Stormwater Infrastructure & Climate Change

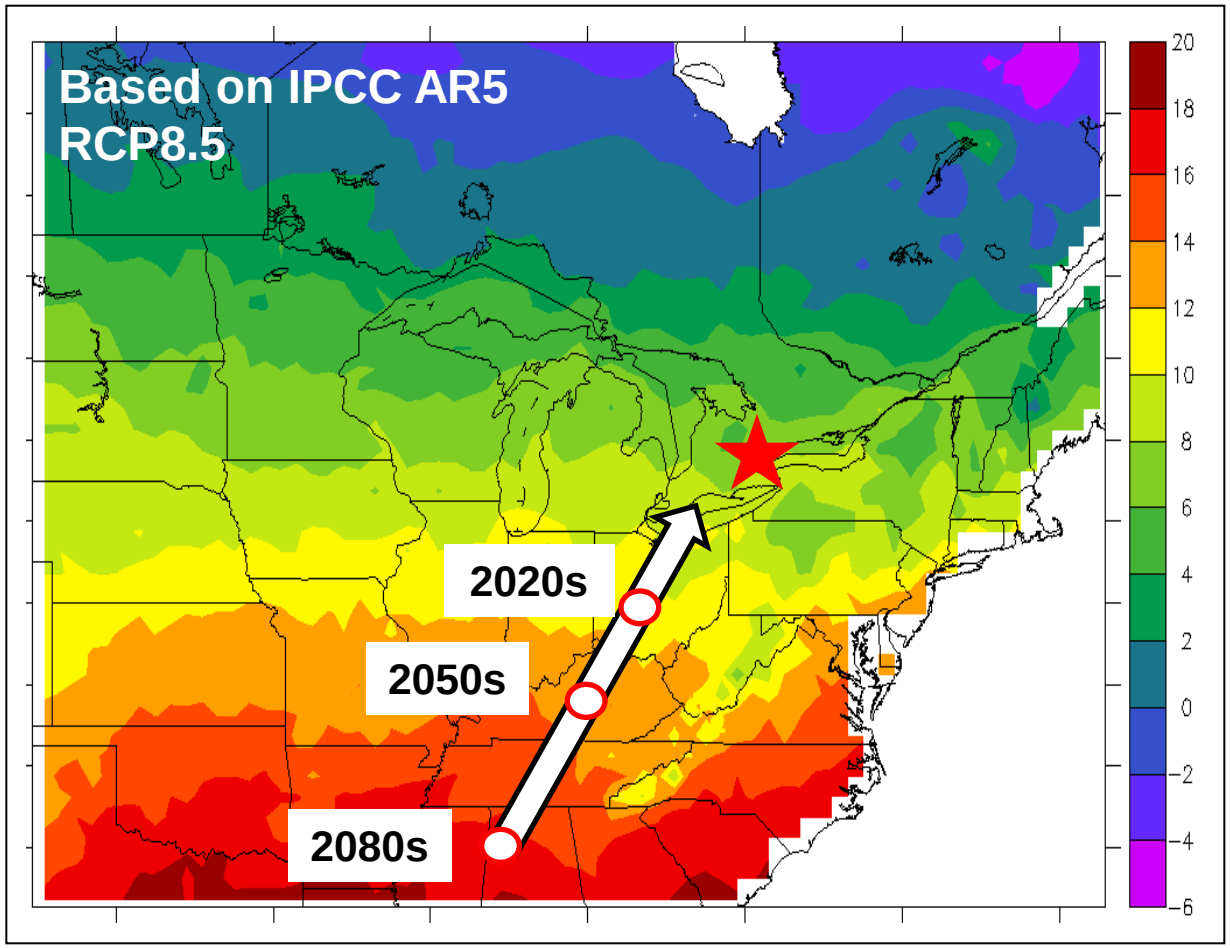
May 12th, 2017
Ontario Climate Consortium Symposium

Presentation Outline

- Context
- Engineering Challenge
- Past Work
- Current Project: Water Infrastructure Design for Adaptation (WIDFA)

