



Environment
Canada

Environnement
Canada

Canada

Tap Runs Dry: Managing and preparing for droughts in southern Ontario communities

ARC Webinar November 18, 2008

Grace Koshida, Adaptation & Impacts Research Division, Toronto

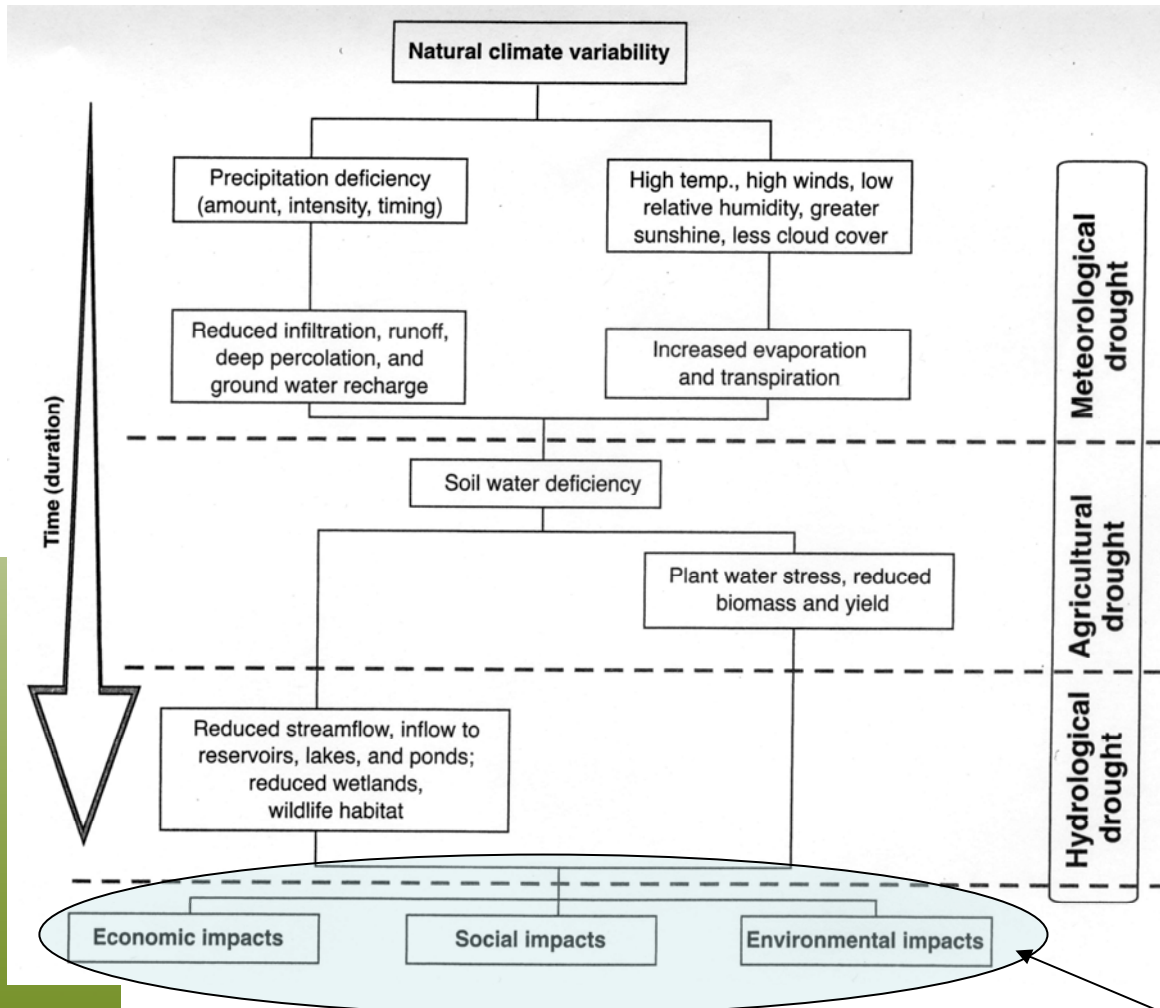


Overview

- Drought definitions, urban drought examples
- Tap Runs Dry: Project overview
- Documentation of historical adaptation to droughts: municipal water



Drought types



- Meteorological, agricultural and hydrological drought
- As progress down, decreasing emphasis on the natural event (precipitation shortages)

Urban Drought:

socioeconomic drought caused by an adverse change in the urban water balance between water supplies and use

Source: Wilhite, 2000



Urban drought examples

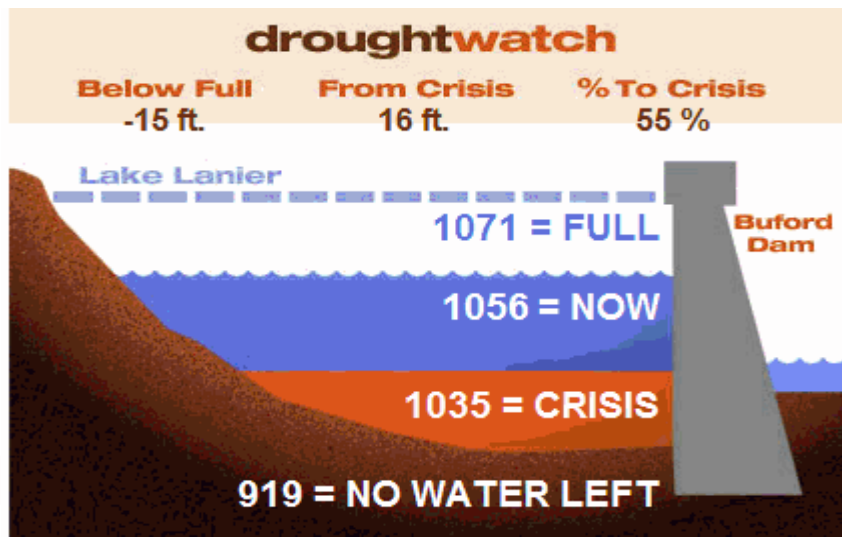
- Tofino, B.C. 2006
 - Record dry August precipitation
 - Population increases >10-fold in summer (1,700 to 20,000)
 - Little water storage capacity
 - Town's drinking water reserve dipped to a record low of about 151,400 litres - well below maximum daily amount of 946,336 litres
 - Tanker trucks delivered water from Ucluelet to keep town open during Labour Day weekend



