Mapping the Future Flood Risk in the City of London

Slobodan P. Simonovic

The University of Western Ontario

The Institute for Catastrophic Loss Reduction

Presentation outline

- Research context – introduction
- Methodology
  - Climate change
  - Hydrologic input
  - Hydraulic modeling
- Use of flood maps
- Implications
- Future work

Research context

- The City of London: Vulnerability of Infrastructure to Climate Change, *City of London*
- Quantifying the Uncertainty in Modelled Estimates of Future Extreme Precipitation Events, *Canadian Foundation for Climate and Atmospheric Sciences*

Research context

- The City of London: Vulnerability of Infrastructure to Climate Change
  - The main objective of the study is to provide an engineering assessment of the vulnerability of London's public infrastructure to changing climate conditions - flooding.
  - An original systematic procedure is used to gather and examine available data in order to develop an understanding of the relevant climate effects and their interactions with infrastructure.
  - The key steps:
    - Inventory of infrastructure components;
    - Data gathering and sufficiency;
    - Qualitative vulnerability assessment;
    - Quantitative vulnerability assessment; and
    - Prioritization of the infrastructure components based on the level of risk.
  - The elements of infrastructure to be considered generally will include: buildings within and adjacent to the flood lines, roads, bridges, culverts, wastewater treatment plants, storm water management network, etc.

Methodology

- Climate change impacts
  - GCM and historic data – precipitation scenarios
- Hydrologic modeling
  - River flows
- Hydraulic modeling
  - Floodplains mapping
- Vulnerability analyses
  - Risk to municipal infrastructure

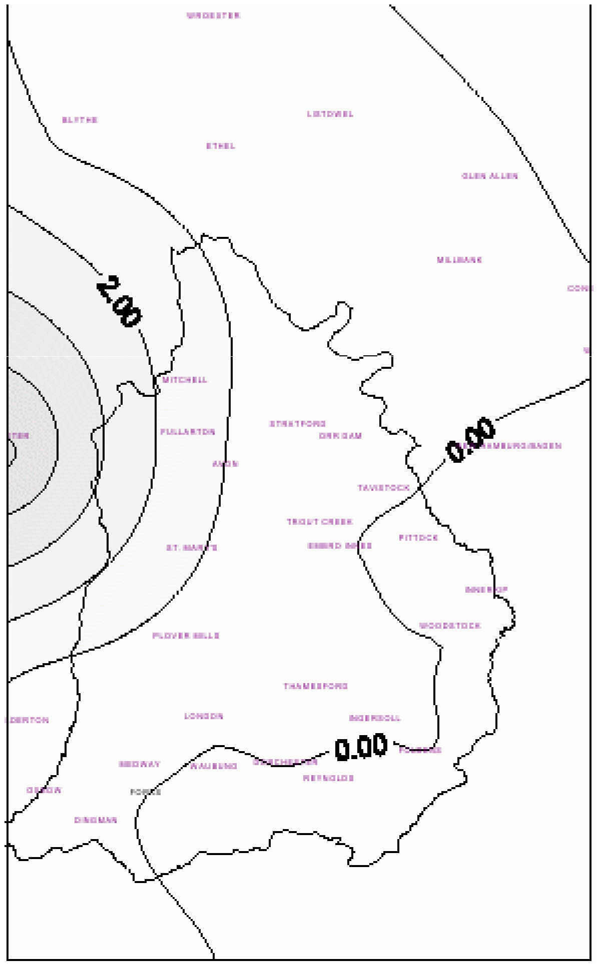
Climate change impacts

- Weather generator
  - Simulate weather data conditioned upon alternative climate change scenarios for the Upper Thames River Basin
  - Develop a weather model that allows nearest neighbour resampling with perturbation of the observed data
  - Create an ensemble of climate change scenarios for the basin
    - Historic climate change scenario
    - Wet climate change scenario

Climate change impacts

- K-NN algorithm
  - Capable of modelling non linear dynamics of geophysical processes
  - Knowledge of the probability distribution of variables not required
  - Dependence among variables is very well preserved
  - Time correlations between variables are adequately preserved
  - Spatial correlations between variables are also well preserved

