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Rainfall IDF Statistics: In Engineering Practice and in a Changing Climate

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1. What are rainfall IDF statistics?
2. What does climate change mean for IDF?
3. How do we move forward?



CSA Technical Guide



PLUS 4013-12

TECHNICAL GUIDE

Development, interpretation, and use of rainfall intensity-duration-frequency (IDF) information: Guideline for Canadian water resources practitioners



Topics:

- Meteorology of extreme rainfall
- Rainfall data collection
- Deriving IDF values
- Climate change and IDF values
- Applying IDF information



What are IDF statistics?



MSC Type B standard rain gauge — non-recording
(Instruction Manual 43 — First Edition, Atmospheric Environment Service, 1971)



MSC Tipping bucket rain gauge — recording
(TM 04-01-03, Environment Canada, 1981)



TB-3 Tipping bucket rain gauge 2002 — recording
(Instruction Manual Tipping Bucket Rain Gauge Model TB-3, Issue 2, Hydrological Services PTY Ltd, 1990)



F&P/Belfort weighing gauge 1965 — recording
(Belfort Model 3000 Specifications, Belfort Instruments, 1998)



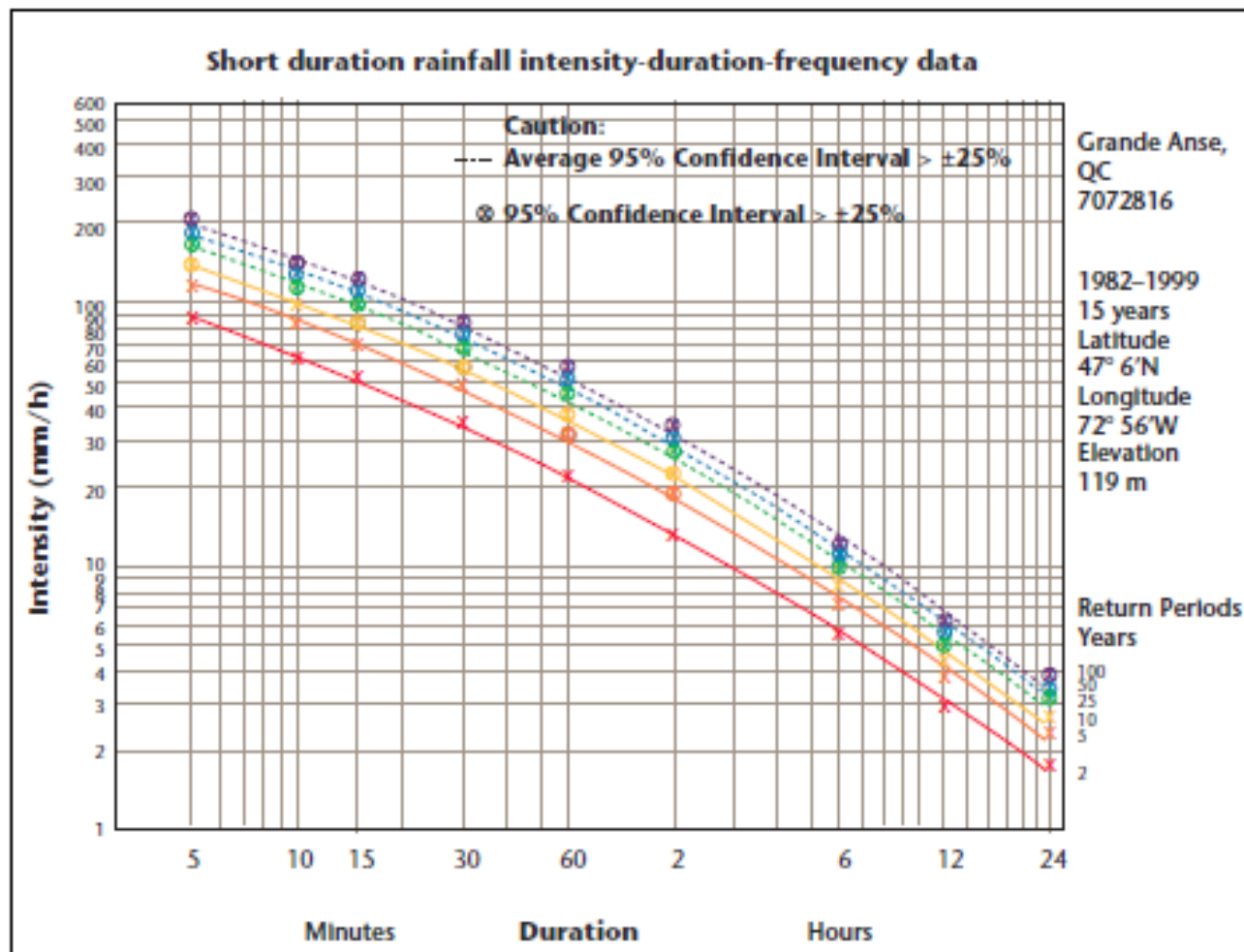
T-200b-GEONOR in the field
(from WMO 2009b)



PLUVIO - OTT in the field
(from WMO 2009b)

