

LECTURE 2_15:
MAR. 6, 2014

WATER

WATER AS A HAZARD, ITS MANAGEMENT AND ETHICS AROUND WATER

Text Reference: Dearden and Mitchell (2012), Ch. 11, pp. 397-416.

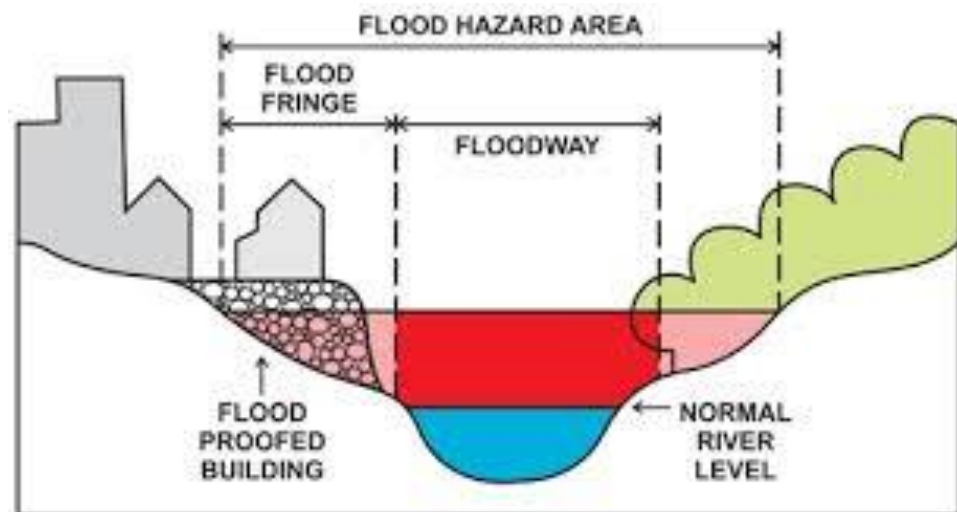
Outline



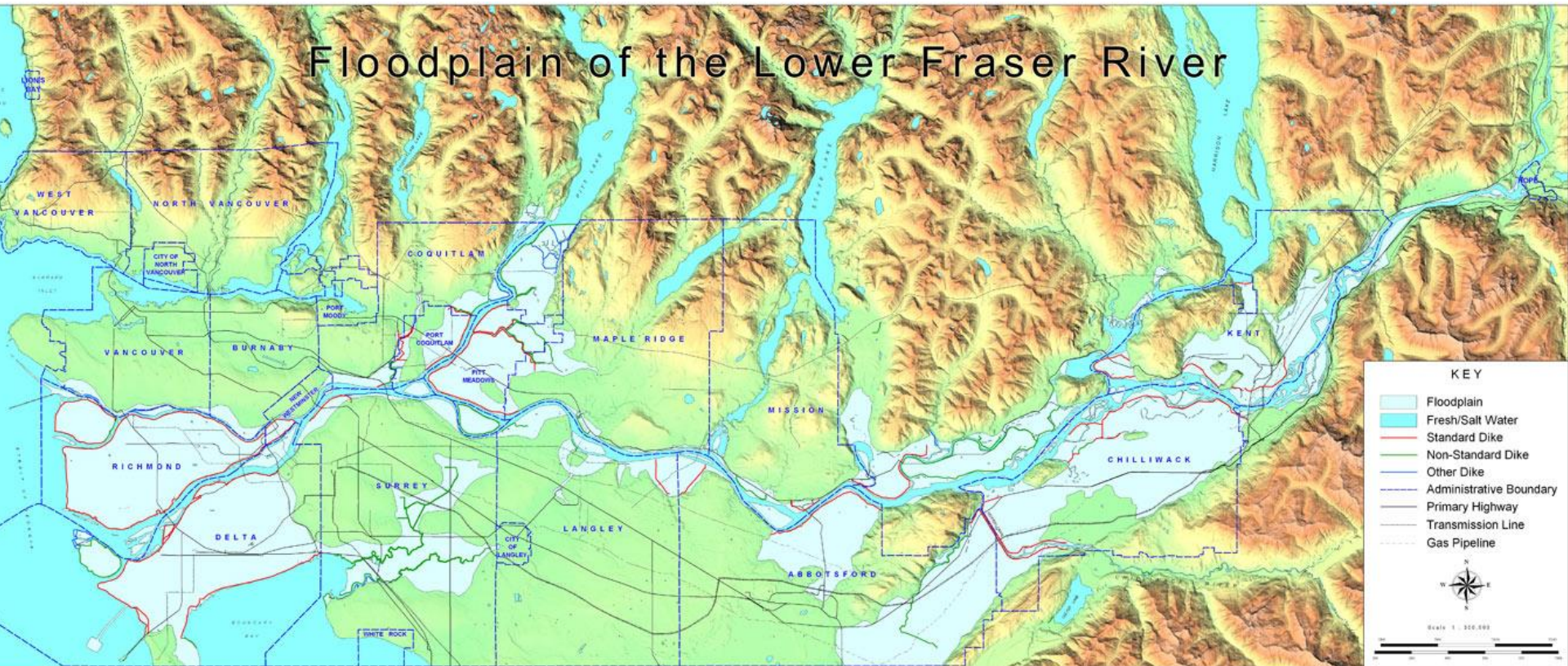
- Water as Hazard
 - ▣ Flooding {floodplains; case studies: Red River; Nechako/Fraser R. Bow R. (Calgary 2013 floods)}
 - ▣ Drought {types of; e.g., Palliser's Triangle}
- Heritage Rivers
- Great Lakes Water Quality Agreement

Photo credit: UBC Geography (Fraser River Gravel Reach Studies)

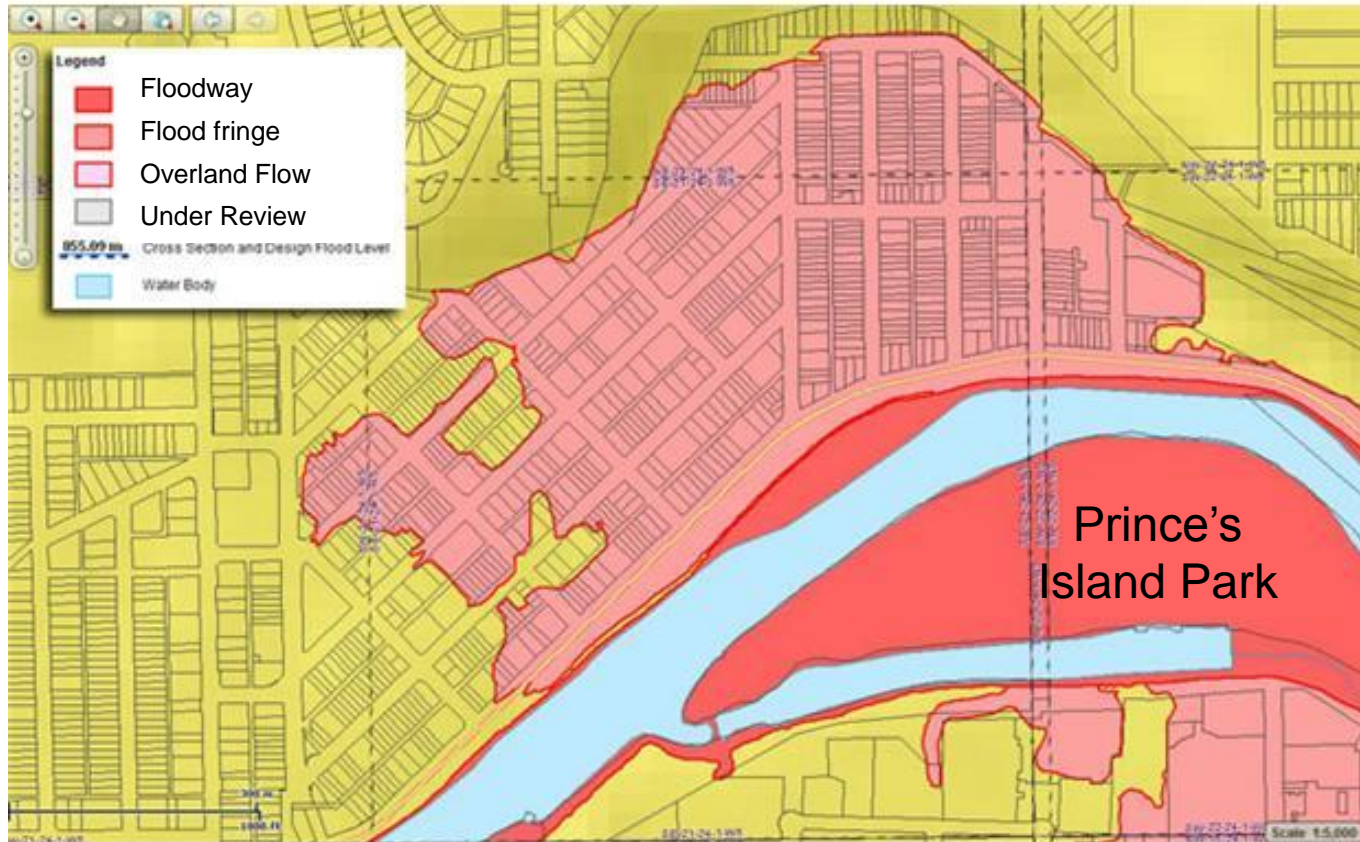
- Floodplain Distinctions
 - A **floodplain** is low-lying land along a river or lake that floods from time to time under normal conditions;
- **Floodway**: area necessary to transmit a selected flood; damage to structures is likely; thus development severely restricted
- **Floodway Fringe**: may be suitable for certain developments



