

2-3 Severe Weather

Outcomes:

1. Analyze a possible cause for extreme weather and describe some of the effects. (214-11, 214-17, 330-4, 331-4)
2. Describe the causes and effects of seasonal weather events such as the Badger flood of 2003. (212-1, 330-6)
3. Integrate global climate change to local weather patterns. (213-7)

Introduction

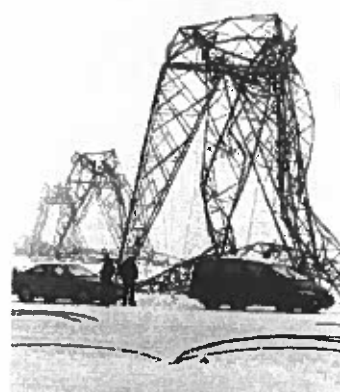
The Ice Storm of 1998 was a natural disaster like no other. It affected millions of Canadians and left everyone wondering just how easily society is affected by the forces of nature.



Starting late on January 4, 1998 and continuing for the next six days until January 10, freezing rain fell on eastern Ontario, southwestern Quebec, and southern New Brunswick and Nova Scotia. These areas were pelted with 80 millimetres or more of freezing rain. The storm doubled the amount of precipitation experienced in any prior ice storm. The result was a catastrophe that produced the largest estimated insured loss (\$1.44 billion Cdn.) in the history of Canada. The combined Canadian and United States insured loss stands in excess of \$1.2 billion U.S. or \$1.75 billion Cdn as of October 1, 1998. The same storm slashed across northern and parts of the United States but the damage in the United States paled in contrast to the damage in Canada.

In Canada, 28 deaths were attributed to the storm, while in the United States, 17 people lost their lives. According to Emergency Preparedness Canada, electric outages in the affected areas of Canada deprived 4.7 million people, or 16 percent of the Canadian population, of power.

Crumpled Steel Towers



People look at a series of Hydro-Quebec high voltage towers near St-Bruno, Que., south of Montreal, Saturday, that collapsed after a severe ice storm hit southwest Quebec. The storm left over one million households out of electricity.

Many Canadians living in large cities, expect that their homes and businesses will be protected from nature's greatest forces. In rural areas, farmers have become more dependent on technology for their work. Their feelings of security were broken in January, 1998 when this ice storm moved into the region.

The freezing rain fell for four days without stopping and thousands of power poles and towers came crashing down under tons of ice. As a result, in most of Quebec and eastern Ontario the power did not come back on for weeks. This meant that Quebec and Ontario had no power for lighting or heat. This was especially difficult with winter conditions becoming worse.

Rebuilding the power network and cleaning up downed lines, fallen trees and crumpled metal hydro towers were huge tasks. So large in fact, the Canadian Armed Forces were called in to help. It was the largest peacetime deployment of troops in Canadian history. Work crews came from Atlantic Canada, the US, and as far away as British Columbia to help restore electricity.

Because the warm air from the Gulf of Mexico was unable to push out the denser, cold air near the ground, the southerly (i.e. from the south) stream of moist air rose up above the cold air that was near the ground setting the scene for the start of freezing rain. The weather map (See figure 1) shows warm, moist air from the United States flowing into Ontario and Quebec. At first, snow fell into the mass of warm air

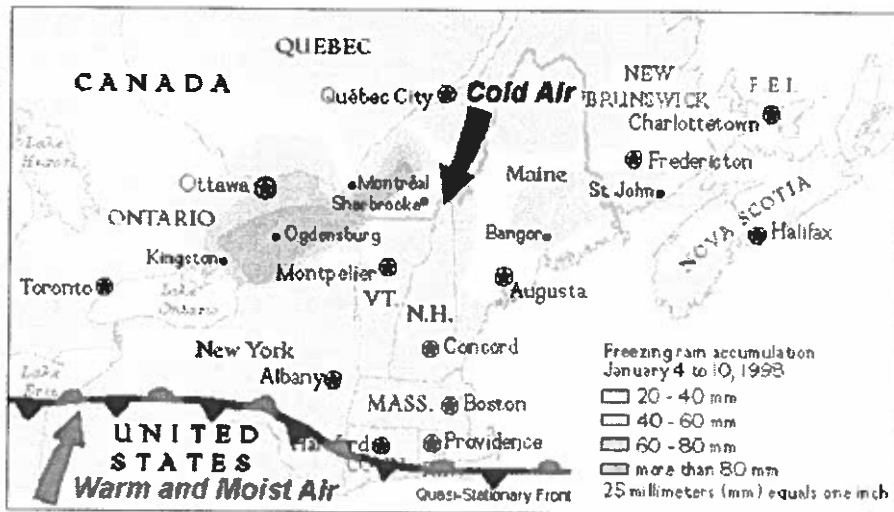


Figure 1

As people waited for power they tried to keep warm with fireplaces or propane heaters. Several died in fires or from carbon monoxide poisoning. Tens of thousands of people were forced into emergency shelters all over southern Quebec where many would stay for weeks. The cost and effects of the storm were still being felt a year later.

