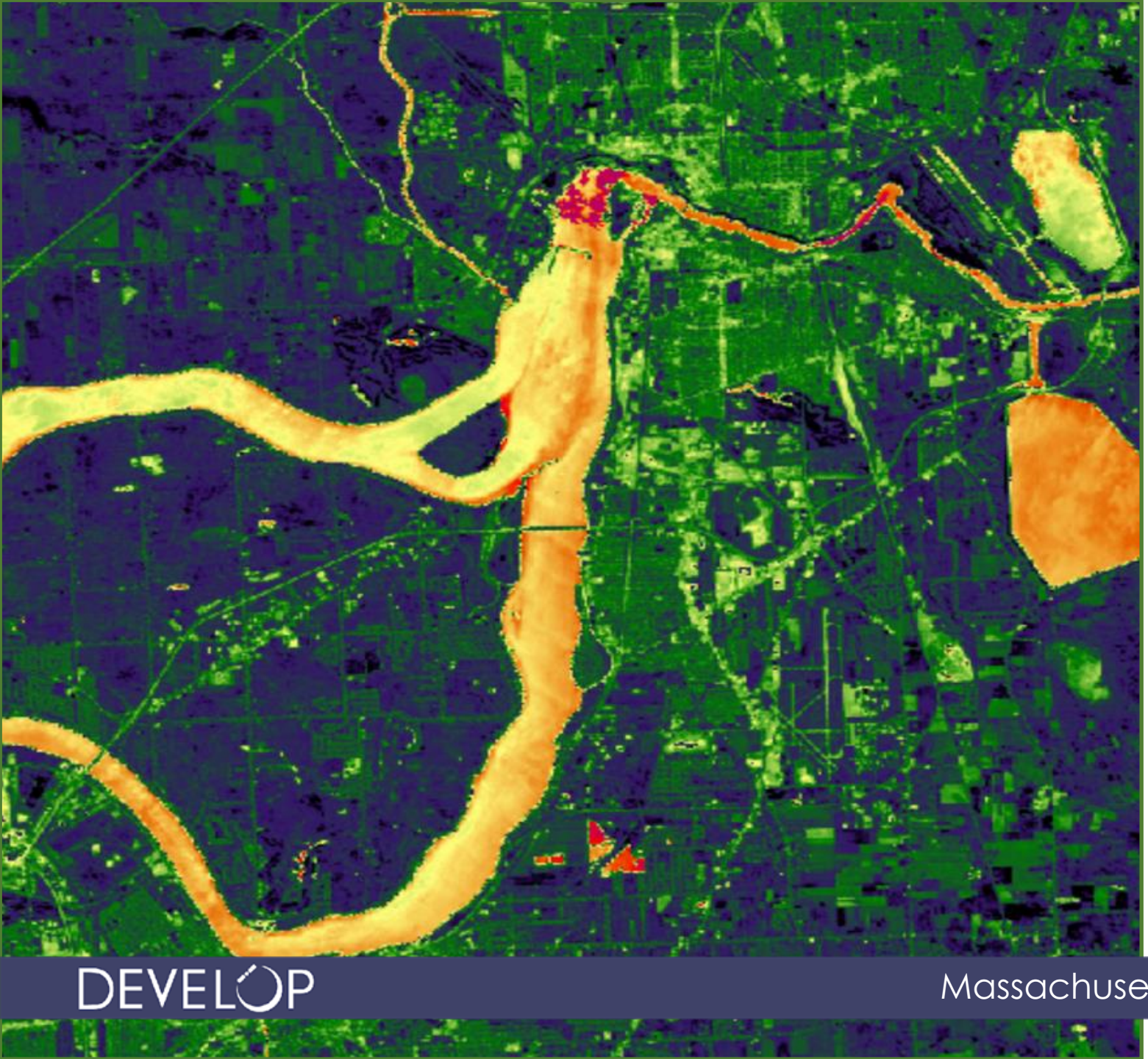

National Aeronautics and Space Administration

NIAGARA FALLS DISASTERS

Employing Remote Sensing Techniques to Evaluate Flood Extent and Environmental Parameters that Contribute to High Water Levels in Lake Ontario's Coastal New York Communities

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Outline

- Study Region
- Community Concerns
- Objectives
- Partners
- Satellites Used
- Methodology
- Results
- Errors & Uncertainties
- Conclusions
- Future Work
- Acknowledgements

Study Region

- Study Region: southern coast of Lake Ontario, the City of Niagara Falls, NY, along Niagara River and Grand Island

