



October 17-19, 2017
Lake Placid, NY

Preparing for Future Climate: The Hudson River Flood Impacts Decision Support System

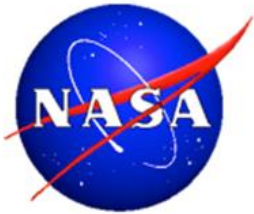
**NYSERDA Program Opportunity Notice
(PON) 2260, Coastal Zones, Category A
Environmental Monitoring, Evaluation, and
Protection (EMEP) Program: Climate
Change Adaptation Research**



Center for International Earth
Science Information Network
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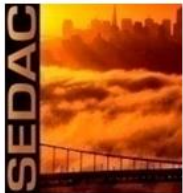
Bio: Kytt MacManus



Adjunct Professor of International and Public Affairs at SIPA since 2010. Adjunct Professor of Ecology, Evolution, and Environmental Biology (E3B) at Columbia College since 2014. Geographic Information System (GIS) Programmer at the Earth Institute's Center for International Earth Science Information Network (CIESIN) since 2007.

Kytt has extensive experience with global dataset and web application development for the NASA Socio-economic Data and Applications Center (SEDAC), a data center in NASA's Earth Observing System Data and Information System (EOSDIS) hosted by CIESIN. His research interests include the development of data driven web applications for decision support; the use integration of global population and housing census to support policy; and the use of Python for Scientific Computing. Most recently he has contributed to local research and development of GIS based interactive online decision-support systems for flood adaptation and mitigation in the Hudson River Valley, and in Jamaica Bay, New York. Globally, he has lead the effort by SEDAC to produce Gridded Population of the World Version 4 (GPW4), a data collection which includes demographic information which will be key for monitoring of progress toward the Sustainable Development Goals (SDGS).

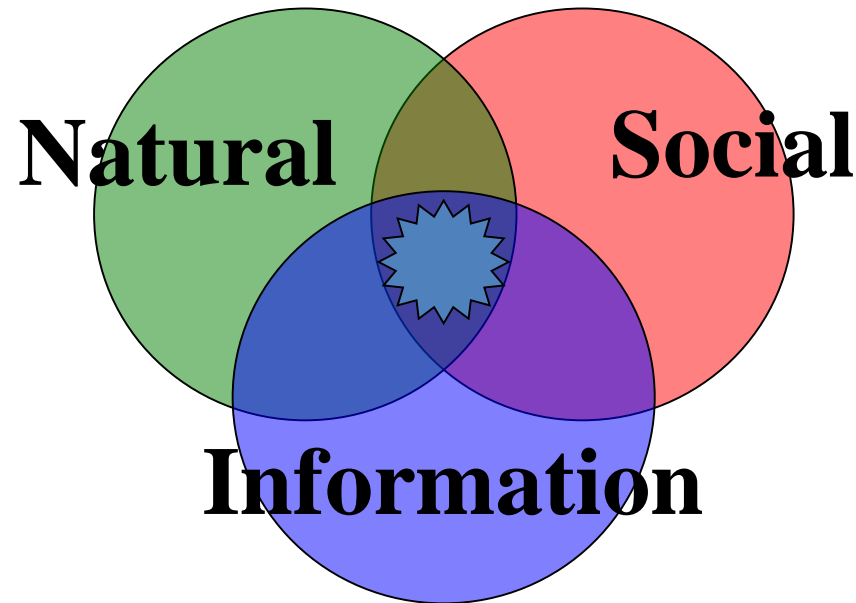
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Email : kmacmanu@ciesin.columbia.edu

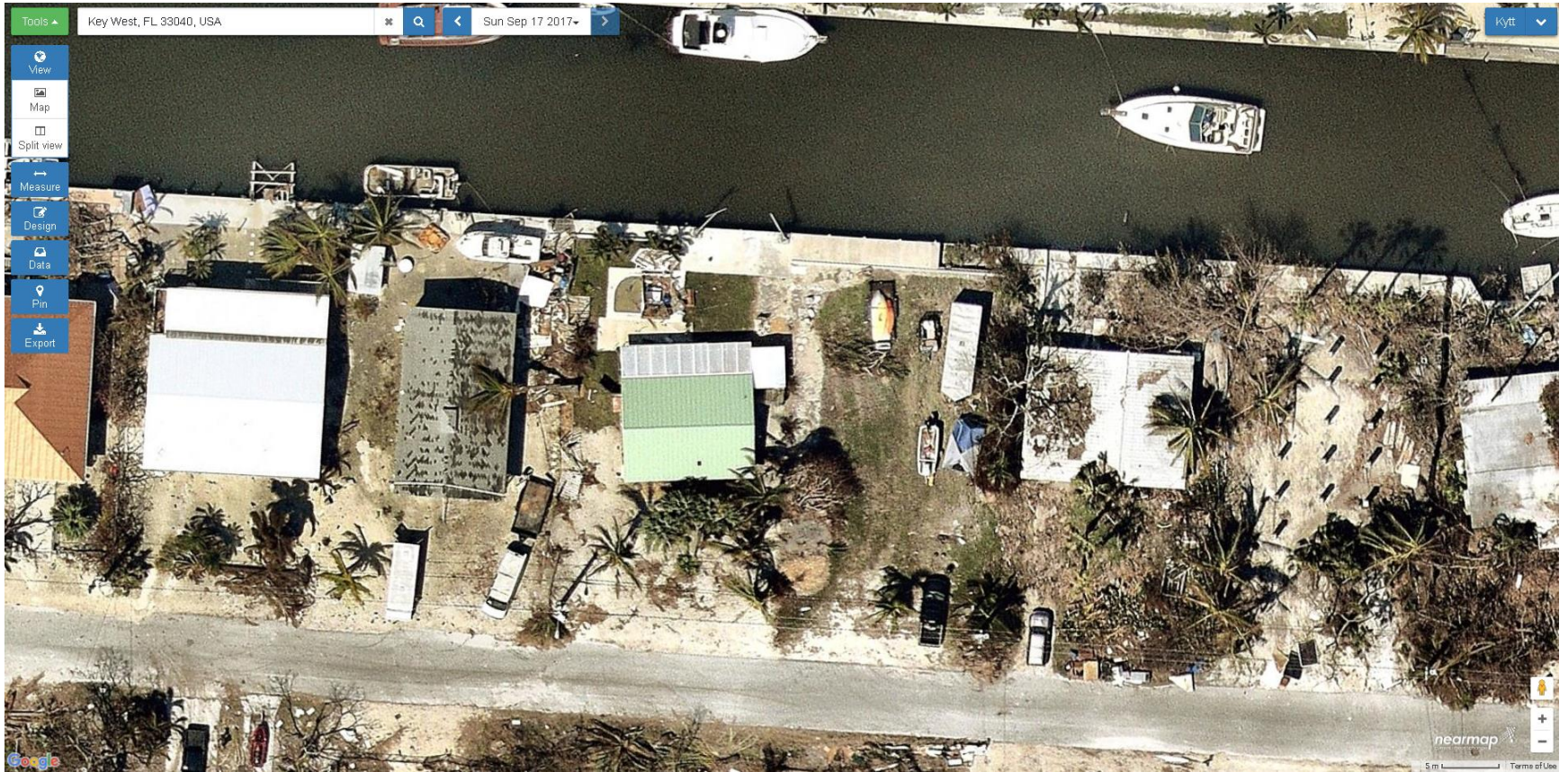
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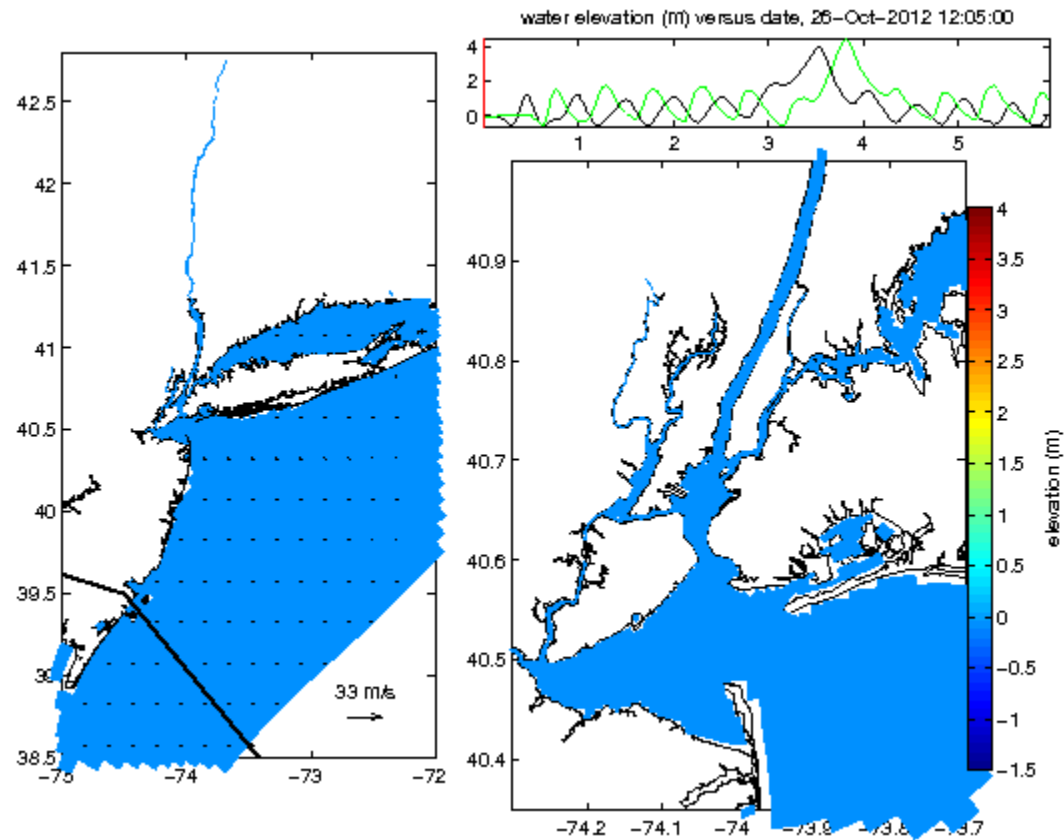


- Working at the Intersection of the natural, social and information sciences.

