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State of Climate Change Science and Practice in Ontario

Fabio Tonto, Project Manager
Edmundo Fausto, Project Manager

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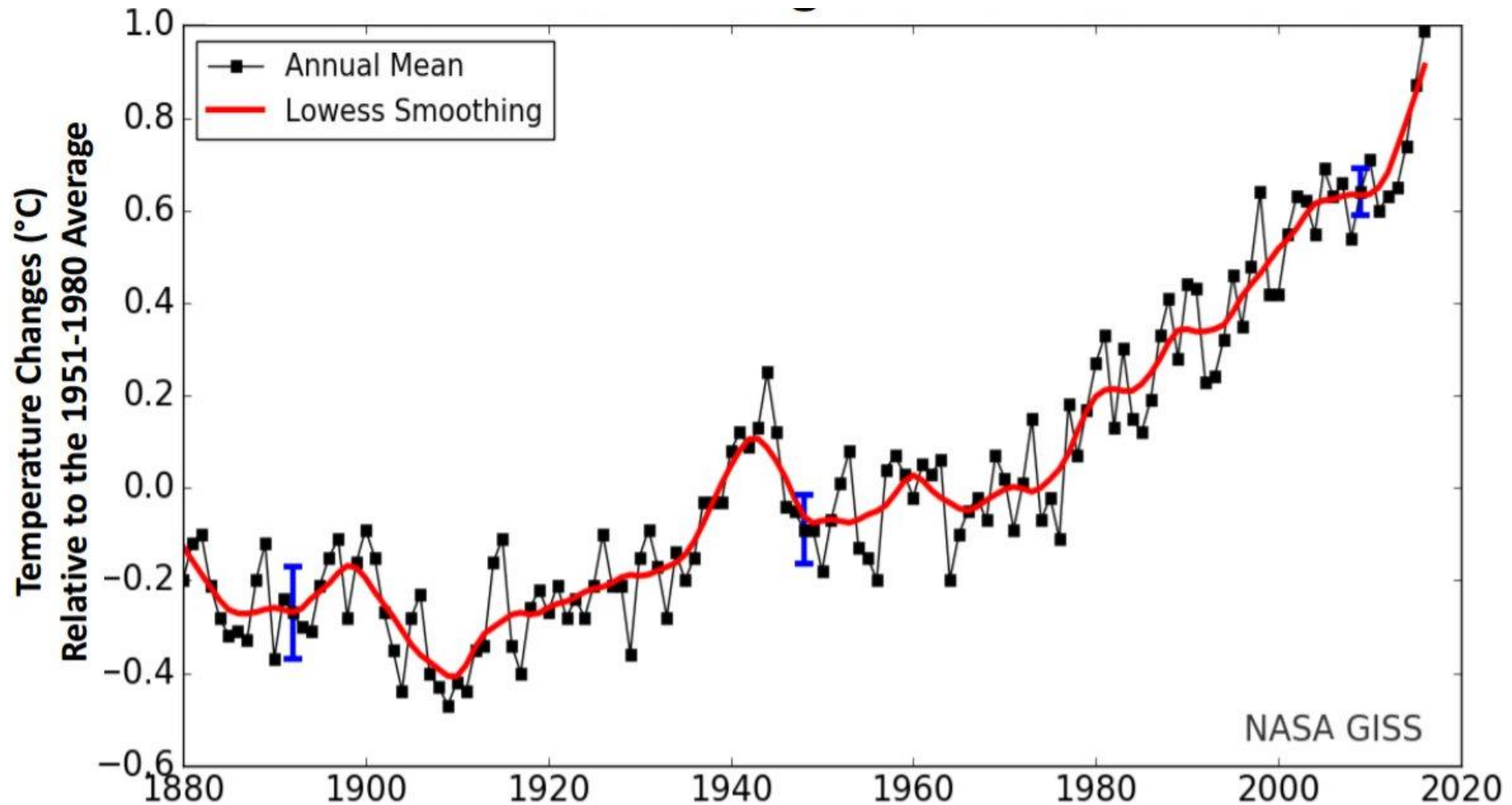
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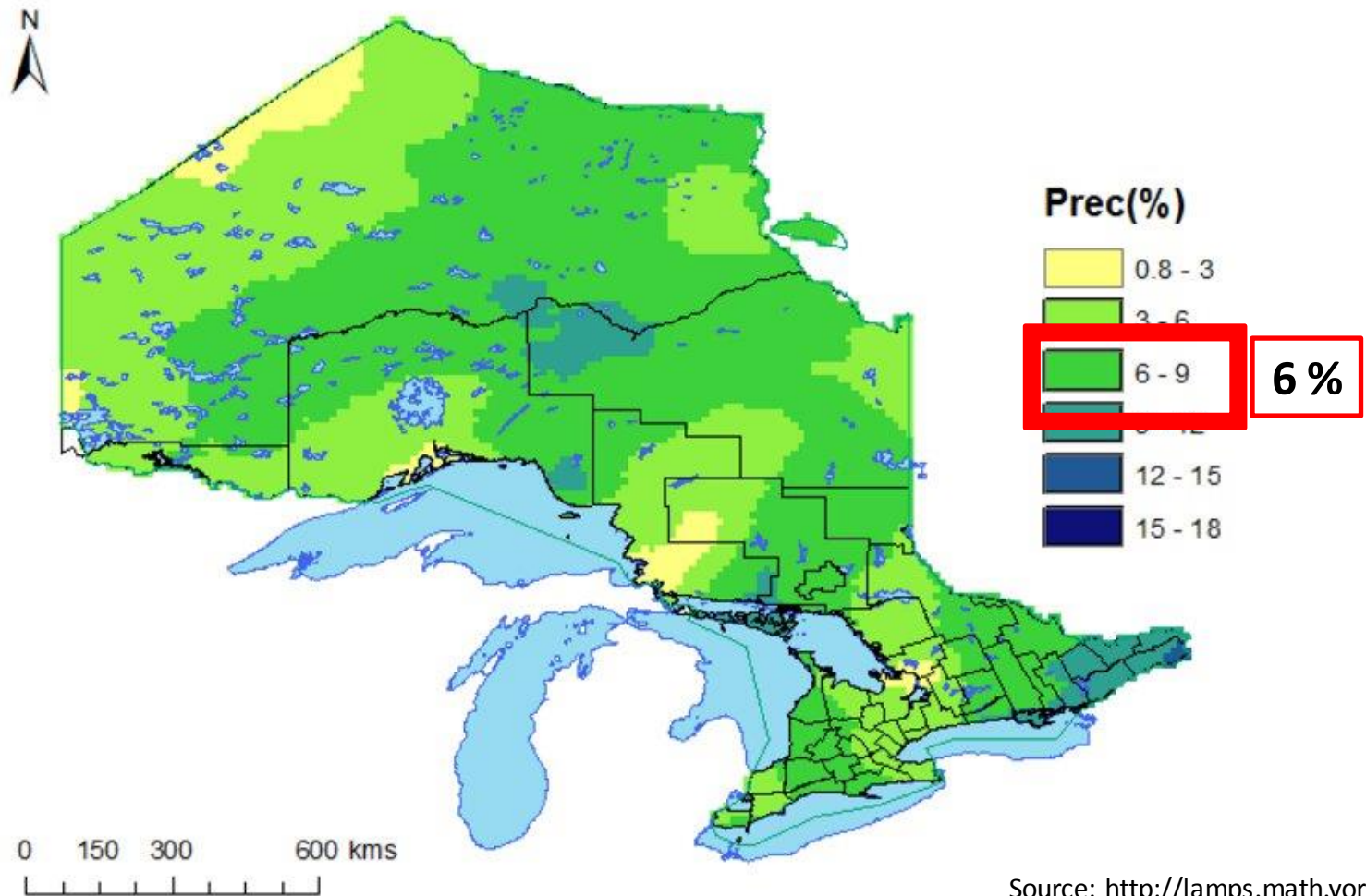
Today's Purpose

- Discuss The Issues and Risks
- Current Methods
- Updated Frameworks to Mitigate Risk