Floodplain, Lower Fraser Valley



Floodplain map (example, Calgary)



Note: infringement of built up areas on flood plain areas;

Preamble: water as hazard

- **Flooding**
- As population concentrations on floodplains increase, the potential of flood damage goes up
- Major flood events have frequently caused enormous damage across Canada:
- Notable Canadian examples:
 - ▣ Fraser River (1948)
 - ▣ Manitoba floods (1997 \$300 million; 2011 \$550 million)
 - ▣ Toronto – Hurricane Hazel (1952, 80 deaths)
 - ▣ Saguenay River Valley, QC (1996, 10 deaths; \$800 million)
 - ▣ Calgary / Southern Alberta (2013, 4 deaths; >100,000 displaced residents, \$1.7 billion)

Southern Alberta Floods

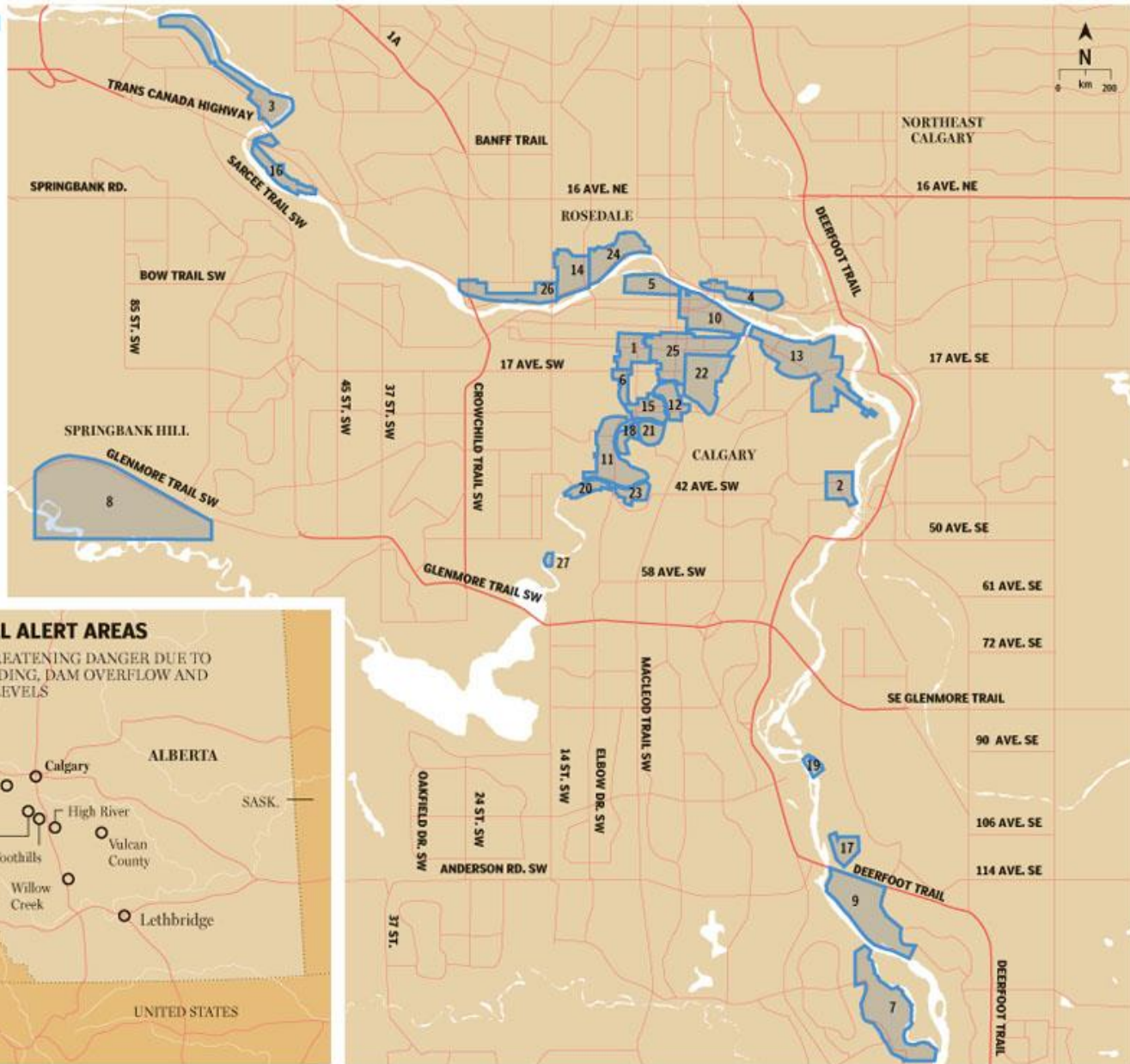
- ❑ Lasted June 19 to July 12, 2013
- ❑ Caused by major precipitation events in Rocky Mountains to west
- ❑ 4 deaths;
- ❑ >100,000 displaced residents
- ❑ Estimated \$1.7 billion in damages
- ❑ Affected communities, notably Calgary, High River ... some residents out of their homes for months; other homes never to be re-occupied
- ❑ Re-assessment of floodway risk



FLOODING IN ALBERTA TRIGGERS EVACUATIONS IN CALGARY

EVACUATION ZONES

1. Beltline
2. Bonnybrook
3. Bowness
4. Bridgeland
5. Chinatown/Eau Claire
6. Cliff Bungalow
7. Deer Run
8. Discovery Ridge
9. Douglasdale (midnight)
10. Downtown/East Village
11. Elbow Park
12. Erlton
13. Inglewood
14. Hillhurst
15. Mission
16. Montgomery
17. Quarry Park
18. Rideau
19. Riverbend
20. Riverdale
21. Roxboro
22. Stampede
23. Stanley Park/Elboya
24. Sunnyside
25. Victoria Park
26. Westmount/West Hillhurst
27. Windsor Park

