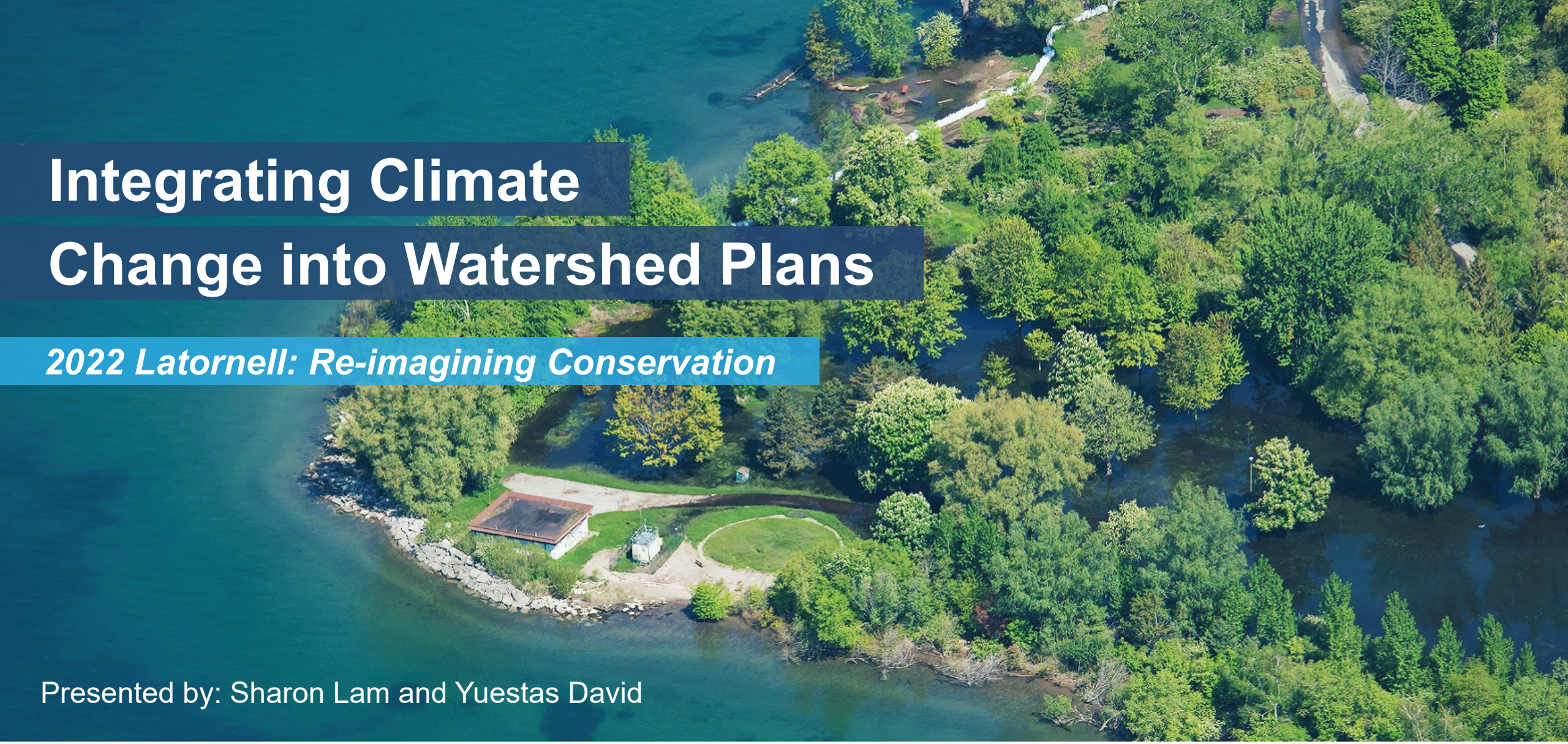
Integrating Climate Change into Watershed Plans

2022 Latornell: Re-imagining Conservation



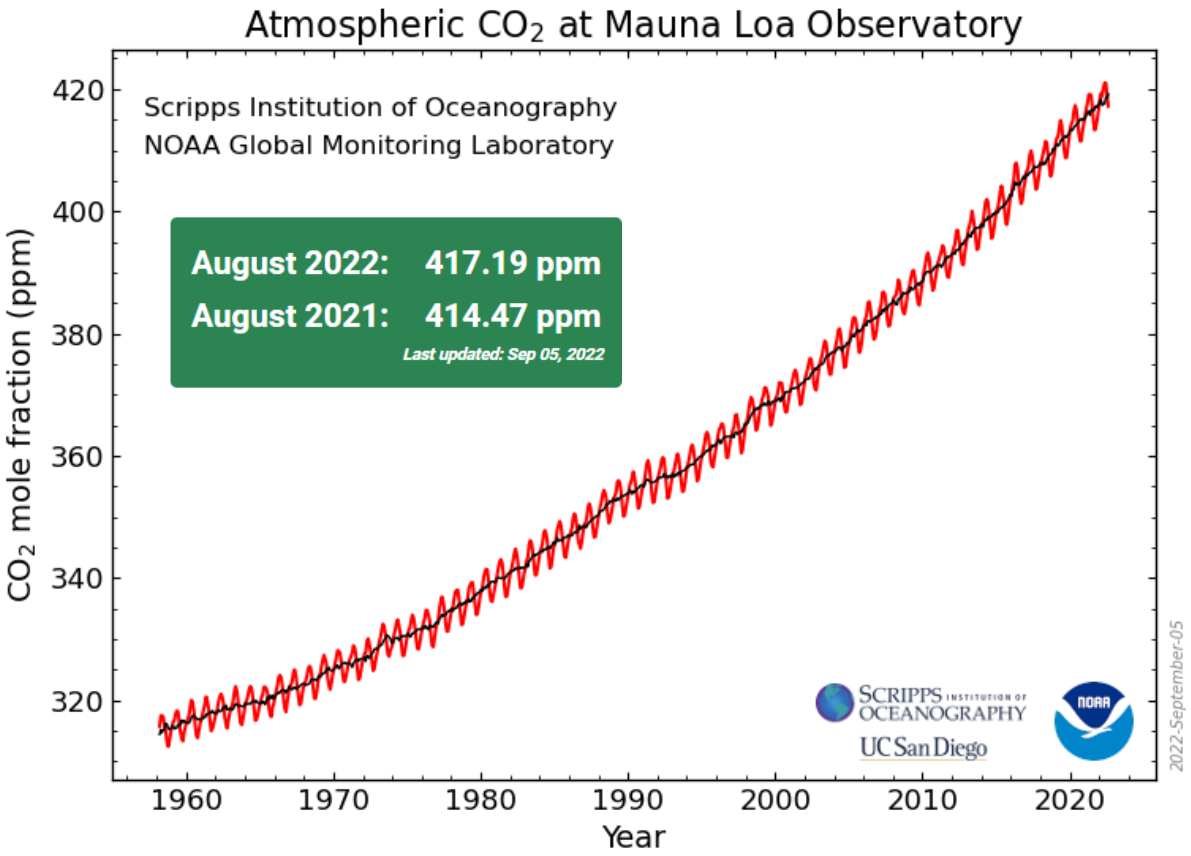
Presented by: Sharon Lam and Yuestas David

October 18, 2022

Toronto and Region Conservation Authority

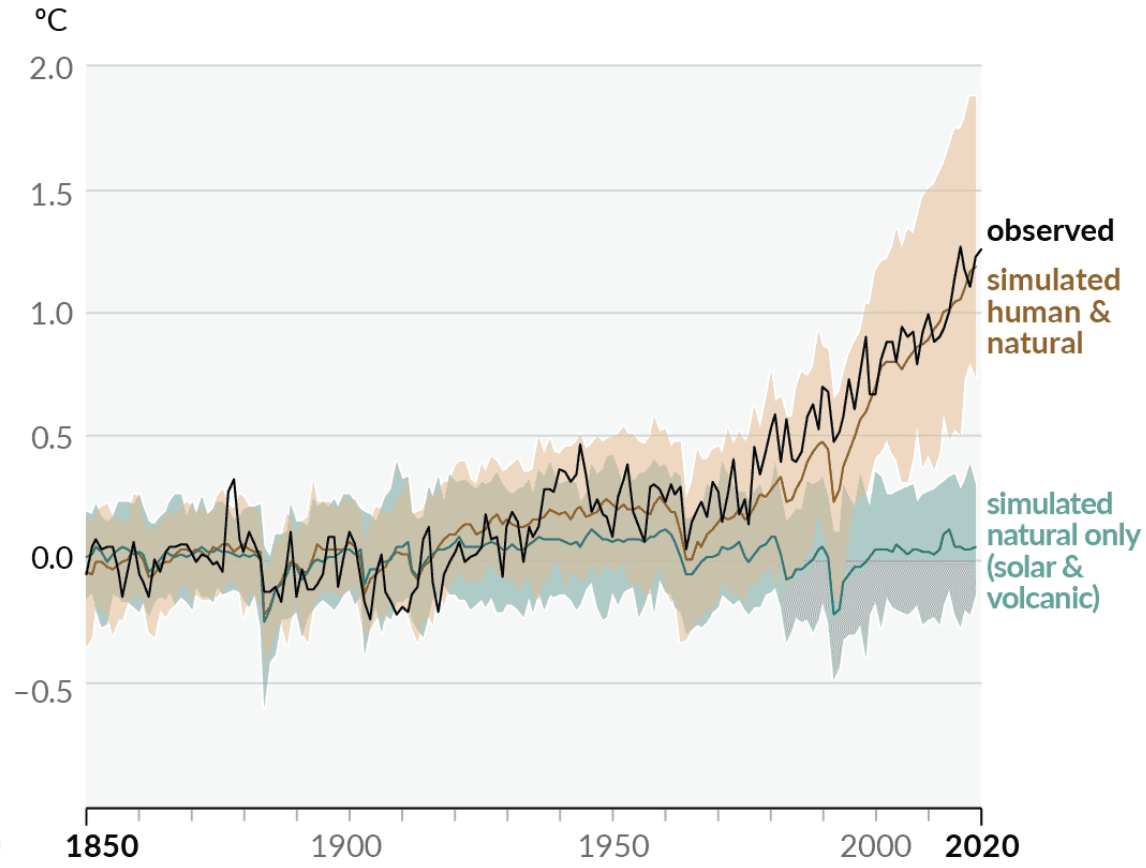
Why?

Climate change is real and we are the cause



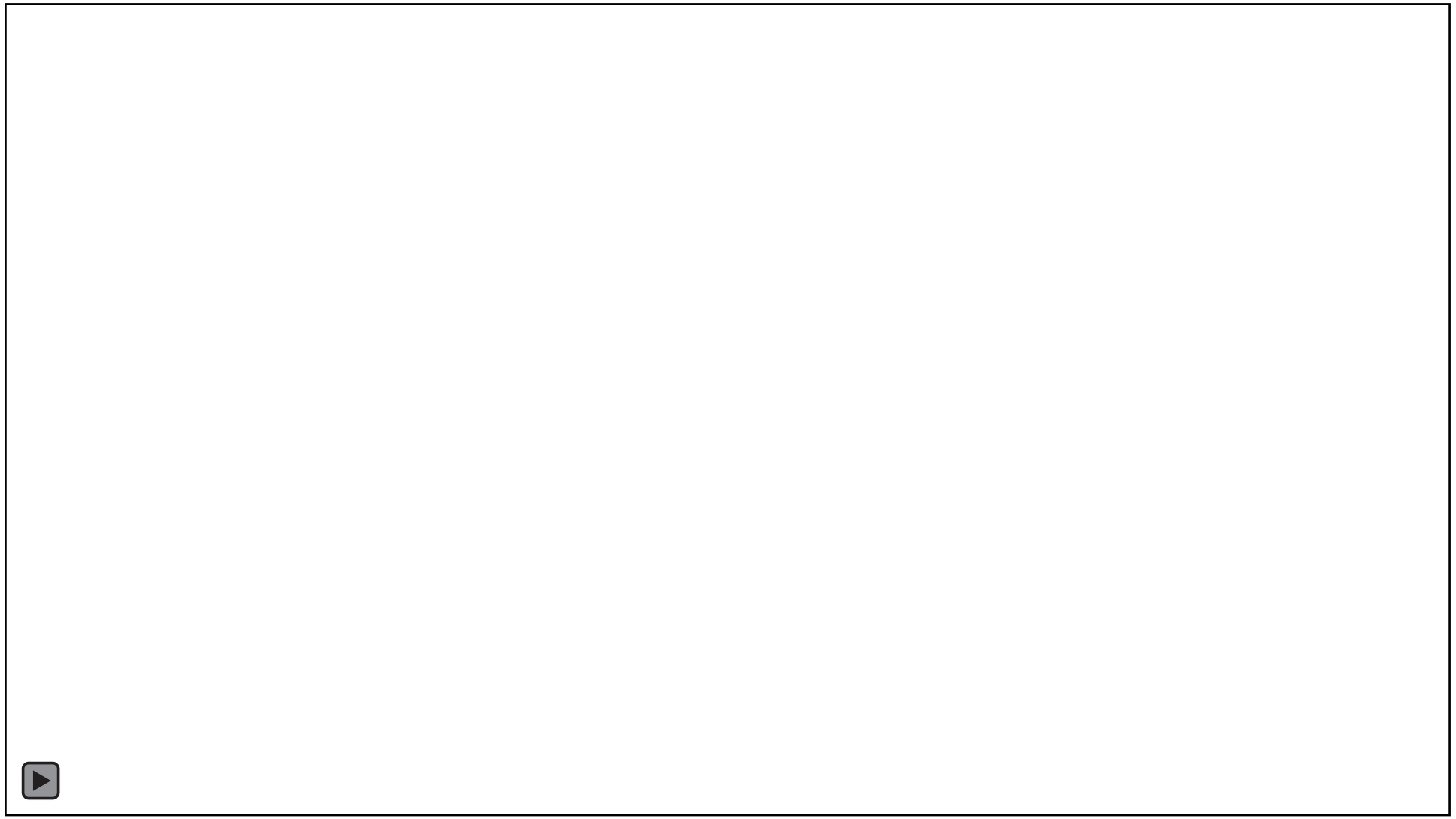
Source: National Oceanic & Atmospheric Administration (NOAA): Trends in Atmospheric Carbon Dioxide

