Flood Documentation and Mapping of 2018 Nor'easters in Coastal Massachusetts

And Outreach Tools for Understanding Flood Risk

Work done by USGS in cooperation with the Federal Emergency Management Agency

Pamela Lombard
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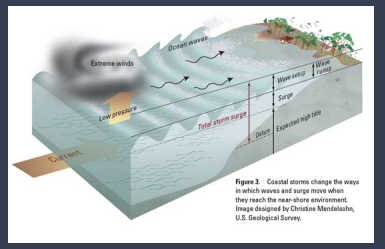
Flood Documentation is critical for putting historical floods into context and better understanding future flood risk

- Collect, Survey & Document Flood Elevations

- Compute Coastal Stillwater Elevations



- Create January & March 2018 Flood Elevation Profiles and Inundation maps

- Create Outreach Tools

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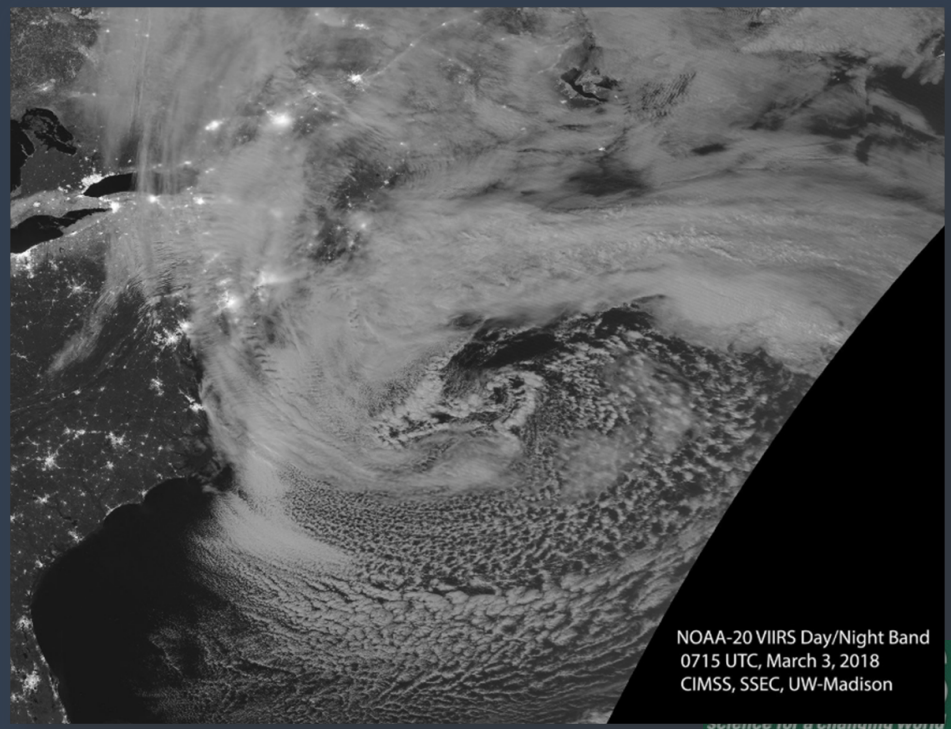
January and March 2018 Nor'easters

<u>BOTH</u>

- Astronomical high tides (full moon)
- Extratropical cyclones that formed in the western North Atlantic Ocean
- Bombogenesis (storm pressure dropped 24 mb in 24 hrs)

- January
  - Developed rapidly
  - 50-70 mph wind gusts
  - 10-22" snow
- March
  - Slower moving
  - 40-90 mph wind gusts (Category 1 Hurricane)
  - Up to 39" snow

GOES-16 satellite image on January 4, 2018 at 8:45 am EST



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Boston Tide Gage (1921-2018)

NOAA National Ocean Service (NOS)

Highest recorded Mean Higher High Water (MHHW):

Average height of the highest tide recorded at a tide station each day

Date	Mean Higher High Water (NAVD88)
Jan 4, 2018	9.66 ft
Feb 7, 1978	9.59 ft
Mar 2, 2018	9.16 ft
Jan 2, 1987	8.69 ft

