

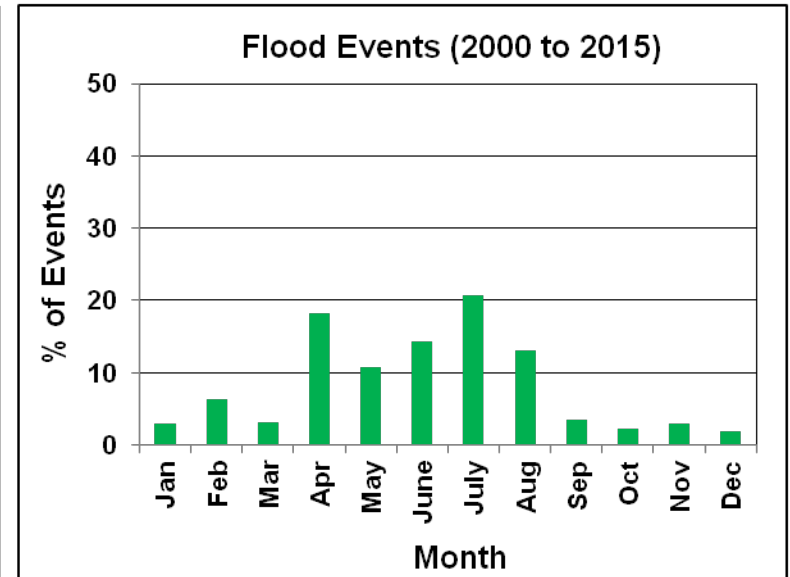
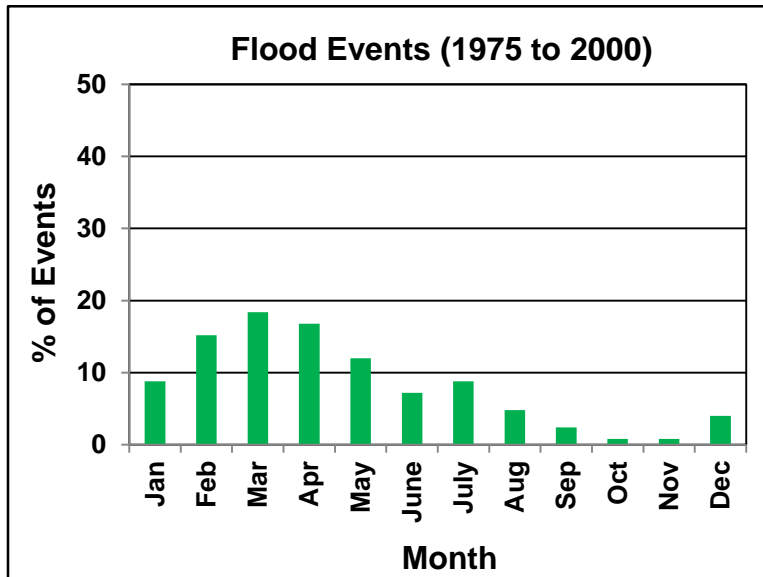
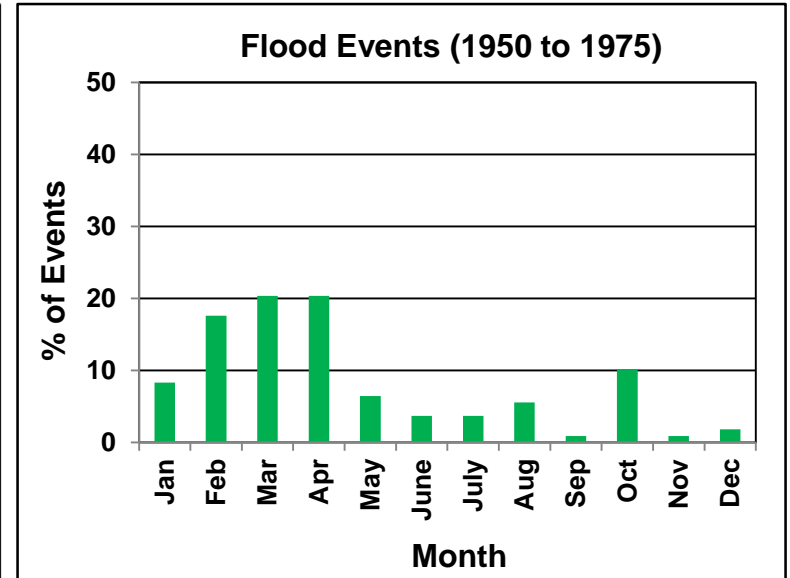
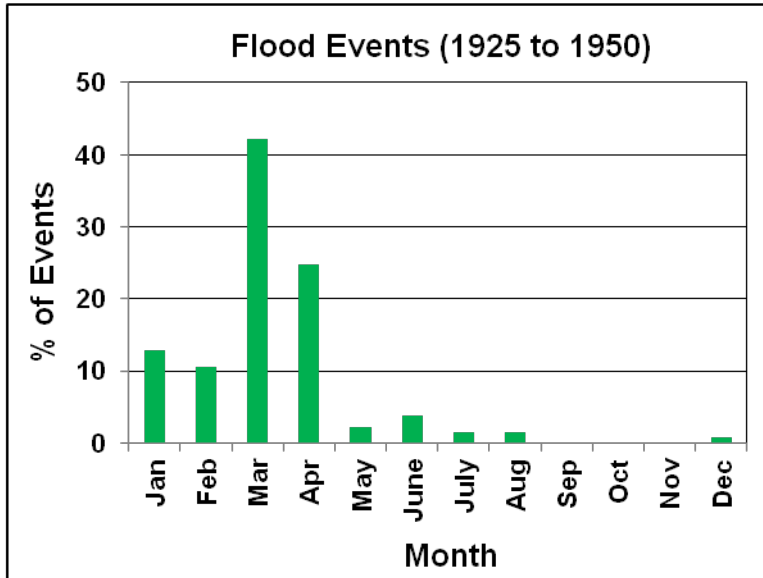
Floods in Southern Ontario Have Changed

