

A History of Ontario Floods Reveals Huge Changes

by

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Acknowledgements

- Agencies
 - NSERC, OMAF, Env. Can., Conservation Authorities & Water Survey of Canada

- Personnel
 - Barry Smith & Other Professional Colleagues
 - Post-Doctoral Research Fellows
 - Amanda Siwik, & Past Graduate & Undergraduate Student Assistants

2016 to 2018

Contract to develop a Historical Flood Database for Ontario

i.e. an inventory of reported floods,
not including shore/beach flooding

2019

“Historical Floods of Ontario: A Reported Flood Event Database and Preliminary Analyses of Variability”

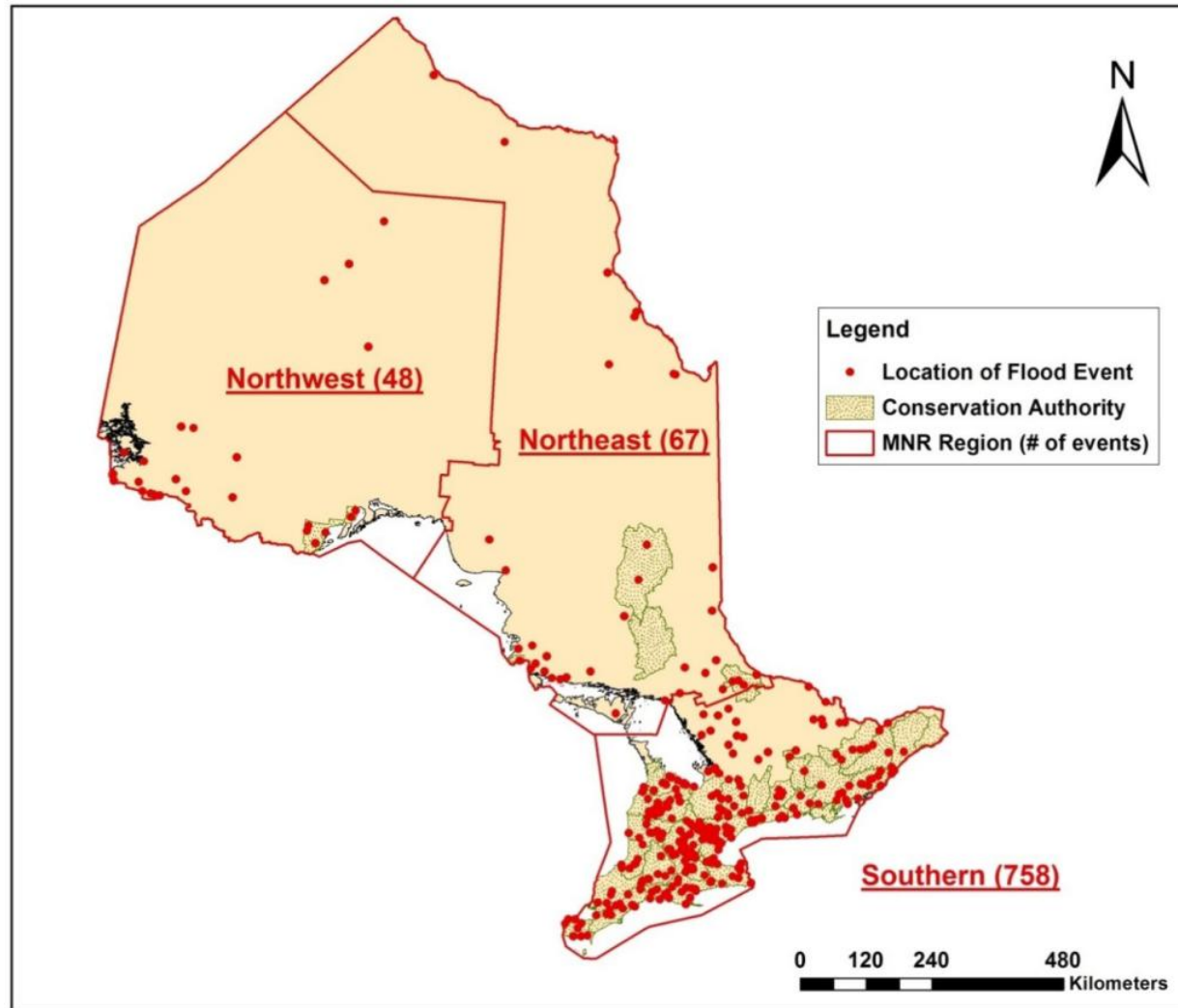
Sources of Information

- Ontario Conservation Authorities
- Canadian Disaster Database from Public Safety Canada
- Conservation Ontario
- Insurance Bureau of Canada
- Property Claims Services Canada
- Ontario Ministry of Natural Resources
- Environment Canada
- Ontario Disaster Relief Assistance Program (Ontario Ministry of Municipal Affairs)
- Municipal & Provincial Archives
- Climate Ontario
- University of Guelph Library Archives
and numerous Newspapers

Flood Attributes

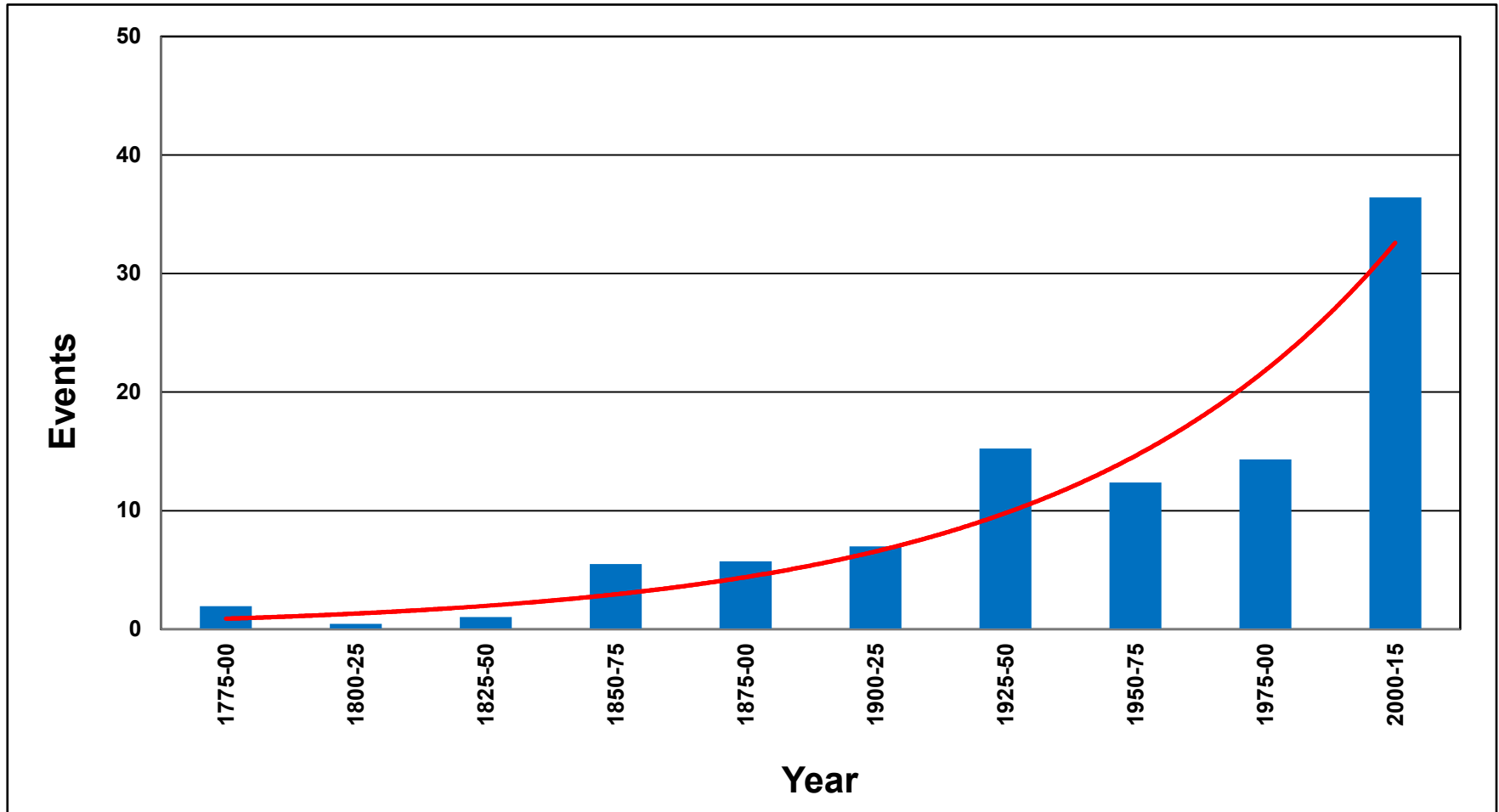
Date	Event Rainfall (mm)	Watercourse	Watershed	Conservation Authority
MNR District	MNR Region	Municipality	Latitude	Longitude
Flood Cause	Flood Elevation	Flood Depth	No. of Houses Affected	No. of People Affected
No. of Basements Affected		No. of Roads Flooded	Other Things Flooded	Damages to Residences
Damages to Public Facilities		Damages to Industries	Total Damages	Documentation