(b) Change in global surface temperature (annual average) as **observed** and simulated using **human & natural** and **only natural** factors (both 1850–2020)



Source: IPCC Sixth Assessment Report, Working Group I

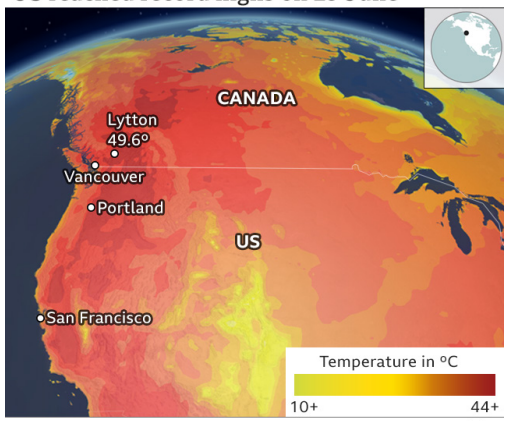
Climate change is happening now



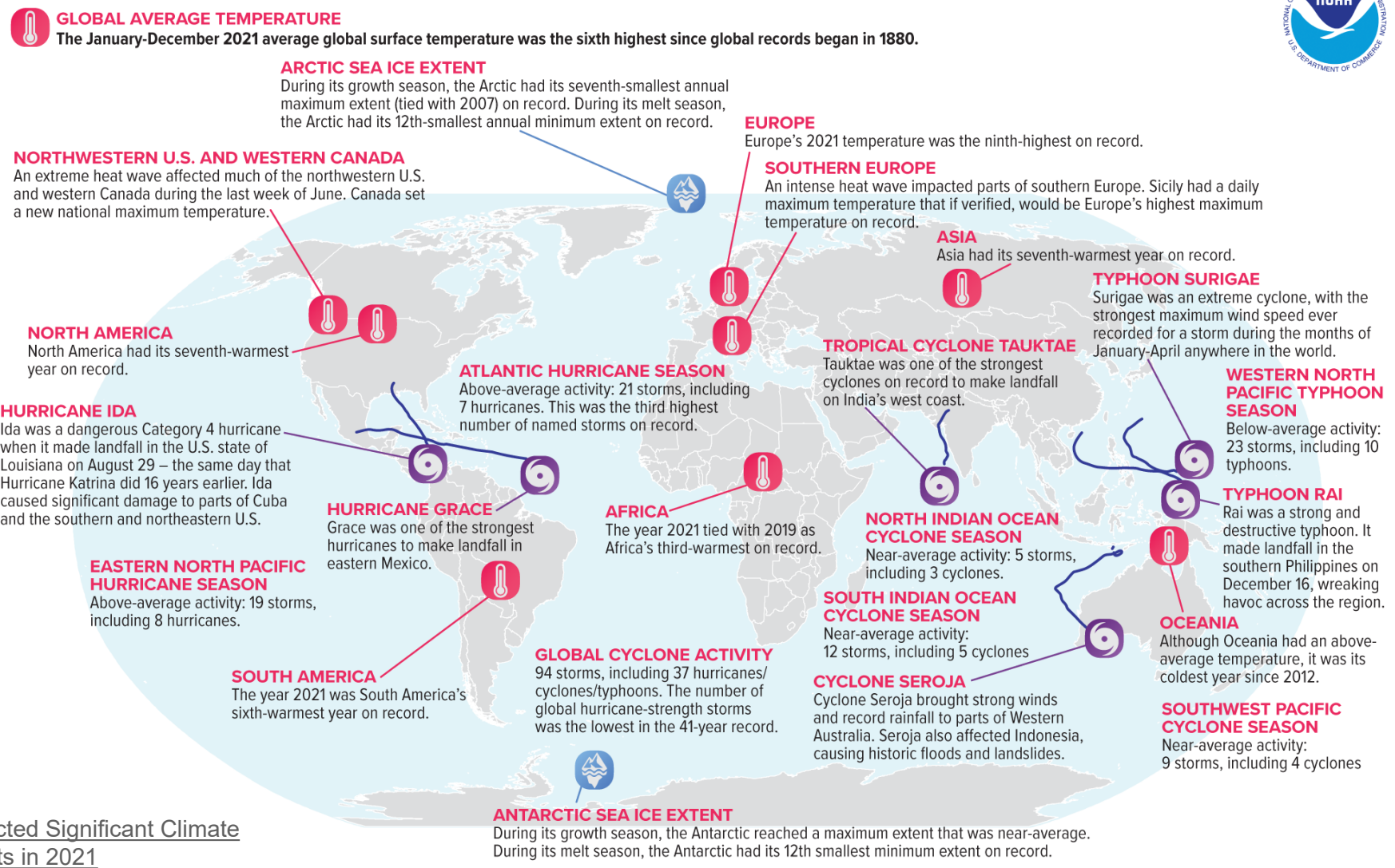
Source: NASA: Global Temperature Anomalies

