



Canada: Beautiful, liveable, but vulnerable

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PART 3: WATER

The NSW Geography Syllabus 7–10 requires the study of places at a variety of scales from local to national and global. Some units specify a study of different countries and others require a study that contrasts Australia with one other country. Australians in general have a fondness for Canada and for many it is a destination they have visited or would like to visit in the future. The reality is that Australians know very little about the geography of Canada beyond tourist images of mountains, forests, lakes and ski fields or media reports about its liveable cities.

Part 1 in this series of articles 'Canada: beautiful, liveable, but vulnerable' investigated Canada's landforms, landscapes and biomes and its vulnerability to natural hazards such as earthquakes, tsunamis, landslides and wildfires.

Part 2 was a study of selected Canadian landforms, the processes responsible for their formation, associated values and the protection of those values, these articles were published in Geography Bulletin Vol 47, No4 2015.

Part 3 will investigate Canada's water resources and its vulnerability to atmospheric and hydrologic hazards such as storms, drought and flood.

Part 4 will be an inquiry based learning activity for the Bow River drainage basin. (this article will be published in a later issue of the Geography Bulletin).

SYLLABUS LINKS

CONTENT: Water in the world

(<http://syllabus.bos.nsw.edu.au/hsie/geography-k10/content/1185/>)

- the characteristics and spatial distribution of global water resources
- how the operation of the water cycle connects people and places
- the quantity and variability of water resources - Australia and other places
- the economic, cultural, spiritual and aesthetic values of water for people

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GLOSSARY (<http://syllabus.bos.nsw.edu.au/hsie/geography-k10/glossary/>)

Catchment area: The area drained by a river or water body. Also known as river basin.

Groundwater: water located beneath Earth's surface filling the spaces between grains of soil or rock.

Precipitation: Forms of water falling from the atmosphere to the Earth's surface

Spatial distribution: The location and arrangement of particular phenomena

Water cycle processes: physical changes to water that change its state and geographical location.

Climate change: A long-term change in regional or global climate patterns eg. annual precipitation, frequency of weather events

Atmospheric hazard: Hazard event originating in the atmosphere eg storms, tropical cyclones

Hydrologic hazard: event originating in the hydrosphere from changes to the water cycle eg floods and droughts

Canada's Water Resources

Canada is the second largest country in the world covering an area of 9,984,670 sq. km. It has the world's longest coastline bordering the Atlantic, Pacific and Arctic Oceans and shares an 8,892 km land border with the USA. With a large latitudinal and longitudinal extent (from 42° to 83° N and 52° to 141° W) annual precipitation varies greatly from north to south and coast to inland.

Considered as one of the world's water rich countries with an estimated 20% of the world's freshwater resources much of which is highly visible as glaciers, icefields, wetlands, rivers and lakes. Fresh water covers around 9% of Canada's total area (or 891 163 square kilometres).

Visible water resources

- Canada has over **2 million lakes, 563 of which are** over 100 square kilometres in area, more than any other country
- The Great Lakes (shared with the USA) is the **largest area of freshwater in the world** storing 18% of global surface freshwater resources
- **Average annual precipitation** (Source 1) varies across the country with the greatest concentrations on the Atlantic and Pacific coasts, reducing inland and to the north.
- About 2% of the country is covered by frozen freshwater in the form of snow, glaciers and ice fields.

- On average 36% of annual precipitation falls as snow but variations occur from north to south and from the coast to the inland. (North, 50%; Prairies, 25%; coasts as low as 5%).
- High precipitation levels and the melting of winter snow contributes to river flow (Source 4) and an average discharge of freshwater from Canadian rivers into the sea totaling nearly 9% of the world's freshwater supplies.
- The Mackenzie River (4,241 km) is Canada's longest river.
- Wetlands are found in every province and cover 14% of the country's total land area.

Precipitation and runoff

High annual precipitation (renewable water resources) results in large amounts of runoff, although runoff also varies due to slope, soils, vegetation cover and human.

Sources 1 and 2 show spatial variations in annual precipitation and runoff.

Water resources are best studied using a drainage basin (catchment) approach. In Canada, water from drainage basins empties into the Pacific Ocean, Atlantic Ocean, Arctic Ocean, Hudson Bay, The Great Lakes and Labrador Sea. It is said that 50 - 60% of the total flow of Canadian rivers drains northward into the Arctic Ocean or into Hudson and James bays, often thousands of kilometres from the water source while most of the population (85%) lives within 300 kilometres of the border with the USA.