Context

GTHA's Approx. Future Climate



2020s: Ohio

2050s: Kentucky

2080s: Mississippi

Physical Effects

Ice Dynamics
Cover
Duration
Thickness
Extent

Groundwater
Winter recharge

Climatology
Air Temp.
Precip.
Wind
Freezing Rain

Water Levels
Lakes
Rivers
Wetlands

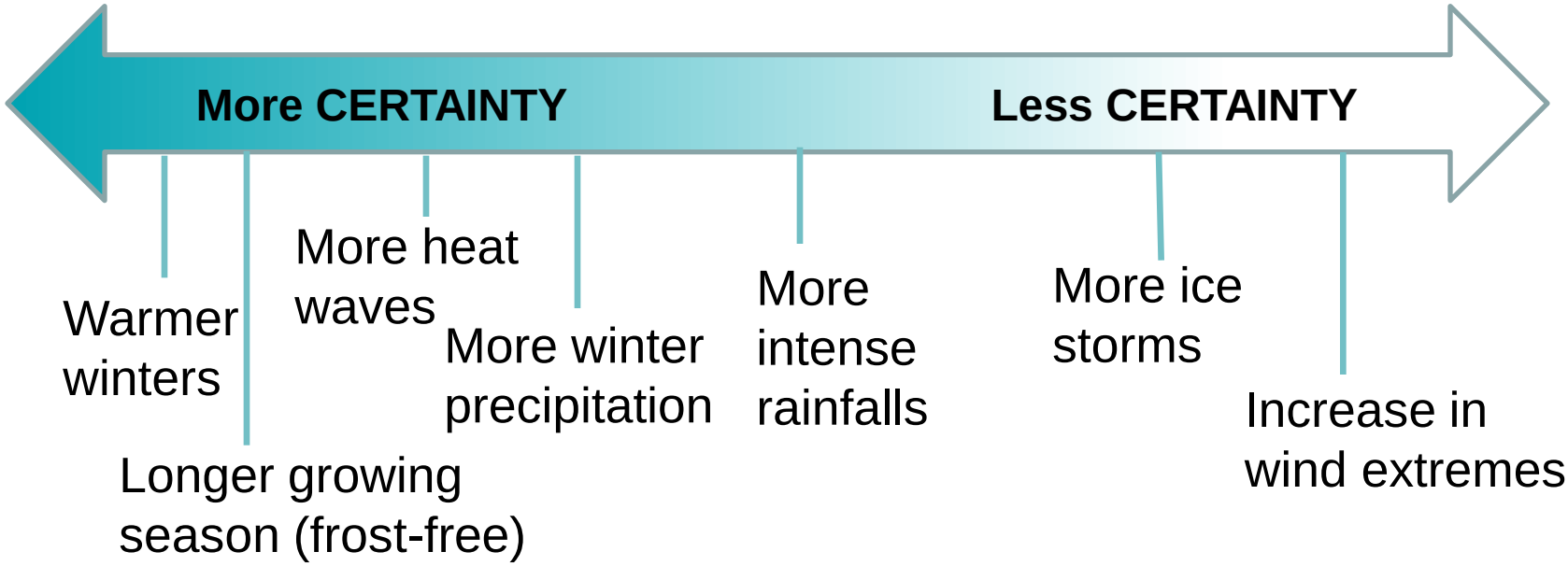
Natural Hazards
Flood
Fire

Water Temperature
Surface water
Ice free season

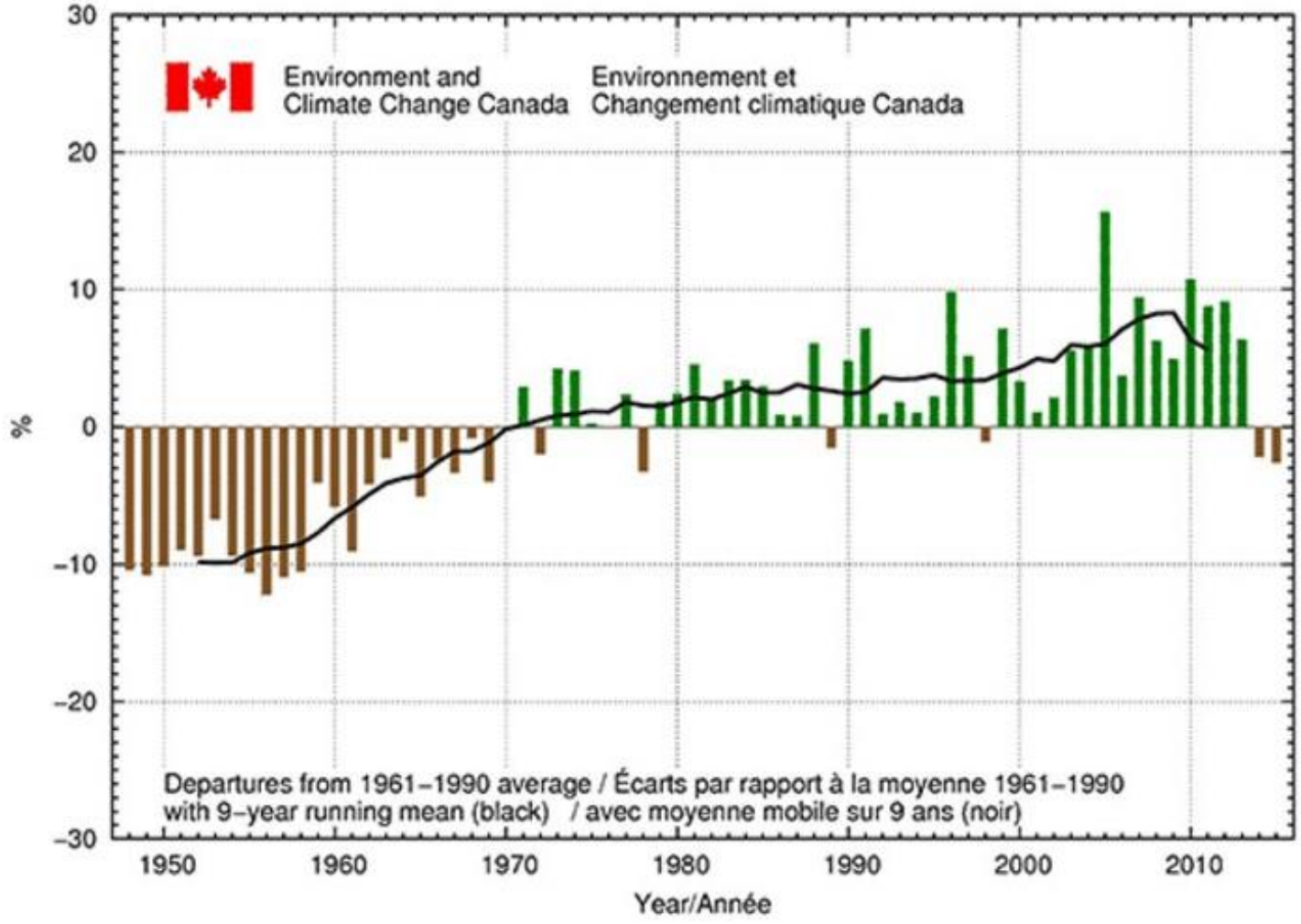
Uncertainty in Future Climate Projections