Urban drought examples

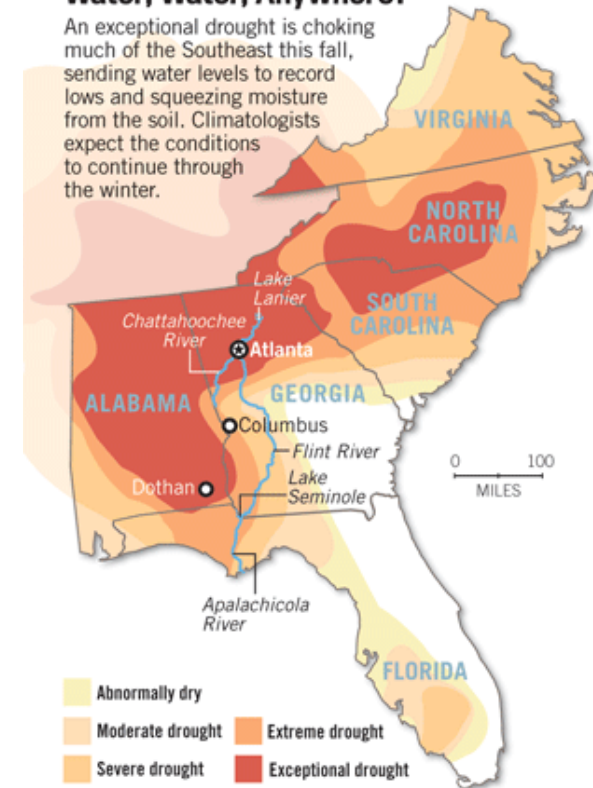
- Atlanta, Georgia, 2007
 - SE USA experienced severe meteorological drought starting from October 2006
 - Georgia's governor declared "drought emergency" in October 2007
 - Lake Lanier, which supplies 3 million people with drinking water, has 90 days supply left, levels dropped 1.4 feet/week
 - Could crisis be averted with better water management programs and water conservation?

Source: Georgia Drought Watch website



Water, Water, Anywhere?

An exceptional drought is choking much of the Southeast this fall, sending water levels to record lows and squeezing moisture from the soil. Climatologists expect the conditions to continue through the winter.



Source: NOAA's U.S. Drought Monitor

Tap Runs Dry: documenting lessons learned from past severe droughts in southern Ontario communities

- **Data Sources:** document review, data analyses, interviews and personal communications with water managers, parks and forest managers and staff
- **Project components:** drought hazard analysis, literature review, **documentation of historical responses to drought (1988-2005)**, and vulnerability mapping)
- **Funded through the Climate Change Impacts and Adaptations Program, Natural Resources Canada**





