Sustainable Management of Groundwater in Canada

A Report by the Council of Canadian Academies

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Council of Canadian Academies
Conseil des académies canadiennes

Council of Canadian Academies (CCA)

- Participating academies:
  - The Royal Society of Canada;
  - The Canadian Academy of Engineering;
  - The Canadian Academy of Health Sciences.
- Independent, science-based, expert assessments.

The Expert Panel on Groundwater

- 15 panel members:
  - 13 from Canada
  - 2 from US
- Expertise in geological engineering, hydrogeology, water governance, conservation, water resources and climate change, economics, geology, groundwater-surface water interactions, environmental health, groundwater remediation and groundwater monitoring
- What is needed to achieve sustainable management of Canada's groundwater resources, from a science perspective?

The Importance of Groundwater

- Drinking water for almost 10 million Canadians
- Entire water supply for over 80% of Canada's rural population
- Irrigation, energy development, manufacturing

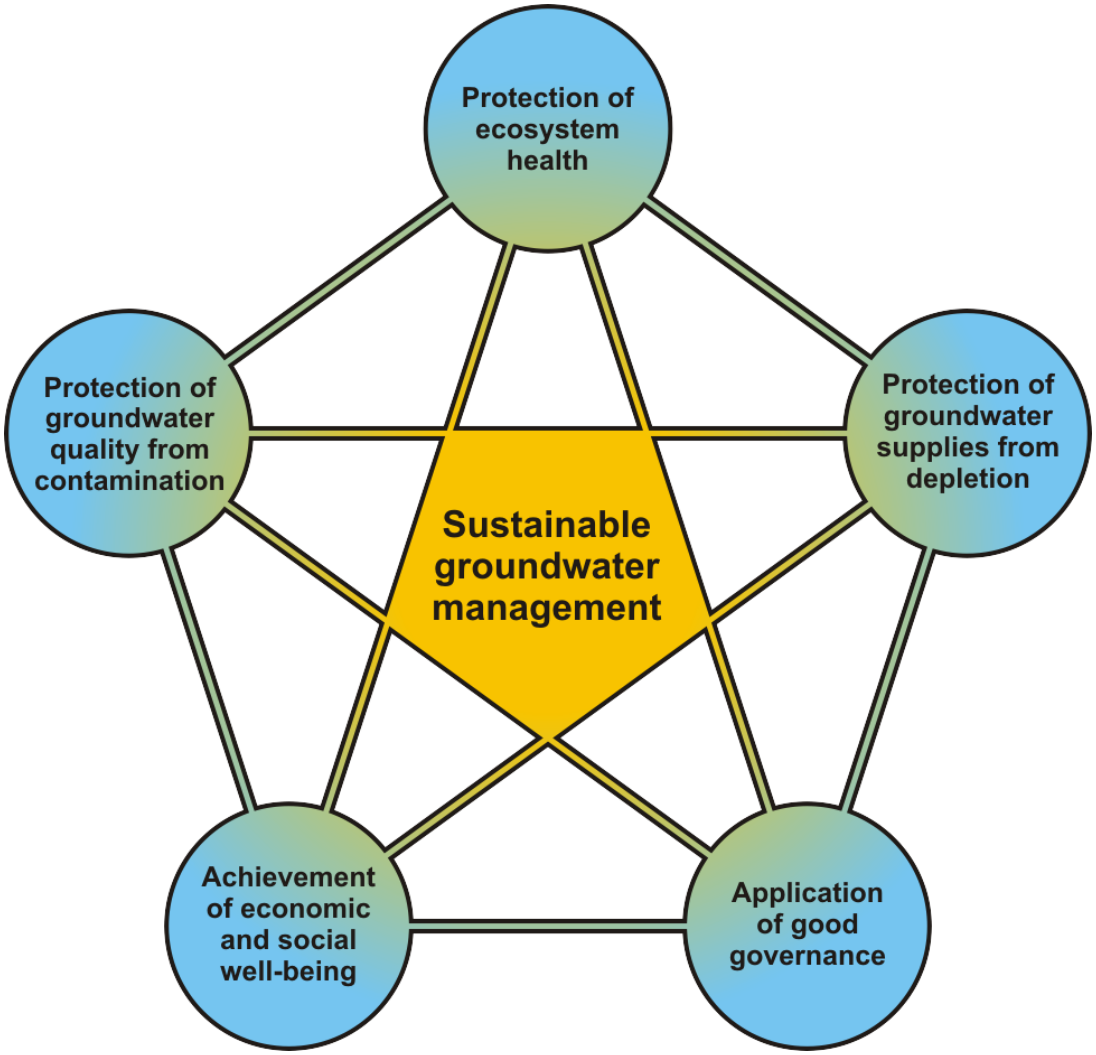


Current and Emerging Challenges

- Population Growth and Urbanization
- Intensification of Agriculture
- Rural Groundwater Quality
- Contaminated Sites and Remediation
- Energy and Mining Activity
- Climate Change
- Transboundary Issues
- Public attitudes and media interest



