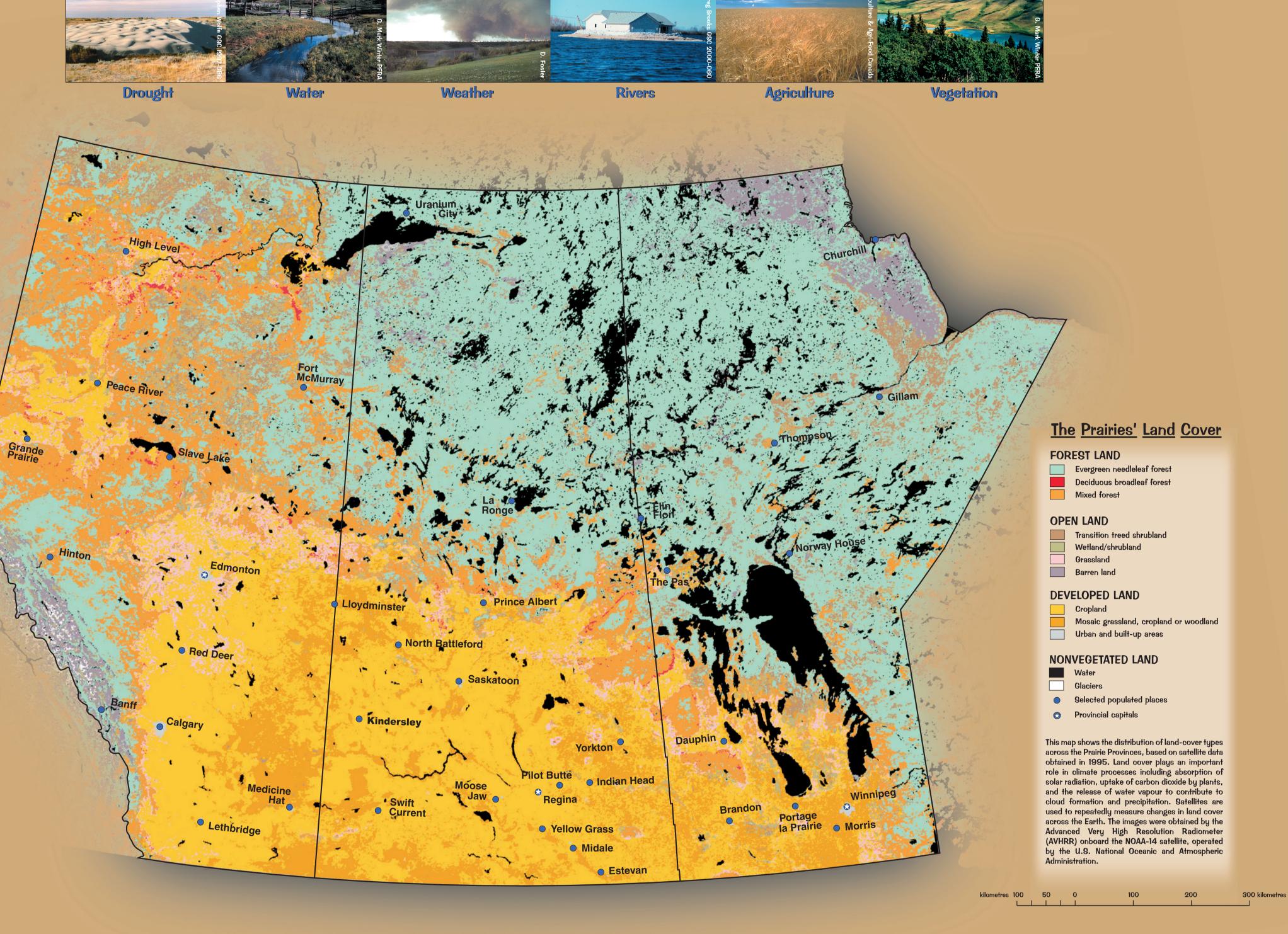
date of the last spring frost has been occurring progressively earlier – about 10 days earlier on average. The length of the growing season on the Prairies has increased, on average, by about 10 to 15 days compared to the 1940s and early 1950s. In the semiarid portions of the Prairies, both the highest and the lowest temperatures in the winter and the spring are warmer than they used to be. Snow-cover fall has decreased, and spring runoff begins earlier now than in past years. The amount of precipitation falling as snow has decreased as