by

Trevor Dickinson, Ramesh Rudra,
& Kishor Panjabi

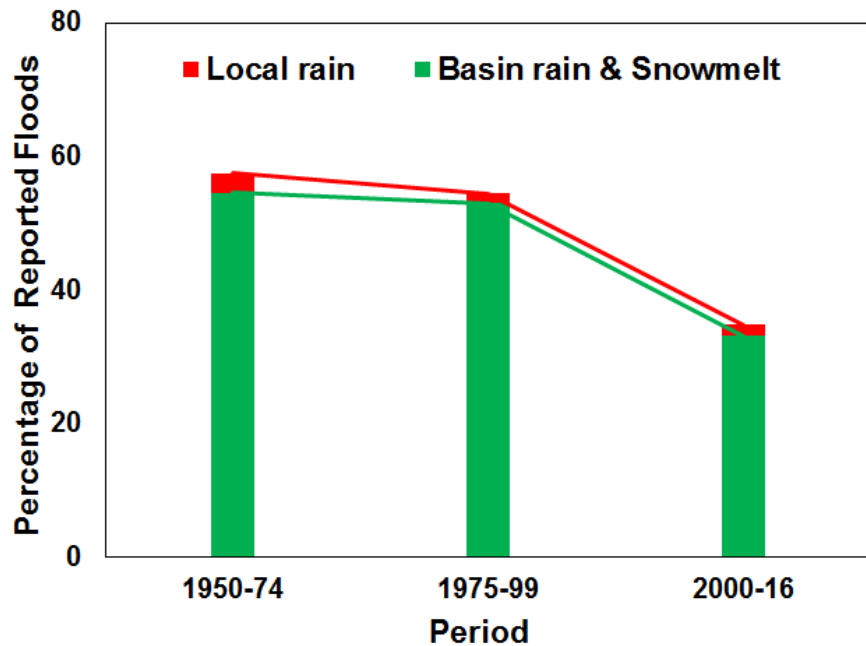
Water Resources Engineering
University of Guelph

