Global Flood Modelling

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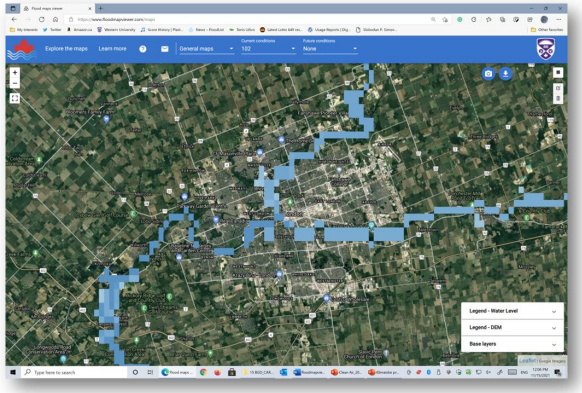
2| WHY?

- Increasing demand for strategic global assessments of flood risks under current and future conditions.
- Modelling progress: Large-scale hydrological models, Land surface models, Global flood models (Inundation & velocity).
- Implementation scope: (re)insurance, large-scale flood preparedness, and climate change adaptation.
- Availability of data: numerous data sets for global flood risk assessment.
- Future direction: refinement of the models - making maps informative at national scales.

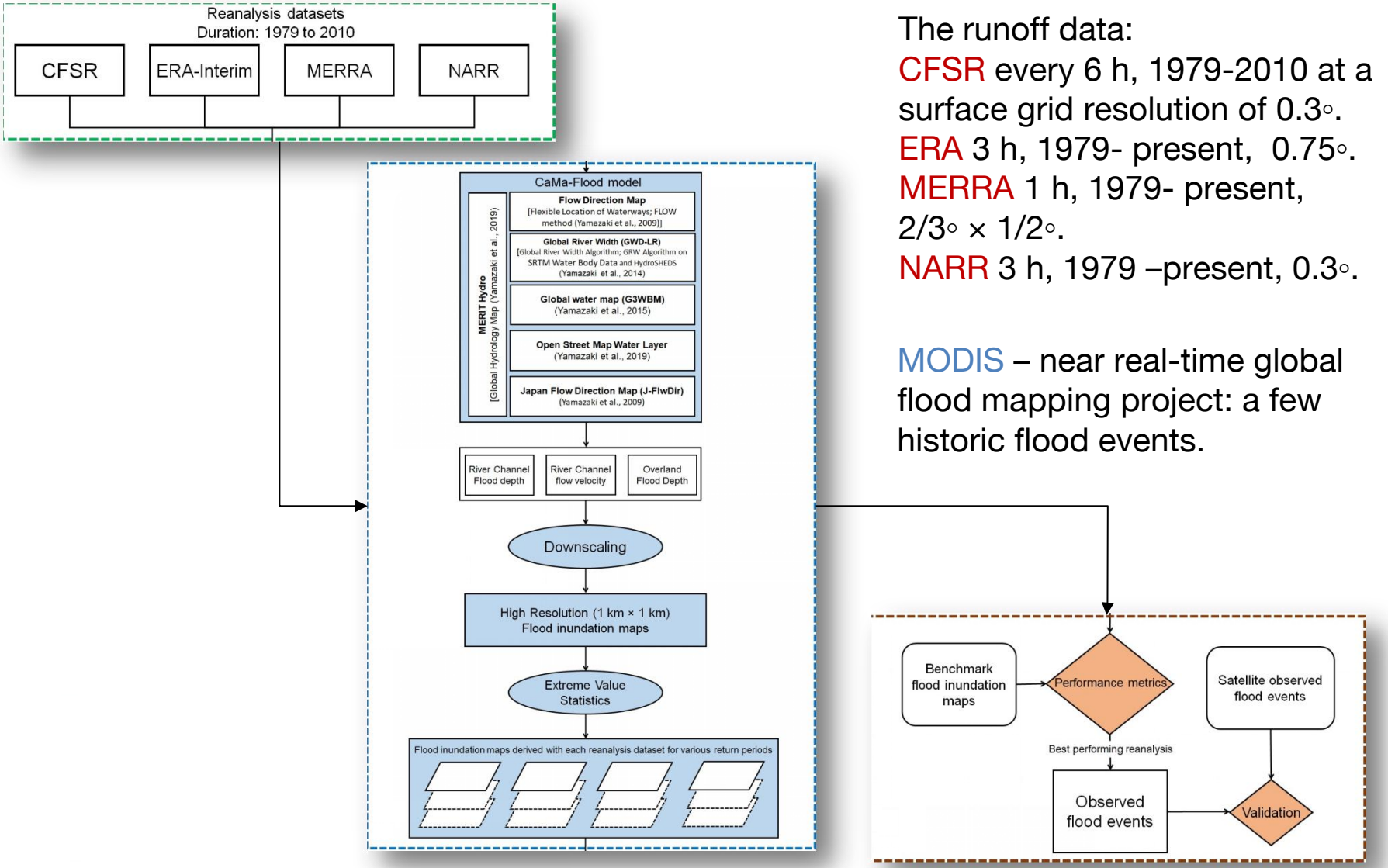


- Flood inundation analyses over large regions – Canadian case study

4| METHODOLOGY
Implementation steps

- Use runoff data from reanalysis products
- At station locations – comparison between observed and reanalysis runoff values (correlation coefficient)
- Fit GEV distribution to the data – extracting 25, 50,100, 150, 200, 300 and 500 yearrunoff values
- Use gridded runoffs with the CaMa-Flood model to derive maximum flood depth (m) and inundation extents (km^2) for entire Canada
- Downscaling maps to 1 km x 1 km spatial resolution

5. METHODOLOGY
Floodplain mapping

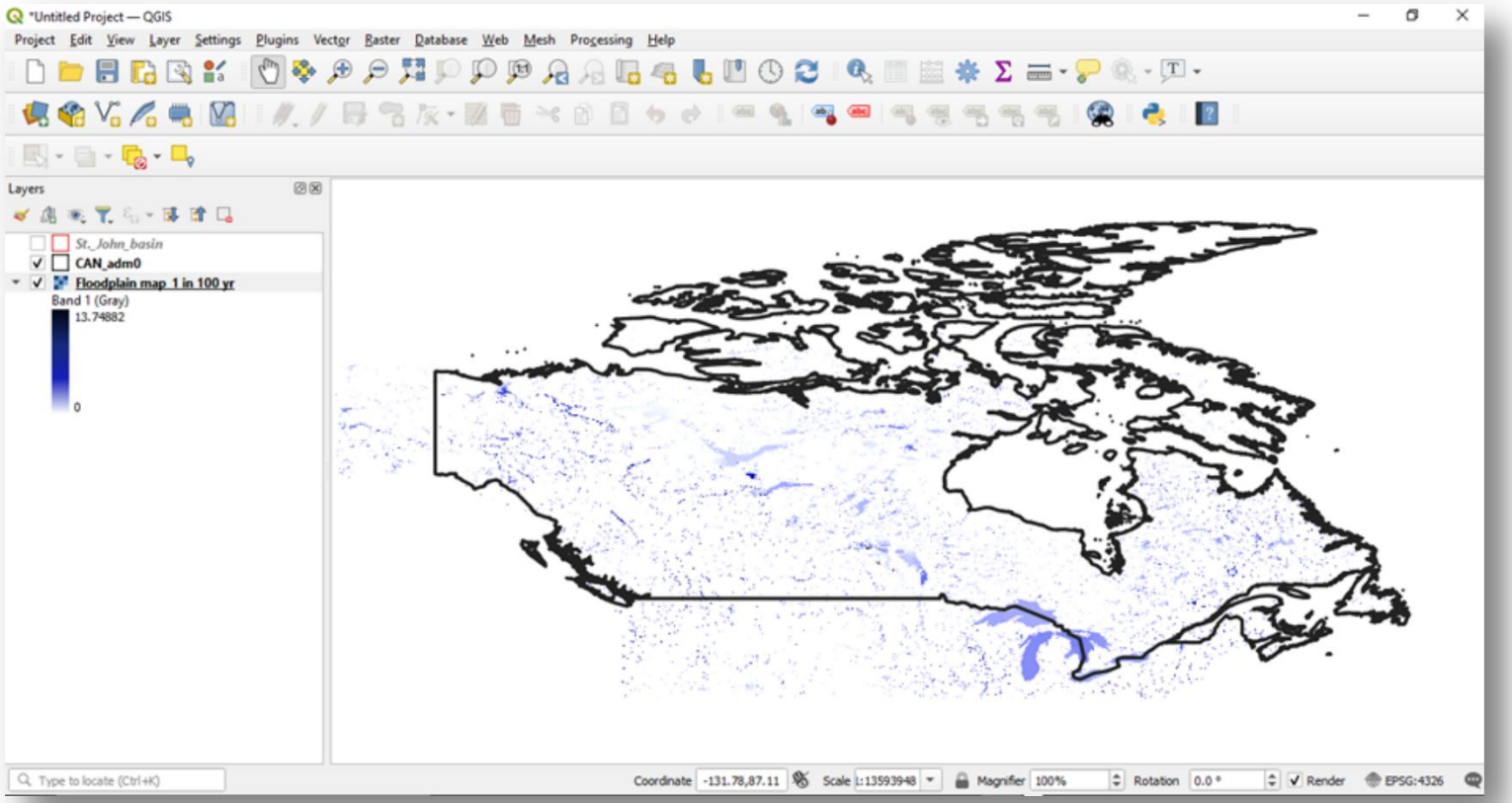


The runoff data:
CFSR every 6 h, 1979-2010 at a surface grid resolution of 0.3◦.
ERA 3 h, 1979- present, 0.75◦.
MERRA 1 h, 1979- present, 2/3◦ × 1/2◦.
NARR 3 h, 1979 –present, 0.3◦.