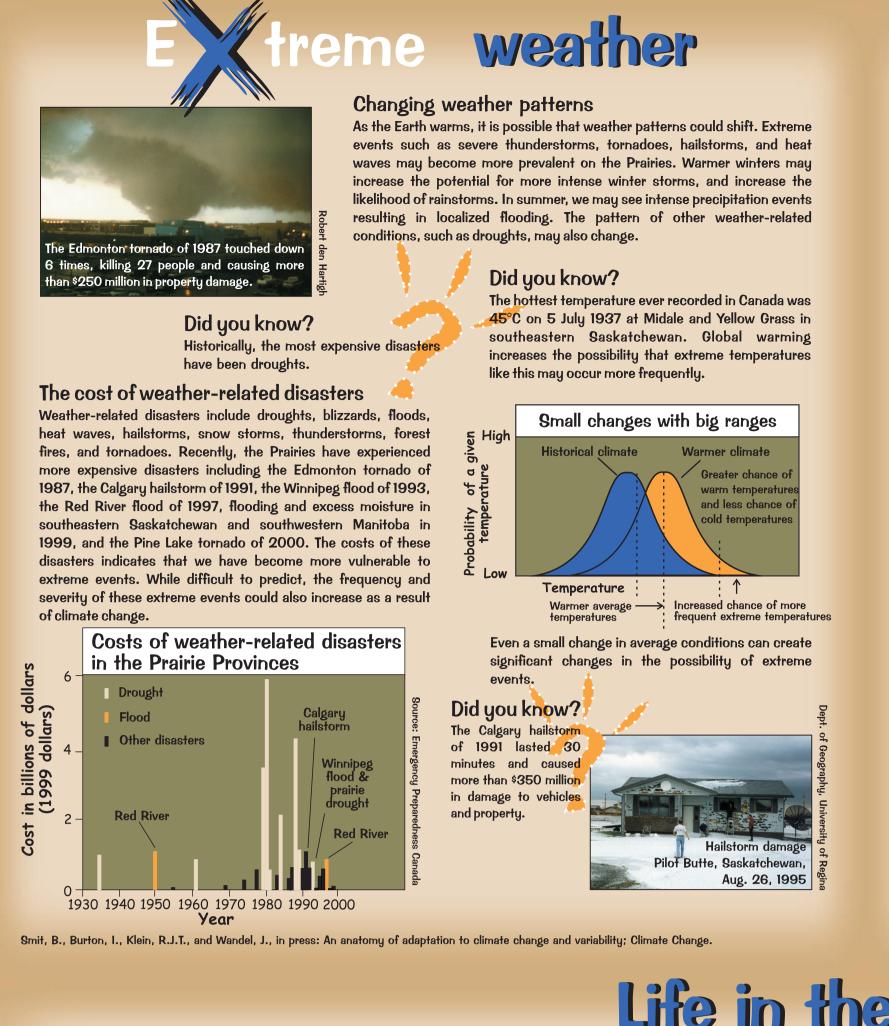
temperatures have risen. Cutforth, H.W., McConkey, B.G., Woodvine, R.J., Smith, D.G., Jefferson, P.G., and Akinremi, O.O., in press: Climate change in the semiarid prairie of southwestern Saskatchewan: late winter — early spring; Canadian Journal of Plant Science.