Monthly Distribution of Reported Floods

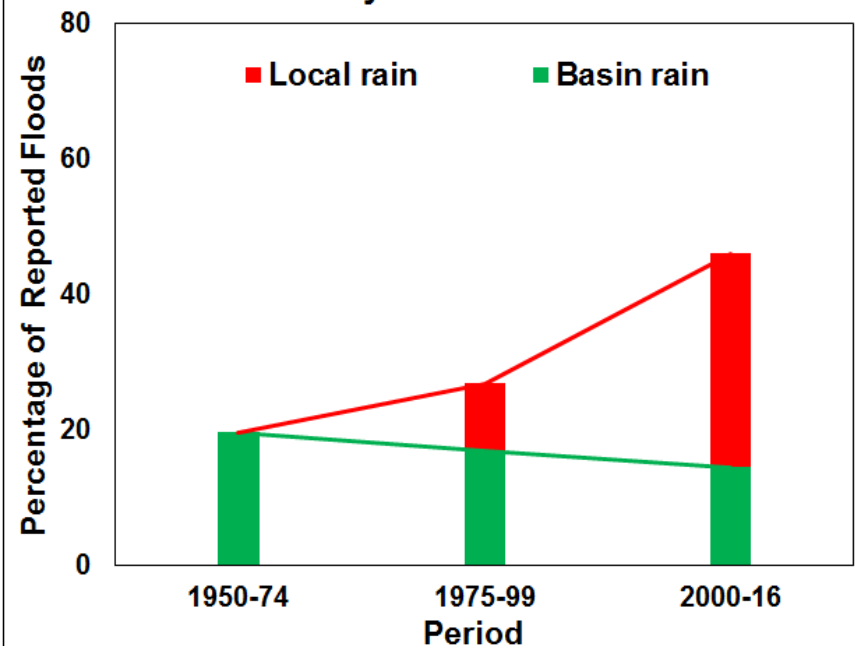


Temporal Change in Reported Floods

February to April



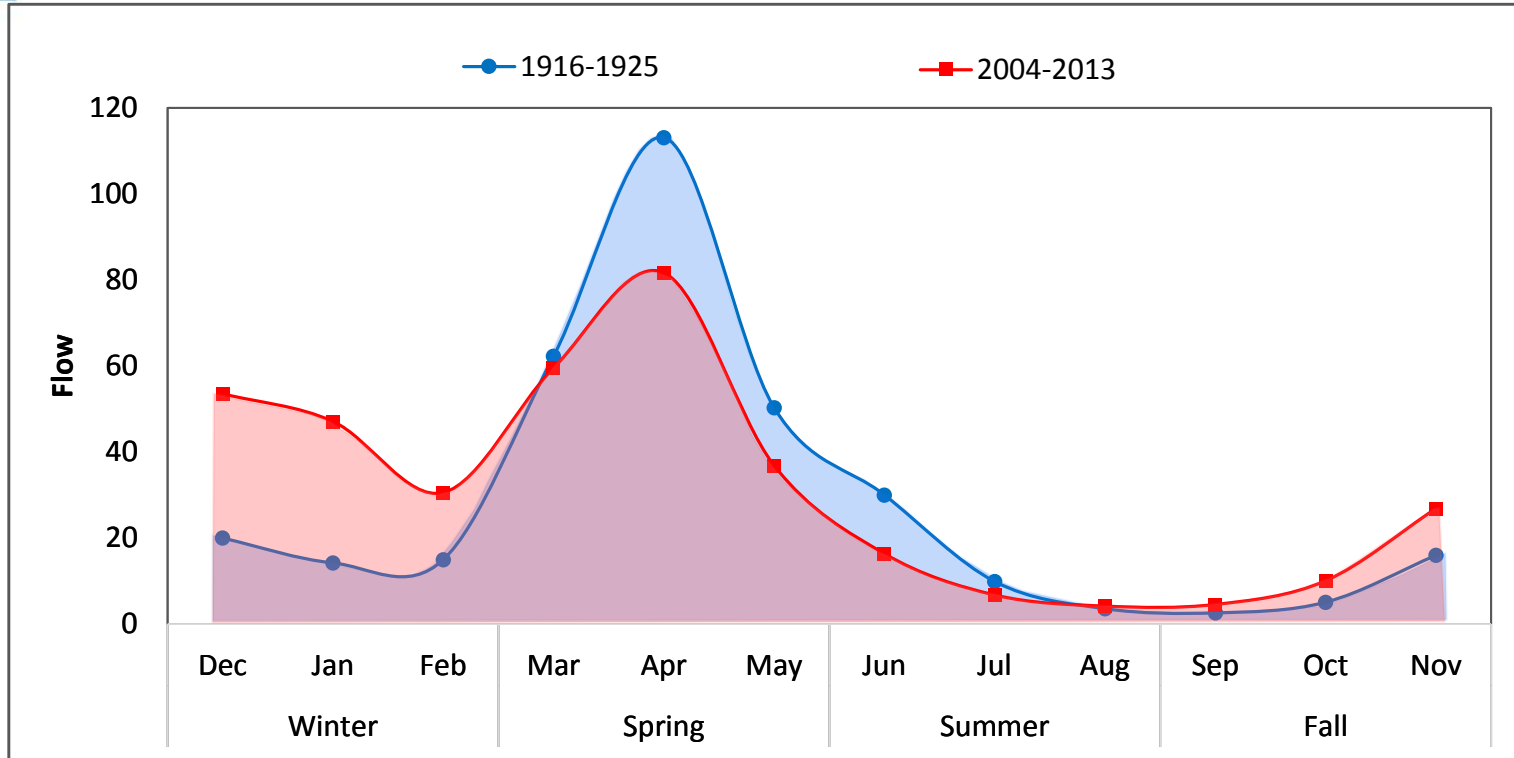