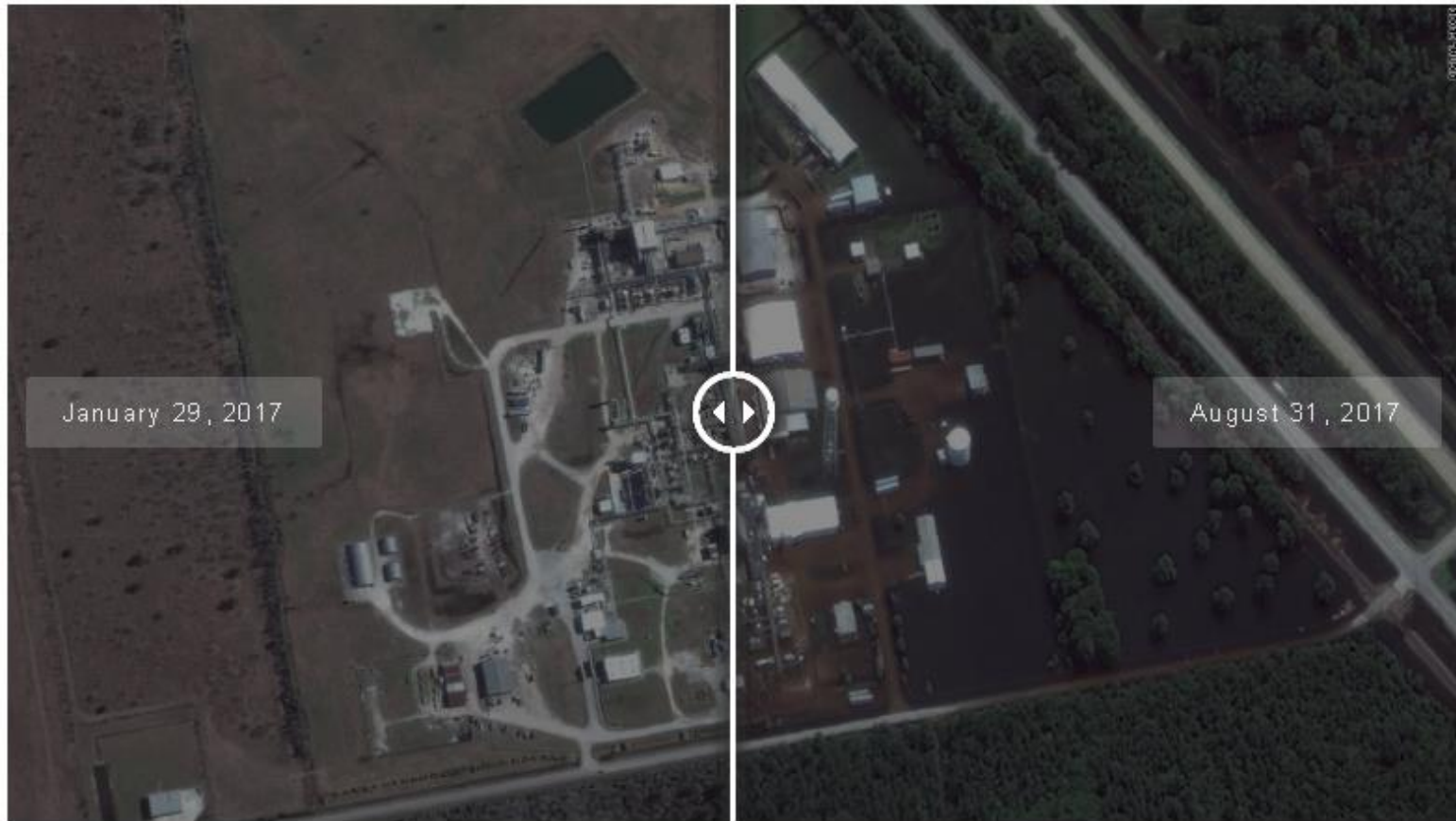
Key West Florida: September 17, 2017



Model of Hurricane Sandy



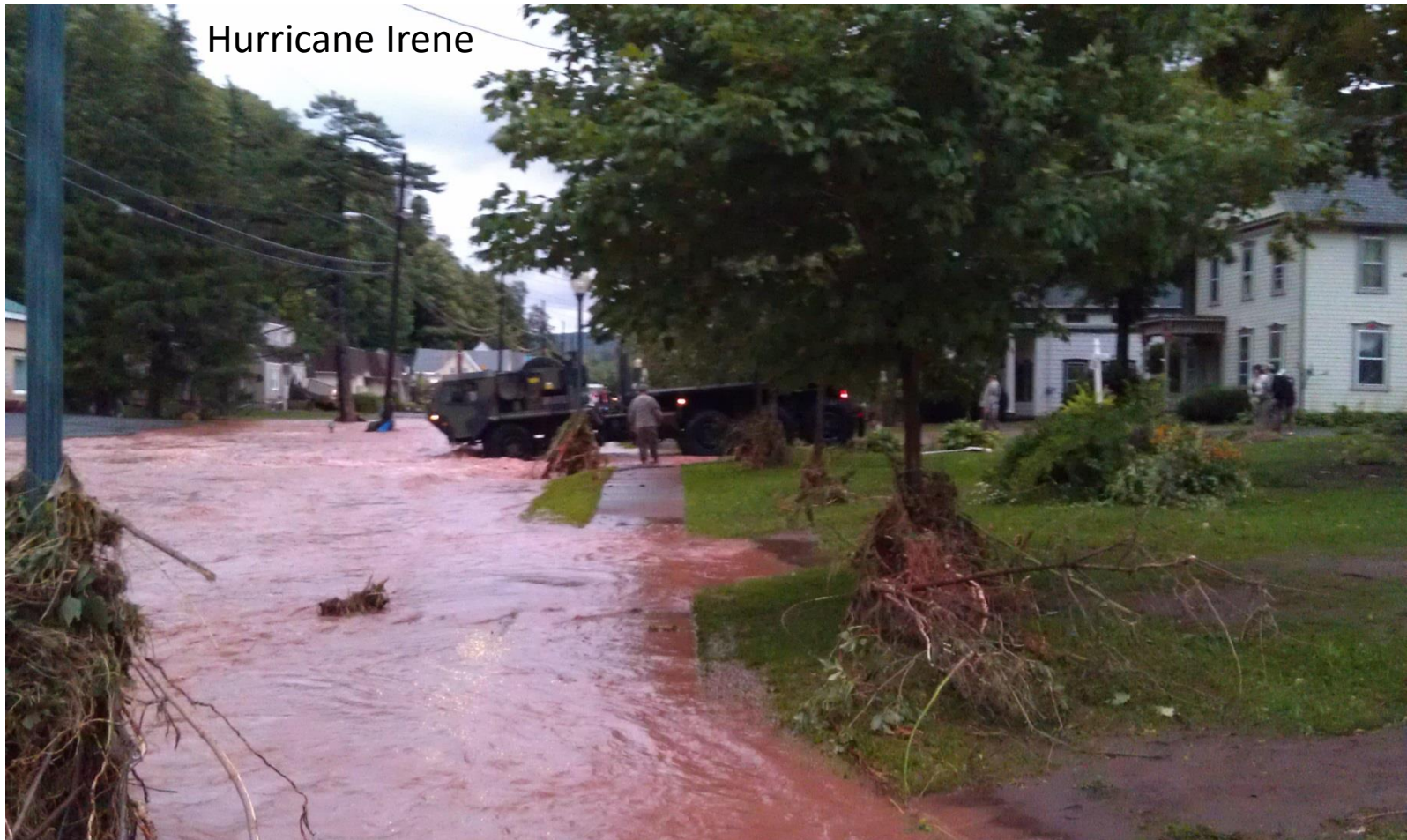
The aftermath of Hurricane Harvey



Arkema chemical plant in Crosby, Texas

DIGITAL GLOBE

Impacts in our area: Windham NY



New York State
Community Risk and Resiliency Act

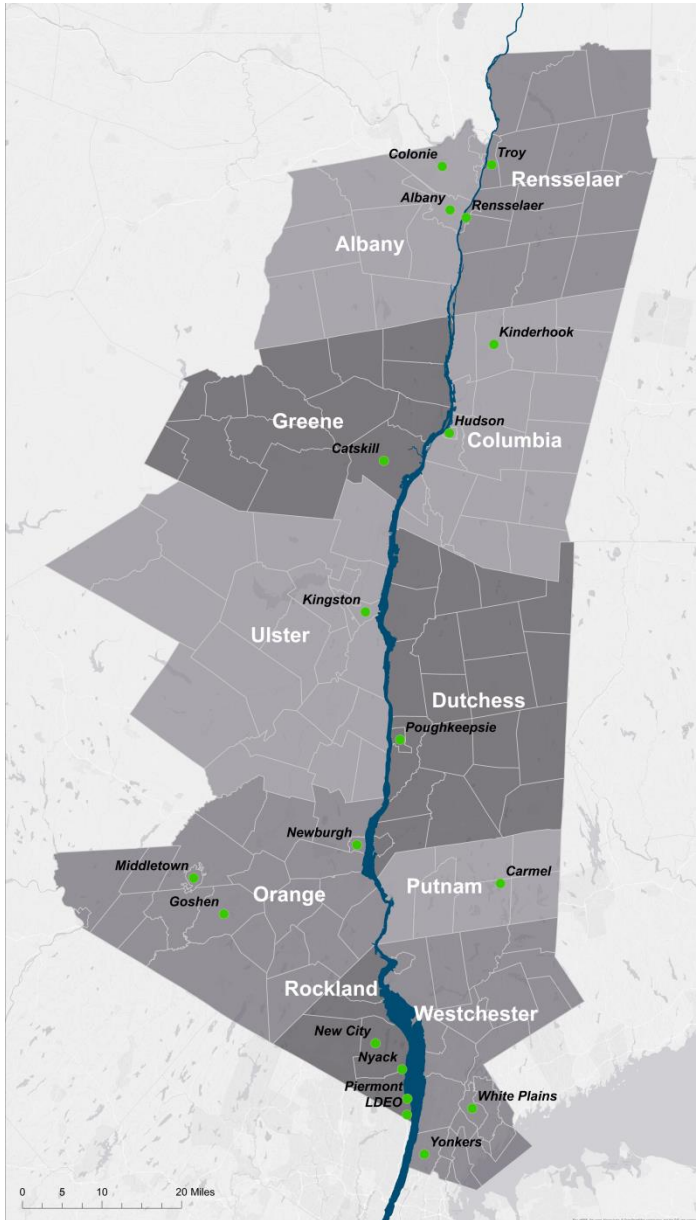
Primary Project Objectives

- Utilize state-of-the-art flood models and adhere to or improve upon the latest FEMA coastal flood mapping techniques.
- Create an easy to use, free, online mapping tool that lets users assess the impacts of flood inundation