Number of Flood Events

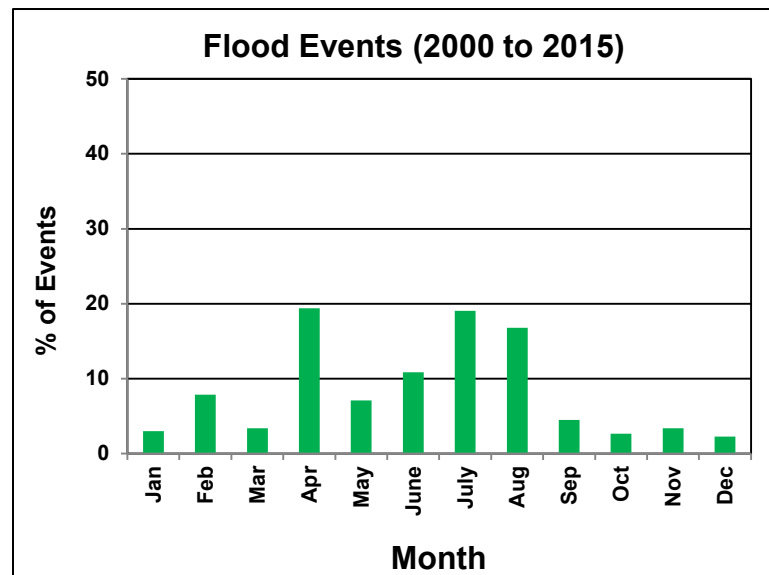
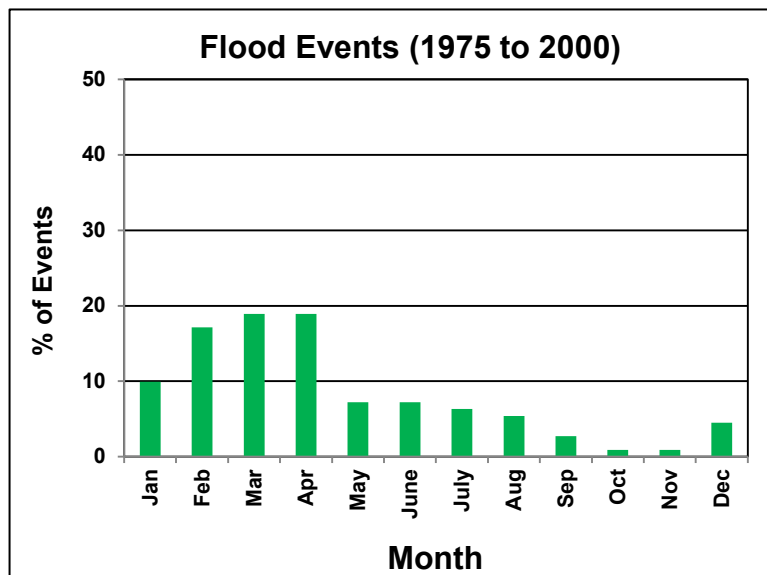
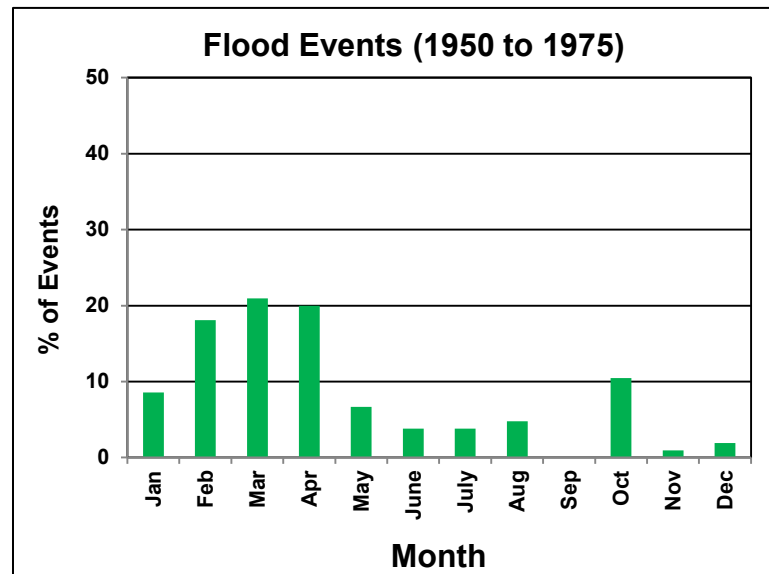
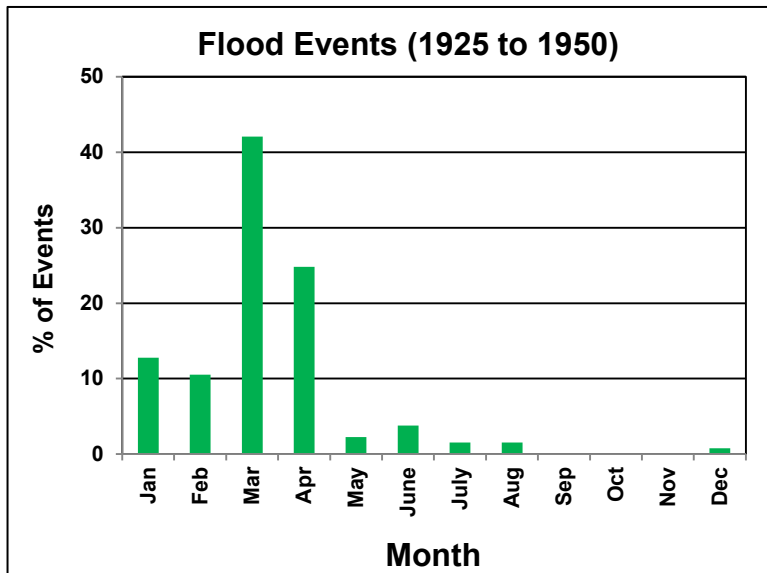


Locations of 873 Reported Flood Events in OMNR Regions
(1775 to 2015)