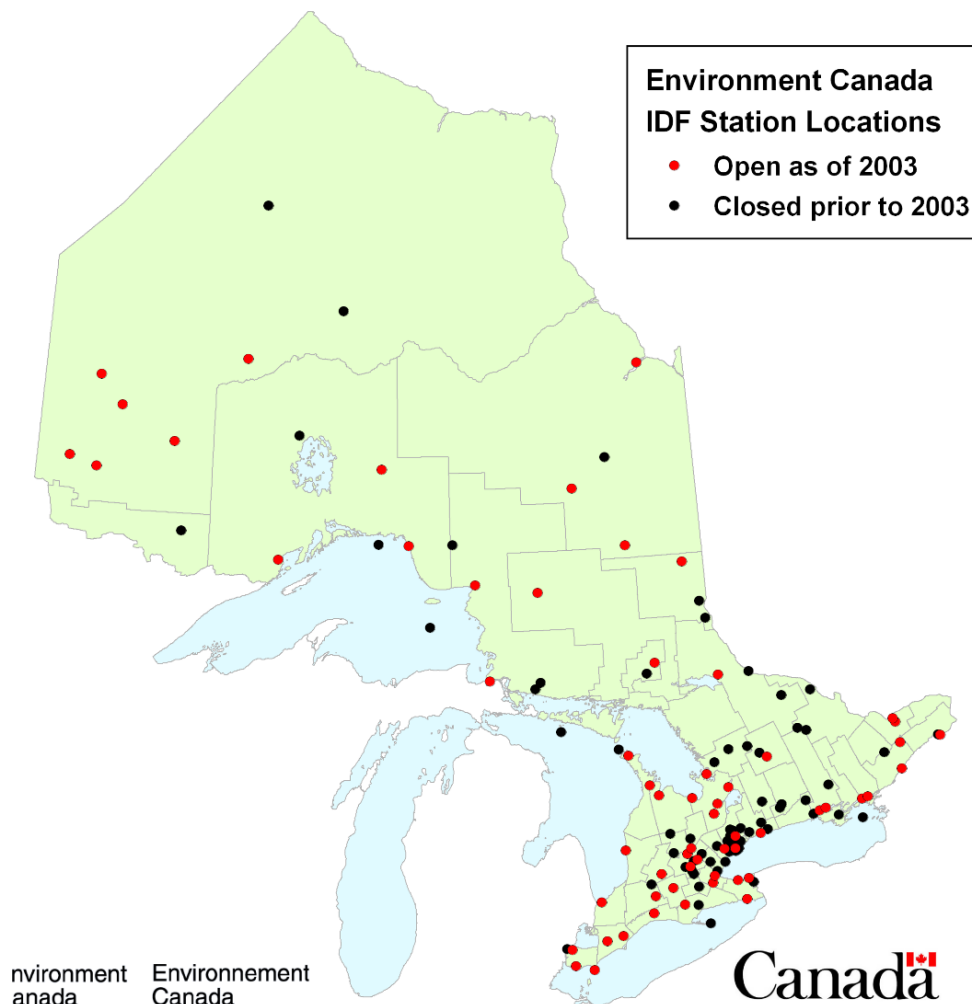


IDF Curves





IDF Data in Ontario





What is a return period?

An event with return period T has a $1/T$ probability of being equalled or exceeded in any given year

A 50-year return period event has a $1/50$ or 2% chance of occurring or being exceeded each year

