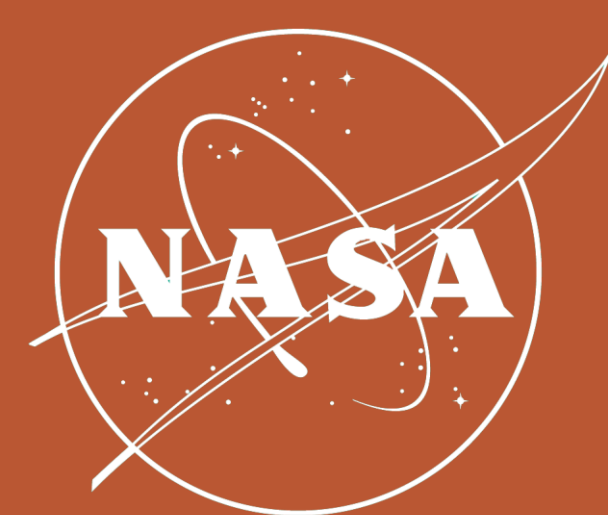# Great Lakes Disasters
Utilizing NASA Earth Observations to Model Flood Impacts and Erosion Vulnerability in the Great Lakes Region

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Abstract

During the extreme precipitation events in the summer of 2012, flash floods inundated Duluth, Minnesota, and Thunder Bay, Ontario, each with over seven inches of rain. Severe flooding impacts such as inundated roadways and hazardous sinkholes caused both cities to enter a state of emergency and cost each area over $100 million (USD) to repair. To assist with future flood mitigation, we examined the feasibility of using FEMA's Hazus software to model the 2012 disaster in Duluth, used data from NASA's Tropical Rainfall Measuring Mission (TRMM) to illustrate the rainfall magnitude in both cities, and implemented several factors from the Revised Universal Soil Loss Equation (RUSLE) in ArcGIS to produce a map of erosion vulnerability in Duluth. Comparing surveyed high-water mark GIS data with Hazus predictions, we found that Hazus flood depth accuracy fluctuated widely throughout the study area, with the highest accuracy occurring close to rivers. These findings can be used to enhance the model's accuracy. TRMM data demonstrated a method for graphically visualizing regional rainfall. Confirmed by reports of actual sinkholes, the erosion susceptibility product accurately identified local erosion risks and is therefore useful for prioritizing erosion control efforts.
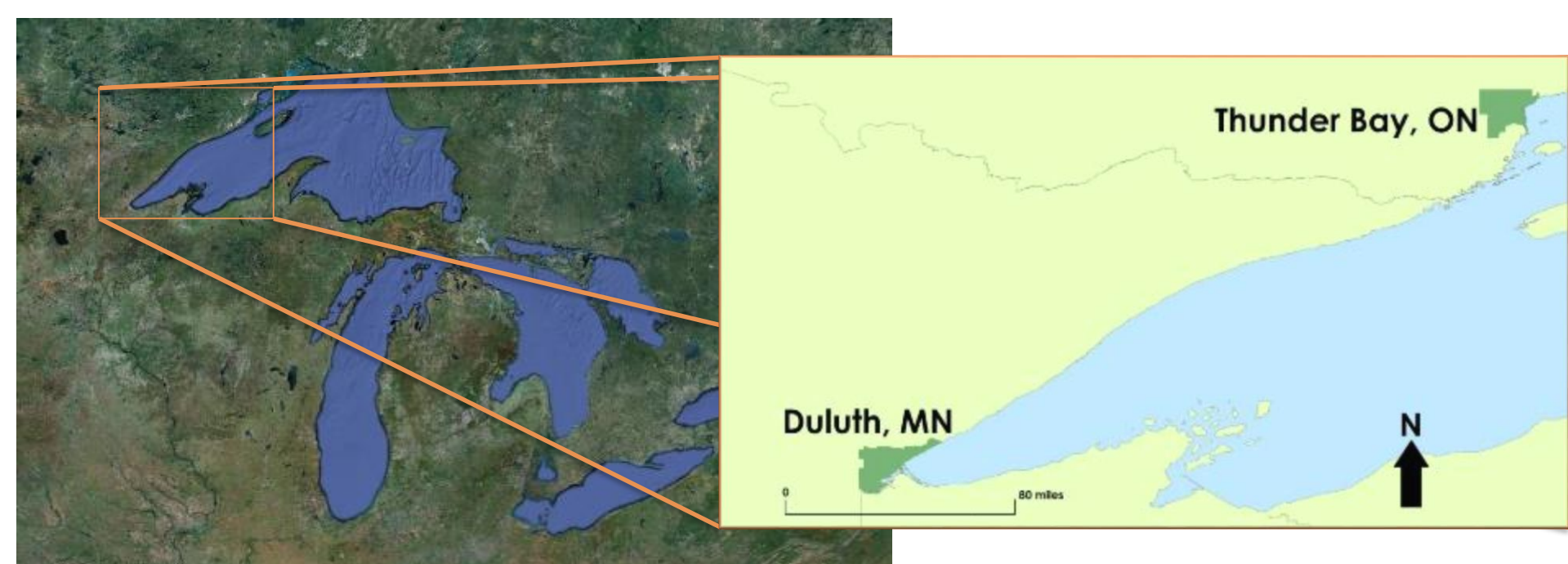
Objectives