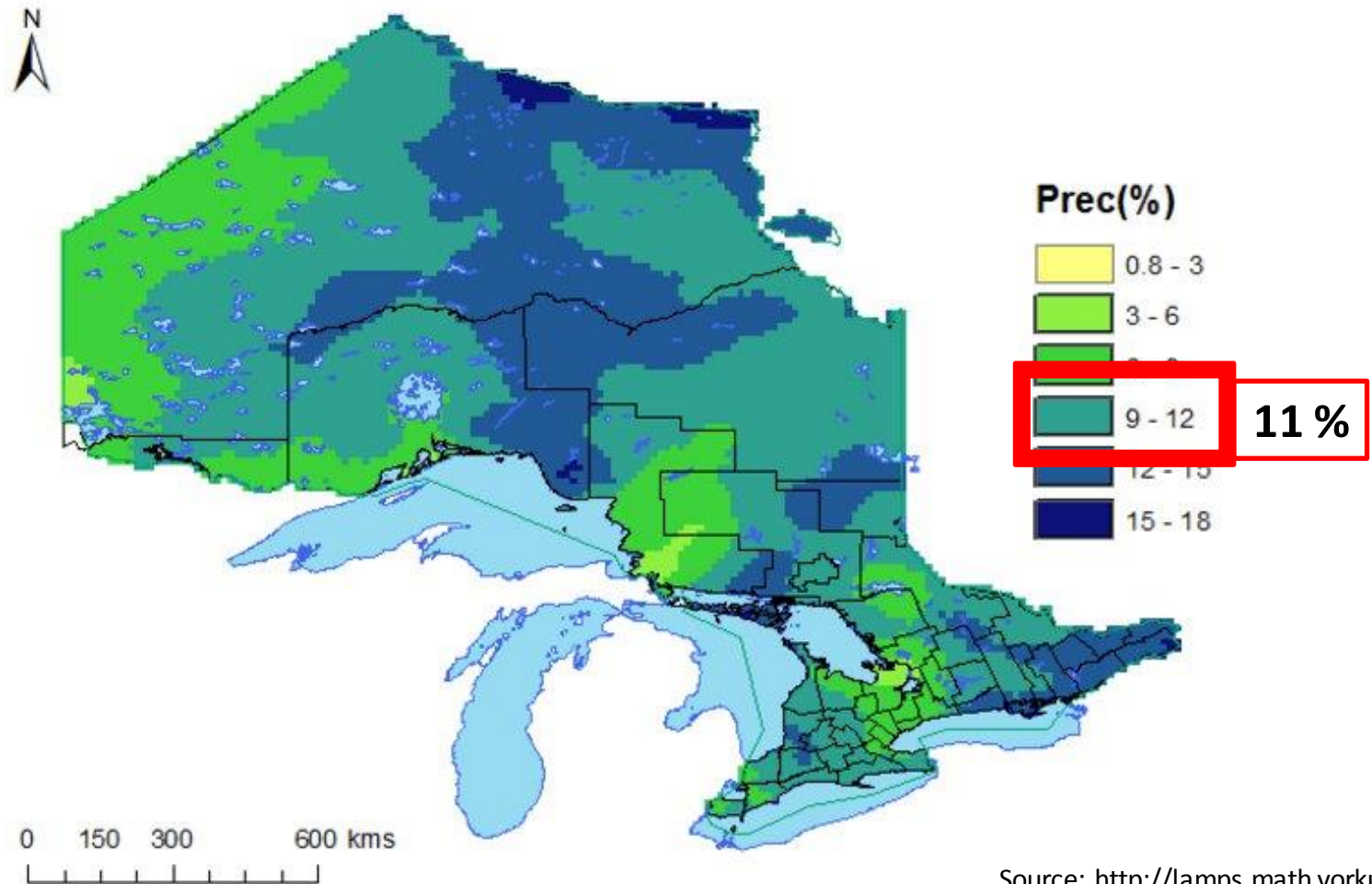
Global Mean Temperatures



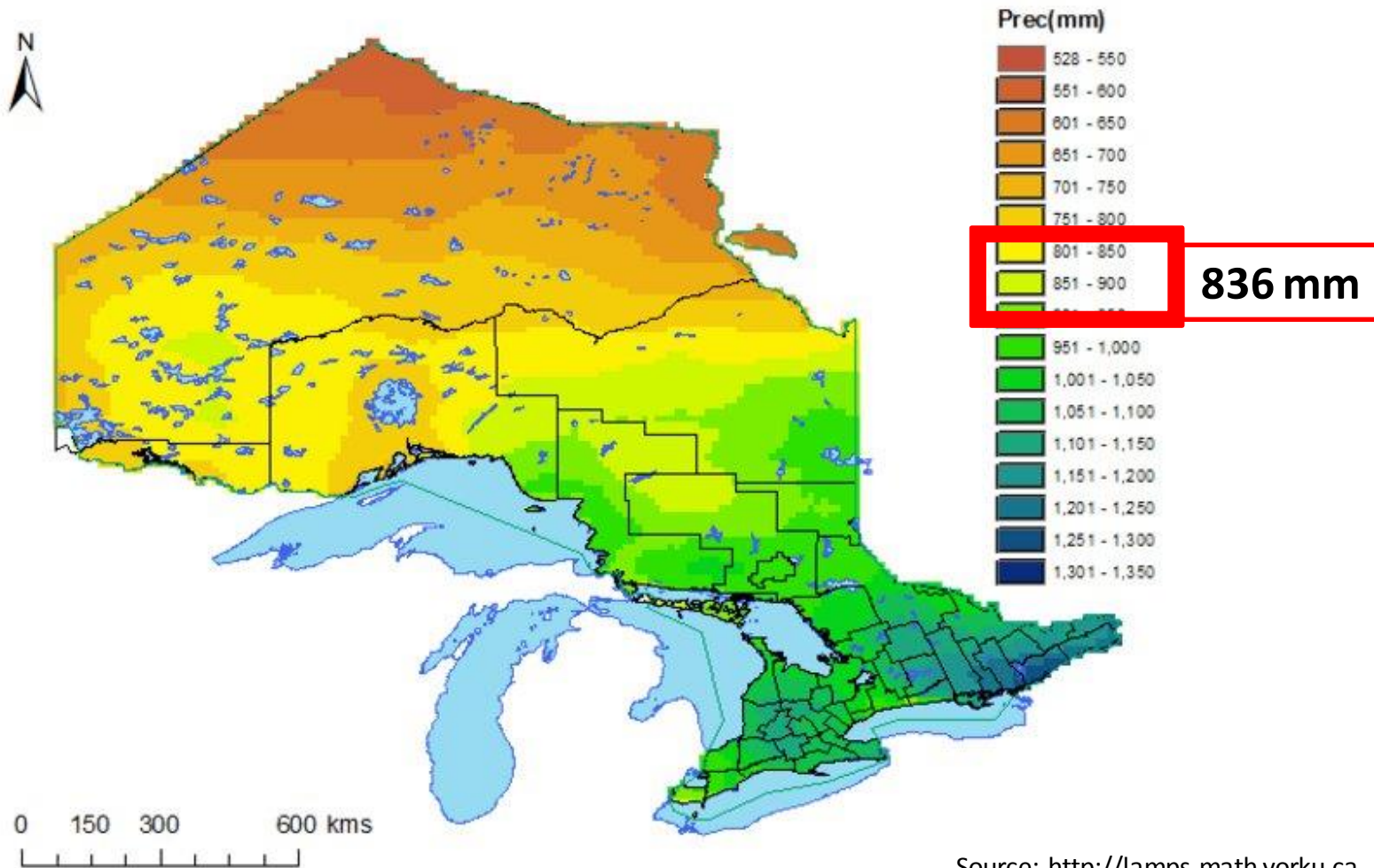
Precipitation changes on the way in Ontario (2050's)



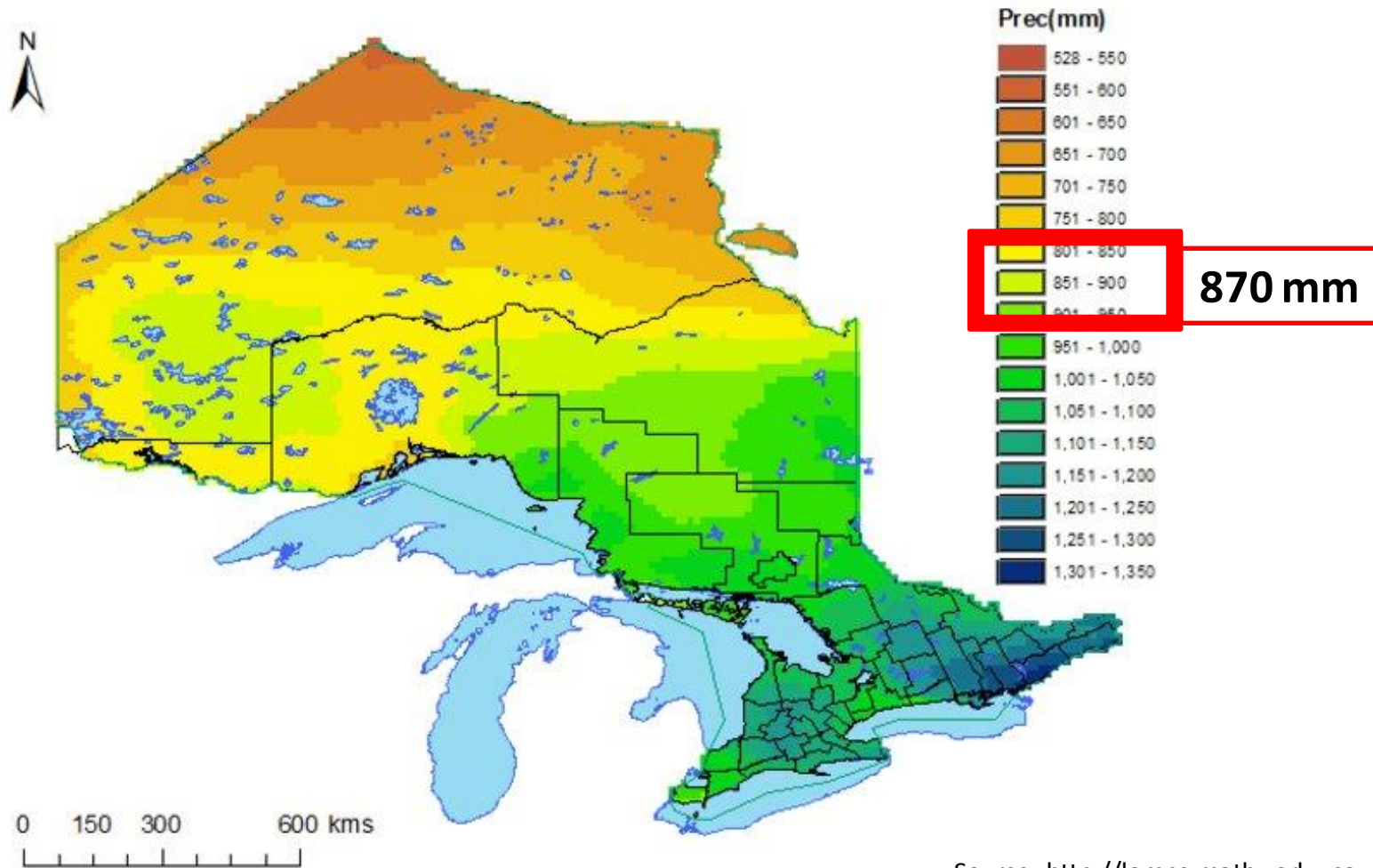
Precipitation changes on the way in Ontario (2080's)



Precipitation changes on the way in Ontario (2050's)