Sustainability Goals



Challenges in Achieving the Sustainability Goals

Protection of groundwater supplies from depletion



- Key knowledge gaps in large-scale groundwater flow dynamics: recharge, sustainable yield, discharge
- Need a common framework for aquifer categorization at different scales
- Need data on groundwater allocations, actual withdrawal, and volumes discharged or reused

Challenges in Achieving the Sustainability Goals

Protection of groundwater quality from contamination



***Case Study*:**
Orange Country, California

- Groundwater requires different management techniques than surface water
- Impacts may take years to appear; repair may be impossible
- Some natural contaminants exist, but poor groundwater quality usually human-induced

Challenges in Achieving the Sustainability Goals

Protection of ecosystem viability



- Surface water features must be considered when estimating groundwater discharge and permitting withdrawals
- Needs and vulnerabilities of aquatic ecosystems must be understood

Challenges in Achieving the Sustainability Goals

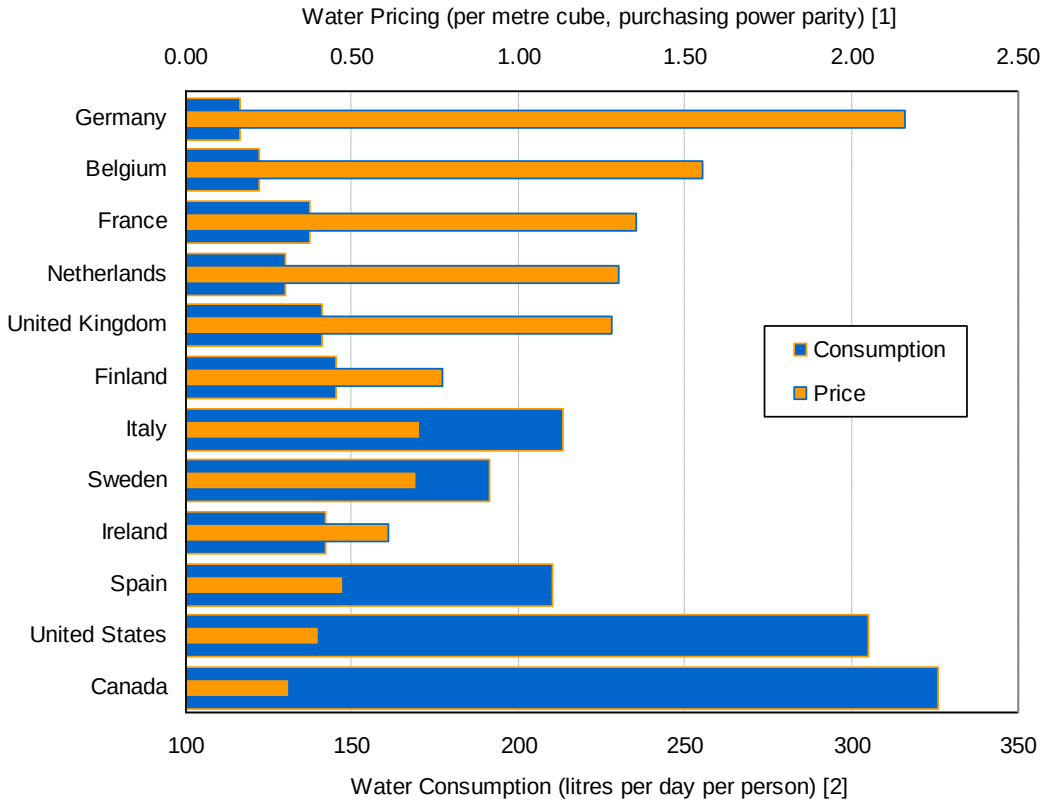
Protection of ecosystem viability



- Mechanisms to assign value to ecosystem benefits are incomplete
- Coordinated surface and groundwater management needed for quality and quantity

