Significant Occurrences of Hail Damage Salmon Arm, B.C. Prairie provinces Prairie provinces \$37,000,000 \$400,000,000 \$15,000,000 \$200,000,000 (1) \$250,000,000 (2) \$27,000,000 * Some cost is attributable to wind and water, not solely hail. The last two occurrences are crop hail. (1) Crop damage (2) \$200,000,000 crop damage, \$50,000,000 estimated residence/vehicle damage catastrophe lailstones have a minimum diameter of half a centimetre.

Hail is a wonder to watch and a curse to farmers

The 1959 Pandemonium Creek avalanche in B.C. reached speeds of up to 360 km/h. In 1903, 90 million tonnes of

Several have taken place in this century on the relatively recent Pleistocene volcanoes of the Garibaldi Volcanic Belt

of the CPR from an earlier avalanche. Defensive works, re-routing of roads and railway tracks and "bombing" snow

Two rockslides in 19th-century Québec killed 77 people. Rockfalls involve a smaller rockmass that disintegrates

Particularly prone are the ancient Cretaceous shales of the Prairies, and the sediments deposited in glacial lakes

following the last Ice Age. A slump in Cretaceous shales destroyed the Alaska Highway suspension bridge over the

limestone fell from Turtle Mountain and buried the coal-mining town of Frank, Alta. About 75 people died.

in southwestern B.C. They are a major hazard to development in the region.

Radar and the International Ice Patrol make sea travel safer than when the Titanic went down. But icebergs still threaten offshore oil

melted or grounded. It is unusual for icebergs to persist south of Newfoundland, due to the warmer temperatures.

rigs, fishing boats and ships. In July 1981, the 900-tonne Canadian survey ship Arctic Explorer struck an iceberg off Newfoundland and sank in 20 minutes. Thirteen crewmen died and 19 others drifted for two days in a liferaft. These icebergs begin as large chunks — up to 40,000 per year — "calved" off the Greenland icecap. They may tower 90 metres above the waves even though eight-ninths of their bulk is underwater. They float southward in the Labrador current, reaching Newfoundland two to three years later if they have not

packs to start safe avalanches have reduced the hazard.

and the village moved earlier by the province

lake burst in the headwaters of the creek.

Peace River, near Fort St. John, B.C., in 1957.

into blocks that bounce and roll down steep slopes.

Hail occurs right across Canada, though more frequently in the West and in southwestern Ontario. For many Canadians, a hailstorm is an intriguing rarity, but for farmers whose crops are crushed, or Canadians whose homes and cars are damaged, a hail-

Average annual number

of days with hail

3 to 5 greater than 5

300 0 300 600 km

0 to 0.9

Hail occurs in the strong updrafts needed to form thunderstorms which tend to occur in warm weather, so damaging hailstorms happen in Canada generally only from May to October. The worst hailstorm in Canadian history in terms of paid insurance claims (indeed, the biggest insurance payout ever in Canada) was the Calgary hailstorm of Sept. 7, 1991. A 30-minute downpour resulted in 62,000

claims totalling \$237 million for property damage, largely broken windows, and a further 54,000 claims for \$105 million in vehicle damage, chiefly dented roofs.

This type of sudden violent hailstorm is spectacularly damaging. But equally important are frequent smaller storms throughout the summer growing season. These can be devastating to vegetables and grains. Parts of the Prairies, particularly the Calgary-Medicine Hat area, can expect up to 10 hailstorms a year. Cloud seeding aimed at creating smaller, softer hailstones has been sponsored by governments and insurance companies.

Nature's force is a cautionary tale and a spectacular show

Main landslide areas on land

300 0 300 600 km

of Ireland's Captain, H.G. Kendall, told an inquest he had brought his

ship to a halt and was waiting for clearer weather when, to his horror,

Fog forms when warm humid air is cooled below its dew point,

the temperature at which water vapour condenses to form water

droplets. Off the Atlantic coast, warm air masses moving north

another ship loomed out of the fog bearing directly upon him, less than

with the Gulf Stream are cooled when they encounter the cold Labrador

As the airmass is cooled from below, a strong inversion is created (in an

Current, producing dense fogs on the Grand Banks off Newfoundland.

inversion cold air is trapped below warm air) and the fog persists.