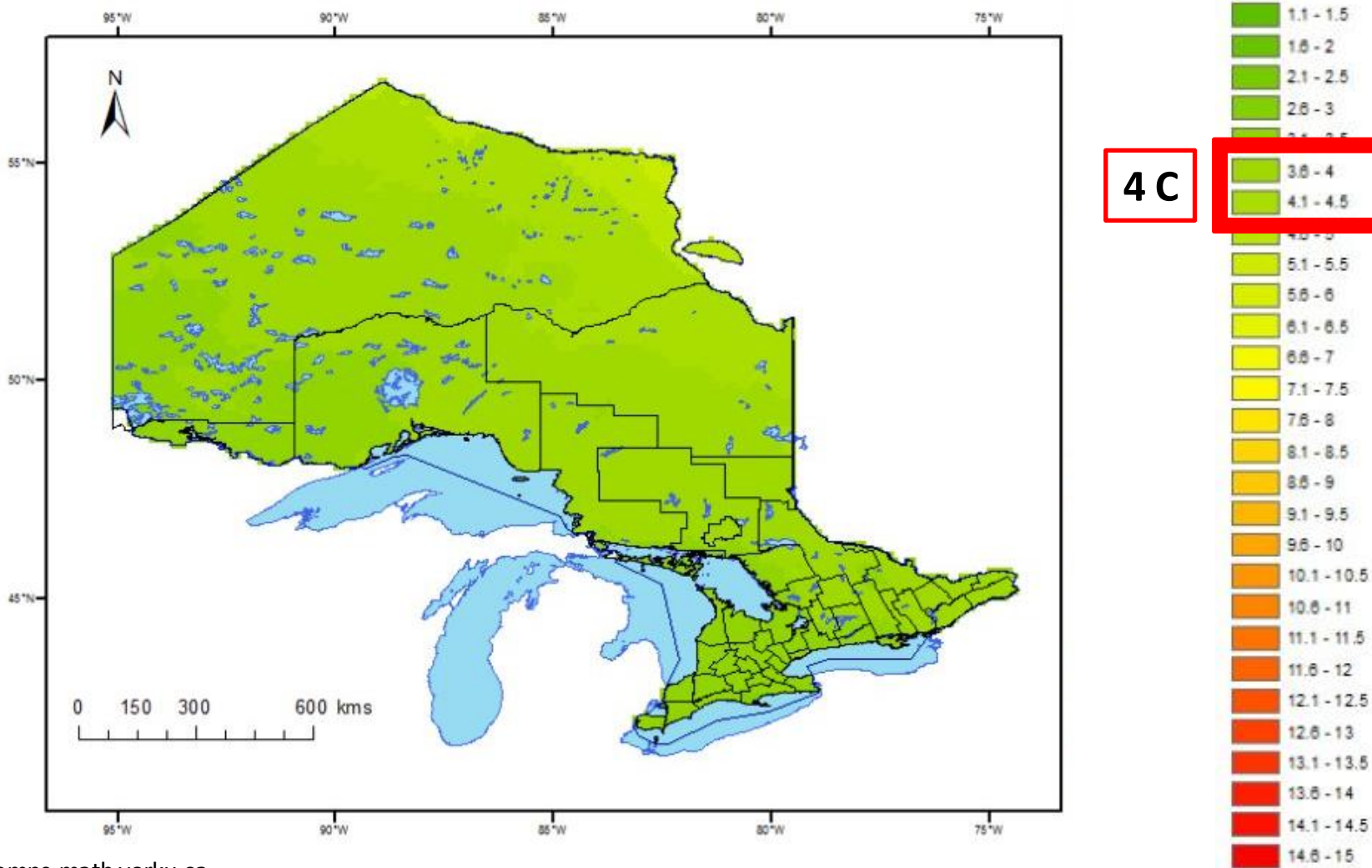


Precipitation changes on the way in Ontario (2080's)



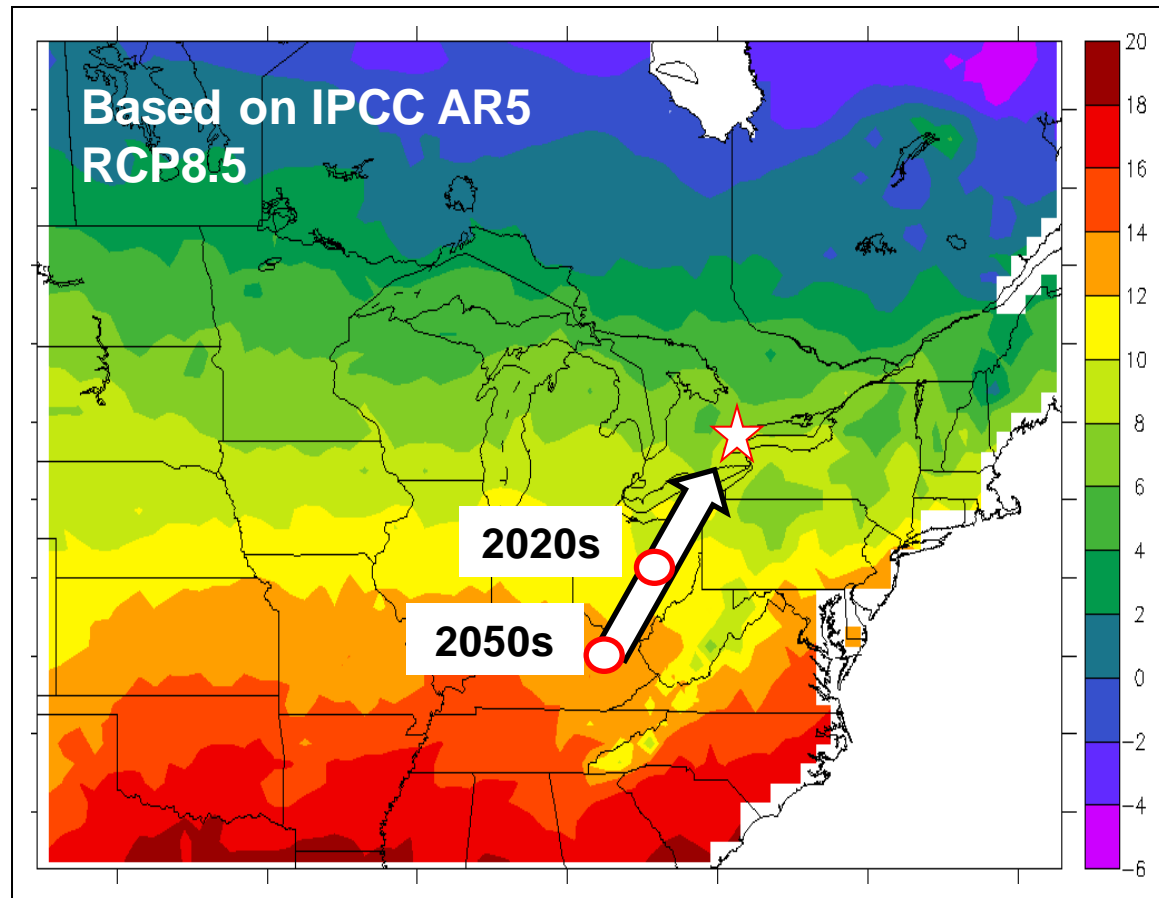
Source: <http://lamps.math.yorku.ca>

Temperature changes in Ontario (2050's)



Source: <http://lamps.math.yorku.ca>

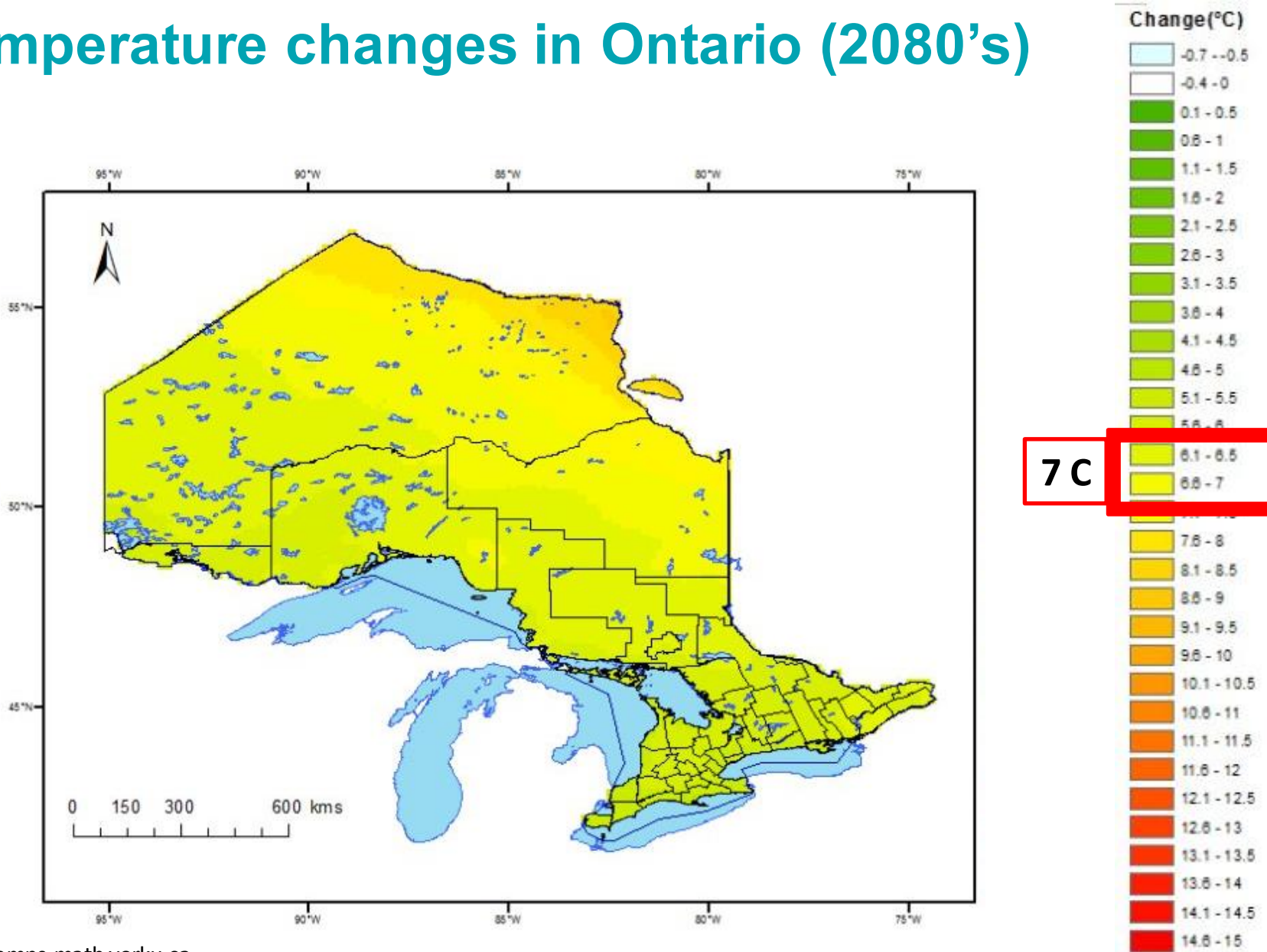
GTHA's Future Climate for 2020s and 2050s