- Assist partners with future flood mitigation
- Assess the accuracy of Hazus for modeling the 2012 flood events
- Produce an erosion susceptibility product
- Measure regional rainfall with TRMM
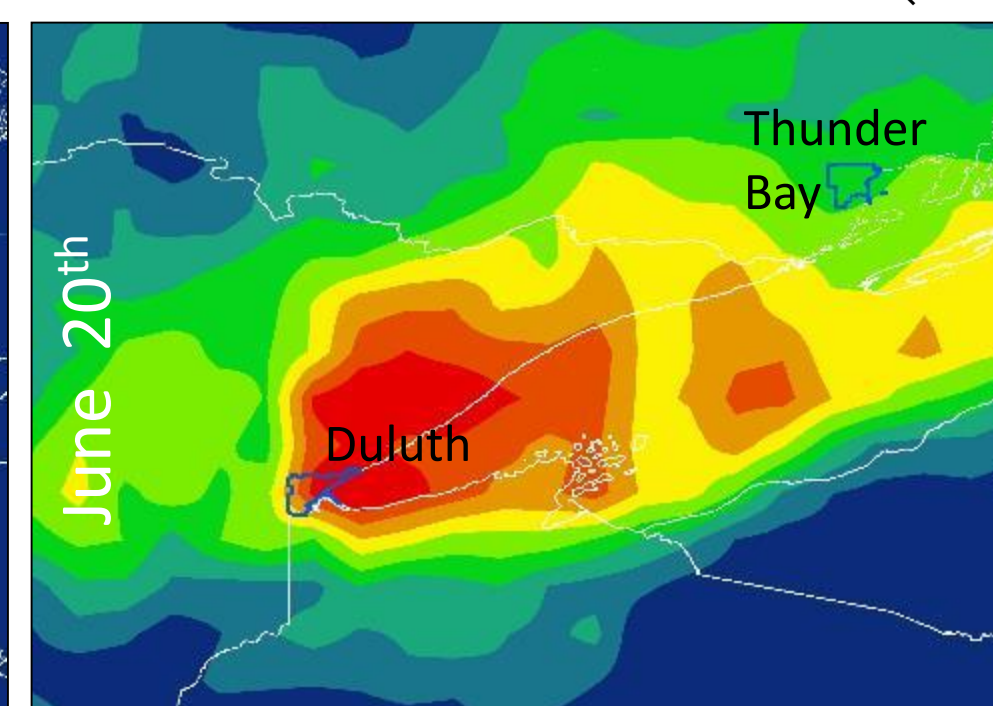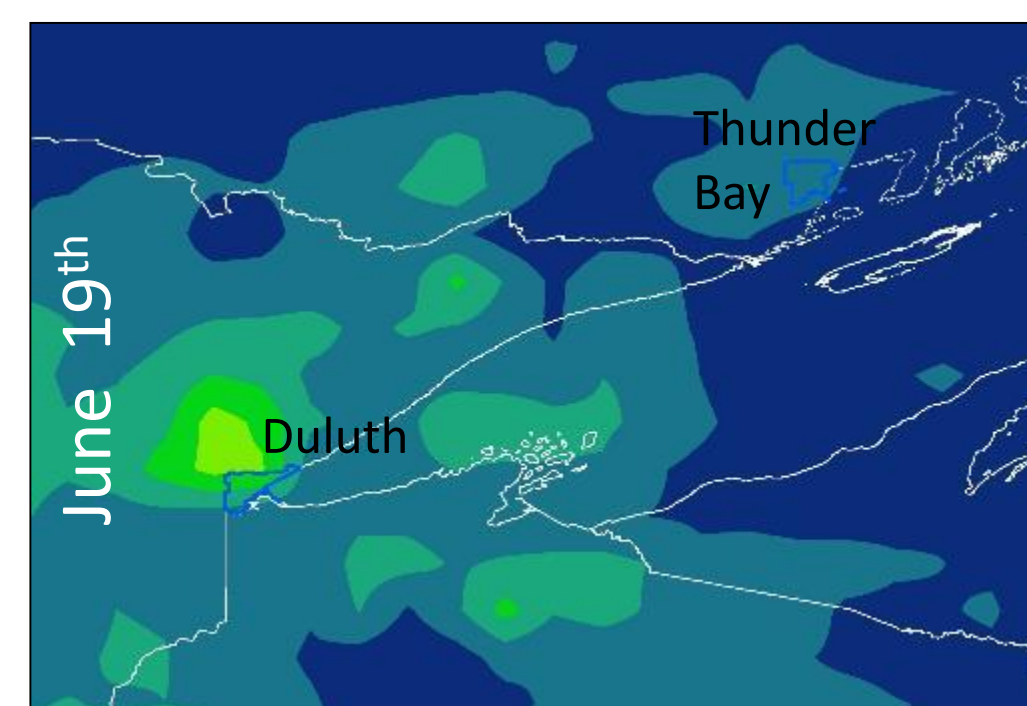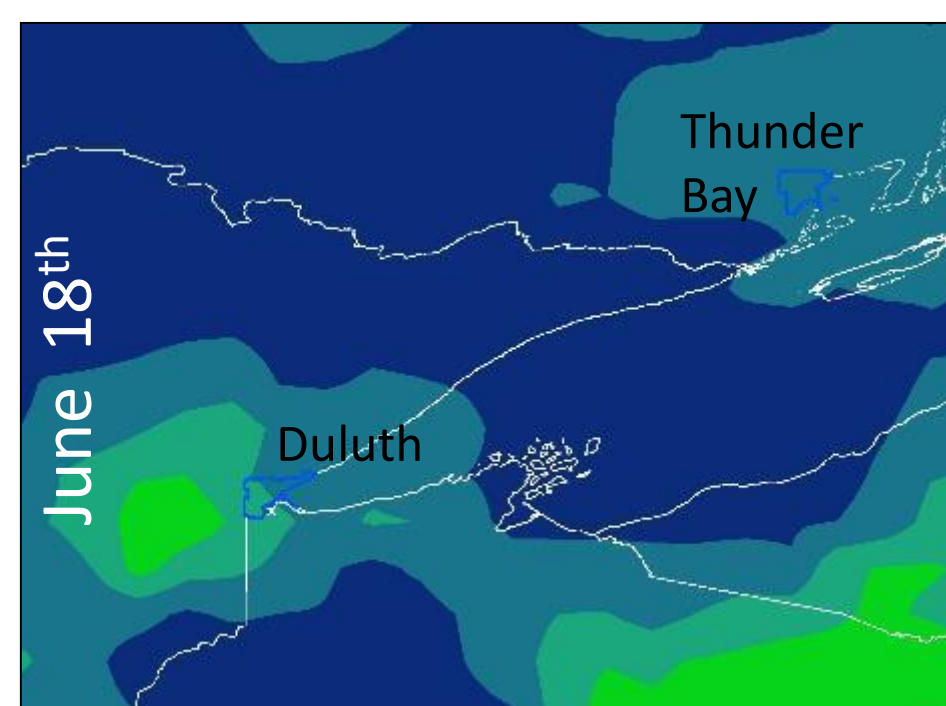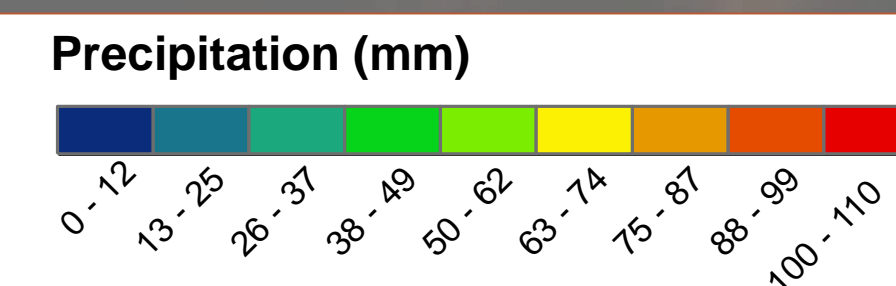- Create user tutorials