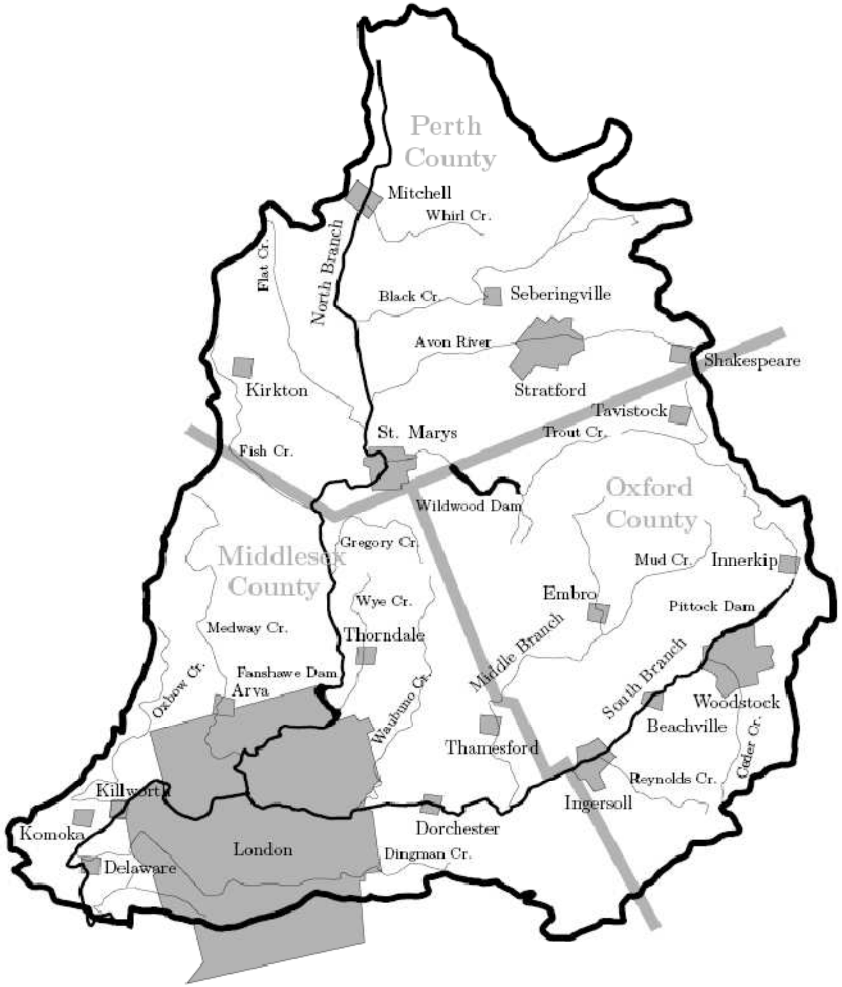
Climate change impacts

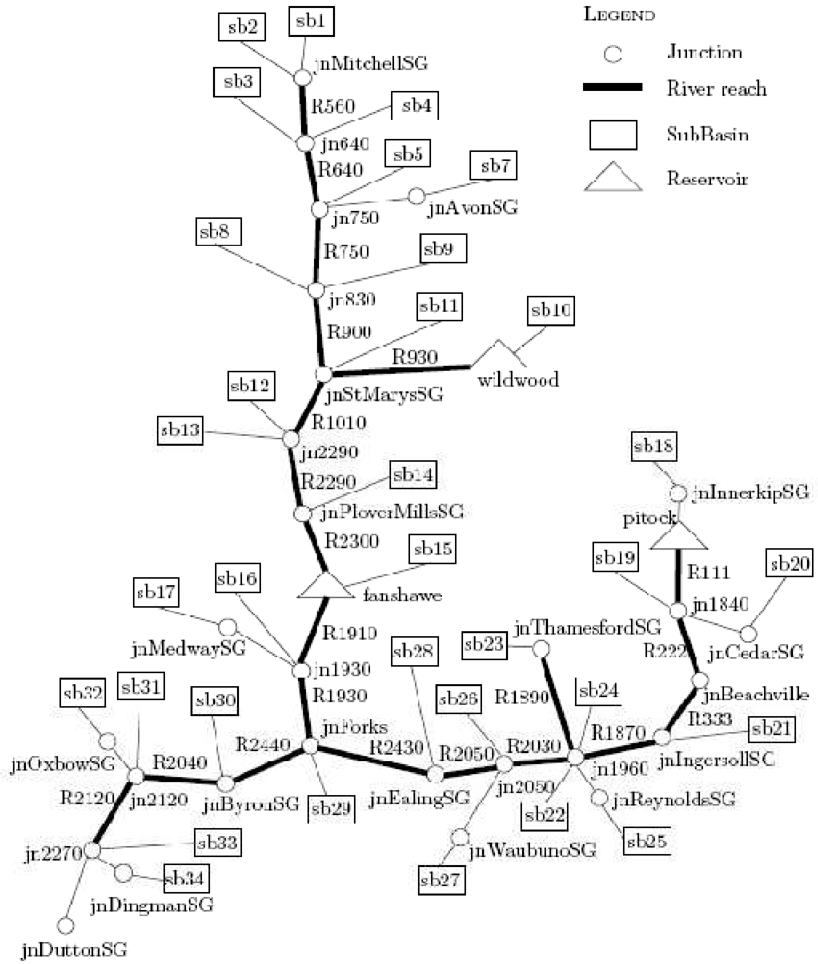


Hydrologic modeling

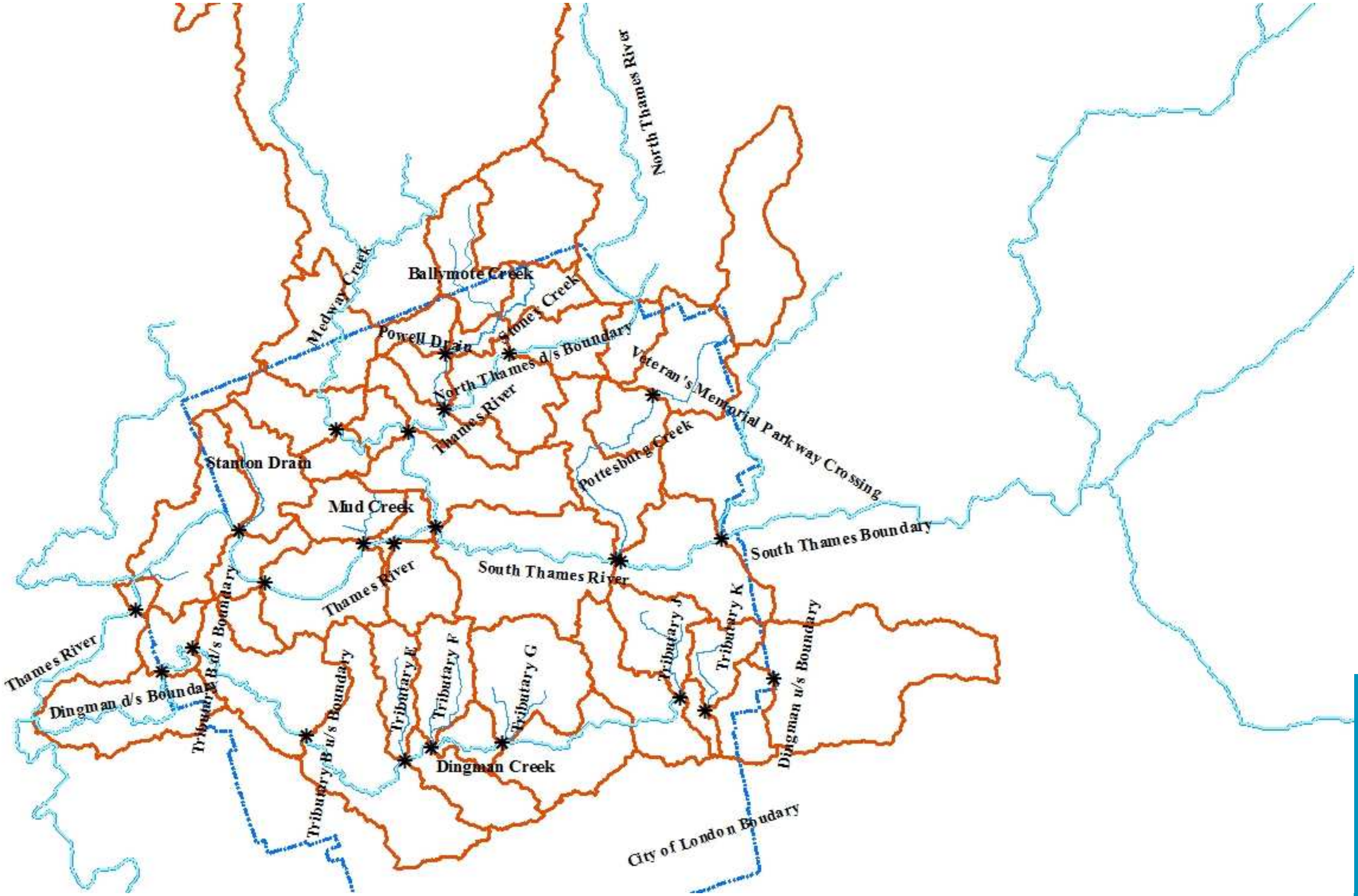
- Single-event precipitation-runoff transformation
- Continuous precipitation-runoff transformation
- Snow accumulation and melt