May to October



Urbanization is a Prime Cause of Flooding

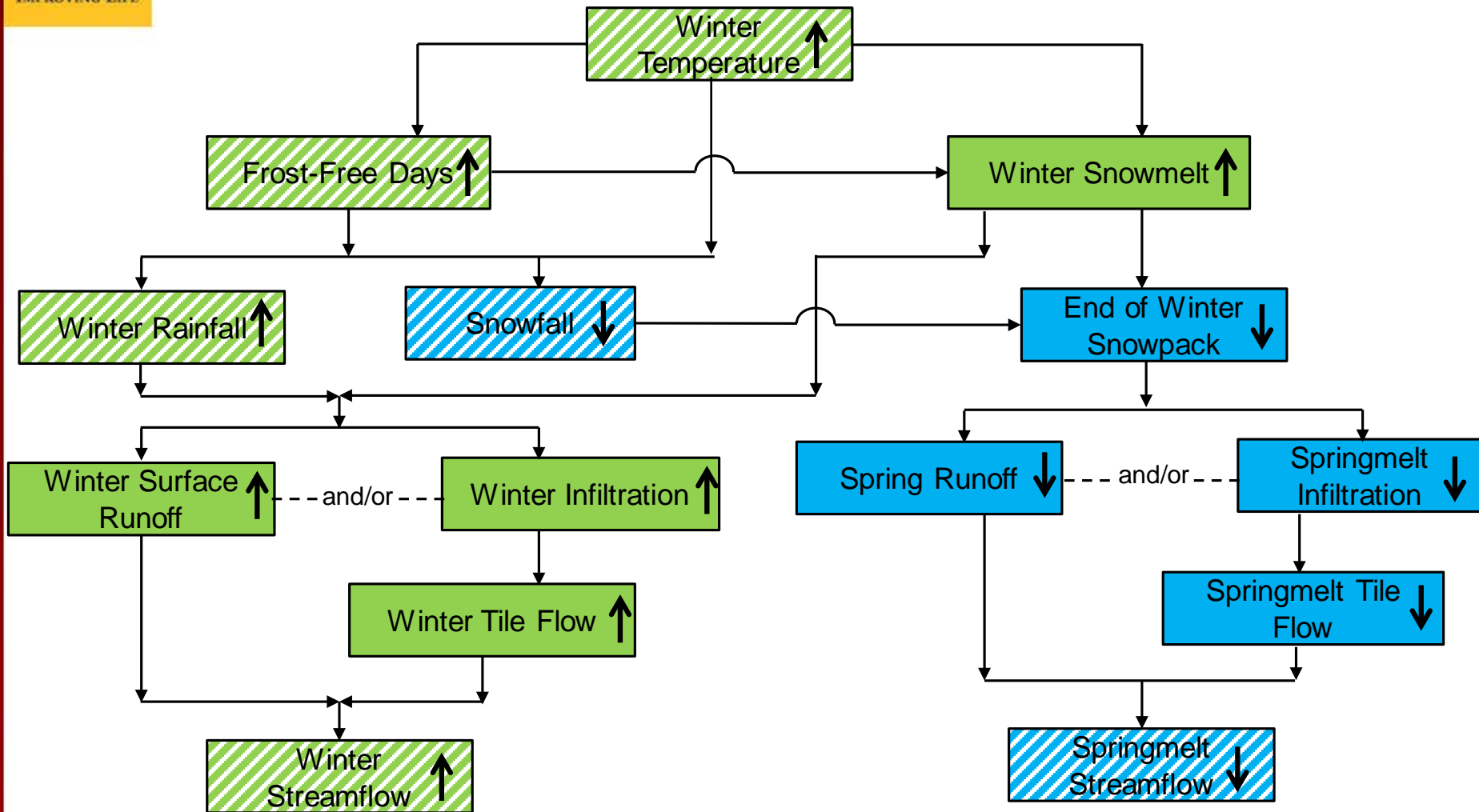
Most flooding reported in southern Ontario
now occurs in urban areas
in the growing season!

