Dataset Description: Model input and output data to assess the storm buffering capacity Piermont marsh

This document provides detailed information about four datasets that were generated through the 2016-2020 collaborative research project, *Understanding the Role Coastal Marshes Play in Protecting Communities from Storm Surge and Flooding*. The project was supported by the National Estuarine Research Reserve System (NERRS) Science Collaborative, which is funded by the National Oceanic and Atmospheric Administration. All Science Collaborative supported projects that collect new data adhere to federal data sharing and archiving requirements.

Data access and archival: The three project datasets described in this document have all been archived with the NERRS Centralized Data Management Office and can be requested through individual data requests forms aces on the Science Collaborative website: http://www.nerrssciencecollaborative.org/project/Sheng16

List of project datasets

1. Hydrologic Data: Observed Water Level in Sparkill Creek
2. Vegetation Data: Marsh Vegetation and Plant Dimensions
3. Flood and Wave Maps: Model Generated Flood and Wave Height Maps

About the Associated Project

Project title: Understanding the Role Coastal Marshes Play in Protecting Communities from Storm Surge and Flooding

Name of reserve(s) involved in the project: Hudson River NERR, NY

Project period: November 2016 – September 2020

Science Collaborative project page:
www.nerrssciencecollaborative.org/project/Sheng16

Project lead and contact information:
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Purpose

The Village of Piermont is located along the Hudson River in New York and is adjacent to a large tidal marsh that is dominated by the tall invasive grass, *Phragmites* (common reed). Resource managers from the Hudson River National Estuarine Research Reserve are interested in restoring native grasses such as cattails in the marsh, but they do not want to impact the wetland's ability to protect the Village from the waves and flooding caused by severe storms**.** In partnership with the local community, researchers, led by Y. Peter Sheng, PhD., designed and applied state-of-the-art coastal and hurricane models to address these questions: (1) What is the flooding risk for the Village of Piermont under current and future conditions? (2) What role does Piermont Marsh play in buffering the village from present and future flood, surge and wave damage? (3) How would the marsh's buffering services be changed if marsh managers were to restore native vegetation a phased approach to a portion of the marsh? (4) What is the economic value of the buffering services the marsh provides, now and in the future?

Abstract
The research team developed a vegetation-resolving three-dimensional surge-wave model to simulate storm impacts on Piermont Marsh and the adjacent Village. The model incorporated locally collected data on plant distribution and structure, as well as observed and simulated wind and water level data from the Hudson River. By modeling the impacts of Superstorm Sandy, they found that marsh vegetation with predominantly invasive common reed, *Phragmites australis,* reduced 66% of the wave energy, but less than 1% of the flood, at the Village. The marsh vegetation also significantly prevented transport of debris from the southeastern corner of the marsh. If managers were to replace *Phragmites* with the shorter, native cattail, *Typha angustifolia*, simulations of Sandy, which occurred in October, suggest that Piermont Marsh's wave and debris buffering capacity would be preserved. However, had Sandy occurred in May/June when *Typha* is much shorter and sparser, the marsh would have been unable to buffer the wave and debris as effectively. The Piermont Marsh Coastal GeoTool allows Village officials and resource managers to explore how homes and buildings would be impacted under marsh management and sea-level rise scenarios.

About the Project Dataset(s)

1. Hydrologic Data: Observed Water Level in Sparkill Creek

General description of data:
Observed water level at a dock located on the Sparkill Creek (Piermont, NY) recorded during high water level events occurring over a span of ~7 months using a pressure sensor and an experimental radar sensor. The equipment was deployed in order to capture big storm events that could be used to parameterize the project's model.

Search keywords:
Piermont, Sparkill Creek, Water level, Pressure sensor, Radar sensor

More about the data:

- **Pressure sensor**
  - Recorded using custom electronics and software (v3.2) based on a TE Connectivity absolute pressure sensor: 85-030A-4C (Range: 0-30psia)
  - The sensor is temperature compensated from -20 to +85C. Sensor was calibrated at 72F. Data is collected at 128 HZ and transmitted data via 2.4Ghz WiFi to a nearby base station in real-time.
- **Radar sensor**