Challenges in Achieving the Sustainability Goals

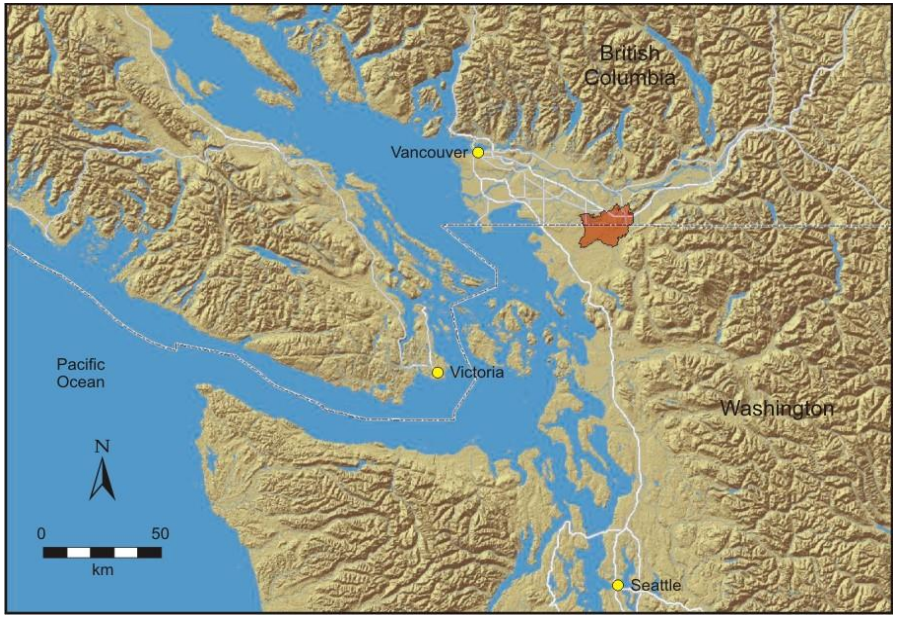
Achievement of economic and social well-being



Local or basin-level management can be effective with adequate resources and scientific support