It is affecting all regions in the world

Temperatures in Canada and north-west US reached record highs on 29 June

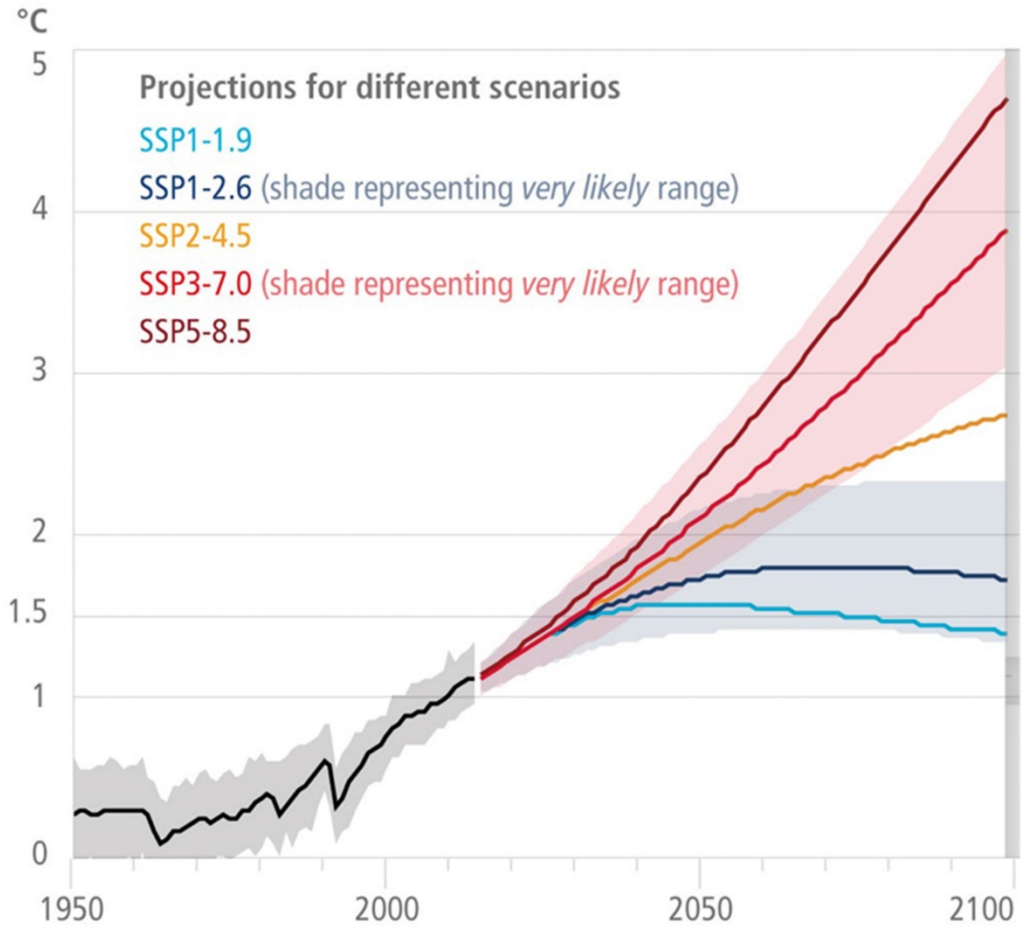


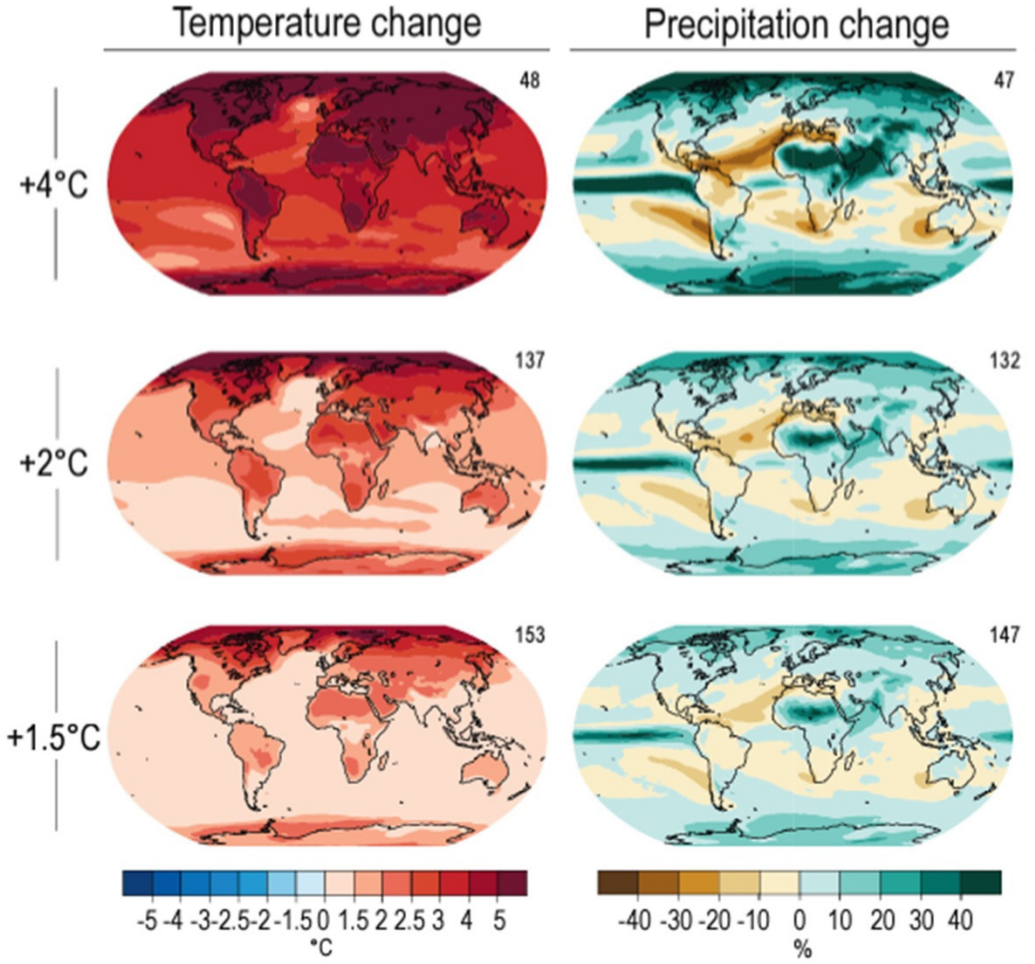
Source: BBC Weather



Source: NOAA: Selected Significant Climate Anomalies and Events in 2021

It will continue without rapid and sustained social and economic transformation

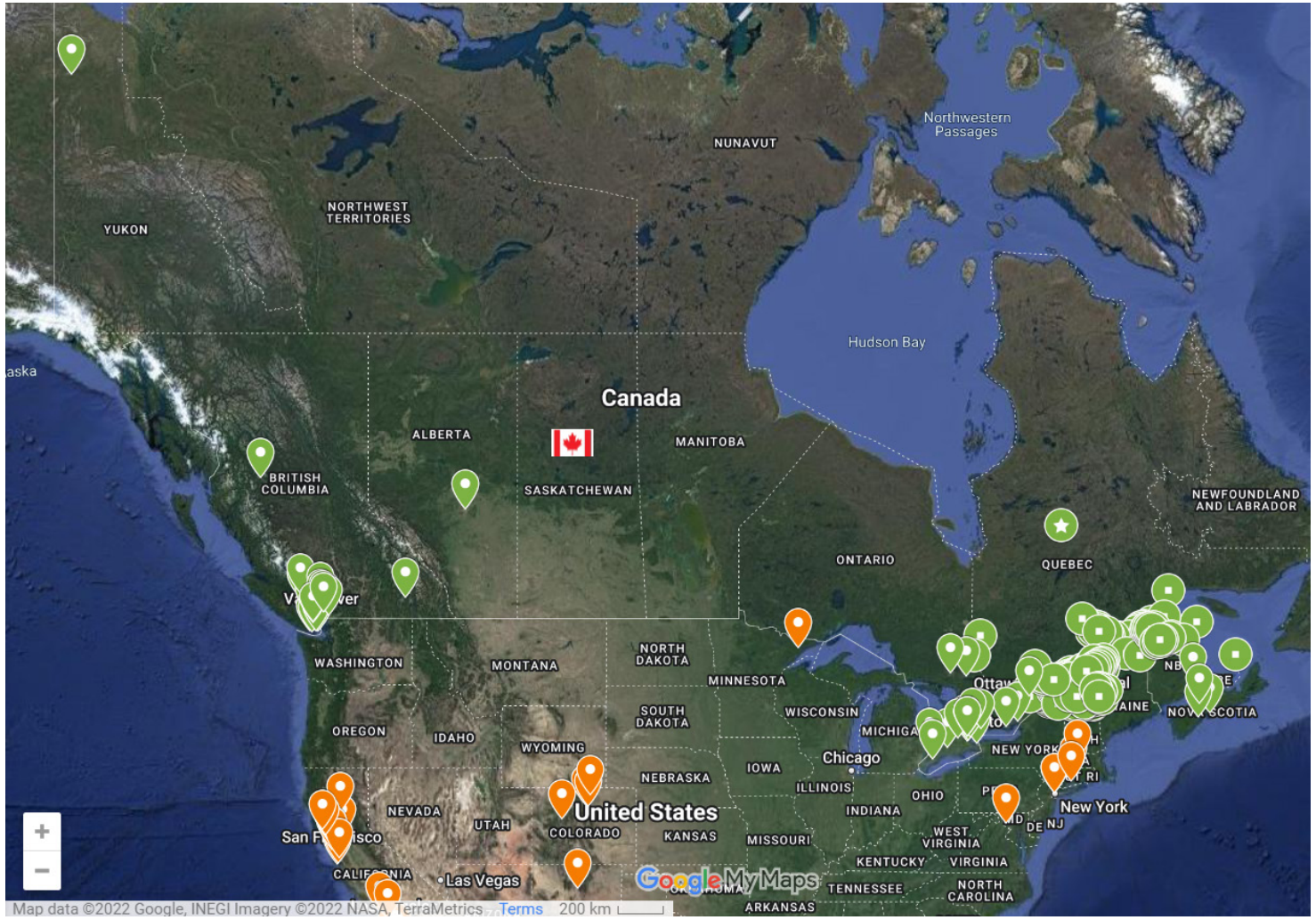




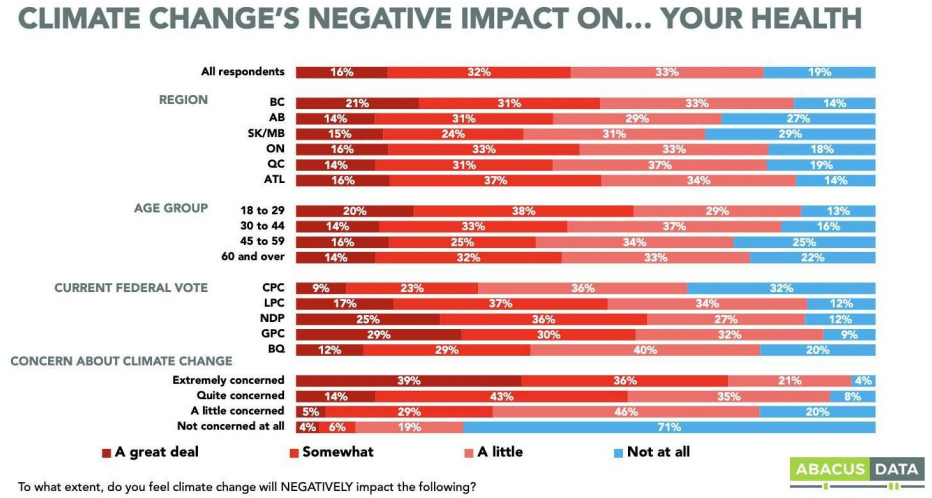
Source: IPCC Sixth Assessment Report, Working Group II

Some good news

Climate emergency declarations



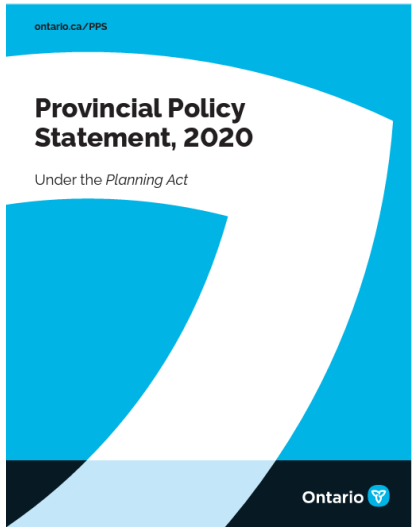
Source: Climate Emergency Declaration and Mobilisation in Action (cedamia)

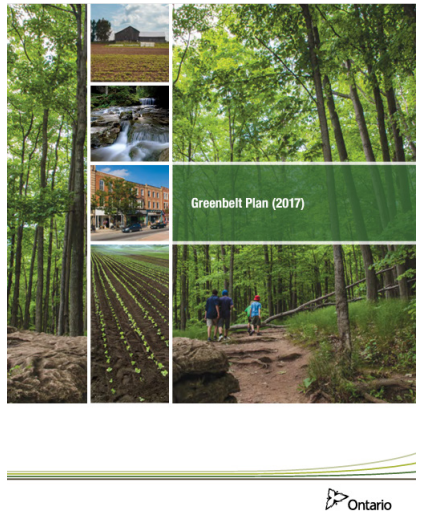


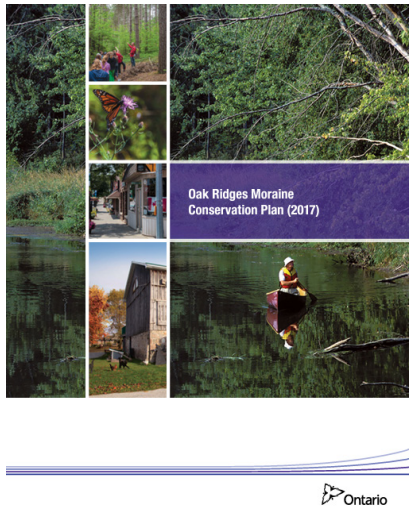
Source: Canadian Climate Institute (Twitter)

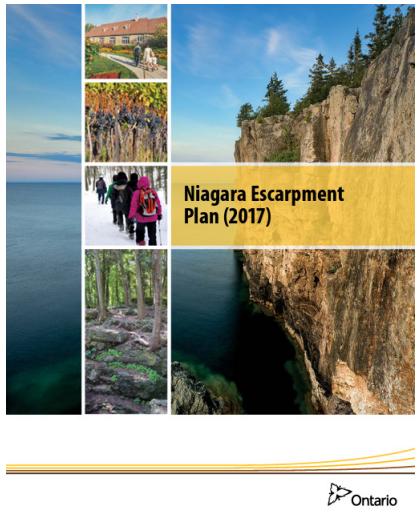
Credit: S. Goldberg

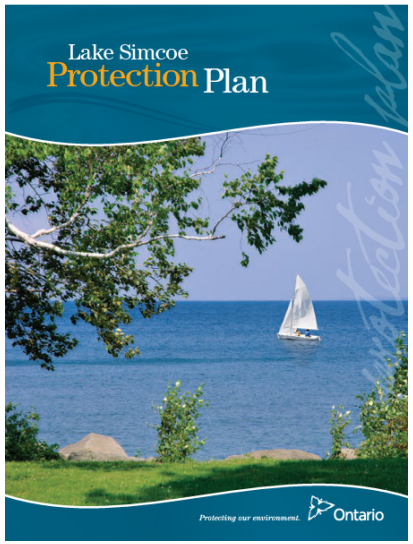
Considering climate change impacts at the watershed scale



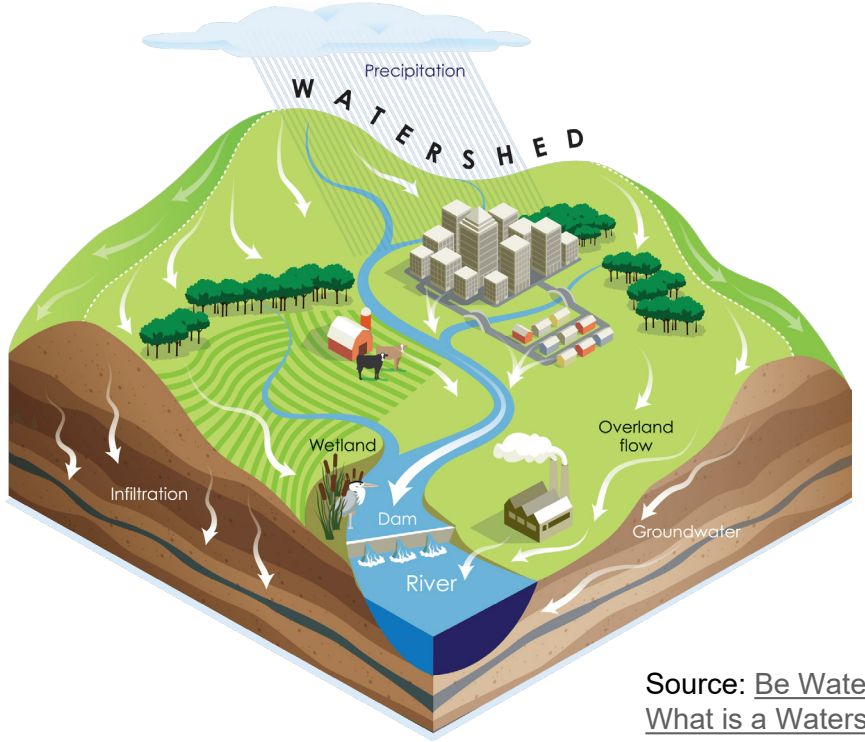








"Planning authorities shall protect, improve or restore the quality and quantity of water by… c) evaluating and preparing for the *impacts of a changing climate* to water resource systems at the watershed level" (PPS, 2020, 2.2.1)



Source: Be Water Friendly: What is a Watershed?

Watershed plans

Helps inform municipal decision-making about:

- Where growth can occur
- How water and wastewater servicing should be planned
- The design of new or expanded infrastructure
- The amount and design of stormwater management that is needed
- How to identify and protect water resources
- Where protection, restoration, and enhancement of the natural environment should occur

How?

How?

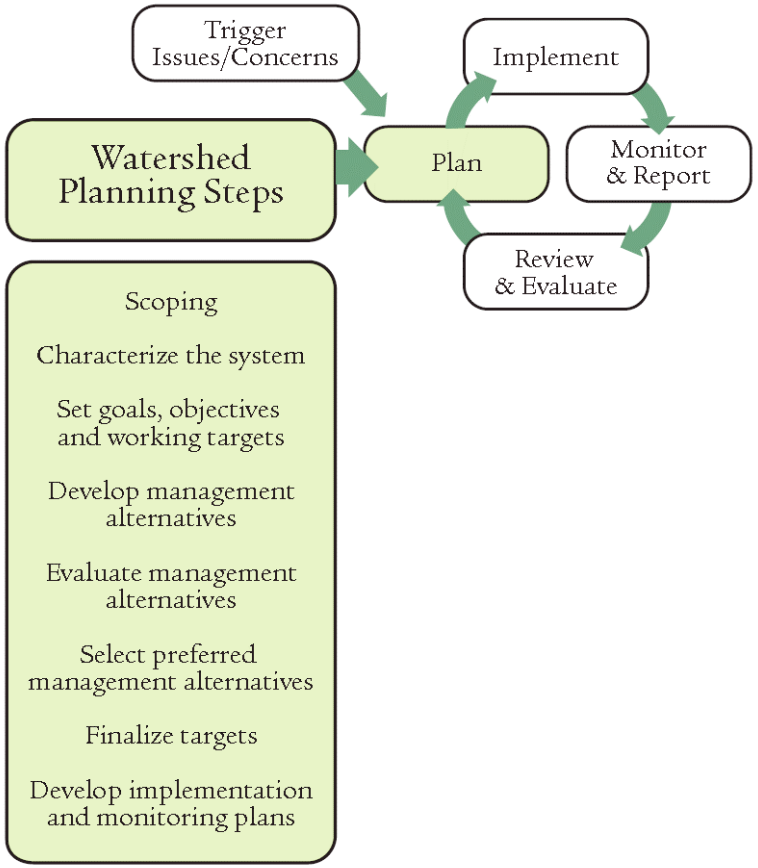
(TRCA’s perspective)