Environment
Canada

Environnement
Canada

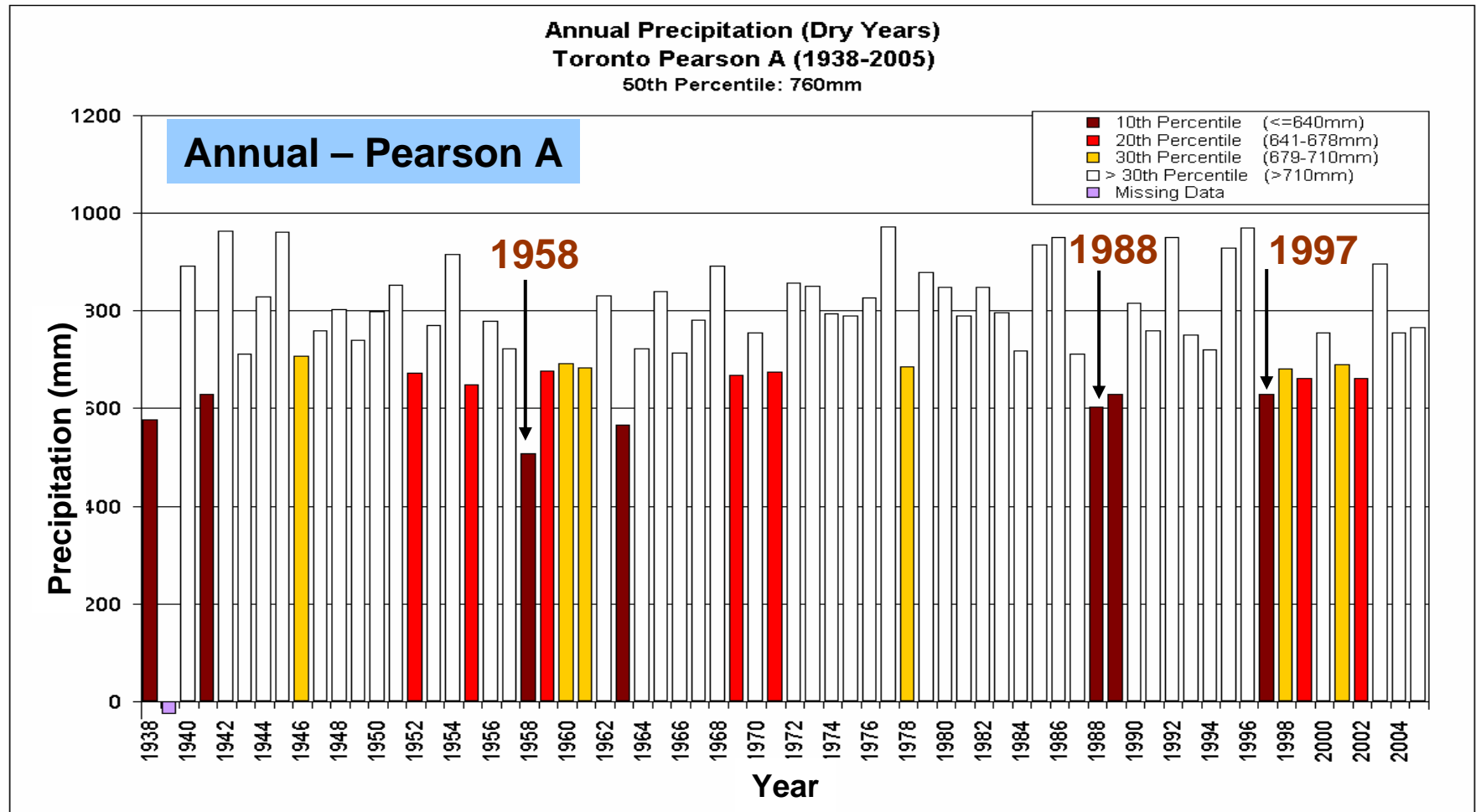
Canada

Historical Drought Hazard Analysis - examples

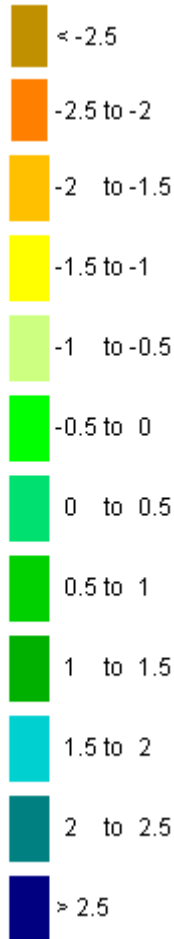


Identifying *DRY* Years...Precipitation Deciles

Toronto Pearson A: Driest 1958; Extreme Dry 1988-1989, 1997



Standardized Precipitation Index – SPI



SPI Drought Severity Classifications

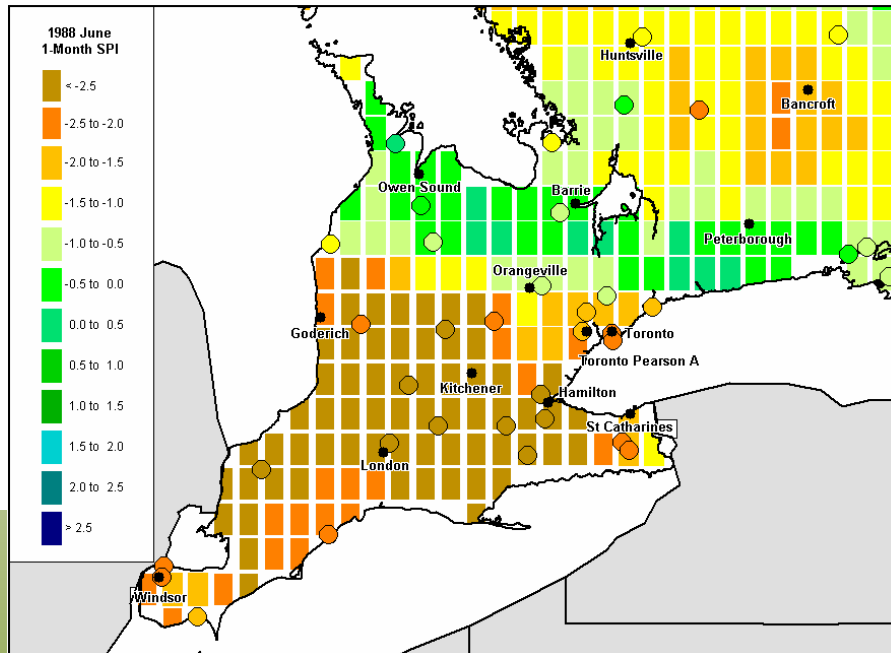
Extreme Drought	≤ -2 (2 categories on maps)
Severe Drought	-1.99 to -1.5
Moderate Drought	-1.49 to -1.0
Near Normal	-0.99 to $+0.99$