- Data (I and Q signals) are recorded via a continuous wave (CW) radar sensor
- In addition to raw data, I and Q are also passed through a DC blocker filter
  - See: https://ccrma.stanford.edu/~jos/filters/DC_Blocker.html
  - y=(x-xm1) + 0.995 * ym1; xm1=x; ym1=y
- Conversion of CW radar I and q values to water level was done based on:
  - Peng, Z., Mishra, A, Davis, J. R., Bridge, J. A., Li, C. (2018) "Long-time non-contact water level measurement with a 5.8 GHz DC-coupled interferometry radar," Proceedings of the 2018 IEEE International Instrumentation and Measurement Technology Conference (I2MTC), IEEE, May 14-17. doi: 10.1109/I2MTC.2018.8409735
- A new approach which better handles sudden jumps in the I and Q noise due to environmental disturbances is described here:
  - D. V. Q. Rodrigues, D. Zuo, Z. Tang, J. Wang, C. Gu and C. Li, "Adaptive Displacement Calibration Strategies for Field Structural Health Monitoring Based on Doppler Radars," in IEEE Transactions on Instrumentation and Measurement, doi: 10.1109/TIM.2020.2982233.

Data collection period:
10/25/2018 – 5/18/2019

Geographic extent:
N41.03934492   W73.91273417

File format:
Water level, temperature, radar and pressure data are being made available through a set of .txt, .data, .png,, .out, .m and .lay files, which are explained in the associated data documentation (readme files).

Pressure Data:
ObsTime(days since 1900):
ObsTime(seconds since epoch):

ObsCount:	Observation count
S1val:	Absolute Pressure (psia)
E1val:	Battery Voltage (V)
E2val:	Sensor current draw (mA)
E3val:	Wifi Signal Strength (dBm)

Radar Data:
Time (days since 1900)
Observation Count
Packet Count

xIv	Radar I signal. Volts: 0-2.5v range
xQv	Radar Q signal. Volts: 0-2.5v range
yIIv	Radar I signal (DC blocker). Volts: 0-2.5v range
yQv	Radar Q signal (DC blocker). Volts: 0-2.5v range

Time is recorded in UTC. Time is referenced in Julian Days since 1/1/1900 where 1900 is incorrectly assumed to be a leap year (Lotus-1-2-3, Microsoft Excel, Tecplot, etc.-style). See: https://docs.microsoft.com/en-us/office/troubleshoot/excel/wrongly-assumes-1900-is-leap-year As such, the number of days after Feb 28, 1900 are one day greater than the actual day count from 1/1/1900.

Contact for Hydrologic Data:
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Y. Peter Sheng, University of Florida, Email: pete@coastal.ufl.edu