*1987 and 1978 are not adjusted for Sea Level Rise

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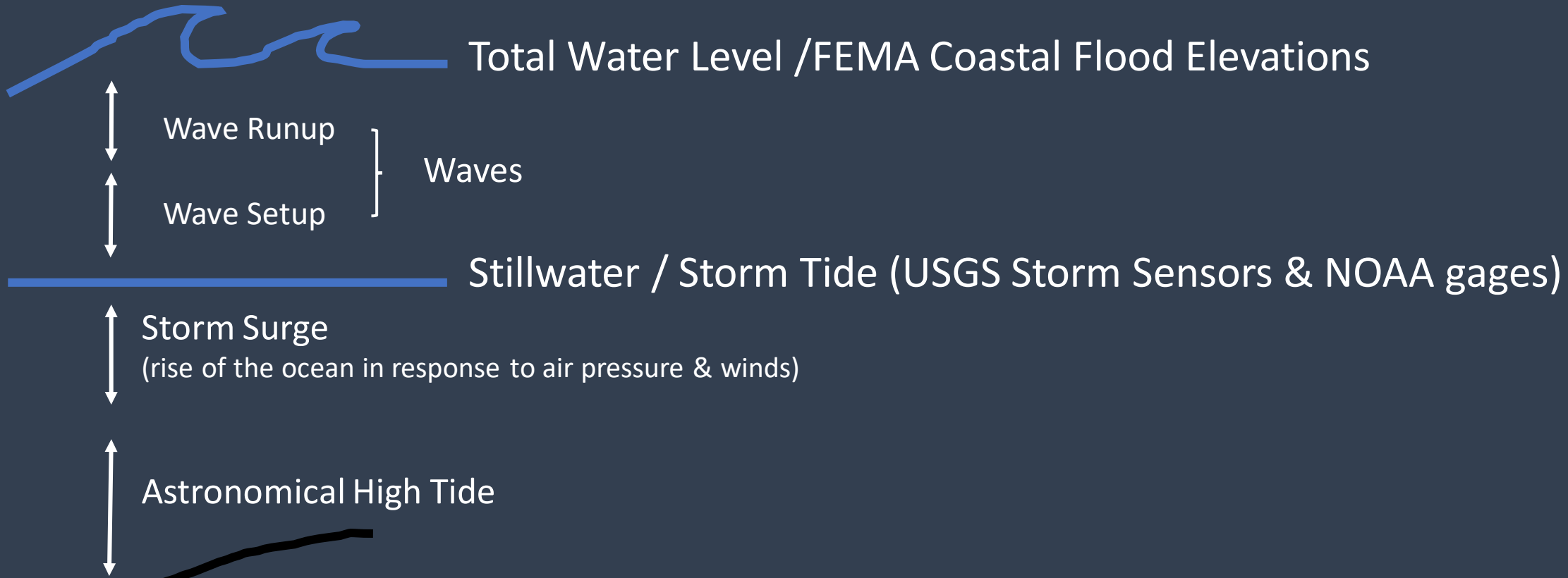
What Did We Measure?



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January 2018 Nor’easter

- 71 HWMs collected
  - Range: 5.8-15.1 ft
  - Average: 9.4 ft
- Five HWM teams for 2 days, and one HWM team for 5 days
- HWMs flagged near HWMs from Feb. 1978 nor’easter and the USGS SWaTH sites
- HWMs limited by weather conditions following the storm
  - 3 days of extreme cold and winds
  - 1 week later rain, warm temps, and winds destroyed HWMs

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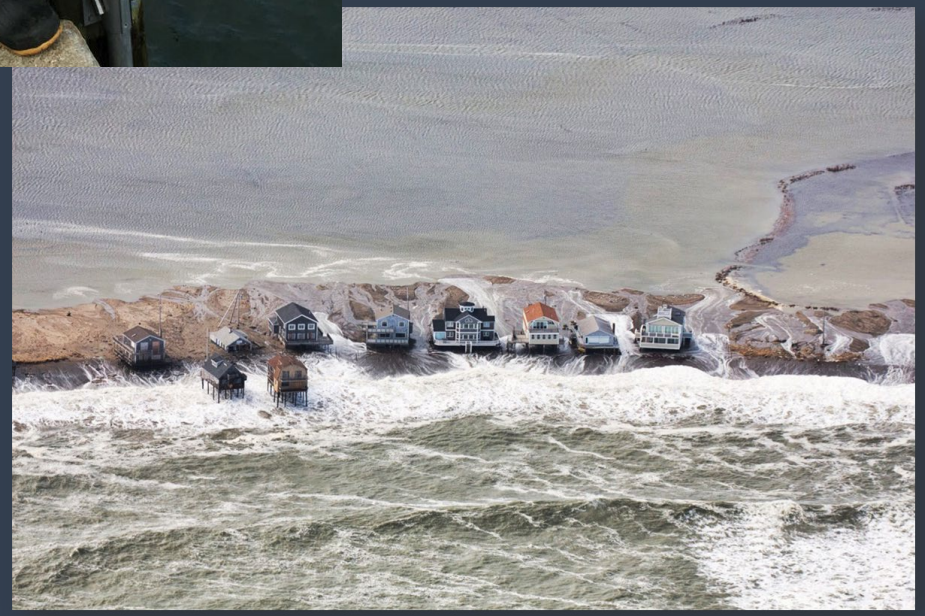
March 2018 Nor'easter