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

Difficult to resolve convective storms in climate models / historical analysis

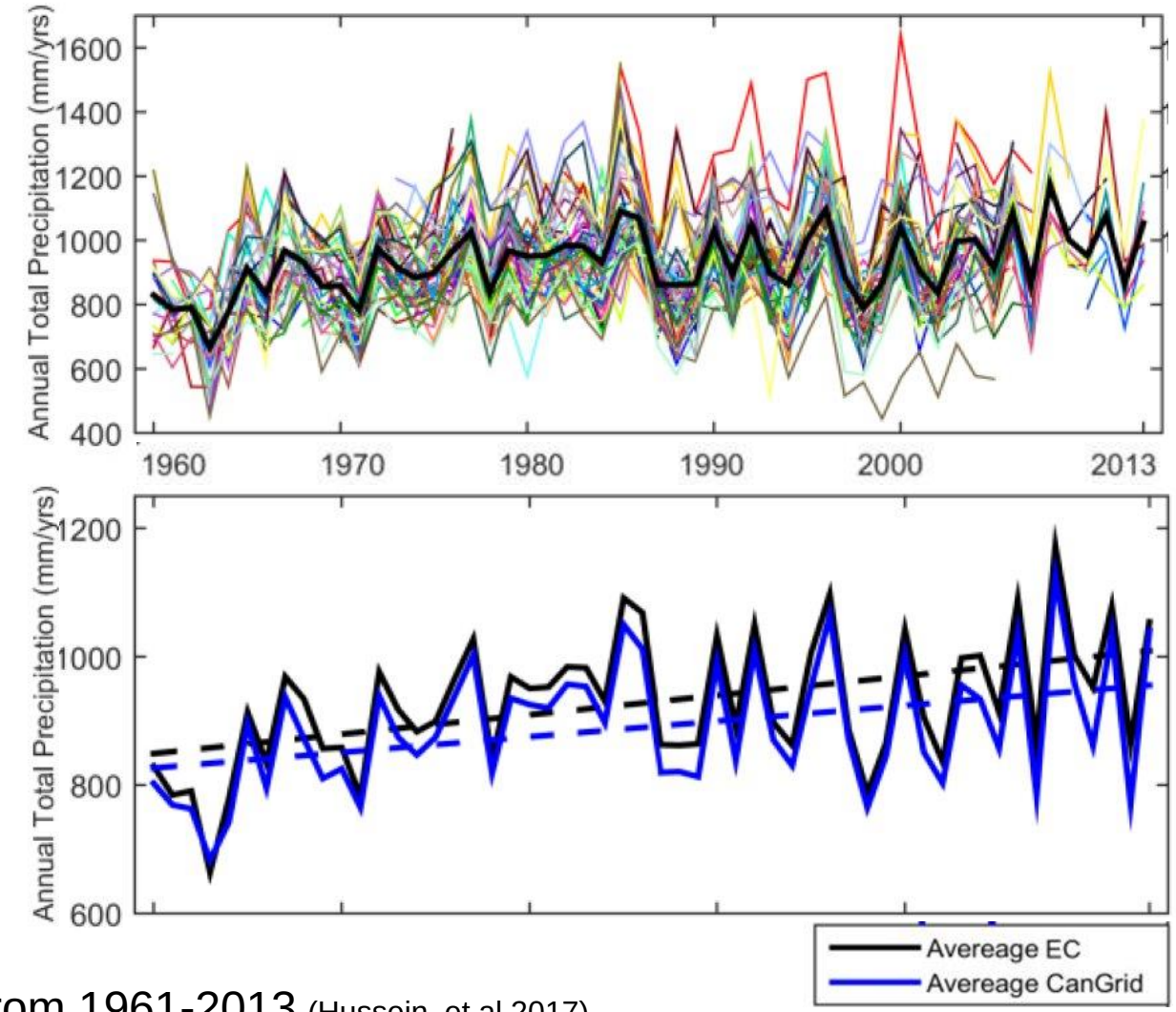


Canada Annual National Precipitation Departures
1948 – 2015 (9 year running average)



Total Precipitation

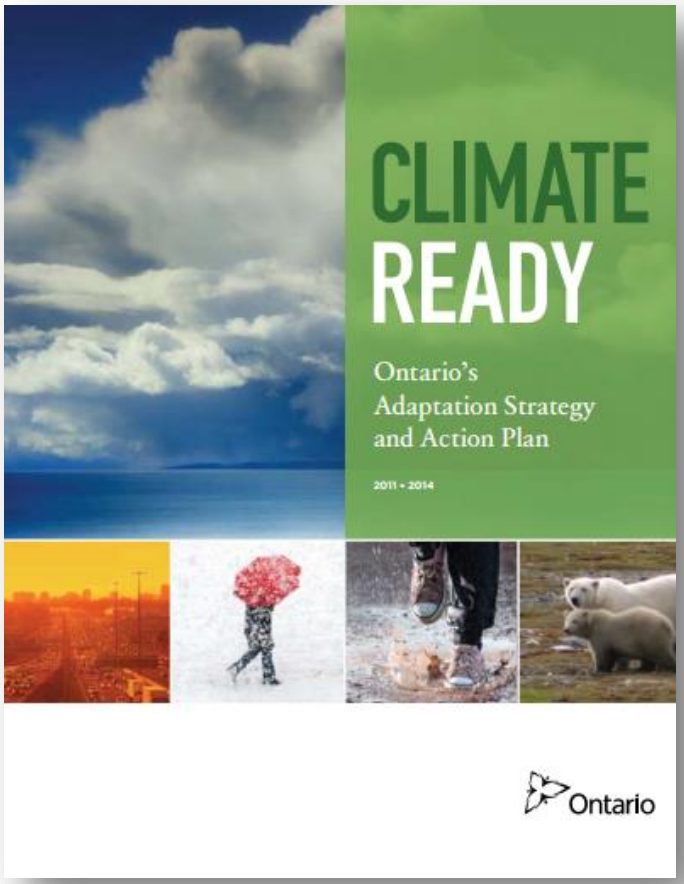
Increasing Volume of rainfall per year



ECCC weather station data from 1961-2013 (Hussein, et al 2017)