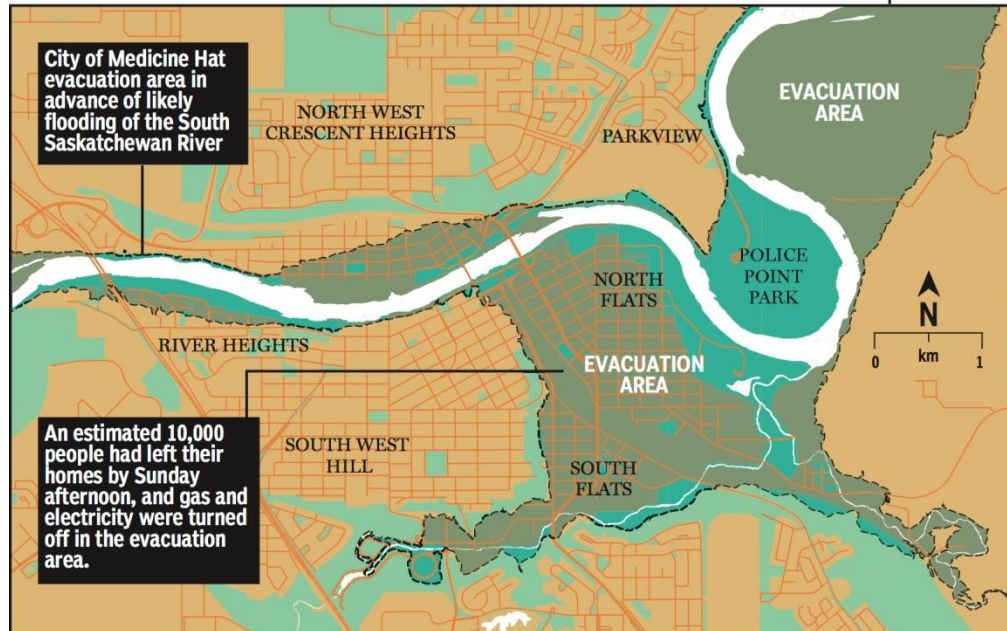


Calgary floods June-July 2013



FLOOD FEARS SHIFT TO MEDICINE HAT

According to the City of Medicine Hat website, the South Saskatchewan River is expected to peak early Monday with a flow rate between 5,100 to 6,000 cubic metres per second.



Water as Hazard

Flooding

- There are various ways of reducing flood damage:
 - **Structural** approaches modify the behaviour of the natural system by delaying or redirecting flood waters, e.g., dams, storage reservoirs, dykes, or levees
 - **Non-structural** approaches focus on modifying the behaviour of people, e.g., land-use zoning, education, and insurance programs
- The best strategies employ both approaches

Non-structural approaches

Zoning

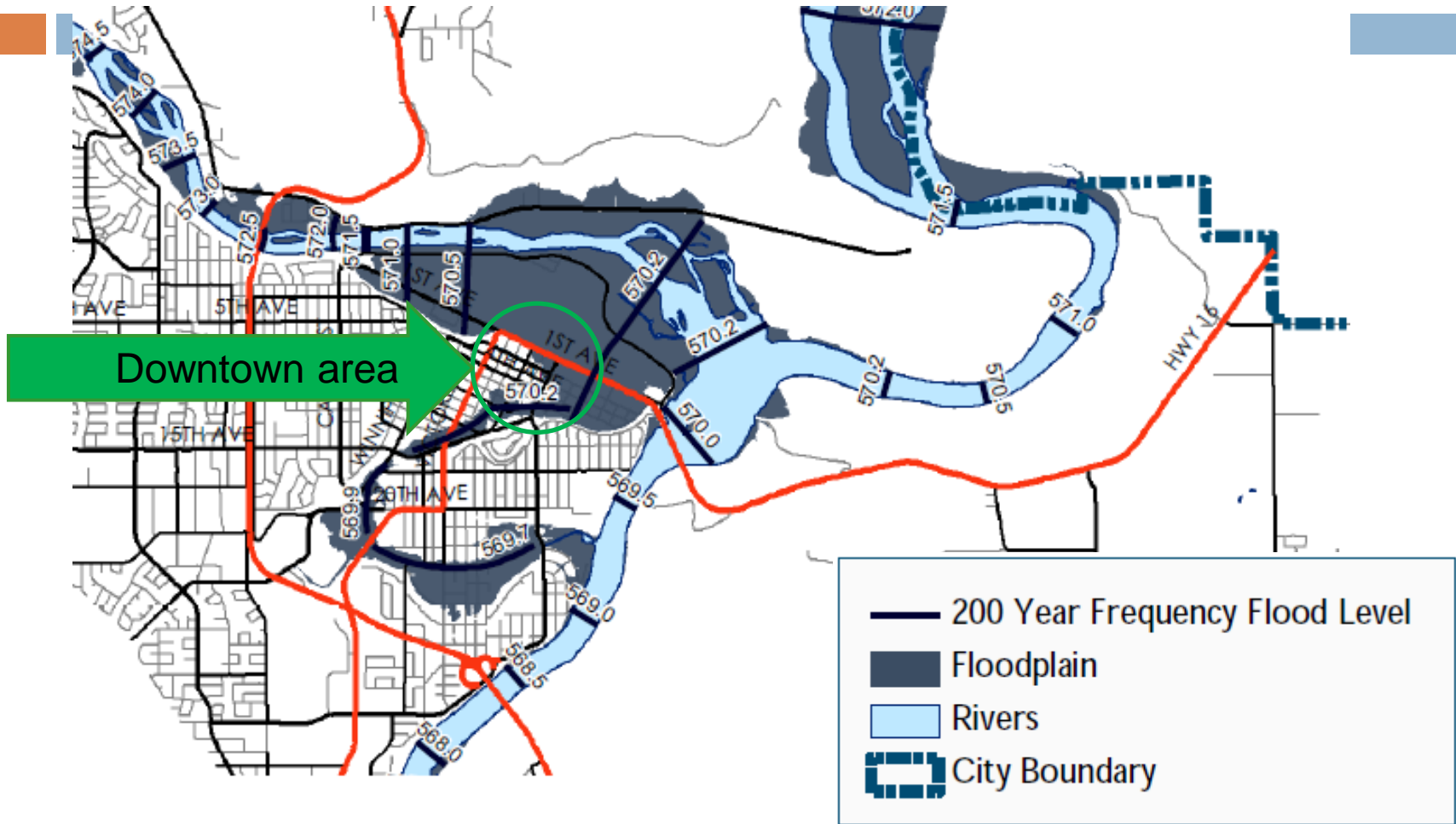
Relocation of flood prone structures

Photo:
Old Fort William Historic Park
along Kaministiquia River (shown
in flood conditions)

*** The Kam is a regulated river.*



City of Prince George Floodplain



Source: City of Prince George Flood Plain Bylaw:
<http://princegeorge.ca/citybusiness/currentplanning/floodplainbylaw/Pages/Default.aspx>



Nechako River Floodplain at Prince George, August 2005

Sawmills (in view) and downtown (not shown) **vulnerable** (at one time) to regular flooding – **ironic** to have noted this in 2006 given events of June and Dec 2007