- 35 storm-tide sensors deployed in New England
  - Range: 6.2-10.4 ft
  - Average: 8.4 ft
- 100 HWMs collected Portland to Cape Cod
  - 5.3-15.1 ft
  - Average = 8.9 ft
- HWMs: 6 ME, 13 NH, 2 RI, 10 CT
- HWMs flagged near HWMs from Jan. 2018 and Feb. 1978 sites

Peggotty Beach, Scituate, MA – midday high tide on March 4, 2018

(photo credit Karl Swenson)

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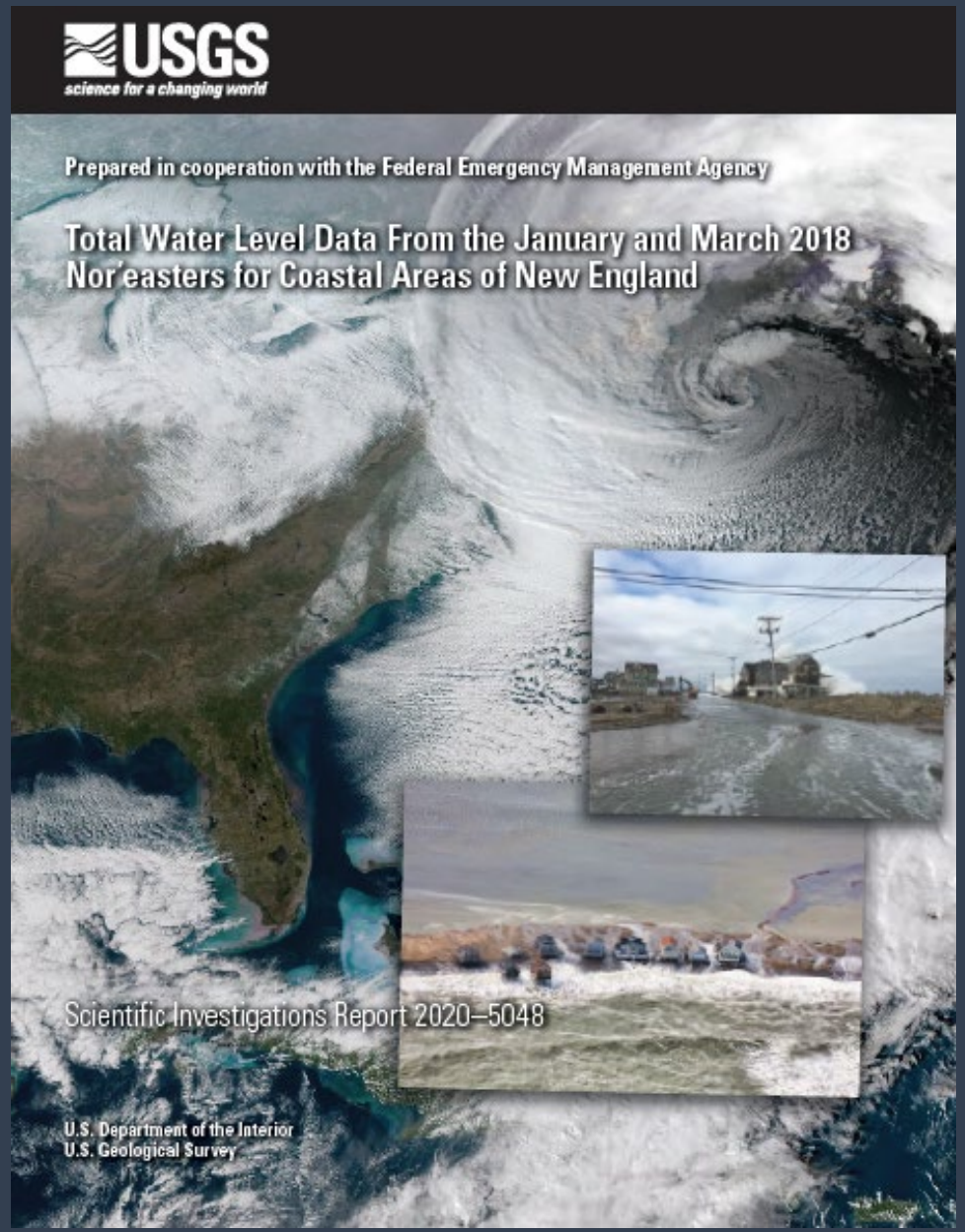
Documenting Flood Elevations
USGS Report