- Study Period: April 2015 to February 2019

Source: DEVELOP Niagara Falls Disasters Team

Community Concerns

- Extreme high water events in 2017 caused flood damage along the Lake Ontario coast
- Niagara Falls, NY, could not accommodate floodwater inundation during the peak of the event
- Local communities and management required further assessment of flood extent and impacts to determine high-risk areas

Source: lizsmith (Flickr)

Objectives

- **Determine** the feasibility of using satellite remote sensing techniques for urban flood extent mapping

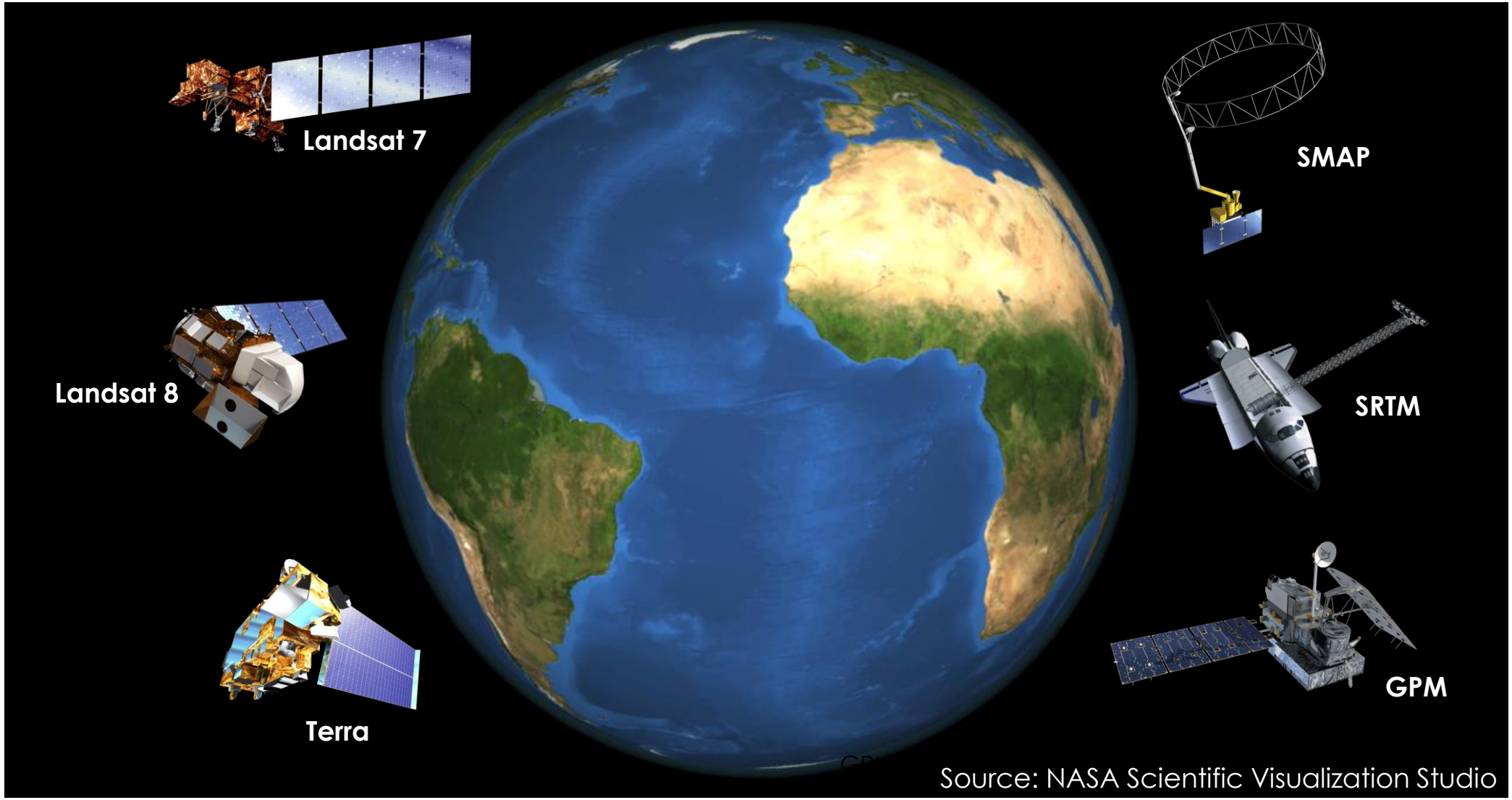
- **Create** flood extent maps that display the extent of high water levels prior to and including the 2017 flood

- **Demonstrate** how specific environmental parameters that contribute to flooding can be measured using satellite remote sensing