MODIS – near real-time global flood mapping project: a few historic flood events.

6| METHODOLOGY

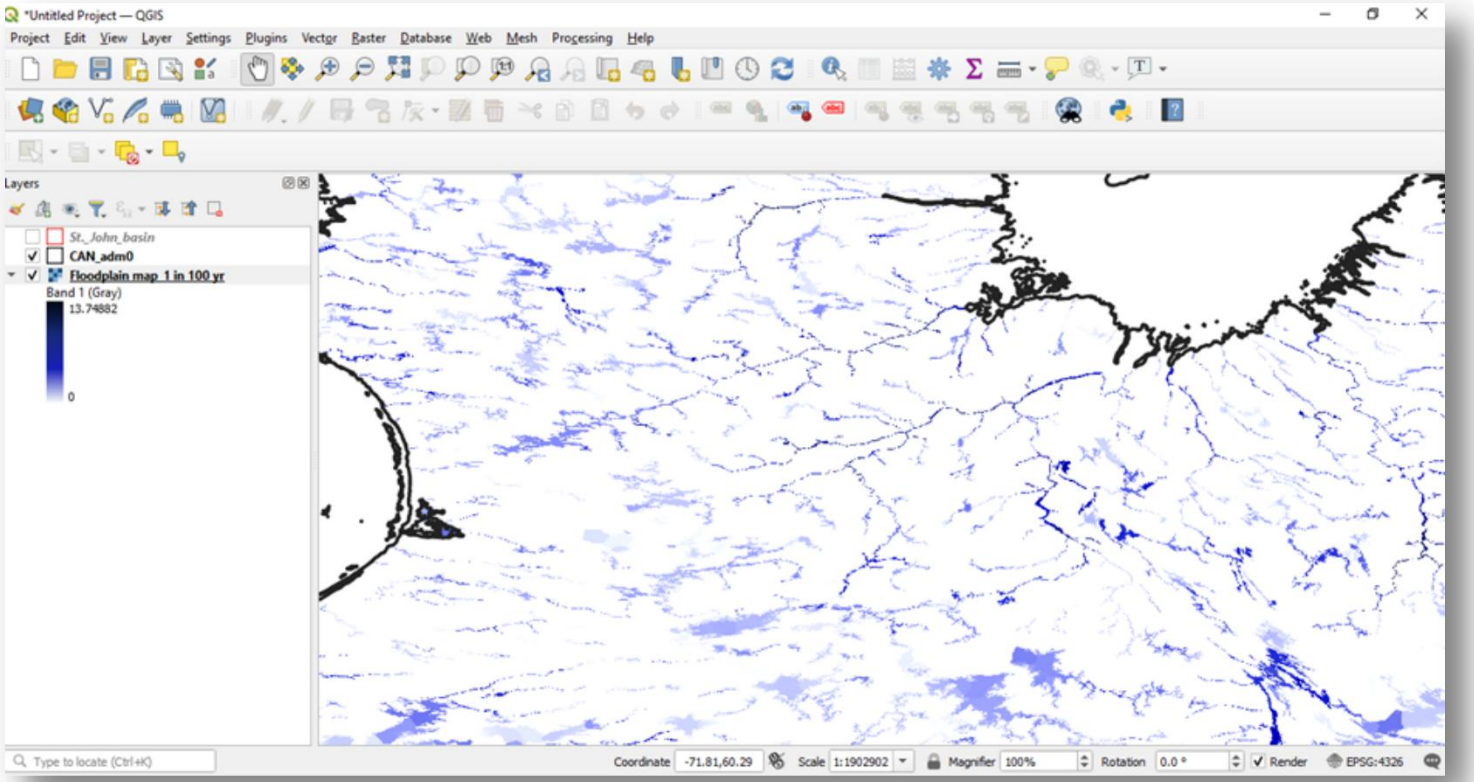
Representative floodplain map



100 yr floodplain map of Canada (opened in QGIS)

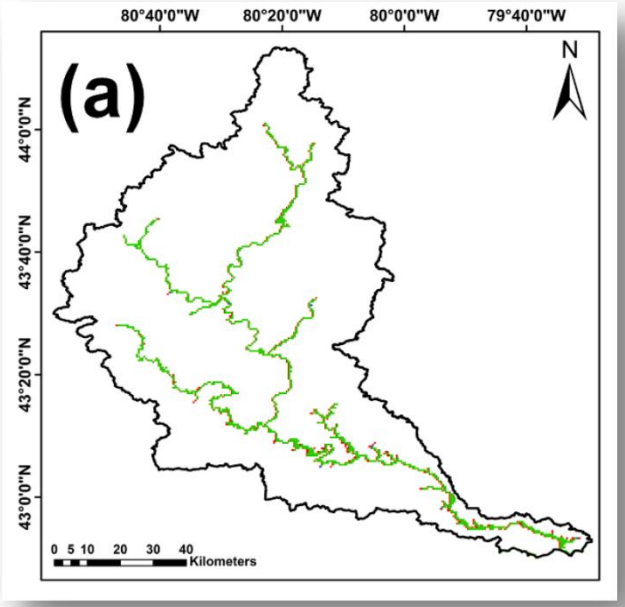
7| METHODOLOGY

Representative floodplain map

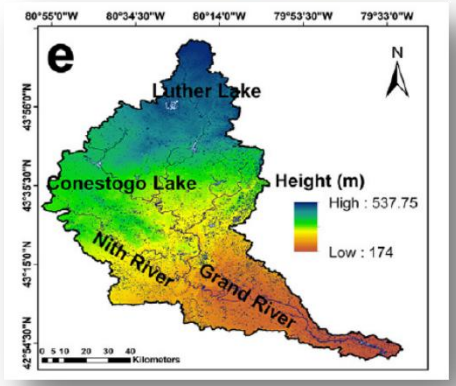


100 yr floodplain map of Canada (zoomed illustration)

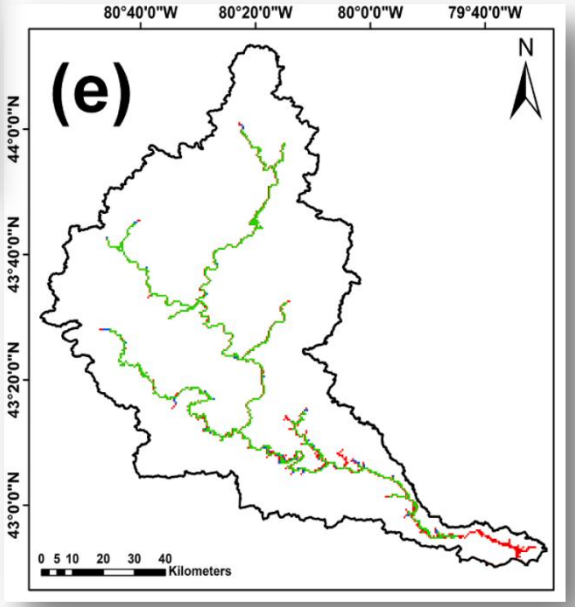
8| METHODOLOGY
Verification



Grand River 100 yr



Grand River DEM



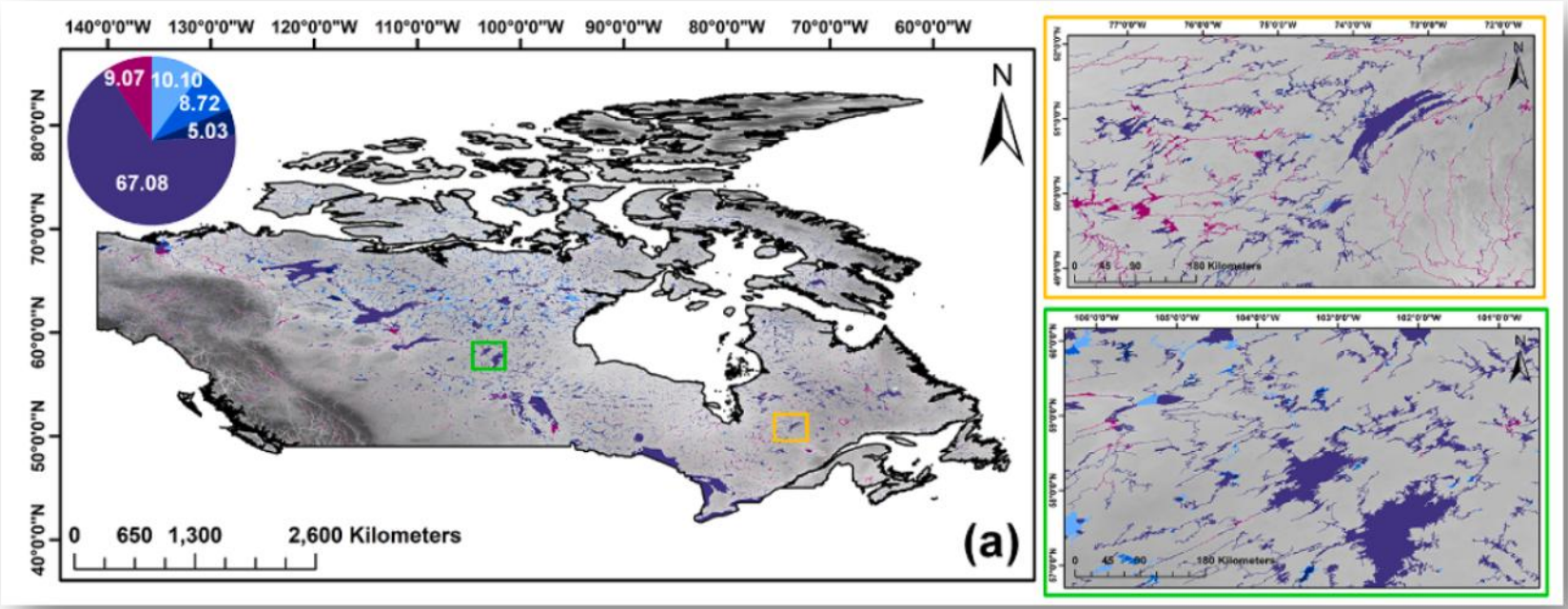
Grand River 200 yr

- What are these maps for?