Remaining +ve SPI categories: **Wet** conditions



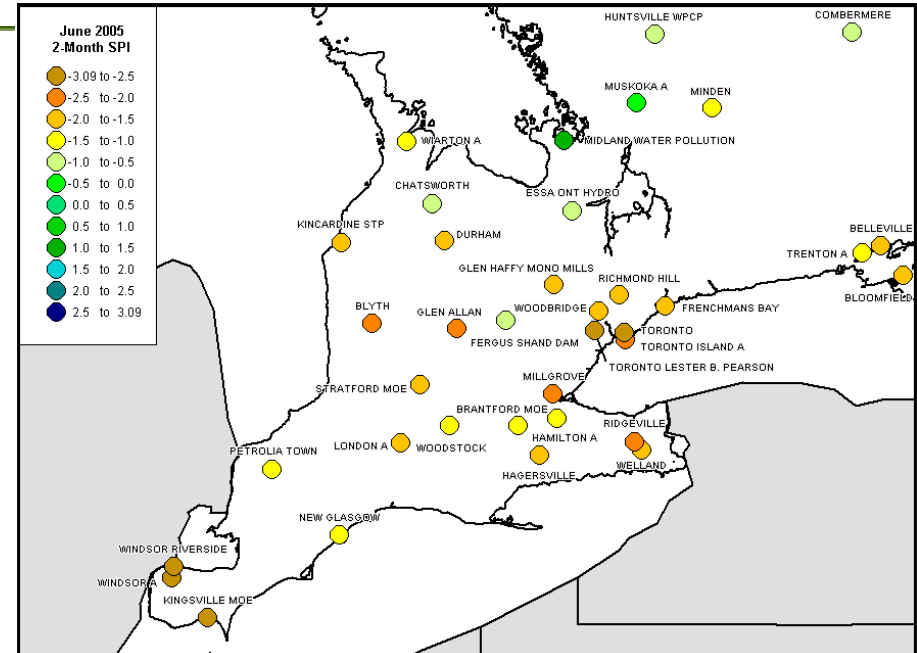
Standardized Precipitation Index – SPI

Investigating Spatial Extent, Severity, Duration of Drought



1988

June 1 Month SPI



2005

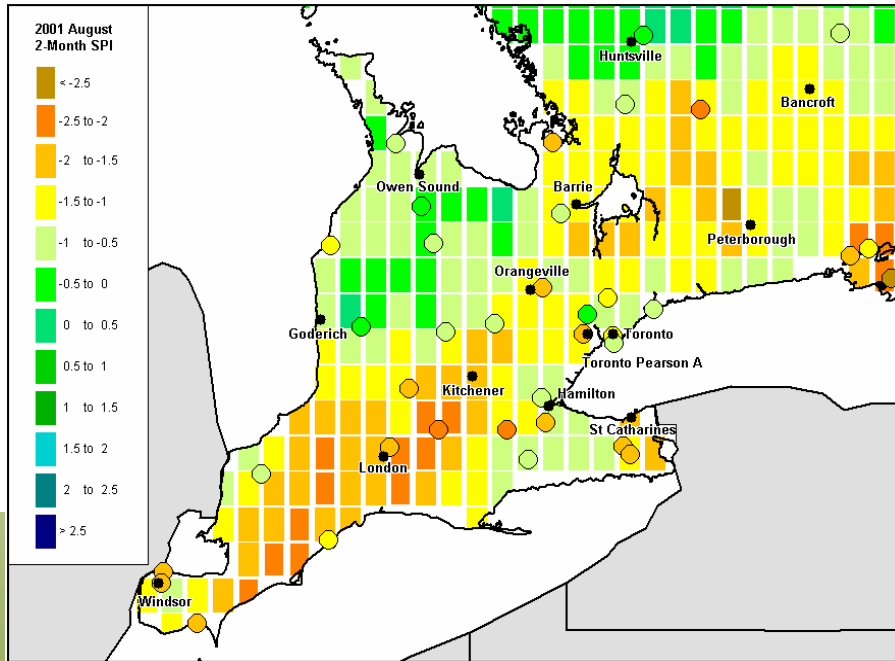
June 2 Month SPI

**Shorter Duration, Widespread, Extreme Drought
In Summers of 1988 and 2005**



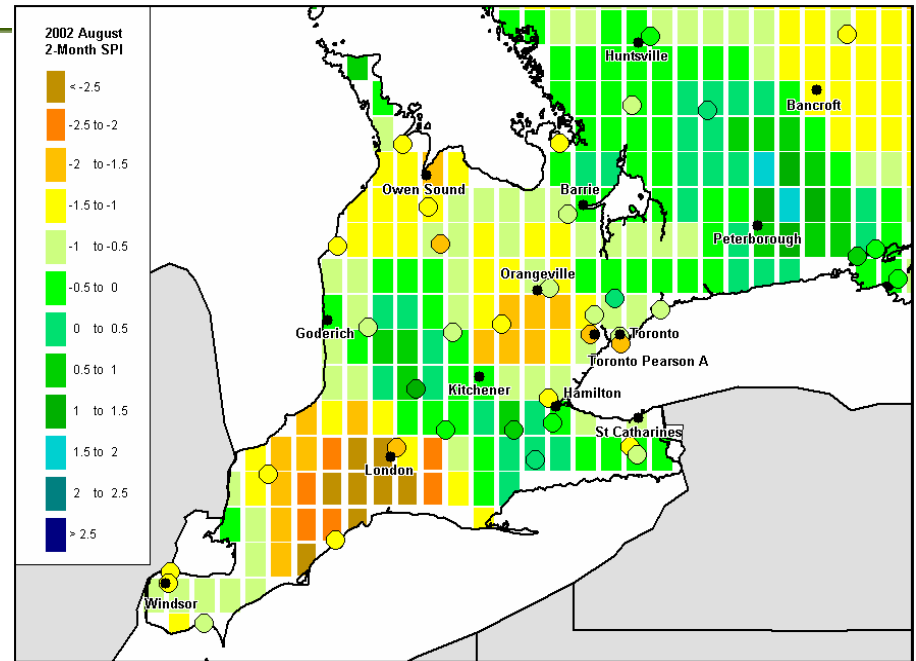
Standardized Precipitation Index – SPI

Investigating Spatial Extent, Severity, Duration of Drought



2001

August 2 Month SPI



2002

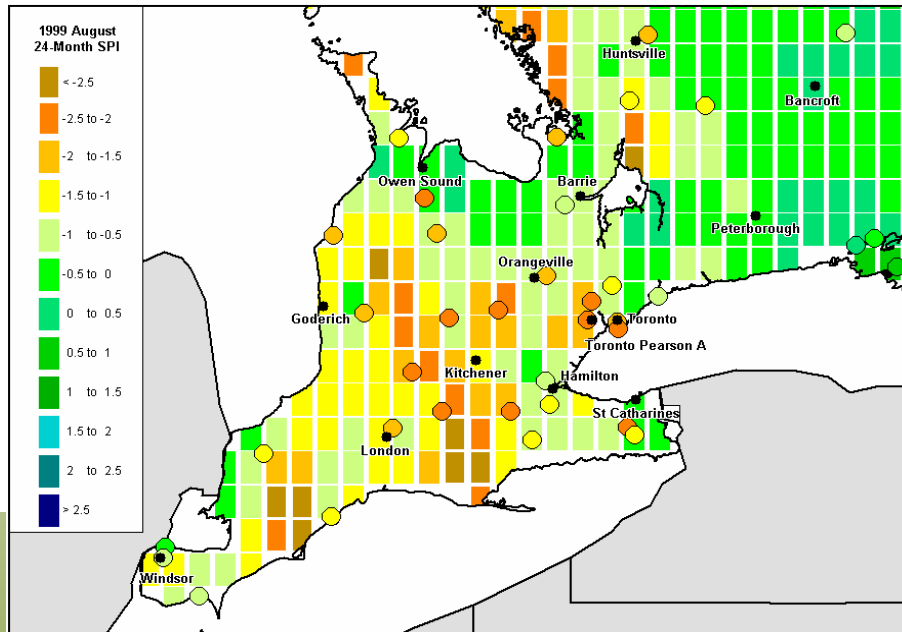
August 2 Month SPI