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.

Changes in Winter Hydrology in Ontario



Variable has increased

Variable has decreased

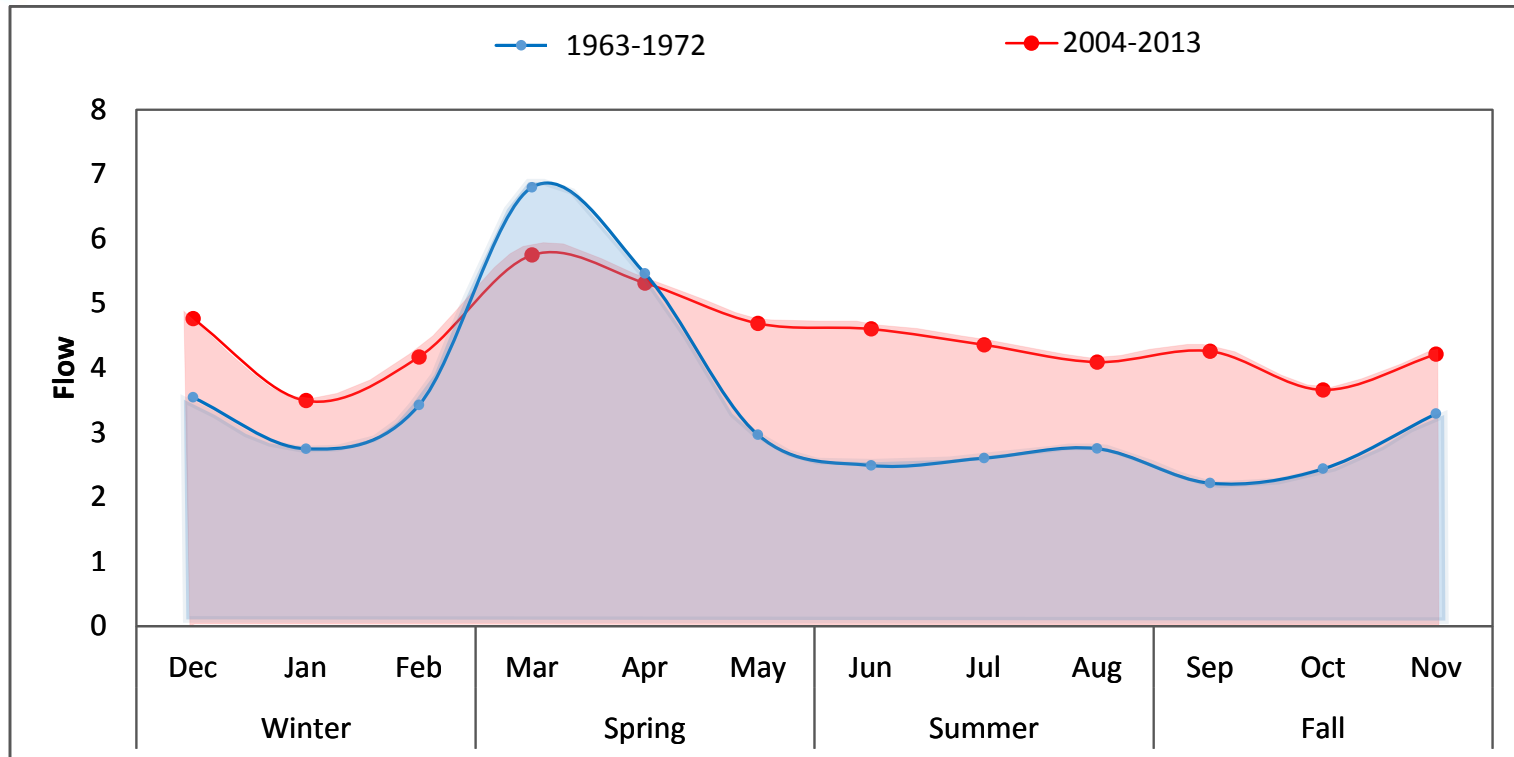
Data Available

Impacts of Winter & Spring Changes

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.

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.