Partners

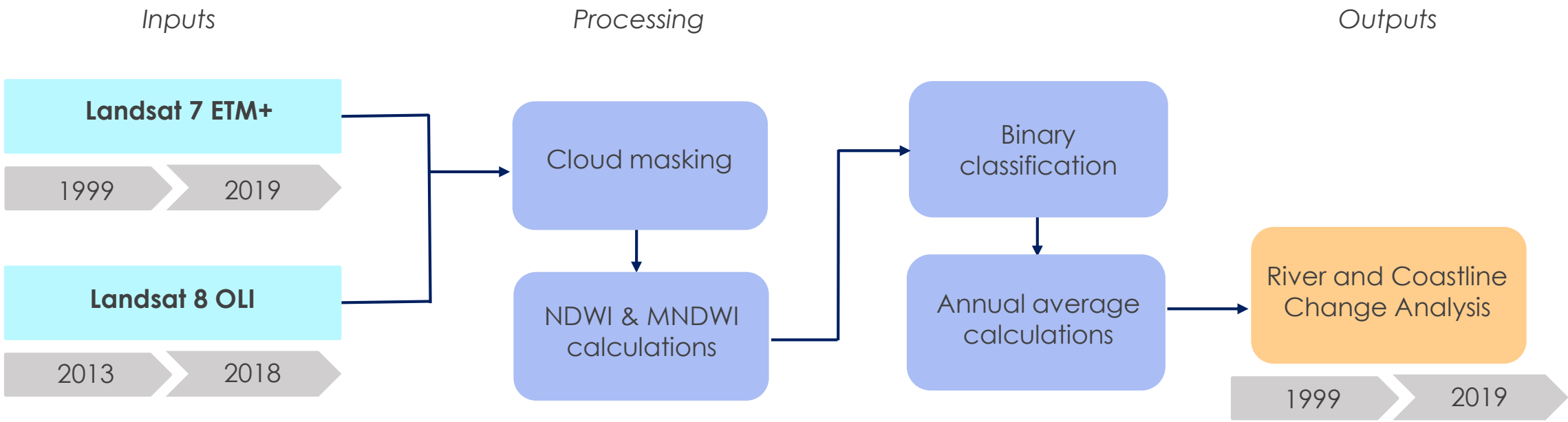
- City of Niagara Falls, Department of Planning and Economic Development
- Great Lakes and St. Lawrence Cities Initiative
- Cornell University
- University of Michigan

Satellites Used



Coastal Annual Land Cover Change (CALCC) Tool Methodology

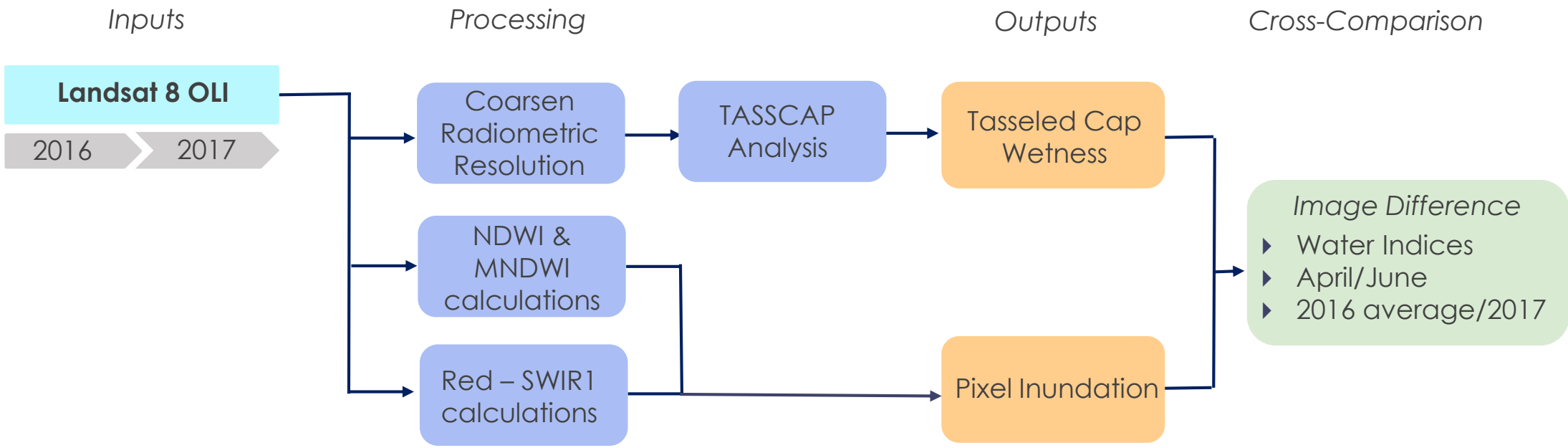
- This tool uses Landsat 7 and 8 data to identify river and coastline change in the Google Earth Engine platform