Engineering Challenge

Climate change and IDF

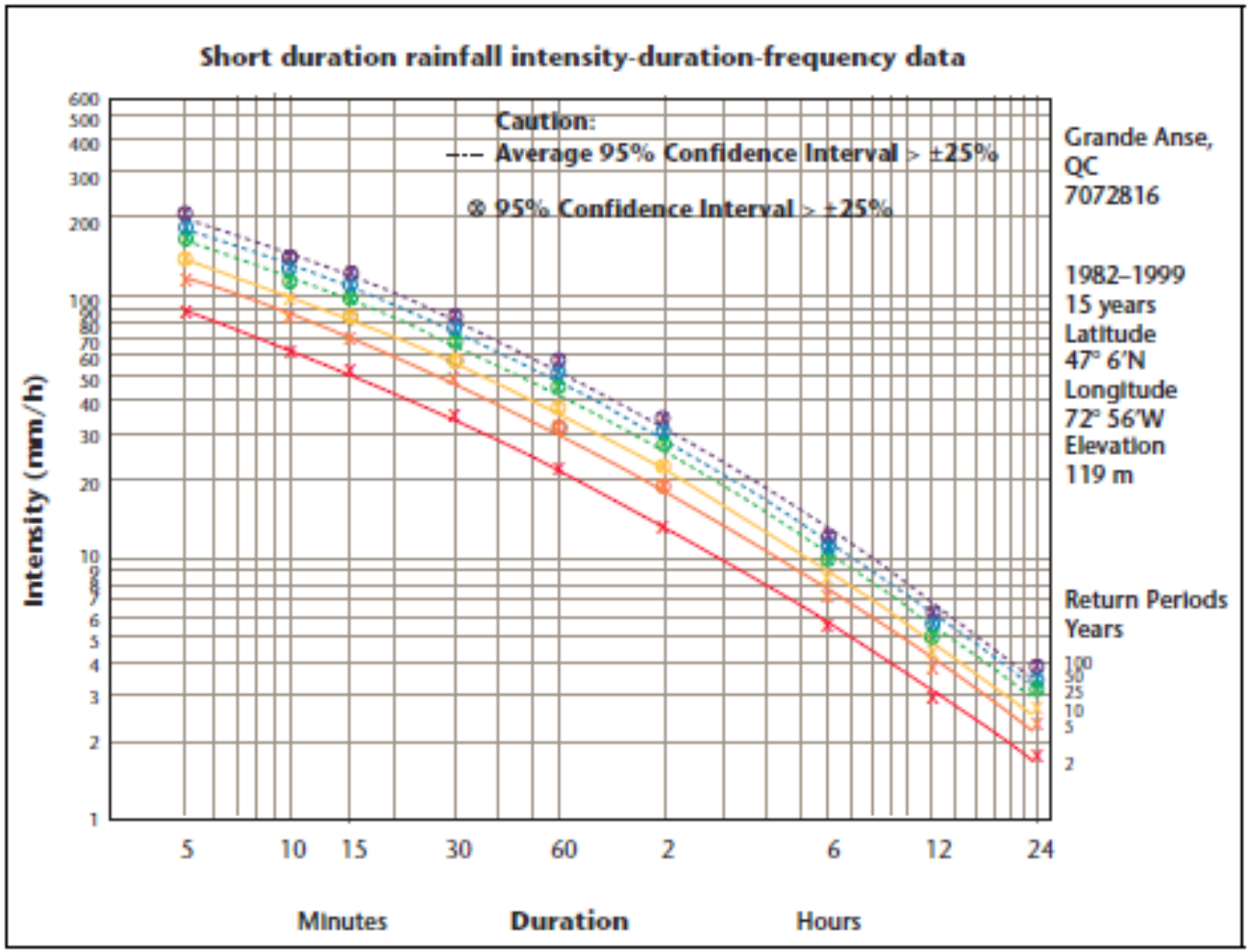


- Climate change **will** increase intense rainfall
- Practitioners **must** acknowledge this in design

ACTION 26

UPDATE INTENSITY-DURATION-FREQUENCY CURVES

IDF Curves


Short duration rainfall intensity-duration-frequency data
Caution:
--- Average 95% Confidence Interval > ±25%
⊗ 95% Confidence Interval > ±25%
Intensity (mm/h)
600
500
400
300
200
100
90
80
70
60
50
40
30
20
10
9
8
7
6
5
4
3
2
1
5
10
15
30
60
2
6
12
24
Minutes
Duration
Hours
Grande Anse, QC
7072816
1982–1999
15 years
Latitude
47° 6'N
Longitude
72° 56'W
Elevation
119 m
Return Periods
Years
100
50
25
10
5
2

