



Lake Simcoe Watershed
Climate Change Vulnerability Assessment:
Water Quantity and Quality

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Vulnerability Assessment

Exposure Sensitivity Adaptive Capacity

A human or ecological system may be exposed and sensitive, but may have a high adaptive capacity which gives that system a low vulnerability.

VULNERABILITY ASSESSMENT: EXPOSURE

Simple Water Balance used to assess exposure.

$$P = ET + \text{Surplus} + \Delta \text{Storage}$$

Potential ET > Actual ET

VULNERABILITY ASSESSMENT: EXPOSURE

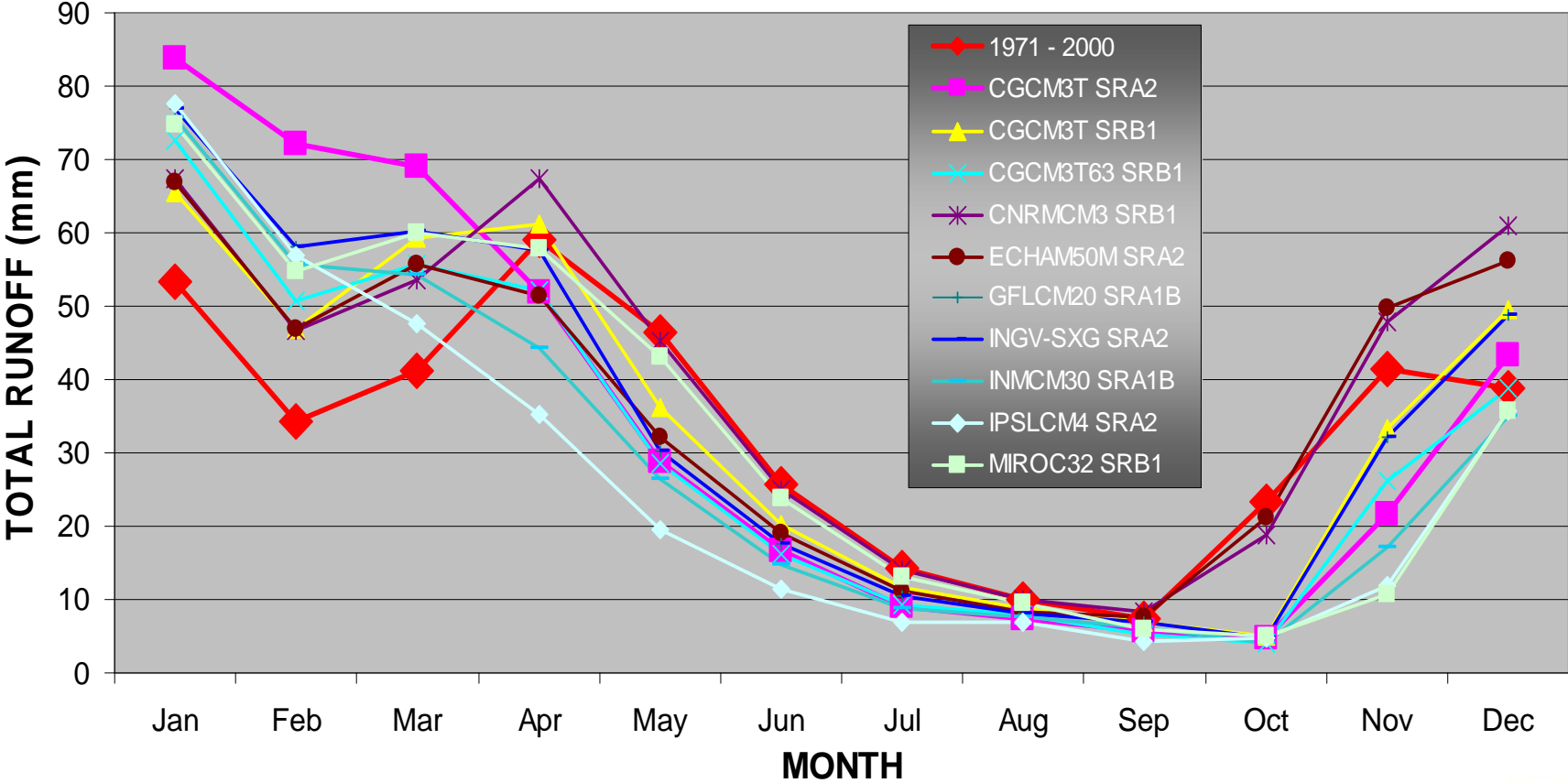
	1971 – 2000 Climate Normals	Projected Range from 10 climate models
Average Annual Temperature Range	6.6 °C	9 to 12.5 °C
Increase in Temperature		2.8 to 5.7 C° for January and July
Annual Precipitation Range	938 mm	881 to 1084 mm