Source: DEVELOP Niagara Falls Disasters Team

Flood Extent Maps Methodology

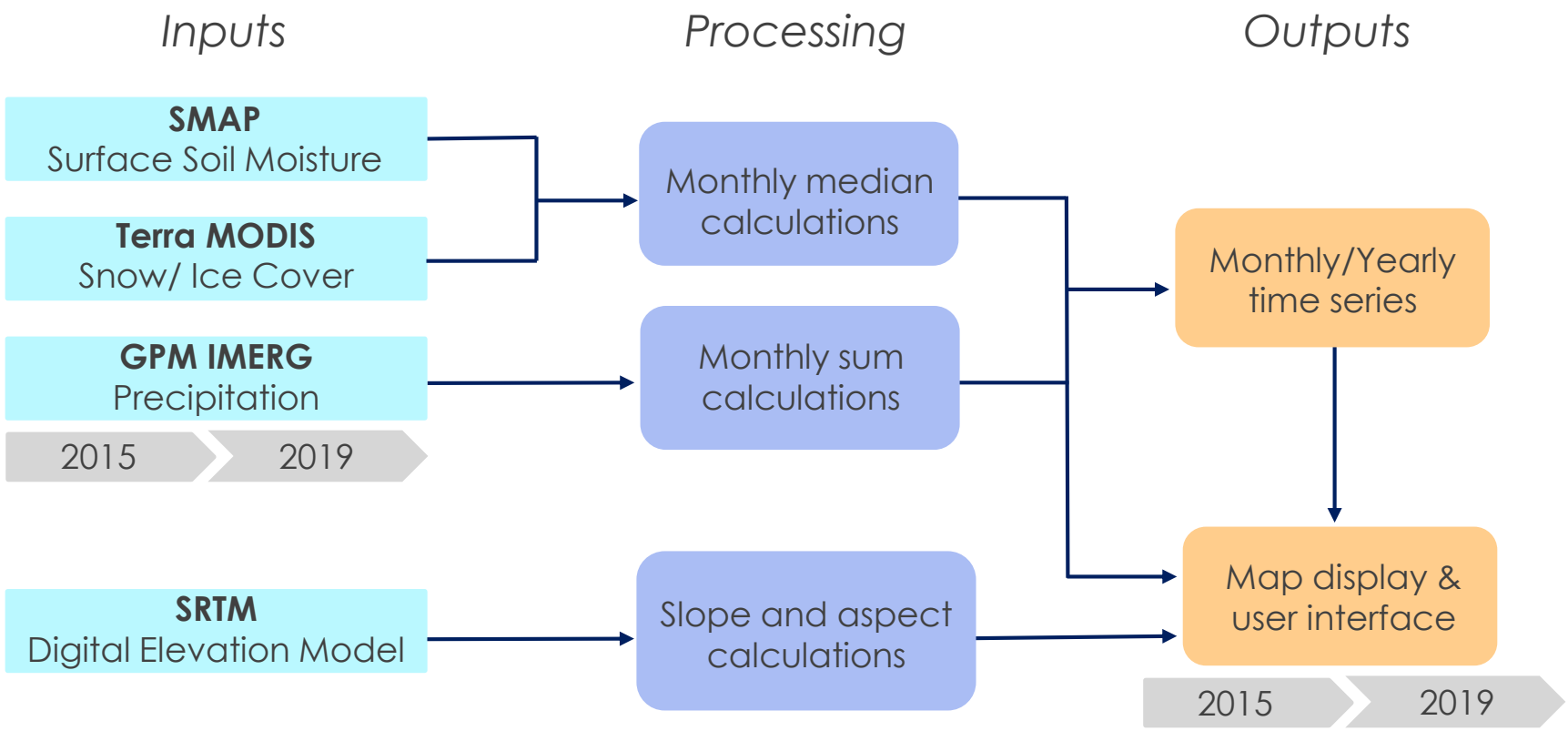
- The Flood Extent Maps assess the feasibility of mapping flood extent using satellite remote sensing