Cycles of adaptive management

Climate adaptation planning process

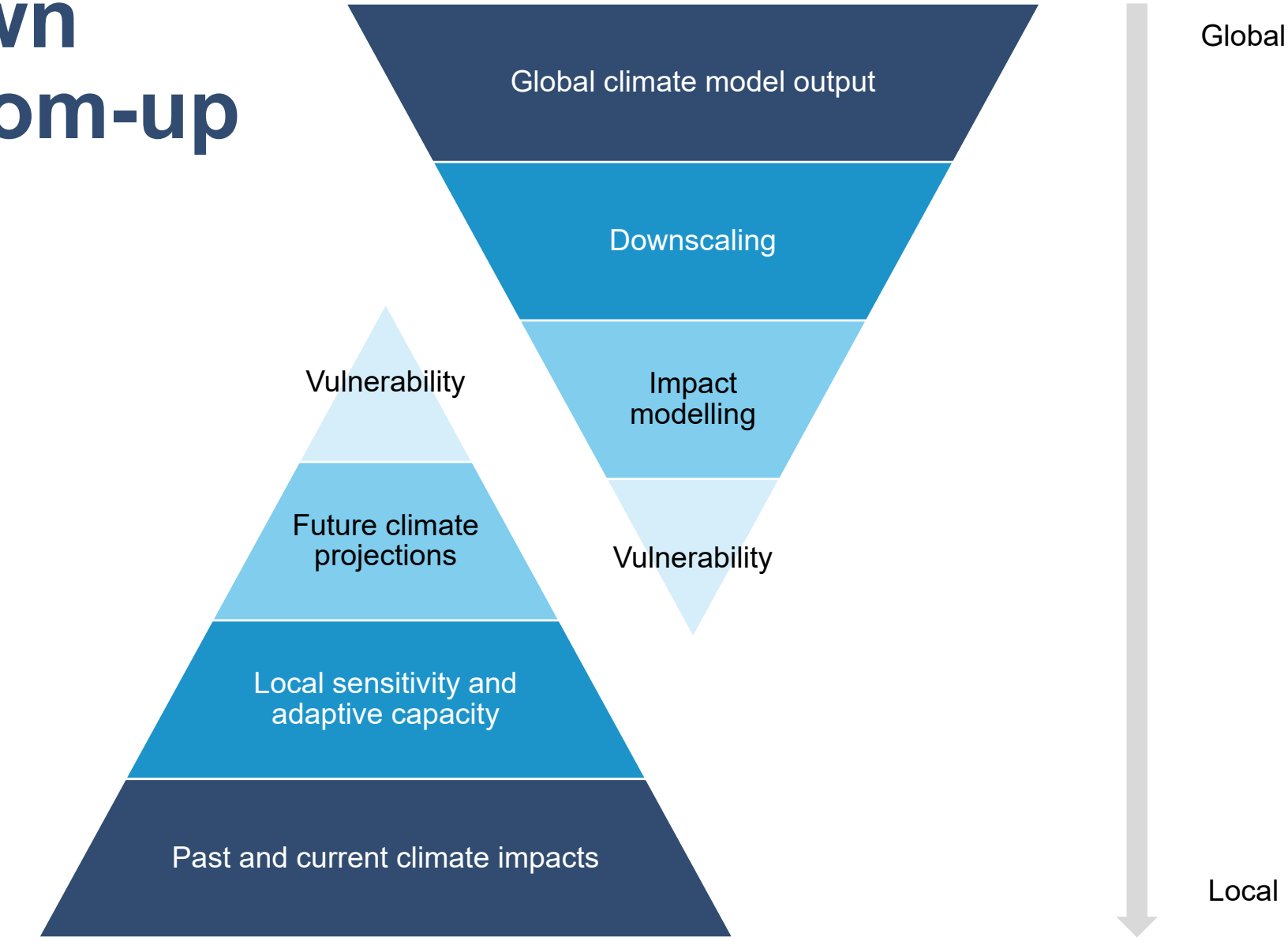
Source: Government of Canada: Canada in a Changing Climate: National Issues Report

Watershed planning process



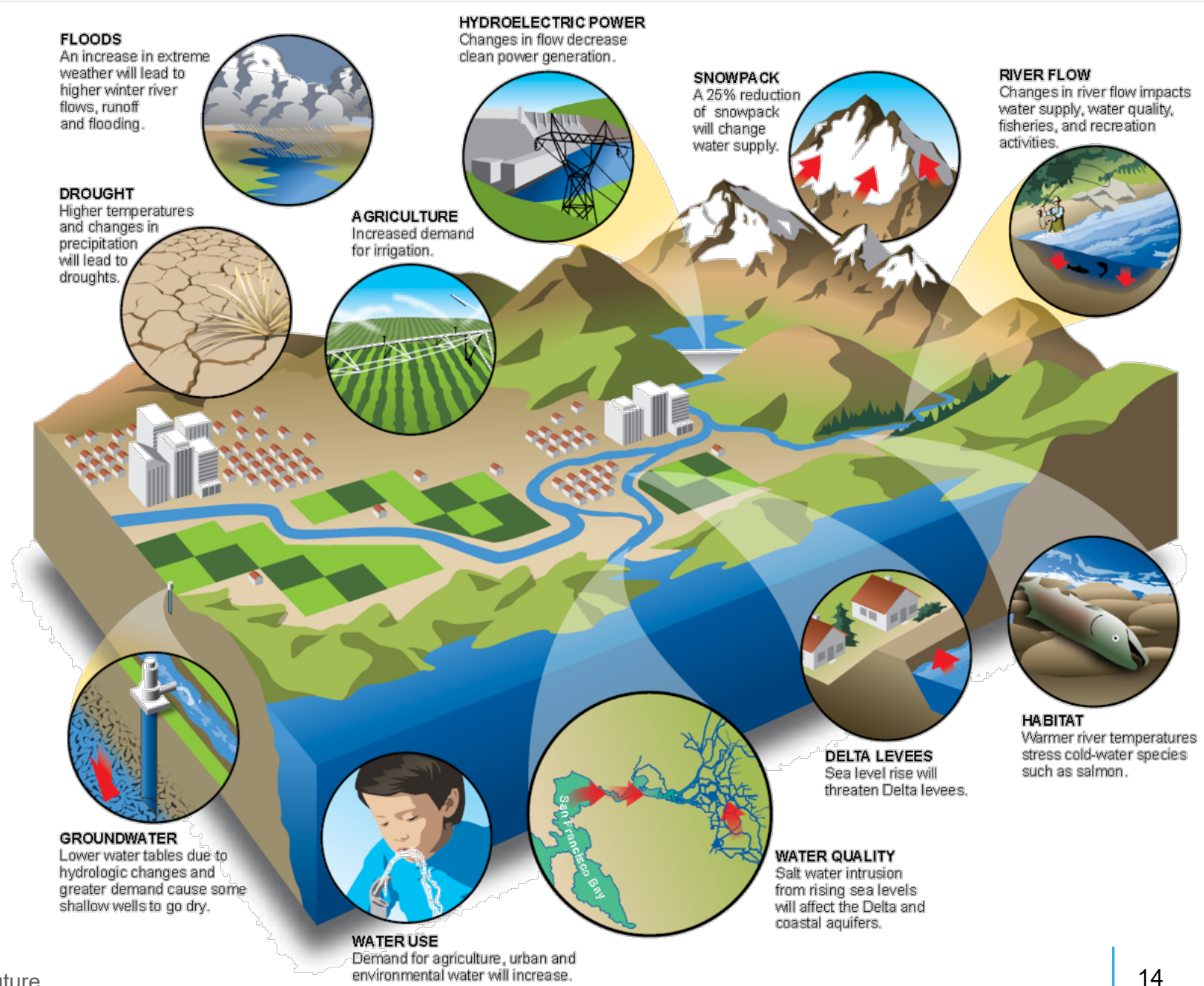
Source: Conservation Ontario: Overview of Integrated Watershed Management in Ontario

Top-down vs. bottom-up

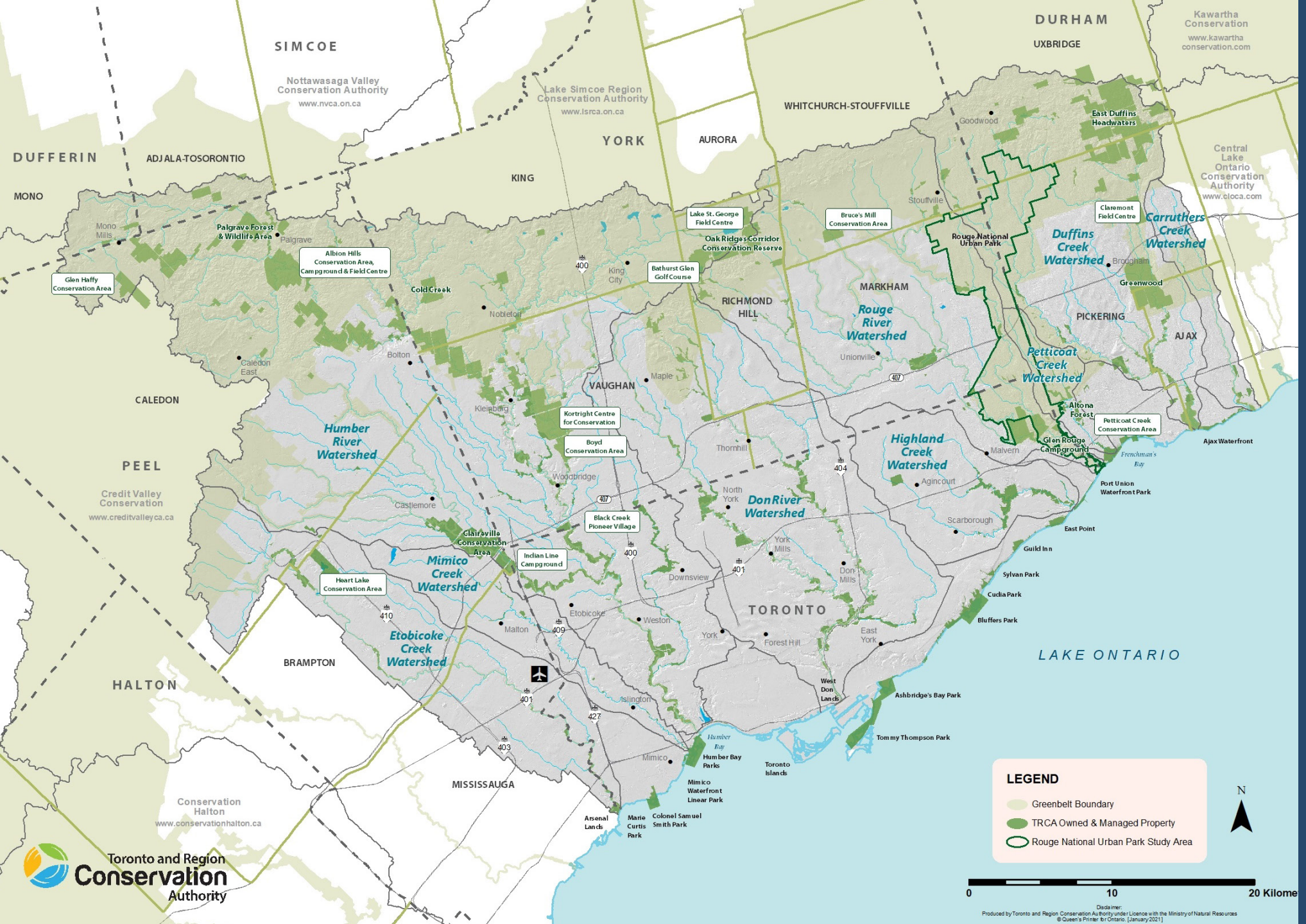


Adapted from various sources including: Canadian Council of Ministers of the Environment: Implementation Framework for Climate Change Adaptation Planning at a Watershed Scale

How climate change impacts a watershed



Source: State of California: Managing an Uncertain Future



By the numbers:

- 9 watersheds
- 6 upper-tier and 15 lower-tier municipalities
- > 3.5 million people live within TRCA-managed watersheds
- ~72 km of Lake Ontario waterfront
- ~18,000 hectares of TRCA-owned lands, making TRCA the largest landowner in the GTA region

TRCA watershed planning process

Engagement

1. Preparation and scoping
2. Watershed characterization
3. Future management scenarios
4. Implementation planning
5. Monitoring and evaluation

Understand historical and current conditions, or the current state of the watershed

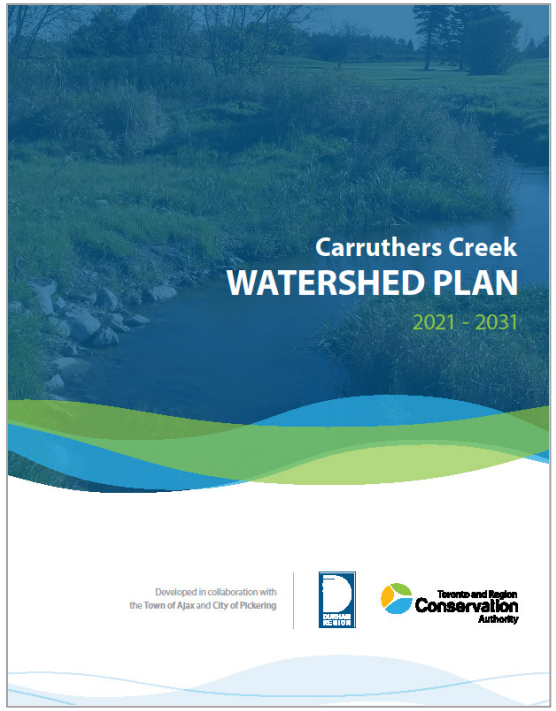
Assess how the watershed would respond to potential future changes

Identify goals, objectives, indicators, and management recommendations

TRCA watershed planning process

Engagement

1. Preparation and scoping
2. **Watershed characterization**
3. **Future management scenarios**
4. Implementation planning
5. Monitoring and evaluation



Etobicoke Creek Watershed Plan (2020-2023)

Humber River Watershed Plan (2022-2025)