Maps and Schematics for Data Collection

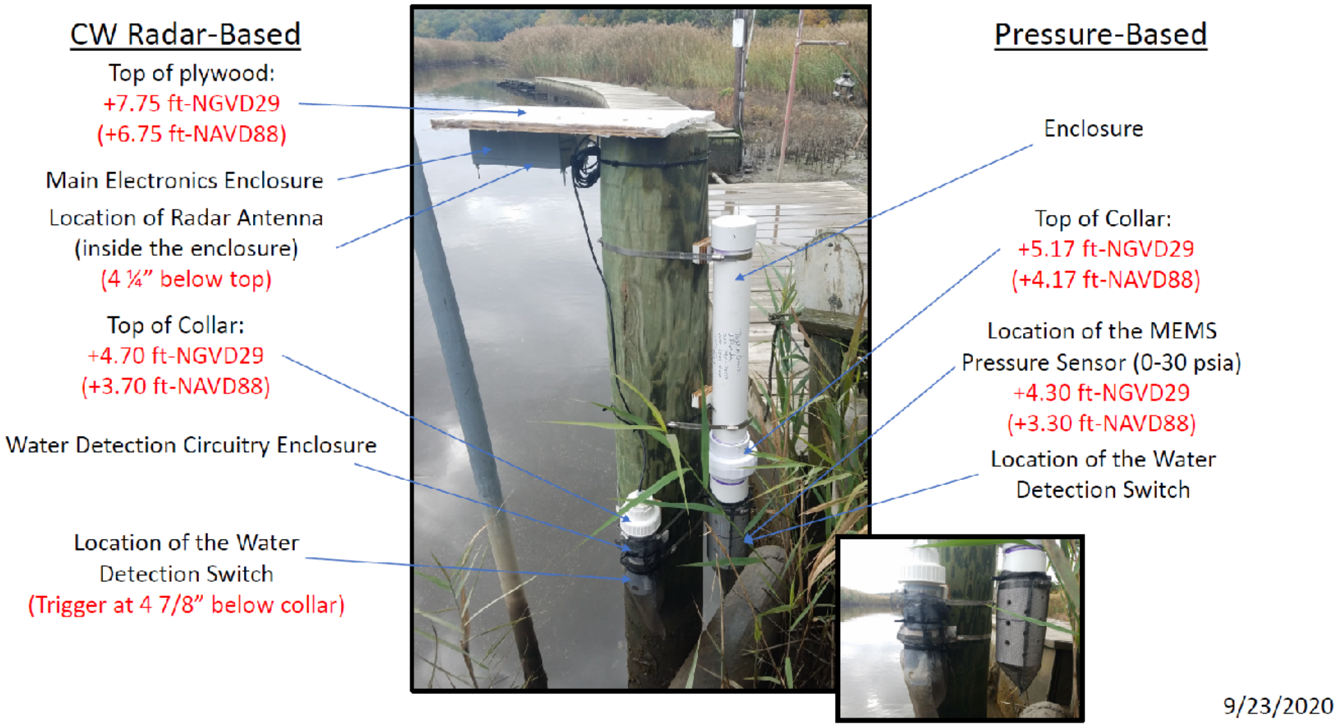

Figure 1. Equipment used to collect water level data.

2. Vegetation Data: Marsh Vegetation and Plant Dimensions

General description of data:
Herbaceous marsh vegetation data collected at two marsh sites along the Hudson River, NY in order to parameterize a 3D storm surge model. This data comprised plant stem density and physical plant dimensions, measured by hand and with a Riegl 400 terrestrial laser scanner. Data were used in a storm surge model as wetted surface area interacting with incoming water. Wetted area was calculated from the physical plant dimensions as the cumulative circumference of all plant stems and leaves per square meter. The Piermont marsh site, located adjacent to the town of Piermont NY, is dominated by invasive *Phragmites australis* with small patches of remnant native communities comprising *Scirpus spp., Spartina patens,* and *Typha angustifolia.* The Iona marsh site, located within Bear Mountain State Park, NY, is dominated by native *Typha angustifolia*

Search keywords:
Phragmites australis, Typha angustifolia, Hudson River, Piermont, New York

More about the data:
We collected vegetation data along 100 m transects in marshes dominated by *Phramgites spp* (n=7 transects) and native-vegetation (*Scirpus spp, Spartina patens,* and *Typha spp;* n=3 transects) in May and September 2017. Along each transect we surveyed ten 0.5 m^2 quadrats spaced at 10 m intervals. We also measured surface elevation using a centimeter-accuracy RTK GPS unit and collected 5-cm diameter soil cores (5 cm depth) to determine particle size and soil organic carbon. All *Phragmites* and *Scirpus spp*/*S. patens* transects were within Piermont Marsh. *Typha spp* transects were located in Iona Marsh.

Along transects in *Phragmites* and *Typha* dominated marshes, we measured stem density of live, dead unbroken, and dead broken stems with 0.25 m^2 quadrats. We used digital calipers to measure the diameter of randomly chosen stems (n=5) at 50 cm height and 150 cm height to capture frontal area of vegetation at different heights. We also measured litter layer depth (n=5) and height of randomly chosen broken stems (n=3) and unbroken stems (n=3) within quadrats to estimate full canopy height and broken canopy height.

Scirpus spp and *S. patens* grow in short, dense tussocks distributed throughout the marsh. To measure this vegetation, we measured stem diameter and height within 0.01 m^2 quadrats within a tussock. We then counted the number of tussocks, measured each tussock diameter, and estimated percent cover of vegetation within 6.25 m^2 quadrats.

We used these vegetation characteristics to measure average canopy height and calculate wetted area of vegetation from 0-1 m and 1-2 m heights using the equation:

$$N * bv * \pi$$

Where N is the density of stems (stems/m^2) and bv is stem diameter.

We used a terrestrial laser scanner to obtain two (2) fine resolution 3-D point clouds which we then used to calculate surface area measurements of vegetation. These scans were taken at one representative *Phragmites spp* stand at Piermont Marsh and one representative *Typha spp* stand at Iona Marsh.

Data collection period:
Measurements were taken during spring 2017 and at peak biomass in fall (September) 2017.

Geographic extent:
This data were collected at two marsh sites along the Hudson River: (1) Piermont Marsh, which is adjacent to the town of Piermont, NY; and (2) Iona Marsh, which is located within Bear Mountain State Park, NY.