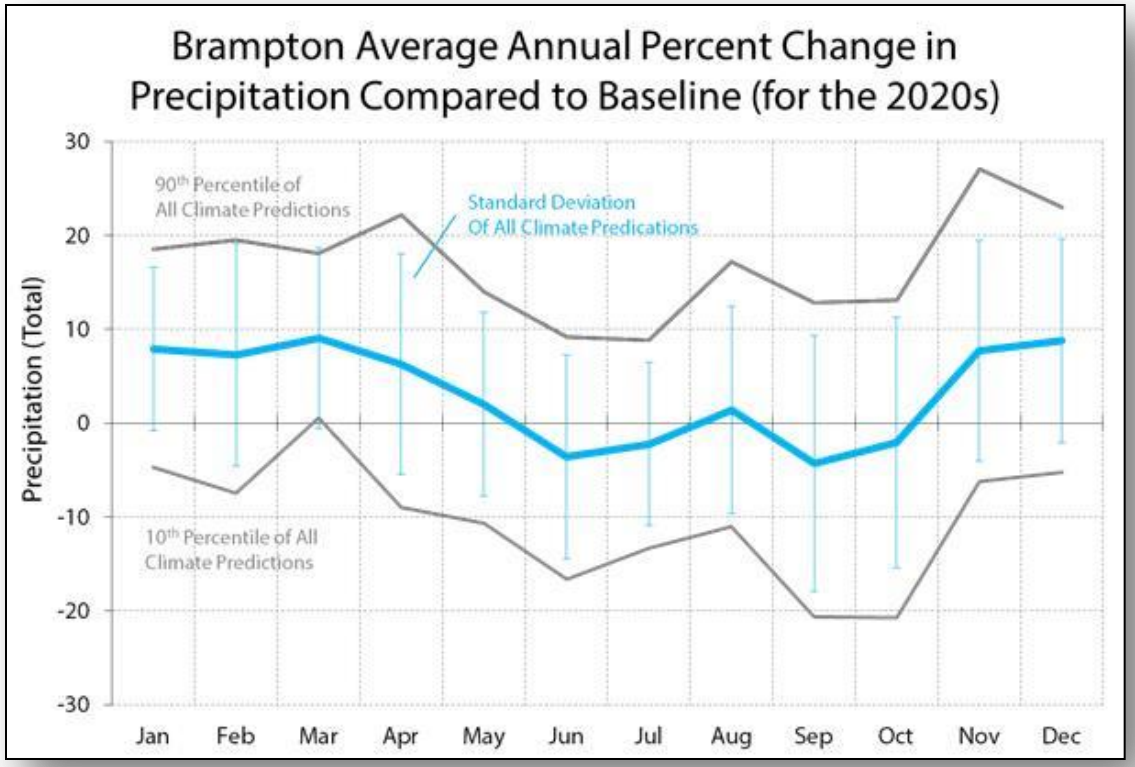
Confidence Intervals

Table 2b :
Return Period Rainfall Rates (mm/h) - 95% Confidence limits
Intensité de la pluie (mm/h) par période de retour - Limites de confiance de 95%

Duration/Durée	2 yr/ans	5 yr/ans	10 yr/ans	25 yr/ans	50 yr/ans	100 yr/ans	#Years Années
5 min	61.3	87.9	105.6	127.9	144.4	160.8	55
	+/- 7.3	+/- 12.3	+/- 16.6	+/- 22.4	+/- 26.9	+/- 31.3	55
10 min	47.1	68.4	82.6	100.4	113.7	126.9	55
	+/- 5.9	+/- 9.9	+/- 13.3	+/- 18.0	+/- 21.5	+/- 25.1	55
15 min	38.8	56.7	68.5	83.4	94.5	105.5	55
					- 18.0	+/- 20.9	55
30 min					62.9	70.4	55
					- 12.4	+/- 14.4	55
1 h						42.6	56
						+/- 8.7	56
2 h					20.8	23.2	56
					- 3.9	+/- 4.5	56
6 h					8.5	9.4	55
	+/- 0.4	+/- 0.7	+/- 0.9	+/- 1.2	+/- 1.4	+/- 1.7	55
12 h	2.6	3.6	4.2	5.0	5.6	6.2	54
	+/- 0.3	+/- 0.5	+/- 0.6	+/- 0.8	+/- 1.0	+/- 1.2	54
24 h	1.6	2.2	2.6	3.2	3.6	4.0	56
	+/- 0.2	+/- 0.3	+/- 0.4	+/- 0.5	+/- 0.6	+/- 0.7	56

42.6
+/- 8.7

It is not easy to estimate future IDF



1. Climate models aren't great with precipitation
2. Climate models don't resolve thunderstorms
3. More than 10 different methods being used in Canada to estimate future IDF curves

Past Work

Partners

- Essex Region Conservation Authority
  - John Henderson
  - 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