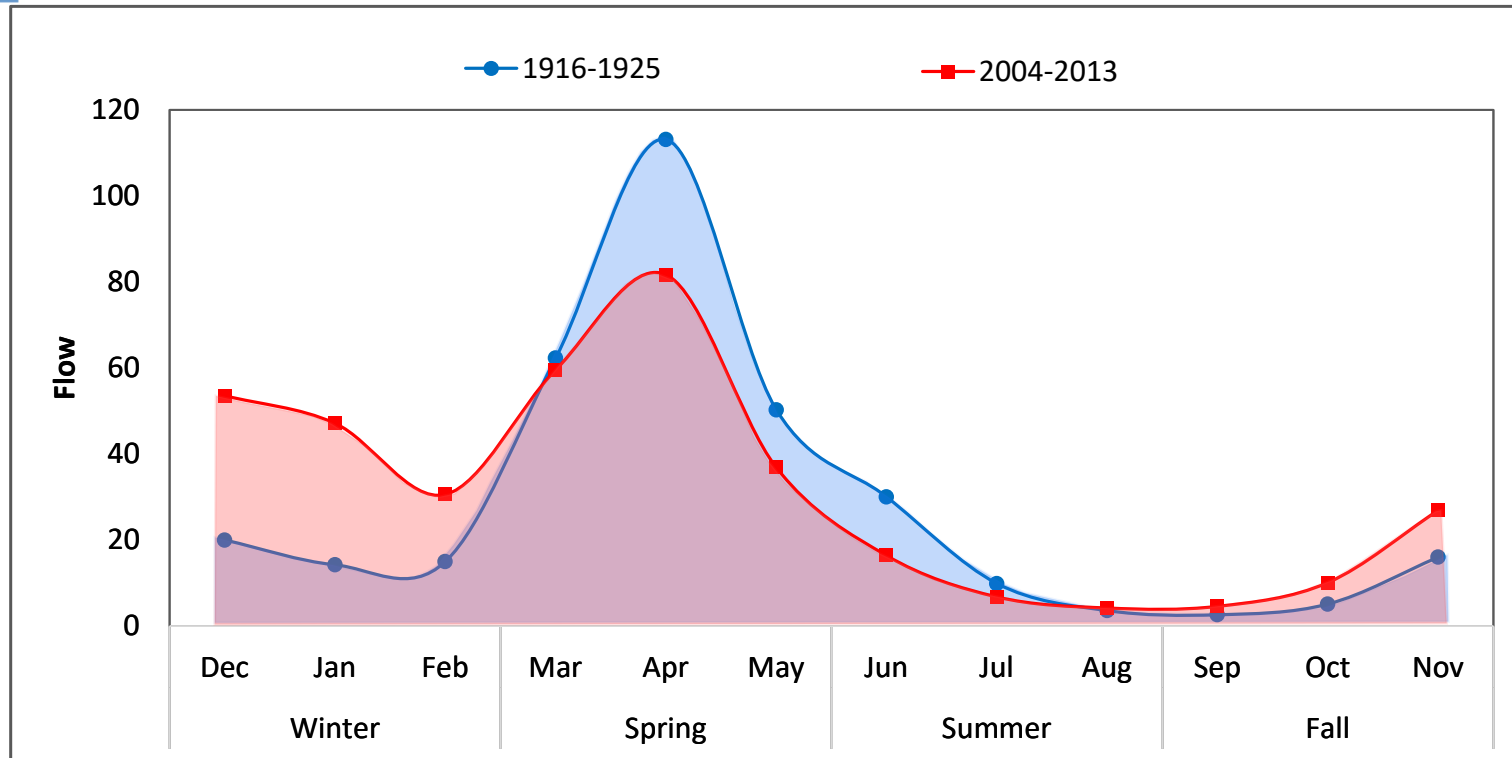
Temporal Occurrence of Reported Flood Events