10| IMPLEMENTATION

Understanding the overall flood hazard across the country

100-yr flood



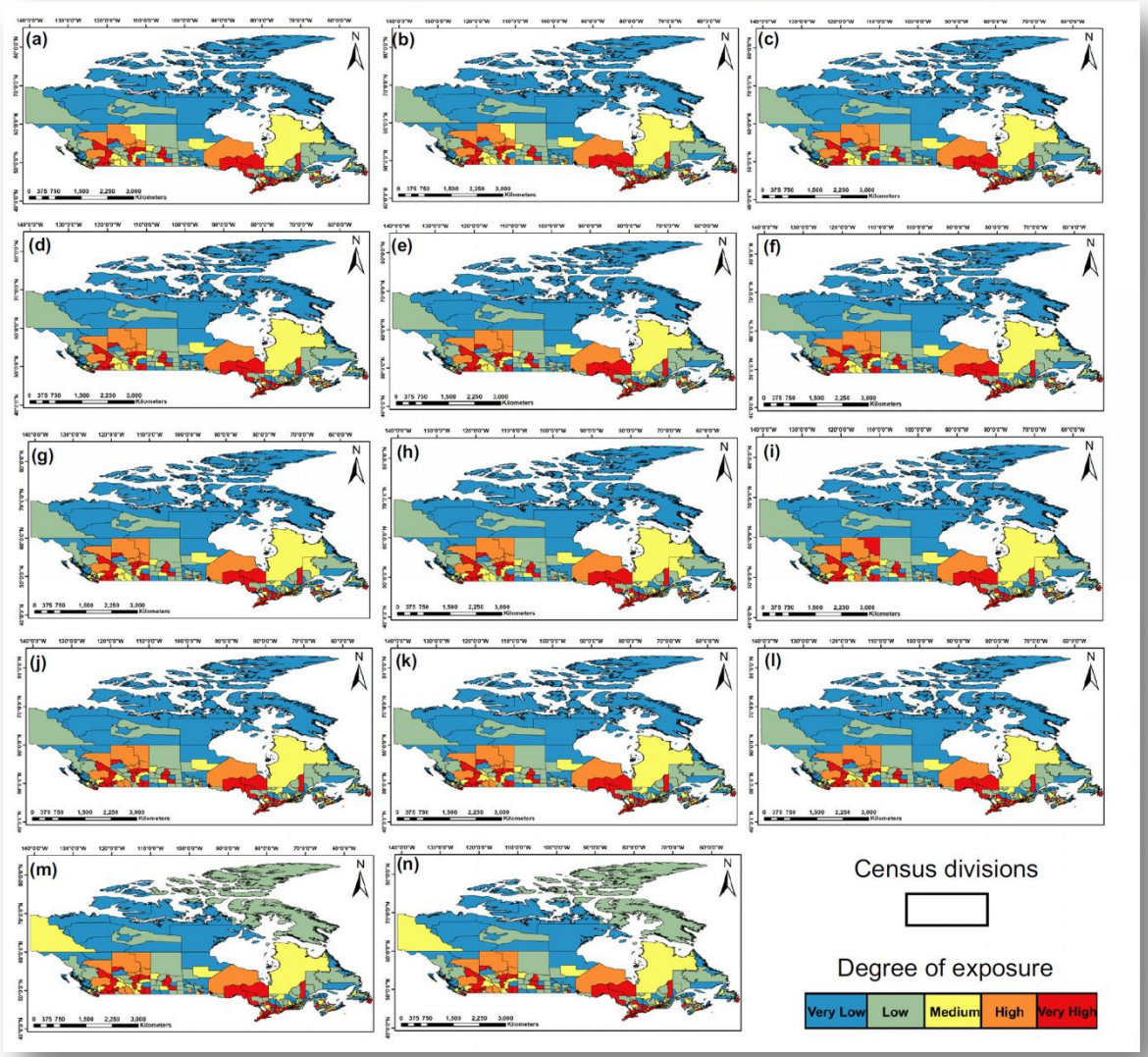
Max. water depth (m)

0 0.2 0.6 1.5 3.5 >3.5

11. IMPLEMENTATION

Identification of regional impacts - population exposure assessment

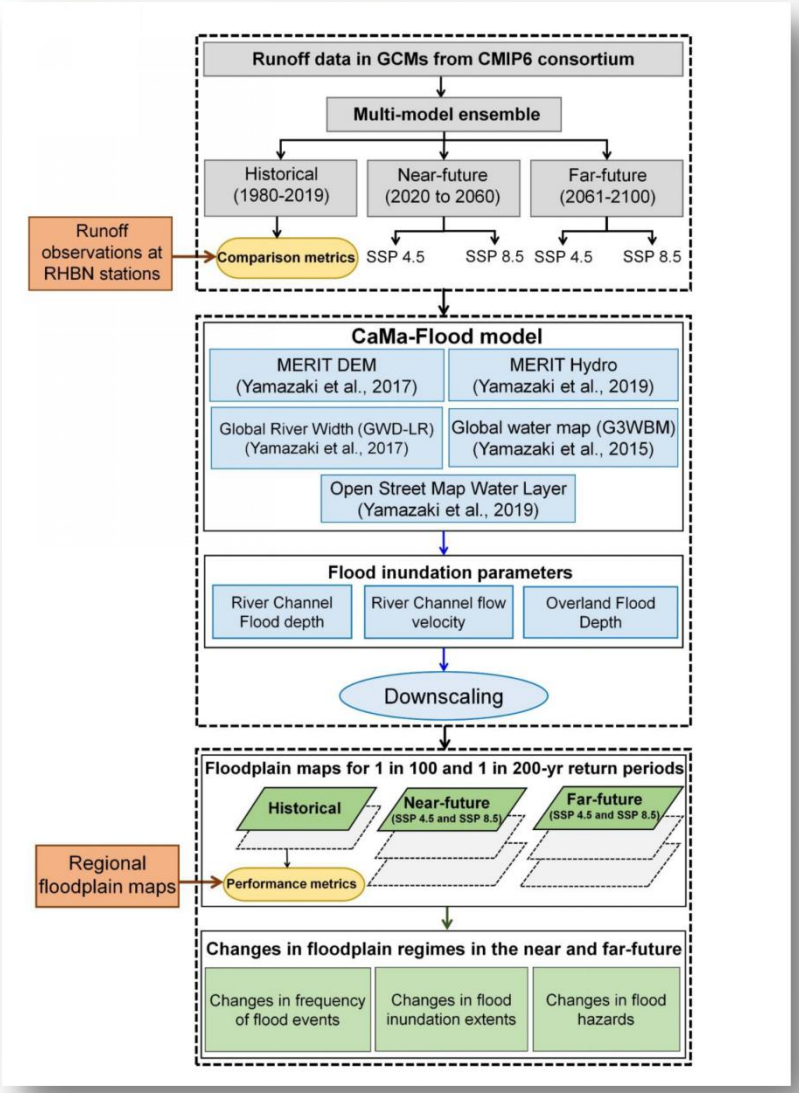
$$\varepsilon_f = \begin{cases} \text{very}-\text{low}, 0 \le \left(P_{f/P_T}\right) \le 5\% \\ \text{low}, 5\% < \left(P_{f/P_T}\right) \le 10\% \\ \text{moderate}, 10\% < \left(P_{f/P_T}\right) \le 15\% \\ \text{high}, 15\% < \left(P_{f/P_T}\right) \le 20\% \\ \text{very}-\text{high}, \left(P_{f/P_T}\right) > 20\% \end{cases}$$



Divisions with various degrees of flood exposure from 2006 to 2019.