posed by sea level rise, storm surge, and rain events on communities bordering the Hudson River.

The Study Area

Focuses on municipal areas adjacent to the Hudson River Shoreline in 10 counties bordering the River:

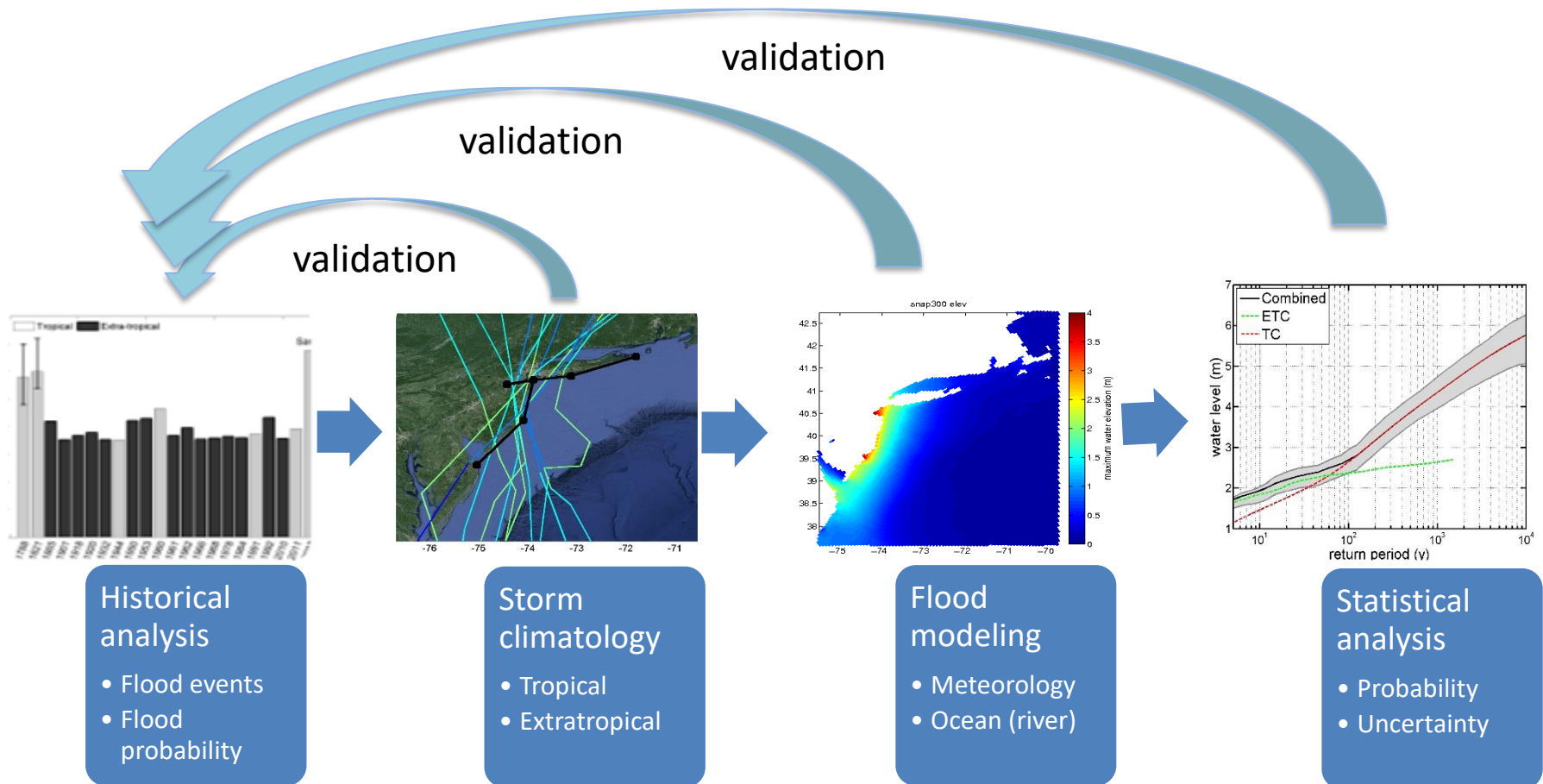
Albany, Columbia, Dutchess, Greene, Orange, Putnam, Rensselaer, Rockland, Ulster, and Westchester



Methods: Flood Hazard Assessment

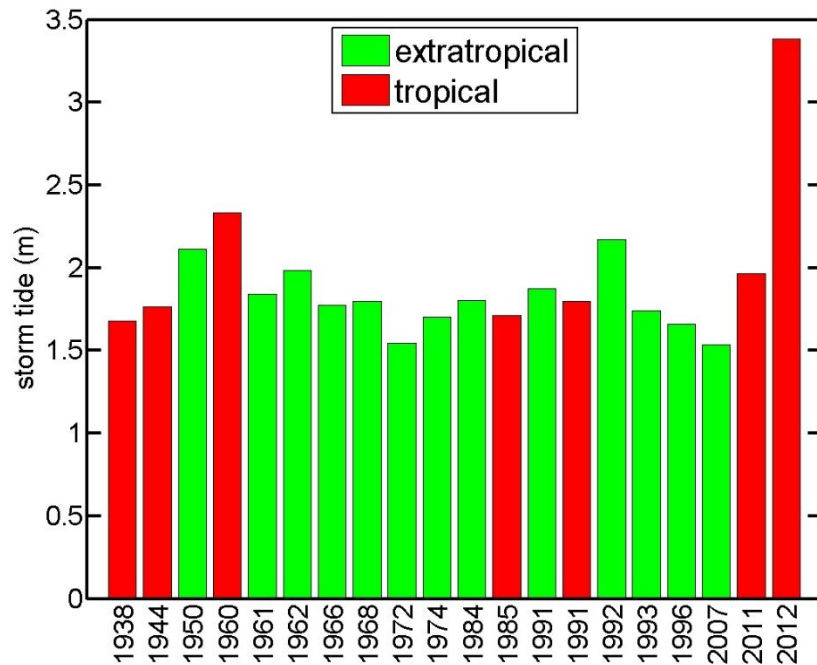
Flood modeling and mapping with Surge + Rainfall + Sea Level Rise
5-year through 1000-year flood zones

Sea level rise scenarios: 0", 6", 12", 18", 24", 30", 36", 48", 60", 72"