Ensemble approach used 10 climate models with the
Thornthwaite Monthly Water Balance Model

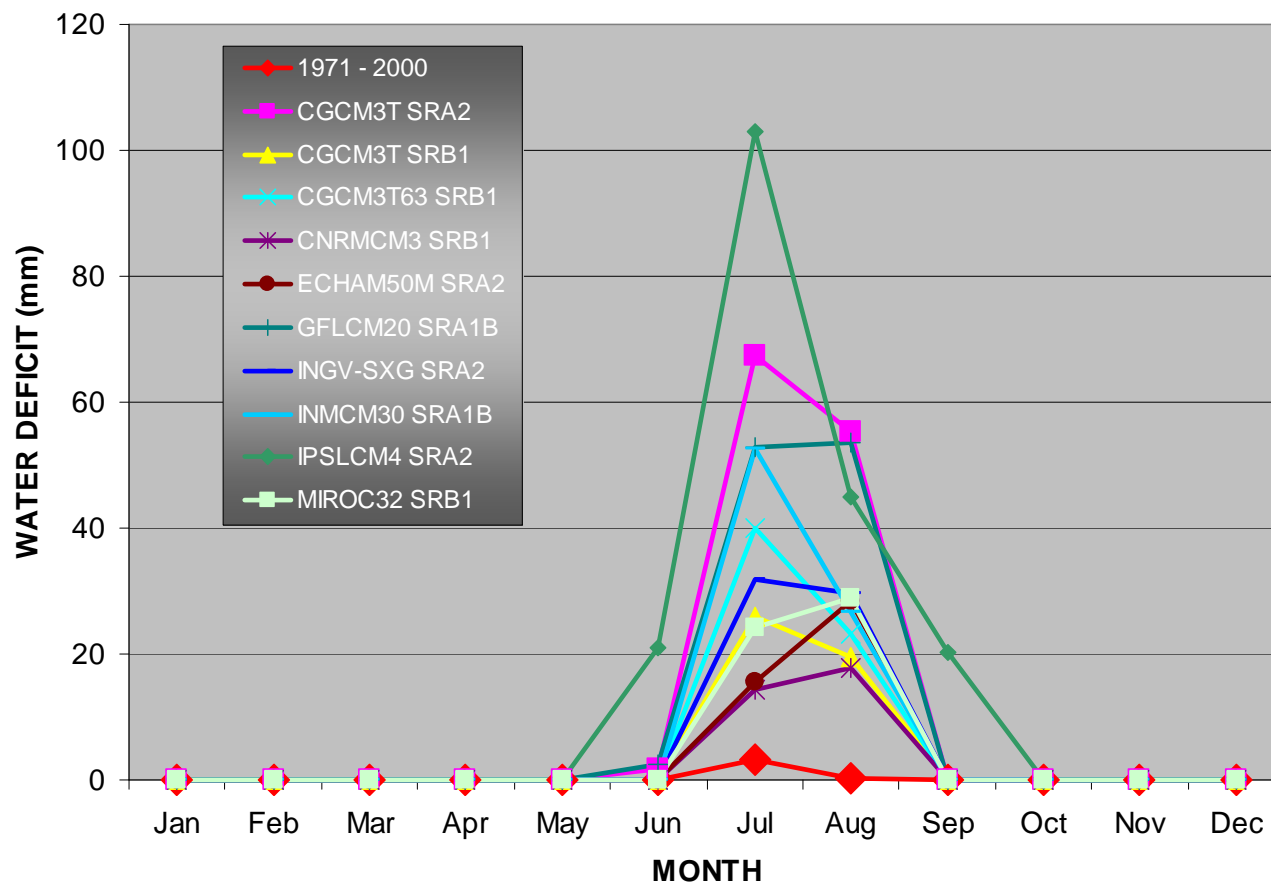
USGS model available for free at:

http://wwwbrr.cr.usgs.gov/projects/SW_MoWS/software/thorn_s/thorn.shtml

Monthly Runoff Predictions using 10 Climate Projections




Monthly Soil Moisture Deficit Predictions using 10 Climate Projections




Sensitivity: Climate Stressors

Water use
Drought
Floods and
Surface Runoff
Phosphorus
Loading



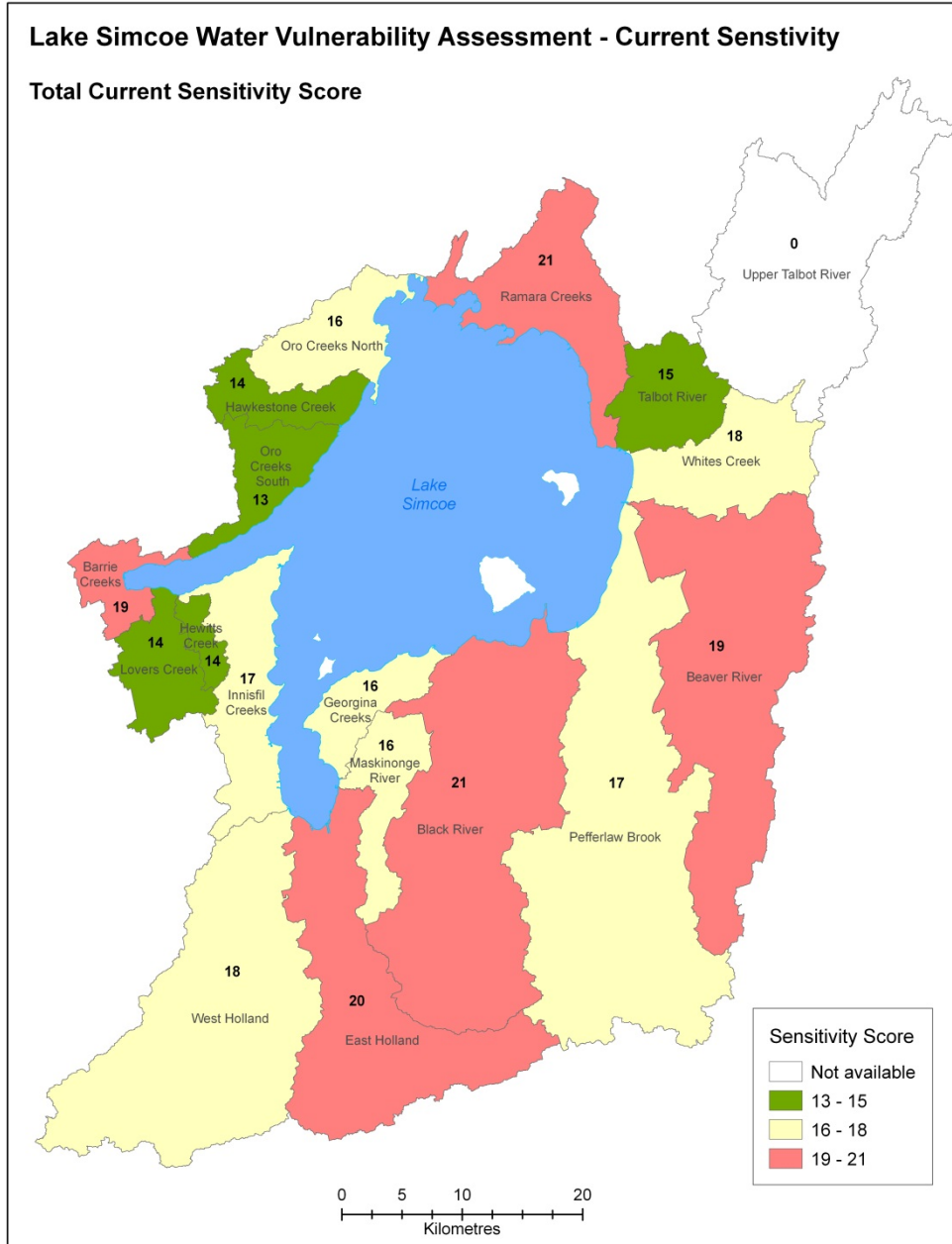
Water availability
Groundwater
recharge/discharge
Wetland Cover
Snow and ice cover