Hydrologic modeling



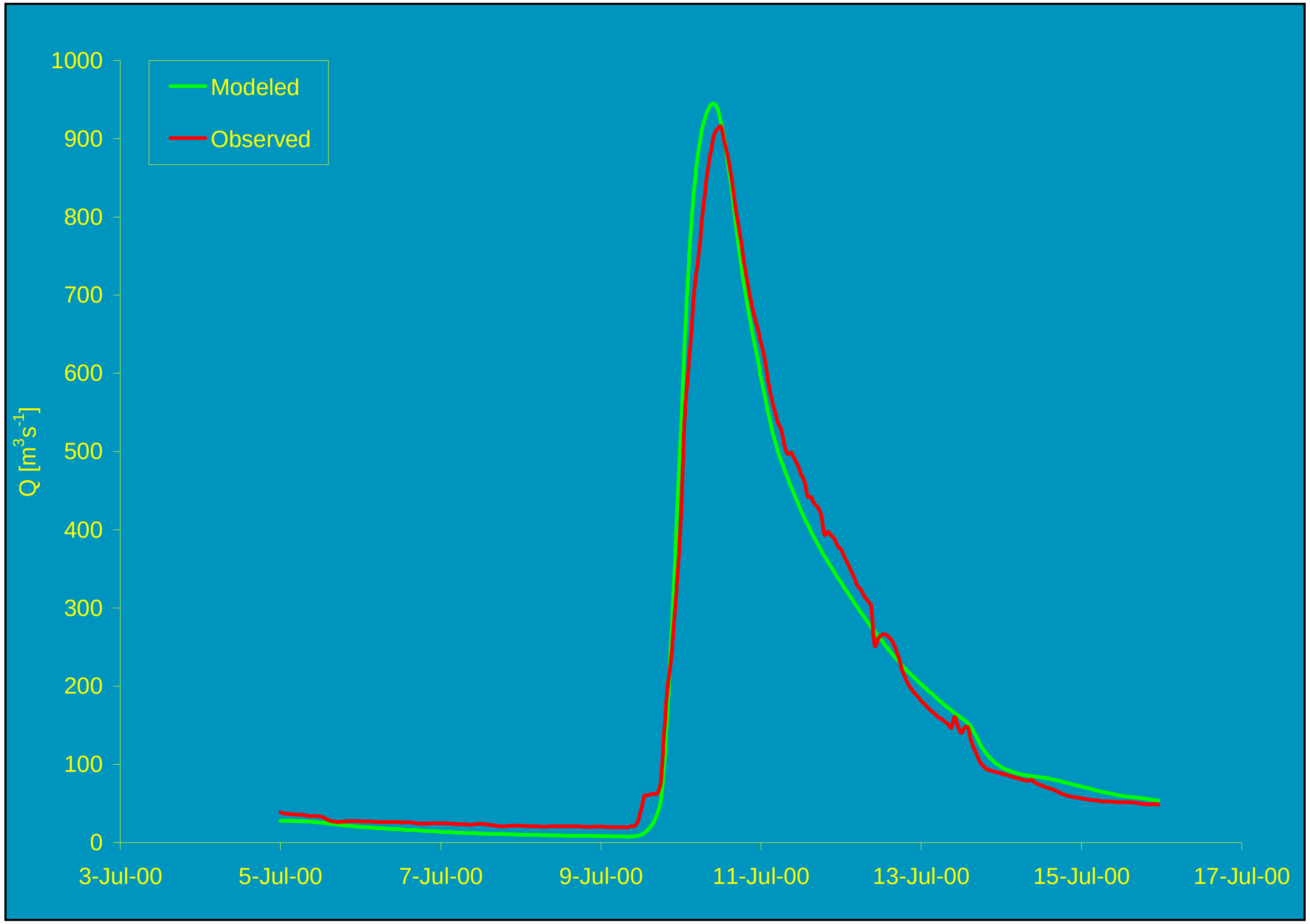


Hydrologic modeling

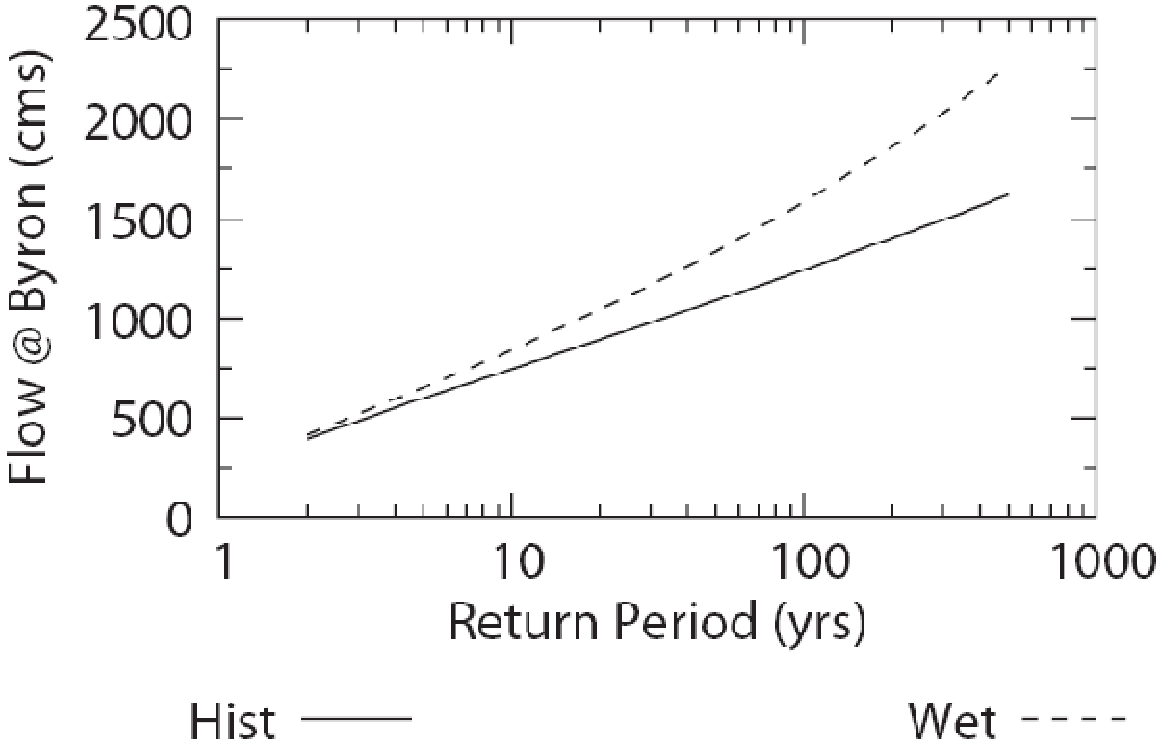


Hydrologic modeling

Byron



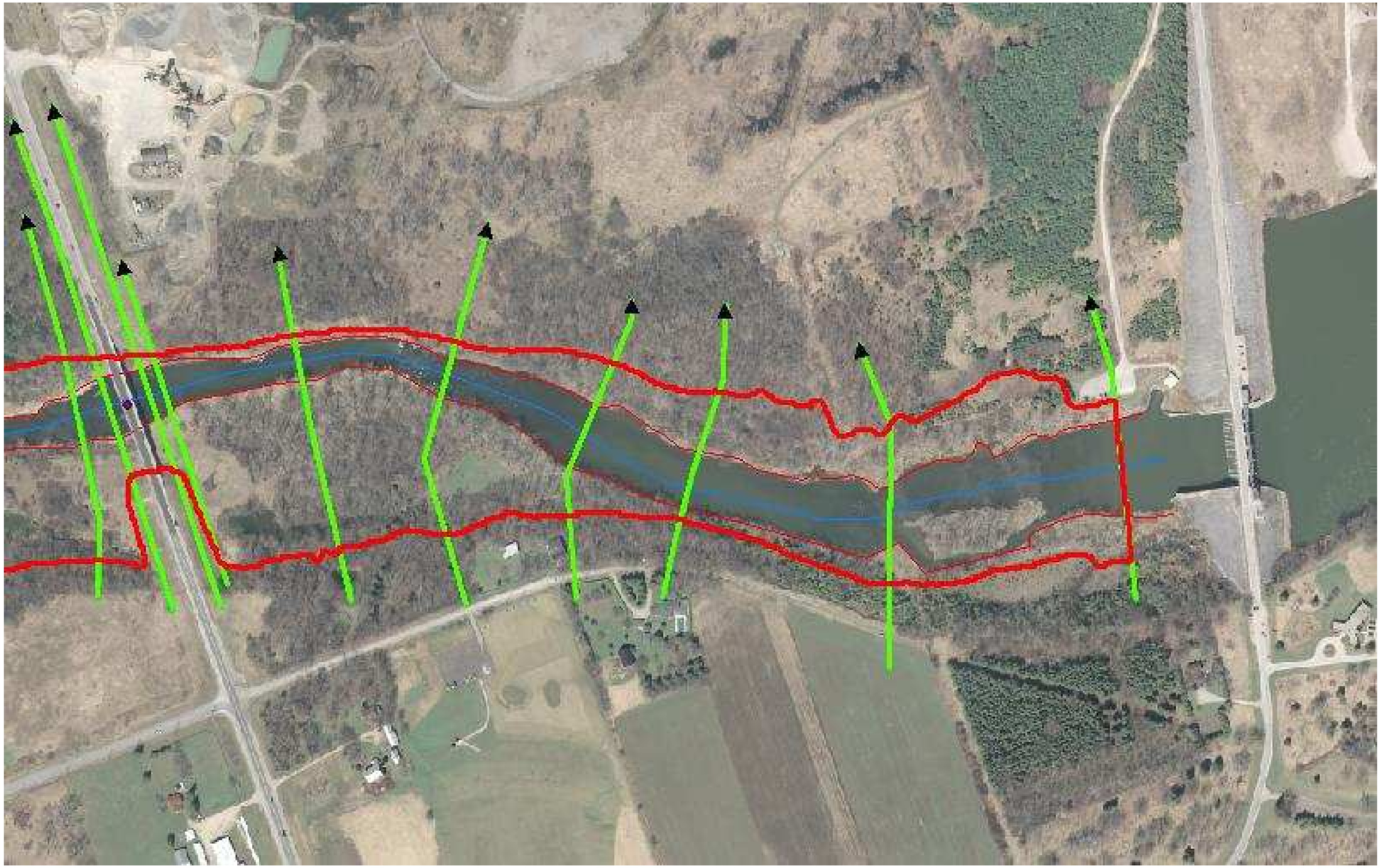
Hydrologic modeling