Watershed Characterization

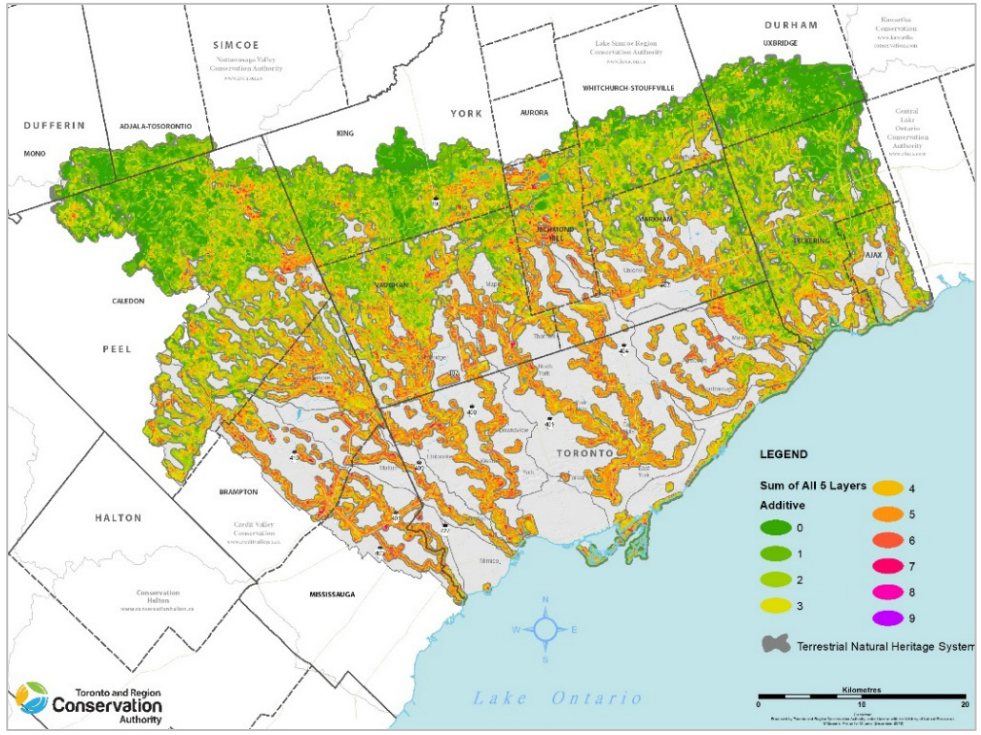
From Carruthers Creek to Humber River

Carruthers Creek	Etobicoke Creek
Aquatic Barriers	Water Resource System
Aquatic Ecology	
Surface Water Quantity	
Headwaters Drainage Features	
Terrestrial Natural Heritage	Natural Heritage System and Urban Forest
Hydrogeology	Natural Hazards
Fluvial Geomorphology Matrix	
Surface Water Quality	Water Quality
	Stormwater Management
	Restoration Planning

New in the Humber River WP: **+ Climate Change**

Etobicoke: Natural Heritage System

- Climate change vulnerability indicators and areas
- Based on TRCA's Terrestrial Ecosystem Climate Change Vulnerability Assessment (2020)



Vulnerability Indicator	Highly Vulnerable Areas (ha)	Percent of natural cover (%)
Habitat patch quality	1,063	41%
Wetland vulnerability	70	2.7%
Climate-sensitive vegetation communities	2	0.1%
Soil drainage	15,586	70%
Ground surface temperature	14,026	63%

Humber: Research questions

Data Analysis

Public Engagement + Literature Scan

Policy Scan

1. How has the climate changed over the Humber River watershed between 1961-1990 to 1981-2010?
    a. Are changes occurring uniformly across the watershed?
    b. How do the changes compare with the rest of the jurisdiction?
2. What climate-related impacts have already been felt across the Humber River watershed, including impacts on natural and human systems?
3. What actions have been undertaken to address climate change (both mitigation and adaptation) at the municipal or watershed-scale?
    a. What targets are municipalities working towards?

Humber: Climate parameters

- Mean temperature
- Maximum temperature
- Minimum temperature
- Extreme heat
- Extreme cold
- Total precipitation
- Extreme precipitation
- Dry days
- Agricultural variables
- Ice potential

- Also exploring:
  - Drought/moisture deficit
  - Length of extreme heat and cold
  - Snow

Local climate data

Dynamical Downscaling

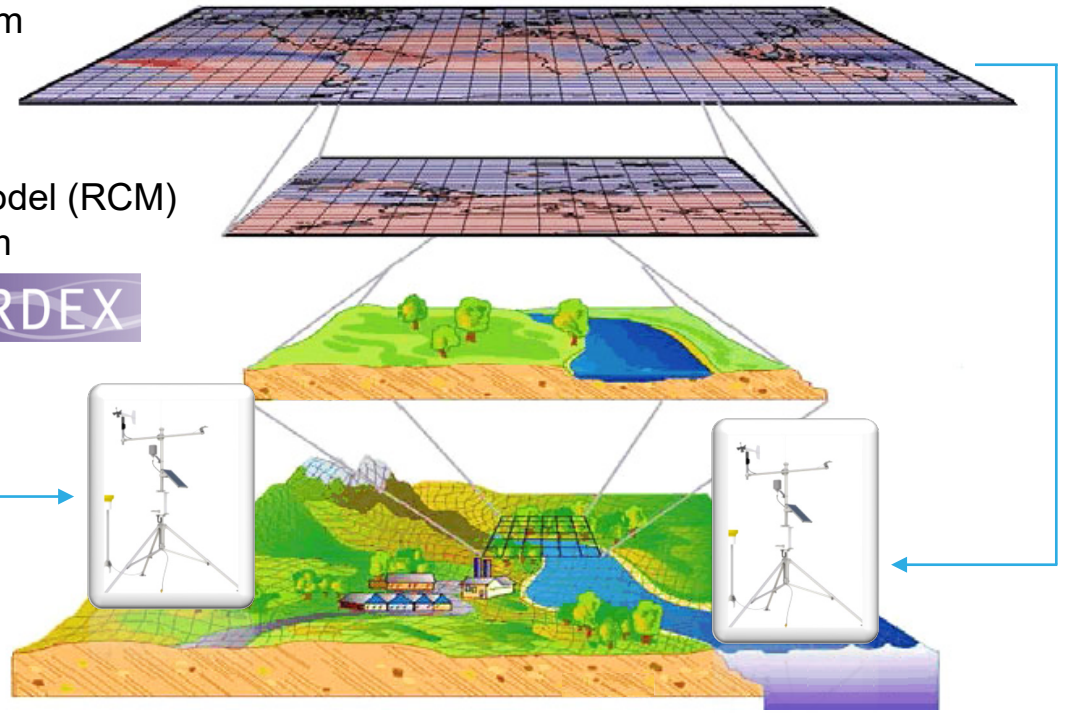
Global climate model (GCM)
~100-300 km

Regional climate model (RCM)
~50-10 km

NA-CORDEX

Bias adjustment

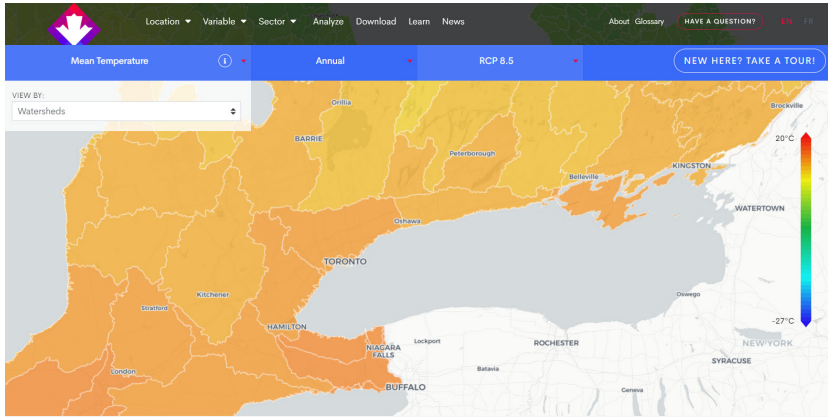
Statistical Downscaling



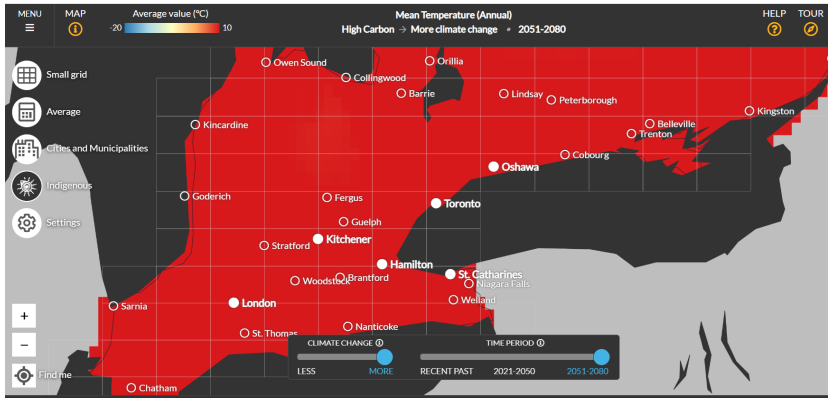
Source: Indiana University Bloomington

Examples of existing climate data portals:

ClimateData.ca

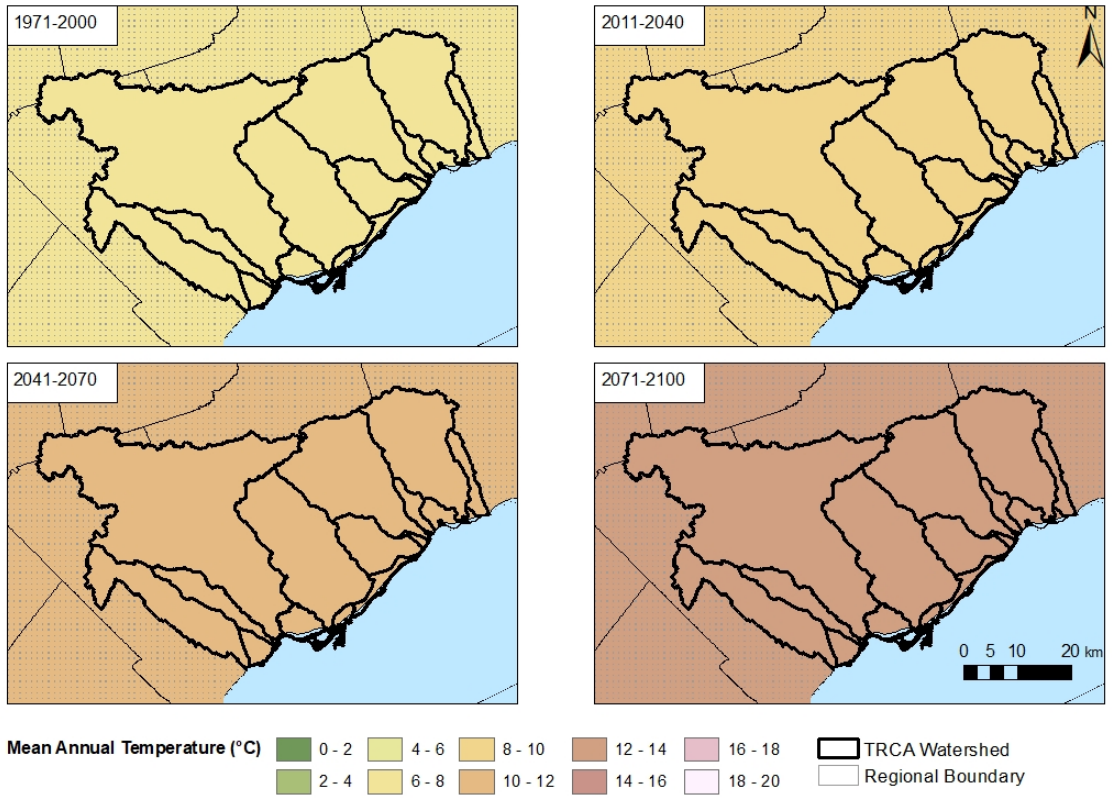


Climate Atlas of Canada



Humber: Climate data and impacts

Bias-adjusted, regional climate model ensemble output



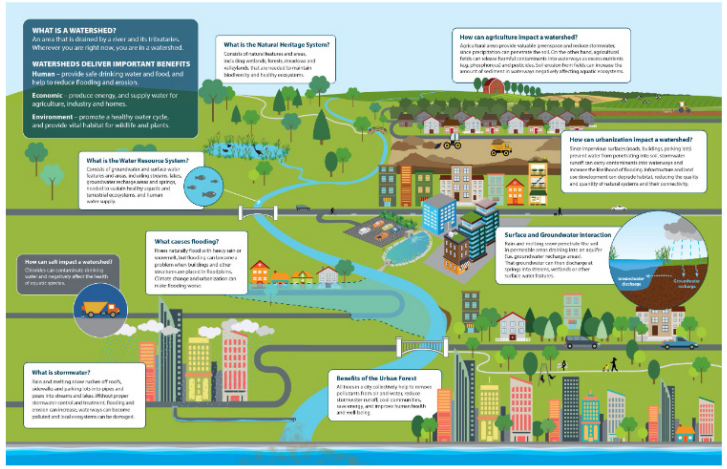
Climate/weather-related stories

HRWP Engagement Survey

The following introduction sets the context for the survey questions, which begin on the next page.

What is a Watershed?

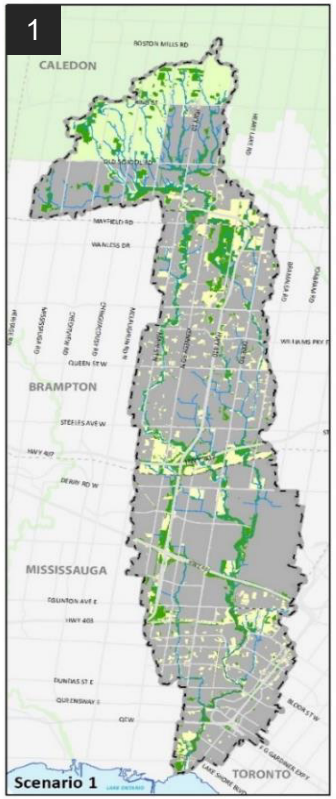
The video and graphic below help explain what a watershed is and the impacts of certain land uses.