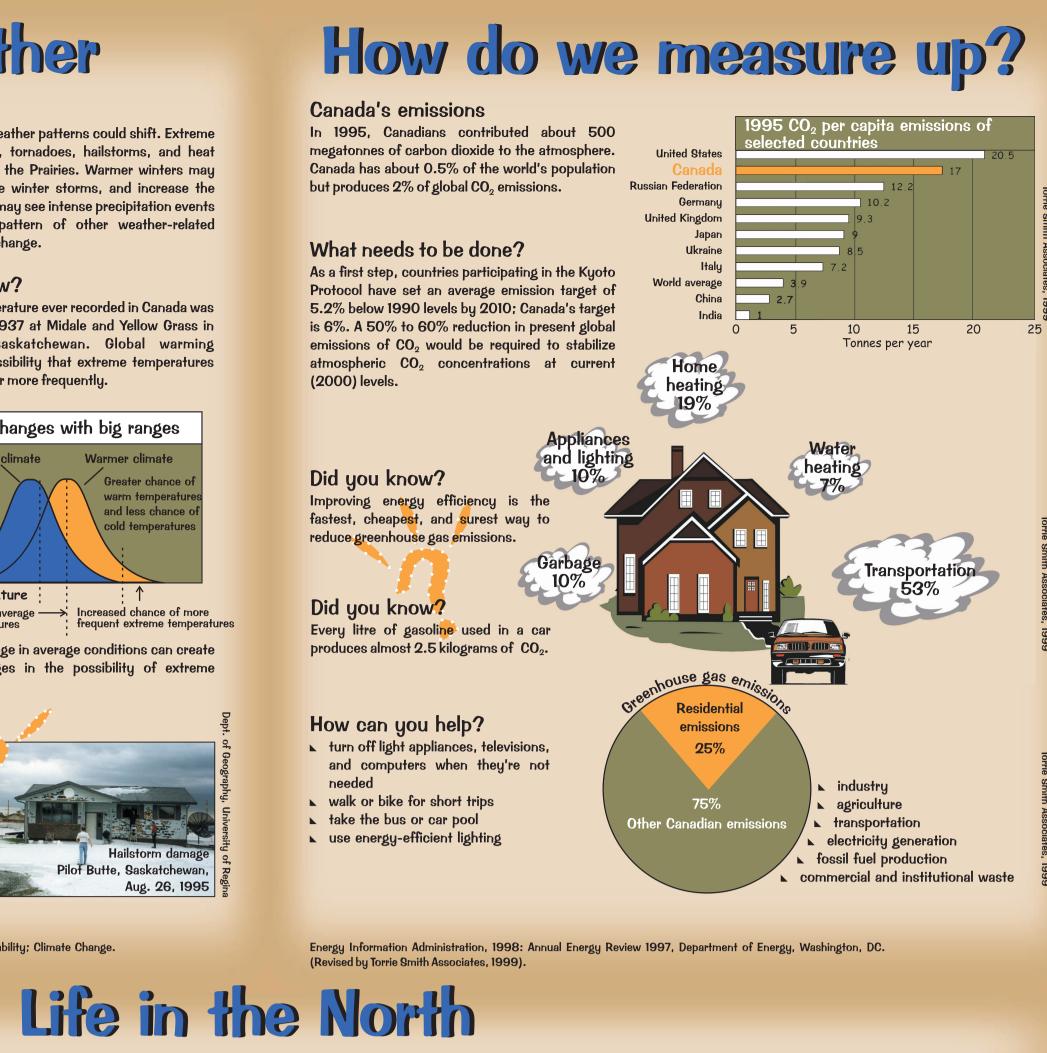
Hengeveld, H.G., 2000: Projections for Canada's climate future: a discussion of recent simulations with the Canadian Global Climate Model; Climate Change Digest 00-01, Environment Canada, Ottawa, Ontario, 27 p. Williams, G.D.V., Fautley, R.A., Jones, K.H., Stewart, R.B., and Wheaton, E.E., 1988: Estimating effects of climate change on agriculture in Saskatchewan, Canada; in The Impact of Climatic Variations on Agriculture Volume 1: Assessments in Cool Temperate and Cold Regions, (ed.) M.L. Parry, T.R. Carter, and N.J. Konijn; Kluwer Academic Publishers, Boston, Massachusetts, p. 221–382.

Longer growing seasons

Climate change in the Prairie Provinces







Polar bears on thin ice Polar bears in western Hudson Bay annually migrate between the mainland and the sea ice to feed on seals in winter and spring. During summer and fall, Hudson Bay is open water so the bears return to land for four months or more to live off their stored fat reserves. Thus, the health of the polar bear population in this region is affected by the distribution and annual duration of sea ice. Earlier break-up of sea ice, due to warmer temperatures, limits hunting opportunities for polar bears by forcing them to come ashore earlier. Since 1981, the condition of adult polar bears in western Hudson Bay, particularly adult females, has declined significantly because they have less time on the ice in spring to feed on seals before beginning their annual fast.