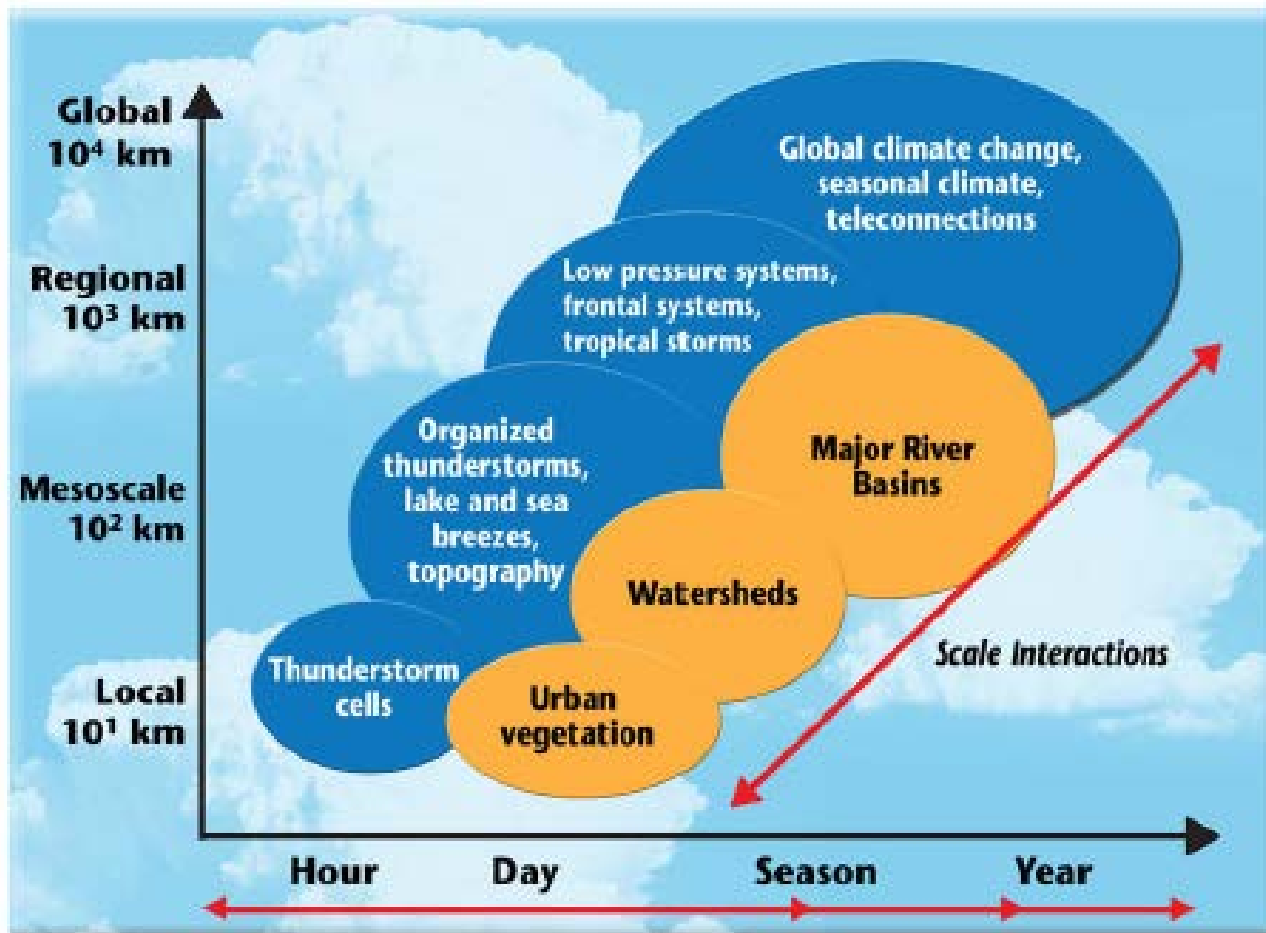
OR

50 years is the average return period between years in which a 50-year event occurs or is exceeded

... at an **INDIVIDUAL POINT LOCATION**

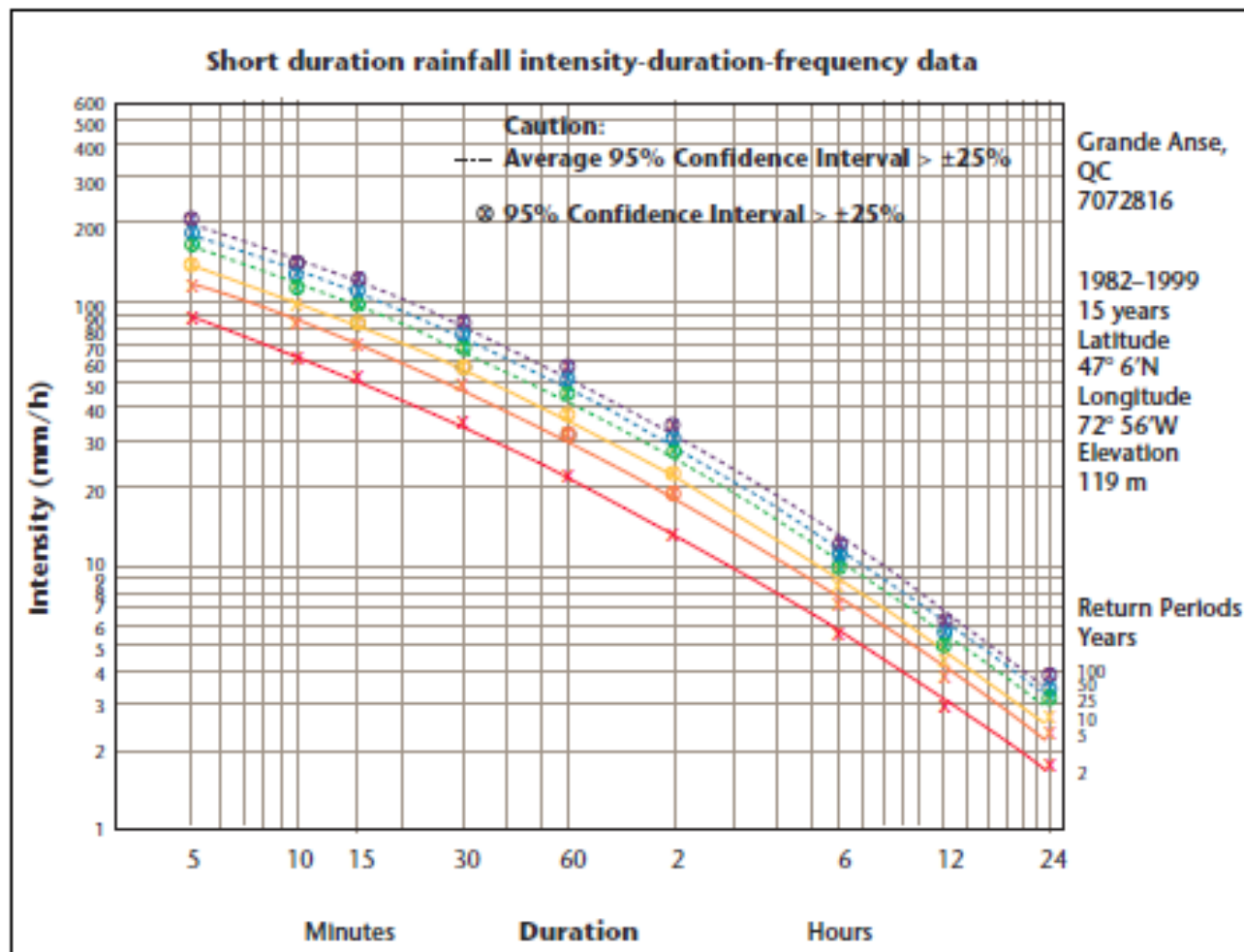


We just had a 100-year storm last year!





