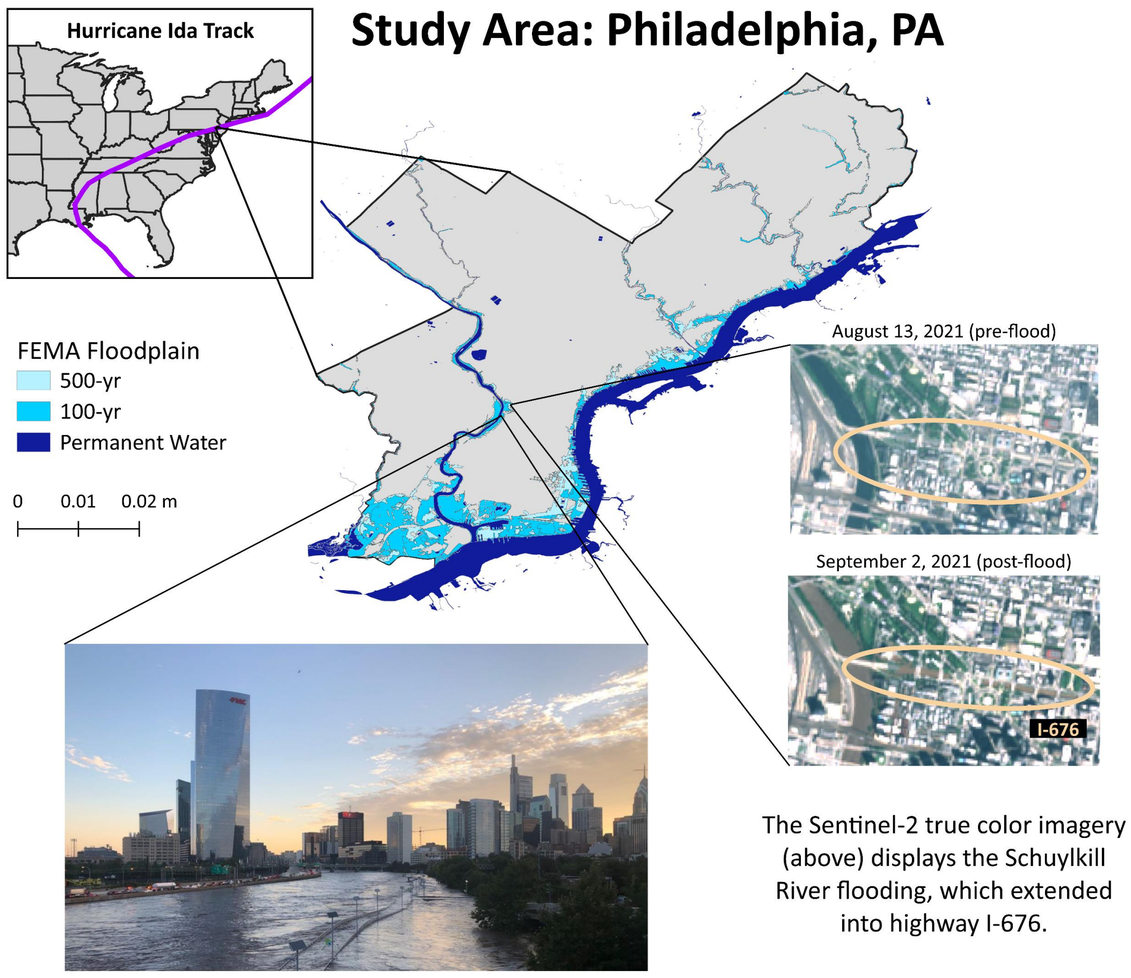
Quantifying Urban Flooding Extent Using Satellite Imagery and Population Impacted After Hurricane Ida in Philadelphia, PA

Rebecca W. Composto[a] and Dr. Mirela G. Tulbure[a,b]

[a]Center for Geospatial Analytics, North Carolina State University, Raleigh, NC

[b]Department of Forestry and Environmental Resources, North Carolina State University, Raleigh, NC

Background



The Sentinel-2 true color imagery (above) displays the Schuylkill River flooding, which extended into highway I-676.