Challenges in Achieving the Sustainability Goals

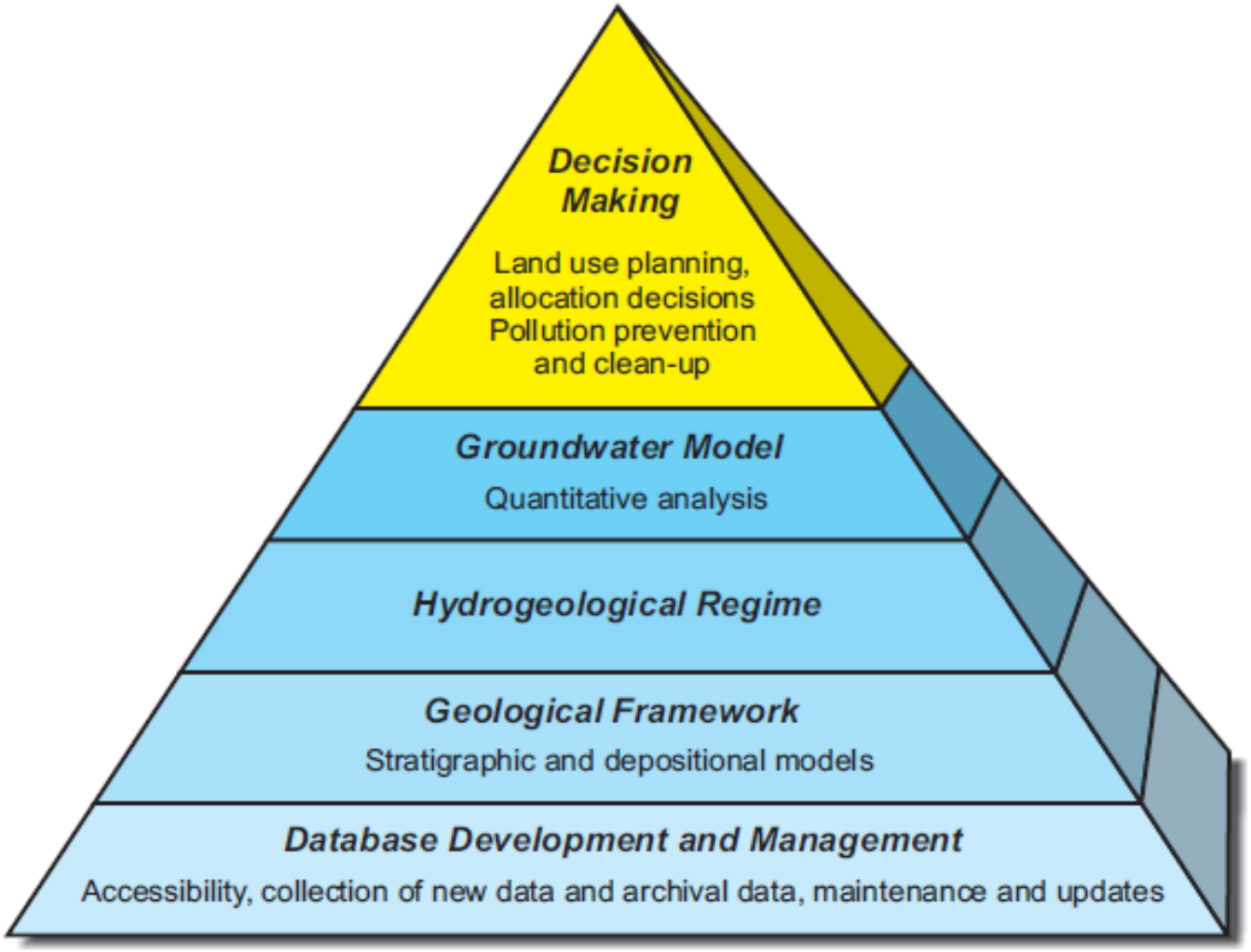
Application of good governance



***Case Study*:**
Abbotsford-Sumas Aquifer

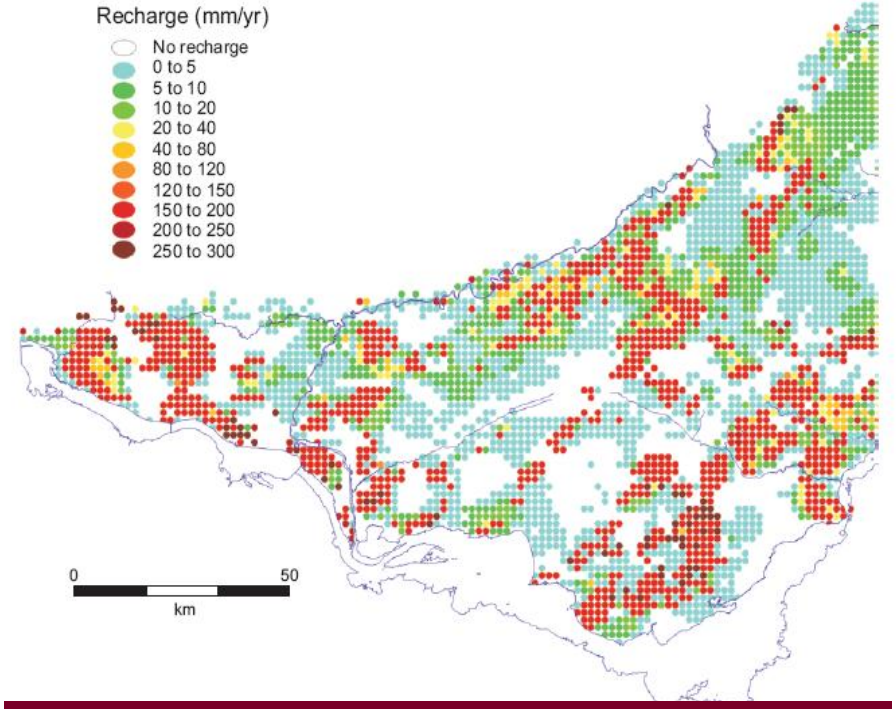
- Must reflect inclusivity, transparency, accountability and the rule of law
- Challenges include fragmented and overlapping jurisdictions, competing priorities, traditional approaches and established ways of thinking

Knowledge and Capacity Needed to Achieve Groundwater Sustainability



Knowledge and Capacity Needed to Achieve Groundwater Sustainability

Understanding the geological and hydrogeological context

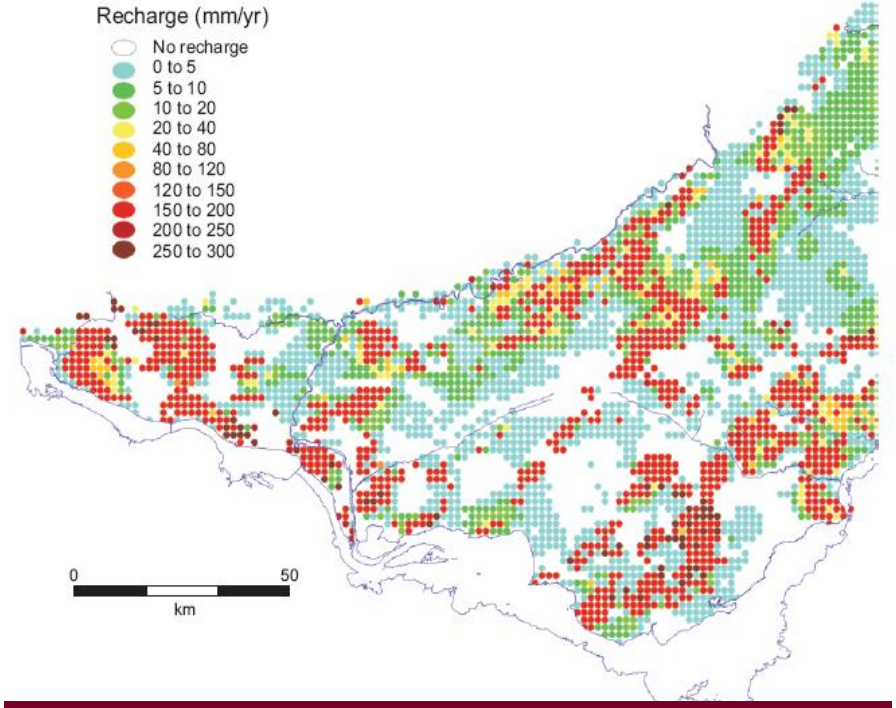


***Case Study*:**
Basses-Laurentides, Québec

- Need a sound understanding of subsurface geology and key hydrogeological parameters
- More rapid pace of mapping needed