File format:
The plant and soil data are available in four excel files that are each explained in the documentation provided with the data. In addition, sampling locations and coordinates are detailed in a kmz(Google/GIS file format) and txt file. Documentation of the data followed the metadata template of the *Federal Geographic Data Committee* (FGDC).

Contact for Vegetation Data:
Christine Angelini, University of Florida, Email: c.angelini@ufl.edu

3. Flood and Wave Maps: Model Generated Flood and Wave Height Maps

General description of data:
These are model generated maps of the predicted 1% flood (0.01 annual exceedance probability) and the predicted 1% wave height (0.01 annual exceedance probability) for 7 management scenarios.

Search keywords:
Piermont, flood map, maximum wave height

More about the data:
- Maps are generated using the JPM-OS method (https://doi.org/10.1007/s11069-019-03807-w) and coupled CH3D/SWAN storm surge/wave models including effects of storms and sea level rise for different time horizons and management scenarios.
- 7 scenarios are considered for both flood height and wave height simulations as outlined in Table 1 below.
- The specific scenarios were defined by the Hudson River NERR, which was attempting to analyze how replacing the currently present invasive strain of *Phragmites australis* with *Typha* may effect flooding in Piermont Village. A map of the Piermont marsh and management areas, identified as I-1, I-2 and I-3 are shown in Figure 2. Current marsh conditions and management areas are shown in the table below.

Data collection period:
Modeling time horizons: 2019, 2022, 2022, 2050, 2100

Geographic extent:
Piermont, NY
Coordinate System: WGS_1984_UTM_Zone_18N, units: meters
Top: 4545071.064316 Bottom: 4540499.064316
Left: 590499.629402 Right: 592902.629402

File format:
- Model output data are provided as GeoTiff which can be viewed using GIS type tools. File names end in rpX, where X is the scenario number and either flood or wave is in the file name (e.g. flood_rp0.tif or waves_rp0.tif).
- Coordinate System: WGS_1984_UTM_Zone_18N, units: meters
- Vertical units: feet

Contact for Flood and Wave Maps Datasets
Y. Peter Sheng, University of Florida, Email: pete@coastal.ufl.edu

Maps and Schematics for Data Collection

	Year	Sea Level Rise, in	Management Phase	Area 1	Area 2	Area 3	Other Areas
0	2019	0	No management	Current Conditions	Current Conditions	Current Conditions	Current Conditions
1	2019	0	Phase 1	No Vegetation	Current Conditions	Current Conditions	Current Conditions
2	2022	0	Phase 2	Low Typha	No Vegetation	Current Conditions	Current Conditions
3	2025	6	Phase 3	High Typha	Low Typha	No Veg	Current Conditions
4	2050	18	Complete	High Typha	High Typha	High Typha	Current Conditions
5	2050	18	No management	Current Conditions	Current Conditions	Current Conditions	Current Conditions
6	2100	114	Extreme	SLAMM Marsh Loss	SLAMM Marsh Loss	SLAMM Marsh Loss	SLAMM Marsh Loss

Table 1. Scenarios used for modeling. The scenarios are based on the phases for a proposed marsh management plan that included restoring native vegetation in a small portion of Piermont marsh (see Figure 2.)