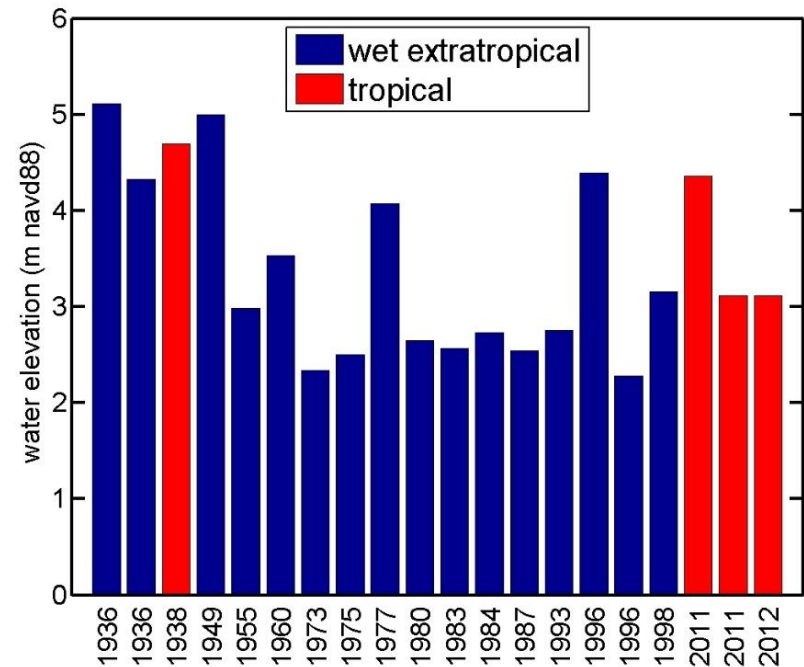


Storm Categories: Historical Floods

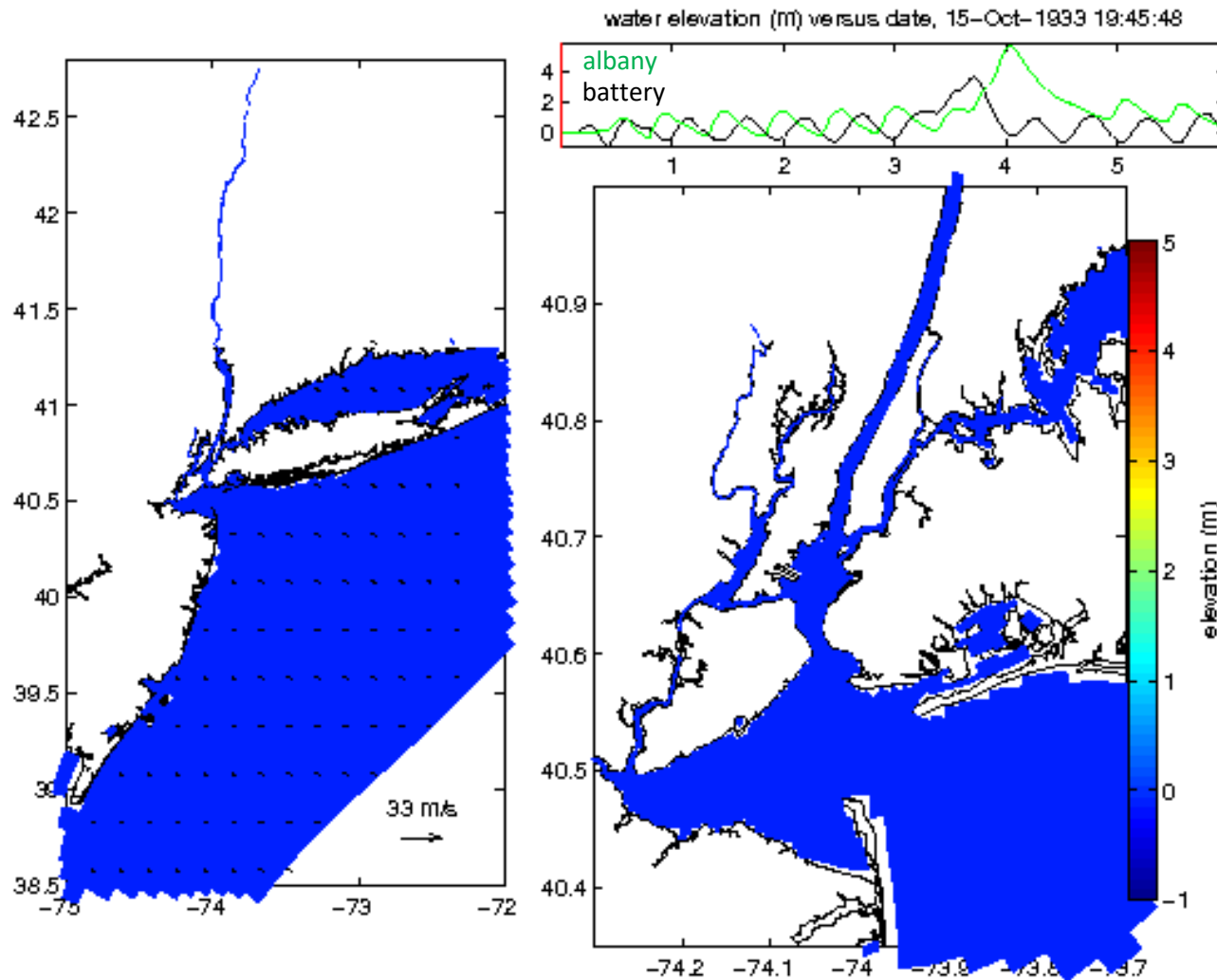
Battery Historical
Top-20 (1931-2012)



Albany Historical
Top-20 (1931-2012)

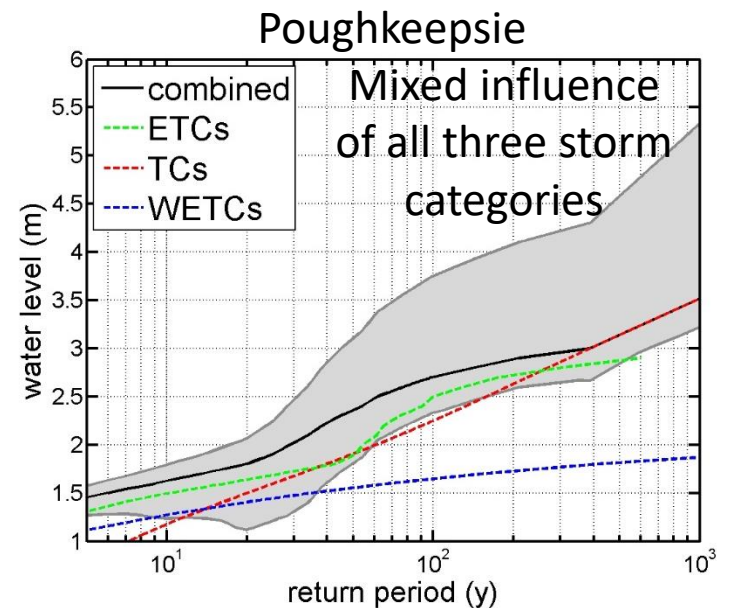
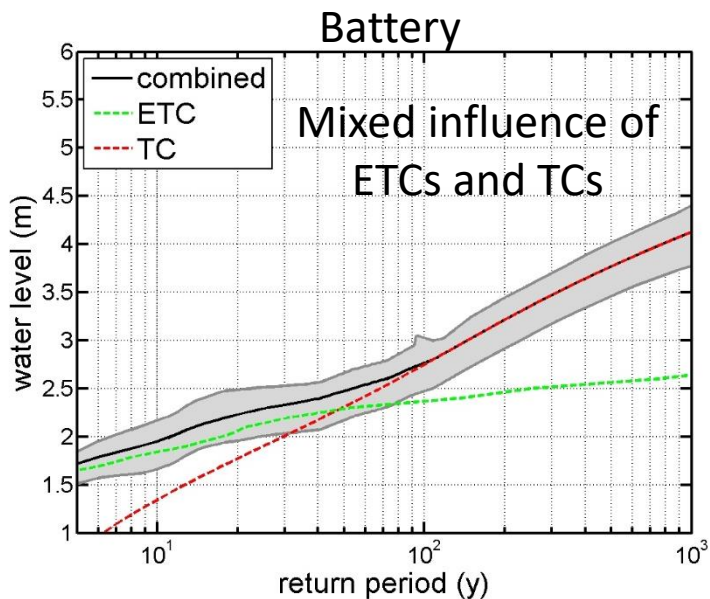
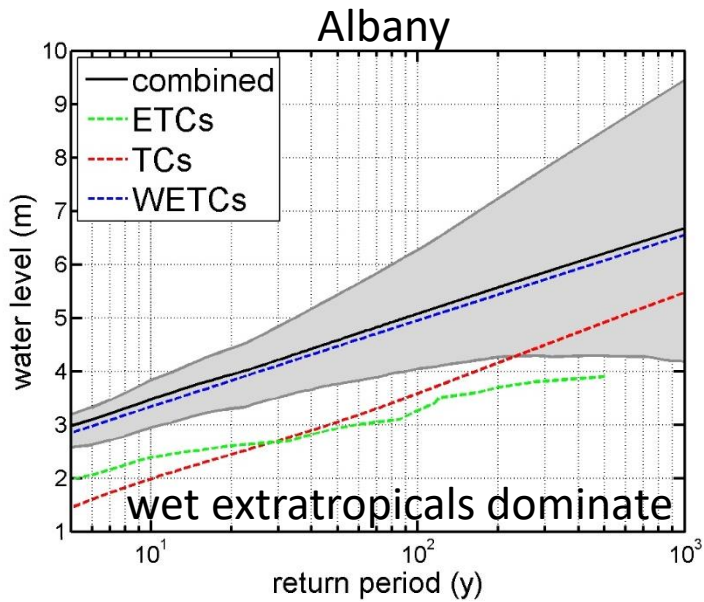