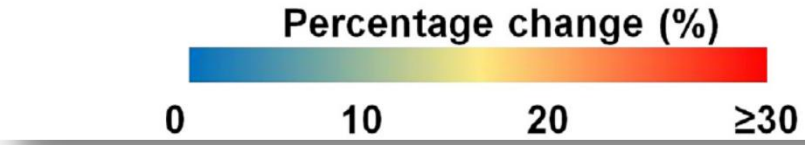
12. IMPLEMENTATION
Climate change impacts

- Coupled Model Intercomparison Project 6 (CMIP6)
- 17 GCMs considered (runoff)
- SSP2 4.5 (medium range of future forcing pathway) and SSP5 8.5 (high range of future forcing pathway) scenarios used
- Three timeframes (historical, near future and far future)



13| IMPLEMENTATION
Climate change impacts - flood inundation

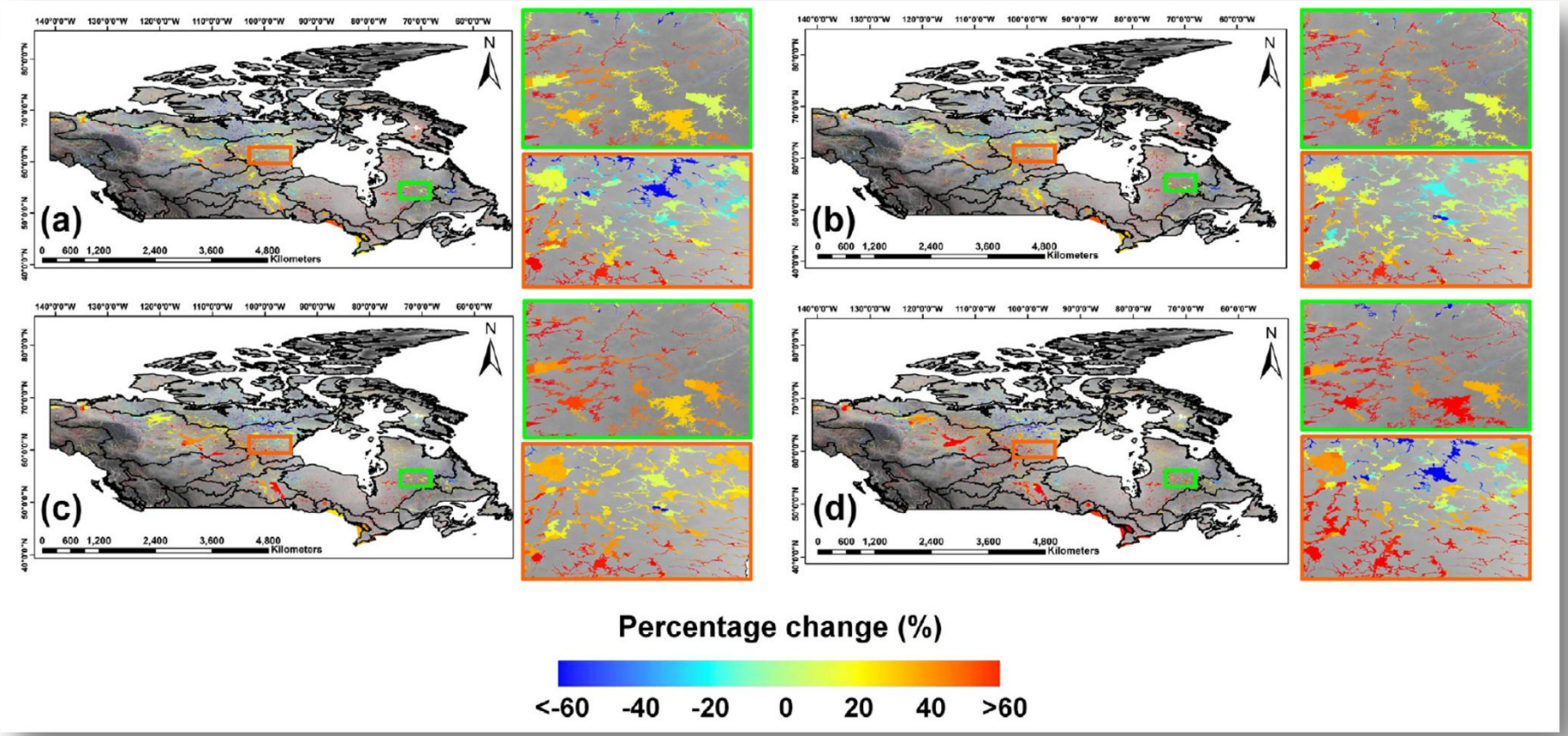
Name of river basin	Near future (SSP 4.5)	Far future (SSP 4.5)	Near future (SSP 8.5)	Far future (SSP 8.5)
Pacific Coastal				
Fraser-Lower Mainland				
Okanagan-Similkameen				
Columbia				
Yukon				
Peace-Athabasca				
Lower Mackenzie				
Arctic Coast Islands				
Missouri				
North Saskatchewan				
South Saskatchewan				
Assiniboine-Red				
Winnipeg				
Lower Saskatchewan- Nelson				
Churchill				
Keewatin Southern Baffin Island				
Northern Ontario				
Northern Quebec				
Great Lakes				
Ottawa				
St. Lawrence				
North Shore Gasp				
Saint John St. Croix				
Maritime Coastal				
Newfoundland Labrador				



100 yr

14| IMPLEMENTATION

Climate change impacts - flood depth (hazard)

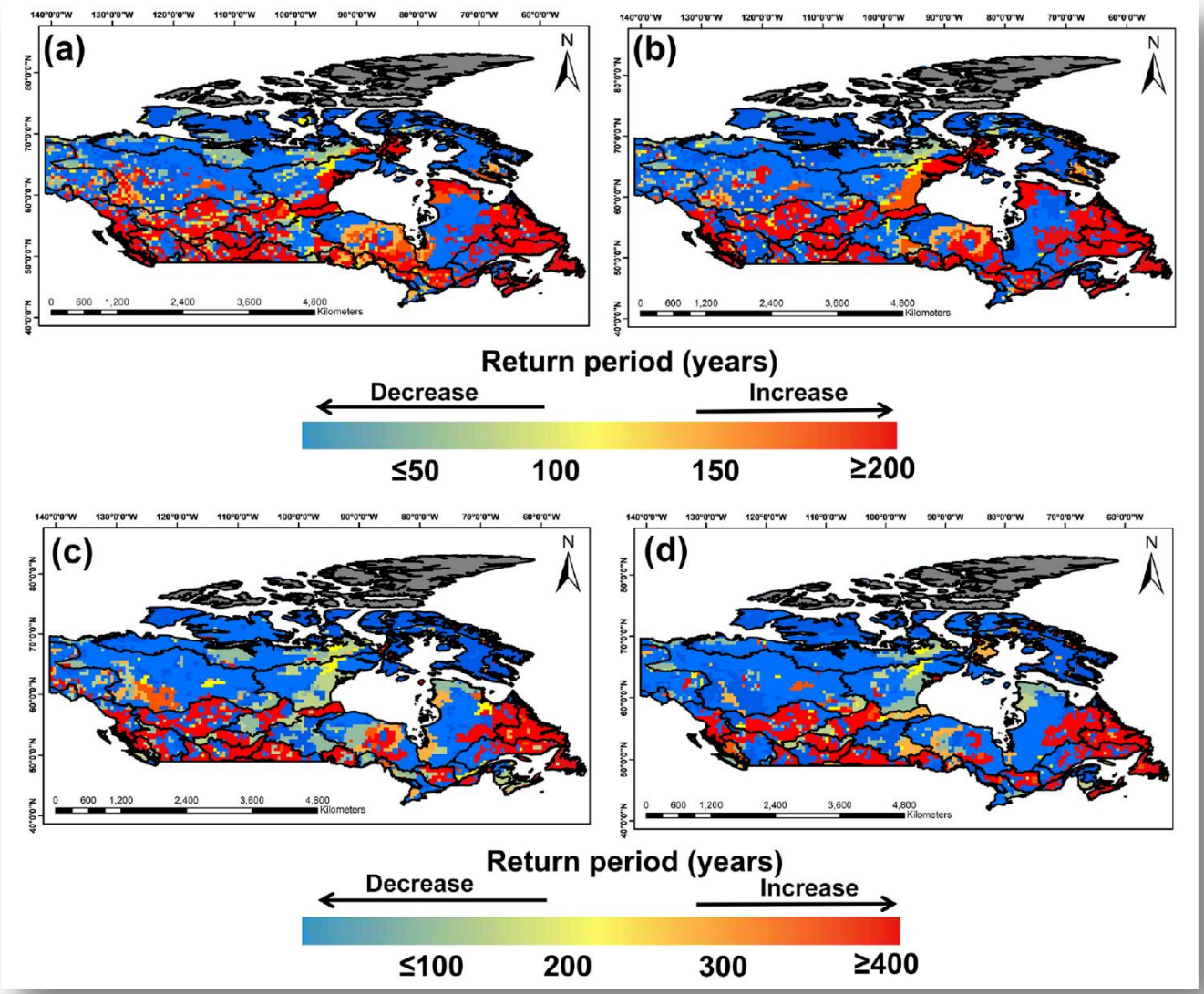


100 yr (near future SSP 4.5; near future 8.5; far future SSP 4.5 far future SSP 8