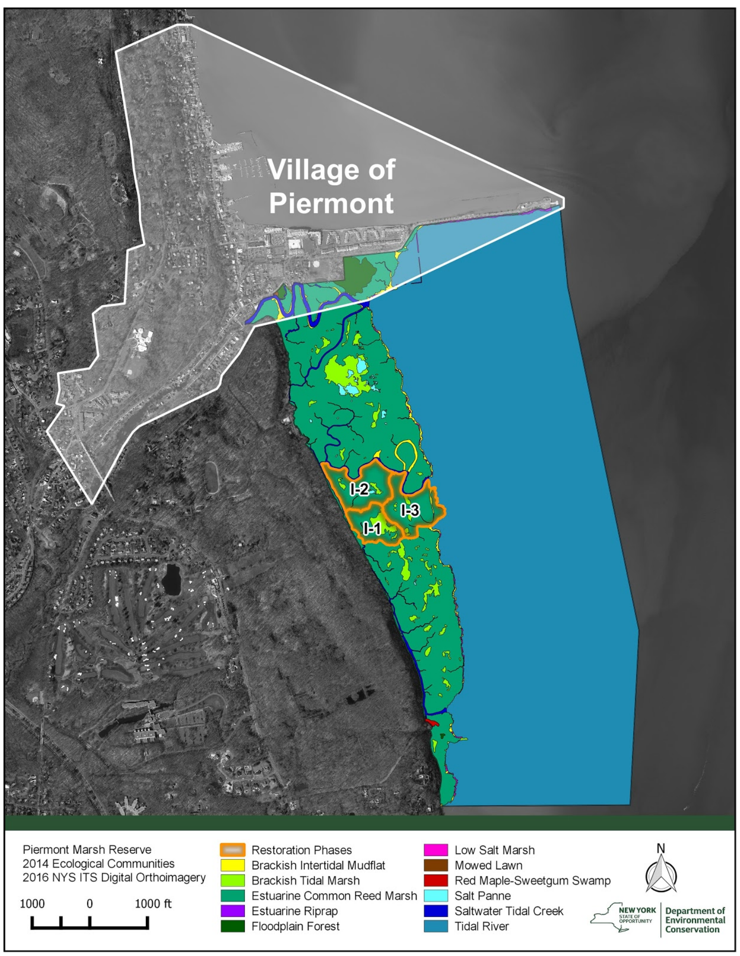

Figure 2. A map of the Piermont marsh and the management areas, identified as I-1, I-2 and I-3, where native vegetation would be restored in phases. This proposed management plan has not been adopted.

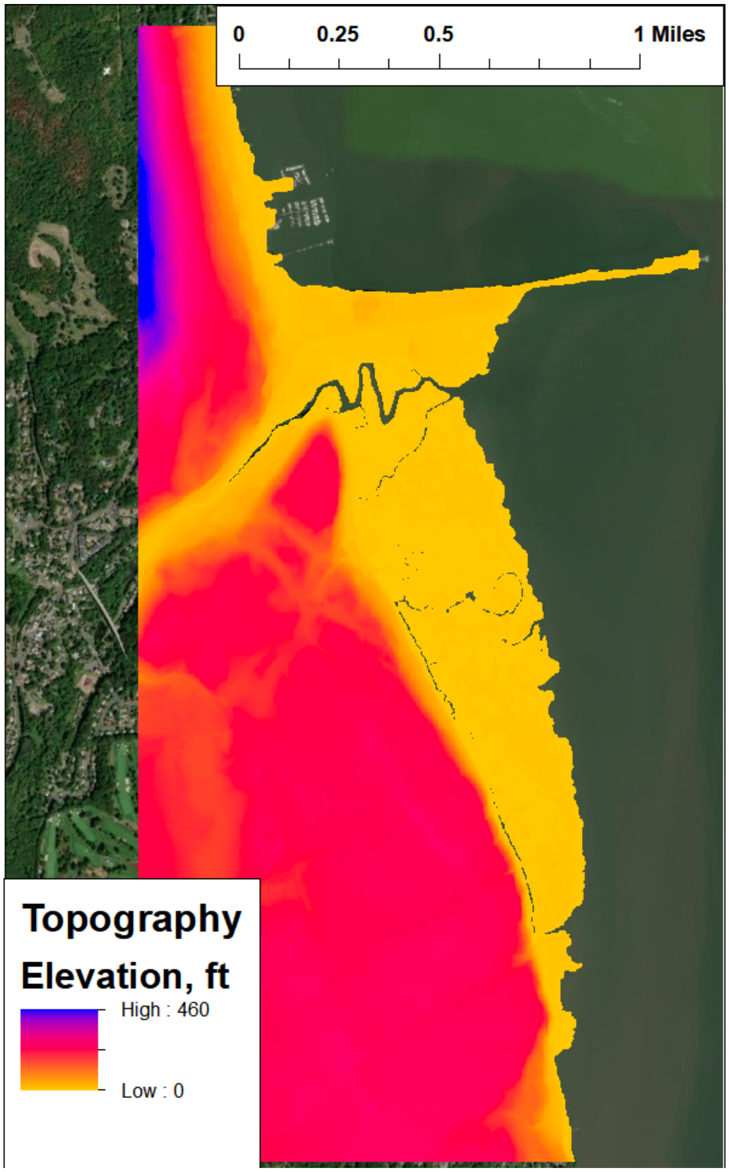

Figure 3. The analysis domain and its topography.