Source: DEVELOP Niagara Falls Disasters Team

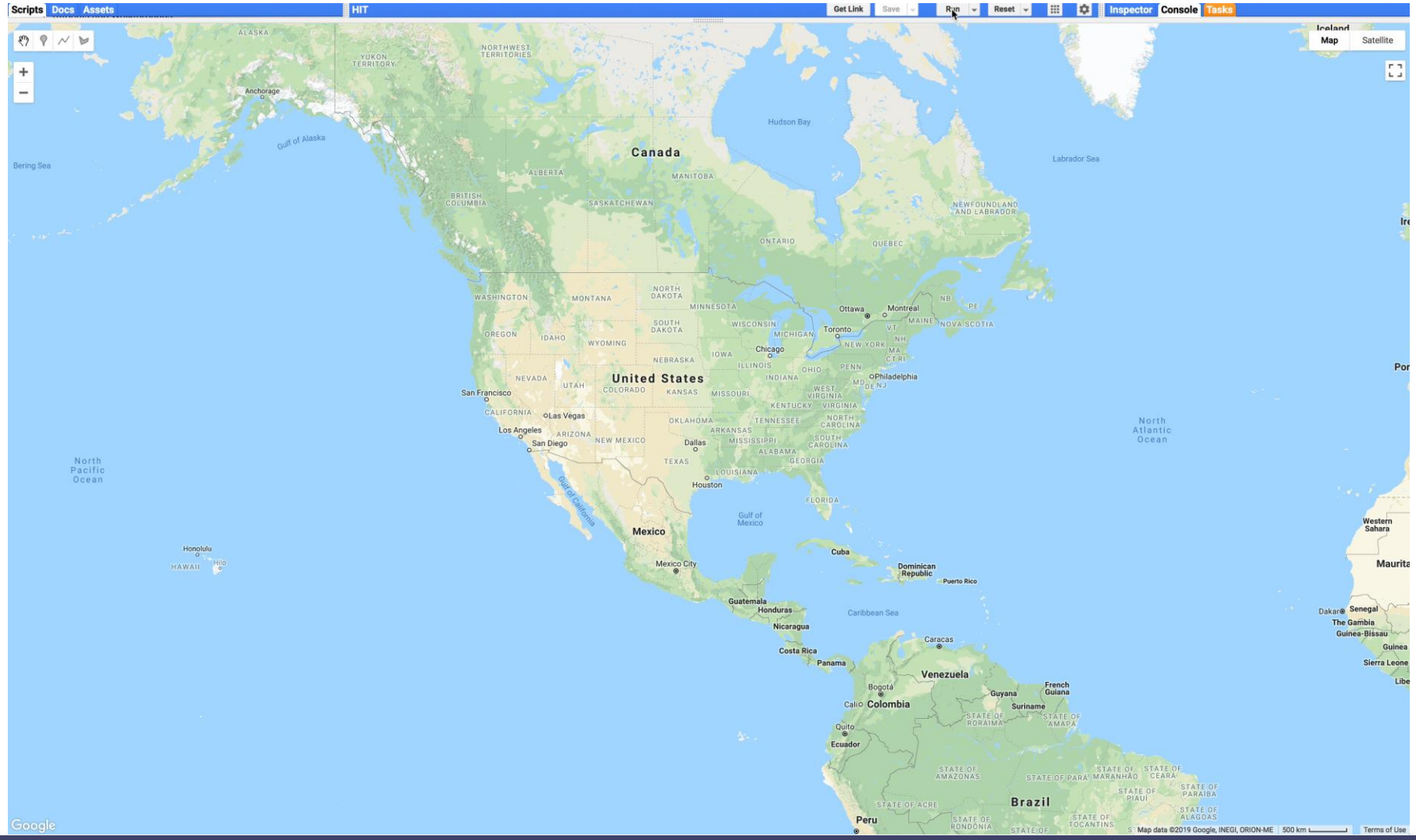
Hydrologic Inputs Tool (HIT) Methodology

- This tool displays remotely sensed environmental data across the Lake Ontario watershed using the Google Earth Engine platform



Source: DEVELOP Niagara Falls Disasters Team

HIT User Interface



Source: DEVELOP Niagara Falls Disasters Team

CALCC Results

- Landsat satellites do not produce satisfactory imagery for reliable urban flood mapping
  - Temporal Resolution
  - Spatial Resolution
  - Spectral Signature