Sample Animation of Flood Event: A (Synthetic) Rainy Tropical Cyclone



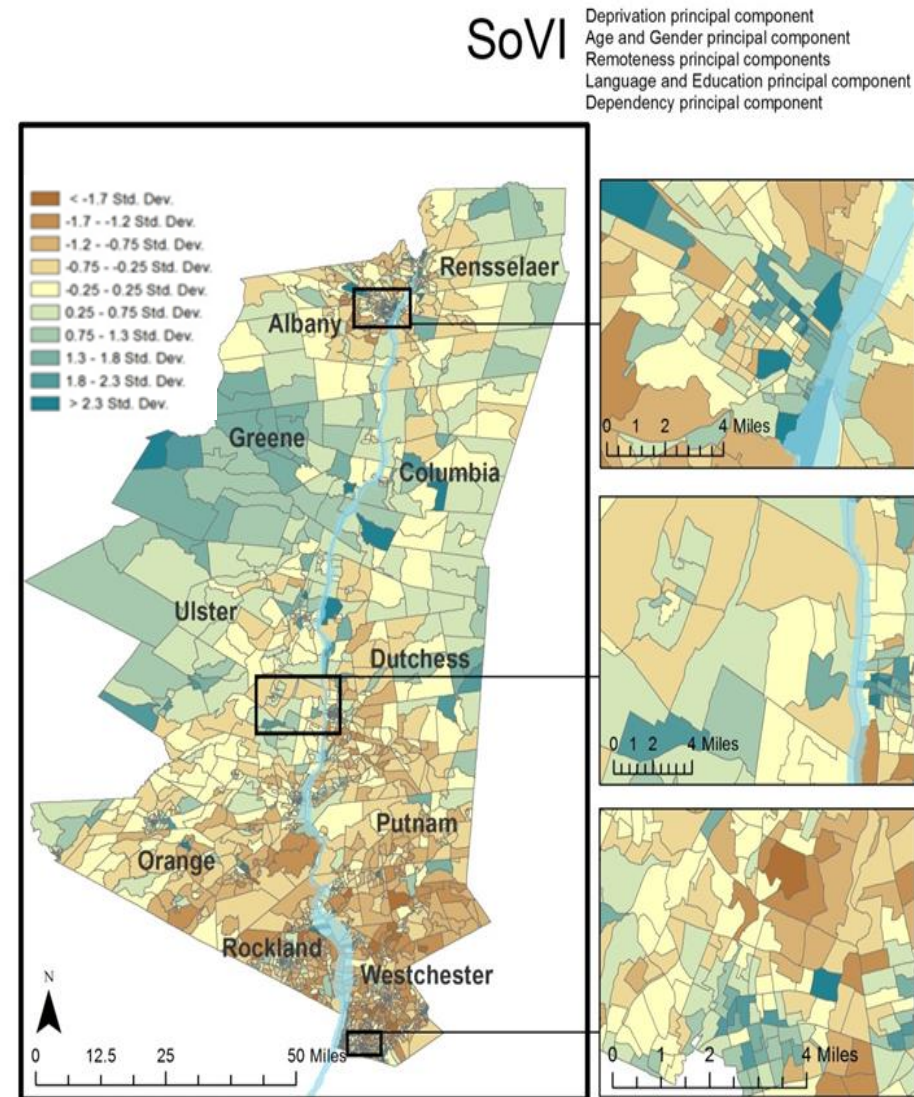
Results

Flood Exceedance Curves for Hudson and its Floodplain



Social Vulnerability Index Component

- The Social Vulnerability Index identifies at-risk populations of U.S. census block groups as relates to environmental hazards.
- The theoretical framework of our index includes dimensions of vulnerability that are most commonly found in the literature: social and economic status, health, education and housing .

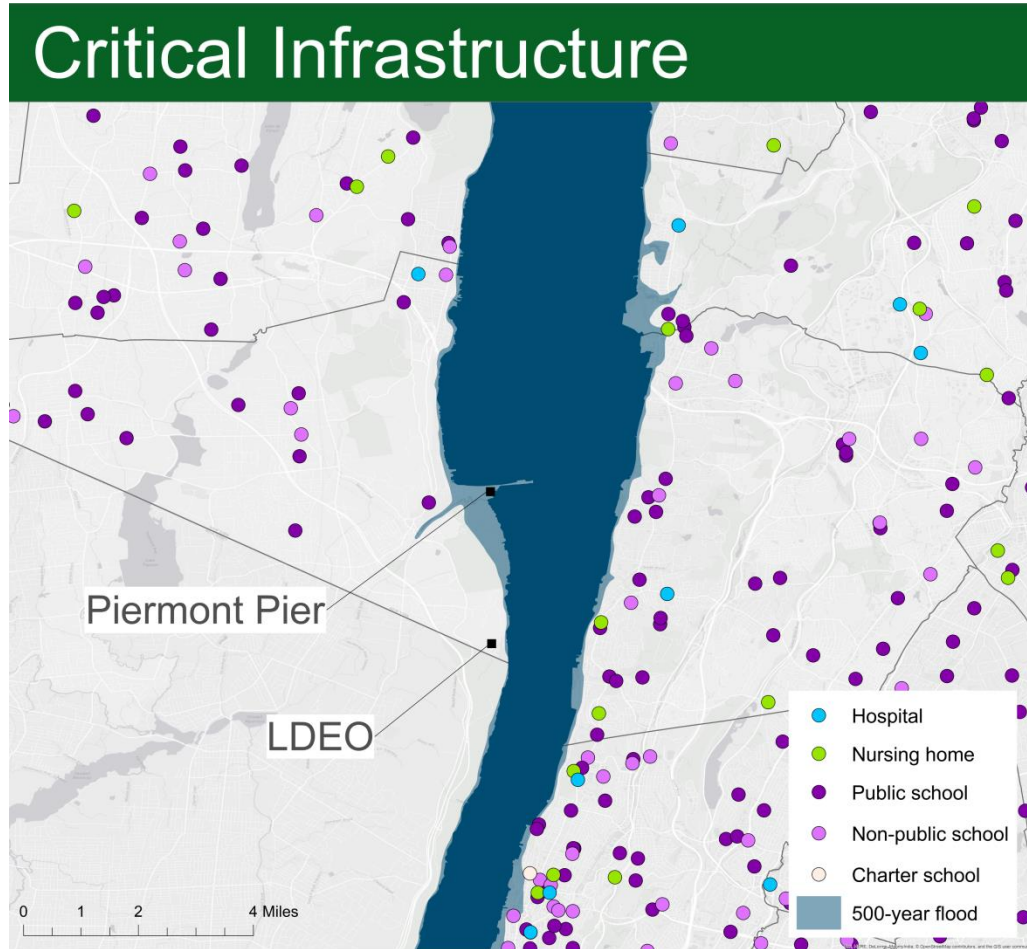


Social Vulnerability Index Principal Components and Demographic Variables Used

*variables sourced from Census 2010 and American Community Survey

	PC1	PC2	PC3	PC4	PC5
Variables	Renting	Over 75 years old	Distance to hospitals	English as second language	Female
	No vehicle	Female headed households	Mobile homes	Less than high school education	Less than 5 years old
	Poverty	Social Security benefits	Income over 100,000(inverse)	Children in married couple families	Population in nursing homes
	Per capita income(inverse)	Median age	Asian	Hispanic	Population per housing unit
	Population density				
	Employment in services				
	Black				
	Urban				