IDF Curves





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	5	10	25	50	100	#Years
	yr/ans	yr/ans	yr/ans	yr/ans	yr/ans	yr/ans	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			42.6		62.9	70.4	55
					- 12.4	+/- 14.4	55
1 h					- 8.0	42.6	56
					- 7.3	+/- 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



Rational Method

$$Q = ciA$$



Uncertainties:

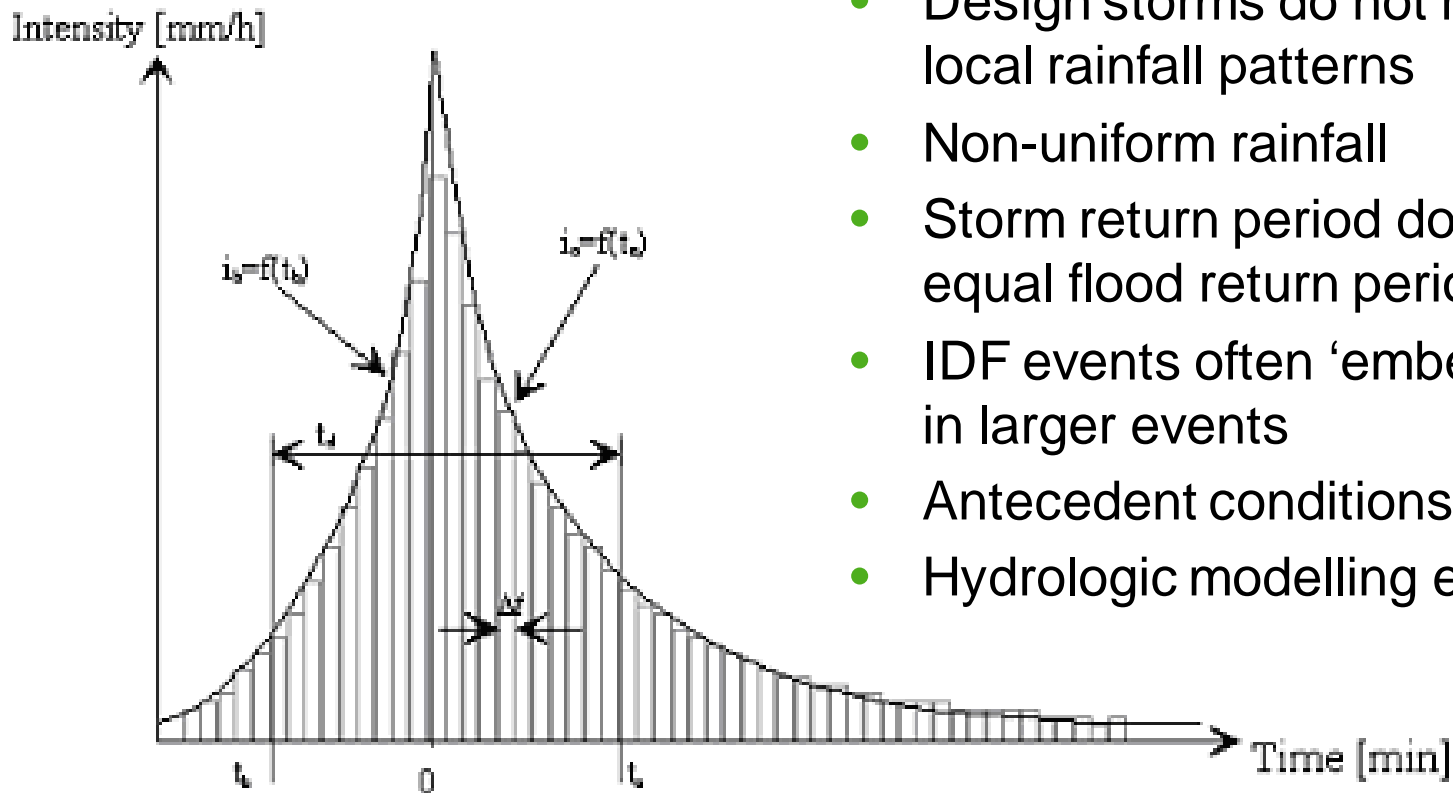
- Time of concentration
- Runoff coefficient
- Hydraulic storage
- Non-uniform rainfall



Design Storms

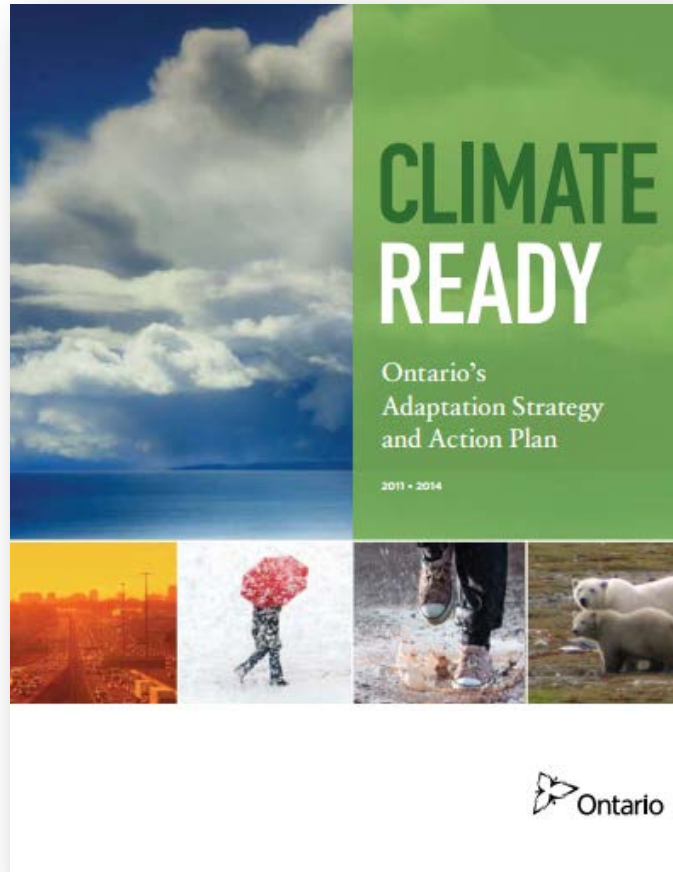
Uncertainties:

- Design storms do not replicate local rainfall patterns
- Non-uniform rainfall
- Storm return period does not equal flood return period
- IDF events often 'embedded' in larger events
- Antecedent conditions
- Hydrologic modelling error





Climate change and IDF



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

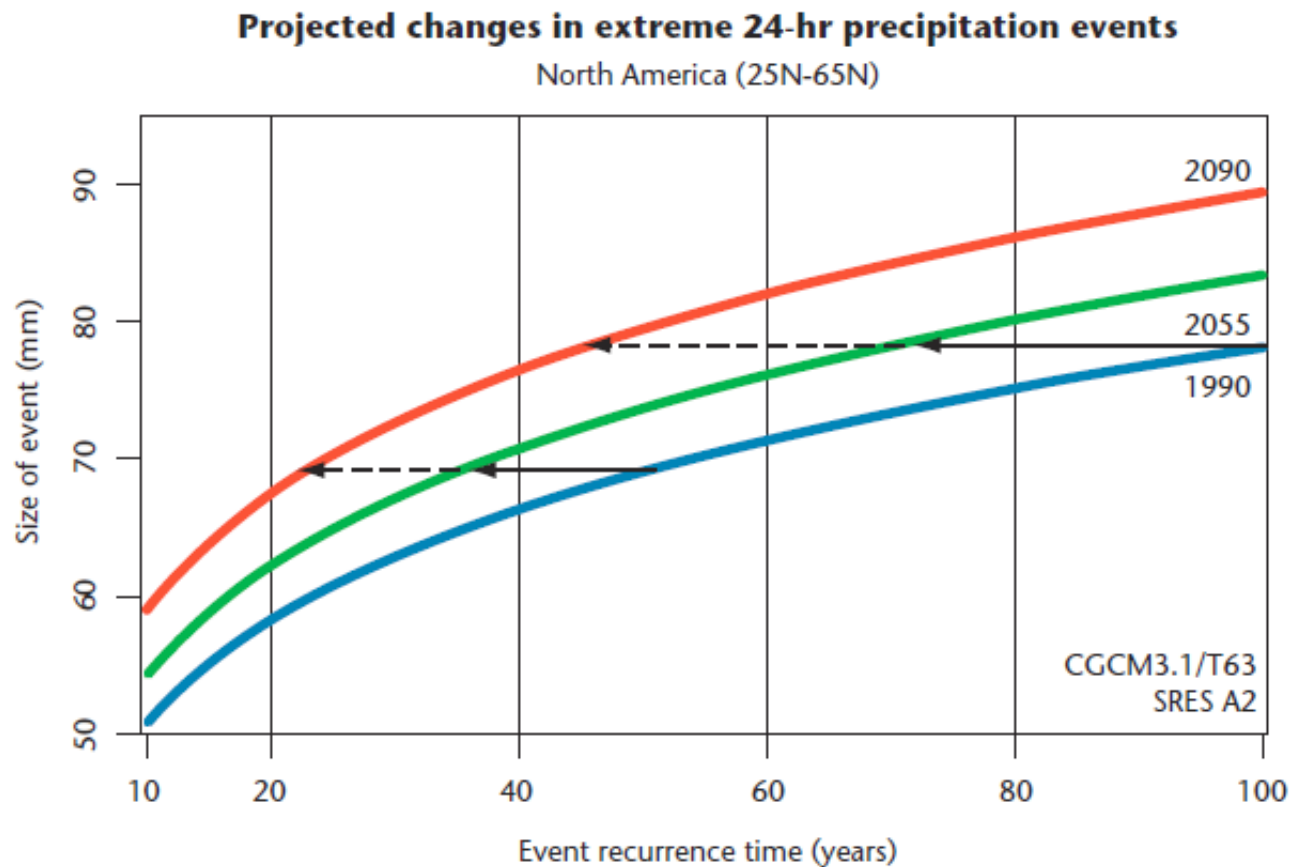


ACTION 26

UPDATE INTENSITY-
DURATION-FREQUENCY
CURVES



Climate Change and Extreme Rainfall



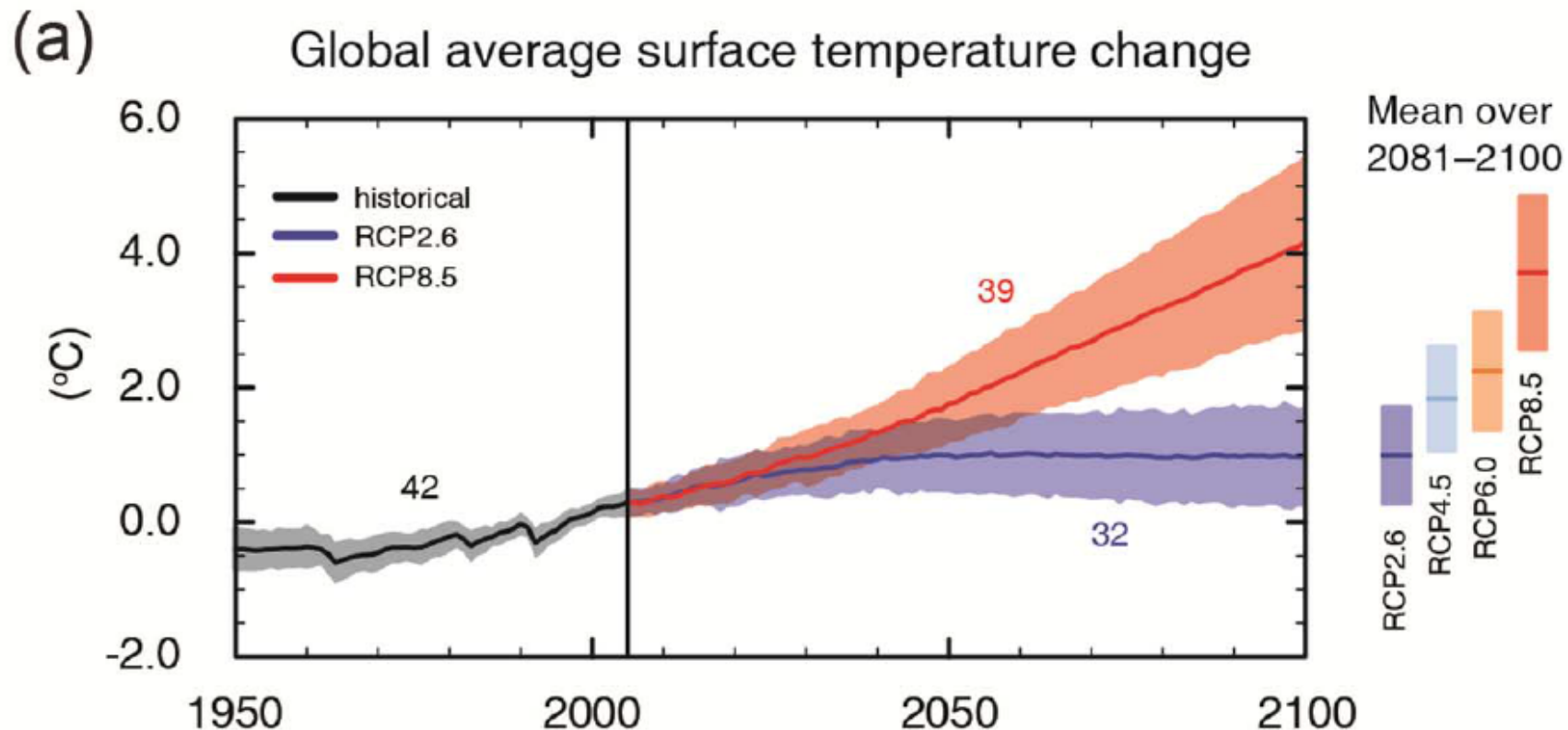


But ...

1. Climate models aren't great with precipitation
2. Climate models don't "do" thunderstorms
3. Regional climate variability is huge
4. No trends have been observed in S. Ontario – yet
5. There are more than 10 different methods being used to incorporate climate change in IDF curves