The Cause

Scientists called the four consecutive days of freezing rain an event never seen before in the history of Canada. The rains began the night of Jan. 5 during an unusually mild winter. A low-pressure weather system over northern Texas had put moist, warm air from the Gulf of Mexico into southern Ontario and Quebec at the higher altitudes (cloud levels). By January 5, a large Arctic high pressure area had established itself over central Quebec with its circulation putting very cold air into Southwestern Quebec, Western Ontario and the Maritimes.

and melted to fall as rain. The rain then met the mass of cold air lying close to the ground and quickly changed to freezing rain. Freezing rain results when super-cooled rain hits cold objects on the ground and freezes on contact. This resulted in the biggest ice storm to hit central Canada. It stretched from Kingston in Ontario, to Quebec City.

Typically at this time of year the region would be getting hit with huge winter snowstorms, but all across Canada the effects of the warming system El Niño had been noticed. British Columbia had a dry, pleasant winter. The prairies had hardly any snow, and warm temperatures produced unusual winter brush fires. So the ice storm was a surprise, but it didn't sneak up quietly. In the first day ice coated everything from trees to cars to hydro wires. Although silvery and beautiful, the ice coatings

El Niño is a weather-related event in the Pacific ocean caused by warmer than average ocean water

were dangerous and disruptive. Trees fell, cars remained shielded in ice casings, hydro wires sagged and poles dropped.



Within 24 hours, more than 750,000 homes were blacked out. Soon one-quarter of all Hydro Quebec's customers were without power. The power utility sent out 2,000 hydro workers to repair lines and restore electricity, but they couldn't keep up as more freezing rain fell.

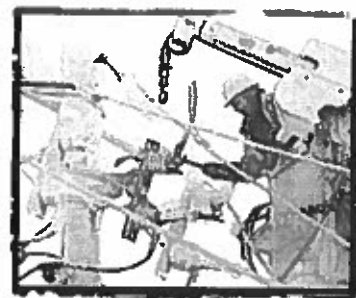
The Results

Three days later on Jan. 7 the massive ice storm had Eastern Canada shut down. People were beginning to realize the already dangerous situation could get worse. Some houses caught fire after people continually burned wood in fireplaces whose chimneys were not built or maintained for constant use. Some people ended up poisoned by carbon monoxide fumes while using propane heaters or barbecues to stay warm. After three days in the cold and dark, many people gave up and sought refuge in shelters. But even the shelters had problems with blackouts.

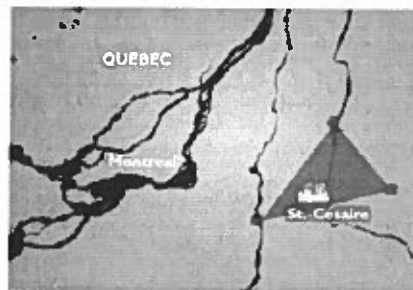
Five days later on Jan. 9, the worst day of the storm was felt. Fallen power lines blocked access to roads and made traveling on highways unsafe. The city of Montreal became completely blocked off as bridges were closed due to risk of falling ice. The few areas that still had power lost it and for the first time in its history all four lines of Montreal's subway, the Metro, were closed.

By late afternoon 3 million people were without electricity and clean water was becoming hard to find. The power crisis shut down water filtration plants and with no back-up generators there was only a two-hour supply of fresh water left. People were warned to boil water from their taps before drinking it.

The rain stopped on Jan. 10 but the effects of the storm carried on. At least 80 km of transmission lines, 23,000 poles and hundreds of transformers had to be repaired and replaced on Quebec's south shore alone.



This area, dubbed the "Triangle of darkness" because of the length of time it spent in a power blackout, was the most devastated section.



In all, 120,000 km of transmission and distribution lines, which took more than half a century to create, came down in a week. Hydro crews came from across the country to work at rebuilding the network and Hydro Quebec had to foot the bill for the hundreds of hours of reconstruction: about \$500 million. Ontario Hydro had some rebuilding of its own to do at a cost of about \$120 million.

Army troops also played a big role in the clean-up effort. Nearly 16,000 soldiers cleared debris from roads, delivered generators and supplies and assisted hydro crews in their work. After 10 days many of the troops headed back home but some stayed into February until all power was restored and the emergency shelters were empty. Some rural areas had gone without power for a month.