Flooding (due to ice jam) on Nechako R at Prince George, December 2007

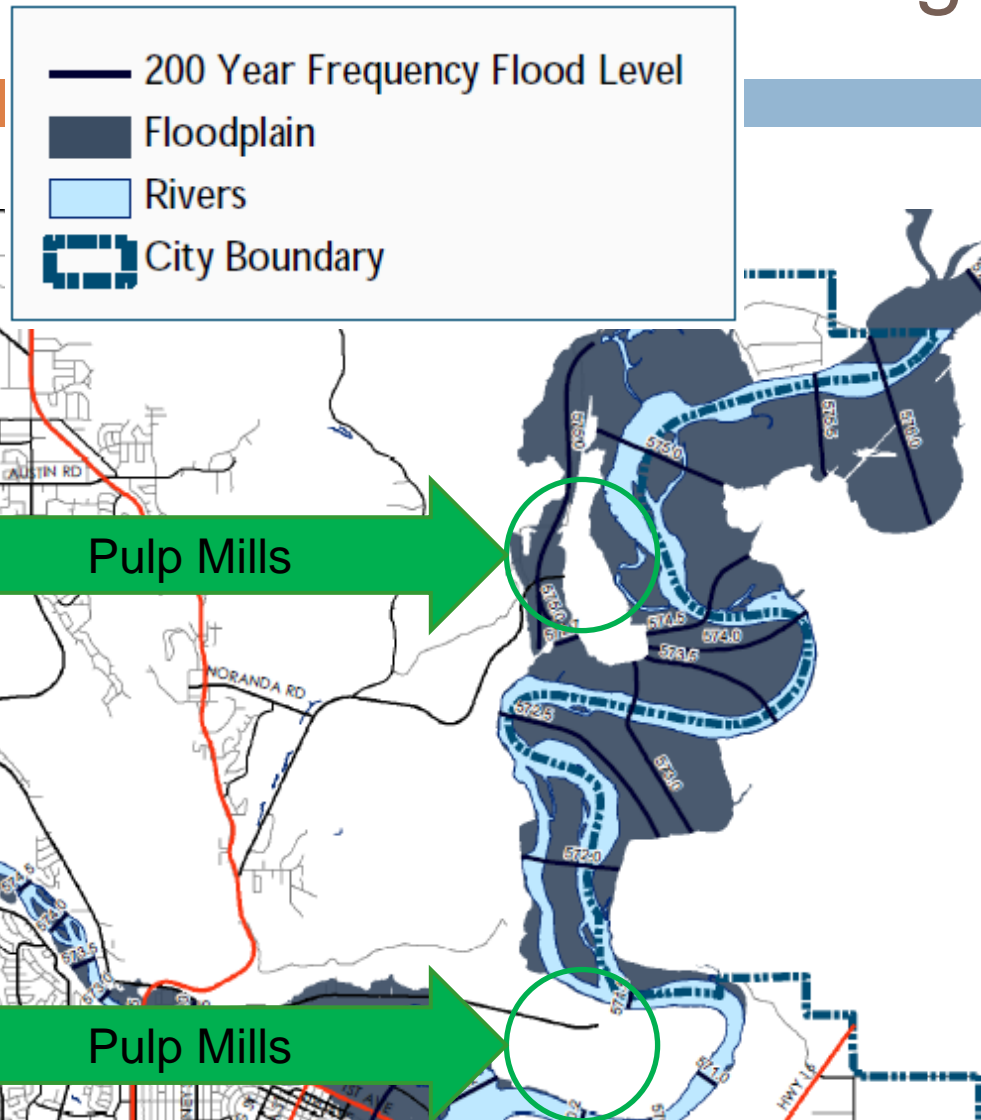


Nechako R. in flood (June 2007) at Vanderhoof, BC (pop 4,500), ~100 km west of Prince George



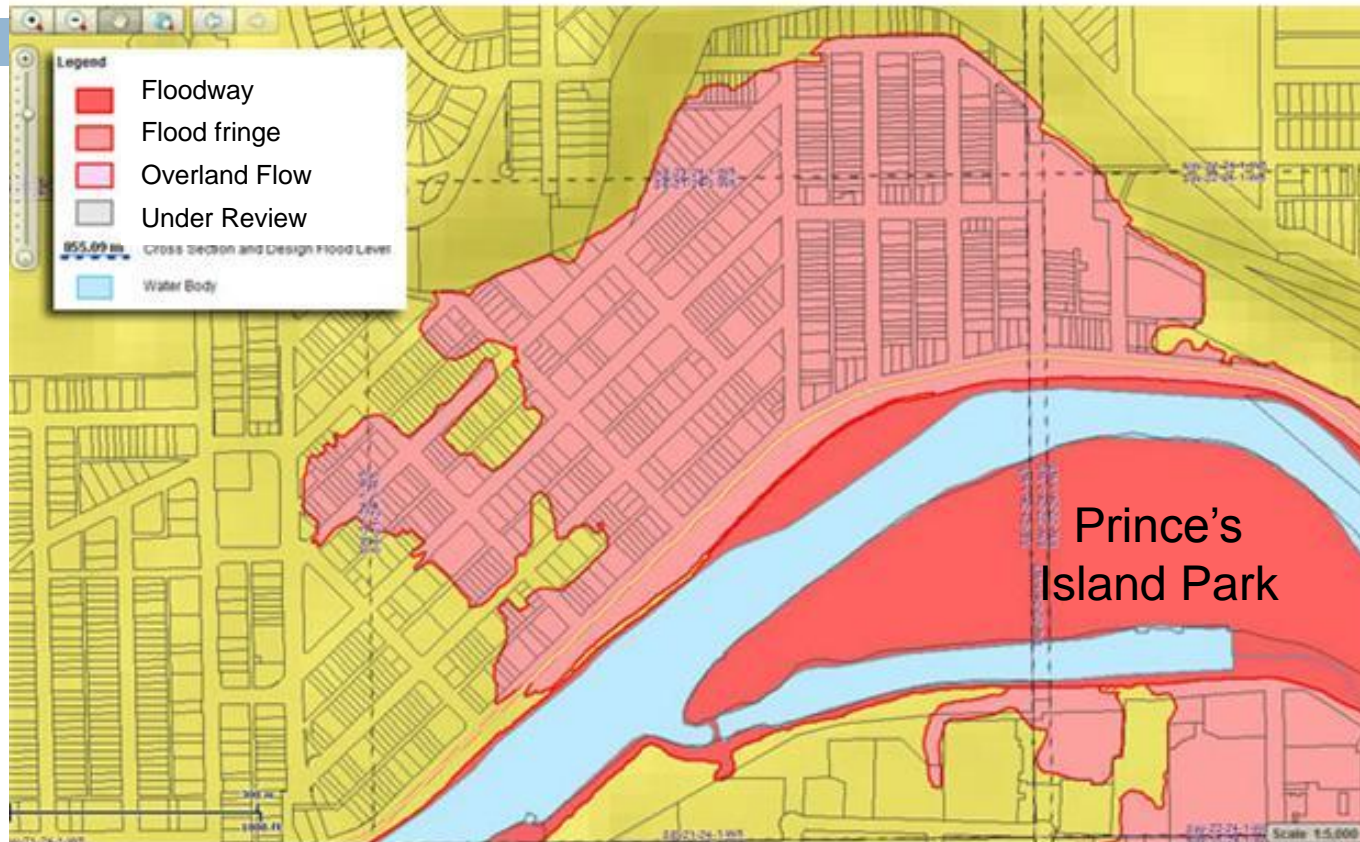
Photo Credit: Nechako River, D.L. Randall (June 2007).

City of Prince George Floodplain



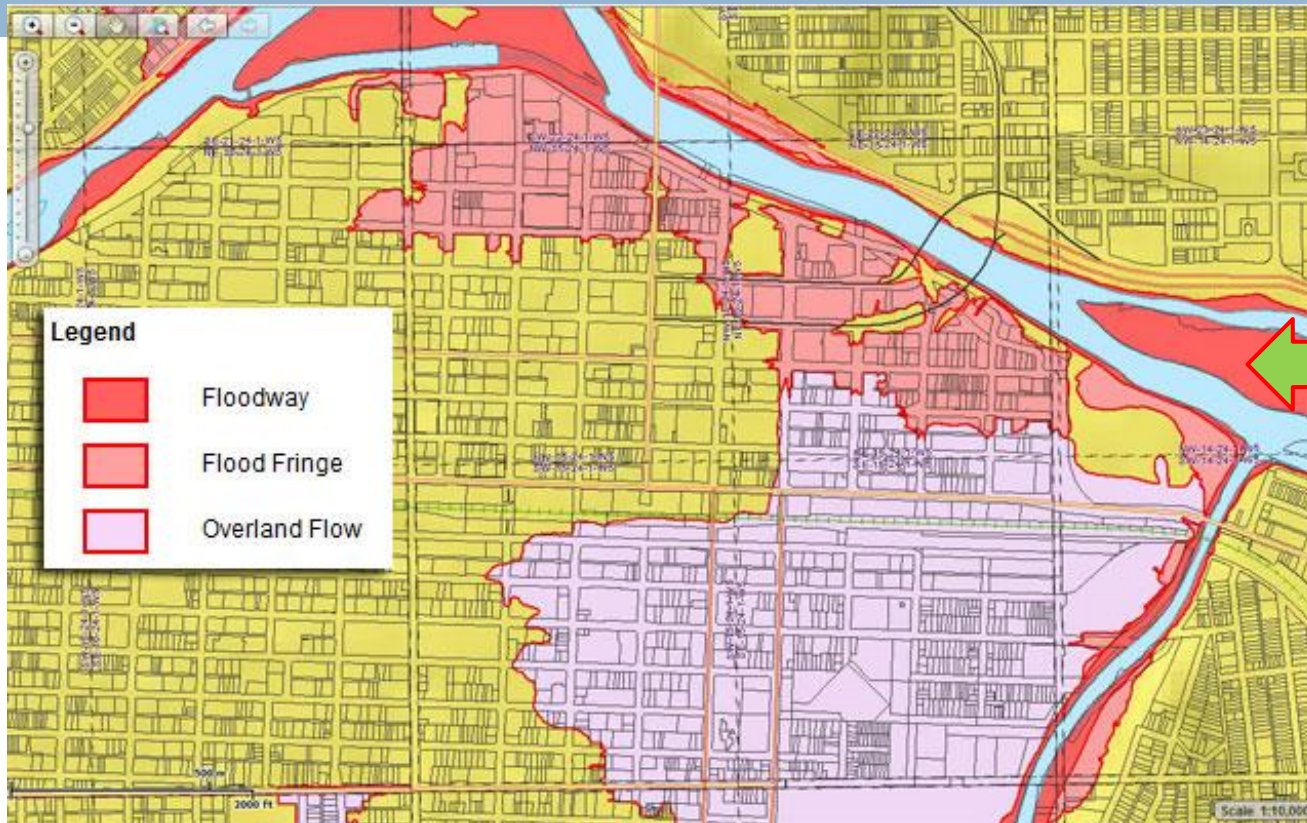
Source: City of Prince George Flood Plain Bylaw:
<http://princegeorge.ca/citybusiness/currentplanning/floodplainbylaw/Pages/Default.aspx>