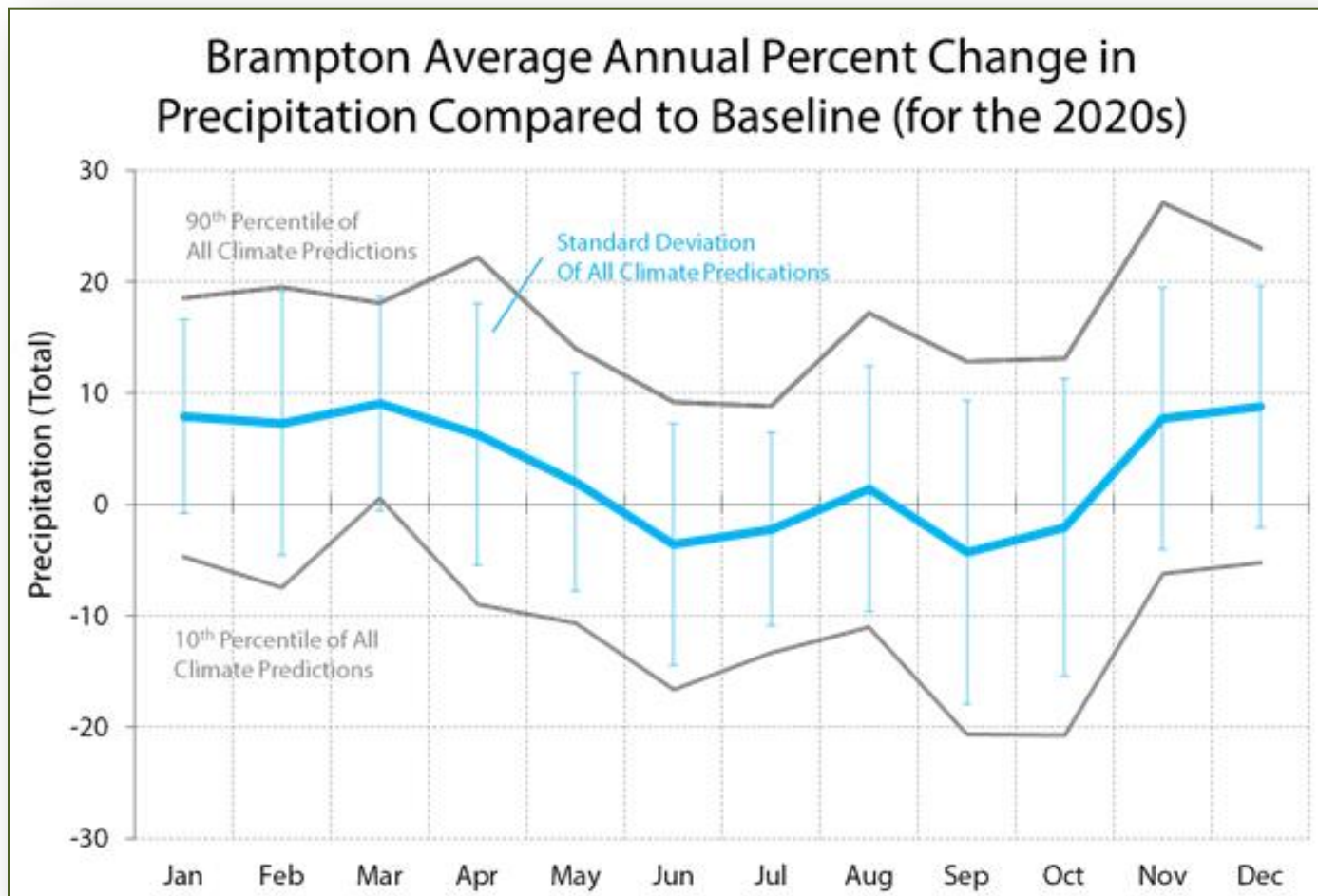


Emissions scenarios





Climate Model Variability





The Future IDF Project



To understand the effectiveness and limitations of different methods to incorporate climate change in IDF values for use in Ontario



Project Outcomes

- Summary of available methods