Other provinces sent relief and volunteer crews. Money poured in to the Red Cross relief fund from many sources including \$500,000 from the National Hockey League. In isolated areas south of Kingston, Ontario volunteers visited individual homes to make sure people were safe and sheltered.

Deaths - Ice Storm '98 caused the deaths of 28 persons from the following causes:

Cause of Death	No. of Deaths
Trauma	9
Carbon monoxide poisoning	7
Fire	5
Hypothermia	4
Hazardous activities, i.e. removal of snow and ice from roofs	3
Total	28

Economic losses

- agricultural losses of \$25 million
- hydro electric towers and transmission lines \$1 billion.
- dairy production losses \$8 million
- insurance claims of \$1.44 billion
- use of military personnel \$60 million

Added to this were the cost of clean-up, cost of sheltering and feeding thousands of individuals, loss of large hardwood forests, and the cost of emergency and overtime police, fire and medical services.



As an extreme weather event, the Ice Storm of 98 ranks as one of the most significant both in terms of its effects on the economy and the general lives of Canadians. (See STSE 2-3 Supplement A)

Analysis

1. Draw a diagram of the layers of air that caused the Ice Storm of 98. Remember, a layer of warm air was wedged between two layers of cold air.

2. Why was the winter of 98 so unusually warm in Eastern Canada?
3. How many people were without electricity in Canada and the USA? What was the longest duration?
4. Estimate the total Canadian economic losses.
5. How many deaths in Canada were directly related to the storm?

Extension

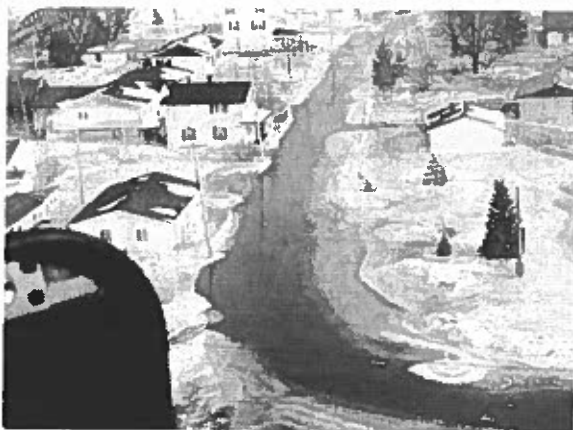
1. Research ice storms in Newfoundland and Labrador to compare the effects on this province to the Ice Storm of 98's effect on Eastern Canada.



The Badger Flood 2003

Introduction

On the morning of Saturday February 15, 2003, the residents of Badger, a central Newfoundland community, awoke to find water rushing into their homes as the three rivers which join near the community (the Exploits, Red Indian, and Badger) backed up with ice jams. At 11:35 a.m. That day Mayor Gerald Hurley declared a State of Emergency. Initially, a partial evacuation was begun but by late evening, the partial evacuation order had been expanded to include the entire community of about 900.



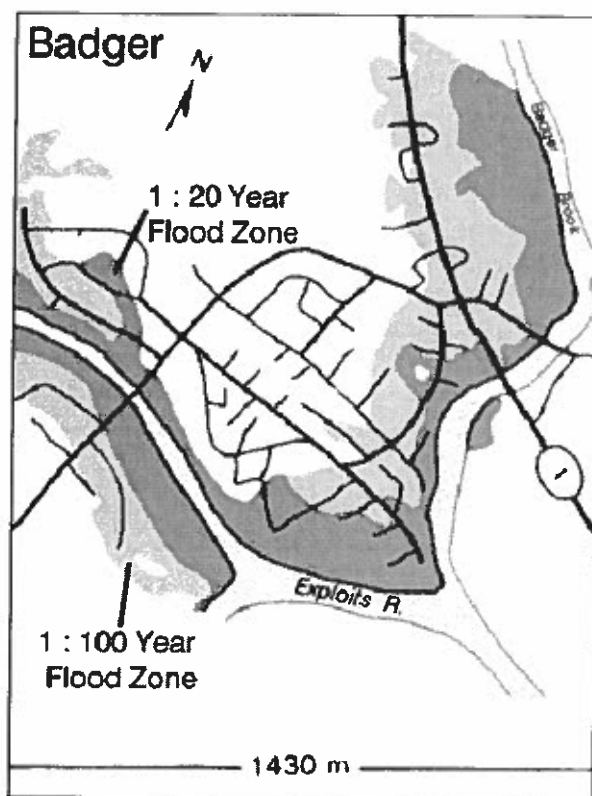
The sewer system had failed, the water supply was thought to be contaminated, and more flooding was feared. People spent the night with friends and relatives in neighbouring communities or at the Beaumont Hamel Armouries in nearby Grand Falls-Windsor, where the Canadian Red Cross had beds, food, and other necessities set up. Firefighters and other volunteers stayed behind to monitor water levels and to heat homes not hit by the flood. The flood had occurred without warning as water swept down the Exploits.