Trends in Monthly Floods in Southern Ontario

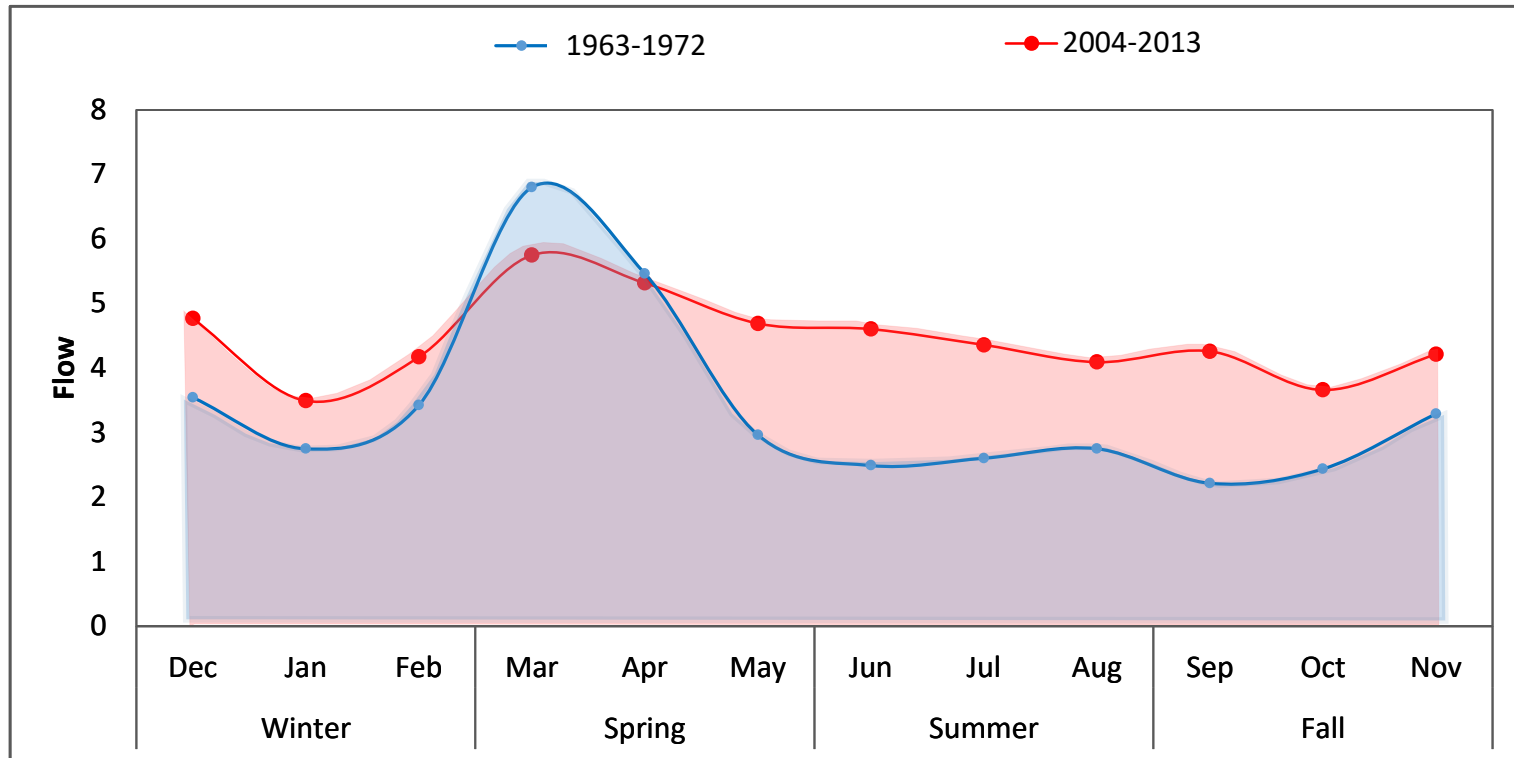


Rural River Flows Have Changed



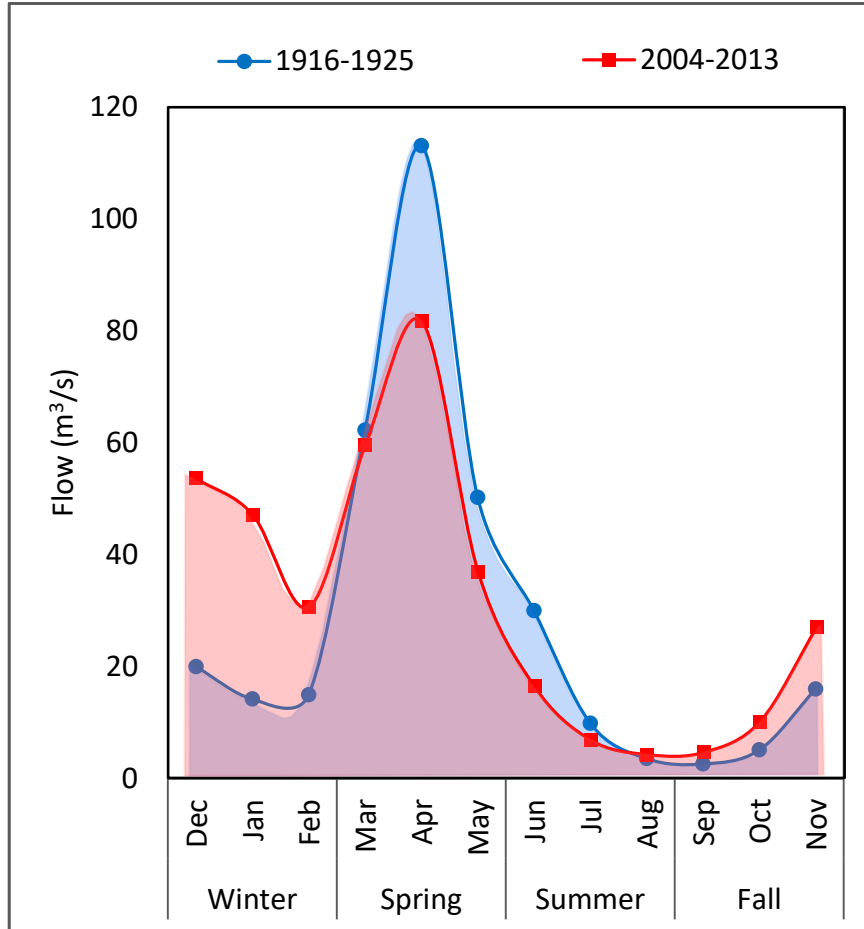
For Rural Watersheds like the Moira River at Foxboro:
winter flows have increased, spring flows have decreased,
& summer flows have remained unchanged.

Urban River Flows Have Changed

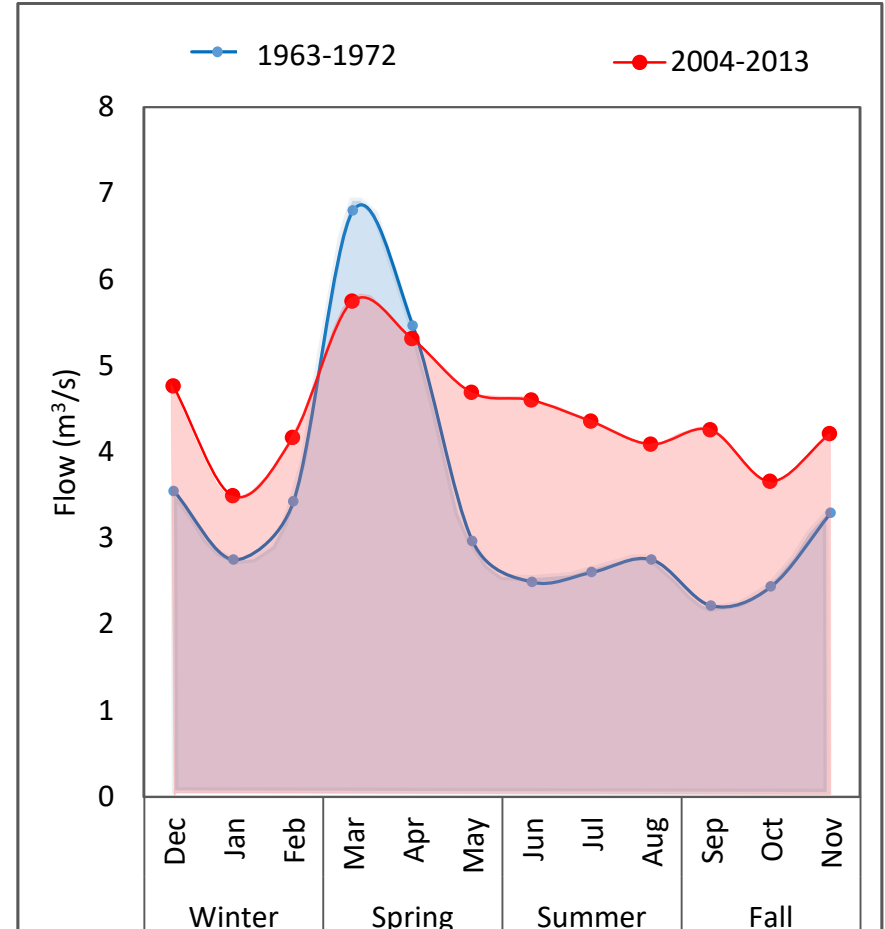


For a highly Urbanized Watershed like the Don River at Todmorden: winter flows have increased, spring flows have decreased, & summer flows have greatly increased in volume.