- Application to case study areas across Ontario
- Comparative analysis of methods and results
- Document strengths, limitations and appropriate applications of the various methods
- Develop guidance materials for application in other jurisdictions

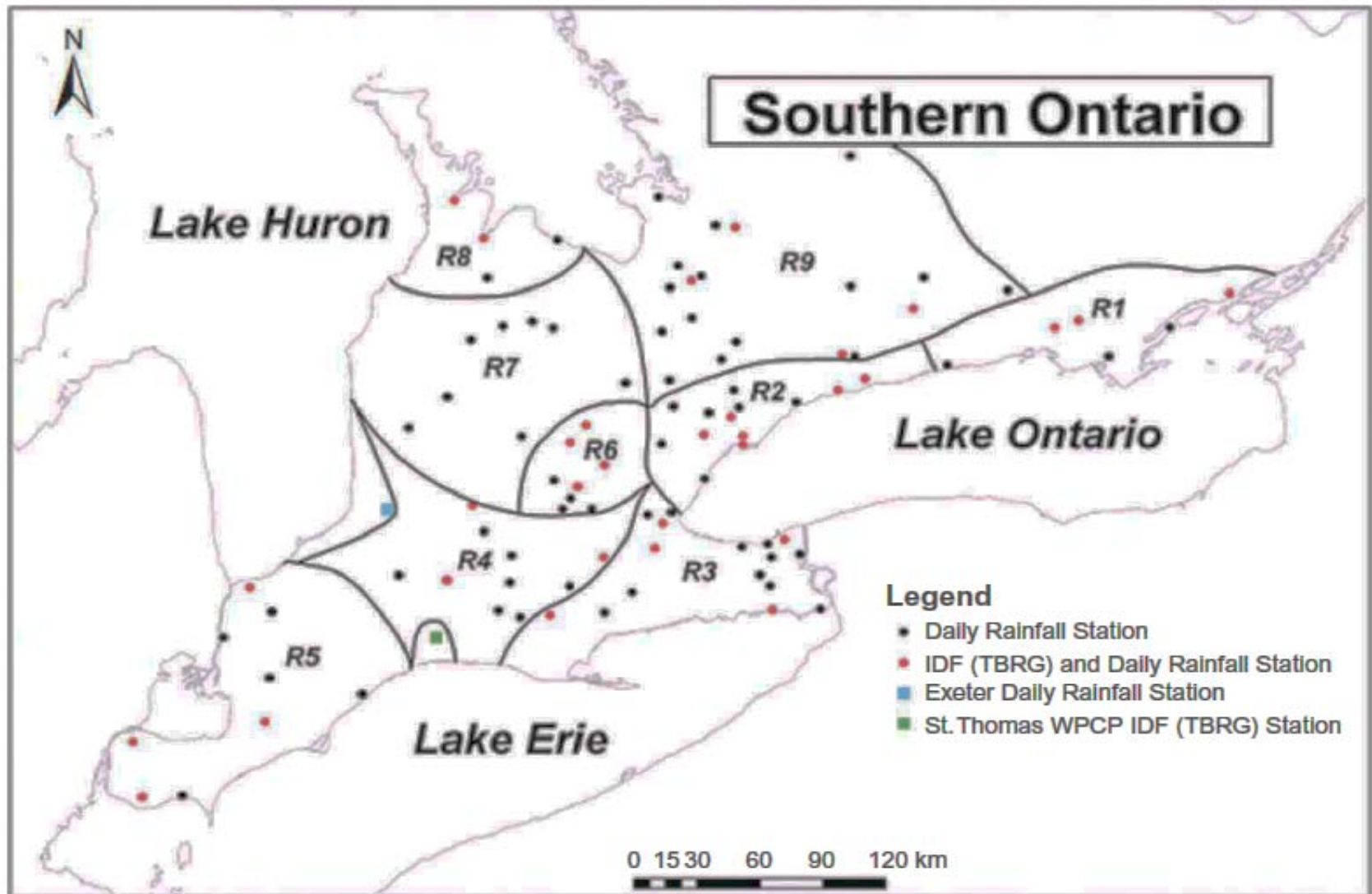


How do we move forward now?