Aerial photograph
0.2 m 21.07.2015

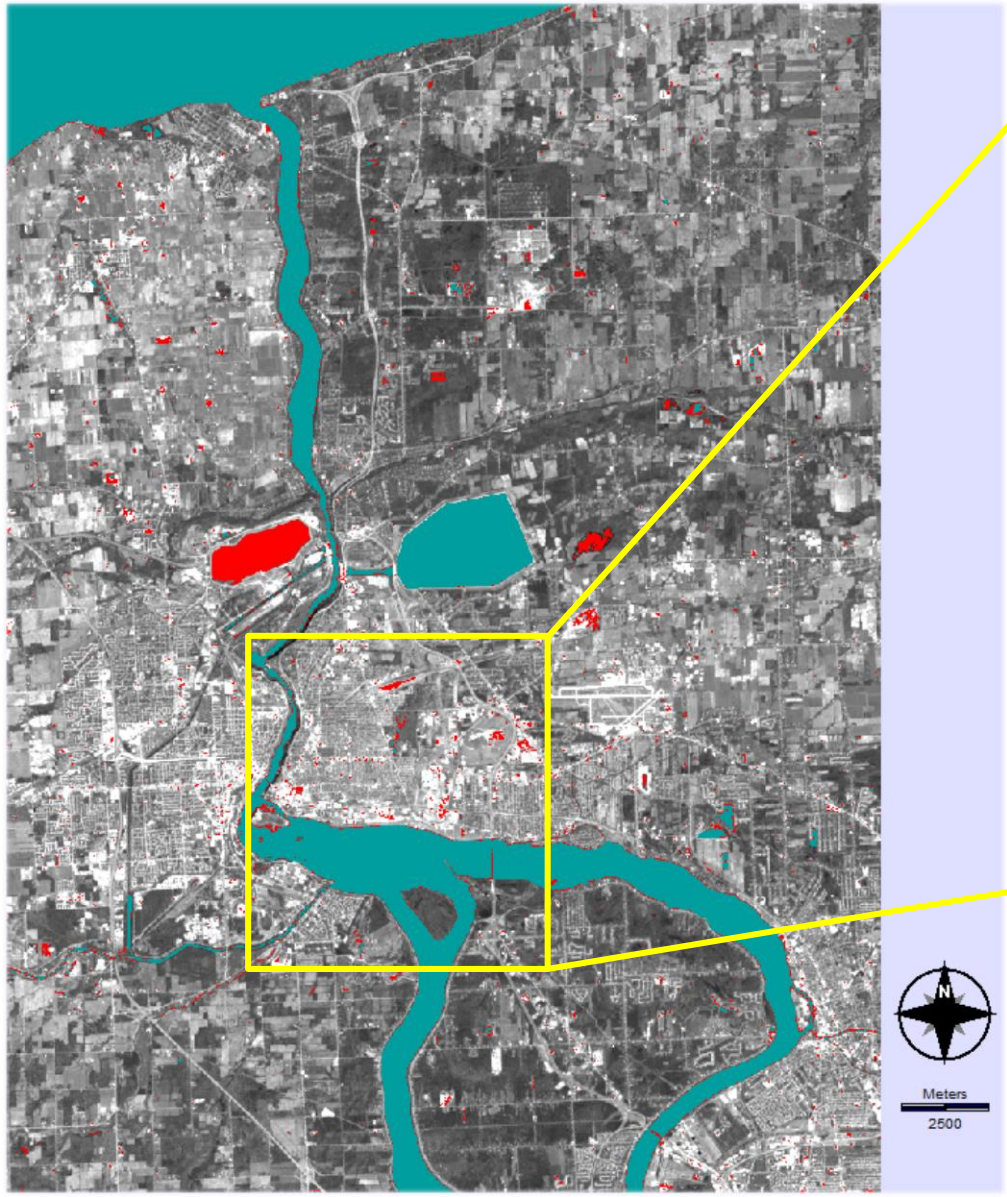
HyMap
3.6 m 20.08.2009

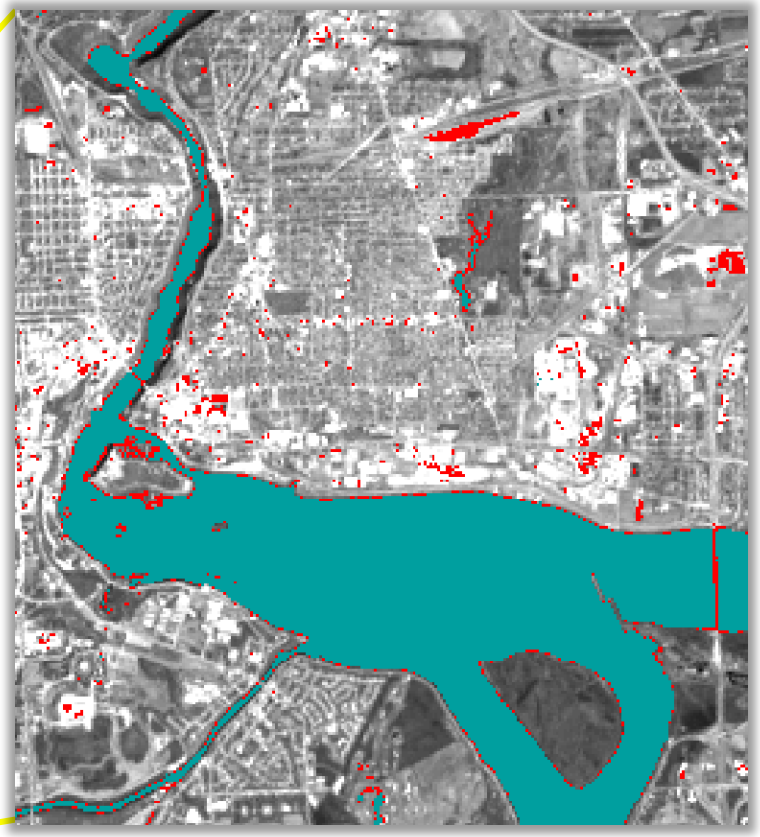
Sentinel-2
10 m 23.08.2015

Landsat 8
30 m 03.10.2015

Sample images from various optical sensors show significant loss in spatial acuity (Liang, Li, & Wang 2012)