- Storm Documentation
- Storm Sensor Data
- High Water Mark Data



Scientific Investigations Report 2020-5048

By Gardner Bent & Nicholas Taylor

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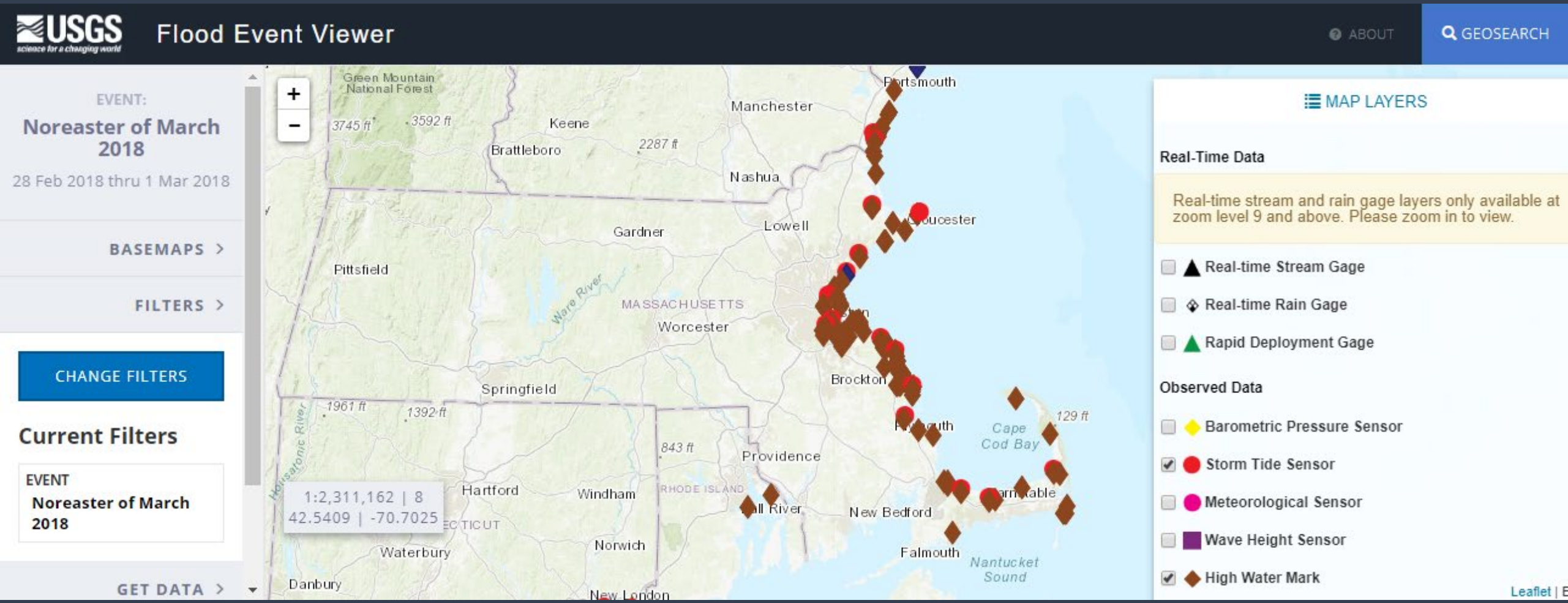
Documenting Flood Elevations
USGS Flood Event Viewer