**Shorter Duration, Widespread, Severe-Extreme Drought
In Summers of 2001 and 2002**



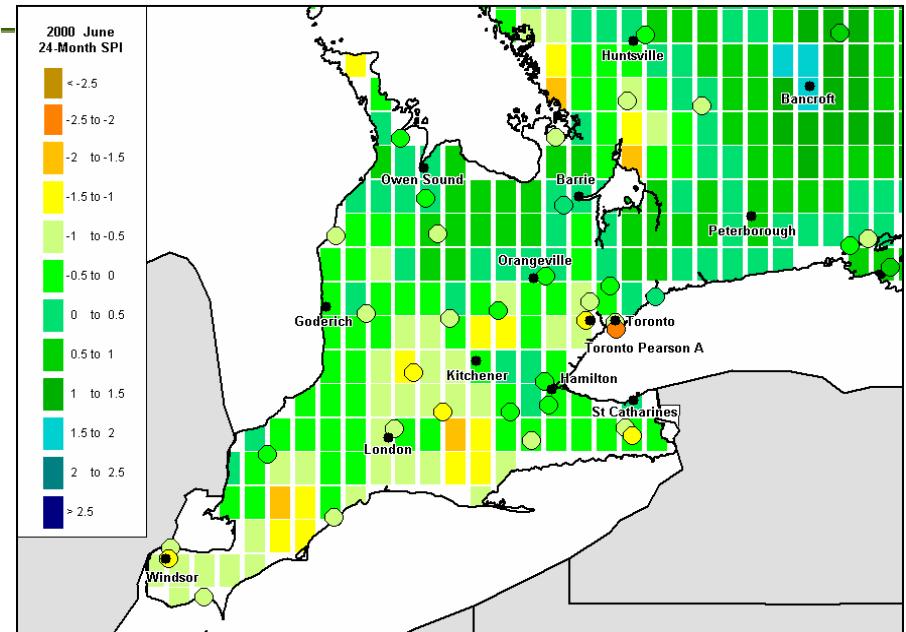
Standardized Precipitation Index – SPI

Investigating Spatial Extent, Severity, Duration of Drought



1999

August 24 Month SPI



2000

June 24 Month SPI

**Longer Duration, Widespread, Severe-Extreme Drought
1997- Spring 2000**





Environment
Canada

Environnement
Canada

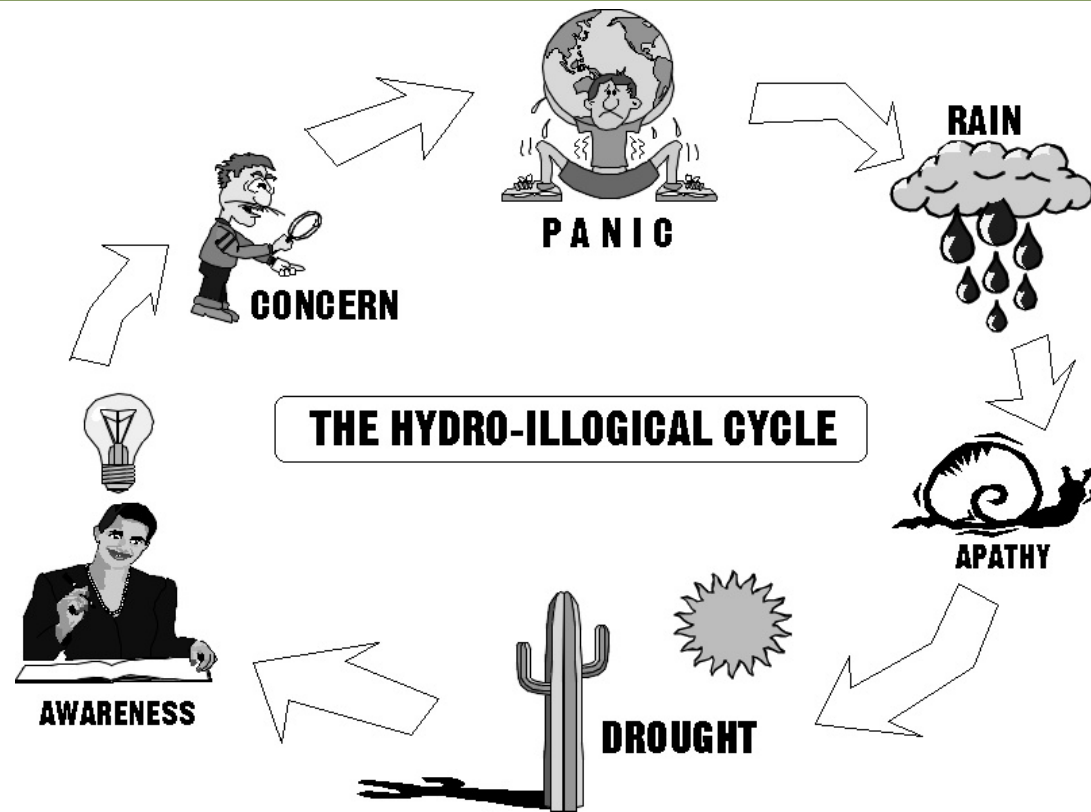
Canada

Documentation of historical adaptations



How do we typically respond to droughts?

- Tend to use a crisis management approach
- HYDRO-ILLOGICAL cycle
- Progress on drought preparedness has been SLOW even in drought-prone regions