Calgary flood 2013: revised flood fringe zones (Sunnyside)



A large swath of Sunnyside is now in a designated flood fringe zone, meaning homeowners must floodproof if they want to get government help repairing after future floods. The provincial government says it will help people rebuild this time, but that homeowners who live in floodways or "flood fringes" will have to take certain precautions and can't expect government help next flood.

Calgary flood 2013



Calgary
Zoo

Parts of Downtown Calgary and Mission are in the flood fringes and susceptible to overland flooding. The provincial government says it will help people rebuild this time, but that homeowners who live in floodways or "flood fringes" will have to take certain precautions and can't expect government help next flood.

Structural approaches

Dams

Reservoirs

Dykes

Levees

Channel straightening

Case Study: Red River Flood, 1997

Flooding: Red River Flood, 1997

- The Red River originates in the northern US (N. Dakota, Minnesota) and flows northward, draining into Lake Winnipeg
- In **spring 1997, the Red River experienced a catastrophic flood** due to ...
 - ▣ high precipitation the previous fall that saturated the soil
 - ▣ near-record high winter precipitation
 - ▣ a long and unusually cold winter (→ large snowpack)
 - ▣ a major blizzard in early April
- The widespread flooding of the Red River valley was typical for that river system, which is a broad, flat area that promotes slow flood rise and fall

Extensive flooding near Roseau River Reserve

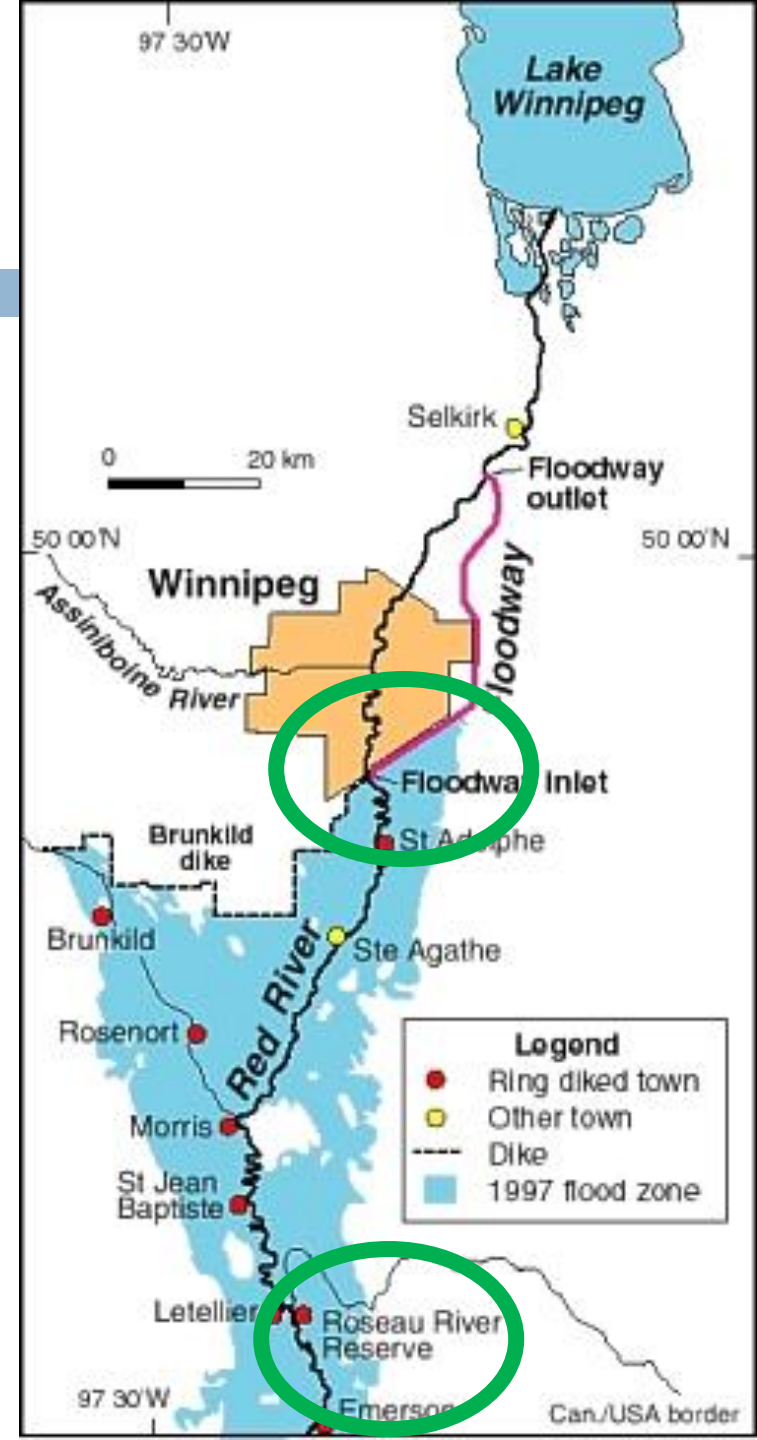


Flooding: Red River Flood, 1997

- A previous **major flood (in 1950) precipitated the construction of a number of structural measures** to mitigate the flooding hazard including:
 - The **Red River Floodway**, an excavated channel that diverts water around Winnipeg's eastern boundary back into the Red River downstream
 - The Portage diversion, an excavated channel west of Winnipeg that diverts water into Lake Manitoba
 - The Shellmouth Dam and Reservoir
 - Earth dykes along the Red, Assiniboine and Seine rivers
 - Ring dykes south of Winnipeg
 - Elevated roads and railway beds

Red River Floodway

- Significantly abated the 1996 and 1997 flood events



Winnipeg spillway – inlet; in operation during 1997 flood





Flooding Near Emerson, Manitoba in the Spring of 1997

The photo taken looking northward shows the Red River Plain near the International Border during the 1997 flood. The normal channel of the Red River, which at times carried more than 120,000 cfs, is picked out by woodland along its banks (1). A ring dike (2) protected Emerson (3), as well some land (4) south of the US border (5), from flooding. The CN railway line (6) crosses the Red River to the west, and the CP line (7), which runs northeast from Emerson, appears to be flooded north of the ring dike (8). Flood waters, no respecter of political boundaries, cover vast areas north (9) and south (10) of the border.