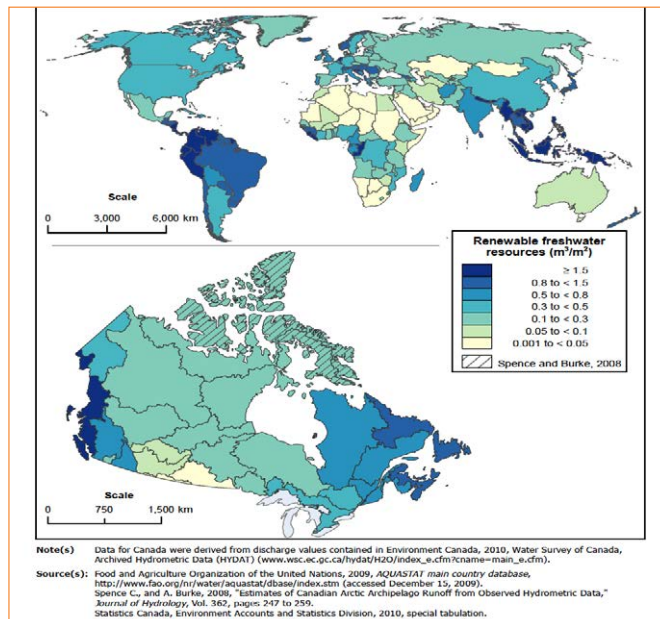
The Bow River drainage Basin for example, begins in the Rocky Mountains west of Calgary and the water

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discharges into Hudson Bay some kilometres away. Some southern catchments drain into The Great Lakes or cross the border into the USA. **See Source 3**

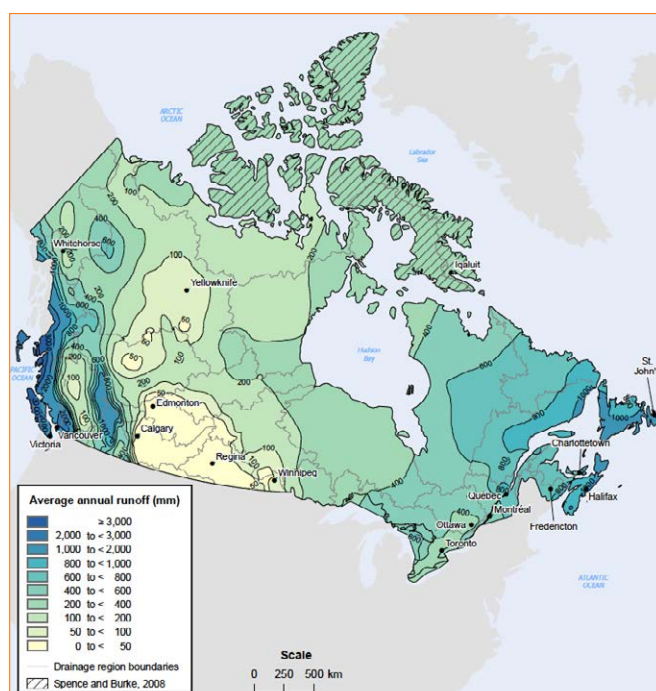
To make use of its surface water resources about 850 large dams and thousands of smaller dams have been built on Canadian rivers and streams storing water for urban, industrial and agricultural use.

SOURCE 1: Spatial variations in annual precipitation (renewable water)



From: Human activity and the environment: Freshwater supply and demand in Canada – <http://www.statcan.gc.ca/pub/16-201-x/16-201-x2010000-eng.pdf>

SOURCE 2: Spatial variations in runoff

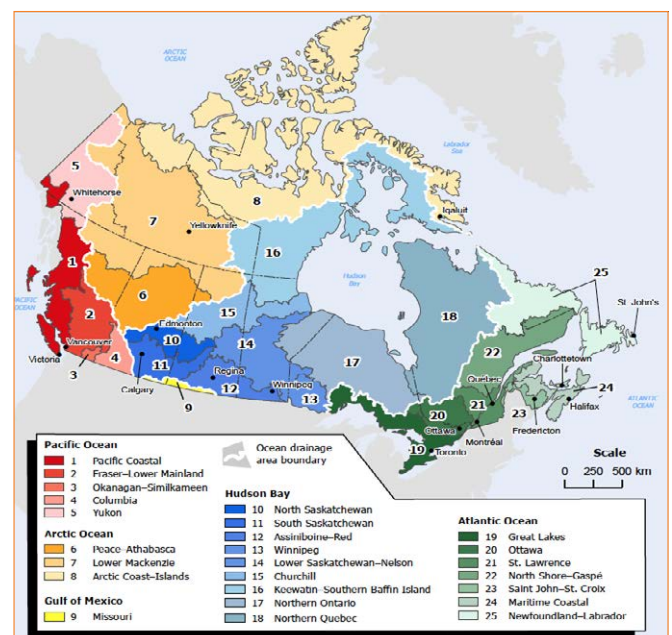


From: Human activity and the environment: Freshwater supply and demand in Canada – <http://www.statcan.gc.ca/pub/16-201-x/16-201-x2010000-eng.pdf>



