A Methodology for Developing Probabilistic River Flood Inundation Maps

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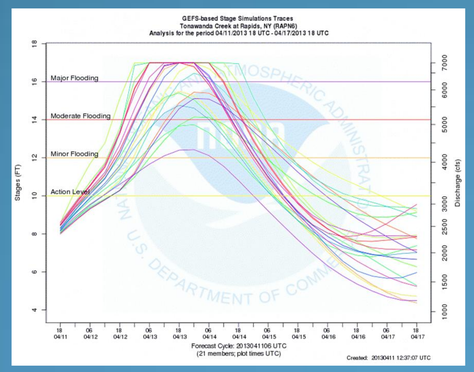
BACKGROUND:

- Flood forecasting is dynamic and uncertain. Many representations of flood inundation are deterministic, with no expression of the underlying uncertainties
- Most existing flood maps are deterministic, like the FEMA Flood Insurance Rate Maps (100-year flood maps) and serve more as long-term reference maps, instead of visualizing real-time flood forecasts
- Probabilistic flood maps can more accurately represent the uncertain nature of flood forecasting and can be more useful for flood management in real-time

METHODS:

- To test the concept of probabilistic flood maps, a river model was created for a reach of the Tonawanda Creek near Buffalo, NY
- With a 2m LiDAR DEM of the study area from the NOAA Digital Coast, the model was built using ArcGIS and HEC-RAS to generate steady state flood simulations
- Discharge data were entered into the model using forecast data from the NWS Meteorological Model-based Ensemble Forecast System (MMEFS). The Ensemble consists of 21 discharge forecasts, each of which were used to create 21 flood simulations
- The probability of flooding was then calculated through two methods:
- 1. Ranking the peak discharges of each MMEFS forecast, to find the 10th, 50th, & 90th-percentiles to create 90%, 50%, and 10% likely flood inundation maps
- 2. Classifying the probability of MMEFS inundation extents by overlap percentage

RESULTS:



Sample MMEFS Forecast (April 11, 2013)

Discharge (cfs)	Flood Stage	Percentile
7,000	Major	90th (10%)
5,200	Moderate	50th (50%)
3,700	Minor	10th (90%)

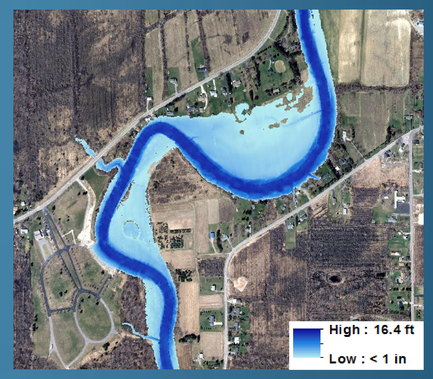
Percentiles of Hypothetical MMEFS Forecasts

STUDY SITE:

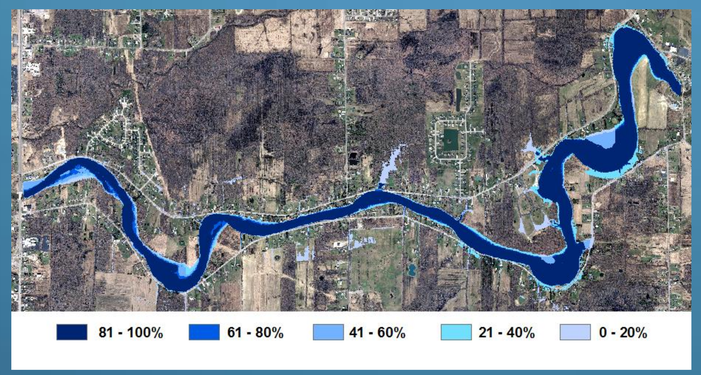
Tonawanda Creek (5.5 mi reach)
beginning at USGS 04218000 Rapids, NY Gauge

10% Likely Flood (7,000 cfs)

50% Likely Flood (5,200 cfs)



90% Likely Flood (3,700 cfs)



Probability of Flooding by MMEFS Forecast Extent Overlap

CONCLUSION:

- Probabilistic maps may be useful to stakeholders to help them quantify the risks of a forecasted flood, by illustrating multiple scenarios of flooding likelihood
- Probabilistic maps intrinsically account for forecast uncertainty and as such, can be used in real-time for flood preparedness and management
- The data and methods used in this project are publicly available and can be replicated for other study areas if sufficient data exist
- The methods can also be adapted to perform hypothetical flood simulations for assessing flood risks before a disaster occurs