Rural Versus Urban River Flow Changes

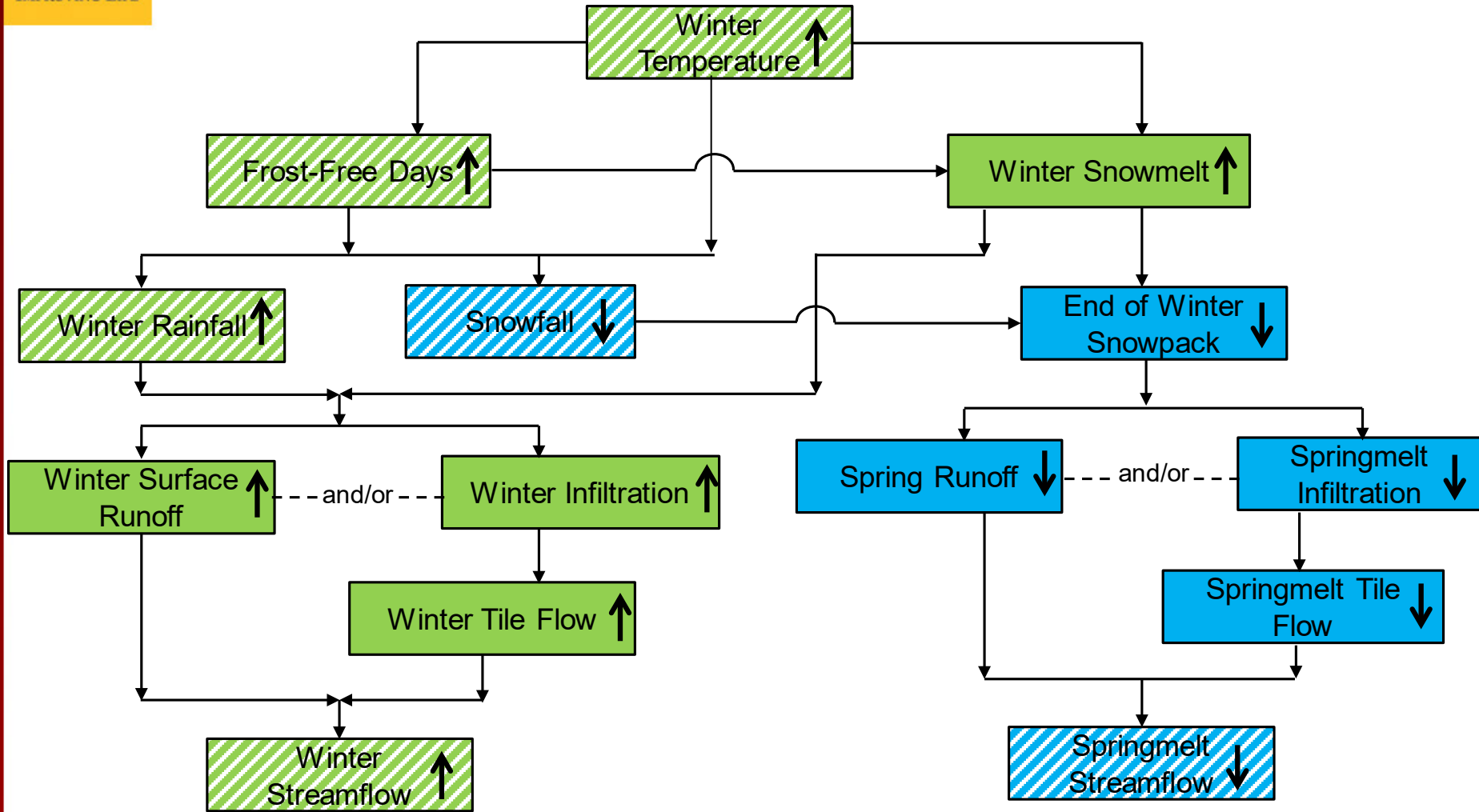


Rural river flows



Urban river flows

Changes in Winter Hydrology in Ontario



Variable has increased

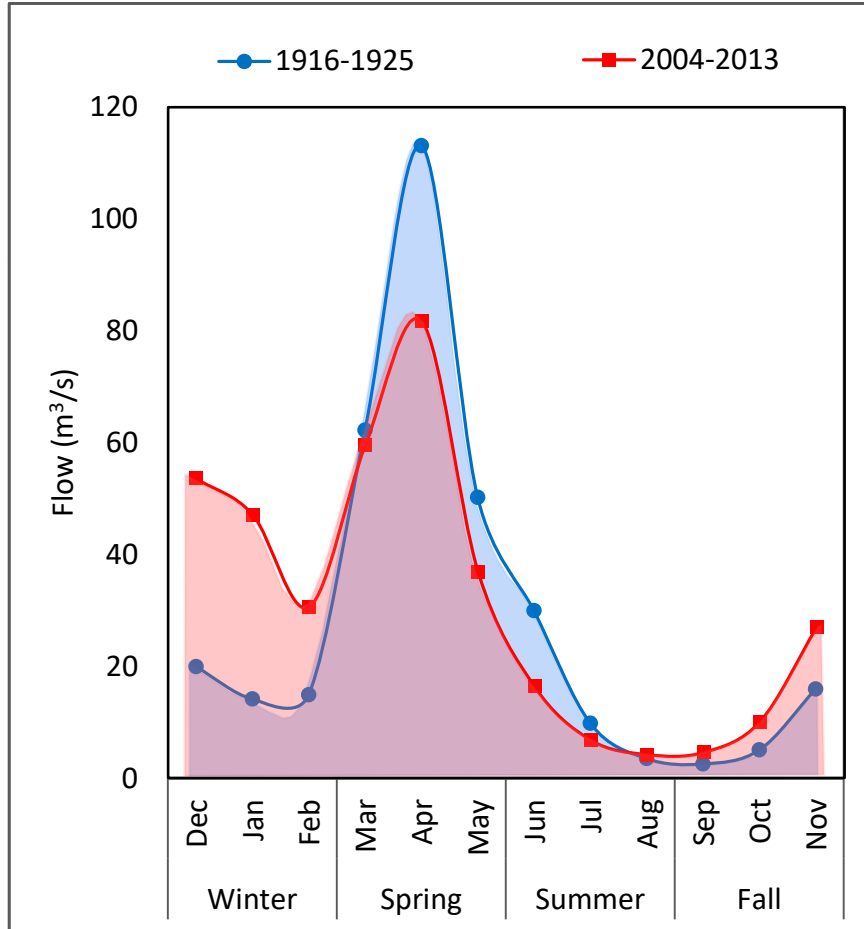
Variable has decreased

Data Available

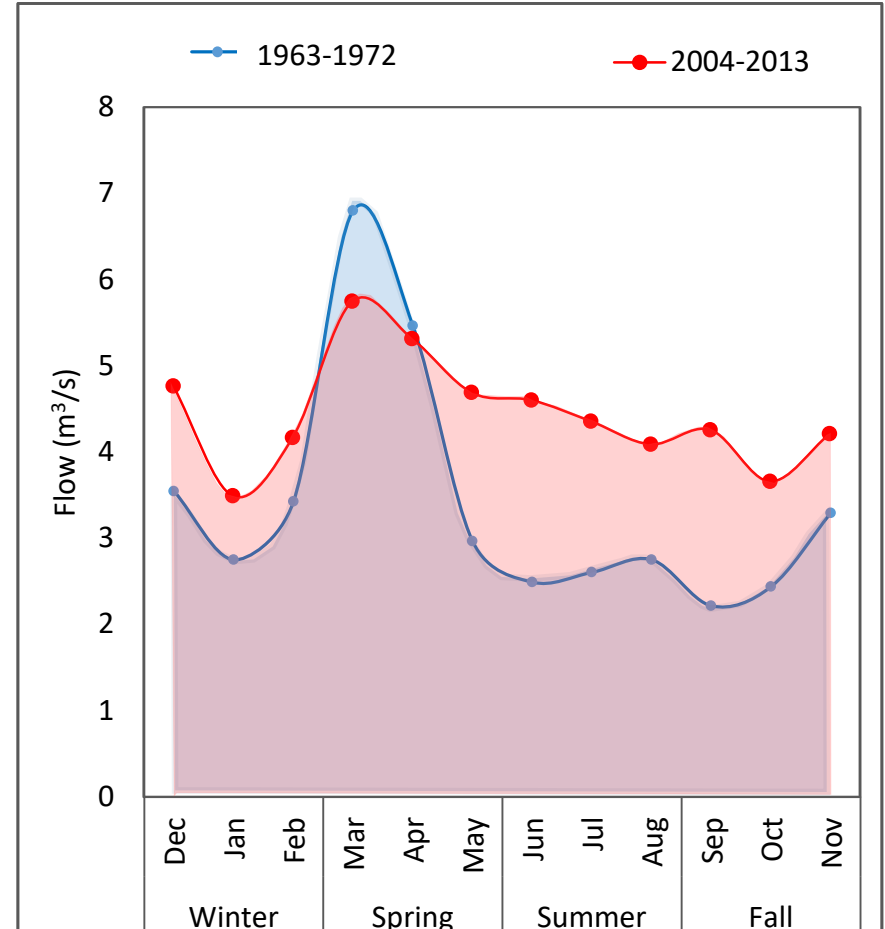
In southern Ontario:

1. Winter flows have increased, and perhaps winter floods are becoming more likely.
2. Spring flows and floods have decreased.
3. Reservoir filling and management have become more difficult.
4. The timing and volumes of water quality discharges have likely changed.

What About the Changes in Urban Summer Flows?



Rural river flows



Urban river flows

Possible Conclusions & The Evidence

One might conclude that:

- we are experiencing many more rain events, and/or much more severe rain events.

In fact:

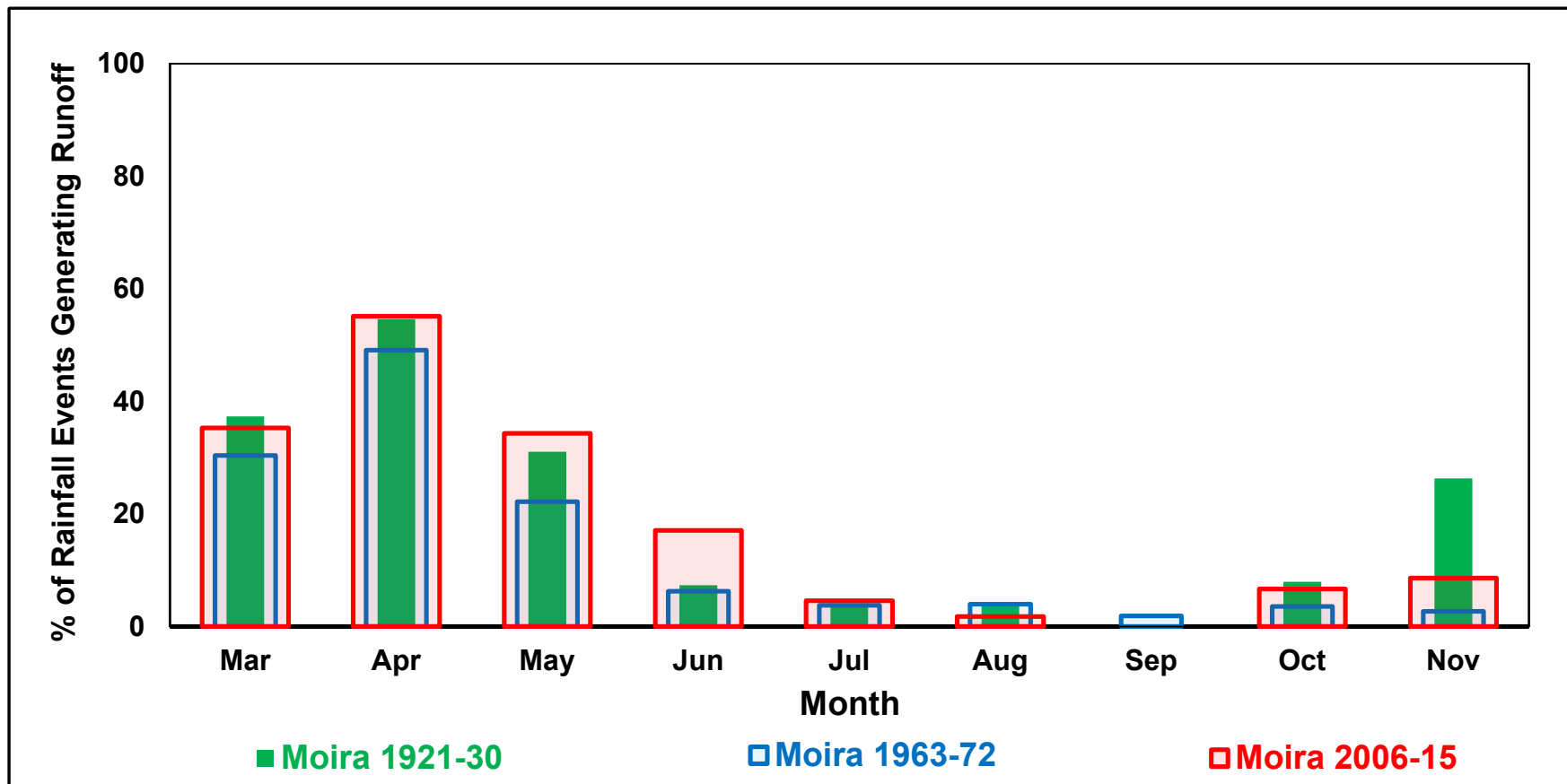
- the number of rainfall events has **not** increased,
- the total amount of rainfall occurring over the growing season has **not** increased, &
- to date, there is **no** evidence that rain storms are more severe.