2020s: Ohio

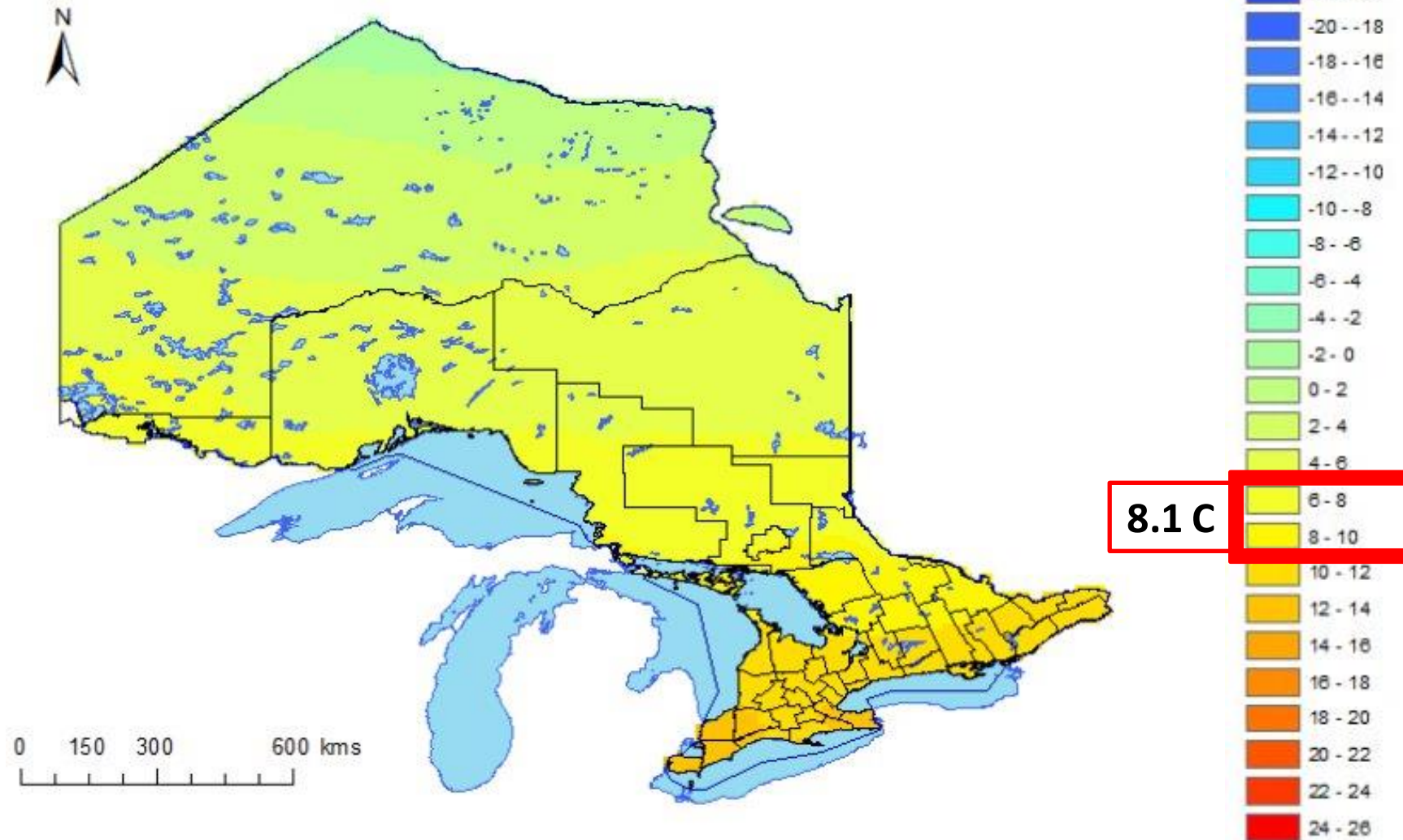
2050s: Kentucky

Temperature changes in Ontario (2080's)



Source: <http://lamps.math.yorku.ca>

Temperature changes in Ontario (2080's)