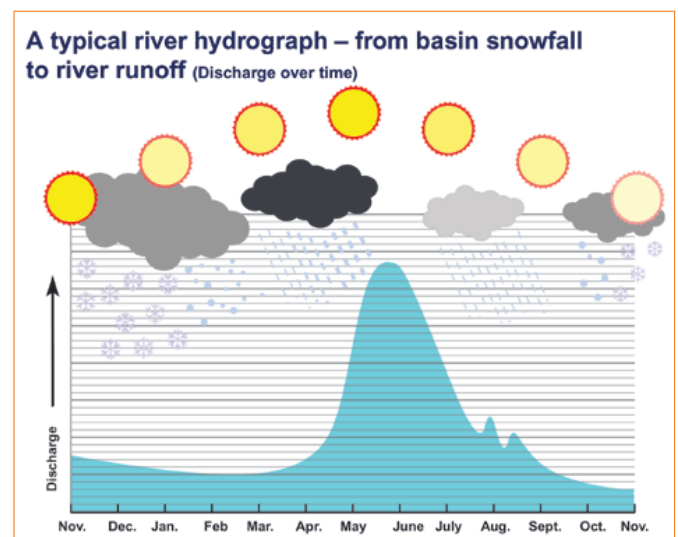
Bow River, Banff National Park. source: Wikimedia Commons

SOURCE 3: Canada's large drainage basins



From: Human activity and the environment: Freshwater supply and demand in Canada – <http://www.statcan.gc.ca/pub/16-201-x/16-201-x2010000-eng.pdf>

SOURCE 4: The contribution of snowmelt to river flow in Canada



<https://www.ec.gc.ca/eau-water/default.asp?lang=En&n=B98C0EB3-1>

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SOURCE 5: Visible water resources include lakes, glaciers, rivers and waterfalls



Examples of visible water resources in Alberta and British Columbia (L Chaffer)

Invisible water resources

Groundwater is an important resource for inland, rural regions and more remote provinces of Canada with an estimated 25–30% of the population relying on groundwater for domestic and agricultural use. Many rural communities use wells to provide a reliable, less expensive water supply than obtainable from nearby lakes, rivers and streams. In some places groundwater is the primary source of water. Spatial variations on groundwater dependence can be seen in Source 6.

Many ecosystems are also dependent on groundwater. Wetlands, such as the Vermillion Lakes wetlands on the Bow River, support millions of Canadian ducks and waterfowl and other iconic Canadian species such as Caribou, are recharged from groundwater flows. Wetlands also store floodwater, filter nutrients to keep

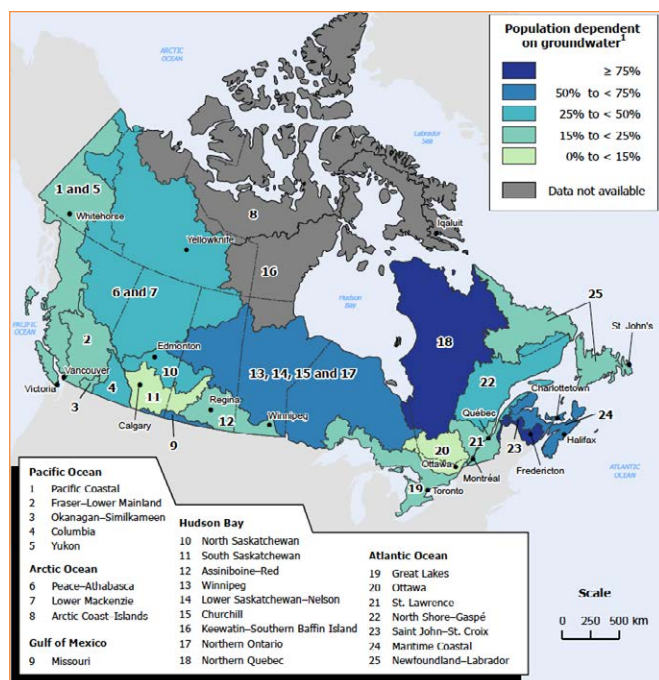
rivers cleaner and recharge rivers in times of drought as in other parts of the world. The contamination of invisible groundwater resources in Canada has become a major concern in recent years. **See Source 7**