As the Earth warms, temperature changes are an<mark>tic</mark>ipated to be greater in the North, and greater in winter than in summer. Kettles, I.M., Tarnocai, C., and Bauke, S.D., 1997: Predicted permafrost distribution in Canada under a climate warming scenario; in Current Research 1997-E;

Living with frozen ground Permafrost, or frozen ground, is soil or rock that remains below 0°C throughout the year. Part of northeastern Manitoba lies in the zone of continuous permafrost, where permafrost is found almost everywhere except beneath lakes, rivers, and other wet areas. In areas farther south, permafrost is less abundant — and may be widespread, sporadic, or ground conditions. Building foundations, roadways, railways, pipelines, and other structures are vulnerable to shifting, or settlement of the ground caused by thawing of Stirling, I., Lunn, N.J., and Iacozza, J., 1999: Long-term trends in the population ecology of polar bears in western Hudson Bay in relation to climatic

Life in the Prairies

and landscaping areas to maximize water storage are good ways

to reduce the need for water in summer.

How can we adapt? Improving building design and reducing transportation needs will help decrease energy demands. In the near term, increasing public/mass transit and encouraging use of hybrid and other lowemission vehicles can help reduce our transportation emissions, as well as improve air quality. Water conservation practises can help reduce the amount of water we use in our homes, schools, and at work. Planting drought-tolerant plants in yards and parks,

experience warmer temperatures, changes in the distribution and amounts of rain and snow, and greater extremes in climate. Climate change will affect our economy, our environment, and many aspects of our lives. Potential impacts on prairie cities longer summer recreational season and shorter winter increased heat stress and decreased air quality

increased demand for air conditioning but reduced decreased need for snow removal invasion of new insects and diseases

Nearly 60% of Albertans — almost 2 million people — live in either Calgary or Edmonton. The area around Calgary is the fastest growing region in the Prairies. Did you know? Near half the population of Saskatchewa lives in rural areas - there are 298 rural

12 cities in Saskatchewan.

Herrington, R., Johnson, B., and Hunter, F., 1997: Responding to global climate change in the Prairies: in Volume III of the Canada Country Study: Climate Impacts and Adaptation; Environment Canada, Ottawa, Ontario, 75 p.

It is now widely recognized that Earth's climate is

changing, and that the impacts of climate change will

be felt in the decades ahead. Scientists have

concluded that the balance of evidence suggests that

there is a discernable human influence on global

Canadians are being encouraged to become informed

on climate change, and support efforts to slow its

progress. On a practical level the most important step

you can take is to practice energy efficiency in your

everyday life — in our homes, our schools, in our

Reducing greenhouse gas emissions is expected to

have only a partial impact — it will slow the warming

trend; however, slowing the rate of warming will

provide us with more time to adapt to our changing

environment. It will give us time to find new ways to

reduce our emissions. The longer we wait to take

action, the fewer options we may have for dealing

transportation habits, and in the workplace.

Better safe than sorry!

Take action on climate change

The climate is changing

climate. It's time to take action.

municipalities, 376 villages, 146 towns, and

Nearly five million people live in Canada's Prairie Provinces, with over three million living in urban areas. People living in this region are used to changing weather conditions, from one season to another, and from year to year. With climate change, the Prairie Provinces are expected to

Potential impacts in rural areas ■ increased risk of drought and dust storms ▶ increased demand for irrigation ▶ increased risk of insect infestations

▶ change in crop yields due changes in growing season crop production may become possible in northern

Let's meet the challenge

Necessity encourages innovatior

they are not a thing of the past. With improved agricultural techniques involving

educed tilling of the soil we can greatly reduce the risk of dust storms and soil

How can we adapt? More farmers are changing agricultural practices by using conservation farming that improves soil conservation and soil moisture. Still others are adapting by irrigating crops. Converting to drought-tolerant crops, specialty crops, and

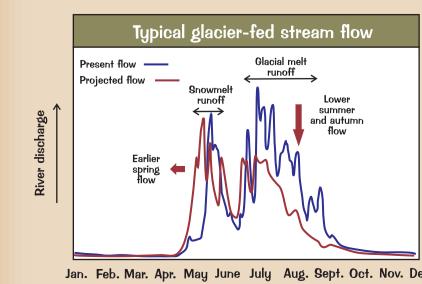
animals provides other options of improving yields in a drier Although the 1930s saw some of the worst dust storms in Canadian history,

Melting glaciers



climate change.