Sensitivity of the Subwatersheds

Water Quantity Indicator	Water Quality Indicator
Water Use / Availability	Phosphorus Loading
Baseflow Index	Variability of Streamflow
Wetland Cover	Floodplain Area
Groundwater Vulnerability	Sewage Bypass
Forest Cover	

Sensitive Subwatersheds	Current Sensitivities
East Holland	Low water availability, high P loading, high floodplain area.
Black River	Low water availability, high wetland cover, high sewage by-passes.
Beaver River	High wetland cover, low forest cover, high stream flow variability.
Barrie Creeks	Low water availability, high baseflow, low forest cover, high P loading.
Ramara Creeks	High baseflow, high wetland cover, high groundwater vulnerability, low forest cover, high floodplain area.



Hydrologic Impact: Potential Consequences

Climate change: increased air temperatures, more precipitation with intense storms in fall and winter but lower precipitation during the summer months

- Water demand could exceed supply during summer months leading to shortages
- Loss or damage to aquatic and terrestrial habitats (wetlands, water stressed vegetation)
- Loss or damage to infrastructure
- Greater erosion, sediment and contaminant loads
- Loss or damage to winter recreation
- Extended growing season

INDICATORS: LAKE SIMCOE

Phosphorus Loadings

Lake Temperature

Ice Cover

Dissolved Oxygen

Sewage and flood control failures

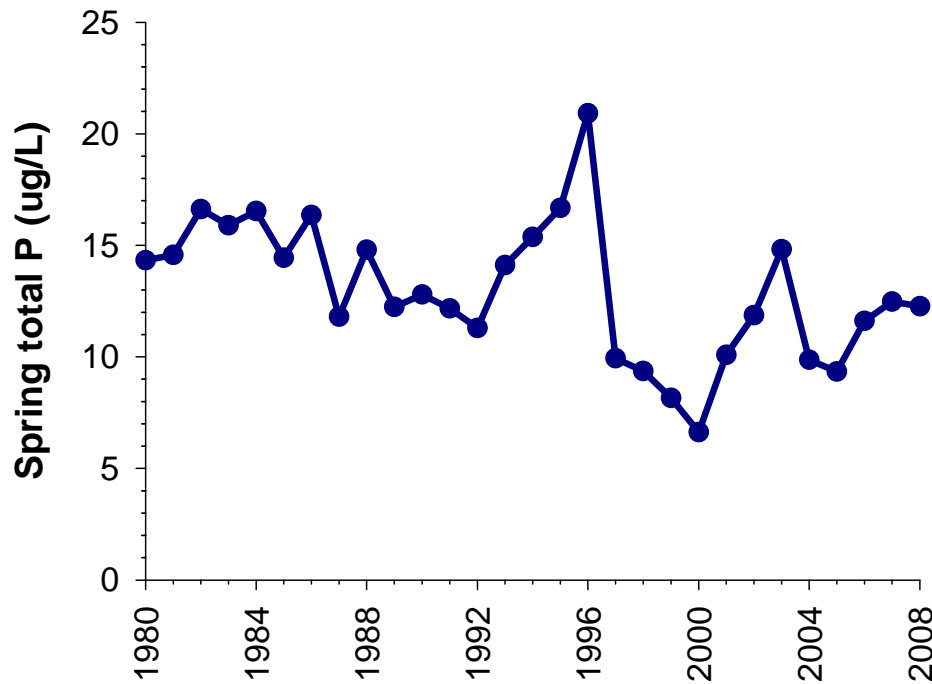
Beach Closures

Drinking water odour and taste problems

Lake Levels

Habitat and Ecosystem Response

Lake Simcoe: Phosphorus Loadings



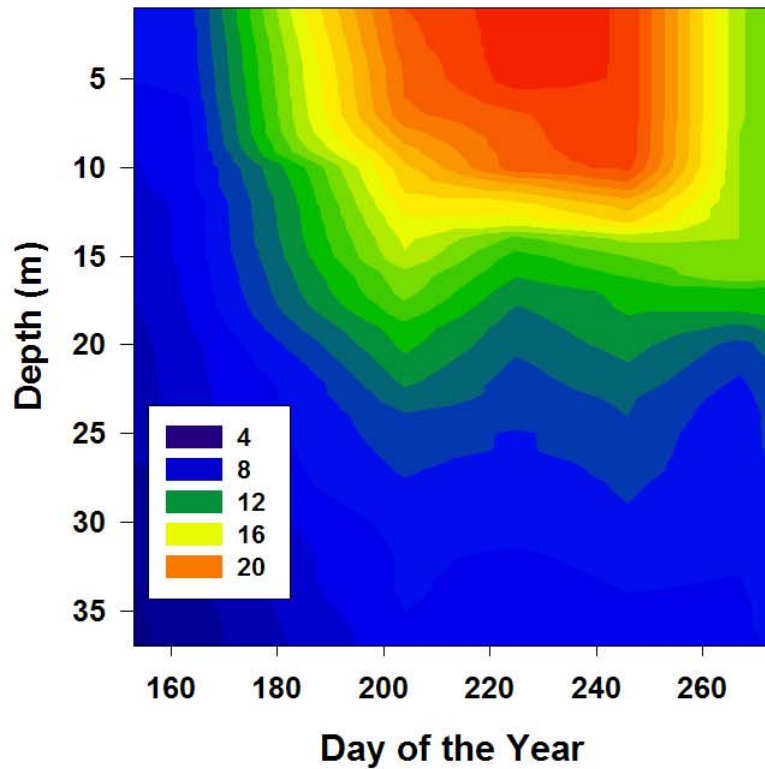
(Young et al, 2010)

Spring total P concentrations have significantly decreased over the past 30 years

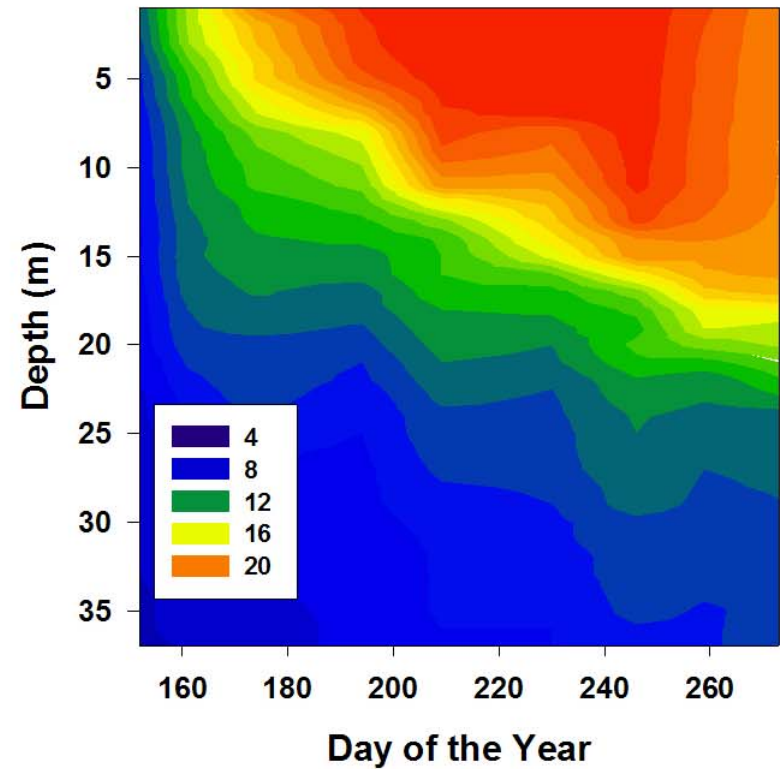
Increases in P loadings are anticipated due to increases in surface runoff due to climate change as well as projected population increases BUT adaptive PRS will work to reduce load to 44 T/yr.