https://stn.wim.usgs.gov/FEV/

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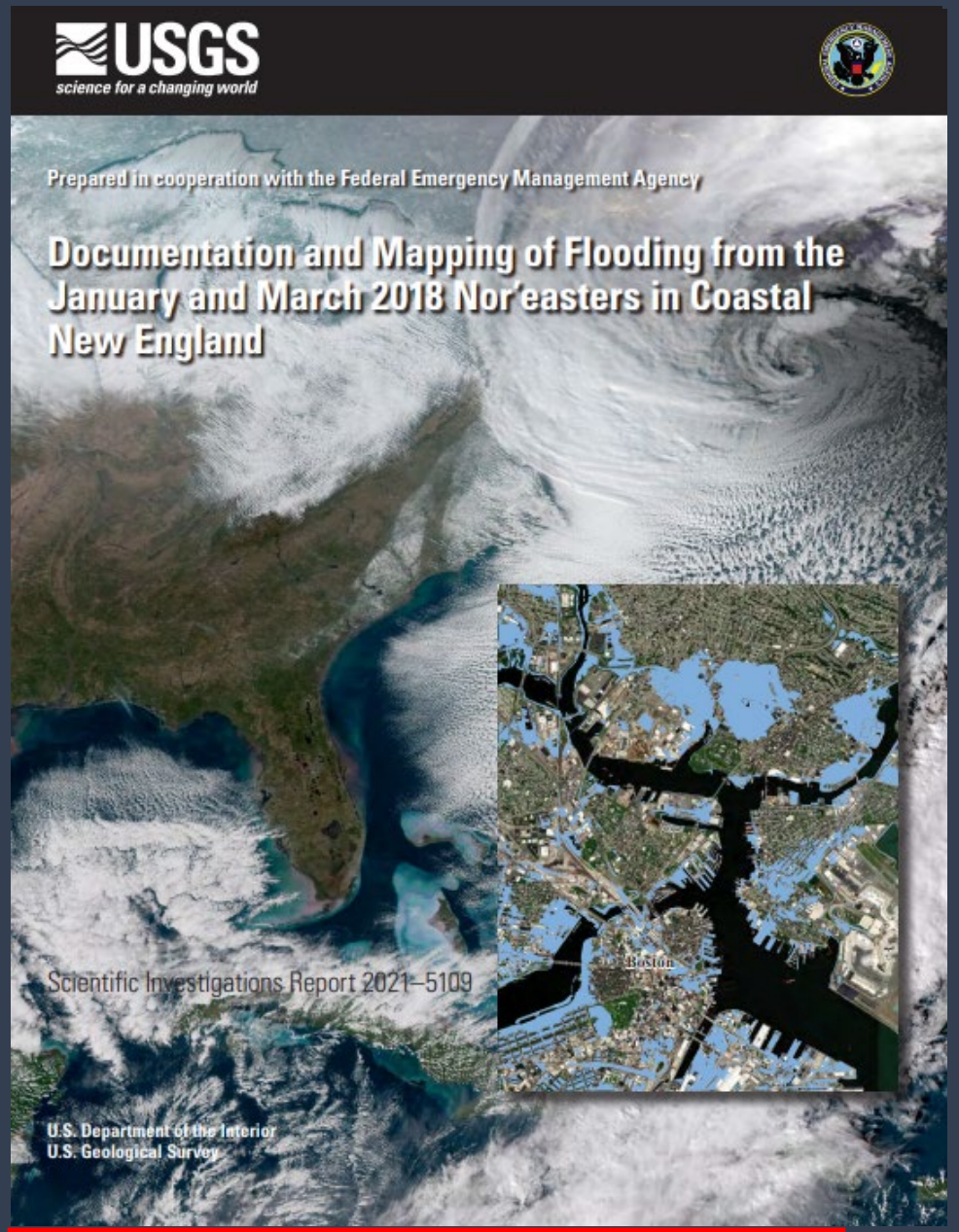
Documenting Flood Elevations
USGS Report

- Coastal Stillwater Analysis
- Flood Profiles
- Flood Inundation Maps
- Storm Attenuation



Scientific Investigations Report 2021-5109

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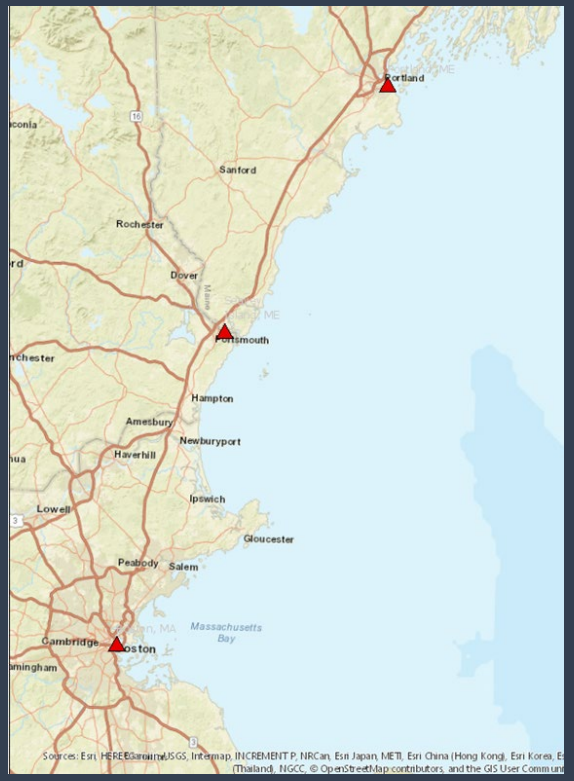
Coastal Stillwater analysis