Source of image and text: <http://mbair.brandonu.ca/book/chapter/16/58>

Flooding: Red River Flood, 1997

- Structural measures (together with community efforts) greatly limited damage during the 1997 flood, however **there were negative outcomes:**
 - Several **small upstream communities were flooded** due to operation of the floodway gates
 - **Peak flow had been underestimated by ~1.6 metres**, leading to non-dyked communities being flooded
 - **Some rural municipalities delayed action** due to provincial rules that don't allow running a deficit
 - **Some aboriginal communities weren't protected due to confusion regarding agency jurisdiction**

Flooding: Red River Flood, 1997

- Following the 1997 flood, the IJC (International Joint Commission) concluded that:
 - ▣ future such major floods could occur (another major flood occurred in 2009)
 - ▣ the Red River Valley would remain at risk unless a comprehensive, integrated, bi-national strategy was in place
 - ▣ a mix of structural and non-structural approaches is needed
 - ▣ specific communities needed flood damage initiatives
 - ▣ ecosystem factors needed more consideration (e.g., hazardous materials and banned substances should be removed from potential flood areas)

- Since 1997 the Canadian and Manitoba governments have spent over \$130 million on structural measures (mostly in rural communities), have enlarged the Red River Floodway to be able to handle a once-in-700-year flood, and have made improvements to bridges, dykes, utilities, and drainage services;



Potential impact of 700 year flood on Winnipeg without the *improved* floodway (left). *Source:* Natural Resources Canada

Water as Hazard: **Droughts**

- Droughts ...the opposite problem to that of floods...
- **Droughts** are a function of lack of precipitation, temperature, evaporation, evapotranspiration, capacity of soil to retain moisture, and resilience of flora and fauna
- Droughts can lead to a 'depletion cycle' where reduced rainfall leads to low soil moisture, triggering irrigation demands, which depletes groundwater supplies



*Photo credit: N. Dakota State University
<http://www.ag.ndsu.edu/drought/>*

Droughts

- Identifying ‘drought-prone’ areas is challenging because a ‘drought’ is difficult to define
 - ▣ Droughts defined by *cause*:
 - **meteorological droughts** caused by deficiency of precipitation, and **hydrological droughts** caused by reduced stream flows and a lowered water table and/or lake levels;
 - the first can trigger the second
 - ▣ Droughts by *effects*
 - **agricultural droughts** where a lack of moisture reduces crop yields, and **urban droughts** where low stream flows or water tables lead to insufficient water to support community demands

□ Droughts are often associated with the Prairie provinces, especially in that area of southern Alberta, Saskatchewan, and extreme southwest Manitoba known as **Palliser's Triangle**

□ drought conditions affected over $\frac{3}{4}$ of the Prairie provinces in 2002, and are likely to become more common in our post-glacial conditions

WORST KNOWN

DROUGHT IN CANADA

Wheat Areas Ravaged

INTENSE HEAT EXPERIENCED

(Australian Cable Service.)

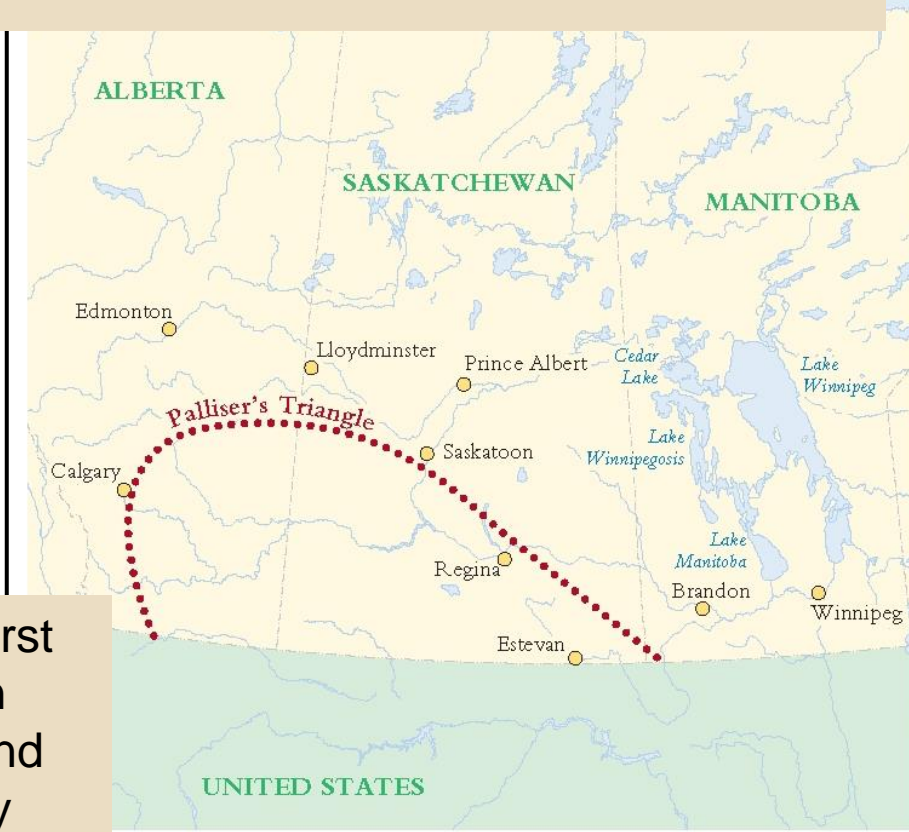
VANCOUVER, June 27.

The hottest June days for 60 years killed 50 persons in the eastern part of the United States yesterday and today.

Temperatures in many cities exceeded 100 deg.

Disaster has overtaken a considerable part of Western Canada's wheat areas. Conditions in Manitoba and the southern parts of the province of Saskatchewan have become suddenly worse since three weeks ago, at which time the crops were described as the worst for 30 years.

The extent of the wheat acreage totally destroyed is described as appalling.