The Atlantic fog season reaches its maximum in July. Over the Pacific

Ocean, this kind of fog is less common as the temperature difference

between airmass and ocean is not as great. Fog typically blows over

land at night, burning off during the day. It is an awesome experience

lowlands, like the tendrils of some living creature.

to stand on a hill in the evening and watch the coastal fog flow into the

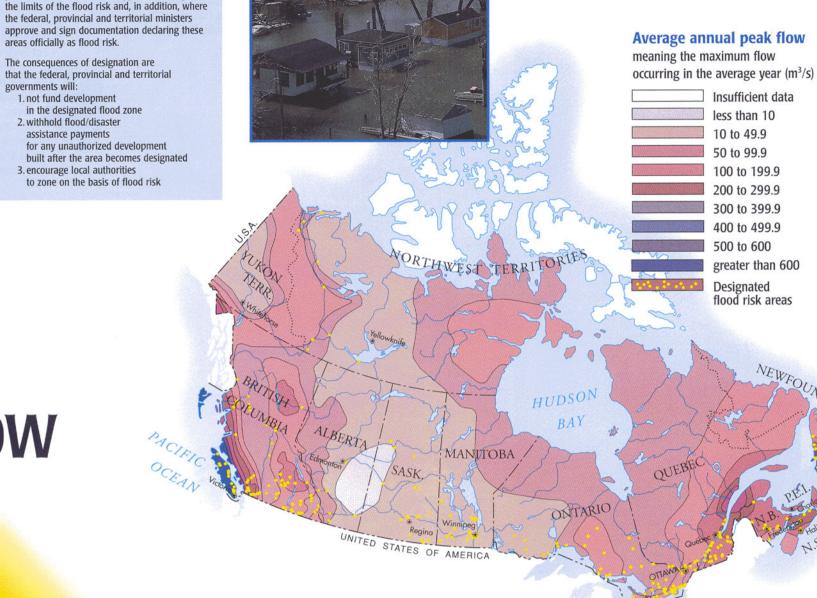
Area of glaciolacustrine clays and fine silt

Area of glaciomarine

Canadian Cordillera

Areas of Cretaceous

bedrock on the Plains



The potential for flooding exists in urban areas

lakes and harbours for the convenience of

commerce and transportation.

because many Canadian cities grew up near rivers,

300 0 300 600 km

e seismic zoning map shown below indicates the severity of apid earthquake shaking which may damage small or rigid strucures such as houses and small apartment buildings. It is used in anada's National Building Code together with another map for lower shaking which indicates threats to tall, flexible structures such as high-rise towers.

Shifting far below ground shakes the surface

The map, below-right, is based on flow data

esignation is a term used to describe a flood

prone area that has been mapped indicating

for rivers with a drainage basin area

f approximately 1,000 square km.

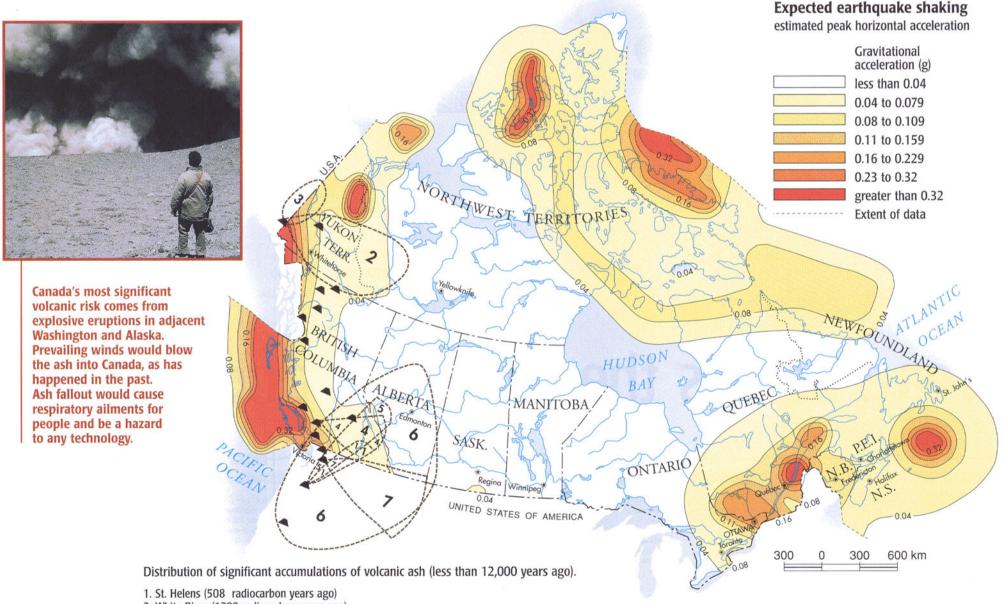
Many large earthquakes have occurred in Canada's short history: millions of dollars in damage was totalled up when a quake hit Cornwall, Ont., in 1944, on southern Vancouver Island in 1946 and in the Saguenay region of Quebec in 1988. In 1929, when an earthquake-generated tsunami hit the south coast of Newfoundland, 27 people died. None of these events have resulted in greater property damage and heavier casualties, mostly because a large quake has yet to strike a heavily populated area.