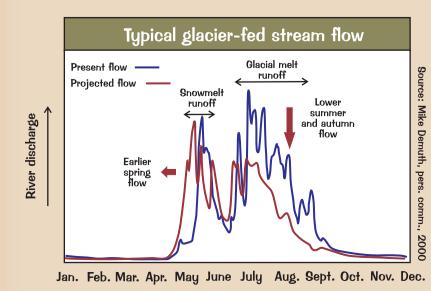
Athabasca glacier in 1917 and 1986. Climate change could result in significant retreat of large glaciers such as this, and related reduction in downstream water flows, wildlife habitat, and hydroelectricity production.



already be having a

late summer and

autumn. A reduction in



The lowdown on the flows Despite predictions that under a warming scenario, melt-water contributions from glaciers would increase in the long term, water flows from glacier-fed rivers are already decreasing. Drastic reductions in the surface area of glaciers in the last century have resulted in reduced downstream water flows, despite the increased melt rates brought on by changing precipitation patterns in winter and the general warming experienced over the past several decades. It is still uncertain, however, to what degree these observed reductions are a result of an overall adjustment of the glacier cover after the "Little Ice Age" maximum (ca. AD 1850), or of more recent

Impacts - fisheries habitat The glacier meltwater helps preserve the habitat for aquatic species that are highly adapted to cool mountain streams. Glacier water levels and habitat that enable trout migrate and spawn in the

serious impact on the Bull Trout population.

Impacts - reservoirs

Seasonal runoff from basins containing glaciers is characterized by longer snowmelt runoff seasons, higher discharge volumes, and peak concentrations of runoff in summer months, compared to basins without glaciers. The glaciers act as storage reservoirs that benefit downstream regions in summer months. They also act as a source of disturbance, such as when rain-on-ice persists for several days, causing extremely high flows, erosion, and flooding.

> Did you know? There are more than 1300 glaciers in the eastern slopes of the Rocky Mountains.

Water resources

Groundwater Since the supply of good quality surface water is limited groundwater, which occurs beneath the surface of the ground, is considered a good alternate source of water throughout the Prairies. Groundwater is a renewable resource, but is not unlimited. We must ensure that it is used in a manner that is sustainable in the long term.

Farm well Water wells are a common feature rural areas of the Prairies, who

for groundwater.

With water being a limited renewable resource in many areas of the Prairies, greater emphasis is being put into the management and conservation of water resources. Efforts are going towards more efficient methods of distribution, storage, and recreational use. Water supply and demand Water on the Prairies is a precious resource that depends to a great extent / on the amount of snowmelt runoff and to a lesser extent to the amount of rainfall runoff. Streams which originate within the Prairies display extreme yearly variability and the majority of the annual runoff may occur

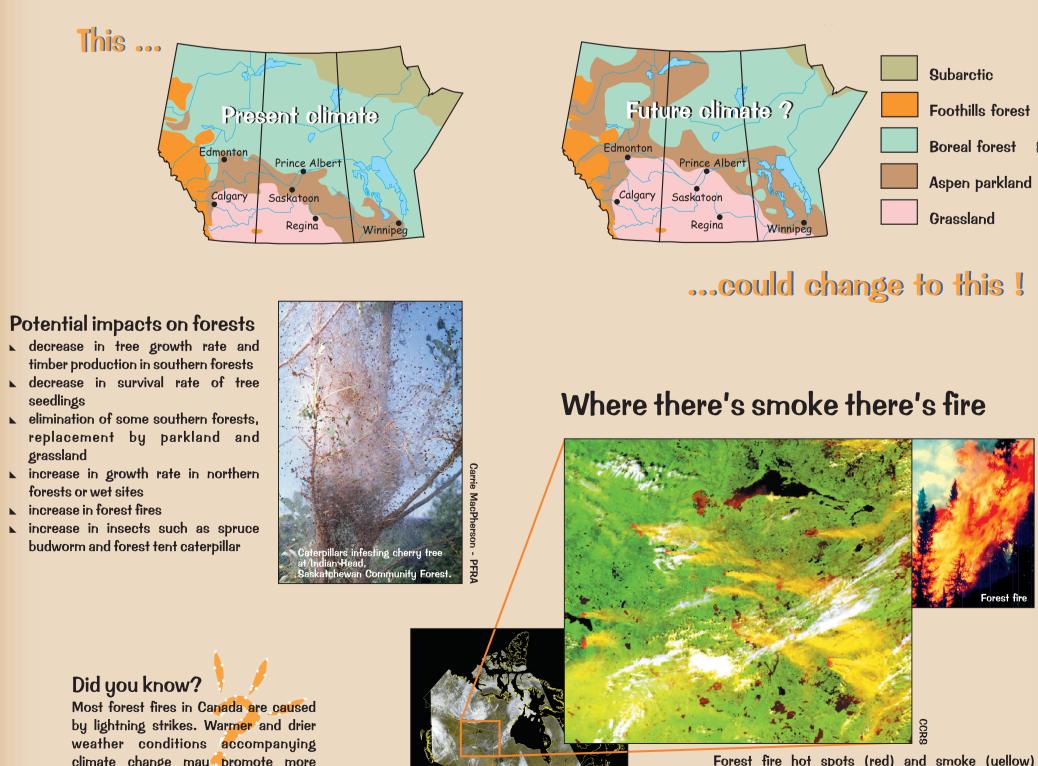
application of water to meet growing demands for agricultural, municipal, domestic, industrial, and Population growth ncreases municipal water demand on summers, increase stream-water evapotranspiration resource levels in dugouts reservoir level during a very short period. As a result, the supply of water is sensitive to changes in our climate. Increased — Hotter and longer summers result in increased evaporation and less surface water is available for use. Less surface water will result in an increase in the demand