15| IMPLEMENTATION
Climate change impacts - flood frequency

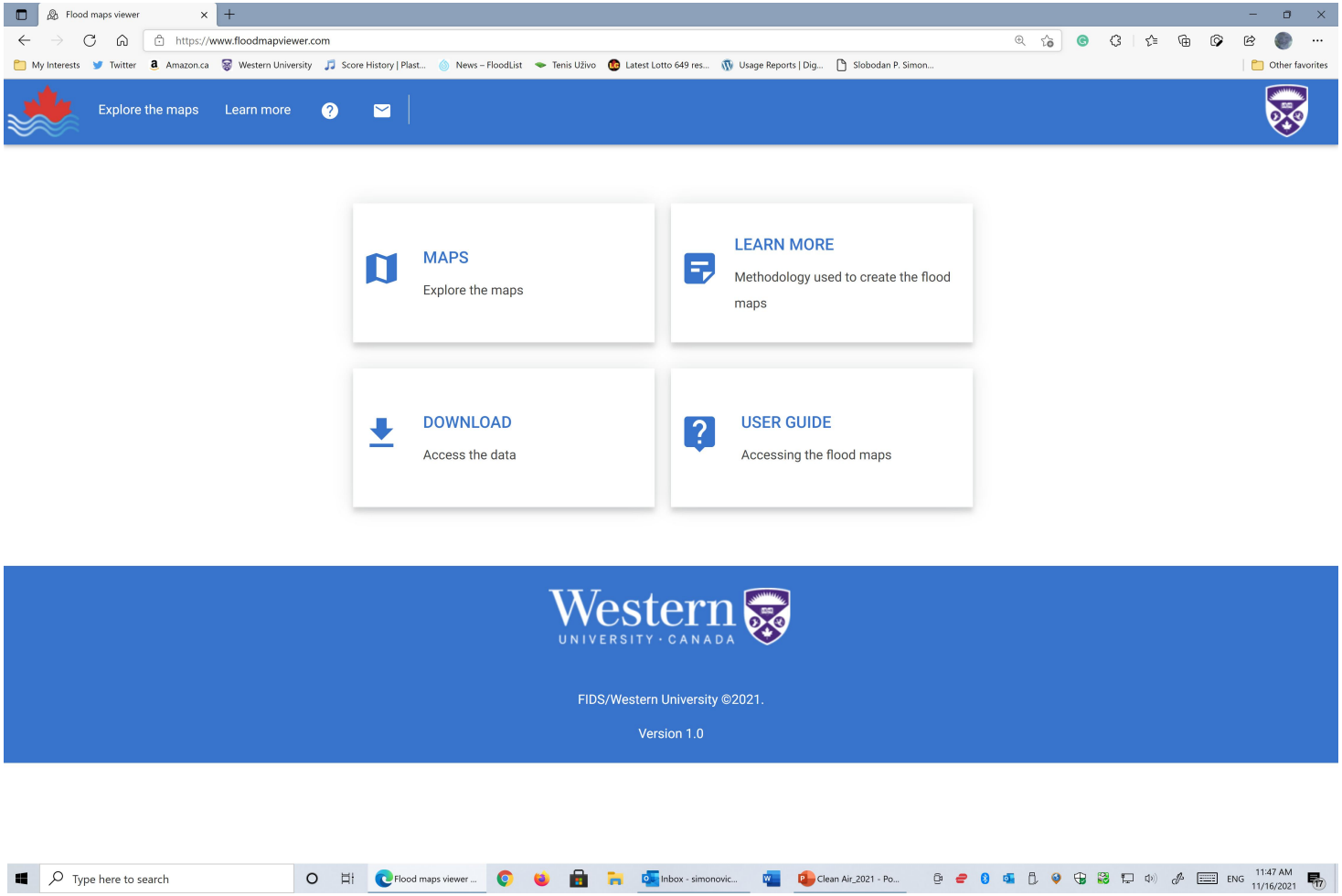
100 yr
far future
SSP 4.5

200 yr
far future
SSP 8.5



- Communication of results to general public

17 | RESULTS COMMUNICATION



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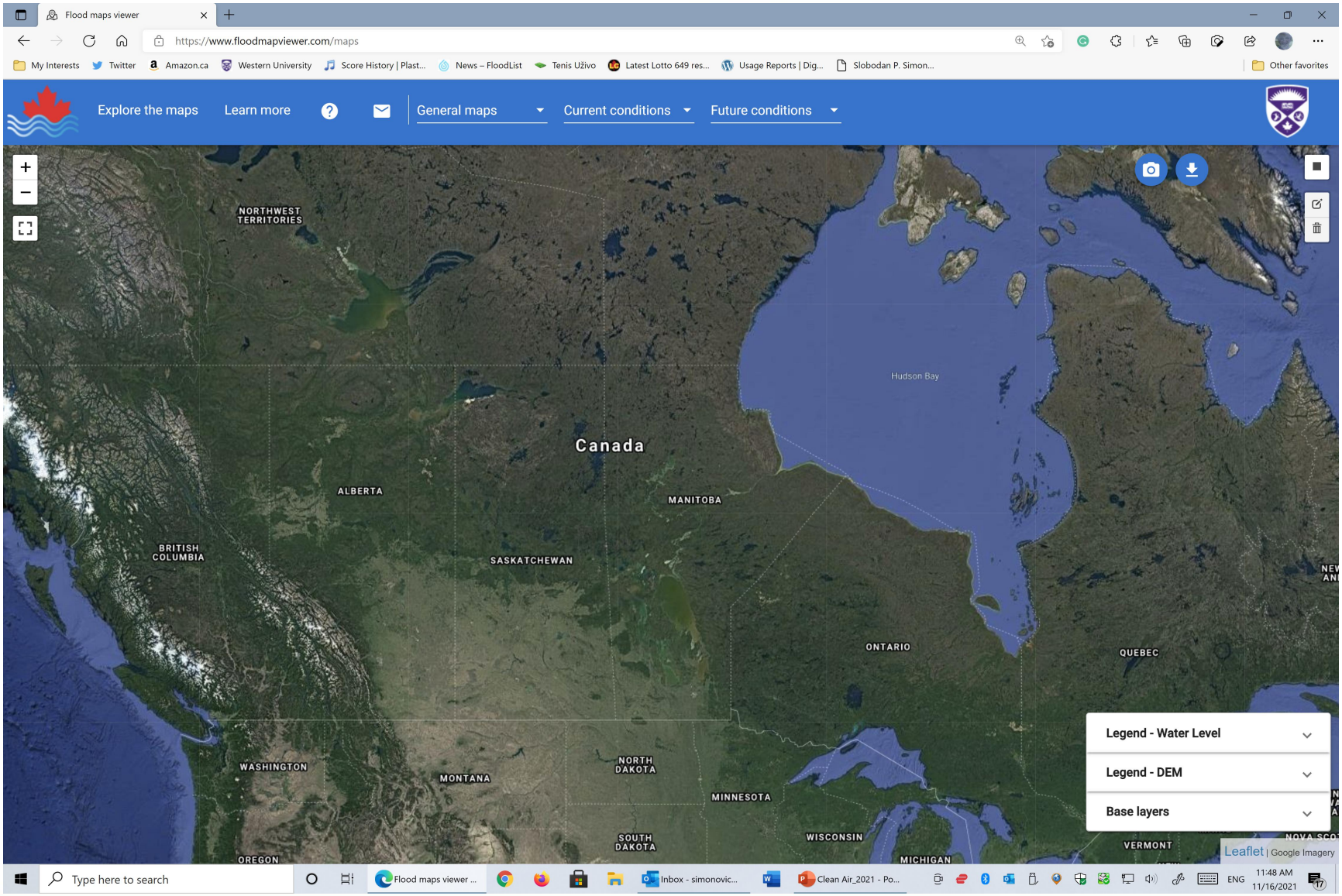
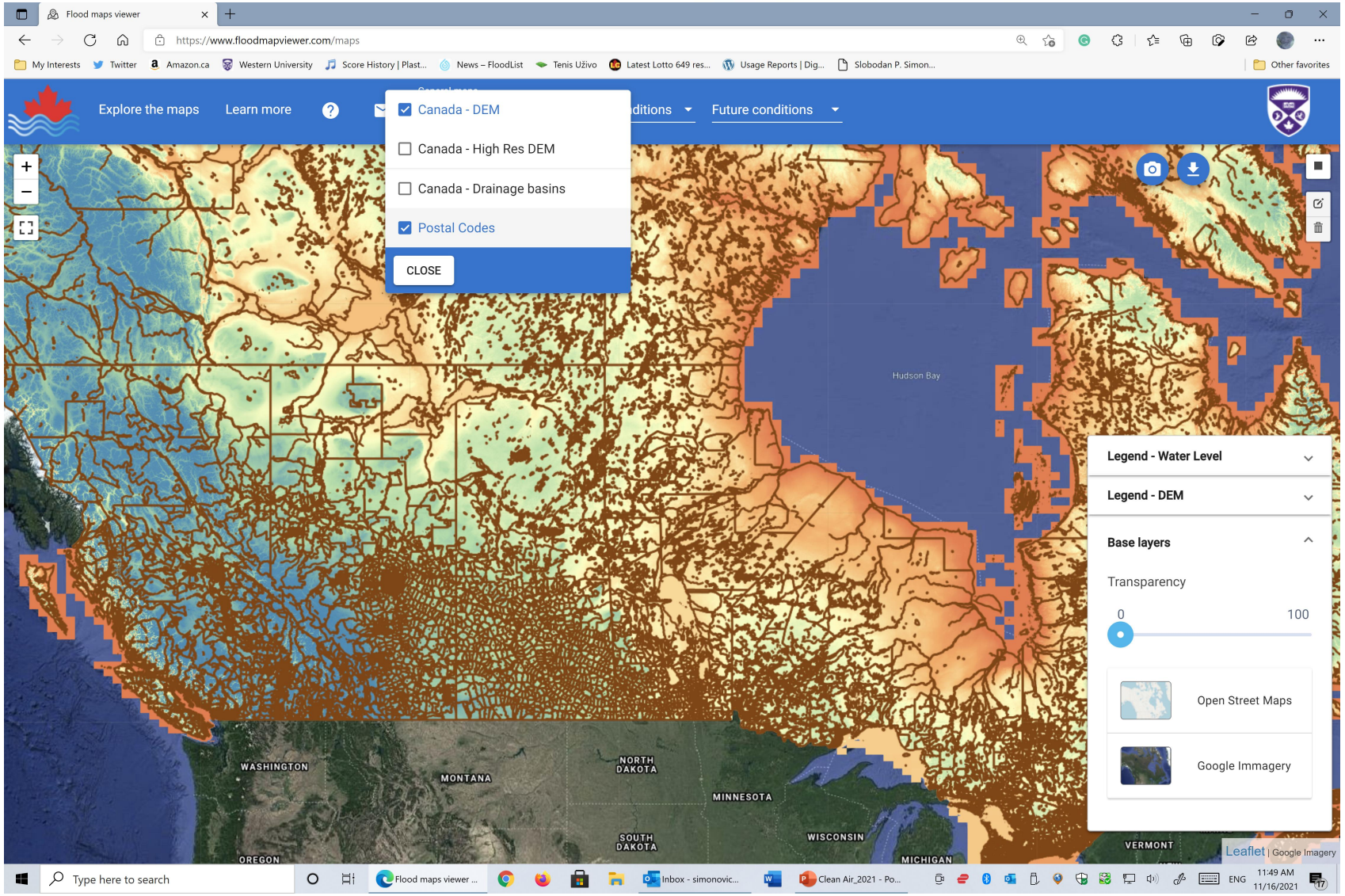
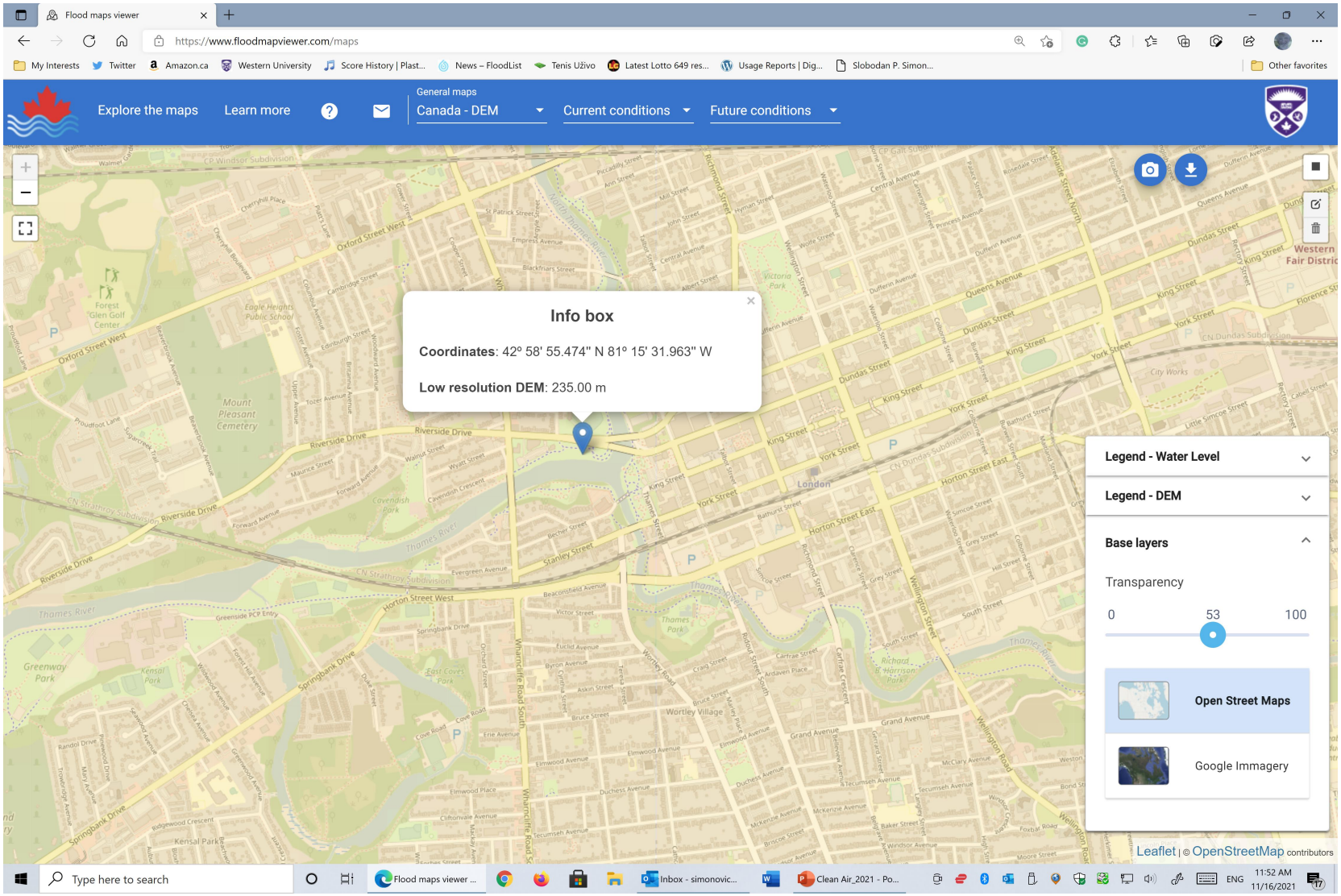
18| RESULTS COMMUNICATION