Changes in % of Rainfall Events Generating Rural Runoff

Rural conditions

Events > 3mm rainfall

Runoff Coefficient > 0.05

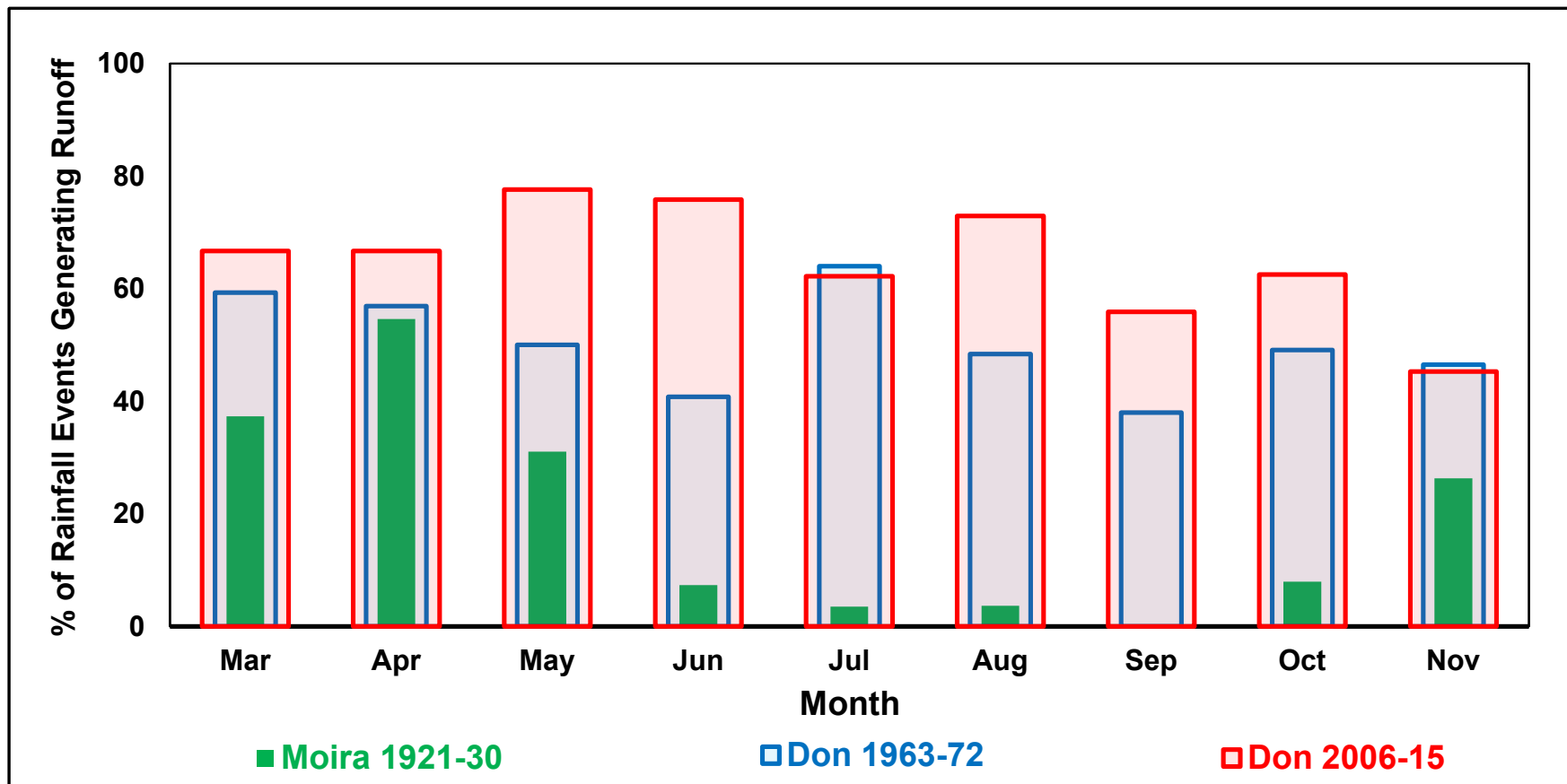


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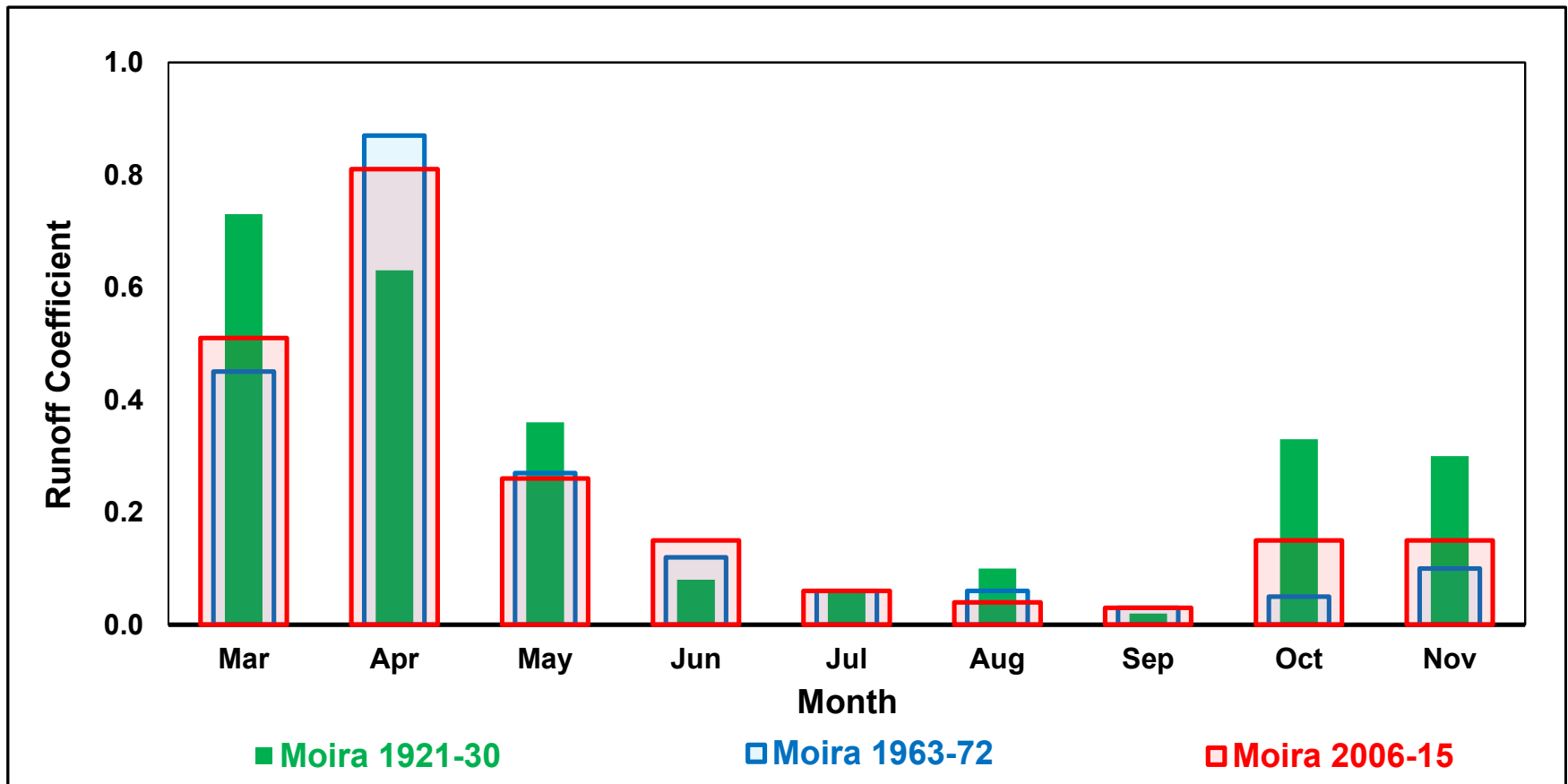


Frequency of Runoff from Highly Urbanized Areas

There are **15 Times** more runoff events
in the Don River
than in rural watersheds
during the growing season.

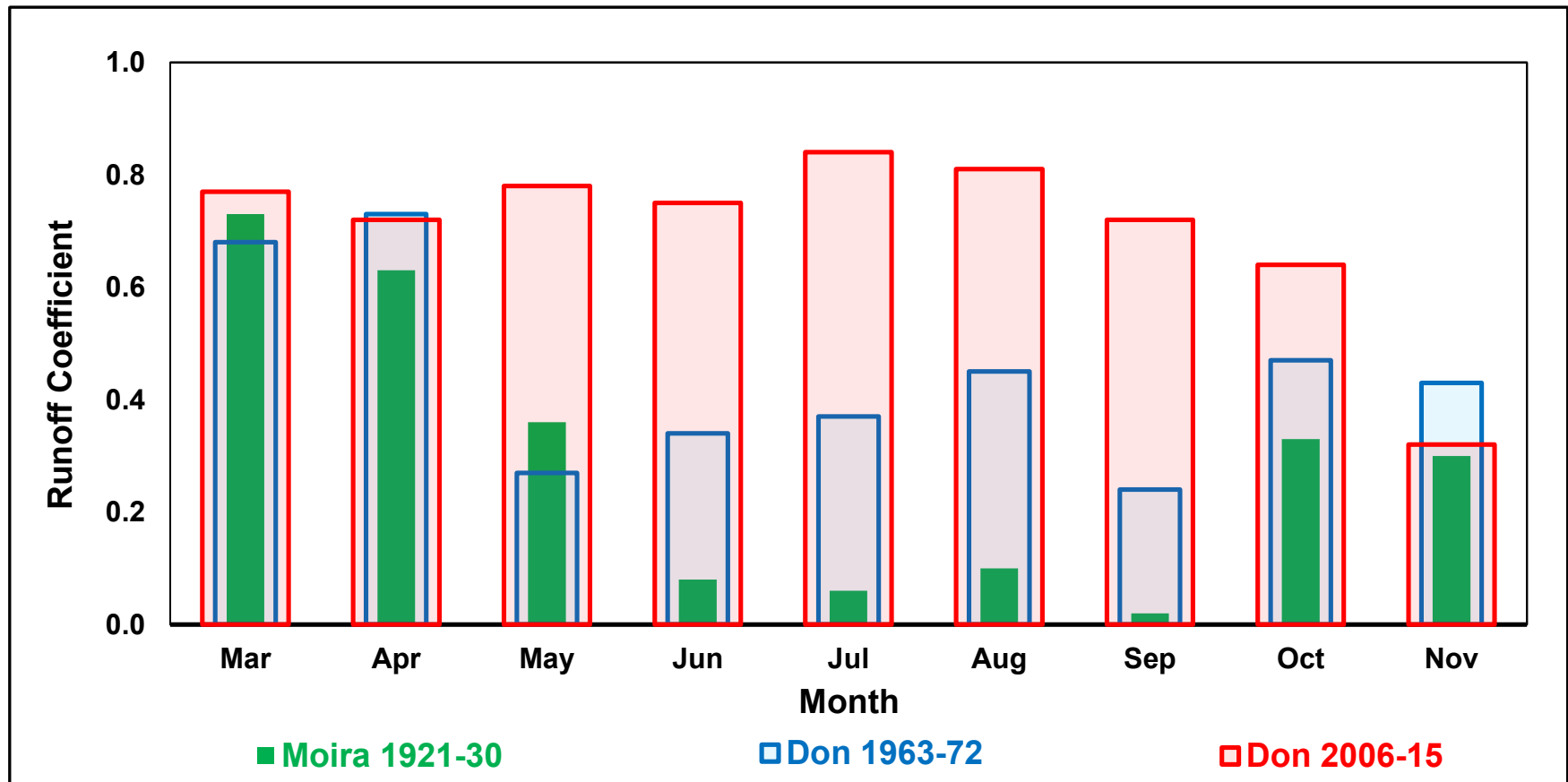
Changes in Upper Decile Rural Runoff Coefficients

Rural conditions



Changes in Upper Decile Urban Runoff Coefficients

Urban conditions



Urban Runoff as a % of Rainfall

The percentage of rainfall that runs off during the largest runoff events during the growing season is **10 Times Greater** in the Don River than in rural watersheds.

Rainfall versus Runoff

So ...

whereas the number of summer rain events has **not** increased,

and the amount and severity of summer rainfall events have **not** increased;

the number of summer runoff events in urban areas has **greatly** increased,

and the volume and rate of summer runoff and stream flows in urban areas like the Don River have **greatly** increased.