1. Better ways of calculating IDF statistics
2. Understand and manage current risks
3. Address other uncertainties



Regional IDF Pilot Project

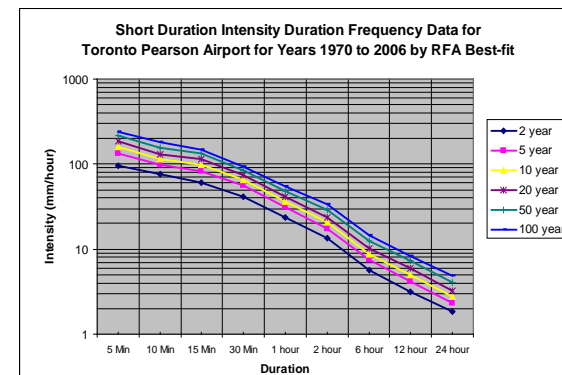
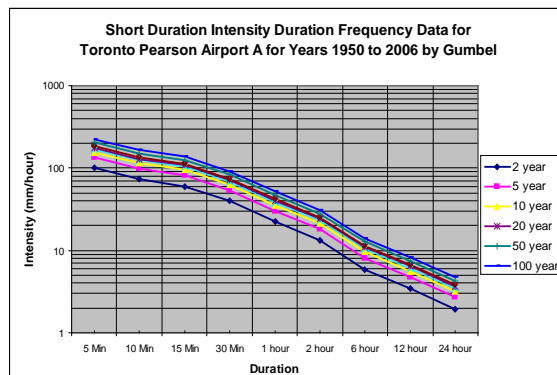
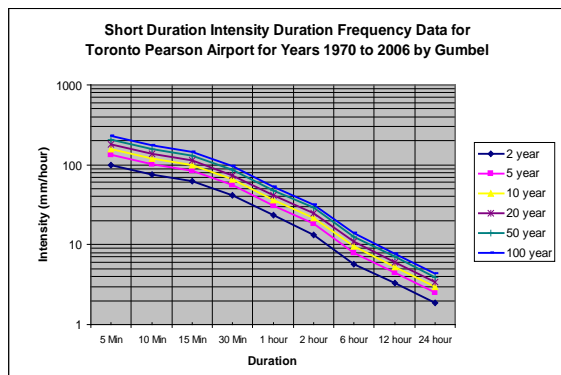




Regional IDF Pilot Project

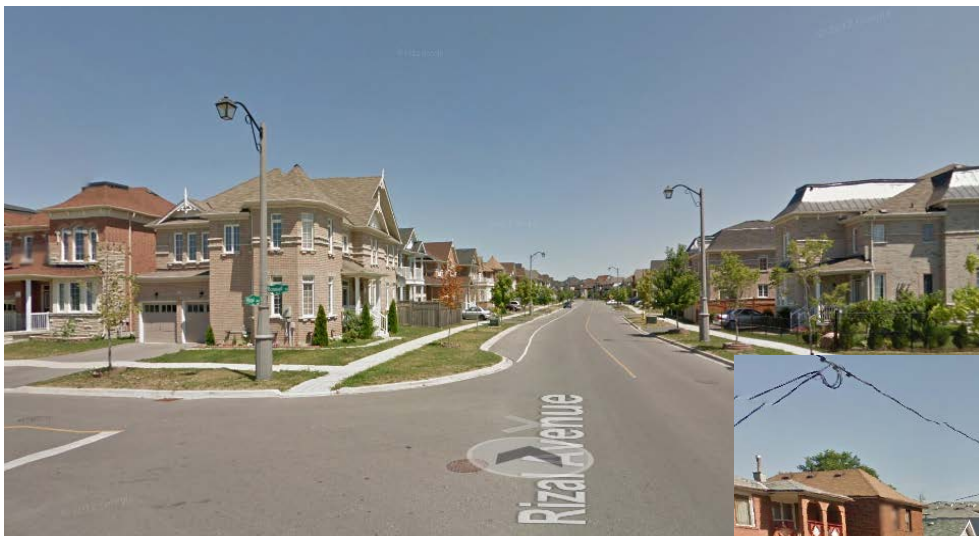
Toronto Pearson Airport – 100 year return period values

Durations	5 Min	10 Min	15 Min	30 Min	1 Hr	2 Hr	6 Hr	12 Hr	24 Hr
EC Current 1950-2003	19.0	27.7	34.8	45.9	51.6	62.2	85.8	100.8	115.1
EC 1970-2006	19.1	28.9	36.1	47.7	52.4	64.0	84.6	92.9	104.0
RFA 1970-2006	20.5	29.9	37.1	45.8	52.4	64.3	82.6	100.9	115.9
Difference	+7.3%	+3.3%	+2.7%	-3.9%	-0.1%	+0.5%	-2.3%	+8.7%	+11.5%





Where is the real risk?





Understanding and Managing Other Uncertainties

- Confidence intervals in IDF data
- Transposing IDF data to other locations
- Using synthetic design events
- Hydrologic modelling / calculation uncertainty
- Assumptions about uniform rainfall
- Storm frequency \neq flood frequency



Thank You

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