Knowledge and Capacity Needed to Achieve Groundwater Sustainability

Understanding the geological and hydrogeological context



***Case Study*:**
Basses-Laurentides, Québec

- Last comprehensive assessment of Canada's groundwater resources published in 1967
- Use of models by regulatory agencies lags behind state-of-the-art in most of the country

Knowledge and Capacity Needed to Achieve Groundwater Sustainability

Use of models



***Case Study*:**
Regional Municipality of Waterloo, Ontario

- Allow predictions of potential impacts of land use and/or pumping on groundwater flow system
- Sustainable groundwater management requires development of new types of sophisticated models

Knowledge and Capacity Needed to Achieve Groundwater Sustainability

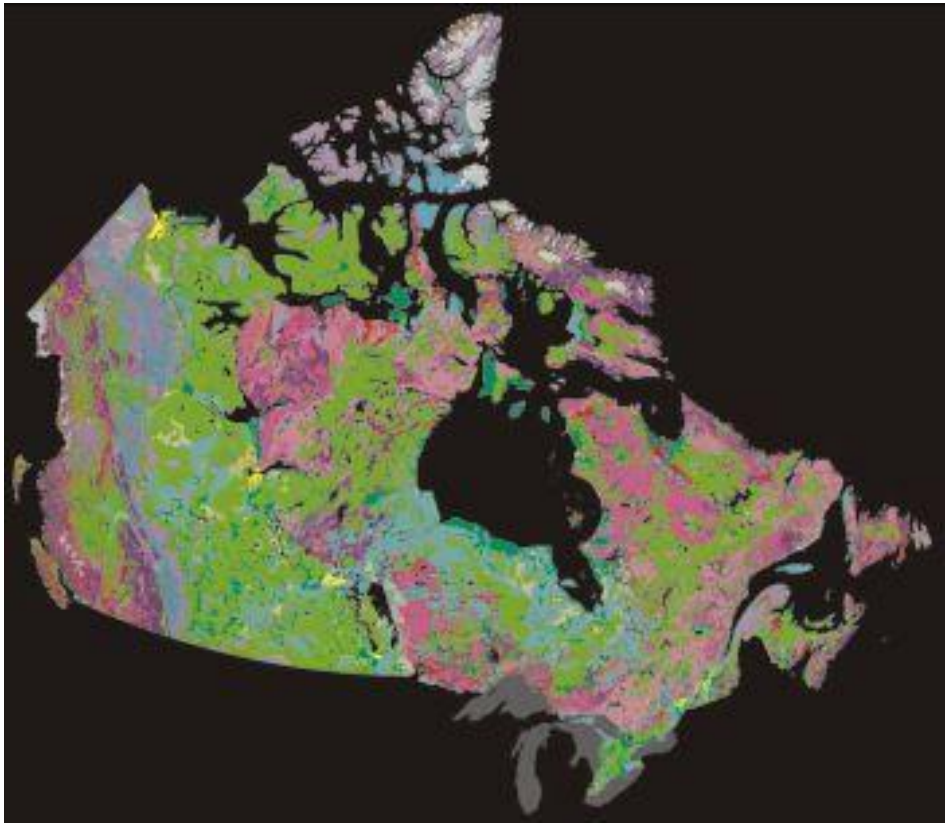
Collection and integration of groundwater data



- Considerable loss of data from many sources
- While a comprehensive national groundwater database is not required, agreement on structure and practices will facilitate data sharing
- Further develop GIN, or similar system

Knowledge and Capacity Needed to Achieve Groundwater Sustainability

Building the needed human capabilities



- Increasing need for relevant science and management skills
- Training needed in:
  - hydrogeology and other hydrological sciences
  - ecosystem sustainability
  - watershed management
  - economics
  - law