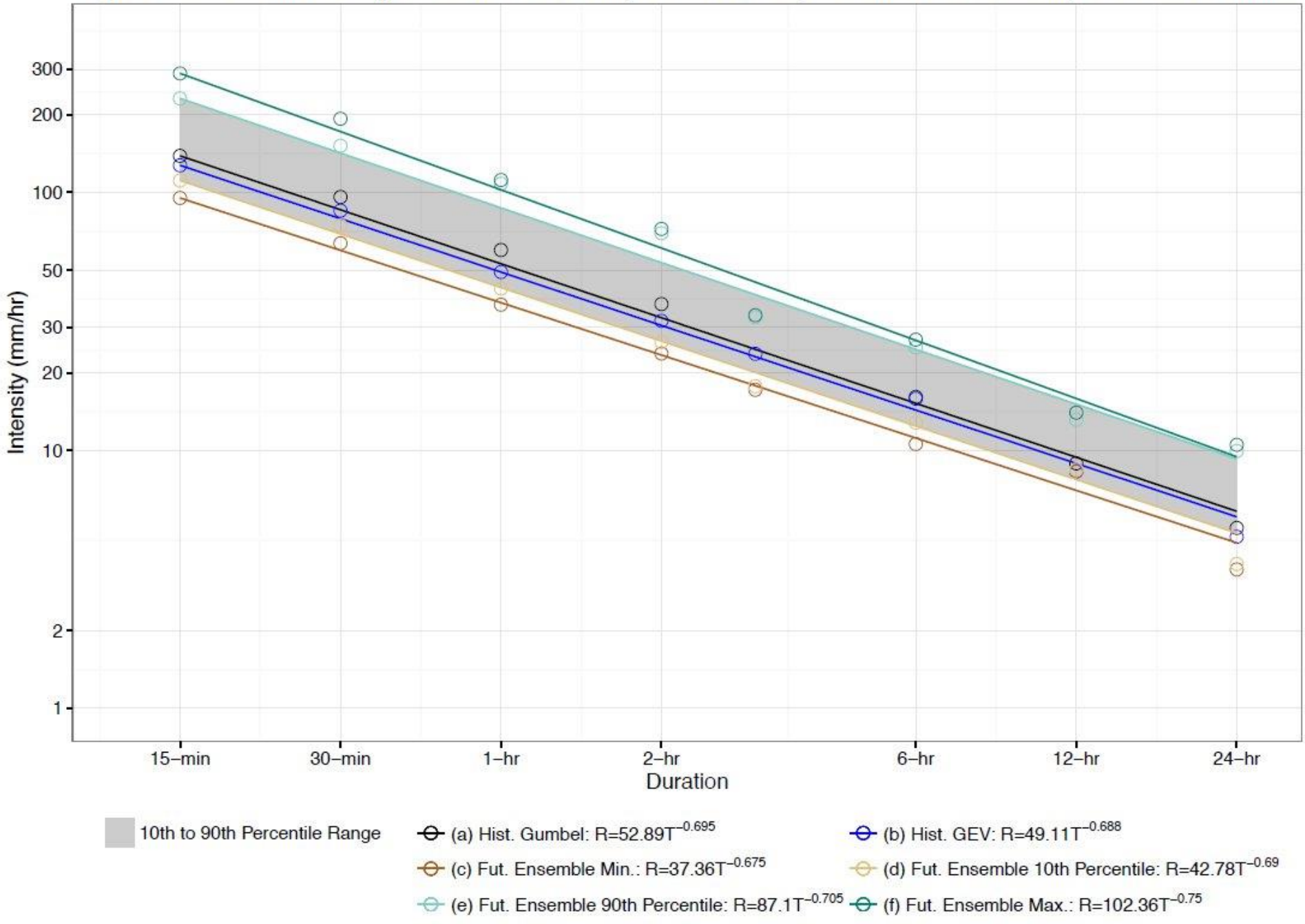
5
Climate Models

1-2
Emissions Scenarios

2
Downscaling Methods

16
Permutations

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



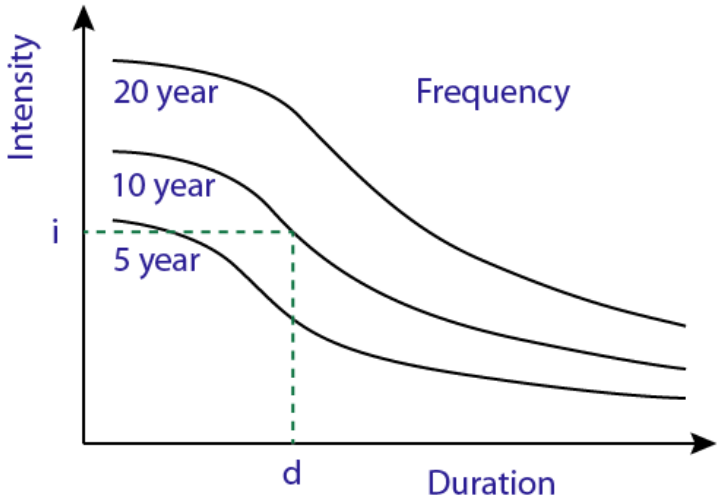
Water Infrastructure Design for Adaptation
-in progress

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?
  - How are the vulnerability and risks being accounted for?