Earth Observations

Terra

TRMM

Study Area

Methodology

Precipitation Analysis
TRMM
Daily and 3 hour intervals

ArcGIS

Erosion Risk Modeling
WorldClim Precipitation
× SSURGO Soils
× Terra ASTER DEM

ArcGIS

HAZUS Flood Model
United States Census — Economic Demographics
USGS science for a changing world — Digital Elevation Model

HAZUS EARTHQUAKE • WIND • FLOOD MH

Streets that may experience damage during a 500 year flood

Conclusions

- Hazus effectively identified flood prone areas, but depth accuracy varied widely across the study area.
- Hazus flood depth predictions were most accurate near rivers but were inaccurate in transitional areas such as those between a river and a lake.
- These findings demonstrate limitations of Hazus and can be useful for refining the model.
- Confirmed by actual sinkholes, the erosion risk product appears qualitatively accurate and can assist with planning erosion control measures.
- Many roads are in areas with high erosion risk.
- TRMM data can visualize regional rainfall.

Results

TRMM Time Series of Daily Regional Rainfall: June 18 – 20, 2012

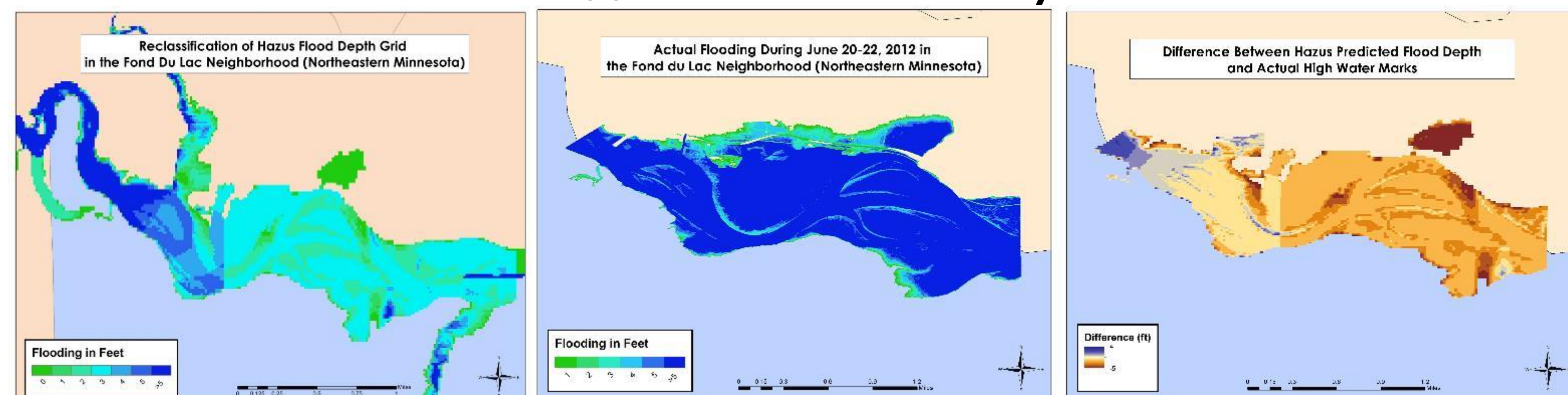Precipitation (mm): 0 - 12, 13 - 25, 26 - 37, 38 - 49, 50 - 62, 63 - 74, 75 - 87, 88 - 99, 100 - 110