19 RESULTS COMMUNICATION



20| RESULTS COMMUNICATION



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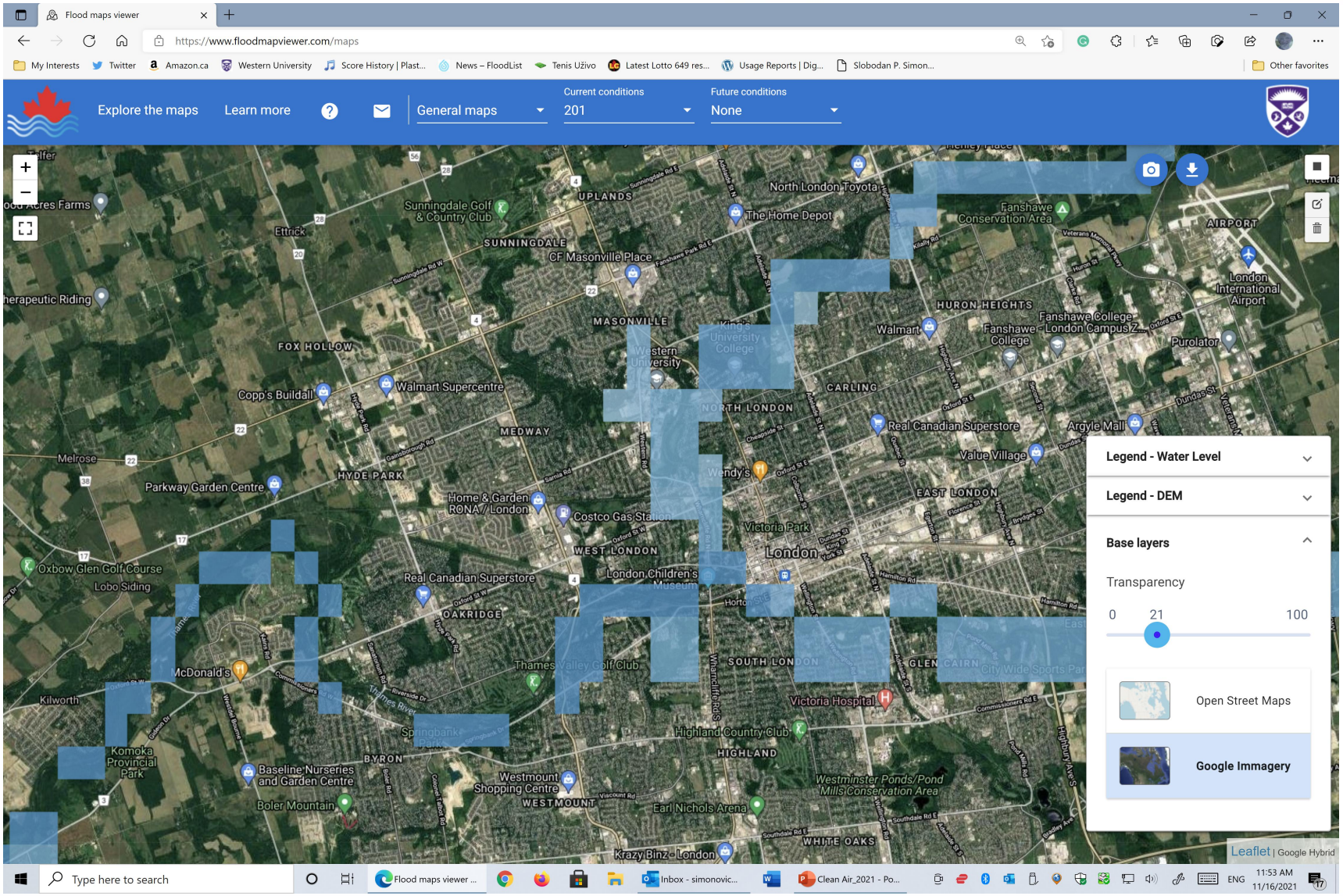