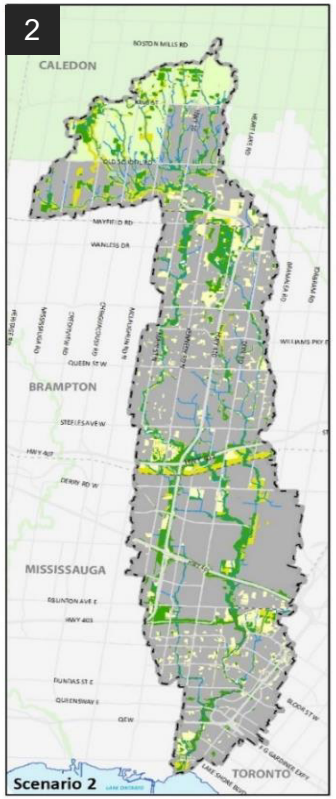
Future Management Scenarios

Future management scenarios

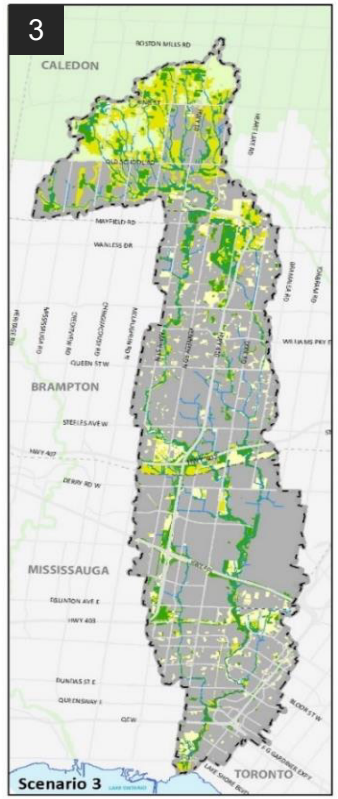
	Urban Expansion	NHS Cover	Canopy Cover	Runoff Control
Current	No	12.3%	14.7%	Existing
1	Yes	12.4%	14.7%	5 mm
2	Yes + Highway 413	18.5%	18.8%	12.5 mm
3	Yes	22.8%	26.5%	25 mm
4	No	22.8%	26.7%	25 mm



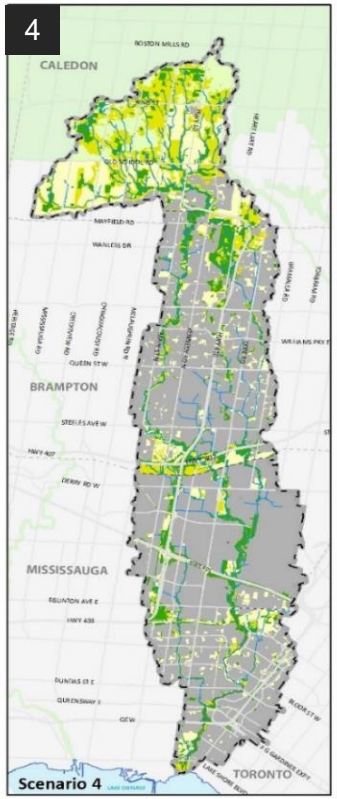
Urban expansion with minimal enhancements



Urban expansion with moderate enhancements
+
GTA West Hwy



Urban expansion with optimal enhancements



Existing urban boundary with optimal enhancements

Qualitative approach

- What if scenarios → climate impact statements

If (climate stressor)	Then (outcome)	So (consequence)
Increase in air temperatures	Warmer water temperatures	Loss of cold/cool fish habitat
Increase in air temperatures	Warmer water temperatures	Increase in algal blooms, especially in lakes, ponds and slow-moving rivers
Increase in the intensity and frequency of precipitation events	Increased runoff from roads and/or agricultural land	Decrease in stream water quality
Increase in the frequency/intensity of extreme weather events	Damage to trees and natural features in riparian corridors	Loss of ecosystem goods and services
Increase in the frequency/intensity of extreme weather events	Damages to urban trees (and reduced urban tree canopy cover)	Loss of ecosystem goods and services
Increase in average temperature and hot days over 30 °C	Higher tree mortality	Decreased shade from loss of urban tree canopy
Increase in average temperatures and changes in precipitation patterns	Shifting eco-regions for flora and fauna	Increased survival and spread of invasive species such as Emerald Ash Borer

Quantitative Approach

Downscaling method	Daily	Subdaily	Needs correction?
Statistically	Climate portals: climatedata.ca; climateatlas.ca	University of Wisconsin-Madison: Daily data disaggregated into hourly	No
Dynamically	NA-CORDEX	NA-CORDEX direct request; bias correction method and daily data needed	Yes, with observed dataset

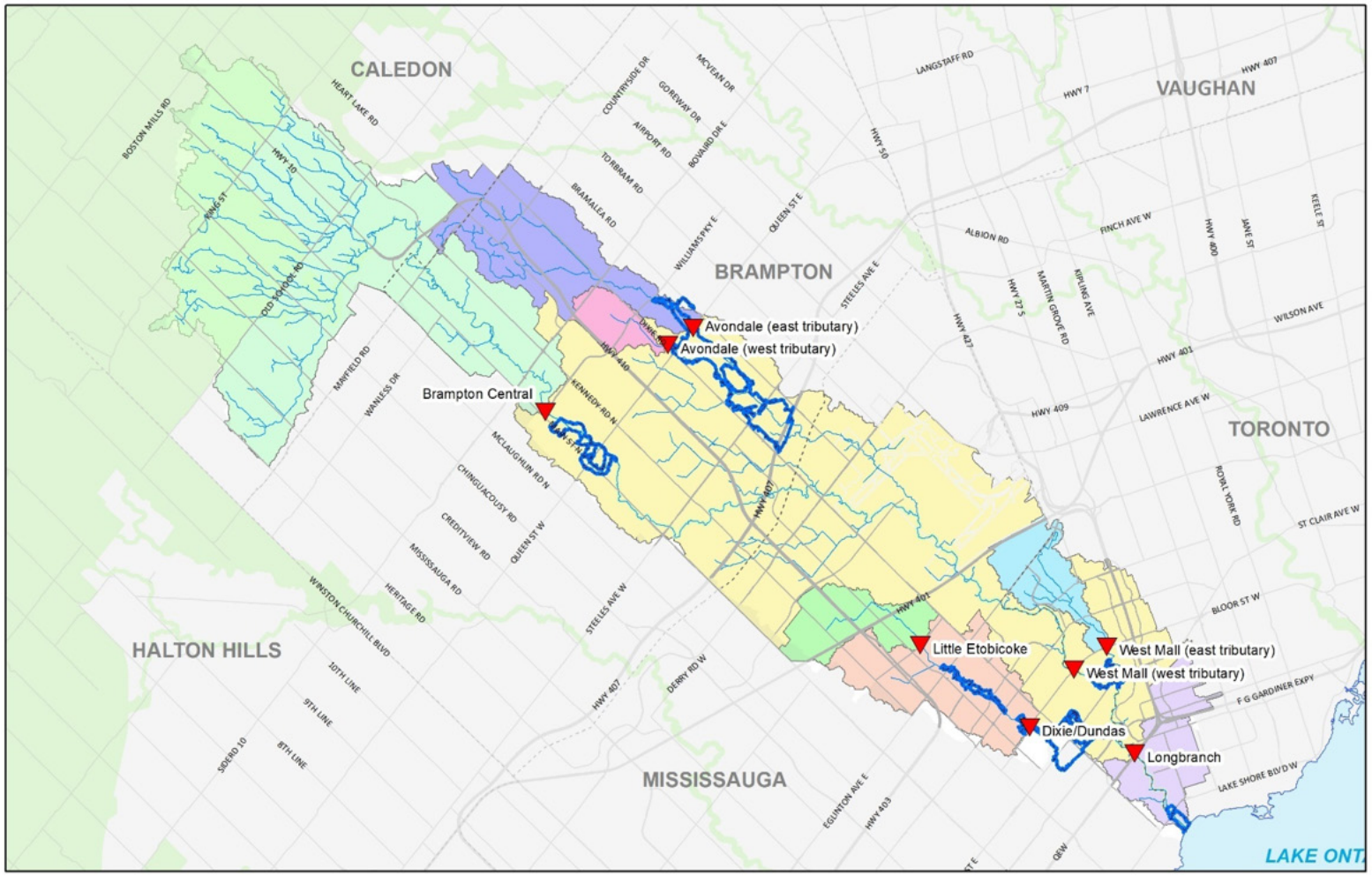
Challenges

Scenario 1: Urban Expansion with Minimal Enhancements	Scenario 2: Urban Expansion with Mid-range Enhancements	Scenario 3: Urban Expansion with Optimal Enhancements	Scenario 4: Existing Urban Boundary with Optimal Enhancements
Current Climate	Current Climate	Current Climate	Current Climate
Future Climate	Future Climate	Future Climate	Future Climate

To include and differentiate climate impacts on future management scenarios, you would need to double the number of scenarios.

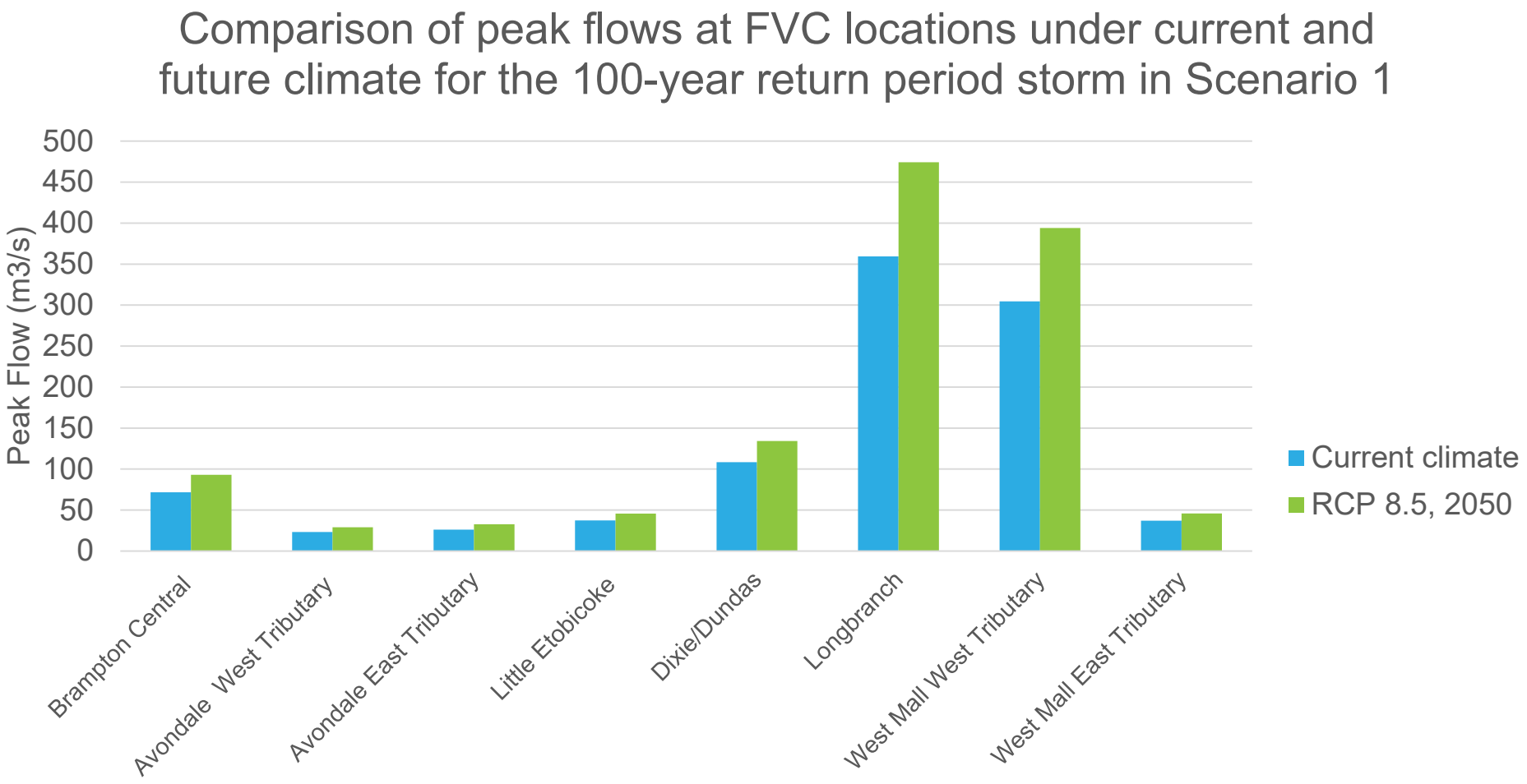
Etobicoke: Flood Risk

- Objective: Identify flood vulnerable clusters and compare peak flows between scenarios
- Integrating CC - Update **event** design storms (2-100 yr return period) used in hydrology model based on projected climate (IDF-CC Tool)
- With **continuous** modeling, can comment on frequency and duration of flooding