Vermillion Lakes near sunset (Mount Rundle to left), Banff National Park, Alberta, Canada. Source: Wikimedia Commons

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SOURCE 6: Spatial variations in groundwater dependence



From: Human activity and the environment: Freshwater supply and demand in Canada – <http://www.statcan.gc.ca/pub/16-201-x/16-201-x2010000-eng.pdf>

SOURCE 7: The Vermillion Lakes wetlands support ecosystem biodiversity



Photos: L Chaffer

Values of water resources

"Water not only slakes thirst and gives Canadians a sense of identity but supports healthy aquatic and terrestrial organisms, provides a myriad of ecological services and is the backbone for a competitive economy"

<http://www.canadiangeographic.ca/atlas/themes.aspx?id=watershedawareness&lang=En>

Aesthetic, spiritual, cultural and social values

Canada's glaciers, lakes, rivers, wetlands and waterfalls add beauty to the environment and are enjoyed by millions of tourists and Canadians every year. The snow covered mountain peaks, glaciers, lakes eg lake Louise and rivers of Banff National Park attracts 3–4 million visitors a year. Other examples include the Athabasca glacier, the Fraser River Valley, Waterton Lakes and Niagara Falls. The Great Lakes alone provide drinking water to 8.5 million Canadians.

SOURCE 8: Aesthetic value



Waterton Lake (L Chaffer)



Athabasca Glacier (L Chaffer)

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Niagara Falls – <http://www.niagarafallslive.com/images/pano2.jpg>

The First Nations people of Canada settled where water resources were plentiful such as along rivers and lakes. Water is a living thing in First Nations culture: part of the biotic rather than the abiotic environment as viewed by scientists.

SOURCE 9: First Nations value water as a living thing

“Water is a meditative medium, a purifier, a source of power, and most importantly it has a spirit. Water is alive – biotic.

The Elders believe that water has a strong spirit, which can be gentle or powerful, forgiving or angry. ‘If you don’t make offerings to the water, sometimes it can take you.’

The water is shown respect and appeased through offerings in the form of gifts of food or coins, and through prayer

‘The water is the biggest part of all our lives; without it we’d never survive. So when you go to the water and you talk to that water, that water helps you. If you go to the water early in the morning and get into it before anybody’s up or around, that water will strengthen you because your spirit cries for that water”

From: Perspectives: Journal of ecosystems and management.
“Water: A first Nations spiritual and ecological perspective” http://forrex.org/sites/default/files/publications/jem_archive/ISS1/vol1_no1_art7.pdf

Economic value

Rivers and groundwater are the lifeblood of Canadian agricultural production, urban settlement, industrial production, hydroelectric generation, transportation and trade across Canada. The Great Lakes are a vital trade highway connecting inland Canada with the USA,

coast and overseas markets through the St Lawrence Seaway.

Water’s annual measurable contribution to the Canadian economy is estimated to be between \$7.5 billion and \$23 billion, and by some estimates, 60 percent of the country’s GDP is directly dependent on water.

Canada’s hydrologic and atmospheric hazards

Winter storms and blizzards consist of heavy snowfall, cold temperatures, high winds and whiteouts. A blizzard occurs when winds are over 40 km/h and visibility is reduced to below about 400 metres because of snow falling and / or blowing for at least four hours.

Cold arctic air from the north brings blizzard conditions, which could last for days.

Floods are the most frequent natural hazard in Canada caused by heavy winter precipitation (snow, sleet and hail) and the spring thaw. Rapid melting of ice and snow accompanied by heavy rain has historically caused serious flooding. Heavy rain also causes flash floods, especially during the hurricane season in the eastern provinces or on the steep slopes of the Canadian Rockies. The growth of urban areas such as Calgary exacerbates the extent of flooding along rivers and lakes. The worst flood in Canada’s recent history occurred in Alberta in June 2013.

Tornadoes in the summer months consist of rotating columns of wind that cause a path of destruction in inland provinces such as Ontario and the Prairies in southern Canada. Canada gets more tornadoes than any other country with the exception of the United States.