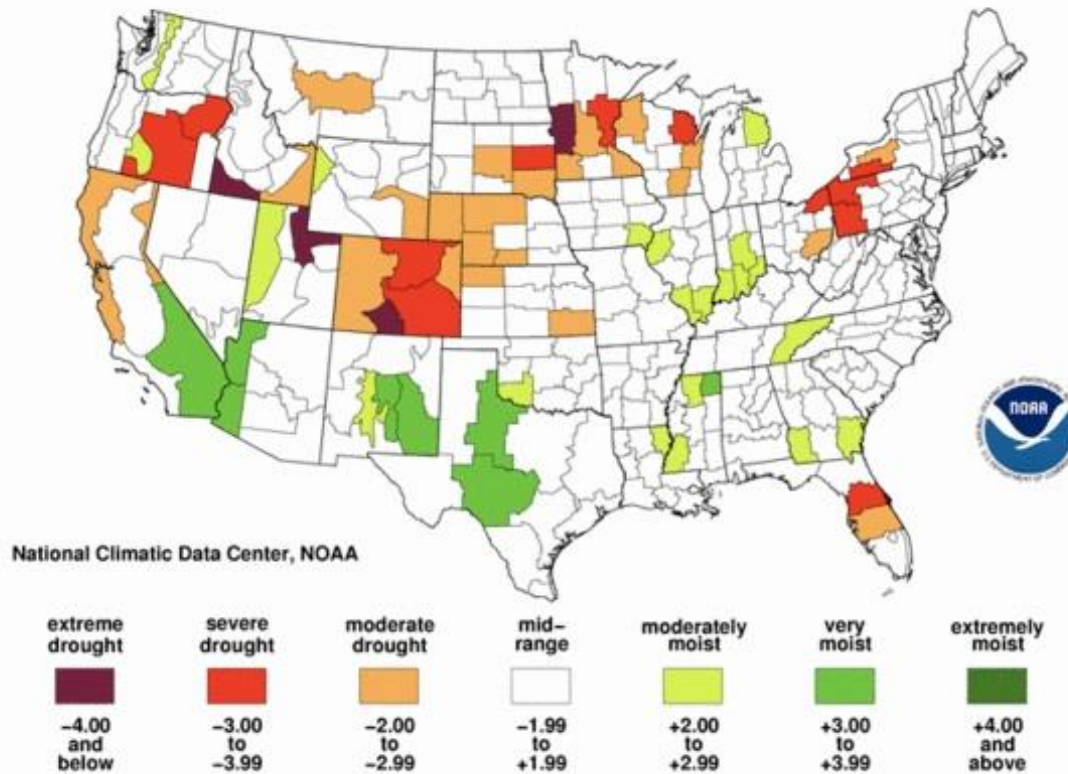


← 1931 : Worst Drought In Canada and US History

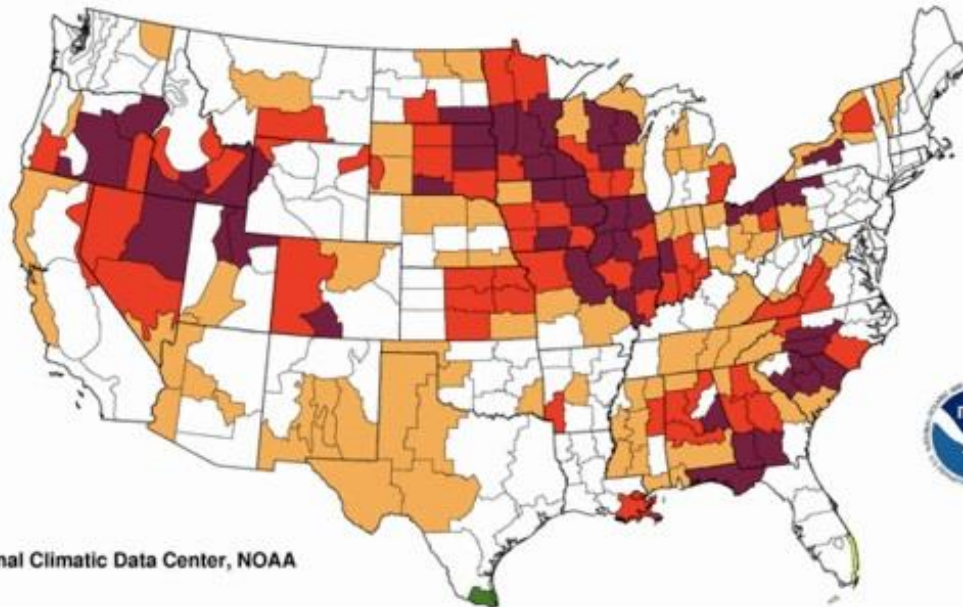
Figure 11.5 | Palliser's Triangle. Source: Adapted from Bone (2005: 410).

US Worst Drought in History (Dust Bowl, 1930s)

Palmer Drought Severity Index
February, 1933



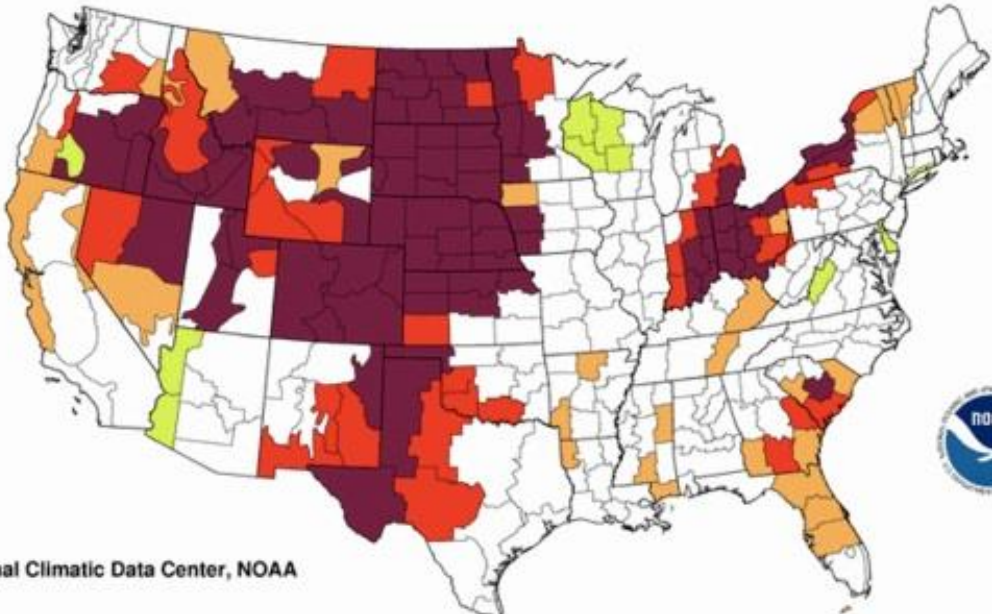
Palmer Drought Severity Index February, 1934



National Climatic Data Center, NOAA



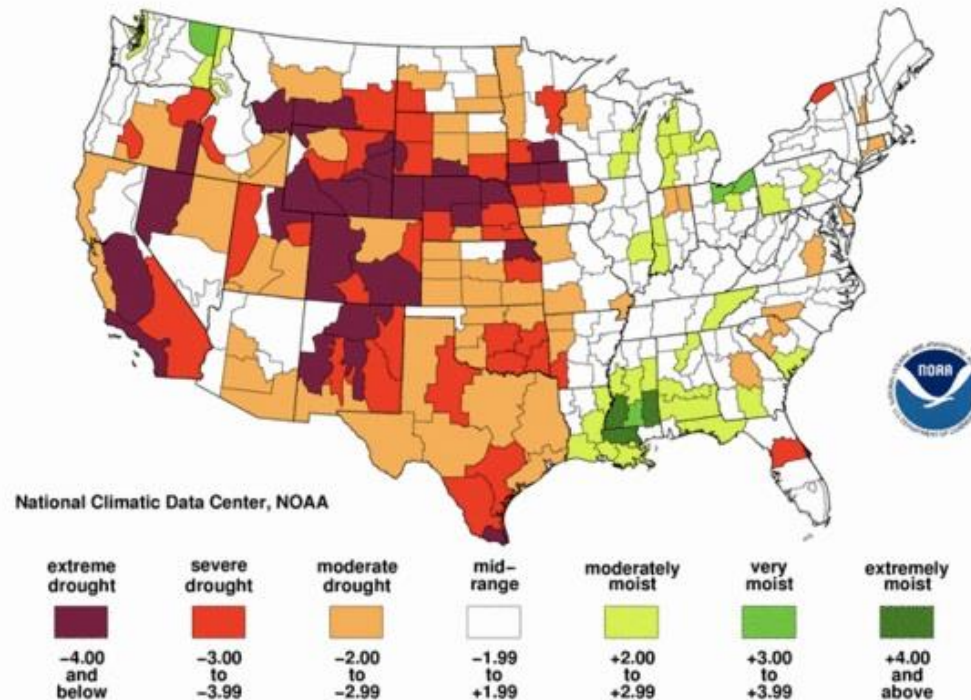
Palmer Drought Severity Index February, 1935



National Climatic Data Center, NOAA

extreme drought	severe drought	moderate drought	mid-range	moderately moist	very moist	extremely moist
						
-4.00 and below	-3.00 to -3.99	-2.00 to -2.99	-1.99 to +1.99	+2.00 to +2.99	+3.00 to +3.99	+4.00 and above

Palmer Drought Severity Index February, 2013



With Drought Season Off to a Bad Start (in 2013), Scientists Forecast Another Bleak Year

Current climate-induced drought is slipping into a trend that scientists say resembles some of the worst droughts in U.S. history, like the Dust Bowl of the 1930s.