Addressing the Key Challenges to Groundwater Sustainability

Population growth and urbanisation

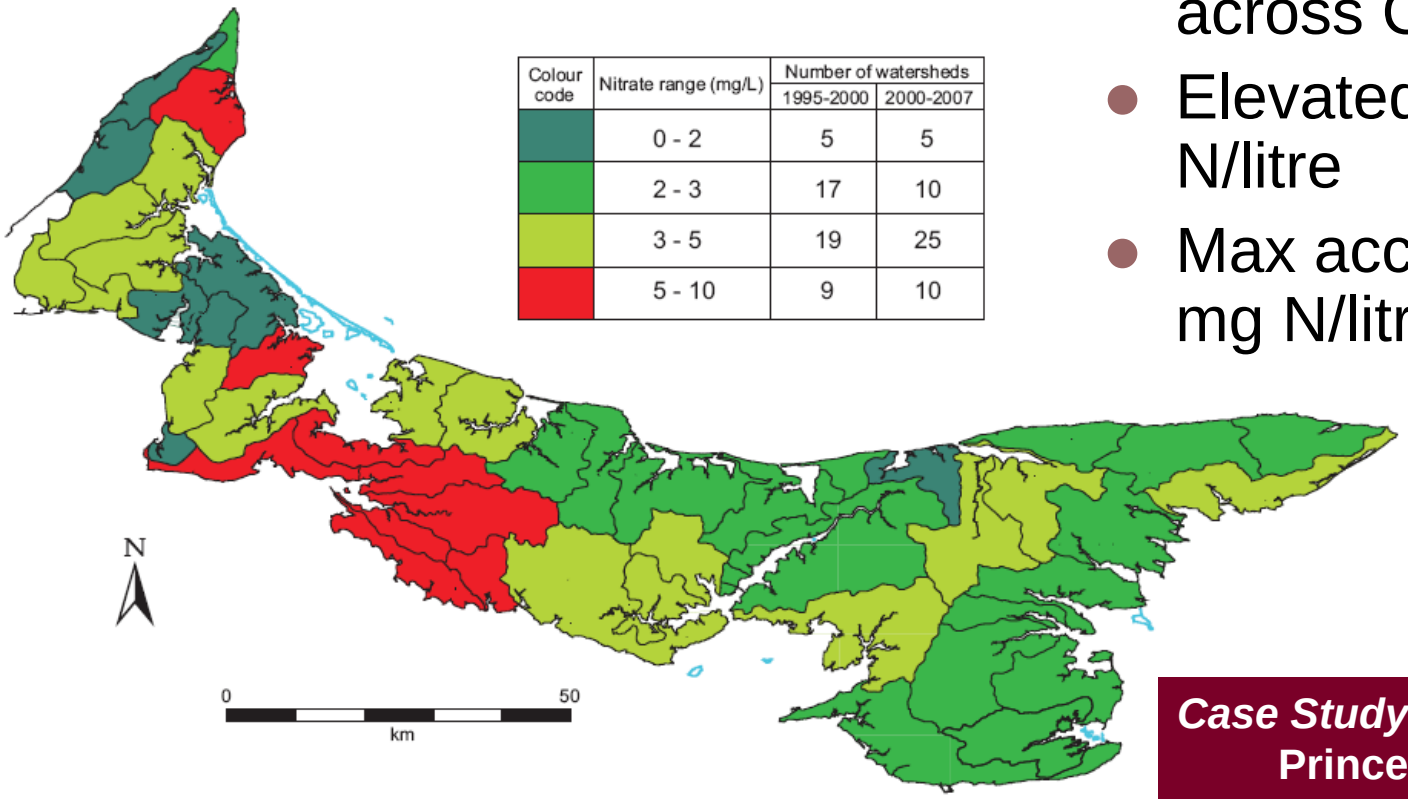


***Case Study*:**
Oak Ridges Moraine Area, Ontario

- Urban population increase to 87% by 2030
- Increased risk of chemical contamination
- Reduced potential for recharge
- Requires coordinated action to protect recharge zones and minimise harmful land use based on groundwater modelling

Addressing the Key Challenges to Groundwater Sustainability

Protection of Groundwater Quality: Intensification of agriculture



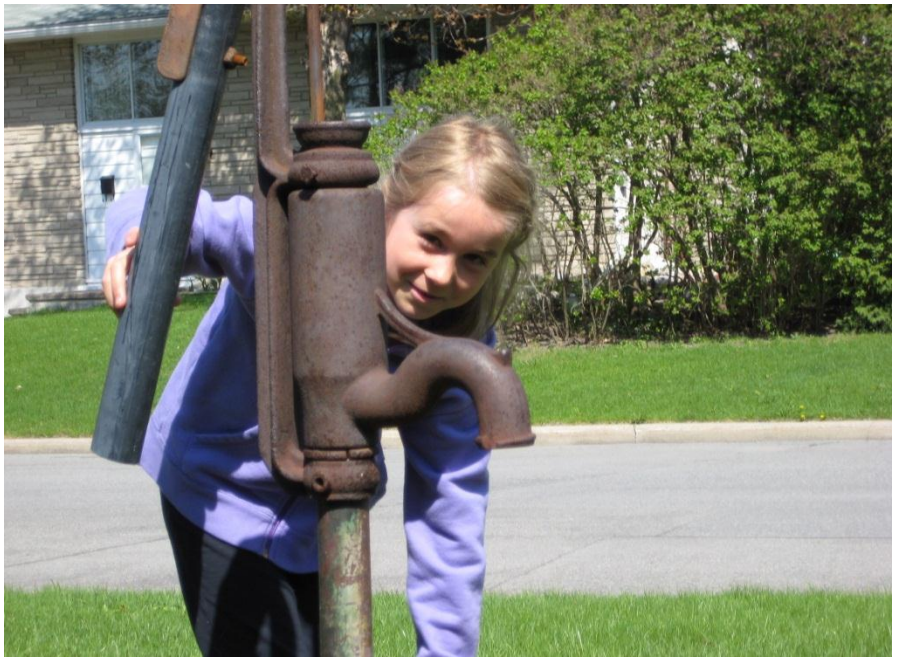
Colour code	Nitrate range (mg/L)	Number of watersheds	
		1995-2000	2000-2007
	0 - 2	5	5
	2 - 3	17	10
	3 - 5	19	25
	5 - 10	9	10