Environment Canada, 1997: The Canada Country Study: Climate Impacts and Adaptation, the Canadian Prairies Summary; Environment Canada, Ottawa, Ontario, 10 p.

Using water wisely

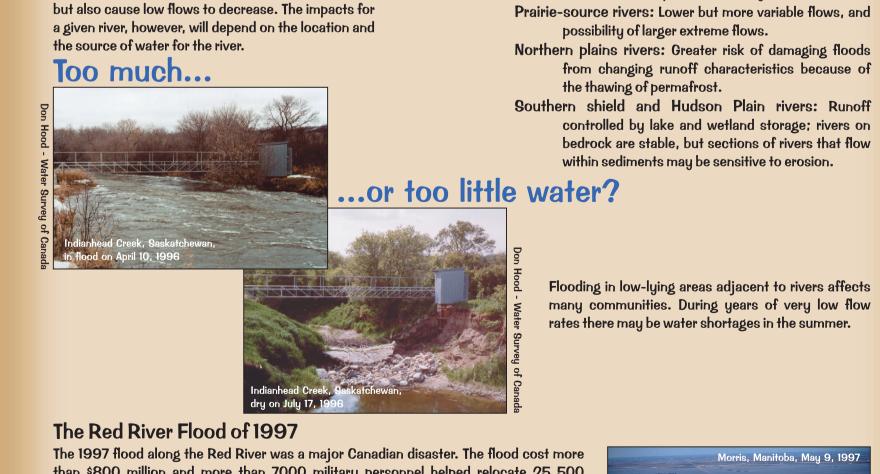
Changing vegetation

Receding forests and expanding grasslands Boreal forests occur in the cooler, moister climates of the Prairie Provinces. Further south, where the climate is warmer and drier, these forests are replaced by aspen parkland and open grassland. In a warmer climate, these ecoclimatic zones may shift northward. Much of the southern forest that supports our timber industry may come under stress or even be eliminated.



...could change to this! Forest fire hot spots (red) and smoke (yellow) detected over northern Alberta and Saskatchewan by satellite on August 11, 1998. Forest fires and smoke plumes detected by satellite

Impacts depend on location Potential impacts Overall, climate change is expected to bring about Mountain-source rivers: Greater risk of extreme flooding more variation in the size of extreme flows in prairie rivers. This could cause large flows to increase in size,



Flooding in low-lying areas adjacent to rivers affects many communities. During years of very low flow rates there may be water shortages in the summer.

in small rivers of the interior Cordillera and

southeastern slopes of the Rocky Mountains.

The 1997 flood along the Red River was a major Canadian disaster. The flood cost more than \$800 million and more than 7000 military personnel helped relocate 25 500 evacuees and prevent further flood damage. Ring-dikes prevented flood damage in most of the towns in the flood zone south of Winnipeg. The town of Morris looked like an A century of change on the Red River The Red River flows northward from the United States into southern Manitoba. Each spring the flow of the river rises. Over the last century there has been a marked increase

Rivers in flux

in the size of the spring flows. Between 1892 and 1945, only two historic peak flows exceeded 2000 cubic metres per second. But between 1945 and 1999 this level has been exceeded eleven times.