Lake Simcoe: Lake Temperature

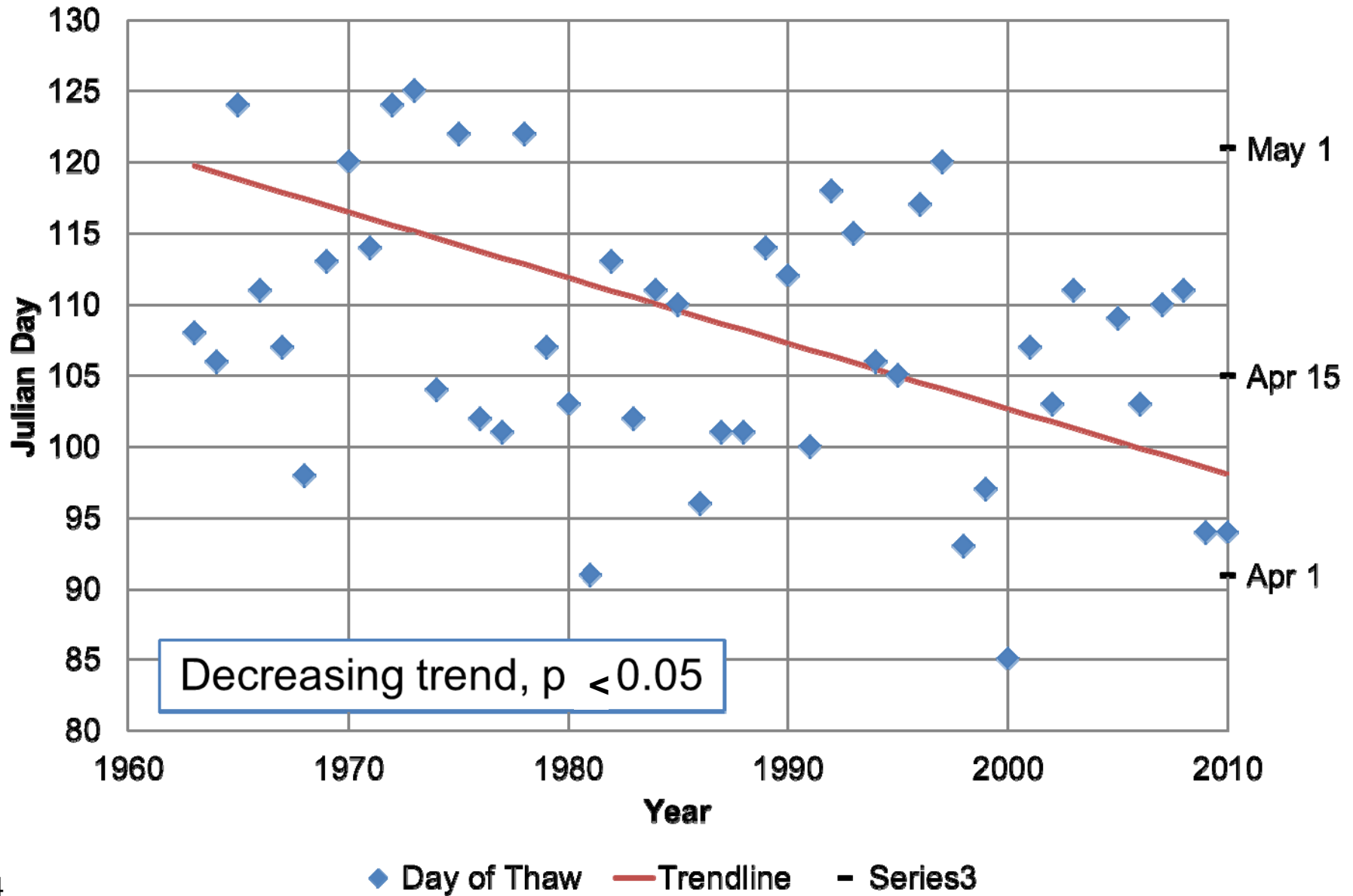
1980



2002



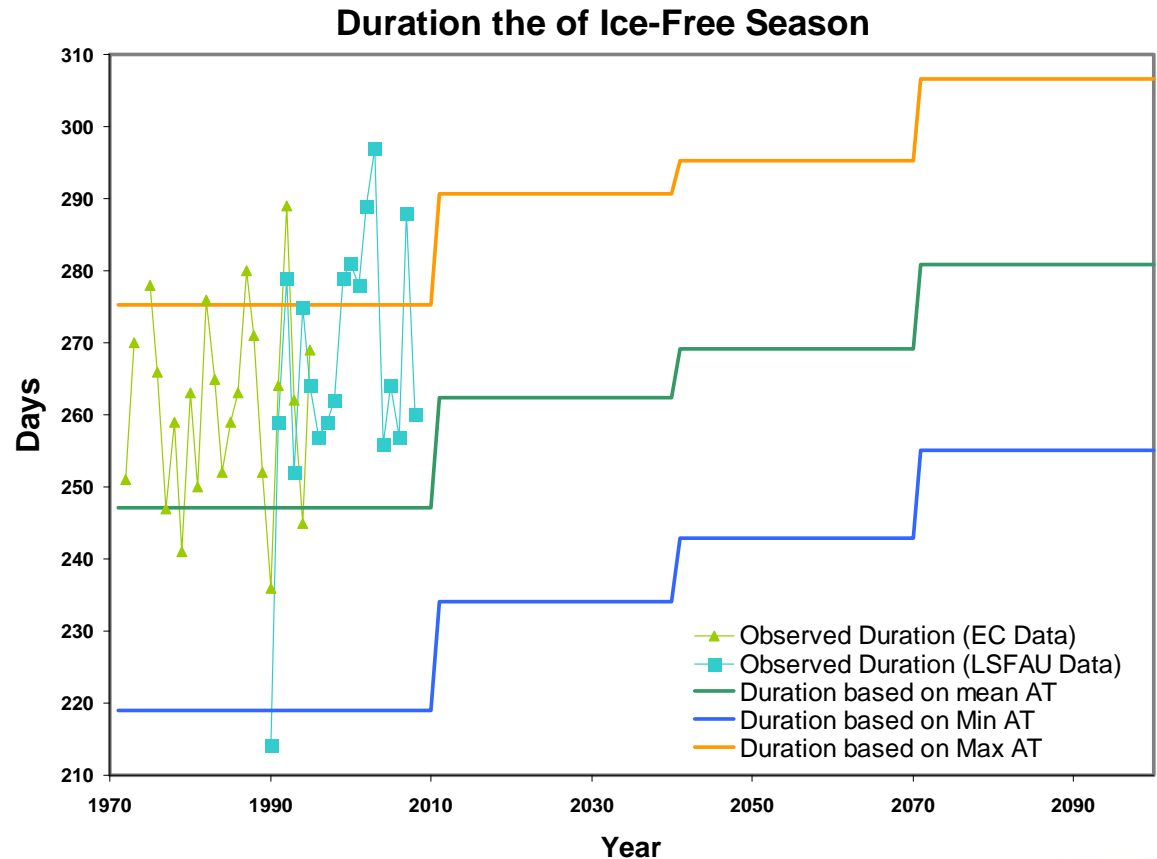
Lake Simcoe: Ice Cover



Lake Simcoe: Ice Cover

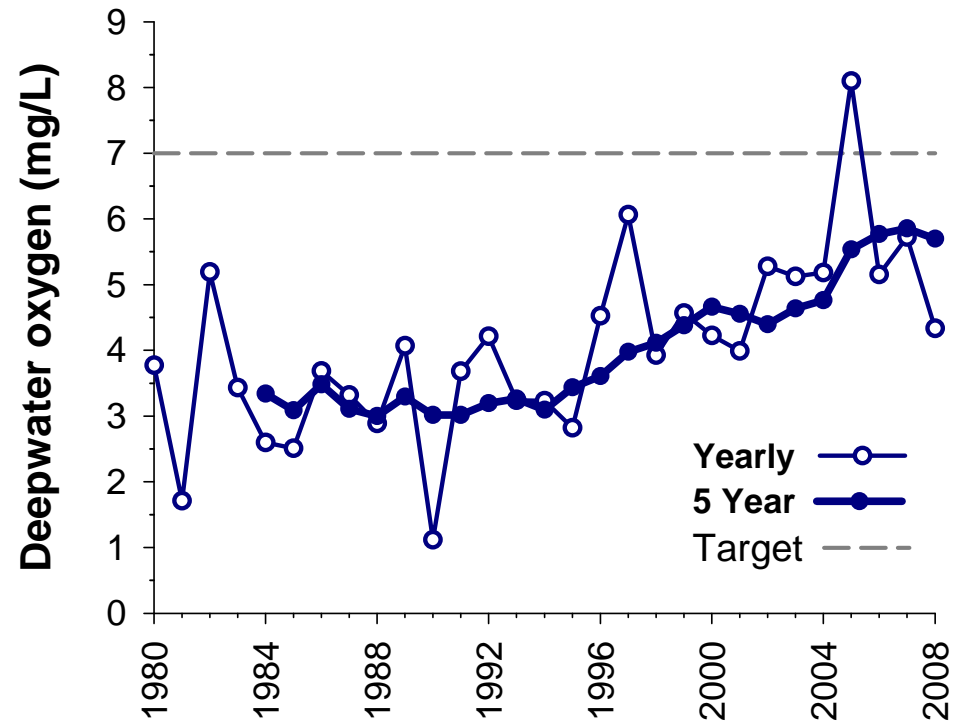
The length of the ice-free season could increase with increasing air temperature by more than a month by 2100.

In addition to ecological impacts, shorter ice cover will impact recreational ice-fishing and tourism



Lake Simcoe: Other Indicators

- Dissolved oxygen
- Sewage and flood control failures
- Beach Closures
- Drinking water odour and taste problems
- Lake Levels
- Habitat & Ecosystem Response



(Young et al, 2010)

Non-Climatic Stressors

Water use ↑ / availability ↓

Increasing demand due to population increases; changes in crops; changes to forest and wetland cover

Groundwater recharge/discharge ↓

Development in groundwater recharge areas; increase in impervious area

Drought ↑

Increased water use during summer with increased population due to tourism

Non-Climatic Stressors

Floods and Surface Runoff ↑

Exacerbated by increased impervious surface due to development

Phosphorus Loading ↑ & ↓

↑ Increasing population leads to increased phosphorus load; intensified farming; loss of natural areas; aging infrastructure.

↓ An adaptive Phosphorus Reduction Strategy working towards reducing loads to 44 T/yr by 2045

Snow and ice cover ↓

Increase in development; changes in forest cover

CURRENT ADAPTIVE CAPACITY

$$\text{Vulnerability} = \frac{(\text{Exposure} + \text{Sensitivity})}{\text{Adaptive Capacity}}$$

(Fonataine & Steinemann, 2009)

Adaptive Capacity: the ability of a system to adjust to climate change (including climate variability and extremes) to moderate potential damages, to take advantage of opportunities or to cope with the consequences (IPCC Working Group II, 2007)



Thank you!

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