Possible Conclusion & The Evidence

One could conclude that:

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

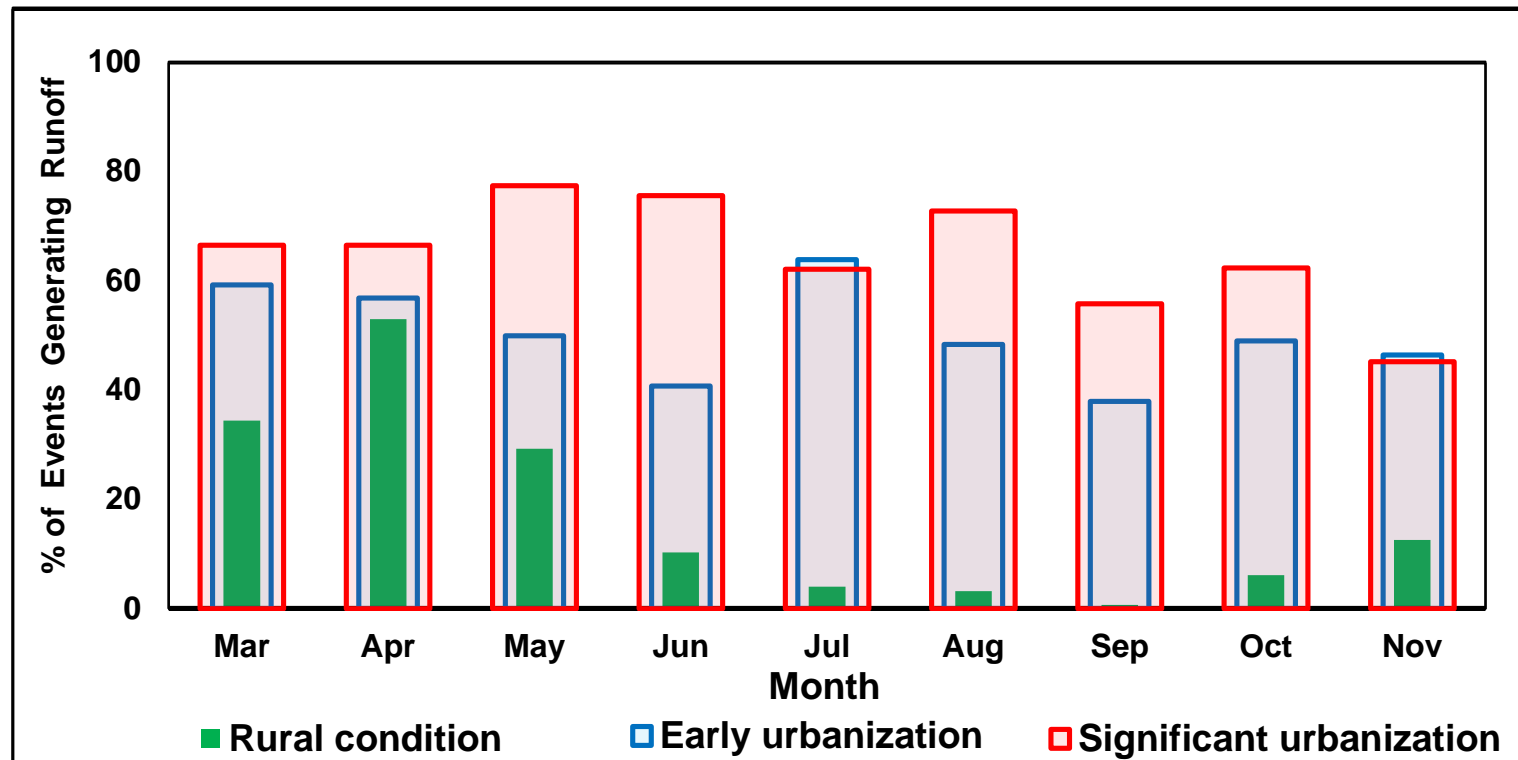
In fact:

- 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.