Flood Extent Maps Results





Tasseled Cap wet areas for April 2017 shown in red overlaid with 2016 Base Average in turquoise

- 2016 average/2017 Water Indices
- NDWI, Tasseled Cap, Red-SWIR
- April/June 2017

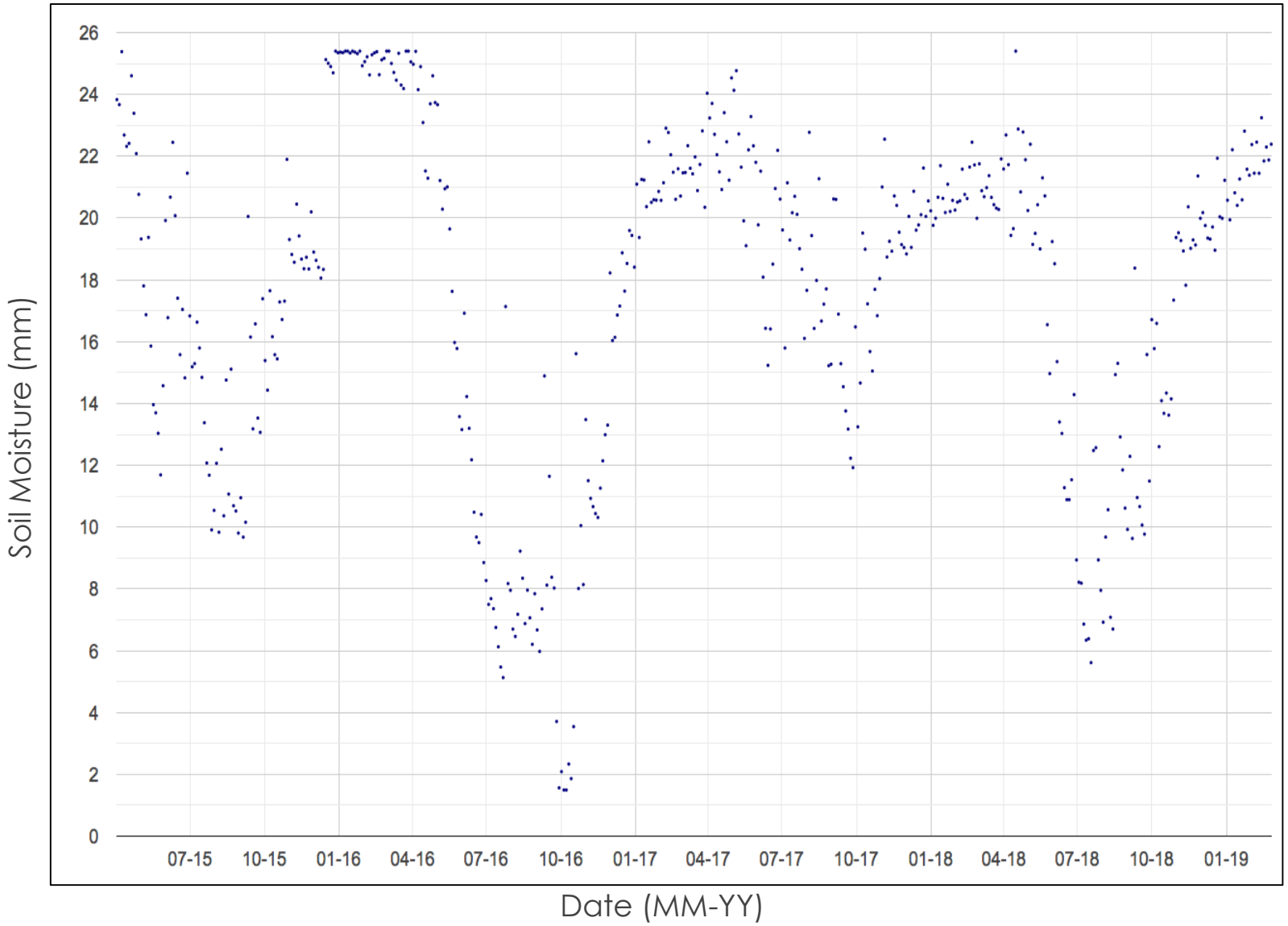
Source: DEVELOP Niagara Falls Disasters Team