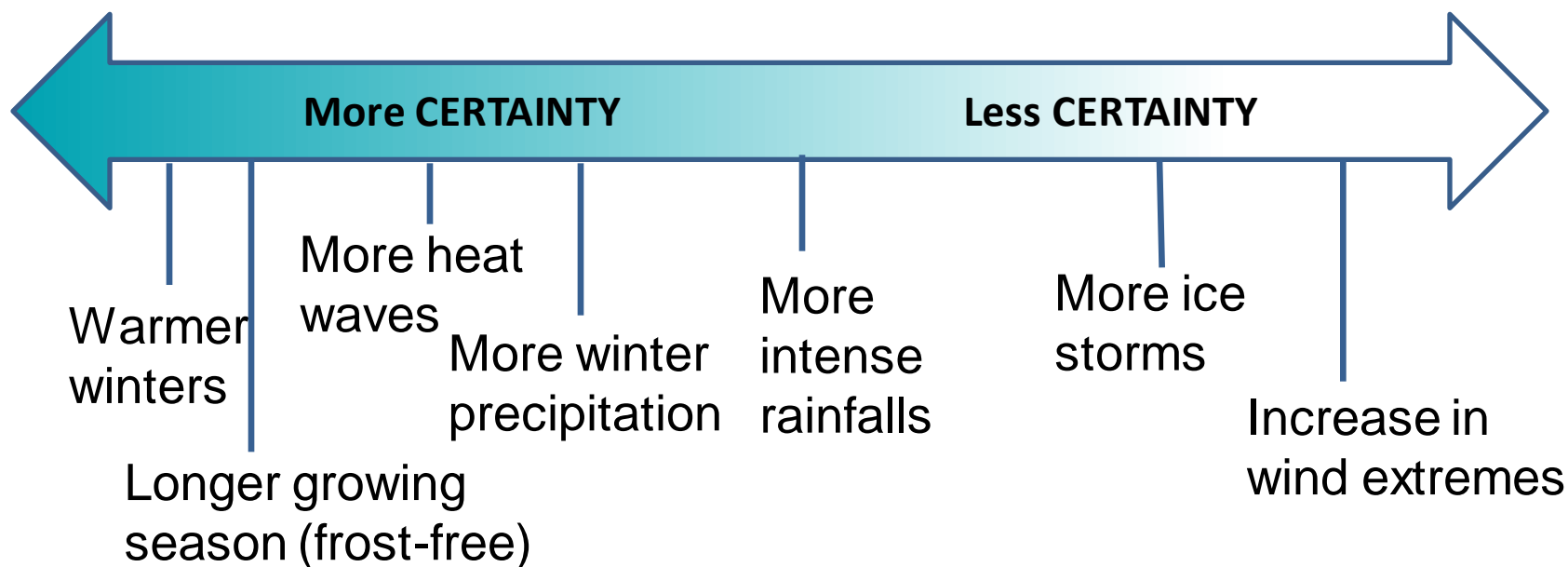


Source: <http://lamps.math.yorku.ca>

Uncertainty in Future Climate Projections

Climate models more effective
at means and large-scale
weather systems / storms

Difficult to resolve convective
storms in climate models /
historical analysis



Physical Effects

Ice Dynamics

Cover
Duration
Thickness
Extent

Groundwater

Winter recharge

Climatology

Air Temp.
Precip.
Wind
Freezing Rain

Decreasing

Increasing

Water Levels

Lakes
Rivers
Wetlands

Natural Hazards

Flood
Fire

Water

Temperature

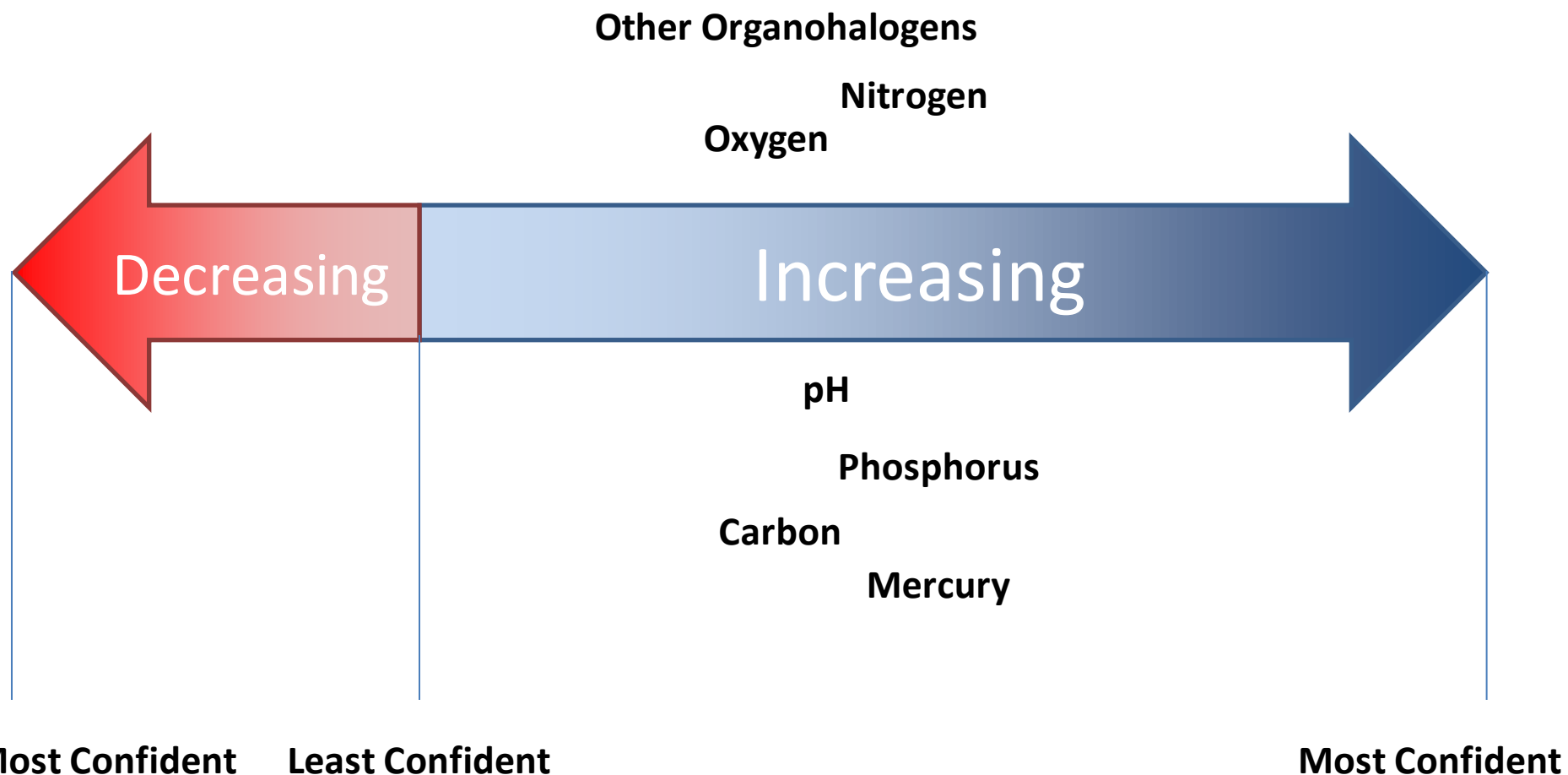
Surface water
Ice free season

Most Confident

Least Confident

Most Confident

Environmental Chemistry & Pollutants



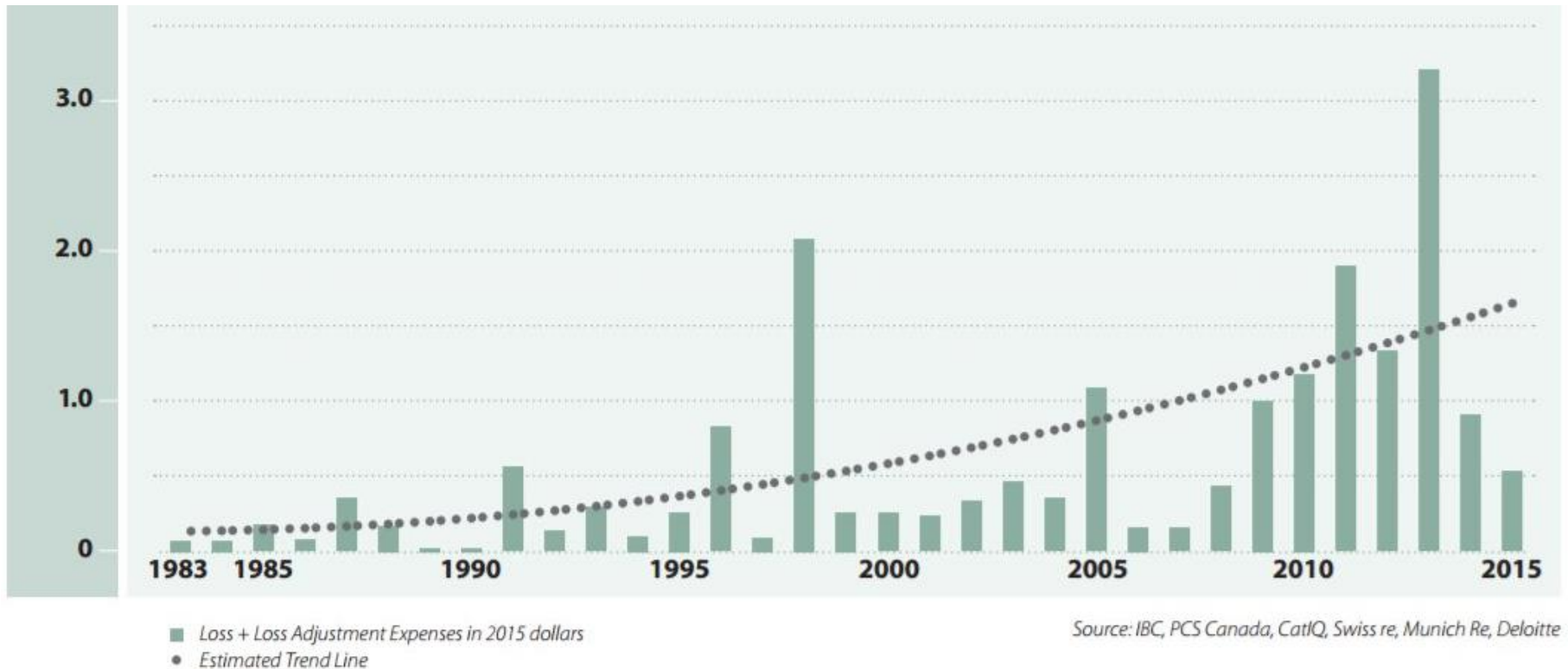
Catastrophic Insurable Losses

Major Events in Canada (2005 – 2014)

- 77 floods
- 31 convective storms
- 6 hurricane / tropical storms
- 4 winter storms

Source: (PBO 2016)

Catastrophic Insurable Losses



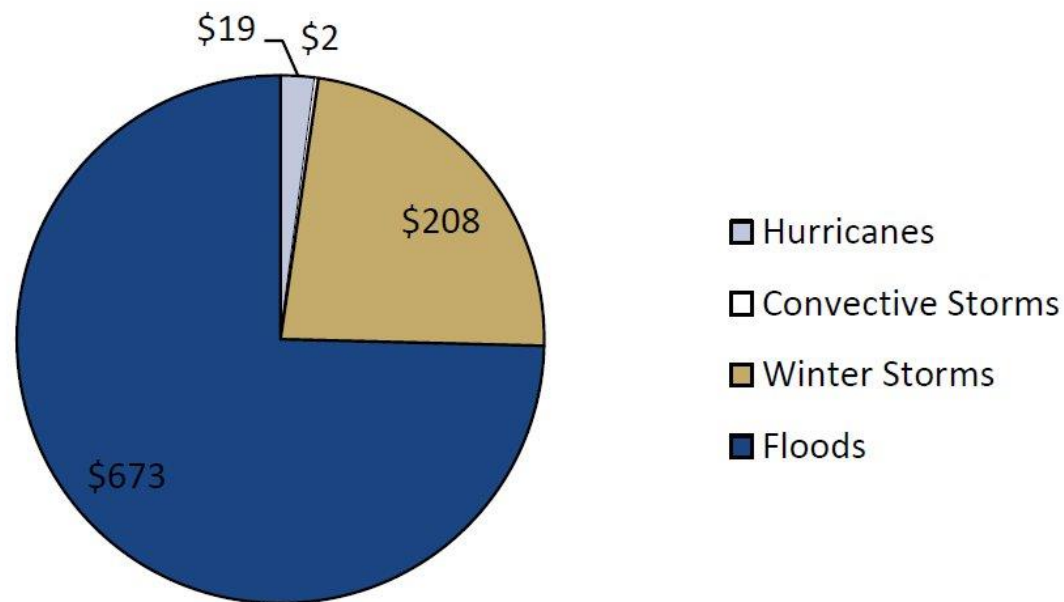
Milestone losses of past decade:

- Hailstorms in Alberta,
- Fire in Alberta,
- Toronto Rains and
- Icestorms

Disaster Financial Assistance

Estimated DFAA annual weather event costs⁶

\$ millions



Sources: PBO; RMS; IBC; DFAA and Swiss Re.

\$100 Mil
Budget

Translating Climate Data into Information for Decision Makers

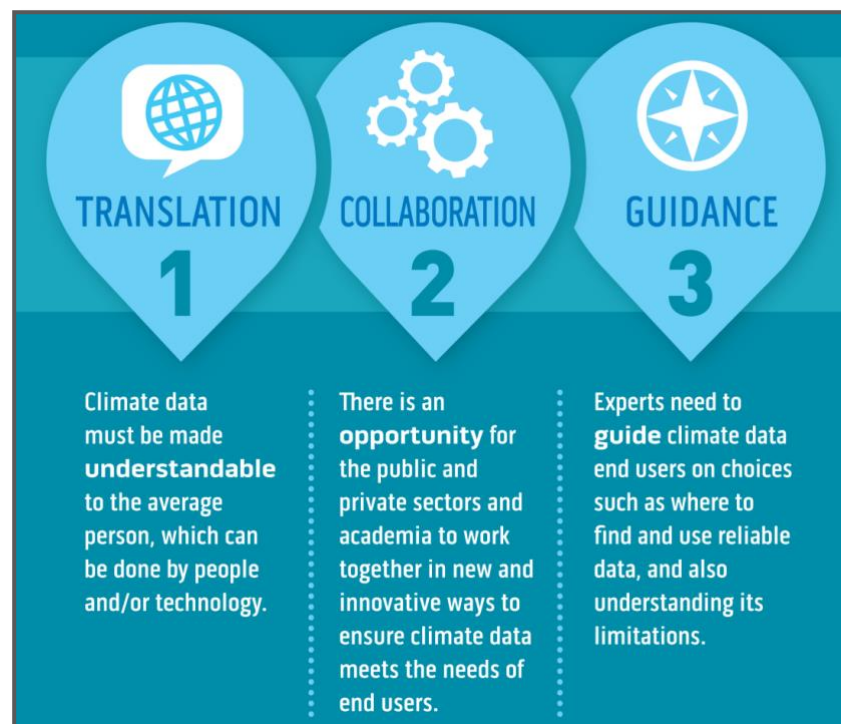
The Problem

Confusion with climate data slows adaptation

Data on climate change can get “lost in translation”

- Environmental Commissioner of Ontario, 2015

The Response





Response

1. Reviewing research on updating IDF curves to take into account climate change
2. Water Infrastructure Design for Adaptation
3. Risk and Vulnerability assessments - Edmundo

Intensity-Duration Frequency Curve Study

Partners



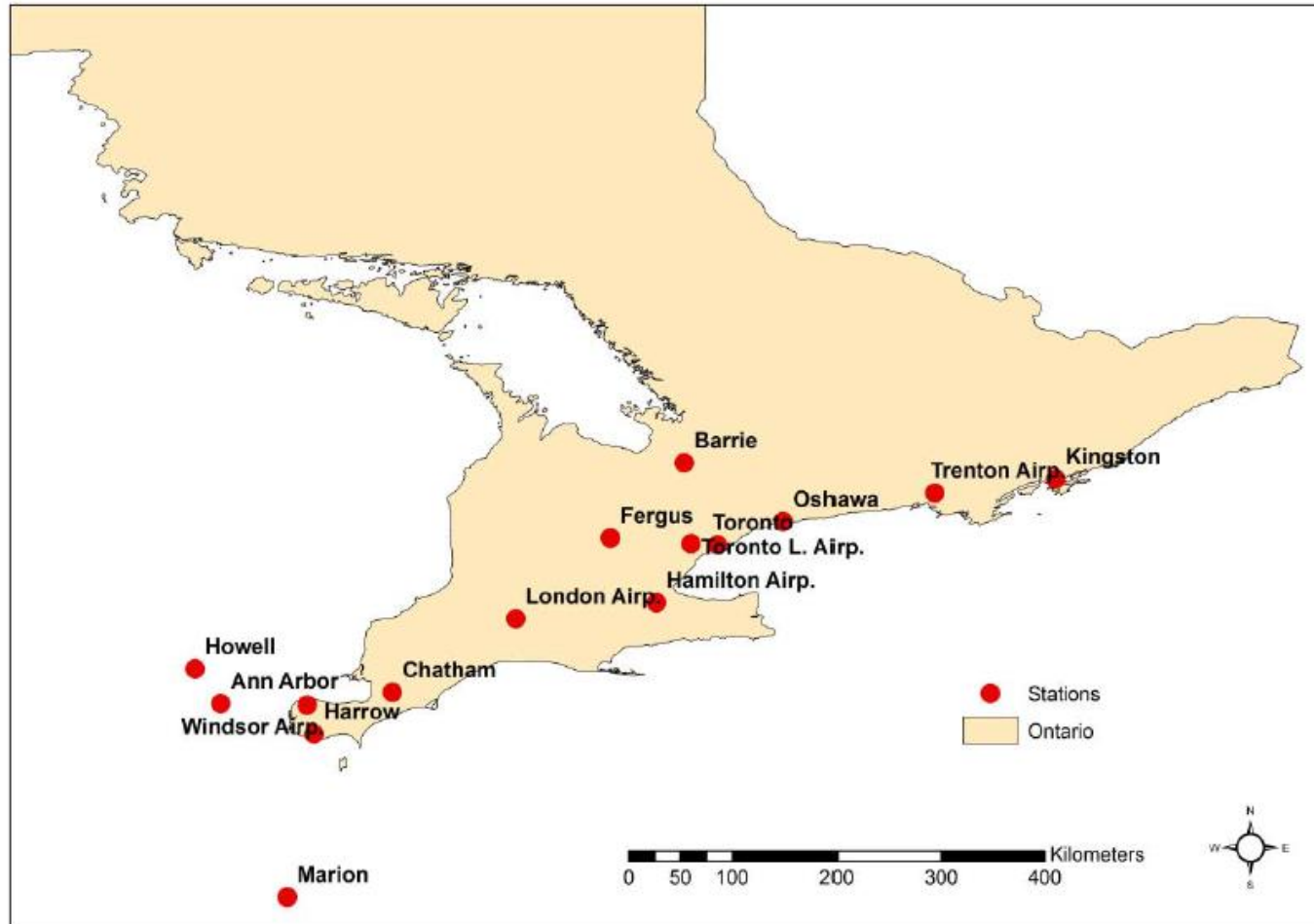
- Essex Region Conservation Authority
 - John Henderson and
 - Richard Wyma
- McMaster University
 - Dr. Paulin Coulibaly
- University of Waterloo
 - Dr. Donald Burn