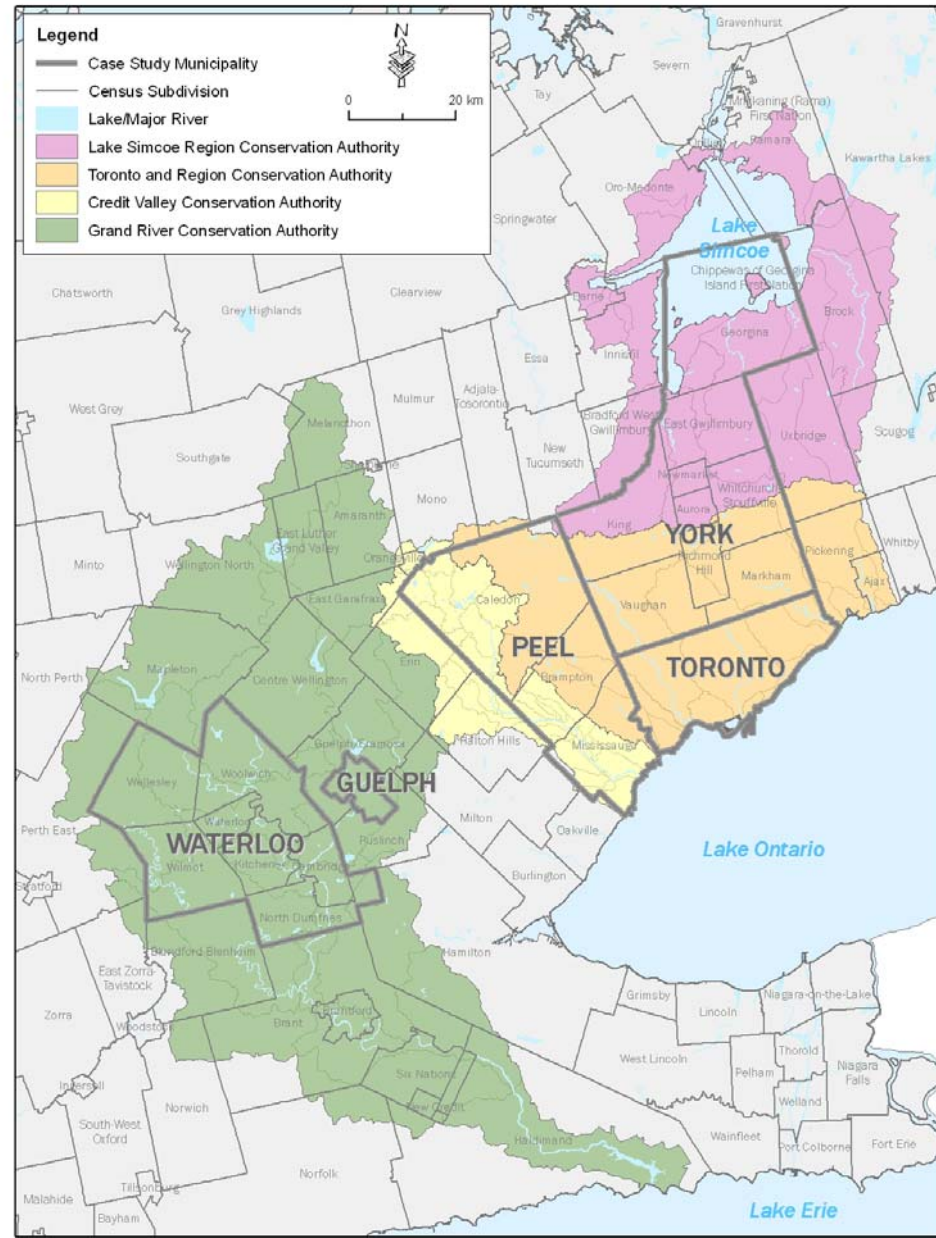
Source: Wilhite, 1987



Case study locations: populations and water sources

- City of Toronto: 2,503,281 people (services 3.1 Million); **Lake Ontario**
- York Region: 892,712 people (services 833,417); **Lake Ontario (80%), groundwater and Lake Simcoe**
- Peel Region: 1,159,405 people; **Lake Ontario (95%), groundwater**
- Waterloo Region: 478,121 people; **groundwater (75%) and the Grand River (25%)**
- City of Guelph: 129,259 people; **groundwater***

* Eramosa River (summer)



Vulnerability to Urban Drought - Water

Municipal Attributes

- Rapid population growth
- Lack of support for demand management measures

Water System Characteristics

- Finite or less accessible water source (e.g., rivers, groundwater)
- Little access to alternative water sources
- Fewer system interconnections or redundancies
- Older infrastructure



Short-term Adaptive Measures - Water

Supply management

- 1988: Water hauling in Southern York Region community

Demand management

- Ad hoc, reactive responses: 1988 and 1997 (North York e.g.)
- Movement from voluntary to mandatory water use restrictions (e.g., Metro Toronto, York Region and Guelph)



Water shortages – York Region 1988

Dates when storage facilities fell below 20% capacity in York Region:		Dates/times when storage facilities were at 0% capacity in York Region:
South Maple Reservoir	June 13-17	June 14 to June 15, 16:00 to 2:00; June 15 to June 16, 15:00 to 7:00
North Maple Reservoir	June 14-17	June 15, 8:00 to 10:00
East Woodbridge Elevated Tank	June 11-15, 20-21, Aug 9-10	June 13, 19:00 to 23:00; June 14, 16:00 to 24:00; June 15, 9:00 to 23:00
West Woodbridge Elevated Tank	June 11, 12-15, July 4, Aug 10	June 13, 22:00 to 23:00; June 14, 20:00 to 24:00
South Richmond Hill Reservoir	June 14-17	
Markham Elevated Tank	June 11-13, 14-15	

Source: Koshida et al., 1998

- Demand exceed ability to distribute and supply water to reservoir and water towers in June 1988 (water supplied by Toronto network)
- Also some shortages in North York & Brampton (June 1988)
- Issues: lack of water for emergency services (e.g. firefighting)
- Water had to be trucked in (ad hoc response)
- Water levels in reservoirs rose overnight to “acceptable” levels



Long-term Adaptive Measures (Supply Management)

- Not generally done in response to drought, but may reduce vulnerability
- Supply management options:
 - Expansion or building new water infrastructure (e.g. Mannheim 1992)
 - Interconnections of water system components creates redundancies helpful in emergency situations (e.g. Peel/York Region in 2005)
 - Seek out new and alternative water sources (e.g. pipelines)
- Water Supply master plans – all municipalities are developing



Above: Mannheim Water Treatment Plant



Right: Groundwater Well House



Long-term Adaptive Measures (Demand Management)

- By-laws restricting peak summer water use (lawn watering, swimming pools) – warnings, fines
 - e.g., York Region, City of Guelph, Waterloo Region
- No evidence of by-laws governing peak summer use in Peel Region or the City of Toronto (most secure water supply) – voluntary conservation **not** enforceable
- Evolution to using demand management measures after 1999



Non-essential water use policies or by-laws and OLWR linkages

- OLWR: Catalyst to improve drought planning and response
- York Region
 - 2002 drought response protocol – harmonize by-laws
- Waterloo Region
 - 2003 outdoor water use by-law
- City of Guelph
 - 2002 outside water use program (OWUP)
 - First municipality to link with OLWR, most comprehensive drought plan at local level with education component