Ashmore, P. and Church, M., in press: The impact of climate change in rivers and river processes in Canada; Geological Survey of Canada, Bulletin 555.

Peak flows of the Red River 1892–1999

Lead agency Natural Resources Canada, Geological Survey of Canada Other participating agencies Agriculture and Agri-Food Canada Alberta Agriculture, Food and Rural Development Alberta Conservation Association Alberta Environment Destination Conservation Environment Canada, Meteorological Service of Canada Environment Canada, National Water Research Institute Emergency Preparedness Canada

Manitoba Conservation

with climate change.

Manitoba Geological Survey Manitoba Hydro Natural Resources Canada, Canada Centre for Remote Sensing Natural Resources Canada, Canadian Forest Service Pembina Institute Saskatchewan Research Council SEEDS Foundation Soltek Solar Energy Ltd.

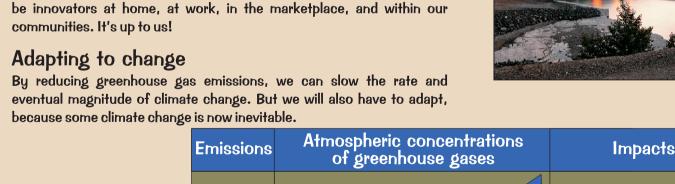
Funding provided in part by the Government of Canada Climate Change Action Fund.

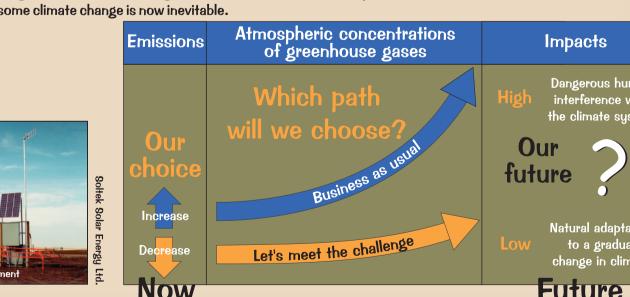
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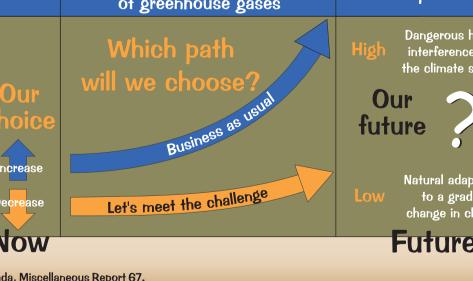
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Climate change is creating a demand for good ideas that will reduce our greenhouse gas emissions - new technologies, alternative energy sources, progressive government policies, and lifestyle choices. We can









The Winds of Change — Climate Change in the Prairie Provinces

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Reviewers: C. Langham, J. Aylsworth This poster is available from Geological Survey of Canada offices: 601 Booth Street, Ottawa, Ontario KIA 0E8 1-888-252-4301 (toll free) This poster is one of a series of posters on climate change in Canada available

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PROVINCE OF ALBERTA

Catalogue No. M41-8/70E

ecology; Freshwater Biology, v. 32, p. 295 – 307.

Milner, A.M. and Petts, G.E., 1994: Glacial rivers: physical habitat and

M.N. Demuth (Geological Survey of Canada - National Glaciology Programme) and A. Pietroniro (National Water Research Institute - Aquatic Ecosystem Impacts

St. Mary Irrigation District in Alberta delivers water to more than 360 000

acres of irrigated farmland. With more than 2000 km of canals and pipelines,

it is the largest irrigation district in Neterhill Community dugout, wet well Irrigation pivot at the Manitoba Crop and tankloading facility north of Diversification Centre sub-station in Kindersley, Saskatchewan.

Portage la Prairie, Manitoba. Did you know? About 10% of Regina, and 40% of the rural population of Saskatchewan relies on

> forests or wet sites increase in forest fires increase in insects such as spruce budworm and forest tent caterpillar Did you know? climate change may promote more forest fires in the Prairie Provinces.

on August 11, 1998 across Canada. Hogg, E.H. and Hurdle, P.A., 1995: The aspen parkland in western Canada: a dry-climate analogue for the future boreal forest?; Water, Air and Soil Pollution, v. 82, p. 391 – 400.