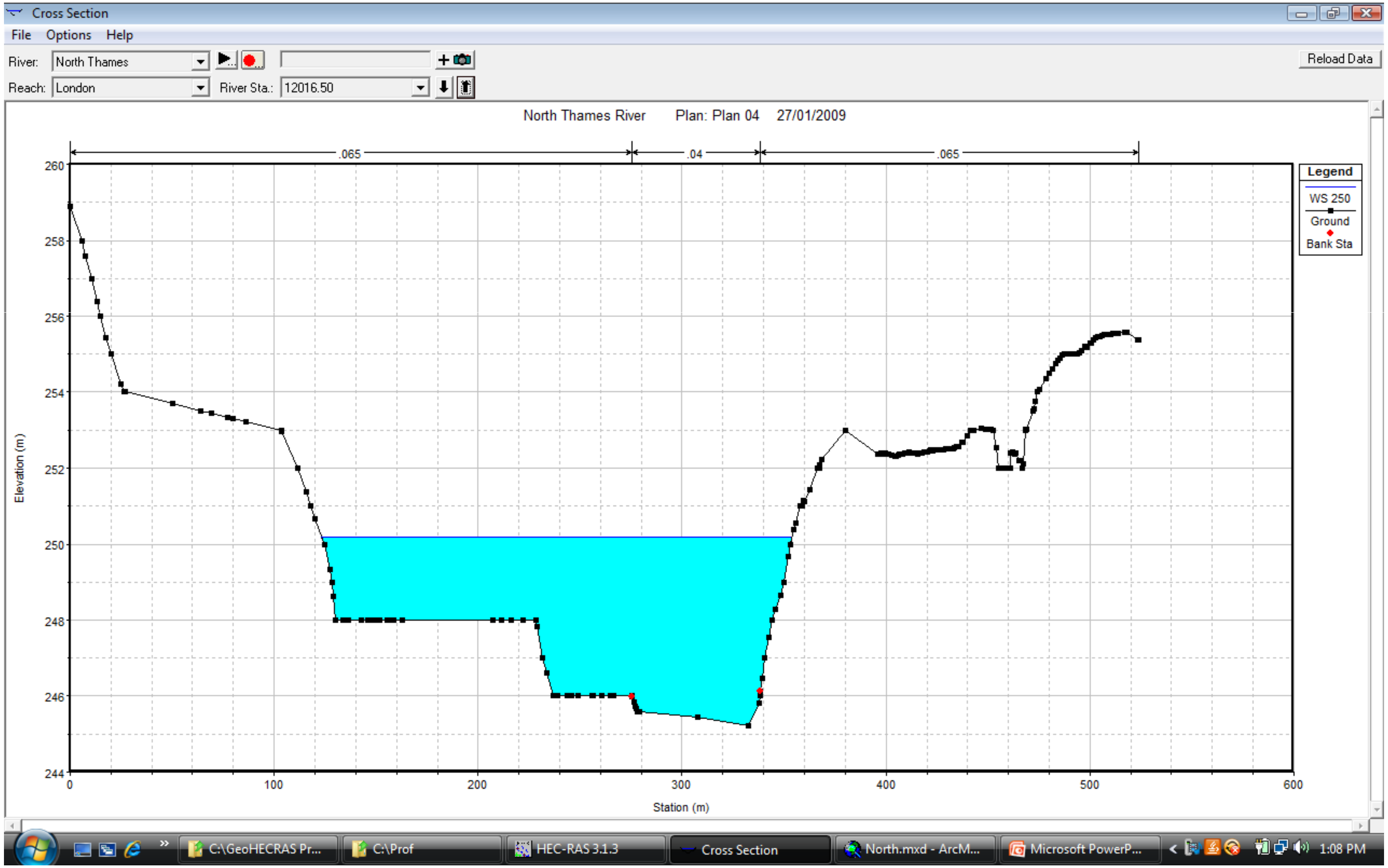
Hydraulic modeling

- Floodplain mapping
- Climate change scenarios - future risk
  - Development of hydraulic model
  - Testing of the model with historic data
  - Change of flood inundation