Environment
Canada

Environnement
Canada

Canada

Municipal outdoor water use by-laws – York Region, 2006 - harmonize

	Town of Aurora	Town of East Gwillimbury	Town of Georgina	Township of King	Town of Markham	Town of Newmarket	Town of Richmond Hill	City of Vaughan	Town of Whitchurch-Stouffville
EFFECTIVE PERIOD	May 15th to Sept 30th	May 15th to Sept 30th	May 15th to Sept 30th	Year Round	June 1st to Sept 30th	Year Round	June 15th to Sept 30th	May 15th to Sept 30th	June 1st to Sept 30th
RESTRICTIONS									
Odd house numbers may use water outdoors only on odd numbered days of the month and even house numbers may use water outdoors only on even numbered days of the month.	✓	✓	✓	✓	✓	✓	✓	✓	✓
Outdoor water use is allowed between 8:00am to 10:00am and 8:00pm to 10:00pm.	✓	✓	✓			✓			✓
Lawn watering is allowed between 8:00 am to 9:00 am or 8:00 pm to 9:00 pm.					✓			✓	
Lawn watering is allowed between 7:00 pm to 10:00 pm.				✓					
Lawn watering is allowed for only 4 hours between the hours of midnight and 8:00 am or between 7:00 pm to 10:00 pm.							✓		
Industrial, commercial and institutional properties also odd/even and only permitted for 3 hours from midnight to 8:00 am.					✓				
Industrial, commercial and institutional properties also odd/even and only permitted for 4 hours from midnight to 8:00 am.							✓		
Industrial, commercial and institutional properties also odd/even and only permitted for 3 hours from midnight to 7:00 am.								✓	
Provides one month grace period for new sod and seed.	✓	✓	✓	✓		✓		✓	✓
Provides two month grace period for new sod and seed.					✓		✓		
Newly planted trees and shrubs can be watered for a period of 24 hours after planting.	✓	✓	✓	✓	✓	✓	✓	✓	✓
FINES									
Maximum fine for contravening a water use ban as provided in the <i>Provincial Offences Act</i> .	\$5,000	\$5,000	\$5,000	\$5,000	\$5,000	\$5,000	\$5,000	\$5,000	\$5,000

Water Use Advisory Definitions:

Stage 1 - All persons will be requested to refrain from using municipal water from a hose, pipe, sprinkler or permanent irrigation system for the purpose of:

- 1) watering lawns and gardens;
- 2) washing of vehicles, sidewalks or driveways
- 3) filling swimming pools



Stage 2 - No person shall use municipal water from a hose, pipe, sprinkler or permanent irrigation system for the purpose of:

- 1) watering lawns and gardens;
- 2) washing of vehicles, sidewalks or driveways
- 3) filling swimming pools

Guelph's OWUP

Activities	Level 0 Careful Use	Level 1 Reduce Outside Use (10% voluntary reduction)	Level 2 Reduce and Stop Non- Essential Use (20% voluntary reduction)	Level 3 Further Reduce and Stop Non-Essential Use (20% mandatory reduction)
Watering lawns	Permitted*	Permitted*	Prohibited	Prohibited
Watering trees, shrubs and gardens	No Restrictions	No Restrictions	Permitted*	Prohibited
Commercial uses of water	No Restrictions	No Restrictions	No Restrictions	Restrictions**

*Alternate day and time restrictions apply

**after direct customer consultation and council approval

Long-term Adaptive Measures Cont. (Demand Management)

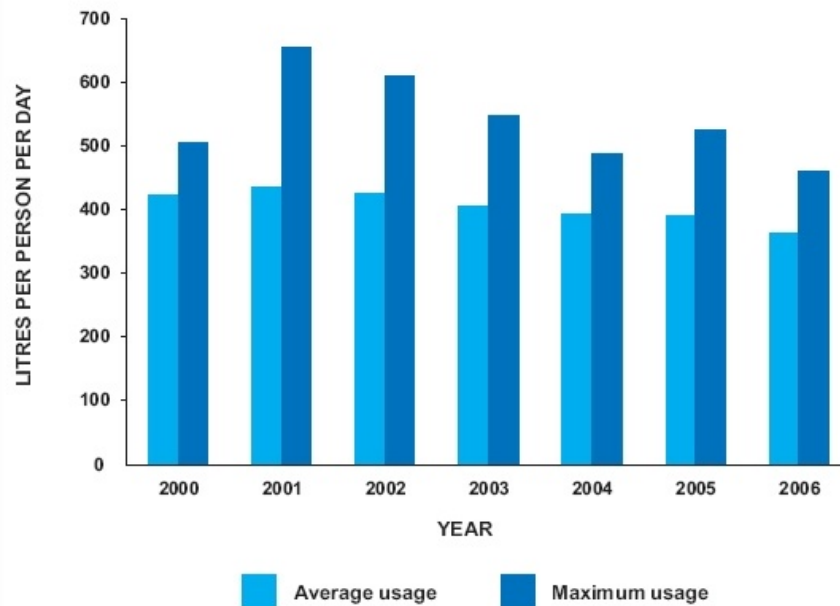


- Issues: community buy-in; enforcement of water use by-laws
- Water Efficiency Plans – exist in all case study locations (defers cost of building new infrastructure)