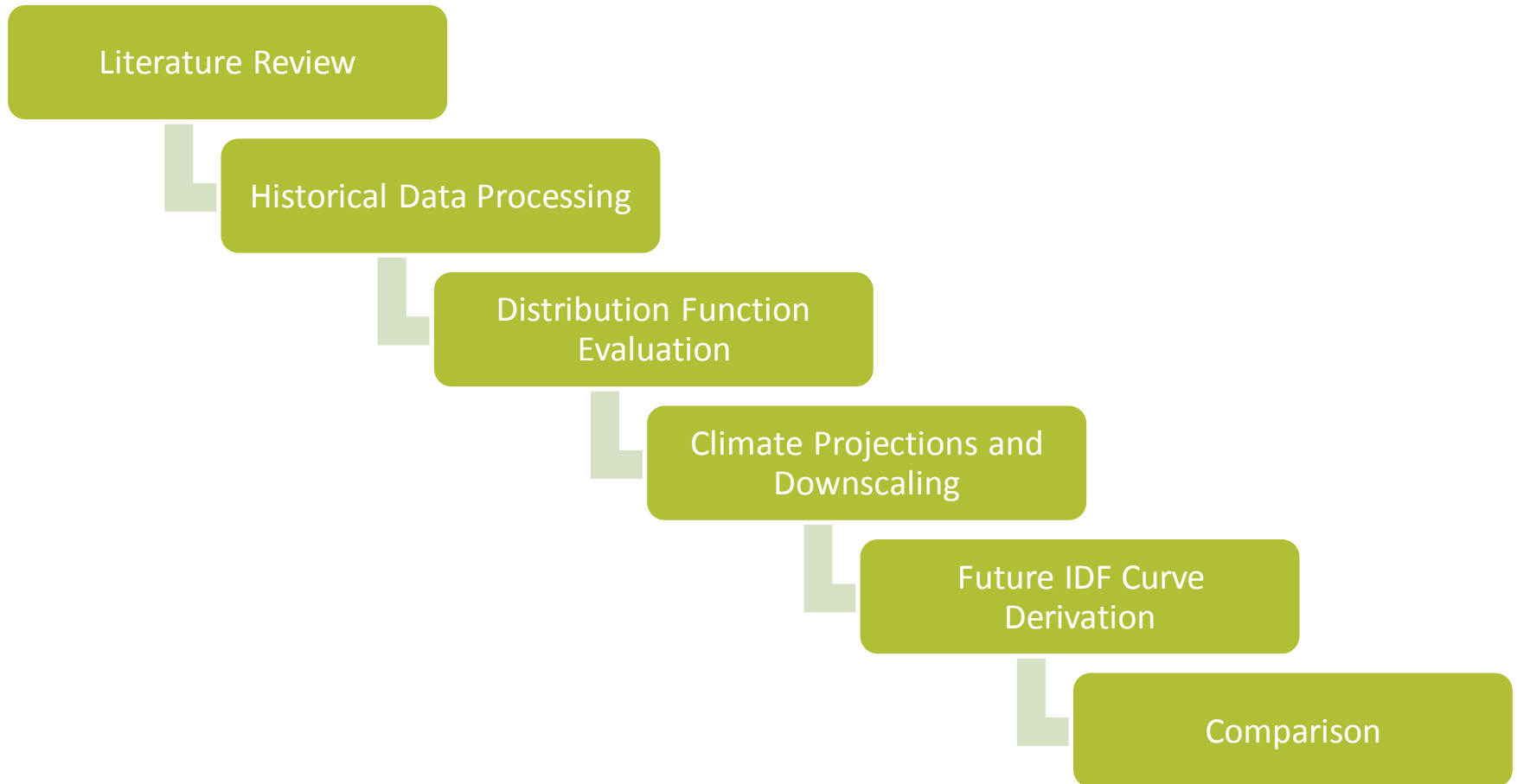
Study Objectives

- To understand the implications of using different methods for incorporating climate change into IDF curves
- To develop an approach to compare outcomes of different permutations of climate model outputs and IDF derivation methods
- To apply this approach to examine outcomes of alternate methods in Essex and Toronto regions

Study Sites



Approach



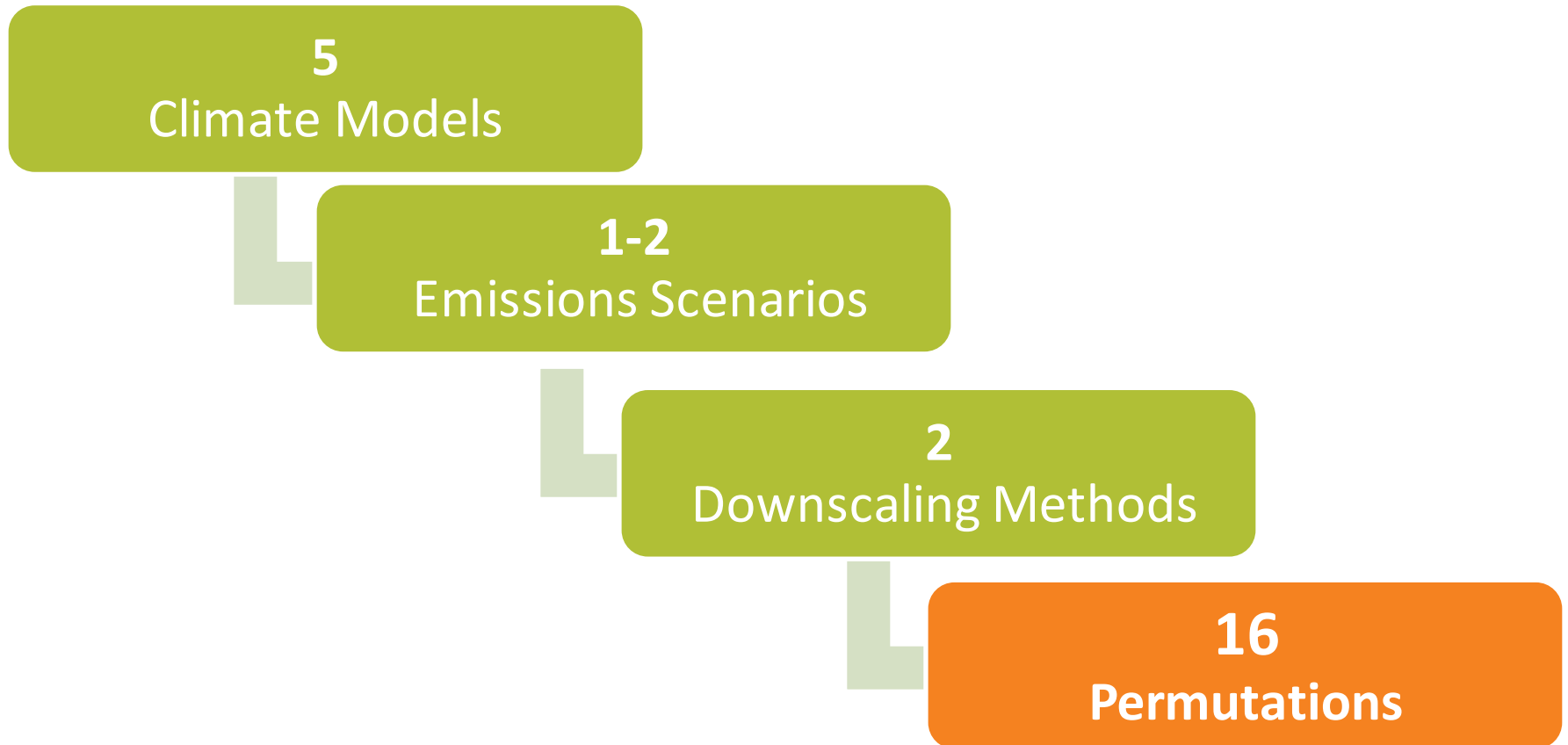
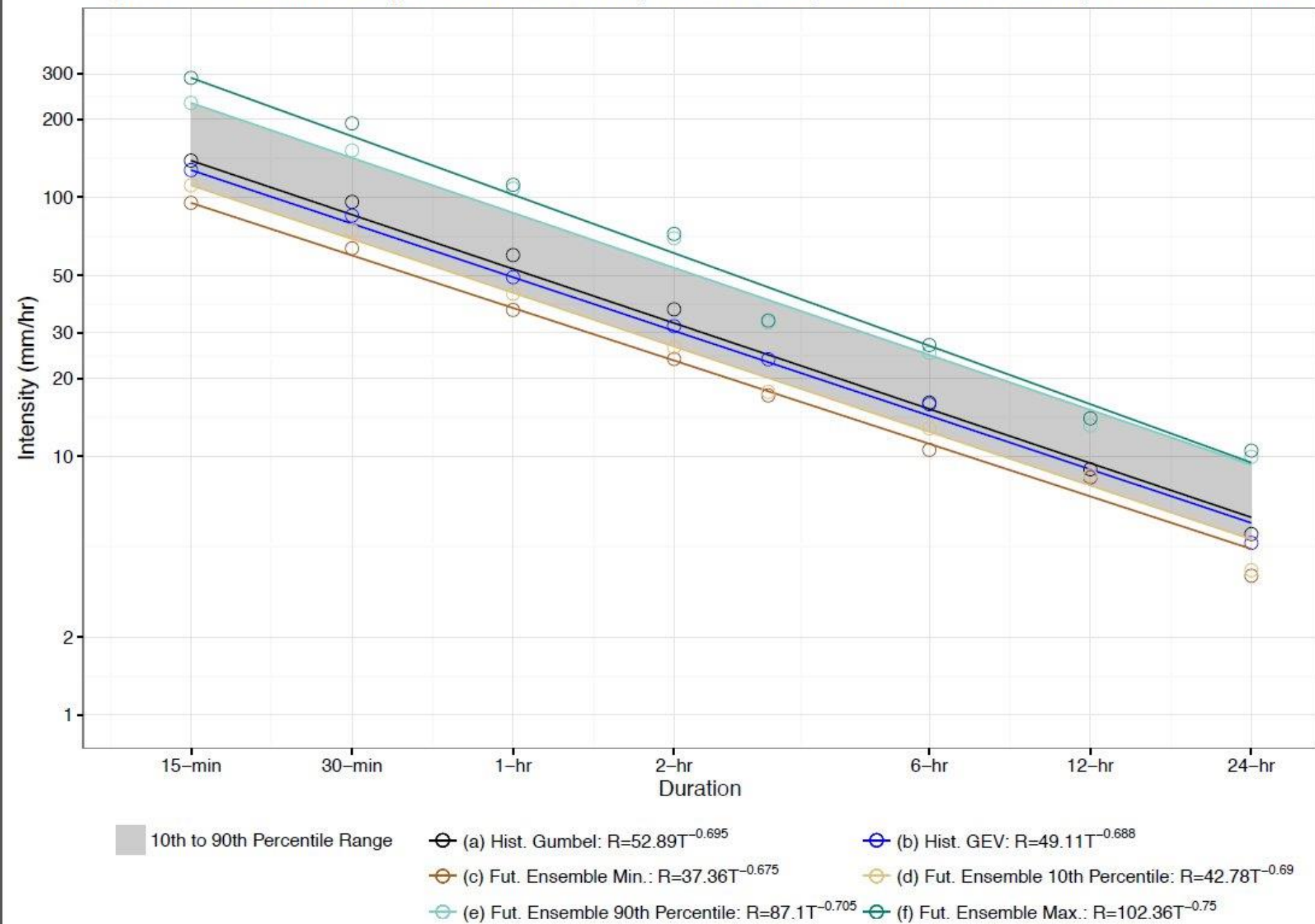