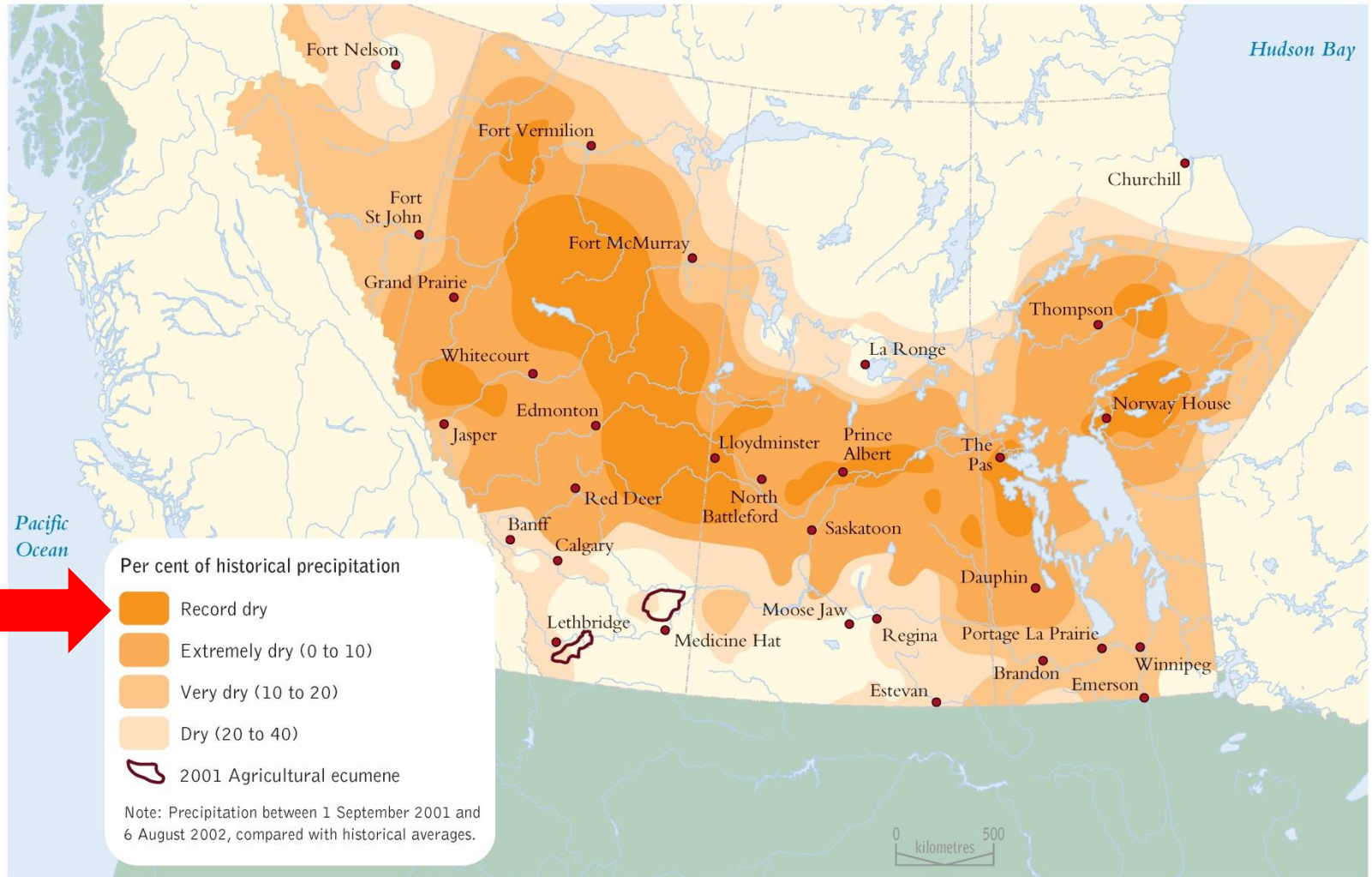
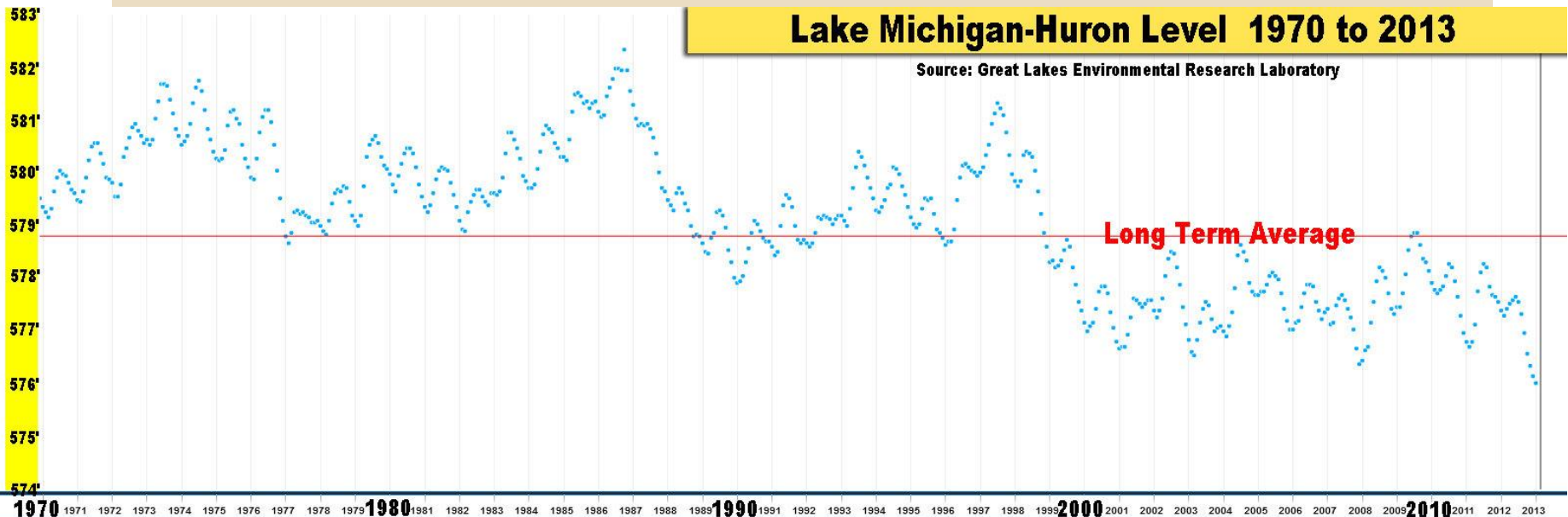


Figure 11.6 | Precipitation below historical averages, 2002. Source: Statistics Canada (2003b: 13).

Source: Dearden and Mitchell (2012)

Figure 11.6: Precipitation below historical averages, 2002

- In Ontario **droughts are frequent** during the growing season, but typically **of short duration** (10–20 days)
- Southwestern Ontario is particularly vulnerable
- **Lake levels are affected by droughts** (affecting shipping on the Great Lakes)
- During low rainfall periods, streams in Ontario are supplied entirely by groundwater discharges, thus groundwater depletion can have a serious impact on surface flows, as can a lowered water table



Hydrosolidarity

- **Hydrosolidarity** is an approach that recognizes the interconnections among aquatic, terrestrial, and other resource systems, leading to management that is integrated, participative, collaborative, coordinated, and shared, whether at local, provincial, national, or international levels
- Versus “**traditional approaches**” where control over water takes place within political boundaries without consideration for downstream users
- Hydrosolidarity recognizes that there are differing upstream and downstream interests; connections exist between land and water systems; and there are multiple uses for water

Hydrosolidarity

- Best practices of hydrosolidarity include:
 - Use of the watershed as the basic management unit (rather than political boundaries)
 - Ensuring attention to upstream–downstream issues
 - Recognizing water–land–resource system relationships
 - Stakeholder engagement
 - Acknowledging biophysical system needs
- Consistent with hydrosolidarity is the concept of **integrated water resource management** (IWRM), an approach that promotes the coordinated development and management of water, land, and related resources in order to maximize the resultant economic and social welfare in an equitable manner without compromising the sustainability of vital ecosystems

Hydrosolidarity

Great Lakes Water Quality Agreement (GLWQA)

- In 1972, Canada and the United States signed this agreement to restore and maintain the chemical, physical and biological integrity of waters in the Great Lakes ecosystem
- Its objectives
 - ▣ to reduce nuisance conditions and discharge of substances toxic to humans, animals, and aquatic life,
 - ▣ to reduce phosphorous loadings in Lakes Erie and Ontario

Hydrosolidarity

Great Lakes Water Quality Agreement

- Amendments to the agreement added:
 - ▣ Adoption of an ecosystem approach and that use of persistent toxic elements would be eliminated (1978)
 - ▣ An increased effort to reduce phosphorus (1983)
 - ▣ Identification of '**areas of concern**', addressing non-point pollution sources, creation of Lakewide Management Plans, and plans to deal with contaminated sediments, airborne toxins, and contaminated groundwater (1987)



There are 37 Areas of Concern (AOCs) in the Great Lakes (indicated by the red dots on the map). These are places where chemical contamination of sediments from the lakes has seriously endangered the quality of life for people and wildlife.

<http://www.saferchemicals.org/resources/great-lakes.html>

Hydrosolidarity

Great Lakes Water Quality Agreement

- Despite good progress on objectives, a review committee in 2007 found that **serious threats are still posed to ecosystem integrity** due to climate change, urbanization, transport of toxics, and invasive species;
- They identified the need to better identify the scope, goals, and responsibilities regarding the GLWQA
- This identifies some of the challenges of a hydrosolidarity approach, even when there is a strong commitment by all partners and the creation of a strong body such as the IJC

Looking Ahead to the next lectures

Tuesday, March 11th: “Sustainable Development I”

Read ahead (Chpt. 13, Urban Environmental Management,
pp. 459 → _____)

References

- Dearden, P and Mitchell, B. 2012. *Environmental Change and Challenge*, Fourth Edition, Don Mills, Ontario: Oxford University Press {Chapter 11: 'Water'}