Inadequate Stormwater Management

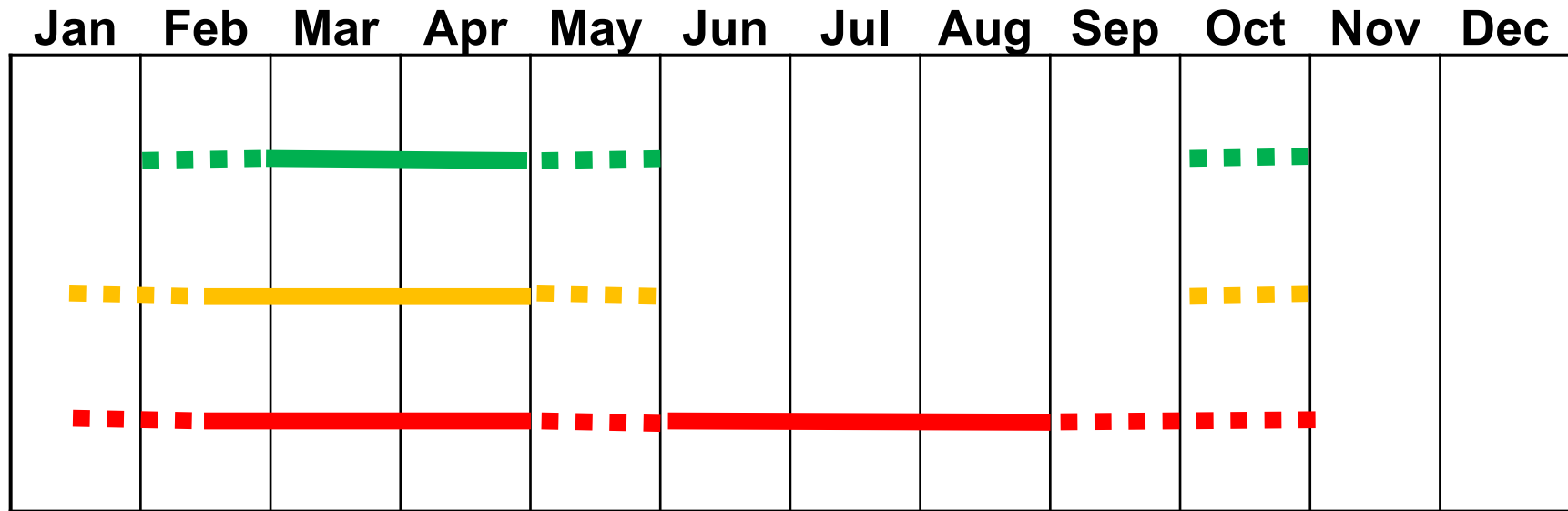
In other words:
many urban stormwater management systems
in southern Ontario
are not adequately mitigating
present localized intense summer rain storms.




Impacts of Urban Summer Flow Changes

As a result, in our Urbanized Areas:

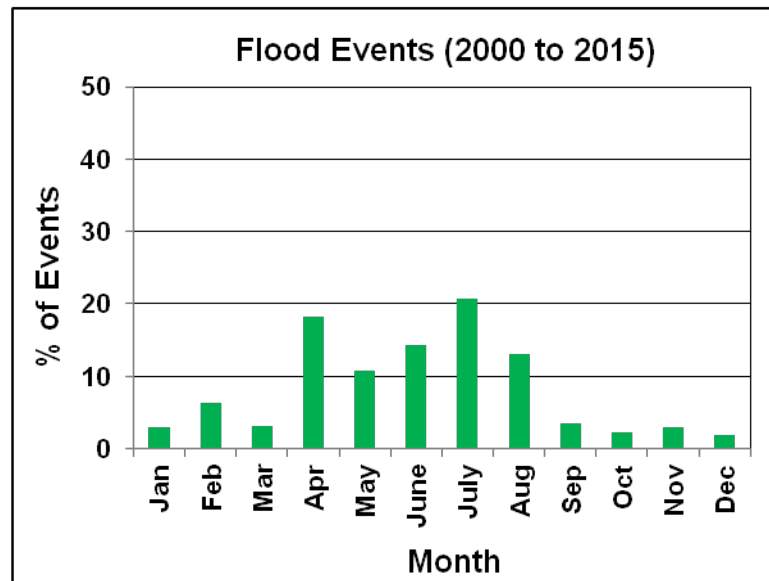
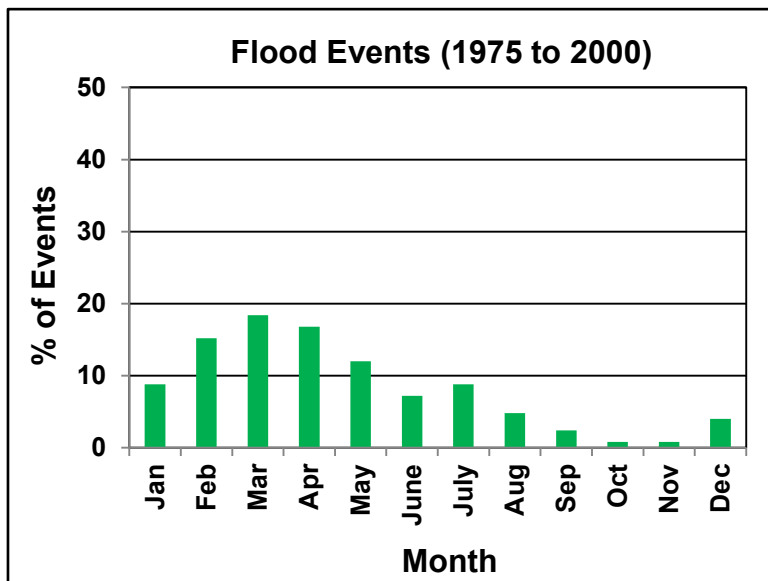
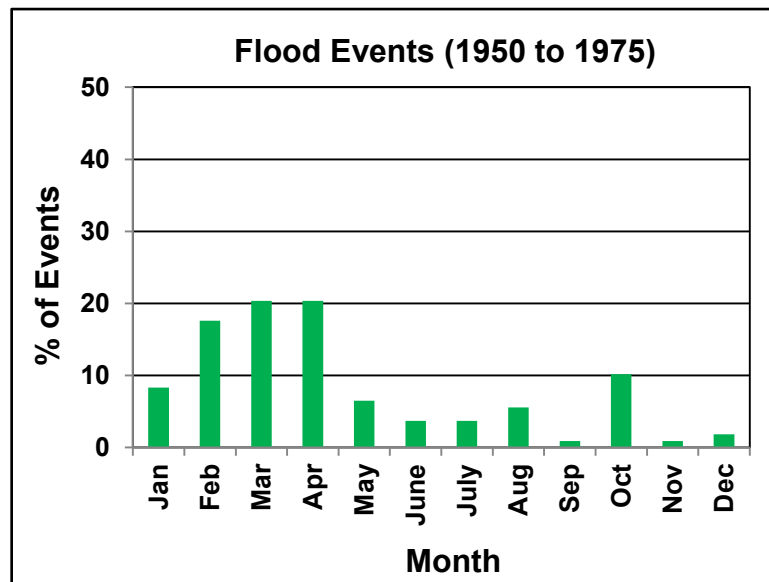
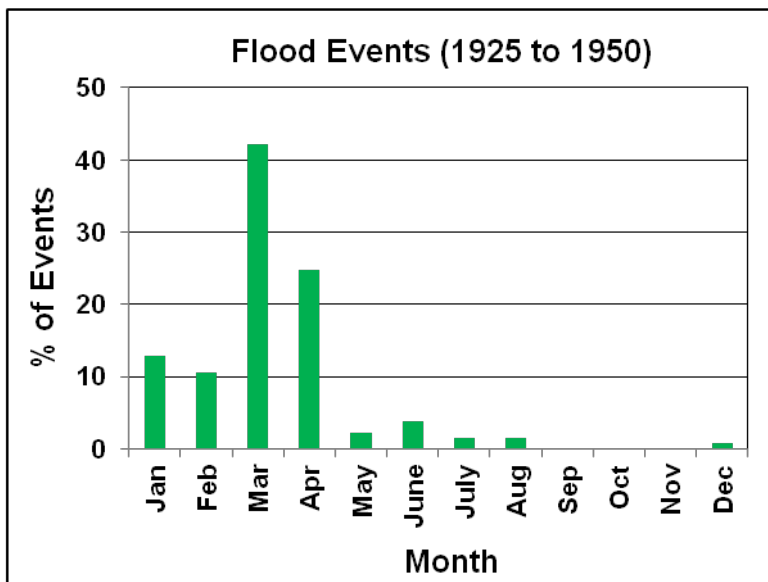
1. Localized and downstream flooding have become more likely in summer months.
2. Streambank and streambed erosion have become much more widespread and severe.
3. Water quality discharges have likely changed considerably.

The Summer Season of Urban Floods



-  Rural Watersheds
-  Rural Watersheds + Climate Change
-  Urban Watersheds + Climate Change

Changes in Monthly Distribution of Reported Floods



What now?

We need to modify our stormwater management design code, to include:

1. A Summer Design Storm

- a localized, intense summer design rain event, and its application,

2. Green Space

- a minimum percentage area allocation for sustained green space, and

3. Rapid Response Plans

- specifications for plans and warning systems for summer flash floods e.g. 30 minute response time.

Questions ???

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