The presence just off our Pacific Coast of an active boundary between tectonic plates makes western Canada subject to frequent and violent activity. Structurally damaging earthquakes can be expected to strike somewhere in southwestern British Columbia each decade.

In southeastern Canada, the slow movement of the North American plate southwestwards at a few centimetres per year creates sufficient stresses to cause earthquakes on faults or zones of weakness such as exist along the St. Lawrence and Ottawa valleys, and the Atlantic seaboard.

In northern Canada, earthquakes are related not only to zones of weakness, but to the slow, inevitable rising of the land as it continues to shake off the weight of the last major ice sheet. This uplift occurs at different rates in different areas, causing

Although earthquakes cannot be prevented or predicted, their effects can be reduced by constructing buildings to withstand the shaking that might occur.



2. White River (1200 radiocarbon years ago) 3. White River (1500 to 1900 radiocarbon years ago) The dates listed are calculated 4. Bridge River (2360 radiocarbon years ago) from radiocarbon dating techniques

7. Glacier Peak (11,200 radiocarbon years ago) ----- Extent of volcanic ash distribution

5. St. Helens (3400 radiocarbon years ago)

6. Mazama (6800 radiocarbon years ago)

Major volcanic areas less than 12,000 years old

Our "ring of fire" erupted 1,300 years ago

to calendar years.

and are not exactly equivalent

Canada's dormant volcanoes are part of the "ring of fire," a circle that surrounds the Pacific Ocean. These volcanoes vary from small cinder cones to volcanic mountains built up during repeated eruptions. These events have ranged from relatively benign outpourings of fluid lava (like those in Hawaii) to massive explosions many times larger that the 1980 eruption of Mount St. Helens in Washington state south of Vancouver. Southwestern B.C. can expect

significant accumulations of ash every few hundred years. Mount Churchill, just across the present Alaska-Yukon border, erupted 1,300 years ago. It covered 300,000 square kilometres of what is now the Yukon under a blanket of ash, in some areas several metres thick. This eruption was a disaster for the native people, and may have led to their mass migration south.

Floods are number one in property damage

High water is natural. People think of high water as ``floods'' only when lives or homes are threatened or when waters endanger industry and vital links like bridges, roads, pipelines and power sources.

Perhaps the most common cause of flooding is the storage of winter precipitation. What falls as snow, sleet or hail sits frozen over several months and then runs off during the few short weeks of spring thaw. During this period, heavy rain, ice jams on rivers, or simply a heavy snow cover and a quick melt, can bring on flooding. Among the worst in Canada's history was the Manitoba flood of May 1950. Melting snow and heavy rains combined to raise the Red and other rivers several metres above normal. More than 60,000 people in Winnipeg and southern Manitoba were forced from their homes. Some 140,000 hectares of farmland were flooded; some farmers had to shoot their starving livestock.

Next to spring thaw, heavy storm rainfall is the most important cause of flooding. Heavy rains caused by warm, moist air rising rapidly, and thunder storms, produce flash floods. If a weather front moves in with storms or low pressure, there is less severe rainfall locally but more rain over a wide area — like the tropical storms or hurricanes in eastern Canada. Hurricane Hazel, in October 1954, deposited more than 100 millimetres of rain on the Toronto area in less than 12 hours. More than 80 people died.

In the western mountains, mud flows after heavy rain on steep slopes often result in flooding. Rain and melting snow in the mountains can cause flooding along the coast.

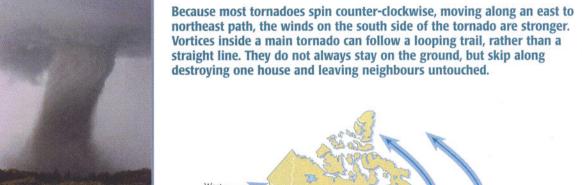
Channel overflows and sudden channel changes on alluvial fans can generate floods. Inland, a "jökulhlaup" or flash flood happens when water breaks out from a lake formerly blocked by a glacier. Prairie flood severity depends on depth of snow, its water content, when it starts to melt, how much moisture was in the soil in the fall and the

Most Yukon and Northwest Territories floods follow spring breakup. Many communities in the Mackenzie River basin are subject to flooding as a result of geography and climate. The Mackenzie flows north. Spring break-up begins in its southern tributaries. Broken ice and warmer waters rush north on the Mackenzie where

winter is still in control. The result is severe ice jams and floods.