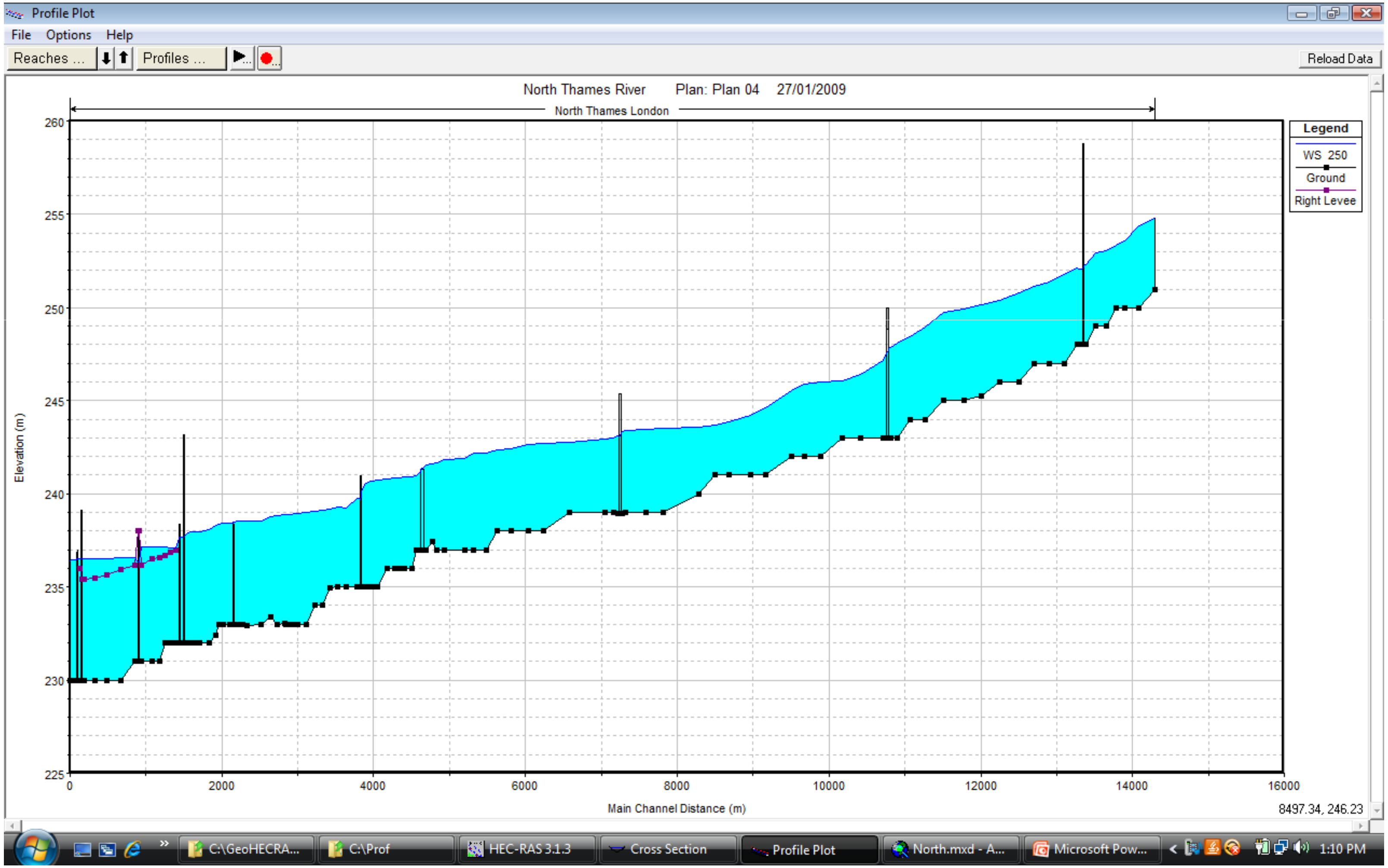
Hydraulic modeling



Hydraulic modeling



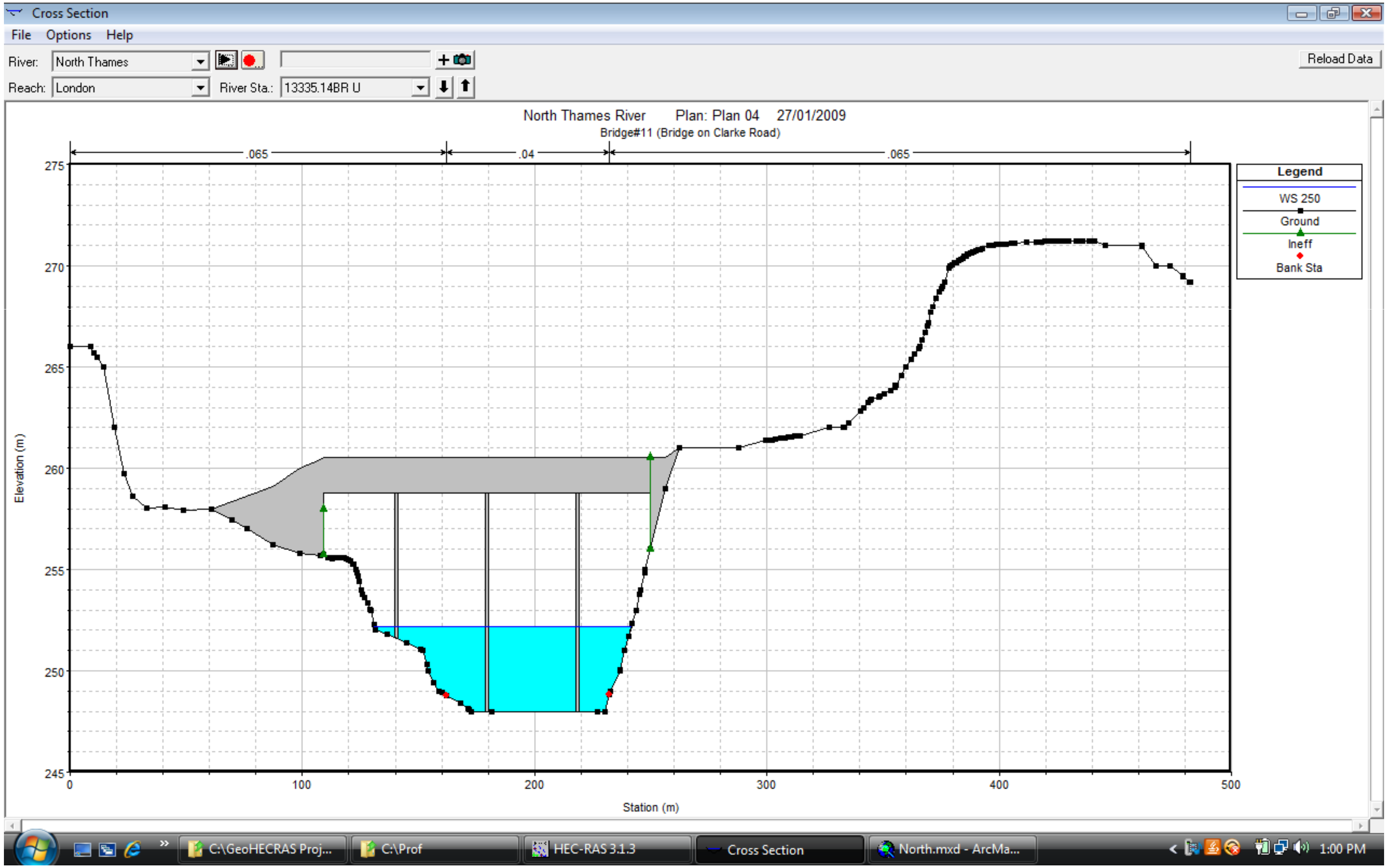
Hydraulic modeling



Hydraulic modeling


For Elgin Hall
and
Housing Offices
Keep Right

Hydraulic modeling



Western

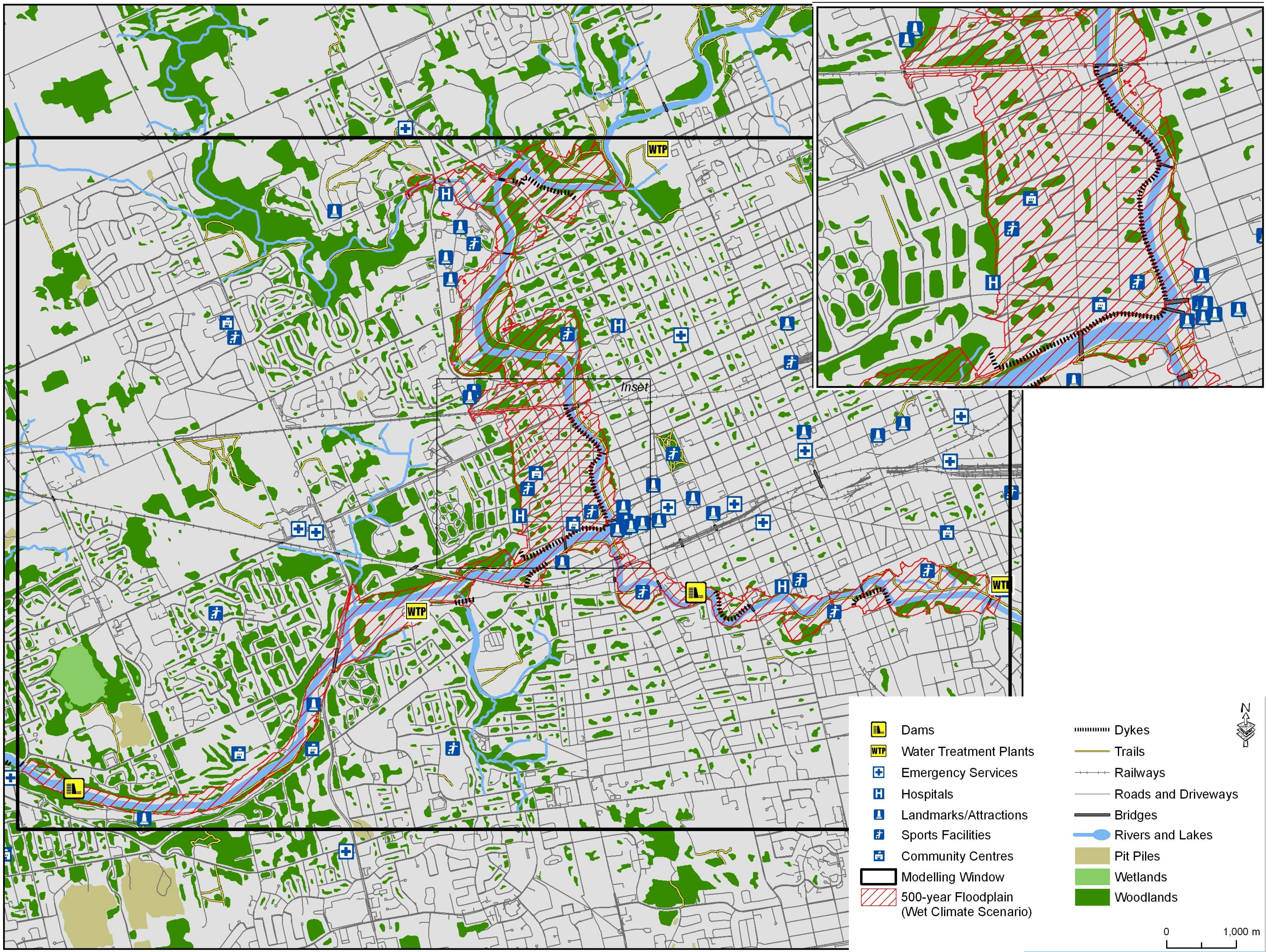
Hydraulic modeling

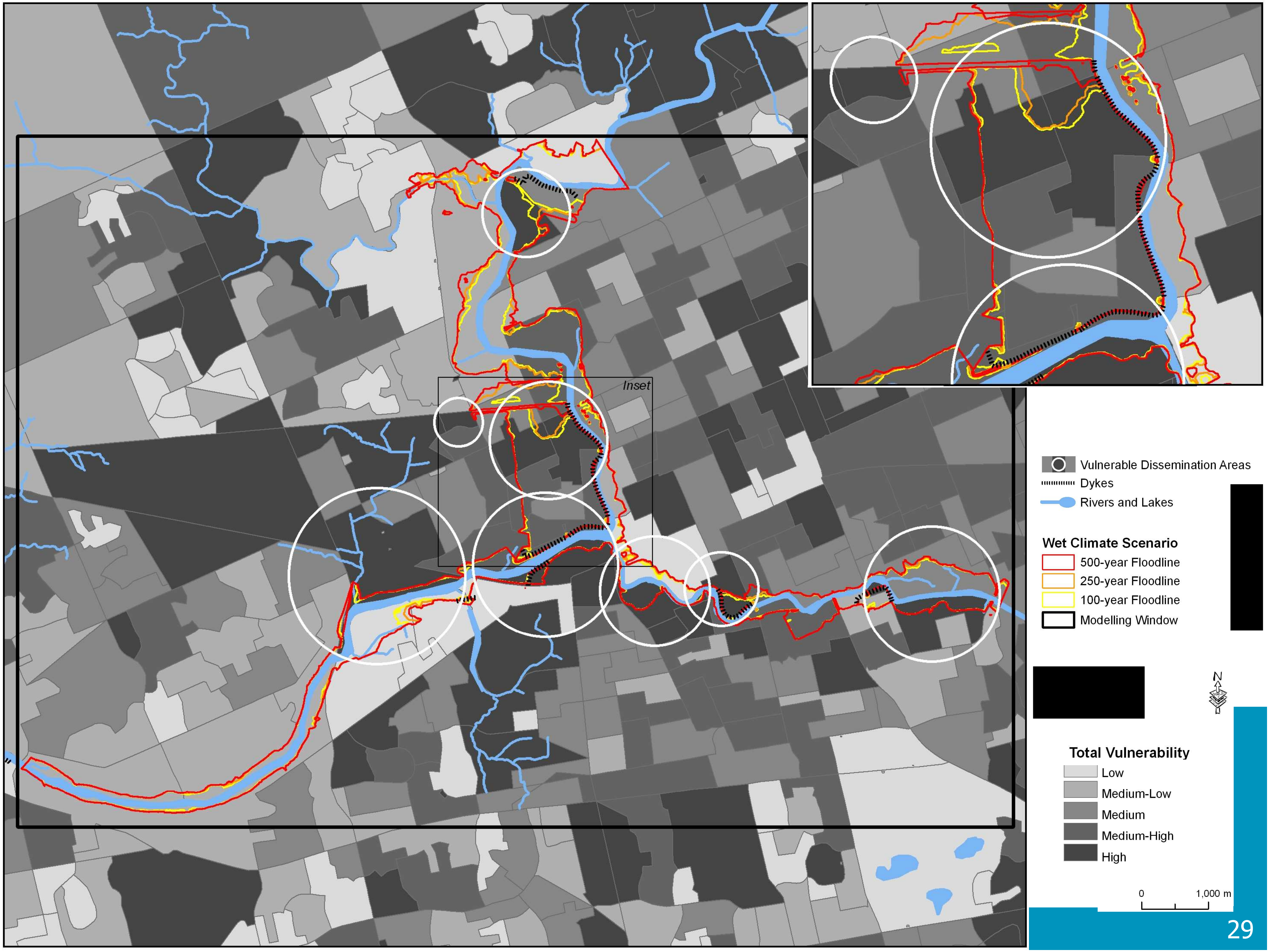
Hydraulic modeling

Hydraulic modeling

Use of floodplain maps

Flood	Climate Scenario	Area (m²)	Change		No. Homes Flooded	No. Buildings Flooded	Proportion Affected (Census Data)*	
			Area (m²)	%			Pop.	Dwellings
100-year	Historic	5,291,440			1,141	34	7,701	3,969
	Dry	3,930,436	-1,361,004	-25.7	68	18	4,881	2,521
	Wet	5,595,988	+304,548	+5.8	1,249	42	7,949	4,109
250-year	Historic	5,858,976			1,376	58	8,474	4,381
	Dry	5,101,848	-757,128	-12.9	1,059	33	7,351	3,802
	Wet	6,116,988	+258,012	+4.4	1,486	59	8,745	4,543
500-year	Historic	6,268,729			1,560	71	9,119	4,740
	Dry	5,362,852	-905,877	-14.5	1,155	36	7,717	3,988
	Wet	6,567,292	+298,563	+4.8	1,690	83	9,388	4,886


Inset
WTP
H
Dams
Water Treatment Plants
Emergency Services