The Cause

Winter floods are not uncommon to Badger. The town is located in the central region of the province of Newfoundland and Labrador, west of Grand Falls-Windsor. It is situated at the meeting point of three

rivers, the largest of which is the Exploits River (See flood zone map). Badger's long recorded history of flooding dates back to 1916. They were hit by major floods in 1978, 1982, and 1985. As is often the case, ice jams, formed during a period of high winds, blowing snow and extremely cold temperatures, caused the Badger, Exploits and Red Indian Rivers to spill their banks, washing away riverside structures and encasing the entire town in ice.

The Exploits River, in particular, has a history of ice jams. These can occur when ice floes encounter ice dams that blocks the movement of ice upstream. Ice jam flooding occurs in two ways. One way this occurs is when river water backs up behind ice jams, thereby flooding low-lying areas. Another way is when ice floes break away, allowing water to spill down stream, an occurrence similar to opening the gates of dam. This is what appears to have happened on February 15.



Ice jams form most frequently in the following areas:

- around islands in rivers
- at bends in rivers
- at points where rivers meet or come together
- near bridges and other obstructions.

Freeze-up jams occur when ice is forming in early to mid winter. Break up jams occur when ice is melting and breaking up. The ice moves down stream in late winter and early spring.

The Result

During the flooding and subsequent evacuations, people had to be rescued from many homes using a front-end tractor because the water flooded Badger so quickly. Reports indicated that the water rose 2.5 meters in the first hour of the flood. As the water filled the town, both the sewage treatment and water treatment plants failed. Later Saturday night and early Sunday morning, air temperatures dropped to -20°C , quickly freezing the water that had filled the homes, offices, businesses and recreational facilities of Badger.



A closer look at the homes revealed many were shifted off their foundations as the ice struck them. Others were suffering water damage as well as damage due to swelling ice as it formed inside the homes. Some homes had half filled oil tanks tipped over, adding to the environmental concerns of the failed treatment systems.



The residents that were struck first by the flood also had no time to remove their vehicles and as a result many were caught in the water and later froze in ice as temperatures dropped.



As the flood waters slowly retreated over the next week, some residents could return to their homes because they had little damage due to the flood. Many others would be out of their homes for months. The impact of this flood created large financial costs. Some were covered by donations from people and organizations like the Royal Canadian Legion and the Canadian Red Cross. The personal costs, however, would be much higher for some people and too high for others who would choose not to return to their homes (See STSE 2-3 Supplement B).



The Badger Flood of 2003 was significant enough to make the list of the top ten weather events of 2003 (See http://www.msc.ec.gc.ca/media/top10/2003_e.html).



Analysis

1. What is an ice jam? How can it occur?
2. How quickly did the Badger flood of 2003 occur?
3. Why is Badger prone to flooding? How many times has flooding occurred?
4. Describe some of the damage suffered by residents and the town.
5. What were some environmental concerns?
6. What made the flooding event significantly worse?
7. Where did people go during the full evacuation? How long did it last?

Extension

1. Research the Newfoundland and Labrador governments' contribution to the Badger relief effort. What conditions, if any, did they place on the town of Badger?
2. Although nothing indicates the involvement of the Abitibi-Consolidated paper mill. The company has denied any responsibility for the flood. Research why they would have to make such a claim.

Resources

CBC Newsworld Online

<http://www.newsworld.cbc.ca/flashback/1998/ice3.html>

CBC St. John's Online

http://stjohns.cbc.ca/regional/servlet/View?filename=nf_badger3_20030218

The Ottawa Sun

<http://boating.ncf.ca/icestorm.html>

ICE STORM '98 by Eugene L. Lecomte with Alan
W. Pang and James W. Russell

[http://collection.nlc-bnc.ca/100/200/300/
institute_for_catastrophic/iclr_research_paper-ef/
no01-e/Research_Paper_No_1.pdf](http://collection.nlc-bnc.ca/100/200/300/institute_for_catastrophic/iclr_research_paper-ef/no01-e/Research_Paper_No_1.pdf)

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[http://www.suire101.com/article.cfm/
canadian_tourism/98976](http://www.suire101.com/article.cfm/canadian_tourism/98976)

Badger Water Level Information-Government of
Newfoundland and Labrador

<http://www.gov.nf.ca/wrmd/Badger/default.asp>

Great Canadian Rivers – Exploits River Focus on
Flooding

[http://www.greatcanadianrivers.com/rivers/explo_n/
flood.htm](http://www.greatcanadianrivers.com/rivers/explo_n/flood.htm)