Current Best Practices – IDF Curves

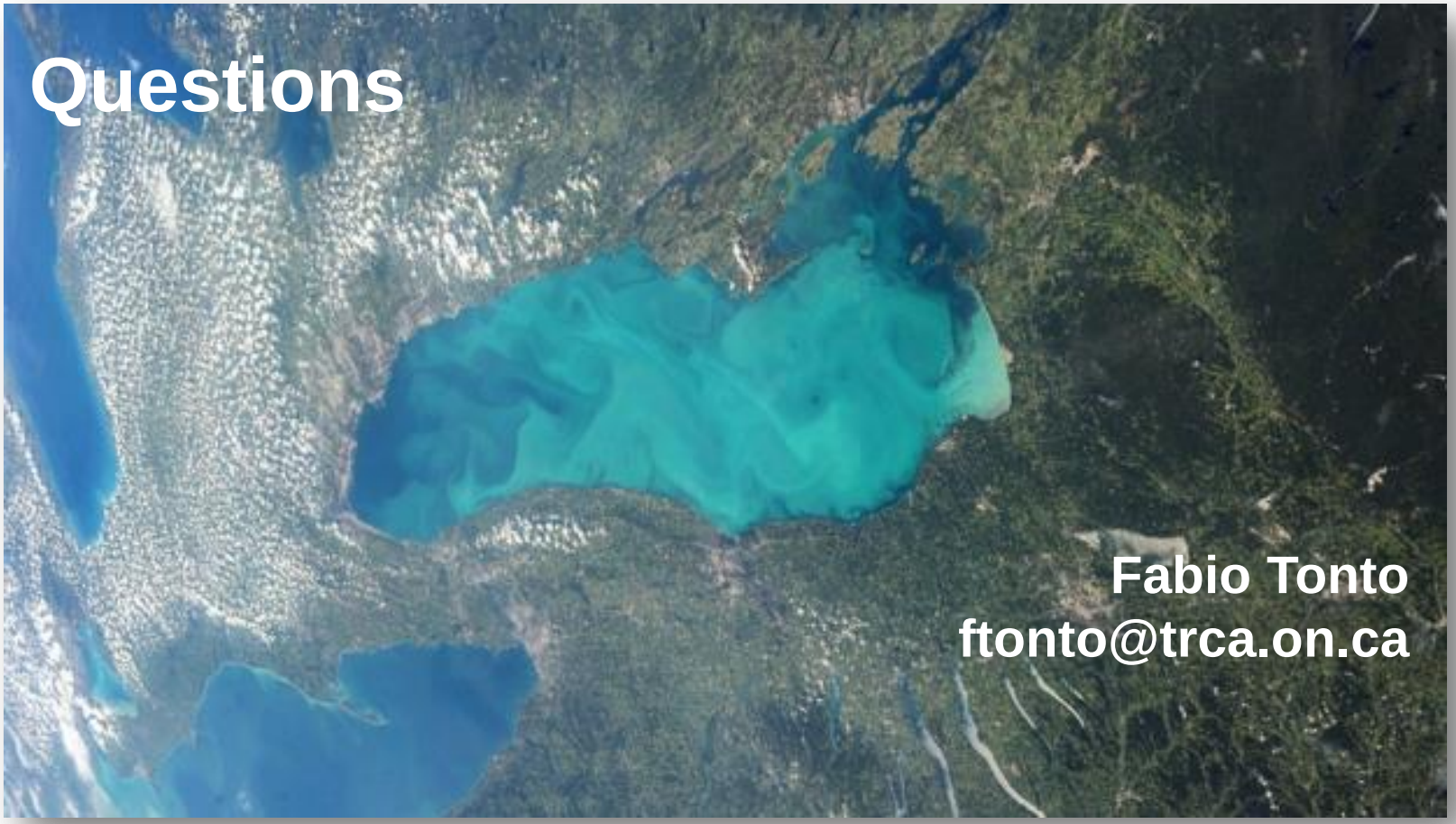
- Some Municipalities and Provincial agencies have updated their IDF curves using future climate model outputs to consider climate change.
  - What guidance has been provided in the use of IDF (current or updated) that may facilitate their use while considering climate change?
  - What is the confidence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



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?
  - Which future climate scenario are you designing to?
  - What are the risks/vulnerabilities associated with designing to a scenario?

- What approach is being taken when designing at a site level to consider impacts of a spatially larger system?
  - How might that be designed/coordinated?
  - Upstream and downstream vulnerabilities?


Questions
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