Critical Infrastructure Component

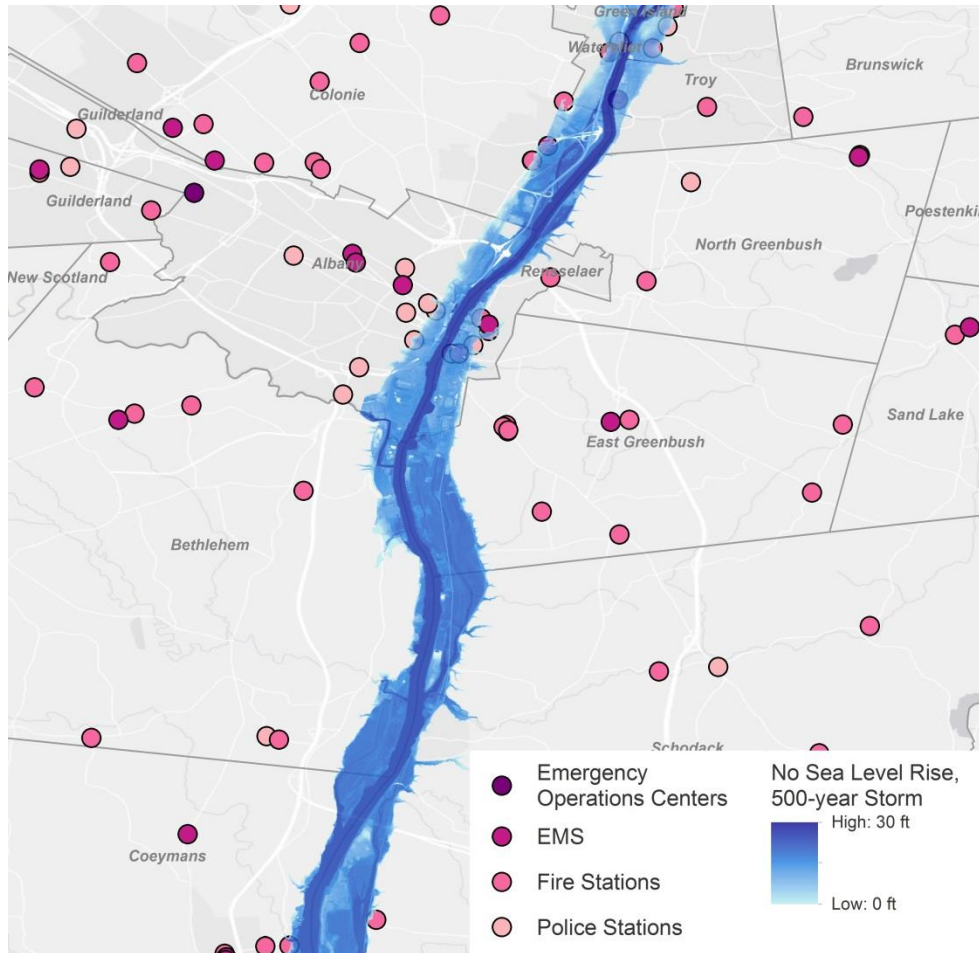


This map shows the locations of critical infrastructure for the area around Piermont Pier and Lamont-Doherty Earth Observatory - Columbia University (LDEO).

The geographic database of critical infrastructure (CI) in our study area includes information on

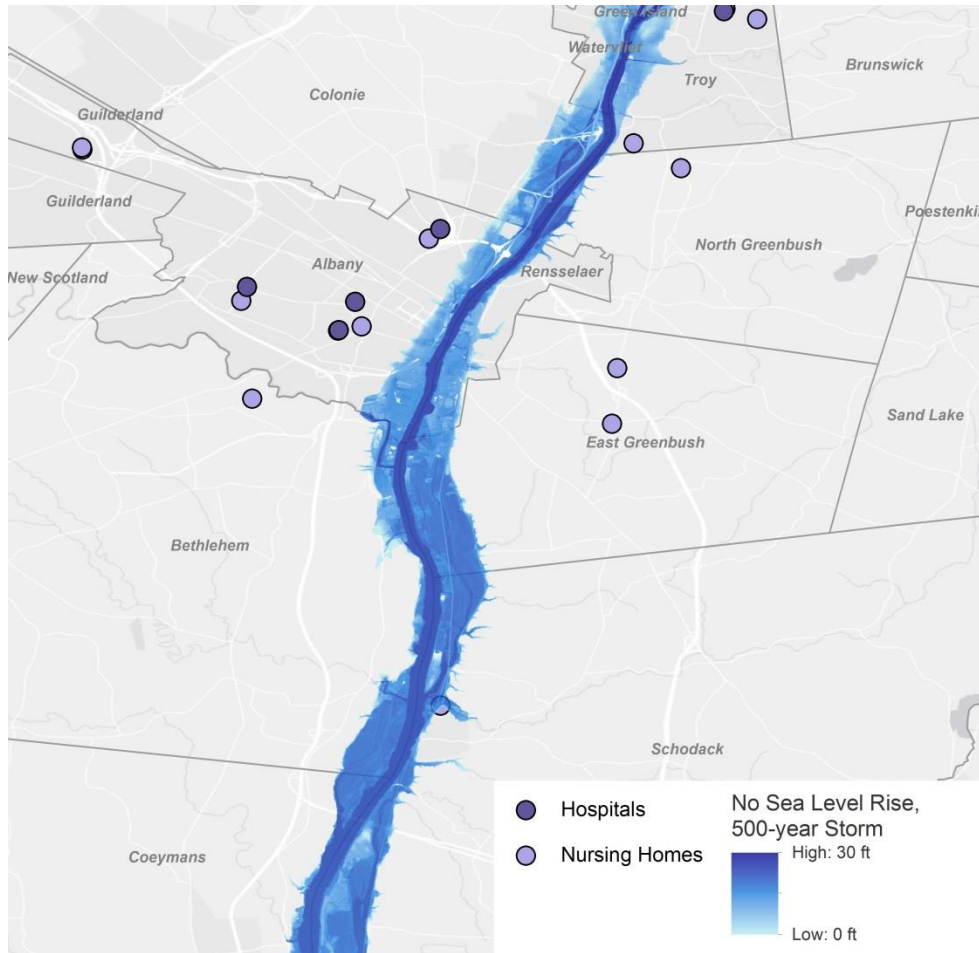
- 1. Transportation**
- 2. Health facilities**
- 3. Schools**
- 4. Energy infrastructure**
- 5. Water treatment plants**
- 6. Emergency operation centers**
- 7. Other critical assets**

Critical Infrastructure Component: Emergency Services



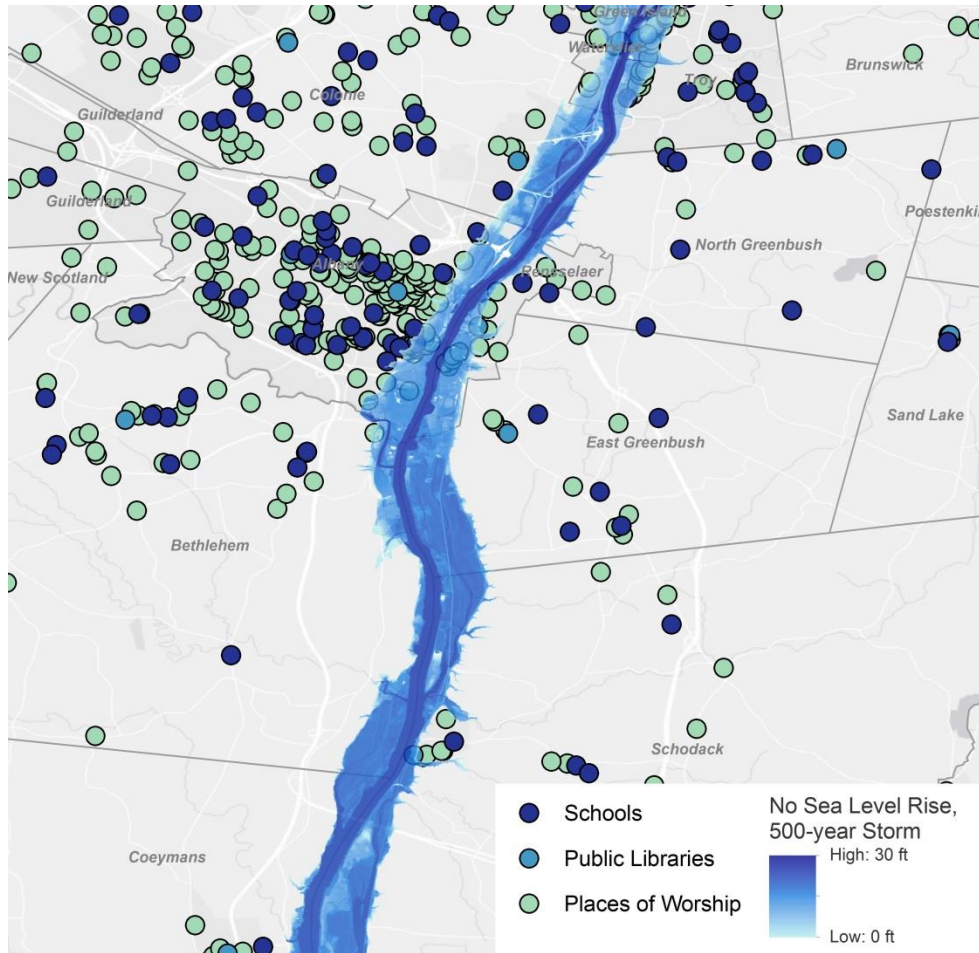
This map shows a 500-year flood and the locations of emergency services (Emergency Operations Centers, EMS, Fire Stations, and Police Stations) for the area around Albany.