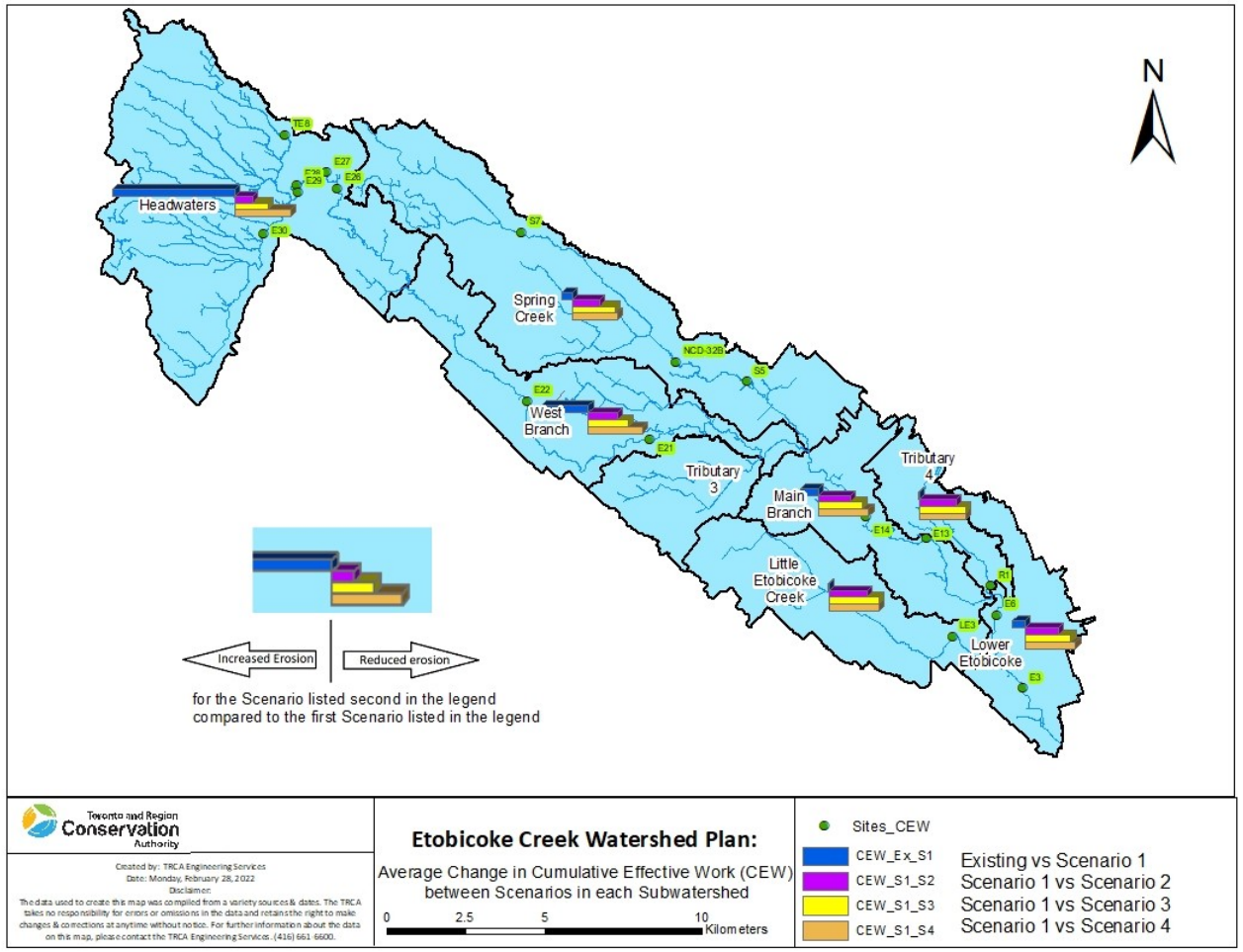


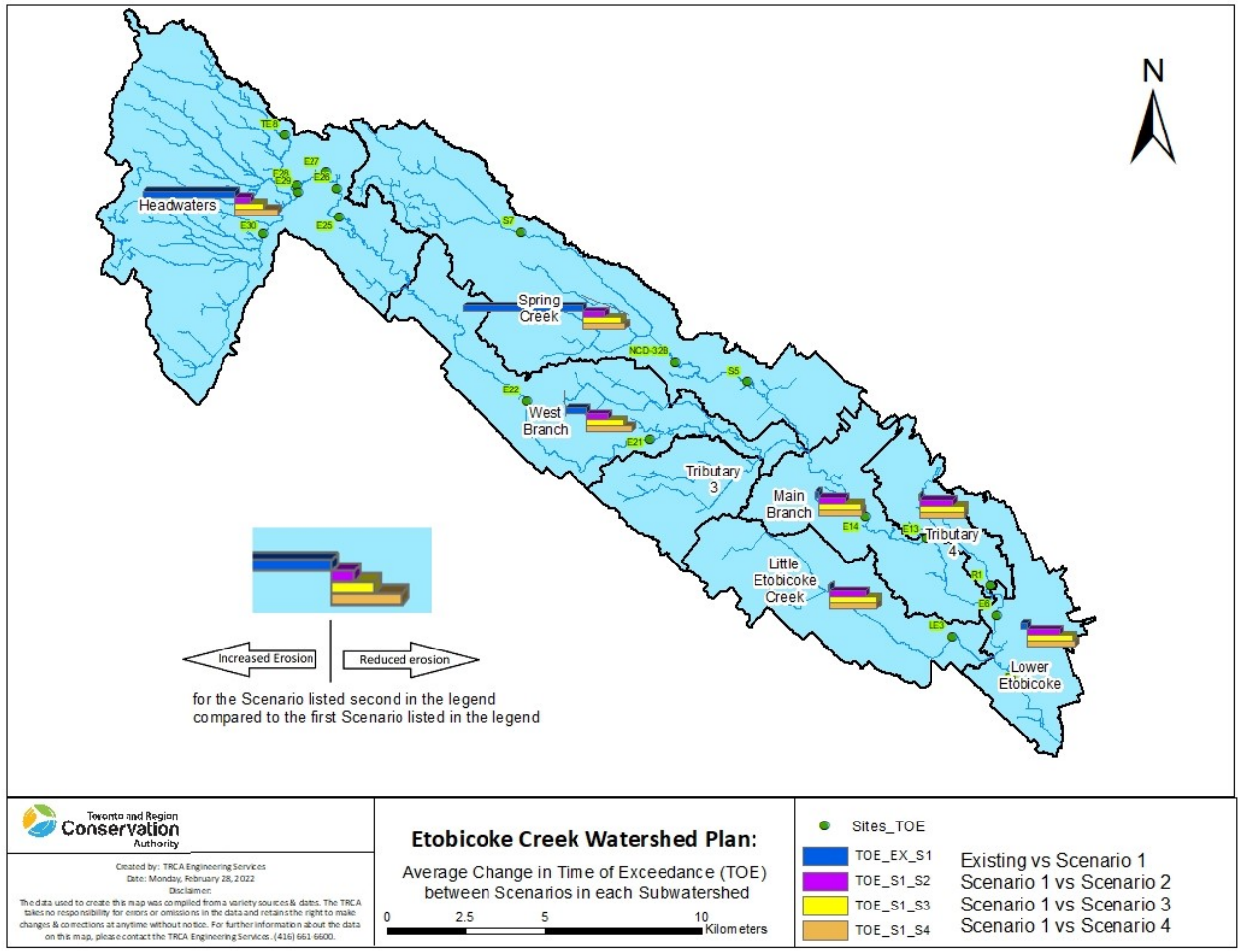
Flood vulnerable clusters in the Etobicoke Creek Watershed