Effect of Urbanization on Runoff Events

Events > 3mm rainfall

Runoff Coefficient > 0.05



Moira River at Foxboro (02HL001): 1921-30, 1963-72, 2006-15

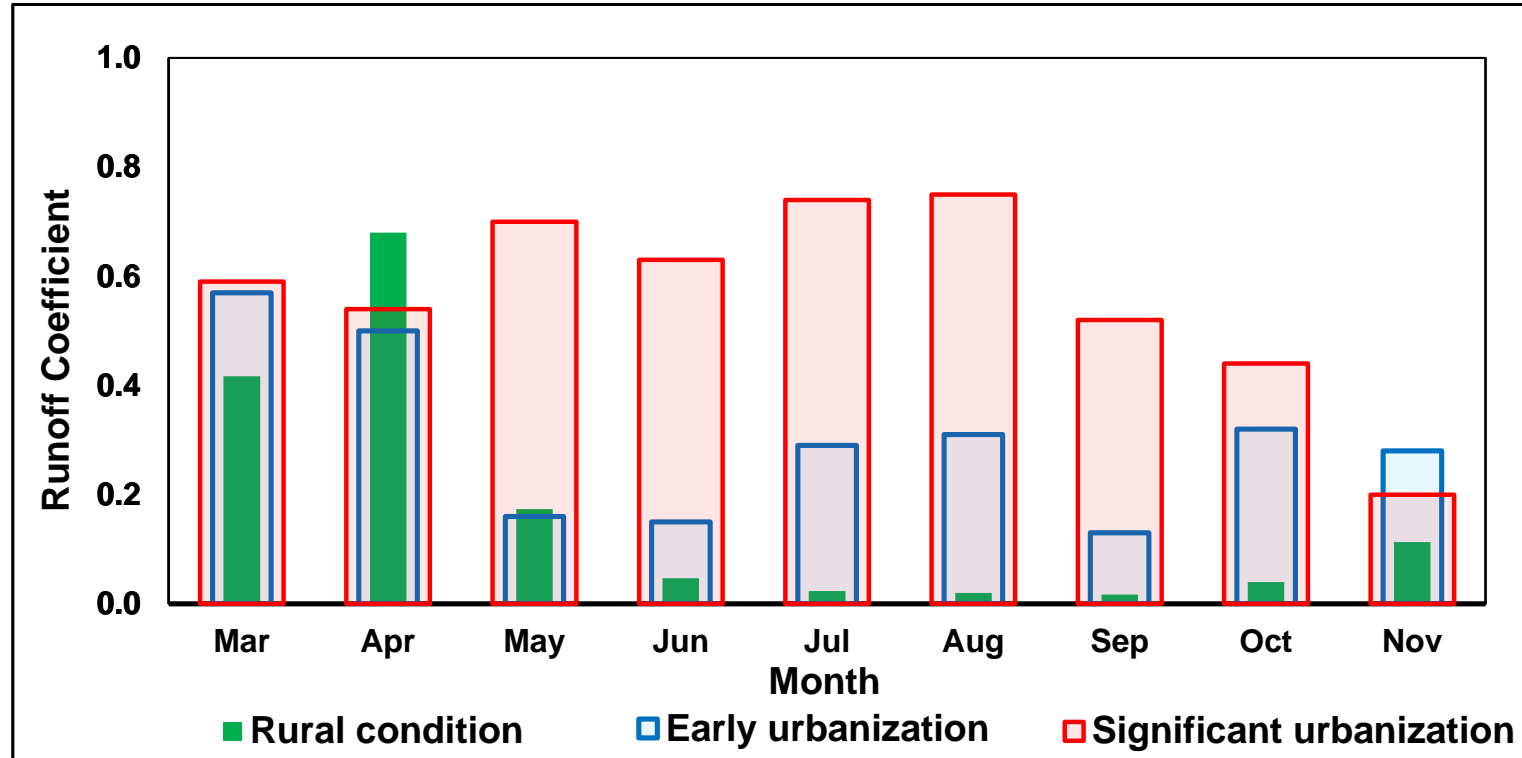
Don River at Todmorden (02HC024): 1963-72

Don River at Todmorden (02HC024): 2006-15

Highly Urbanized Versus Rural Areas

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

Upper Decile of Runoff Coefficients



Moira River at Foxboro (02HL001): 1921-30, 1963-72, 2006-15

Don River at Todmorden (02HC024): 1963-72

Don River at Todmorden (02HC024): 2006-15

Highly Urbanized Versus Rural Areas

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 ...