- Numerous examples across Canada
- Elevated: > 3 mg N/litre
- Max acceptable: 10 mg N/litre

***Case Study*:**
Prince Edward Island

Addressing the Key Challenges to Groundwater Sustainability

Protection of Groundwater Quality: Rural and small communities



- Private wells: extension programs e.g. wellhead protection
- Improve septic systems and reduce leaky sewer pipes
- Water quality monitoring programs
- Stronger enforcement and regulatory environment for small communities

Addressing the Key Challenges to Groundwater Sustainability

Contaminated sites and remediation

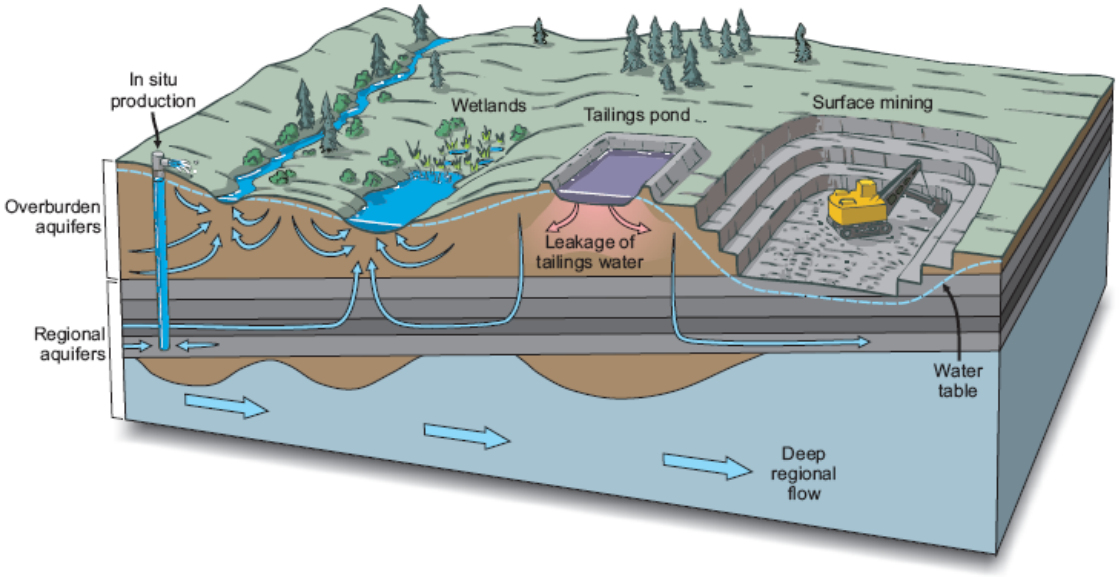




- Coordination among jurisdictions needed to:
  - regulate existing contaminants
  - identify emerging contaminants
  - select and maintain appropriate disposal sites
  - Promote remediation of key sites

Addressing the Key Challenges to Groundwater Sustainability

Energy and mining activity



***Case Study*:**
Athabasca Oil Sands

- Clear groundwater objectives, quantity and quality needed before major withdrawals are approved based on:
  - hydrogeology
  - linkage with surface water
  - cumulative effects assessment
- Bitumen extraction (ARC, 2007)