Etobicoke: Flood Risk

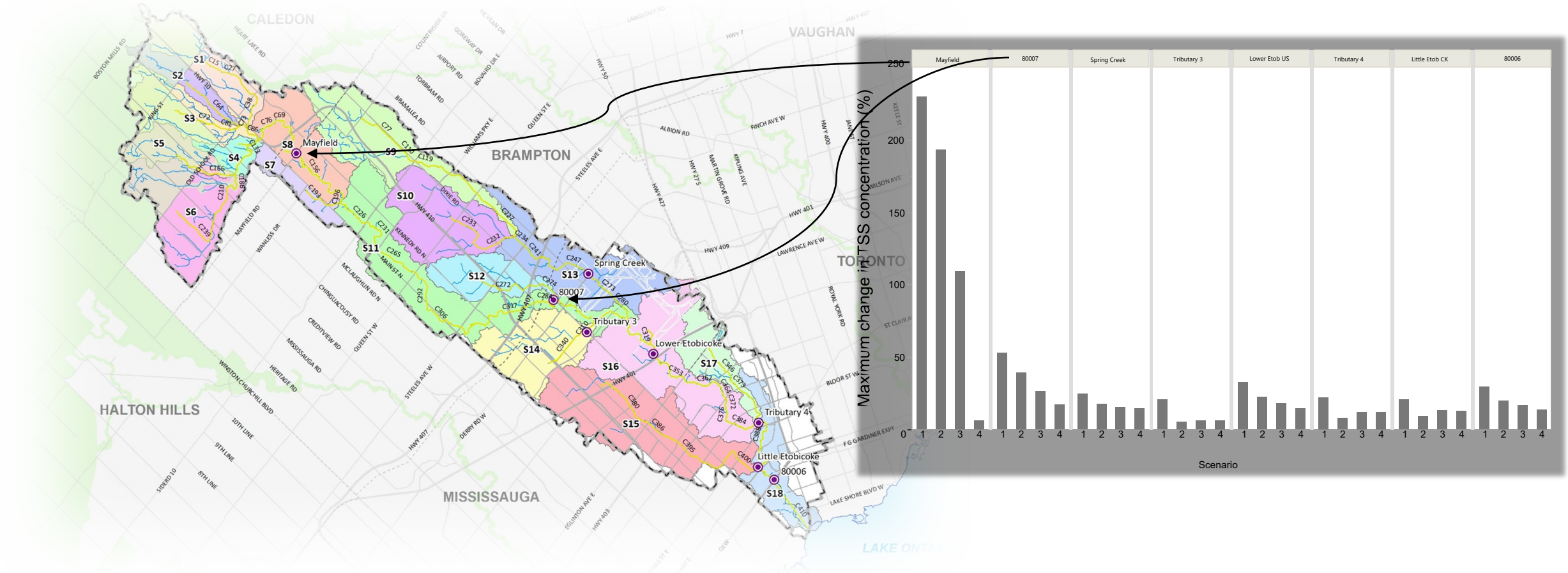


Etobicoke: Erosion Potential





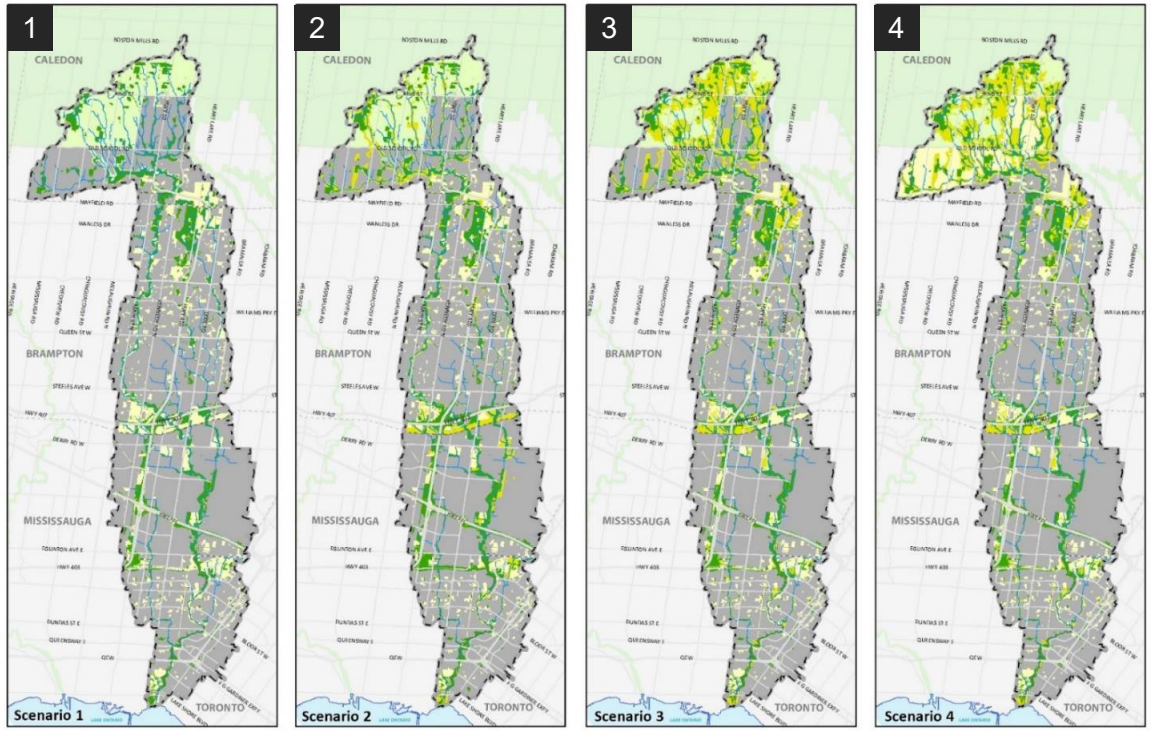
Etobicoke: Water Quality



Etobicoke: Urban forest

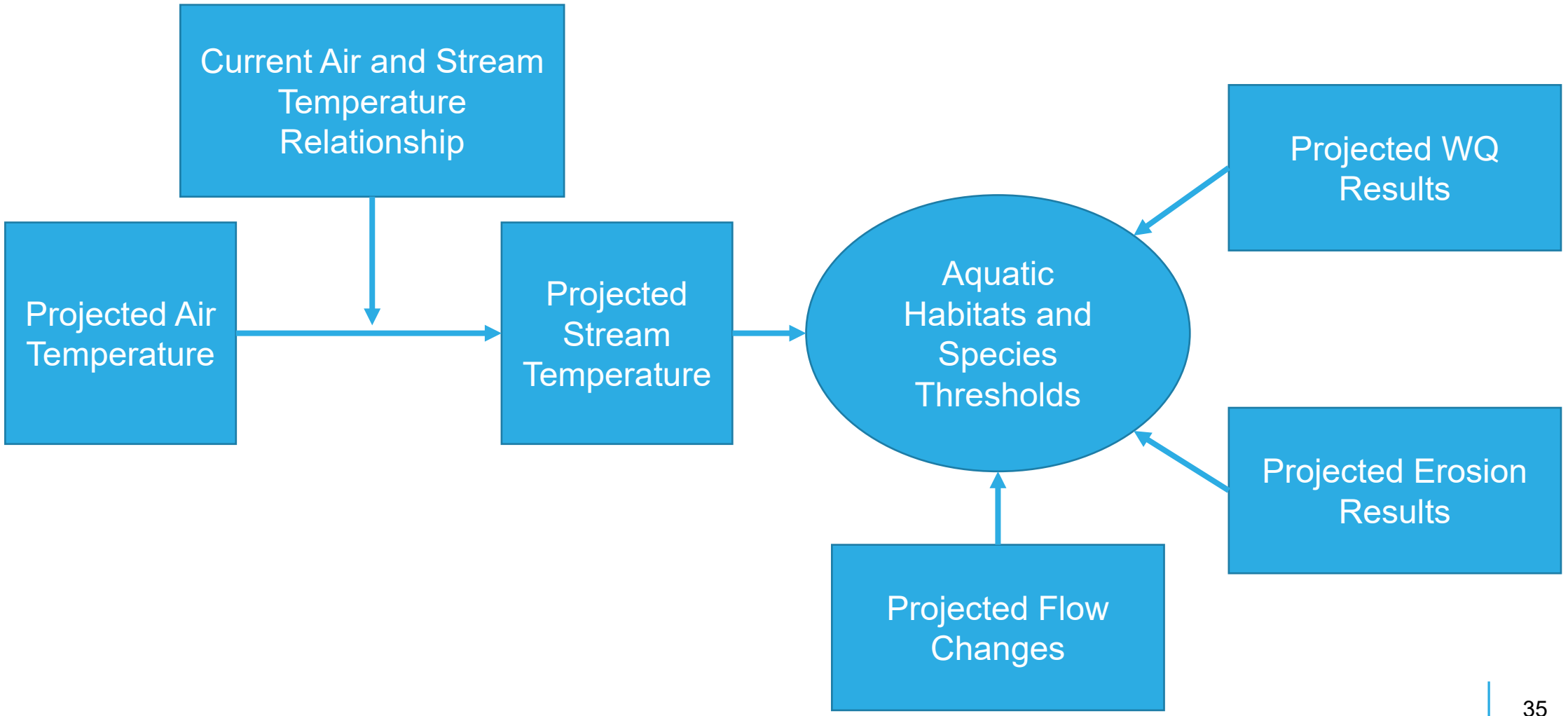
- Objective: Identify tree planting opportunities under each future management scenario
- Integrating CC – a qualitative approach was taken (if-then-so)
- With species distribution data, a more quantitative spatial analysis of vulnerability could be undertaken (e.g. heat and drought tolerance)
- CC can also be considered in the prioritization phase to identify suitable/strategic areas to prioritize planting

Etobicoke Creek Scenarios



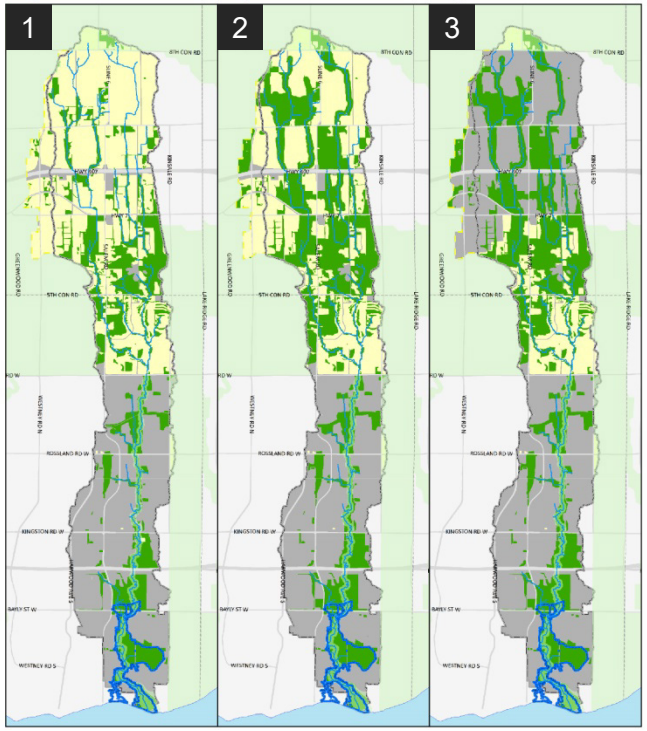
Scenario 1	Scenario 2	Scenario 3	Scenario 4
Urban expansion with minimal enhancements	Urban expansion with moderate enhancements + GTA West Hwy	Urban expansion with optimal enhancements	Existing urban boundary with optimal enhancements

Etobicoke: WRS-Aquatic Species/Habitat



From Carruthers Creek to Humber River

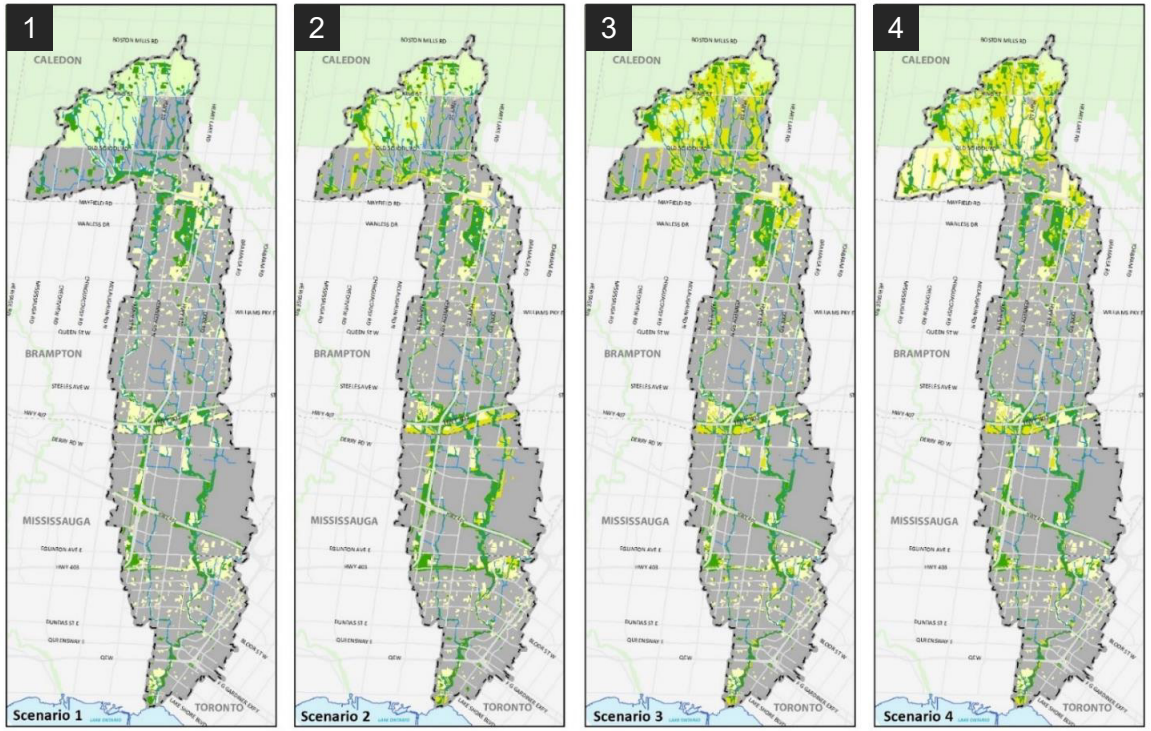
Carruthers Creek → Etobicoke Creek → Humber River



Official Plan (2031)

Official Plan (2031) + Enhanced NHS

Post-2031 development in the headwaters outside the enhanced NHS



Urban expansion with minimal enhancements

Urban expansion with moderate enhancements + GTA West Hwy

Urban expansion with optimal enhancements

Existing urban boundary with optimal enhancements

+ Climate change (RCP 8.5, possibly 4.5)

Work with Tech Leads to develop a tailored approach to integrating CC into all technical components

Align climate projections with land use scenario timelines

Future directions for integrating climate change

- Ecosystem response modelling
- IPCC Sixth Assessment Report (AR6) scenarios
- Cumulative effects assessment (including development applications)
- Ecosystem services (valuation and impacts)
- Monitoring and evaluation (including key performance indicators)
- TRCA Climate Change Action Plan


Credit: Jason Raposo

Workshop

Activities:

1. Mapping approaches for integrating climate change into watershed planning (*12 min*)

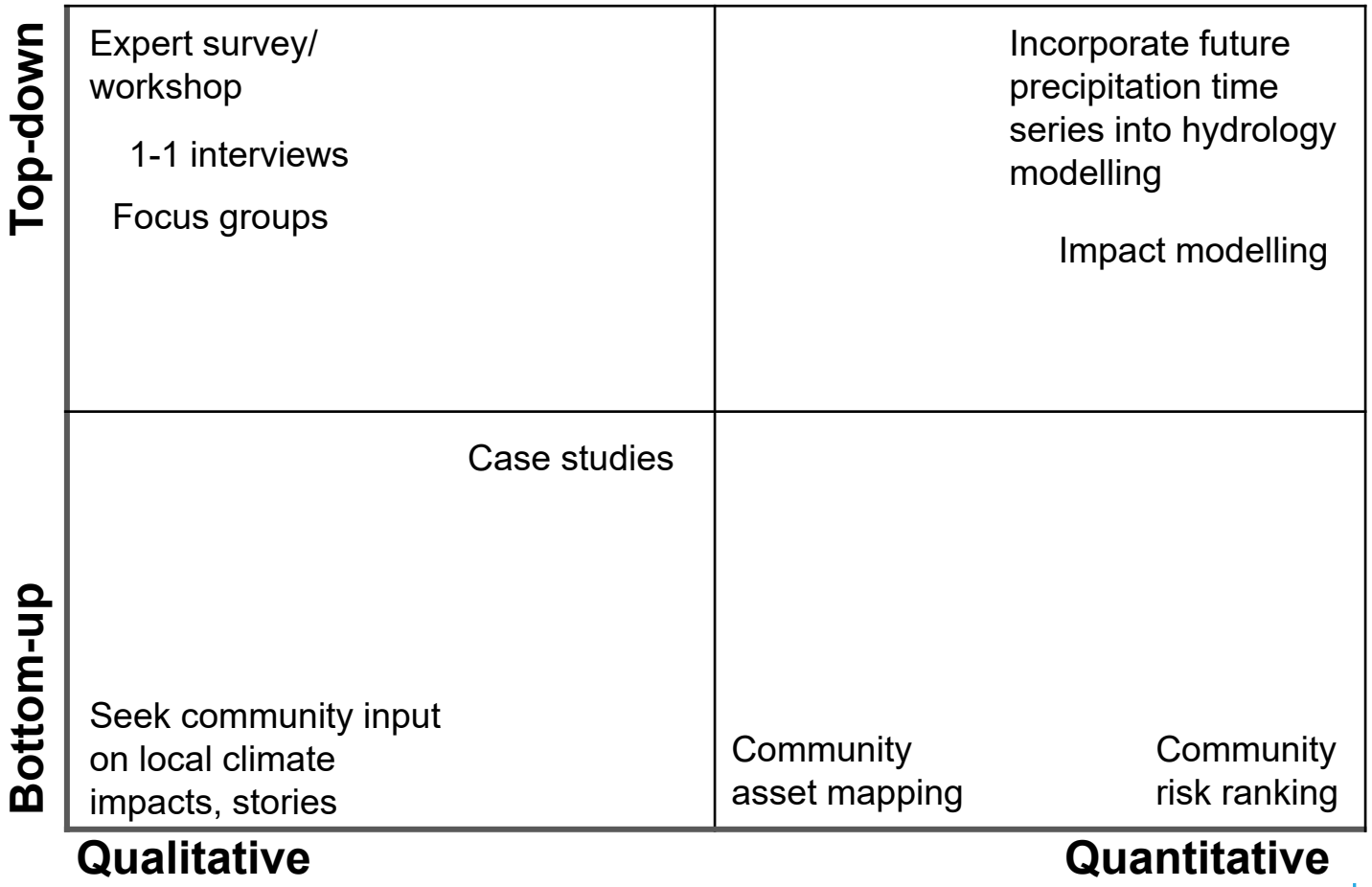
2. Identifying existing knowledge and implementation gaps (*15 min*)

Activity 1: Mapping approaches for integrating climate change into watershed planning

How have you integrated climate change into watershed planning, or what plans or ideas do you have?

Think:

- Characterization
- Scenario planning
- Management framework



Activity 2: Identifying existing knowledge and implementation gaps

What knowledge/implementation gaps have you encountered, and how have you overcome them?

Think:

- Governance
- Policy, planning, and program
- Engagement
- Research and evidence
- Implementation
- Monitoring and evaluation

Examples from the 2018 Watershed Forum:

Barriers	Actions
• Lack of a clear definition of roles and responsibilities involved in watershed planning • Lack of a comprehensive and holistic guidance from the Province related to climate change and watershed planning • Misunderstanding of the costs and benefits of climate impacts on water resources • Funding limitations	• Provide a clear definition of roles and responsibilities • Build partnerships and collaborations among experts who can inform the integration of climate data into watershed plans • Formalize provincial guidance • Bring implementers to the table during the watershed planning process • Express climate change actions in terms of cost-benefit

Workshop

Activities:

1. Mapping approaches for integrating climate change into watershed planning (*12 min*)
2. Identifying existing knowledge and implementation gaps (*15 min*)

Break-out Group Facilitators:

1. Yuestas David & Andrew Chin
2. Sharon Lam
3. Jonathan Ruppert & Rebecca Dolson
4. Lyndsay Cartwright & Caitlin Fortune
5. Meredith Carter & Karen Halley

Thank you

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Watershed plan components affected by climate

WRS	NHS/Urban Forest	Water Quality	Natural Hazards
Aquatic (fish and benthic) biodiversity	Terrestrial biodiversity	Pollutant wash-off	Flood risk (FVC)
Aquatic habitat quality	Habitat patch vulnerability		Erosion risk
Streamflow	Urban forest biodiversity		
Groundwater			