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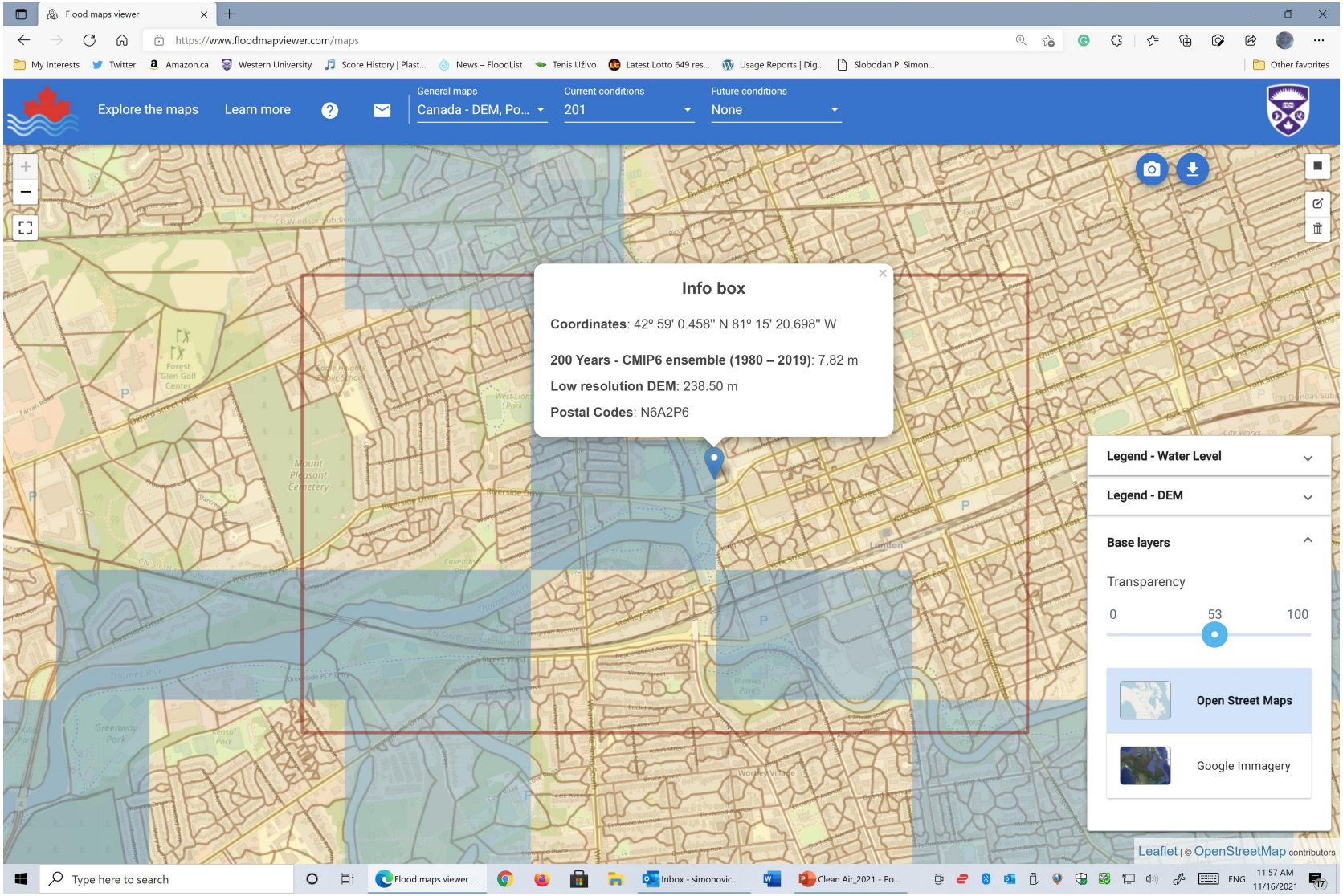
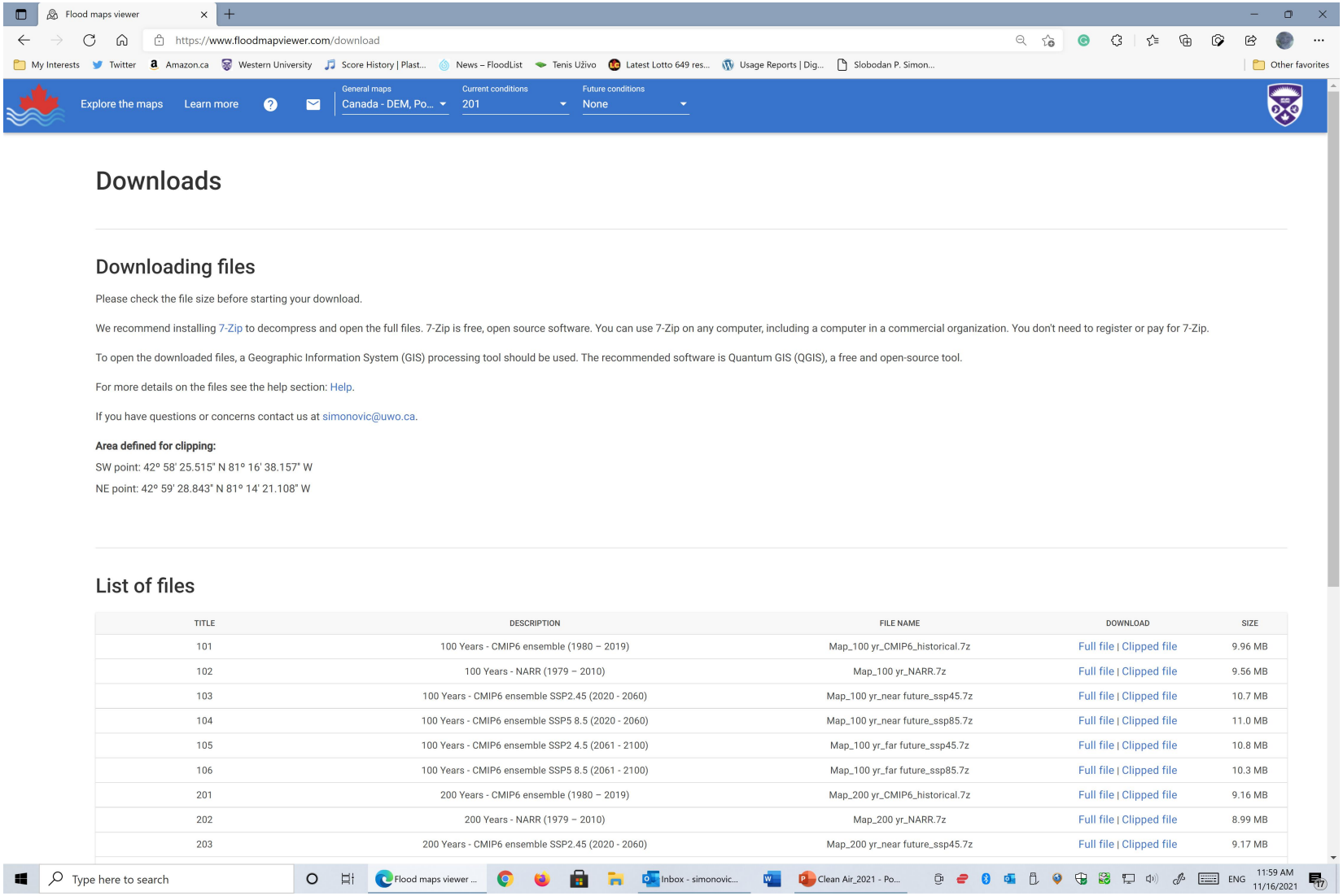
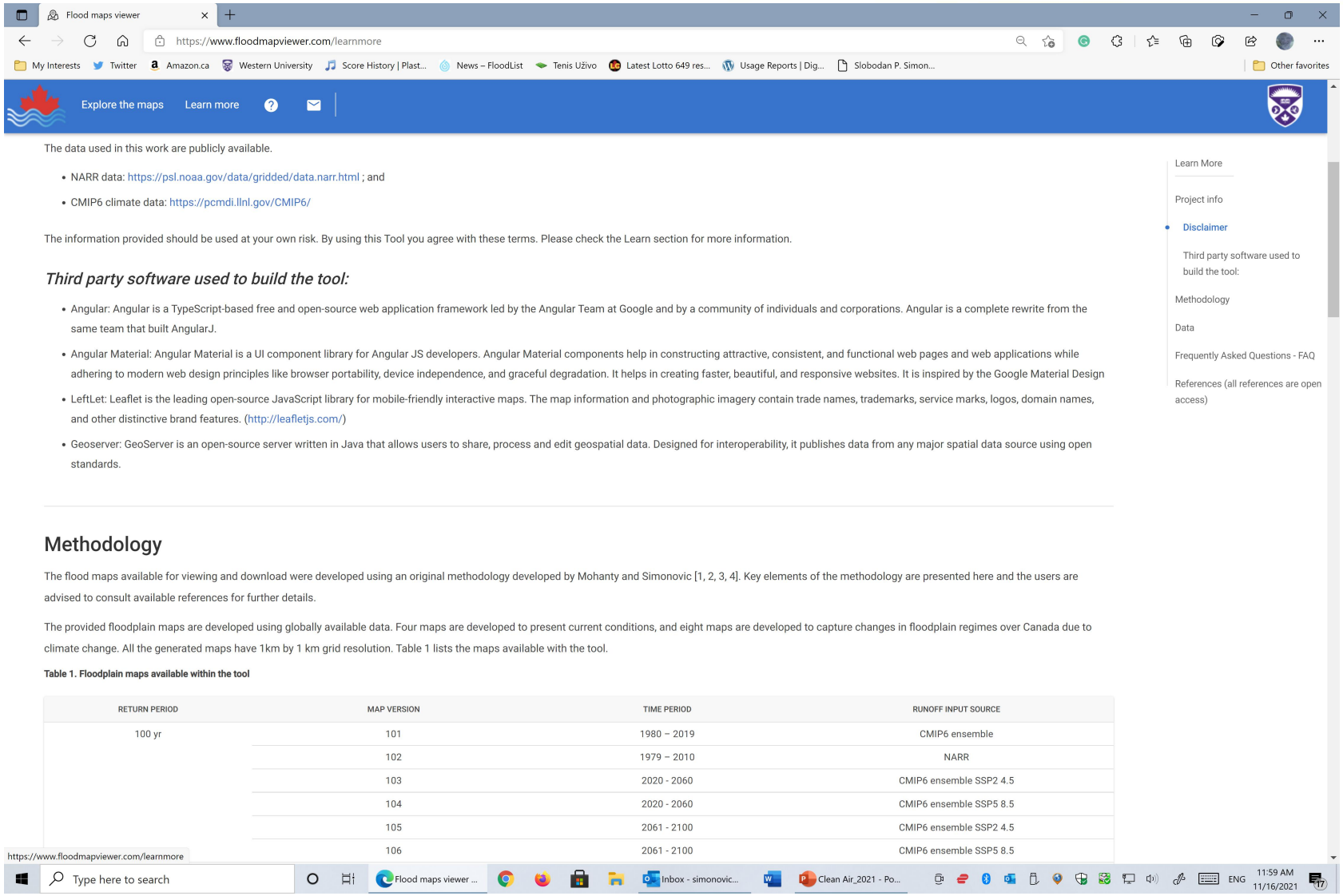


23 | RESULTS COMMUNICATION



24 | RESULTS COMMUNICATION



25 | RESULTS COMMUNICATION

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Flood maps viewer

https://www.floodmapviewer.com/userguide#download-export

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Exporting and downloading

The following buttons allow the export (create a screenshot of the visible map area and all visible layers, and access the download page, respectively).