- Frequency analysis on annual peaks at 3 NOAA gages

- Data de-trended (adjusted to 2018 levels) prior to analysis



By Scott Olson

2018 Storms in the Context of Stillwater Elevation Analyses

Coastal Gage	Elevations for Selected Recurrence Intervals (ft in NAVD88)				
	10 -yr	25-yr	50-yr	100-yr	500-yr
Boston, MA	8.58 ft	9.06	9.42	9.80	10.72

March 2018
Elev = 9.16

Jan. 2018
Elev = 9.66

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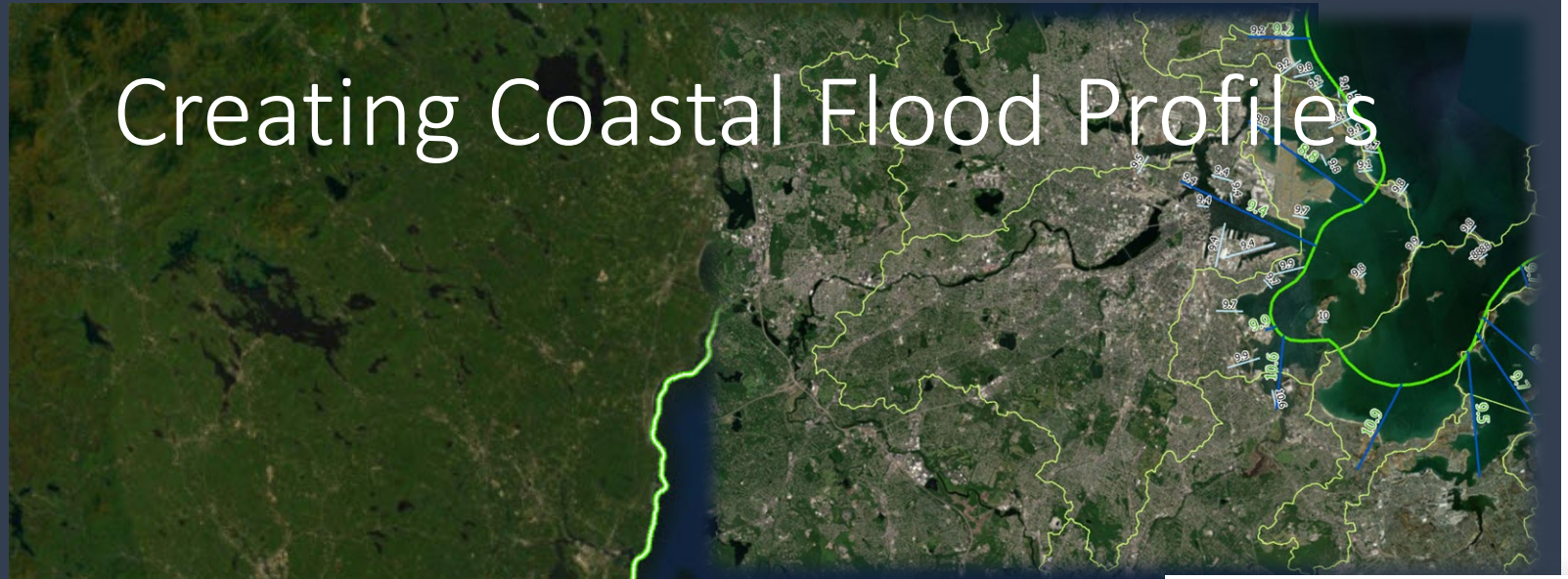
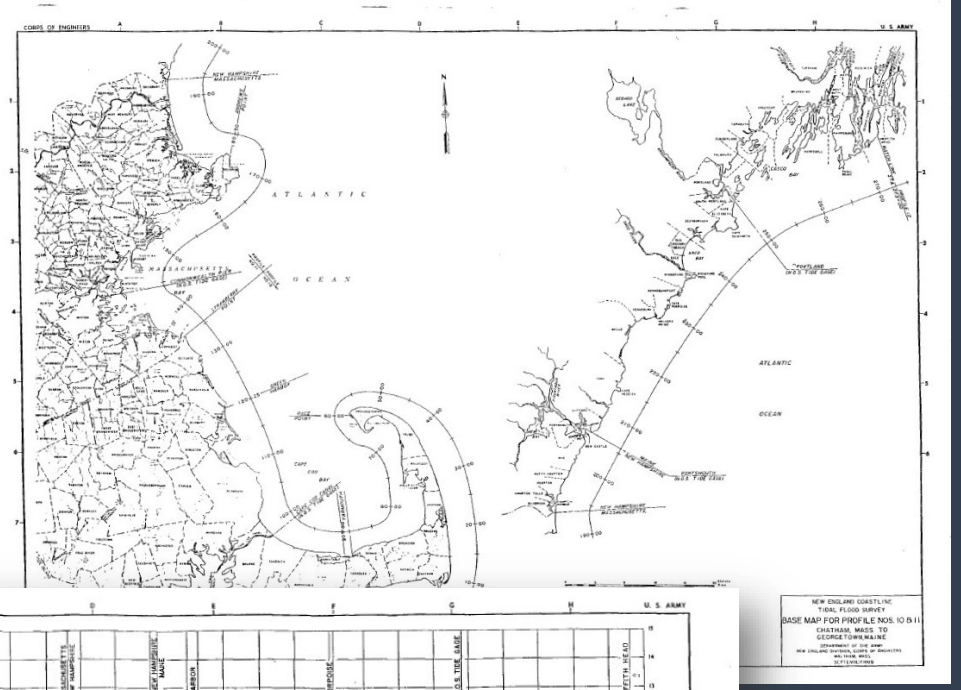
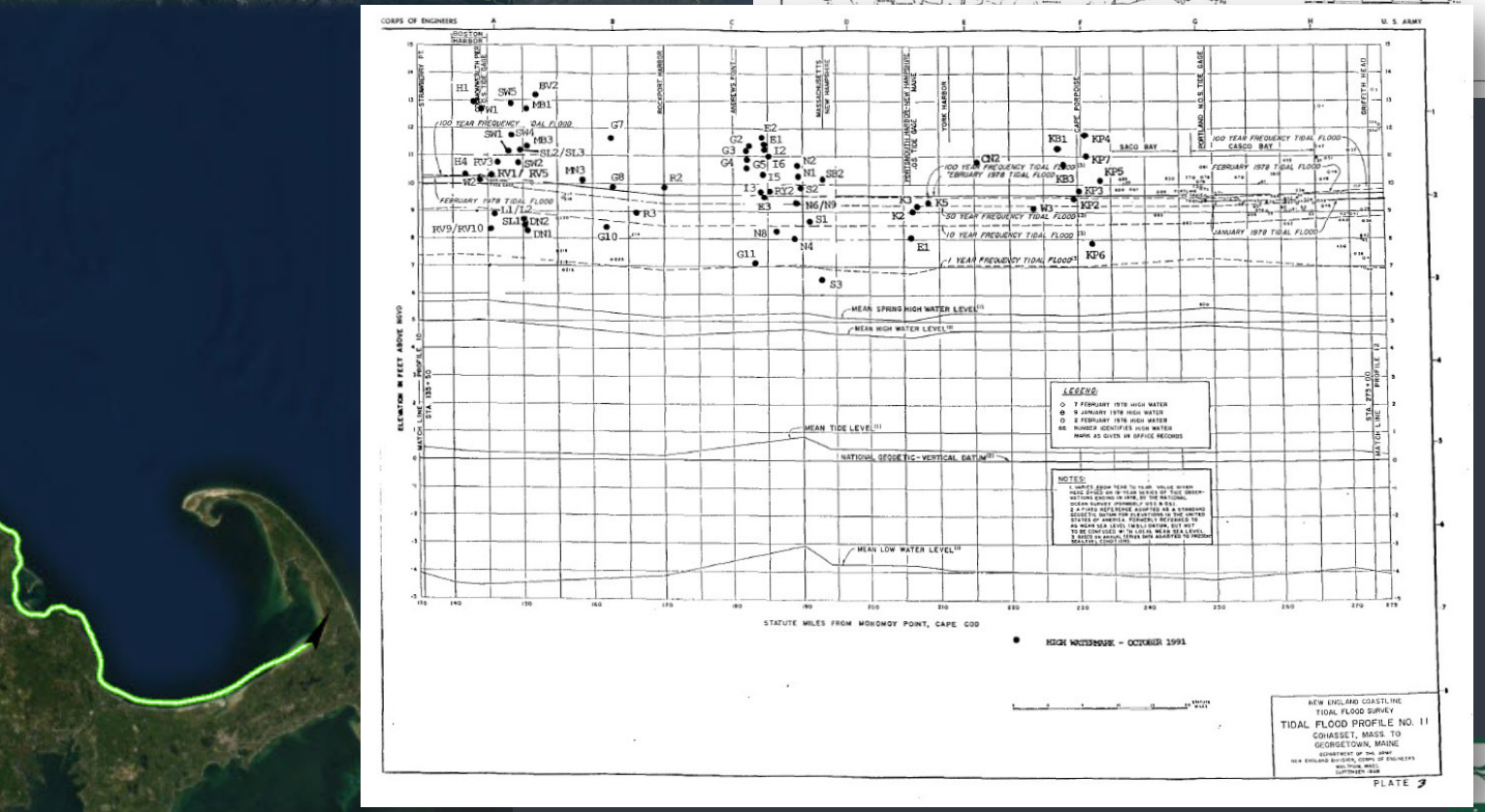
Creating Coastal Flood Profiles