Source: Guelph Water Management Group,
University of Guelph

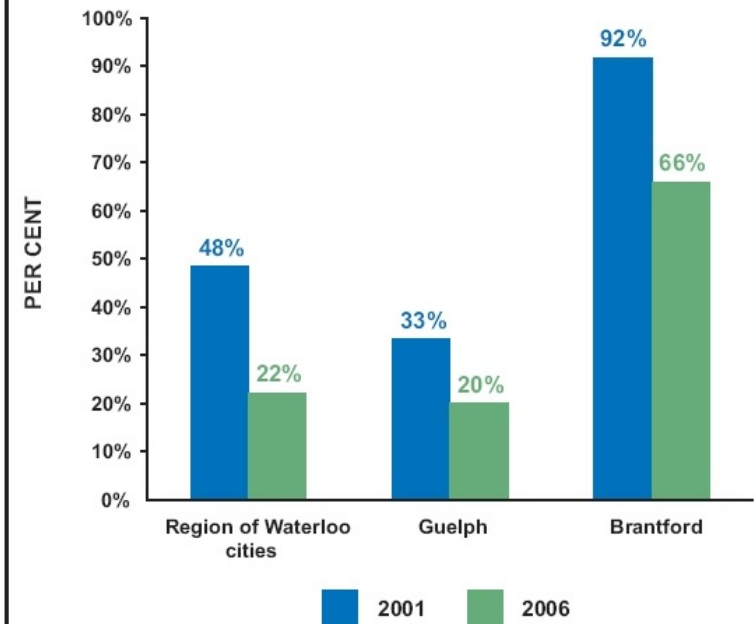
Water conservation is working...but

Water use in Grand River cities



Per capita water demand has dropped steadily in the cities of the Grand River watershed as a result of water conservation activities, especially lawn watering rules. "Average usage" is the amount used for normal day-to-day activities in homes, businesses, industry and institutions. "Maximum usage" is the peak flow on the busiest day of the year which usually occurs in summer.

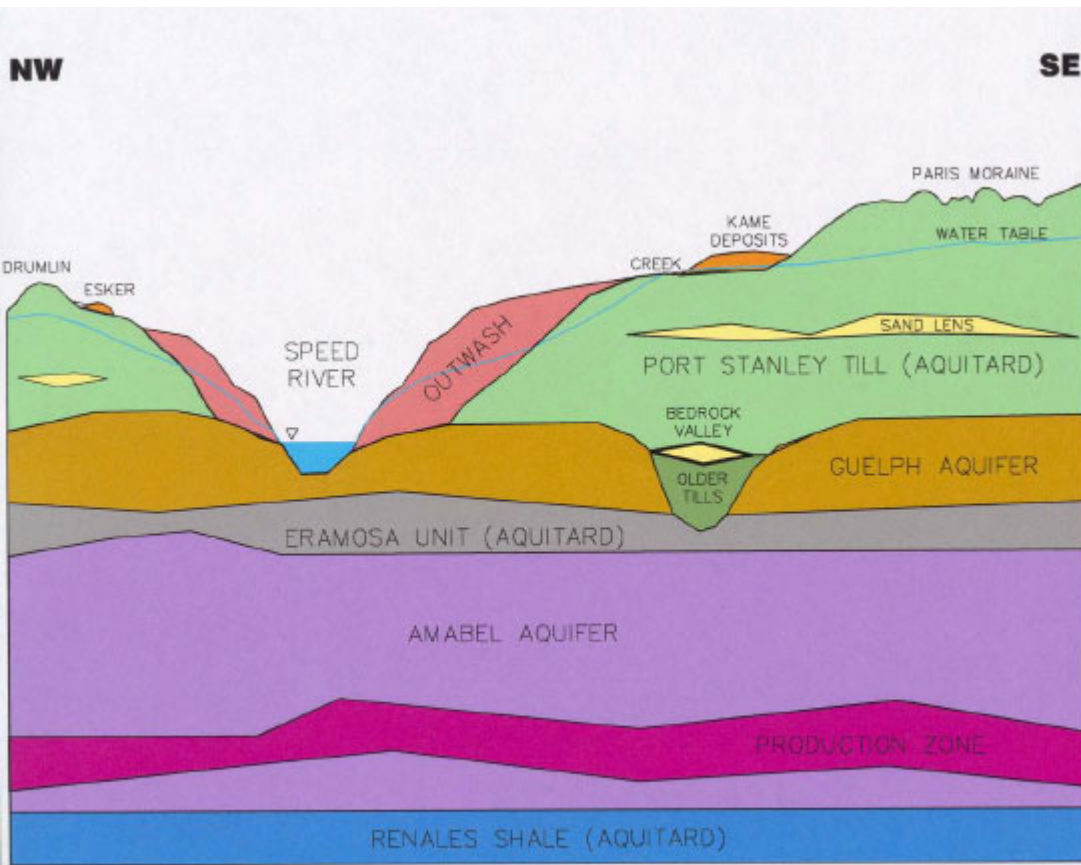
Falling peaks



Municipal water managers keep track of the relationship between the average day water use and the peak day water use. In Waterloo Region, for example, peak day consumption was 48 per cent higher than average day consumption in 2001. The major urban areas have all seen significant declines in their "peaking factors" since lawn watering bylaws came into effect.



Nestlé bottled water license renewal



- Nestlé takes water from the Guelph groundwater source
- Nestlé was allowed to increase its extraction to 3.6 million l/day (from 2 million l/day)
- Nestlé's permit was renewed in 2005 by the Ontario MOE. Permit extended in 2007 pending review, despite getting 6,000 letters of objection from public.

Figure 1 - Conceptual Model of the Guelph Aquifer System. The majority of Guelph's water comes from a zone in the Amabel Formation referred to as the "Production Zone".



Conclusions - Water



- Has drought management improved?
 - YES (**kind of**)
 - OLWR increased the profile of drought in the province and improved drought planning at the municipal level
 - Willingness to adopt long-term demand management strategies – **CHALLENGE**: how to turn temporary water conservation measure behaviours into permanent water savings?
 - Supply management measures are being pursued (multiple water sources) **but mainly to deal with population growth, not drought (or climate change)**
- Potential issues:
 - Limiting development does not appear to be warranted at present, but could be an issue for public acceptance of water use restrictions
 - Contradictory policies at different levels of government: *Municipal* water conservation initiatives encouraged yet *province* allows large-scale private sector water extraction (Nestlé)



Challenges - Water

- Need to enhance drought preparedness planning in municipalities
 - acknowledge drought as a normal part of climate
 - move from ad hoc drought response to planned preparedness
- Few formal drought management plans exist at the municipal level in Canada (e.g. Gibsons B.C.). U.S. – NYC e.g.
- Municipalities will have to address site-specific vulnerabilities (system characteristics or municipal attributes)
- Managers need to plan for how drought will manifest itself in urban environments under a changing climate



Thank you! Questions?

Grace.Koshida@ec.gc.ca



Environment
Canada

Environnement
Canada

Canada