Hospitals
Landmarks/Attractions
Sports Facilities
Community Centres
Modelling Window
500-year Floodplain
(Wet Climate Scenario)
Dykes
Trails
Railways
Roads and Driveways
Bridges
Rivers and Lakes
Pit Piles
Wetlands
Woodlands
N
0
1,000 m


Inset
Vulnerable Dissemination Areas
Dykes
Rivers and Lakes
Wet Climate Scenario
500-year Floodline
250-year Floodline
100-year Floodline
Modelling Window
Total Vulnerability
Low
Medium-Low
Medium
Medium-High
High
N
0
1,000 m

Implications

Implications - *Regulatory*

- Issuing of permits for floodplain development (including construction of roads, buildings, bridges, culverts, drains, sewer systems, etc);
- Use of river and its adjacent park land for recreation;
- Removal of pumping stations near area rivers during the course of a flood;
- Patrolling of river banks during periods of high water levels and monitoring performance of critical infrastructure (such as roads, bridges, culverts, drains, sewer systems);
- Revision of reservoir operating procedures (including smaller dams, weirs, outflows, etc.); etc.

Implications - *Regulatory*

100 yr

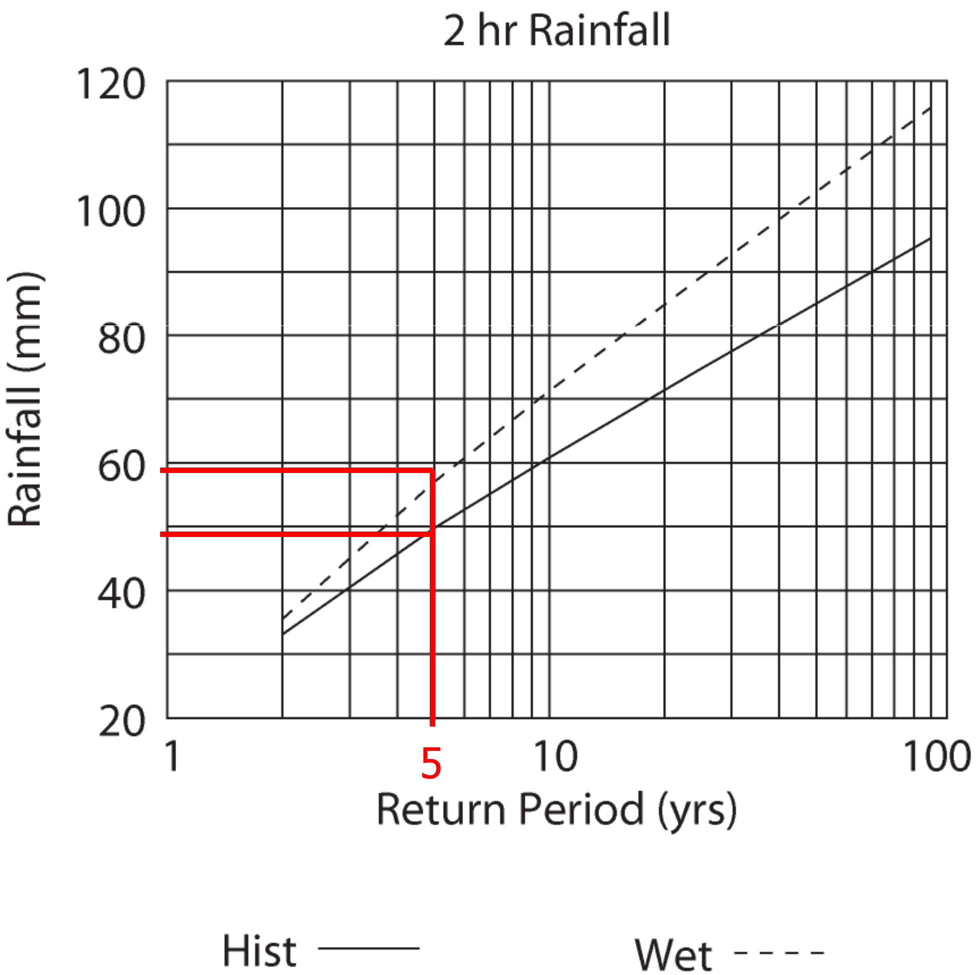
Implications - *Regulatory*

250 yr

Implications - *Engineering*

- Changes in design standards for municipal infrastructure (roads, buildings, bridges, culverts, drains, sewer systems, treatment plants, etc).

Implications - *Engineering*



Implications - *Budgetary*

- Allocation of budget for safe operation and maintenance of existing flood management infrastructure;
- Planning for future infrastructure;
- Valuation of current structural and non-structural measures (reservoirs, dykes, floodwalls or implementation of land use zoning practises, flood warning systems, waterproofing, etc.); etc.

Implications - *Inconvenience*

Work in progress

- Quantifying the Uncertainty in Modelled Estimates of Future Extreme Precipitation Events, *Canadian Foundation for Climate and Atmospheric Sciences*
- An Update of Rainfall Intensity-Duration-Frequency Curves for the City of London Under the Changing Climate, *City of London*
- The City of London: Vulnerability of Infrastructure to Climate Change, *City of London*