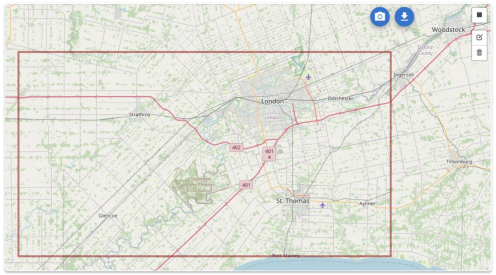
Clipping

The clipping functionality allows you to select a region of interest to zoom in and download reduced (clipped) map layers. The buttons located on the top right are:

1. Rectangle button: create the clipping region
2. Edit button: edit, change and move the existing clipping area
3. Delete button: remove the clipping area

The list of buttons described is shown on the Map page as follows

Once a clipping area has been selected, a region (rectangle) is displayed to indicate your selection.



When editing a clipping area, dashed lines are shown, and the corners and center point are highlighted.

User guide

- Prerequisites
- Landing page
- Explore the maps
  - General and Current and Future Conditions Flood maps
  - Base maps and transparency
  - Legends
- Exporting, clipping and downloading
  - Exporting and downloading
  - Clipping
  - Downloading files

Type here to search | Flood maps viewer... | Inbox - simonovic... | Clean Air_2021 - P... | ENG | 12:01 PM 11/16/2021

SUMMARY
Floodplain mapping

- Specific aspects of the methodology
  - Consideration of the whole country (large region almost 10M km^2) - standardized
  - Use of publicly available runoff data (runoff observations sparse – reanalysis products; future climate according to CMIP6 (Coupled Model Intercomparison Project) and 17 GCM models from that experiment
  - Use of other public data required for hydrodynamic modelling (global DEM; global river width; global water; open street;….)
  - Modelling outcome: flood depth; flood inundation; and flow velocity in gridded form (1 km by 1 km)

27 | REFERENCES

Mohanty, M. and S.P. Simonovic (2021) “Fidelity of Reanalysis Datasets in Floodplain Mapping: Investigating Performance at Inundation Level over Large Regions”, *Journal of Hydrology*, Vol.597, 125757, available online at https://doi.org/10.1016/j.jhydrol.2020.125757

Mohanty, M. and S.P. Simonovic (2021) “Changes in floodplain regimes over Canada due to climate change impacts: observations from CMIP6 models”, *The Science of Total Environment,* 792, 148323, open access https://doi.org/10.1016/j.scitotenv.2021.148323 .

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Additional resources

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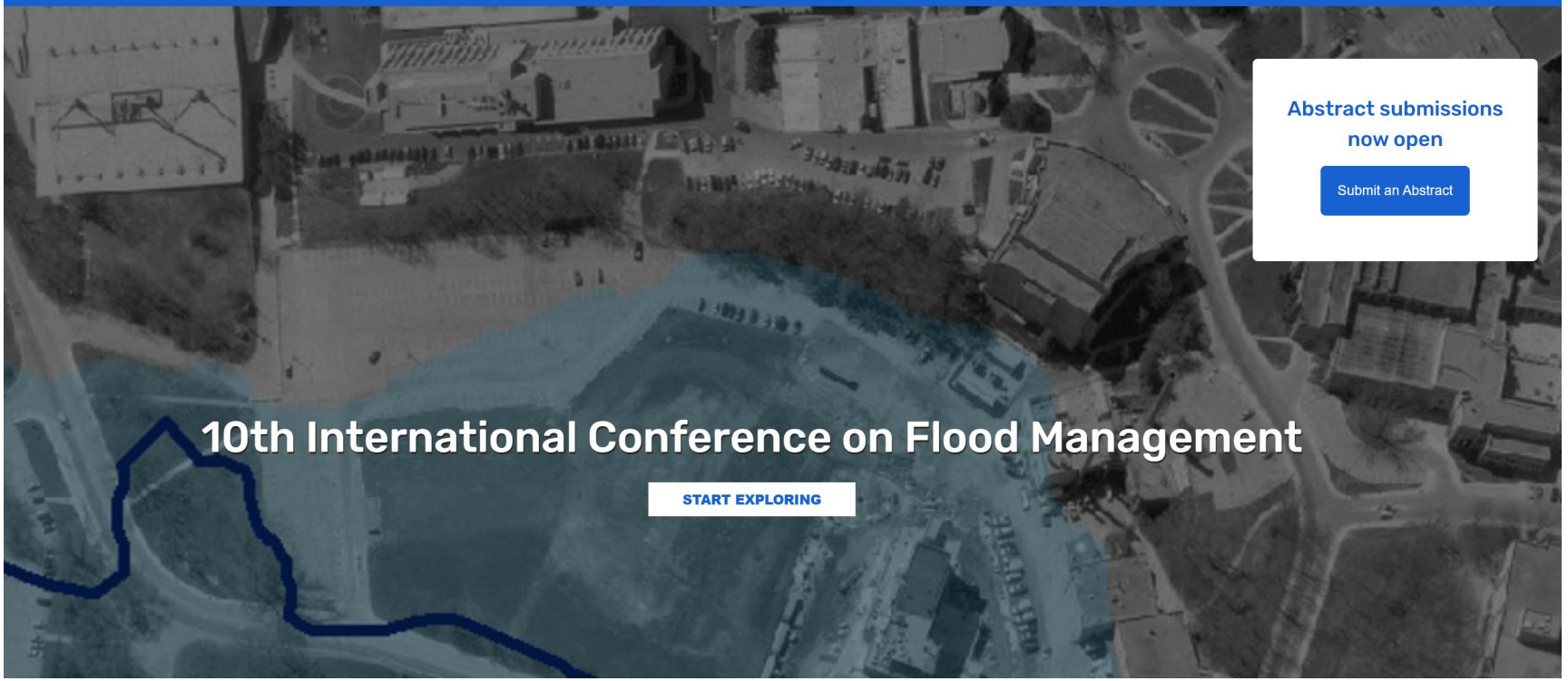

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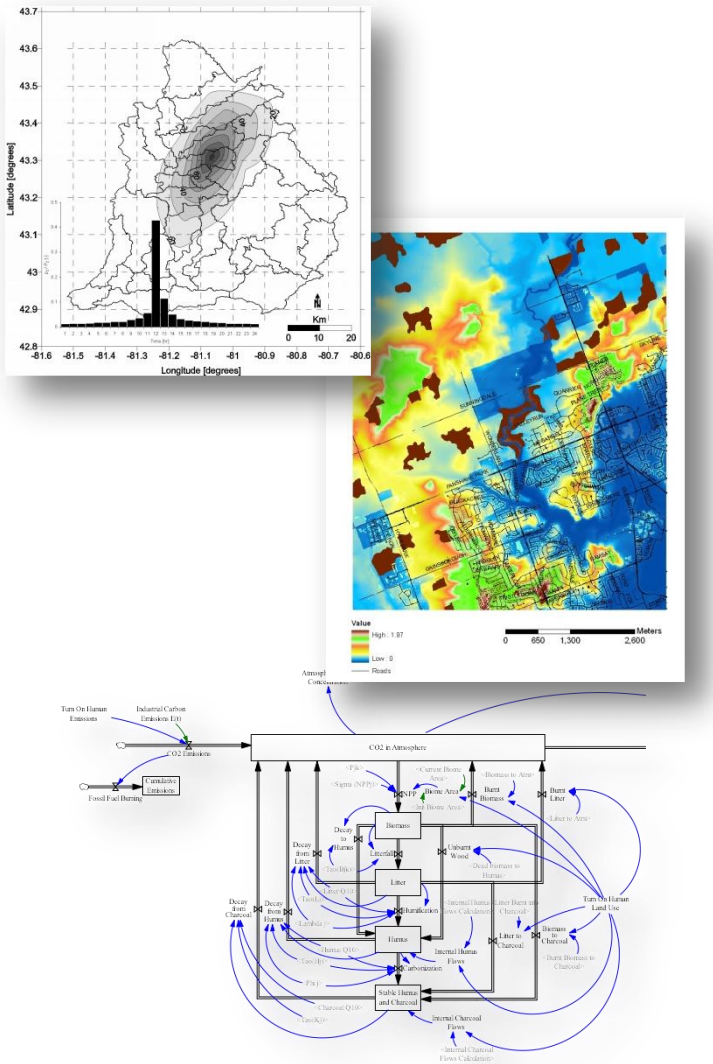
Research

- Research:
  - *Subject Matter* - Systems modeling; Risk and reliability; Water resources and environmental systems analysis; Computer-based decision support systems development.
  - *Topical Area* - Reservoirs; Flood control; Hydropower energy; Operational hydrology; Climatic Change; Integrated water resources management.
- 75 research projects
- 12 visiting fellows
- 21 PosDoc
- 24 PhD and
- 45 MESc



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Publications

- ~ 620 professional publications
- 272 in peer reviewed journals
- 3 major textbooks

- Water Resources Research Reports 117 volumes – https://ir.lib.uwo.ca/wrrr/
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