Addressing the Key Challenges to Groundwater Sustainability

Climate change

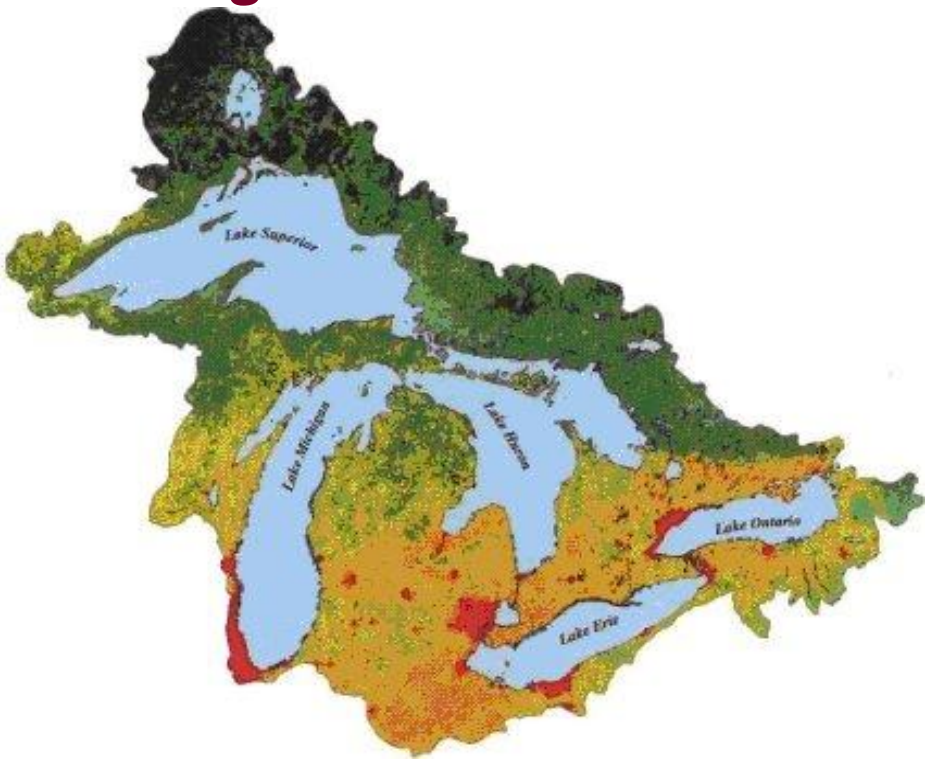


***Case Study*:**
Prairie Groundwater

- Research urgently needed on issues of reduced recharge and increased withdrawals:
  - to ensure sustainability of supply
  - to assess ecosystem impacts

Addressing the Key Challenges to Groundwater Sustainability

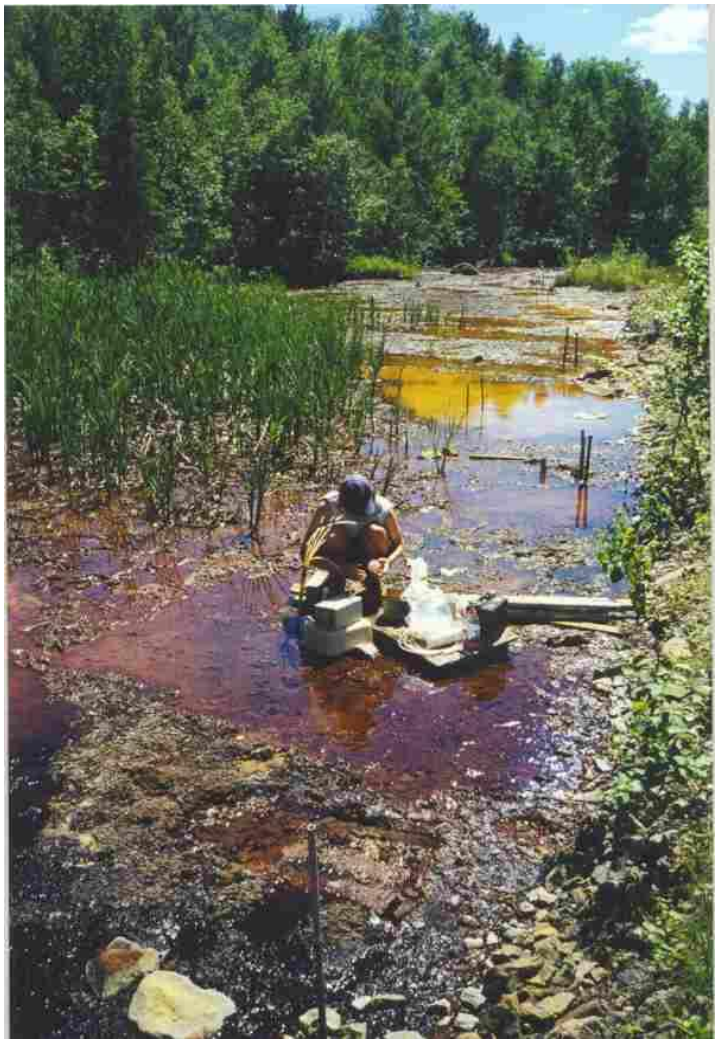
Transboundary water challenges



***Case Study*:**
Groundwater in the Great Lakes Basin

- Boundary Waters Treaty is not ideal for groundwater
- UN draft convention on Transboundary Aquifers should be considered for adoption by Canada and the US

Reporting to Canadians on Groundwater Sustainability



- Federal-provincial report on current state of groundwater should be completed within two years
- Update at regular intervals