Critical Infrastructure Component: Health Services



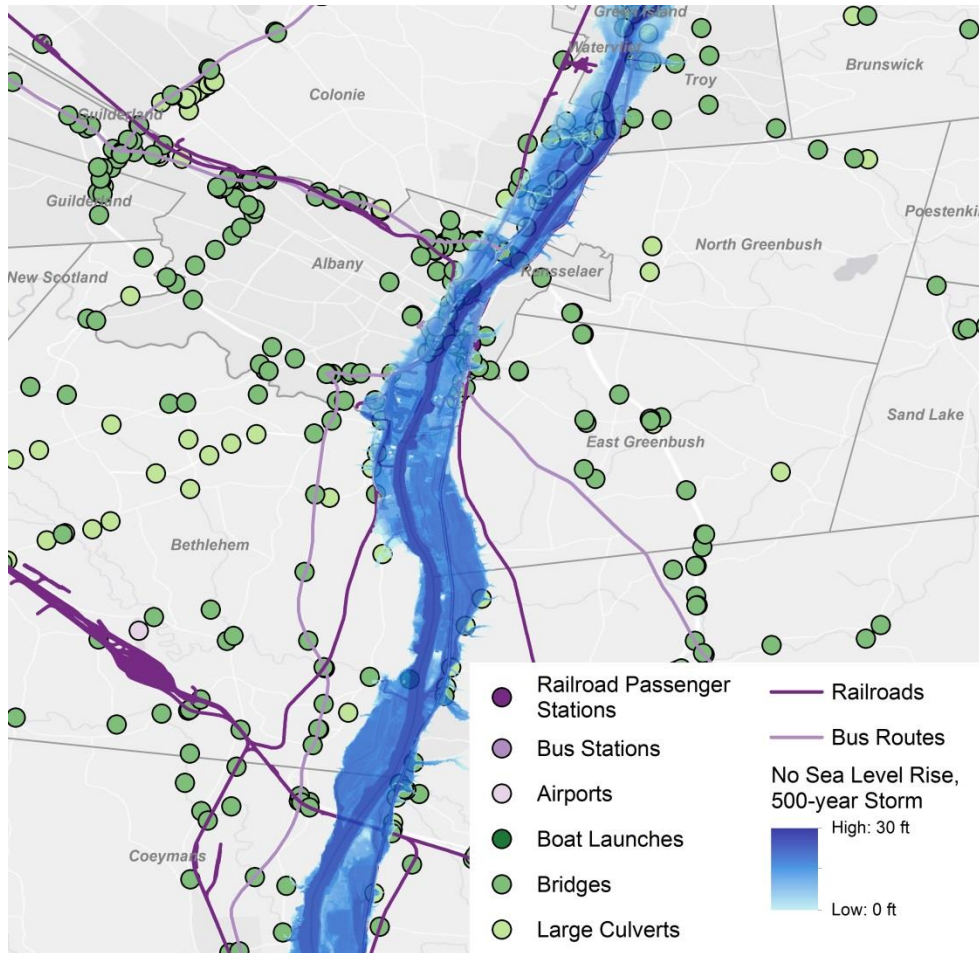
This map shows a 500-year flood and the locations of health services (hospitals and nursing homes) for the area around Albany.

Critical Infrastructure Component: Institutions



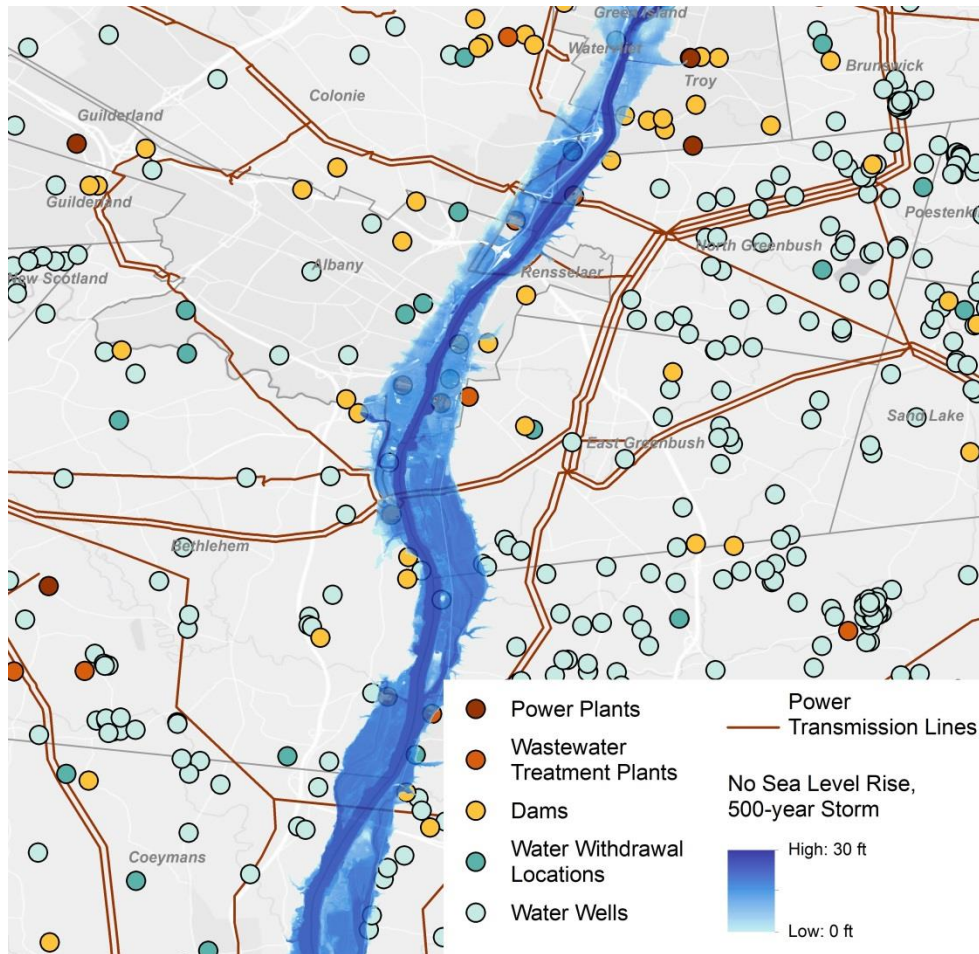
This map shows a 500-year flood and the locations of institutions (schools, public libraries, and places of worship) for the area around Albany.

Critical Infrastructure Component: Transportation



This map shows a 500-year flood and the locations of transportation services (railroads, busses, airports, boat launches, bridges, and culverts) for the area around Albany.

Critical Infrastructure Component: Utilities

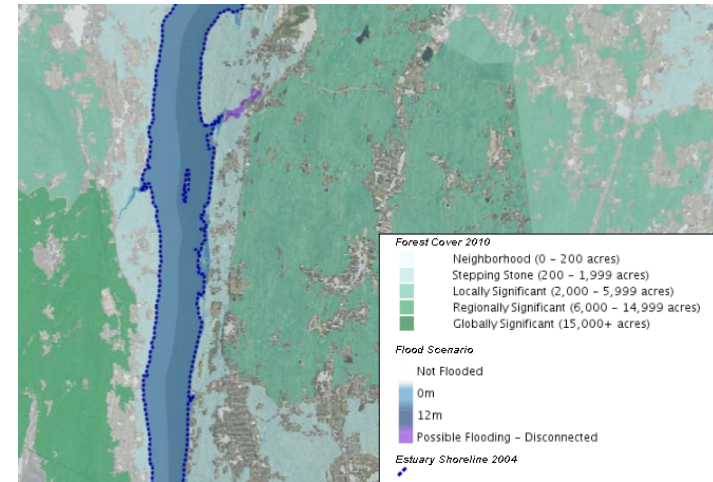


This map shows a 500-year flood and the locations of utilities (power plants, power transmission lines, wastewater treatment plants, dams, water withdrawal, and water wells) for the area around Albany.

Natural Resilience Features Component

- Natural areas like forests, wetlands, and floodplains are vital assets to consider in assessing vulnerability and planning for resilience. In contrast to impervious developed areas, these natural features retain, slow, filter, and infiltrate water to the soil, reducing erosion and flood impacts.

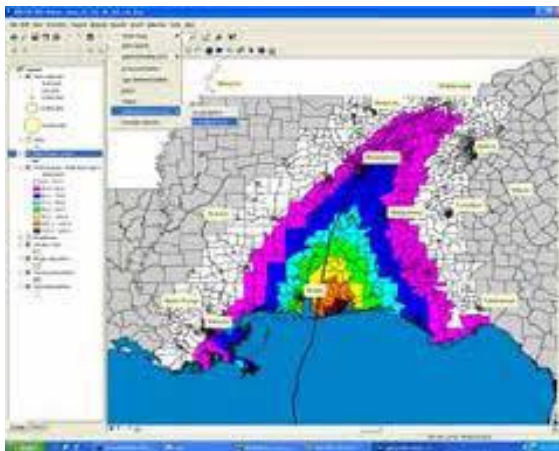
- Variables include Wetlands, Forests, Floodplain, and impervious surfaces in acres or as percentages of total municipal land area.



- Used together with the ecology and infrastructure layers, these results allow you to analyze spatial patterns and to locate areas of particular vulnerability as well as natural areas of greatest importance to slow and store water during a flood.