- Hurricanes have devastating and destructive impacts due to climate change and human development in high-risk areas.
- Hurricane Ida brought unprecedented flooding to Philadelphia, PA.
- **Research Gap**: Flooding from hurricanes is understudied and difficult to detect with satellite imagery in urban areas due to the building density and their shadows.
- **Approach:** Harness satellite imagery to determine the flood extent in Philadelphia and refine methods for quantifying urban flood extent. Use socioeconomic data to characterize the impacted population.

Methods

Step 1: Collect Satellite Imagery & Additional Data

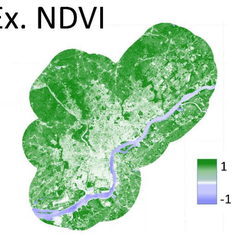
Sentinel-2 (10-60m)

Derived Products

Normalized Difference Vegetation Index (NDVI)
Enhanced Vegetation Index (EVI)
Normalized Difference Water Index (NDWI)
Modified Normalized Difference Water Index (MNDWI)
Normalized Difference Moisure Index (NDMI)
Automated Water Extraction Index (AWEI)

+

Ex. NDVI

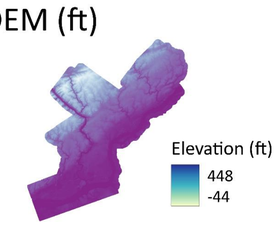


+

Additional Data

Buildings & Roads
Hydrography (JRC, NHD)
DEM (Slope, Hillshade)
FEMA Floodplain

Ex. DEM (ft)



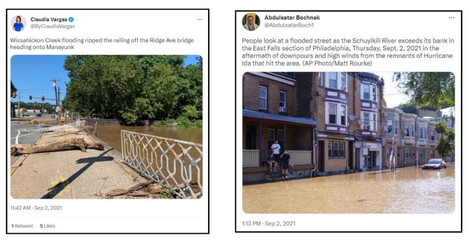
Step 2: Create Training & Validation Data

Planet Scope (3m)

National Agriculture Imagery Program (NAIP)

Satellite imagery from PlanetScope (3 m) on September 2, 2021 and NAIP imagery (1 m) from 2019 are used to create polygons of water and non-water pixels.

Tweets



Tweets related to Ida from GlobalFloodMonitor.org provide in-situ observations and will inform where to look for training data in PlanetScope.

Use datasets to create a known flooding dataset.

A portion of the dataset goes to training and the rest goes to validation.

Step 3: Put Inputs & Training data into Random Forest model

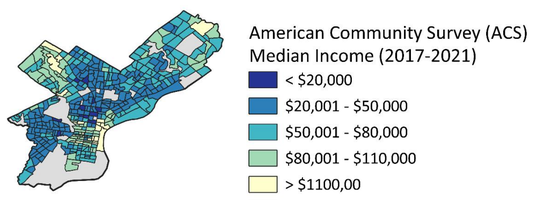
Use the Random Forest (RF) model, a type of machine learning (ML), with inputs from Step 1 and training data from Step 2.

Step 4: Validate

Validate the Random Forest model with the validation data from Step 2.

Step 5: Use Flooding Extent

- Compare the Ida flooding extent with the established FEMA floodplain.
- Determine the socioeconomic & demographic characteristics of tracts most impacted by flooding.



Anticipated Results

- Quantify the flooding extent of Hurricane Ida in Philadelphia public the map and results online.
- Releasing the code with a guide so the methods can be applied to other urban areas after major flood events to assess flooding extent and impact.

Applications

Individuals: View flooded areas, and understand established floodplain

Emergency Management: Inform preparedness and recovery plans

City Planning: Improve storm water management and resiliency plans

GEOSPATIAL ANALYSIS FOR ENVIRONMENTAL CHANGE LAB

NC STATE UNIVERSITY
Center for Geospatial Analytics