HIT Results

- Relative comparison of parameters through time can demonstrate the impact of environmental conditions on water levels

- Time series of an environmental parameter can highlight yearly fluctuations and patterns through time

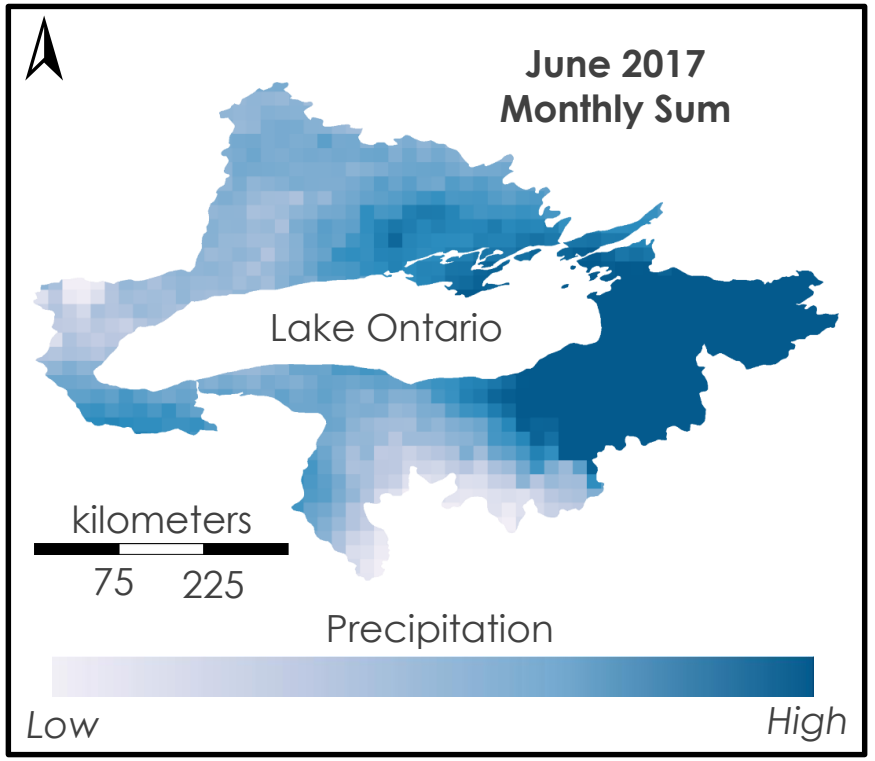
Soil Moisture, 2015 to 2019



Source: DEVELOP Niagara Falls Disasters Team

Errors and Uncertainties

- Landsat Series was not sufficient for urban flood mapping
- Atmospheric correction and thresholding values for water indices
- SMAP data spatial resolution
- Implications for HIT median and mean statistics
- Accuracy assessment



Source: DEVELOP Niagara Falls Disasters Team

Conclusions

- Given the relatively coarse spatial resolution of Landsat 7 & 8, NASA optical satellites provide limited functionality for mapping floods in urban environments.

- Our team found that using NASA Earth observations to assess environmental parameters that contribute to high water can effectively enhance flood condition monitoring, hydrological model validation, and flood forecasting efforts completed by our partner organizations.

- During April and May of 2017, precipitation was approximately 166 mm more than April and May 2016 and soil moisture was the highest of all months in 2017 and 2018.

Future Work

- WRF-Hydro Model output comparison/validation using SWE & Soil Moisture data
  - Our partner at University of Michigan and other researchers working with hydrological models can use data from HIT to validate and test their model outputs

- Inputs can be integrated into predictive models
  - Our partner at Cornell University is interested in integrating remotely sensed data into forecasting efforts to prepare New York communities for future flood events

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- Zachary Bengtsson, DEVELOP Massachusetts – Boston Node
- Lake Ontario Disasters Team, DEVELOP Arizona – Tempe Node

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