Impact Assessments Component

- Estimate damage to buildings and their contents
- Estimate number of building affected
- Estimate the number of critical infrastructure facilities affected



Interactive mapping application

- Key functionalities
 - **Visualize flood scenarios** for an array of SLR and Storm Return Period Options
 - **Display and make available for download impact assessment estimates by municipality and flood scenario** based on HAZUS and summaries of Social Vulnerability and Natural Resilience metrics
 - Enable users to print their scenario map
 - **Enable users to upload and visualize their own shapefiles**
 - Provide OGC Interoperable Web Services

Interactive Mapping Application

Choose from
Among 80 Sea Level
& Storm Return
Scenarios

More than 30
operational layers

Hudson River Flooding Decision Support System Version 1

Scenario Builder Layer List

Build Your Flood and Inundation Scenario

Choose Area of Interest

County: Rensselaer

Town: North Greenbush

Select Flood Scenario

Sea Level: No Sea Level Rise

Return Period: 1000 year

Submit Filter Reset Filter

Impact Summary for North Greenbush
(fipskey: 3608352100)

Critical Infrastructure Natural Resilience Social Vulnerability

Building Loss: 2293000 (\$)
Contents Loss: 3534000 (\$)
Depreciated Building Loss: 1699000 (\$)
Depreciated Contents Loss: 2618000 (\$)
SPDES Wastewater: 1
Railroads: 2 (Linear Miles)
Power Transmission Lines: 3 (Linear Miles)

Icon fill color indicates:

- Not in flood zone
- In flood zone
- No flood info

Icon shape indicates layer group, icon border color corresponds to layer-name color (for clickable layers within group). For complete layer information please see the Data Dictionary (pdf).

Hudson River Features

- Emergency Services
- Health Services
- Water and Wastewater
 - SPDES Wastewater
 - Wells
 - Water Withdrawal Locations
 - Dams
- Energy Production
- Transportation Infrastructure
- Institutions
- Social Vulnerability
- Additional Information
- Ecology
 - Forest Cover 2010
 - National Wetland Inventory
 - Hudson River Estuary Tidal Wetlands 2007
 - Important Areas for Natural Communities
 - Important Areas for Rare Animals
 - Important Areas for Rare Plants
- Administrative
- Base maps
 - NY State Imagery
 - ArcGIS World Imagery
 - OSM

Legend

Icon fill color indicates:

- Not in flood zone
- In flood zone
- No flood info

Ecology

Forest Cover 2010

- Neighborhood (0 - 200 acres)
- Stepping Stone (200 - 1,999 acres)
- Locally Significant (2,000 - 5,999 acres)
- Regionally Significant (6,000 - 14,999 acres)
- Globally Significant (15,000+ acres)

Flood Scenario

- Not Flooded
- 0m
- 12m
- Possible Flooding - Disconnected

Estuary Shoreline 2004

Municipality

County

Full Study Area

Water and Wastewater

SPDES Wastewater

Selected Region:
North Greenbush

SPDES Wastewater:

- Name: Rensselaer Co Sd 1 WWTP;
- Owner: Rensselaer County; Discharge Level: Municipal/EPA Major

Map Feedback

Interactive Mapping Application

Descriptive
Statistics of
Potential Impacts
with each scenario

Available for
download in Excel
format

Hudson River Flooding Decision Support System Version 1

The screenshot displays the Hudson River Flooding Decision Support System interface. The main map shows an aerial view of Albany, New York, with a blue shaded area representing the flood zone along the Hudson River. Various critical infrastructure and features are marked with colored icons: green squares for buildings, blue diamonds for transportation infrastructure, and purple circles for schools. A legend on the right side of the map identifies these categories: Critical Infrastructure, Natural Resilience Features, and Social Vulnerability.

Critical Infrastructure

Natural Resilience Features

Social Vulnerability

Impact Summary for Albany
(fipskey: 3600101000)

Critical Infrastructure	Natural Resilience	Social Vulnerability
Total Damaged Buildings: 379		
Buildings with Substantial Damage: 35		
Building Loss: 265421000 (\$)		
Contents Loss: 671329000 (\$)		
Depreciated Building Loss: 86419000 (\$)		
Depreciated Contents Loss: 214792000 (\$)		
SPDES Wastewater: 6		
Bridges: 47		
Railroads: 34 (Linear Miles)		
Railroad Junctions: 1		
Boat Launches: 1		
Bus Routes: 62 (Linear Miles)		
Bus Stations: 1		
Power Transmission Lines: 3 (Linear Miles)		
Police Stations: 1		
Schools: 1		
Places of Worship: 10		

Layer List

Build Your Flood and Inundation Scenario

Choose Area of Interest

County: Albany

Town: Albany

Select Flood Scenario

Sea Level: 72 inches

Return Period: 1000 year

Submit Filter Reset Filter

Icon fill color indicates:

- Not in flood zone
- In flood zone
- No flood info

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Hudson River Features

- Emergency Services
 - Police stations
 - Fire stations
 - EMS
 - Emergency operations centers
- Health Services
 - Nursing homes
 - Hospitals
- Water and Wastewater
- Energy Production
- Transportation Infrastructure
- Institutions
 - Schools
 - Public libraries
 - Prisons
 - Places of worship
- Social Vulnerability
- Additional Information
- Ecology
- Administrative
- Base maps

Interactive Mapping Application

Hudson River Flooding Decision Support System Version 1

Scenario Builder Layer List

Print Tips Download Statistics Upload Your GIS Data Legend

Layer List >>

Build Your Flood and Inundation Scenario

Choose Area of Interest

County: Rensselaer

Town: North Greenbush

Select Flood Scenario

Sea Level: No Sea Level Rise

Return Period: 100 year

Submit Filter Reset Filter

Impact Summary for North Greenbush (fipskey: 3608352100)

Critical Infrastructure Natural Resilience Social Vulnerability

Building Loss: 2293000 (\$)

Contents Loss: 3534000 (\$)

Depreciated Building Loss: 1699000 (\$)

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Power Transmission Lines: 3 (Linear Miles)

Icon fill color indicates:

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Hudson River Features

Emergency Services

Health Services

Water and Wastewater

SPDES Wastewater

Wells

Water Withdrawal Locations

Dams

Energy Production

Transportation Infrastructure

Institutions

Social Vulnerability

Additional Information

Ecology

Forest Cover 2010

National Wetland Inventory

Hudson River Estuary Tidal Wetlands 2007

Important Areas for Natural Communities

Important Areas for Rare Animals

Important Areas for Rare Plants

Administrative

Base maps

NY State Imagery

ArcGIS World Imagery

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Icon fill color indicates:

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Neighborhood (0 - 200 acres)

Stepping Stone (200 - 1,999 acres)

Locally Significant (2,000 - 5,999 acres)

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Globally Significant (15,000+ acres)

Flood Scenario

Not Flooded

0m

12m

Possible Flooding - Disconnected

Estuary Shoreline 2004

Municipality

County

Full Study Area

Water and Wastewater

SPDES Wastewater

Selected Region: North Greenbush

SPDES Wastewater:

- Name: Rensselaer Co Sid 1 WWTP;
- Owner: Rensselaer County; Discharge Level: Municipal/EPA Major

Map Feedback

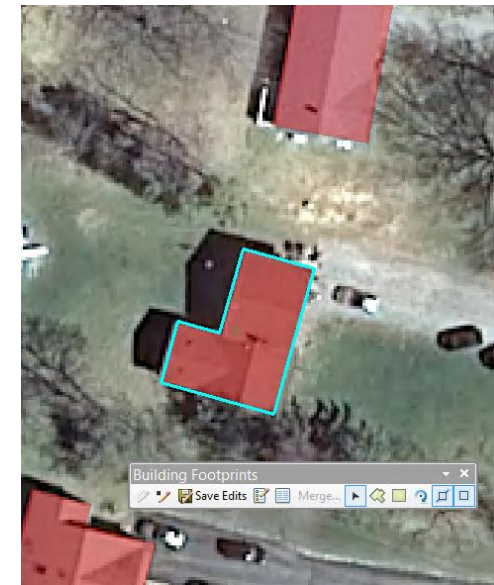
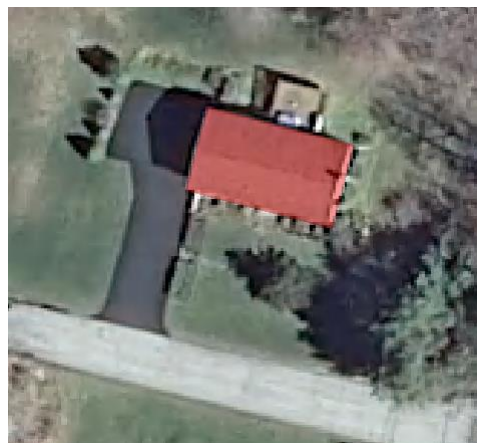
<http://www.ciesin.columbia.edu/hudson-river-flood-map/>

<http://fidss.ciesin.columbia.edu>

Continuing to Improve

Building data for climate change adaptation:
filling data gaps and characterizing storm surge
impacts in the Hudson River Valley and Long
Island

- NYSERDA PON 2941: Climate Change Adaptation Research and Strategies
- 2 year project



Open and Accessible Building Footprints

- All counties adjacent to the Hudson River from the southern border of Westchester County to the Federal Dam at Troy, as well as counties outside NYC adjacent to Long Island Sound.
- Will be assigned attributes from New York State Office of Real Property Services
- Site-specific adaptation options will also be developed and assigned as building-footprint attributes