Drought is less common but in 2015 record-breaking high temperatures and low rainfall brought drought western Canada, devastating agricultural production and causing widespread bushfires (**Source 11**). For parts of Alberta conditions meant the lowest rainfall in 50 years. Several Alberta counties declared states of

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agricultural disasters. Water restrictions were imposed throughout Alberta, Saskatchewan and along on the West Coast.

A contemporary natural hazard: Alberta Flood 2013

On June 20, a large weather system moved in from the southwest, dropping nearly 100 mm of rain in just over a day in some areas. The river systems and ground were unable to handle the massive amount of precipitation and rivers crested creating flooding across much of southern Alberta. The rain persisted creating devastating conditions in and around Calgary, including High River and Red Deer. Homes were washed away, people struggled to save their homes and cars,

but many were forced out of their homes. At least four people died. Many people were unable to return to their homes or businesses.

The Insurance Bureau of Canada estimated that the flooding was the costliest in Canadian history, topping off at \$1.7 billion.

- 100,000 Albertans displaced
- Closure of part of the Trans-Canada Highway
- 4,000 businesses impacted in Calgary alone
- Closure of Calgary Zoo
- Rainfall averaged 75 to 150 mm in under three days
- Almost 500,000 people across southern Ontario were left without power due to the storm

SOURCE 10: Flooding in Calgary, Alberta June 2013



Left and above: Aerial view of the flooded Calgary Stampede stadium, Calgary, June 2013.



Debris and water pours down suburban streets and across the Trans-Canada Highway



<http://globalnews.ca/news/1046844/worst-natural-disasters-in-canadian-history> and <http://globalnews.ca/news/1012584/2013-weather-year-in-review/>

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SOURCE 11 Forest fires associated with drought conditions in 2015



<http://www.bloomberg.com/news/articles/2015-08-26/snowy-canada-suffers-drought-heat-fires-as-earth-gets-warmer>



During the first week of June 2009, Sustainable Resource Alberta burned nearly 8,000 hectares of forest in Western Alberta. The forest was destroyed to bring about greater diversity, stem the spread of mountain pine beetle and to create a fire barrier for any future wild fires. Source: https://upload.wikimedia.org/wikipedia/commons/f/ff/Big_controlled_burn_in_Alberta.jpg

Sources

Canada: Environment and climate change
<https://www.ec.gc.ca/default.asp?lang=en&n=FD9B0E51-1>

Human activity and the environment: Freshwater supply and demand in Canada – <http://www.statcan.gc.ca/pub/16-201-x/16-201-x2010000-eng.pdf>

Perspectives: Journal of ecosystems and management.
“*Water: A first Nations spiritual and ecological perspective*” – http://forrex.org/sites/default/files/publications/jem_archive/ISS1/vol1_no1_art7.pdf

Natural hazards of Canada – <https://www.youtube.com/watch?v=3U5oYr-yAZQ>

Alberta Flood 2013 – <https://www.youtube.com/watch?v=RBLZyolbvts>

Calgary Flood 2013 – <https://www.youtube.com/watch?v=KwqLYfdiqxl>

Alberta Flood 2013: How it happened – <https://www.youtube.com/watch?v=PxSfbi9vLPA>

Flood – <http://globalnews.ca/news/1046844/worst-natural-disasters-in-canadian-history/>

<http://globalnews.ca/news/1012584/2013-weather-year-in-review/>

Drought and fire – <http://www.bloomberg.com/news/articles/2015-08-26/snowy-canada-suffers-drought-heat-fires-as-earth-gets-warmer>

STUDENT ACTIVITIES

1. Explain why Canada is considered a water rich country.
2. Differentiate between visible and invisible water resources using Canadian examples.
3. Use examples to illustrate the aesthetic value of Canada's water resources
4. Compare Canada's First Nation people's perspective on water to that of scientists.
5. Explain the economic value of water in Canada using examples and statistics.
6. The Bow River Wetlands have environmental value – what does this mean?
7. Why is flooding the most common hydrologic hazard in Canada?

Inquiry activity

Choose one aspect of Canada's water resources eg. rivers, precipitation, a hydrologic or atmospheric hazard.

Conduct an inquiry to compare Australia and Canada for the selected topic.

Communicate your results using a web-based program.



Left: Vamp Creek showing damage from the 2010 forest fire Kisseynew Lake, Canada
Source: https://commons.wikimedia.org/wiki/File:Vamp_Creek_showing_damage_from_2010_Kisseynew_Lake_Forest_Fire.jpg