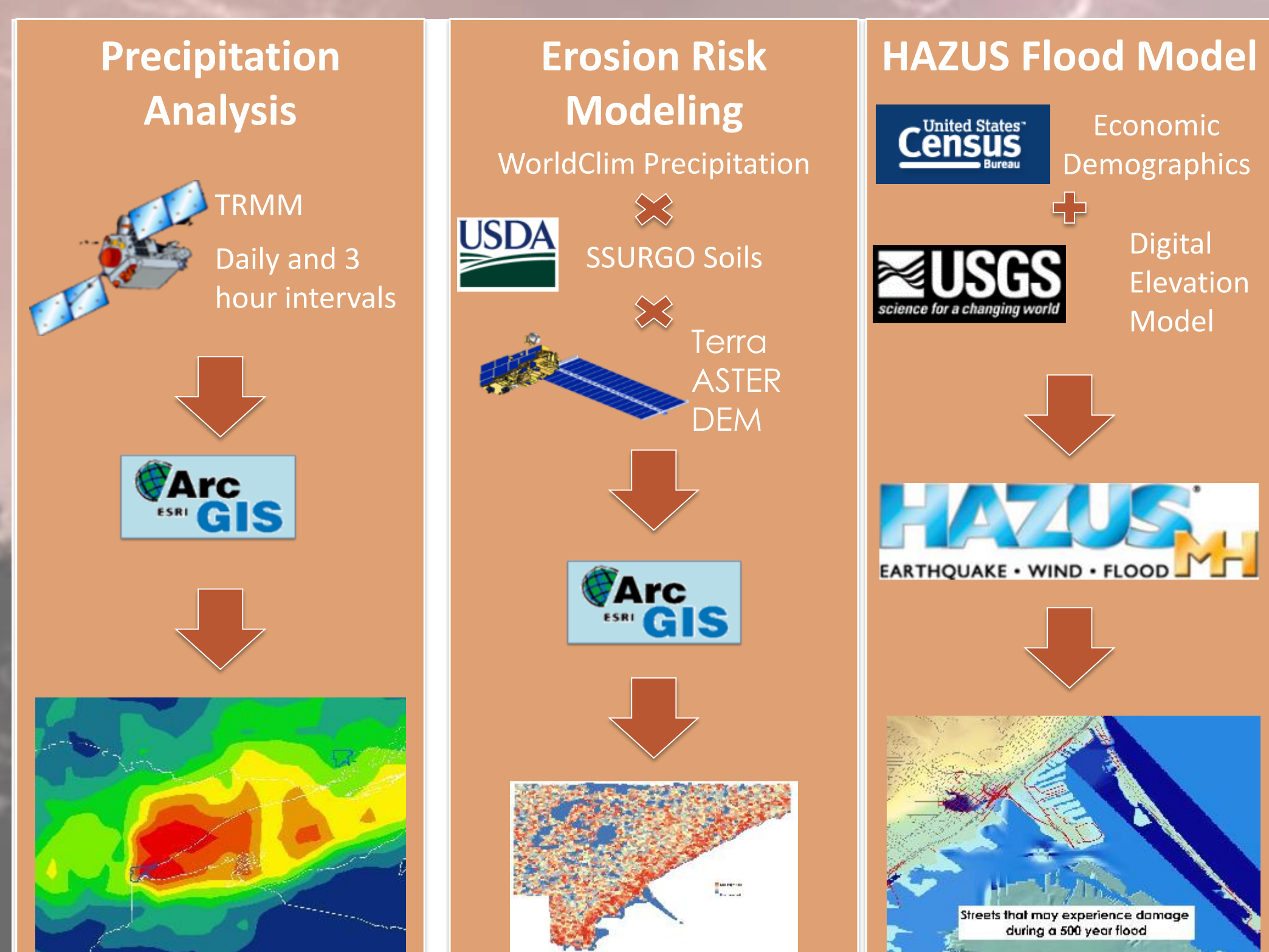
Rainfall in Thunder Bay: May 28, 2012
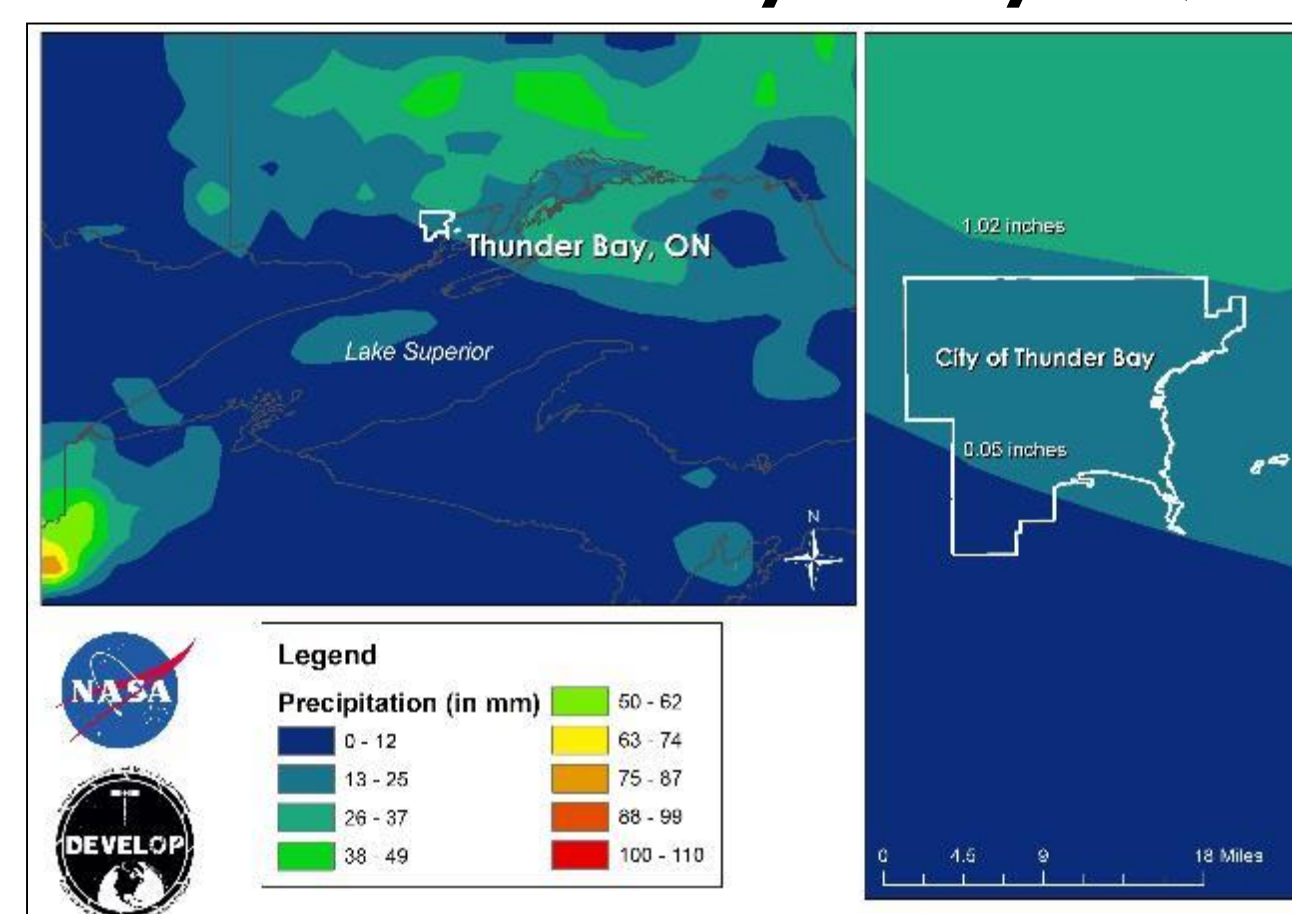
Duluth Erosion Susceptibility

HAZUS Flood Model Analysis

Reclassification of Hazus Flood Depth Grid in the Fond Du Lac Neighborhood (Northeastern Minnesota)

Actual Flooding During June 20-22, 2012 in the Fond du Lac Neighborhood (Northeastern Minnesota)

Difference Between Hazus Predicted Flood Depth and Actual High Water Marks

Team Members

Daniel Dykes, Taylor Hotchkiss, Lauren Makely, Ben Brigida, and Jason Jones (not pictured)

Acknowledgements

Project Partners

The Great Lakes and St. Lawrence Cities Initiative