Figure A-18: IDF Curve Comparison for Pearson Airport, 2090s 100-year Return Period Event (10th–90th Percentile)



Water Infrastructure Design for Adaptation -in progress

Discussion Points

1. Current Best practices in adapting stormwater infrastructure design to a changing climate
2. Systems Approach to Advancing Adaptation and Addressing Risk

Current Best Practices – IDF Curves

- Some jurisdictions have updated their IDF curves using future climate model outputs to consider climate change.
 - What techniques did they use?
 - What guidance has been provided in the use of IDF (current or updated) that may facilitate their use while considering climate change?
 - What is the confidence in the proposed IDF curve solution?

Current Best Practices

– Case Studies

- Best practice or case studies that demonstrate decision making processes and actions taken to adapt infrastructure design to a changing climate
 - Why were these approaches taken? Are there any concerns of this approach?
 - How has the uncertainty of climate change projections been taken into account?

Flexible Solutions with Multiple Benefits

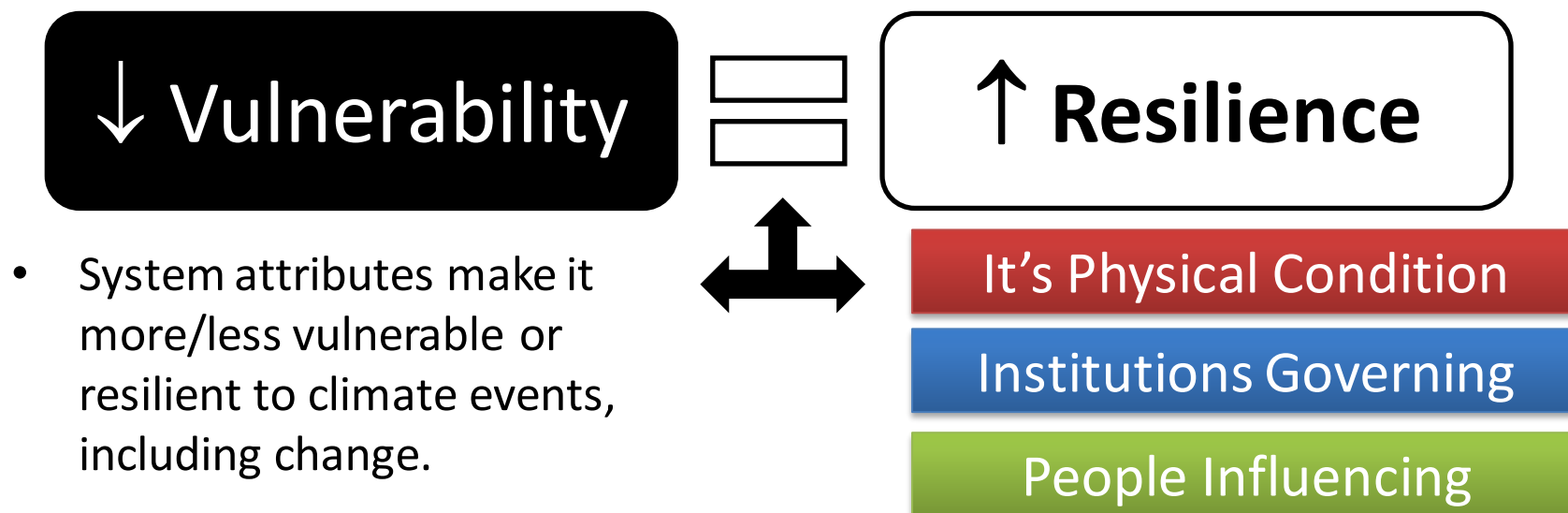


Systems Approach – Temporal/Spatial

- How might the temporal aspect of climate change over the life of the stormwater system be taken into account when replacing infrastructure?
- Is it possible to develop an approach that minimizes the cost of replacing infrastructure while maximizing benefit? How might that be designed?

Risk and Vulnerability Assessments

So What Does The Response Look Like?



*"It is estimated that **one** US dollar invested in anticipatory measures can save up to **7** US dollars in future relief costs"*

- UNFCC

Risk and Vulnerability Assessments

How Vulnerable Am I?



Ice storms



Extreme rainfall



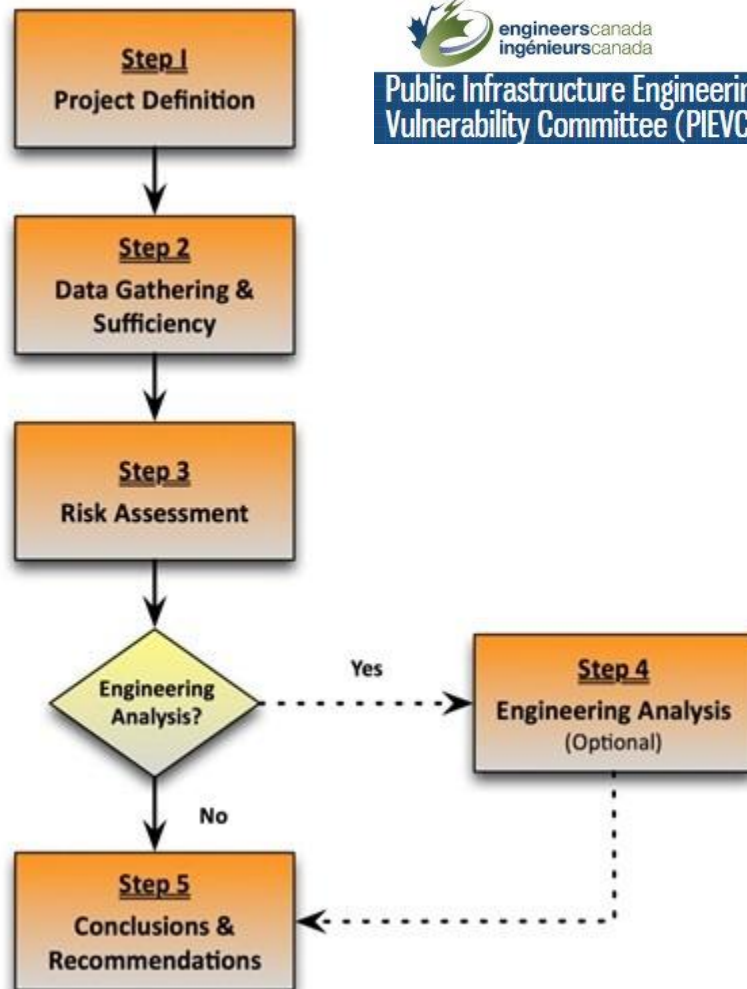
Extreme heat



**Tornadoes and other high
wind events**



**Reporting
and
Recommendations**



1. DEFINE SCOPE

IDENTIFY KEY

- CLIMATE VARIABLES
- Climate impacts of concern
- Sensitive assets & thresholds for impacts