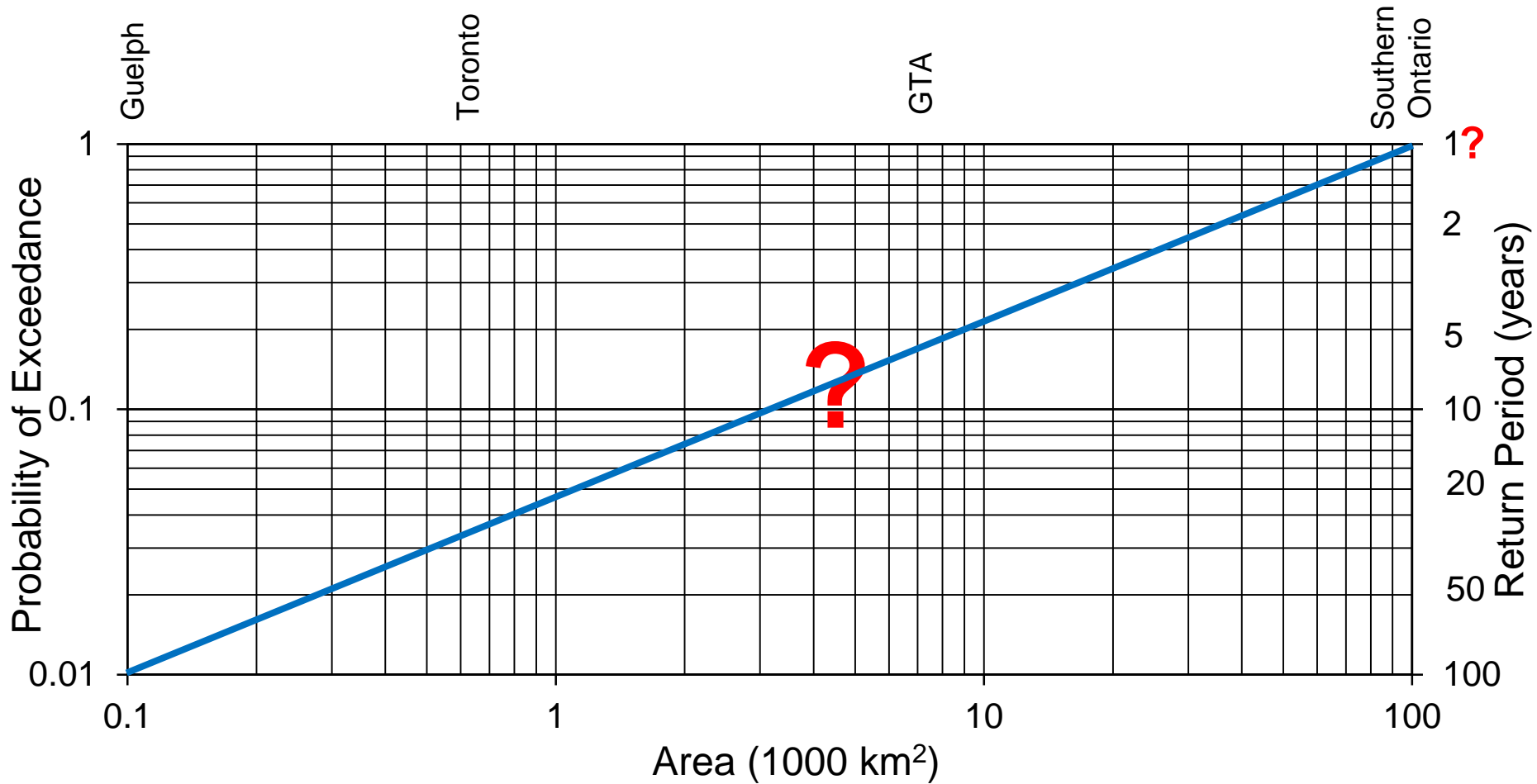
whereas the number of summer rain events has **not** increased,

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

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

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

Frequency of 100 Year Rainfall



Severe Storms Over Urban Areas

Severe localized storms are occurring more frequently over urban areas in southern Ontario, and that frequency will only increase as the urban areas increase.

The Flood Gates

Urban Development has opened
the Flood Gates
– has been a Tipping Point -
for Runoff from Summer Storms !

Growing Season Probabilities

In Rural Conditions,
 $P(\text{Runoff}) \approx 0$

In Urban Conditions,
 $P(\text{Runoff}) \triangleright P(\text{Rainfall})$

Impacts of Summer Flow Changes

In 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.

What now?

1. Plan for local as well as river flooding.
2. Address the questions:
 - How much of southern Ontario do we plan to pave? or
 - How can we preserve, protect & incorporate Green Space into ongoing & future development plans?.
3. Remain alert to known and anticipated changes in climate.
4. Explore possible impacts on water quality and other environmental conditions.

Acknowledgements

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Questions ???