Don't try to outrun a tornado they can move up to 70 km/h

extent of ground frost.



Number of tornadoes per 10,000 km² 0.5 to 0.9 1.0 to 2.49 2.5 to 4.9 greater than 10 — 110 — 50 years return period wind speed (km/hr)

Tornadoes are graded for intensity on the "Fujita scale" (named after a noted tornado research scientist), from 0 to 5. Canada has never had an F-5 tornado. Most tornadoes in Canada are weak: fully 45 percent are F-0, 29 percent are F-1, 21 percent are F-2, four percent are F-3, and just one percent are F-4. An average F-0 tornado track is estimated to be about 40 metres wide and 1.7 kilometres long. An average F-4 track may be 400 metres wide and 36 kilometres long.

The F-scale rates tornadoes according to how much damage they cause

181 - 253

Moderate Considerable Severe

117 - 180

Most tornadoes occur in June and July, though their season extends from April to September and there is no month when a tornado has not occurred. They are most common from mid-afternoon to early evening.

Environment Canada warns the public about tornadoes. But because they are hard to predict and can move so quickly (they can move up to 70 kilometres per hour, so don't try to outrun one!), tornadoes may strike without warning. Typically, a tornado is preceded by a severe thunderstorm — the tornado's funnel-shaped form descends from the base of a thunderstorm cloud — and is associated with black skies, strong winds, lightning, thunder and heavy rain or hail. Sometimes the sky will turn an unusual colour, such as green, and the wind will sound as if it's "roaring like a freight train."

There is protection from a tornado. Most deaths and injury occur when buildings collapse or when people are struck by flying debris, especially glass. So the best move is to get

quickly into a well-supported basement area. If this is not possible, go into a room which has strong walls, such as a bathroom or under stairs. Cover yourself with pillows or other heavy material. If you are outside, crouch or lie down in a ditch. Houses collapse most often because of improper anchoring of walls to foundations and roofs to walls. Mobile homes and cottages are the most susceptible to damage, because they are most likely to be unanchored or weakly constructed.

254 - 331

332 - 418

The worst Canadian tornado by death toll occurred at Regina on June 30, 1912. When an F-4 cut a five-block-wide swath through the city, 28 people died, 200 were injured and 2,500 left homeless. About 500 buildings were destroyed. Other devastating Canadian tornadoes include the Edmonton tornado of July 31, 1987, which killed 27 people, injured 300 and caused \$300 million in damage.

SAFE GUARD is a national public information program based on partnerships and aimed at increasing awareness of emergency preparedness in Canada.

Wind speed (km/h) | 64 - 116

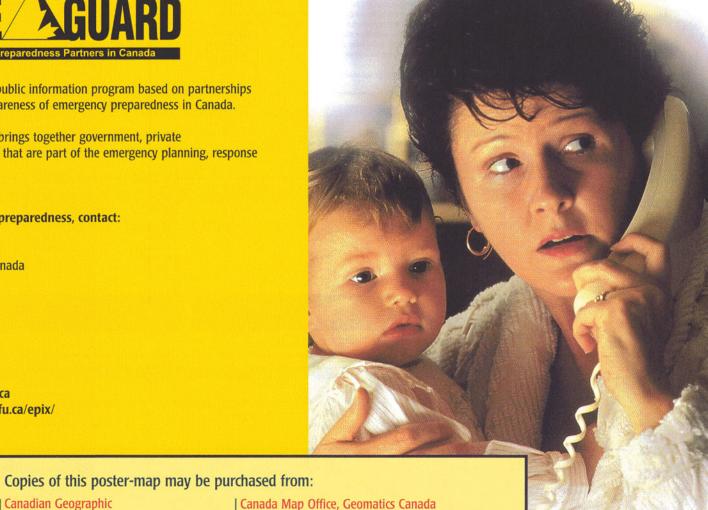
The SAFE GUARD program brings together government, private and voluntary organizations that are part of the emergency planning, response and recovery community.

For advice on emergency preparedness, contact

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Natural Resources Canada Natural Resources Canada **Emergency Preparedness Canada**

a ship's length away.

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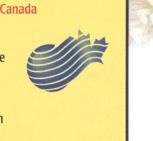
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