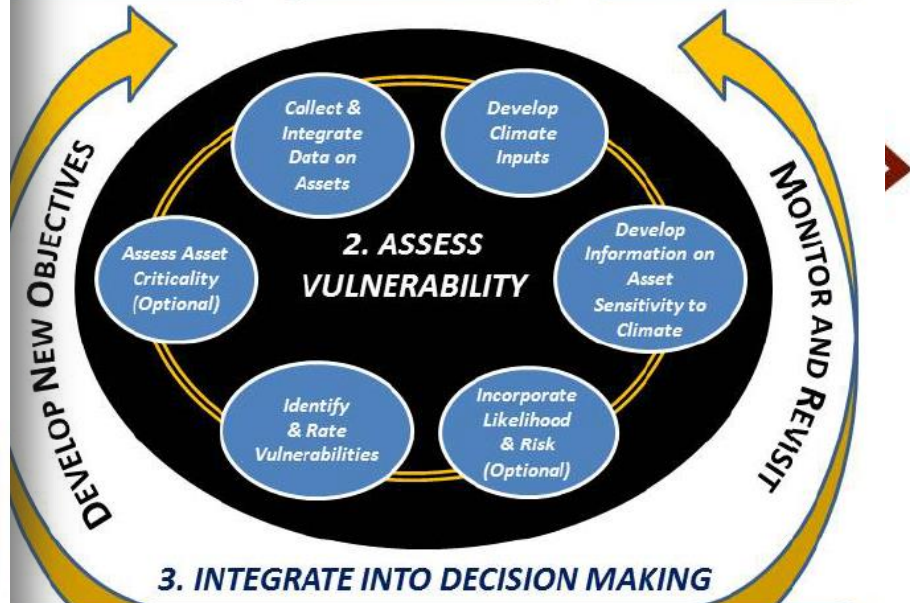
ARTICULATE OBJECTIVES

- Actions motivated by assessment
- Target audience
- Products needed
- Level of detail required

SELECT & CHARACTERIZE

RELEVANT ASSETS

- Asset type
- Existing vs. planned
- Data availability
- Further delineate



3. INTEGRATE INTO DECISION MAKING

- INCORPORATE INTO ASSET MANAGEMENT
- INTEGRATE INTO EMERGENCY & RISK MANAGEMENT
- CONTRIBUTE TO LONG RANGE TRANSPORTATION PLAN
- ASSIST IN PROJECT PRIORITIZATION

- IDENTIFY OPPORTUNITIES FOR IMPROVING DATA COLLECTION, OPERATIONS OR DESIGNS
- BUILD PUBLIC SUPPORT FOR ADAPTATION INVESTMENT
- EDUCATE & ENGAGE STAFF & DECISION MAKERS

Government's & Municipalities' Efforts

- System Risk & Vulnerability Assessments
- Standardized Heat Alerts
- Updates on Public Health Standards
- Sustainable Development Initiatives (e.g. LID)
- Flood Plain Updates
- Monitoring Programs
- Adaptation and Mitigation Inclusive sustainability Master Plans

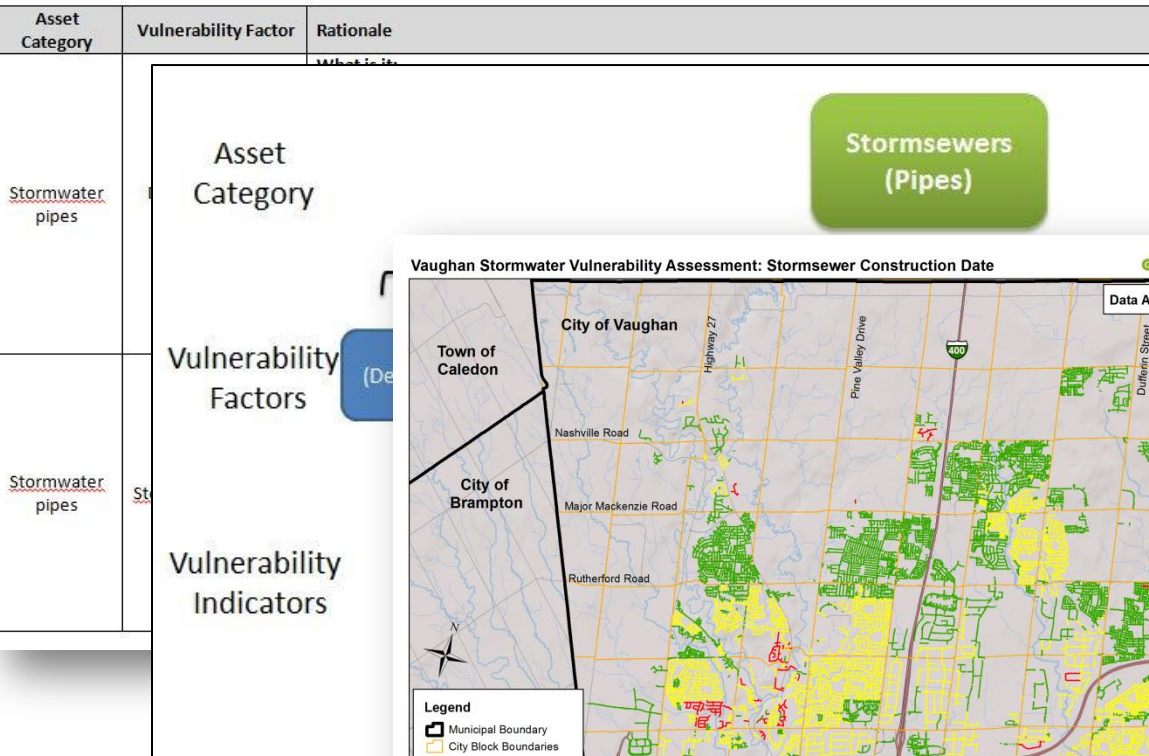
Vulnerability Factors (P-CRAFT)

REFERENCE NUMBER	SYSTEM	CLIMATE DRIVER	COMPONENT	REFERENCE	INFORMATION	Severity	Intensity	Frequency	Duration	Vulnerability Factor	Vulnerability Factor Effect	IMPACT	IMPACT SEVERITY AND RISK	ADAPTATION
										Analysis of the impact which makes it vulnerable to climate variability or adaptive capacity	A category of structural vulnerability factor that describes various levels of vulnerability to climate change	Physical effects of climate variability on infrastructure	Design to establish the impact but an effective security of the impact	As a result of effects of the impact on the system
1	Stormwater Infrastructure	Precipitation/Flood	Low Impact Development (LID) On-site Stormwater Management Reduced Stormwater Runoff	Poly et al., 2011	Climate change during the next century will add greater uncertainty to the design, operation, and maintenance of stormwater management infrastructure, a challenge that may prove insurmountable and design measures are part to provide the needed.					Design efforts, associated protection and maintenance needs	Low impact development of infrastructure assets, precipitation volume and event frequency, runoff volume and pollutants	Storm degradation, flooding, thermal variability, water quality impairment and deterioration of aquatic habitats	The implications of climate change on infrastructure are complex and difficult to differentiate between different scenarios. The type of change that occurs will be the most important to the design and operation of aquatic habitat	

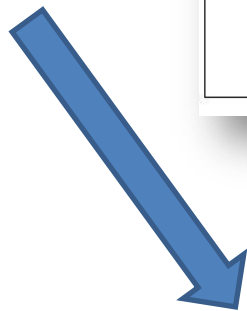
Vulnerability Factors for the Stormwater System

Stormwater Pipes

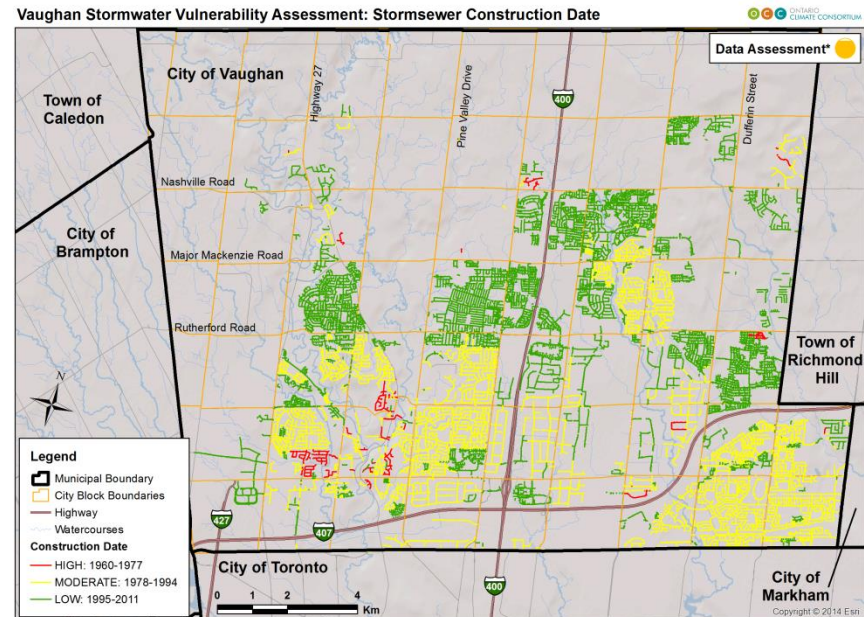
4	Stormwater infrastructure	Extreme precipitation / Flood	Link to drainage system	Halbath & Duckworth, 2011										
40	Stormwater infrastructure	Precipitation/Flood	Combined storm and sanitary sewer system	Farrick & Halbach, 2010										
41	Stormwater infrastructure	Precipitation/Flood	Separable Stormwater Management System (SSMS) (sanitary sewer, stormwater, and combined sewer systems, with stormwater and sanitary sewer systems, the detection points) and (SSMS)	Exceeding-Daniel et al., 2010										
42	Stormwater infrastructure	Precipitation	Combined stormwater and sanitary sewer treatment plant	Exceeding-Daniel et al., 2010										
36	Stormwater infrastructure	Extreme precipitation / Flood	Traditions of stormwater system (sanitary sewer, stormwater, and combined sewer systems, with stormwater and sanitary sewer systems, the detection points) and (SSMS)	Waters et al., (2005)										
35	Stormwater infrastructure	Extreme precipitation / Flood	Separable Stormwater Management System (SSMS) (sanitary sewer, stormwater, and combined sewer systems, with stormwater and sanitary sewer systems, the detection points) and (SSMS)	Shen, 2014										



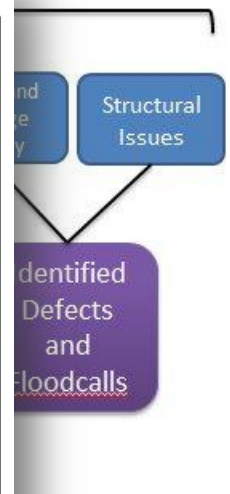
Science



Knowledge



*The results of an assessment of the data are illustrated in terms of its 1) Level of Completeness (the 'fill' of the circle as low, medium or high) and 2) Level of Confidence as the colour of the circle in green (high), yellow (medium), and red (low).



Estimating Risk

Present



Future



Thank-you!

For more information, please visit:

<http://climateconnections.org>

Contact Email:

ftonto@trca.on.ca

efausto@trca.on.ca

www.climateconnections.ca

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