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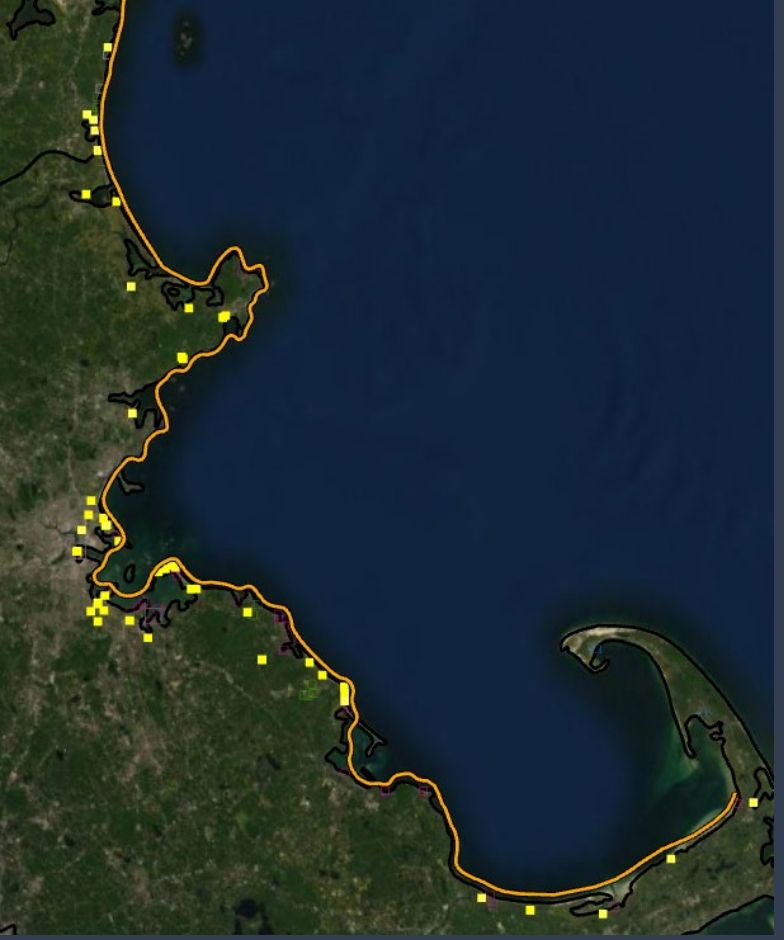
Creating Coastal Profiles



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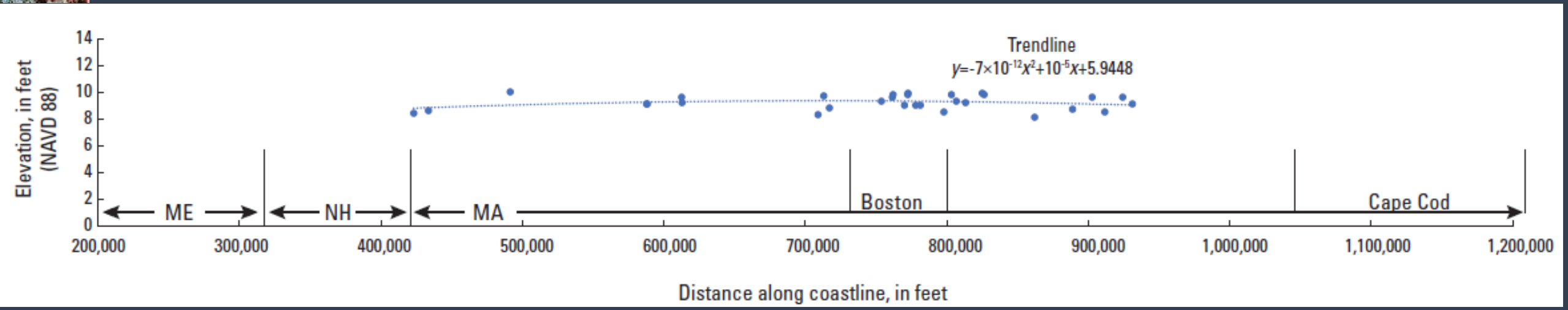
Coastal Profile January 2018 HWMs



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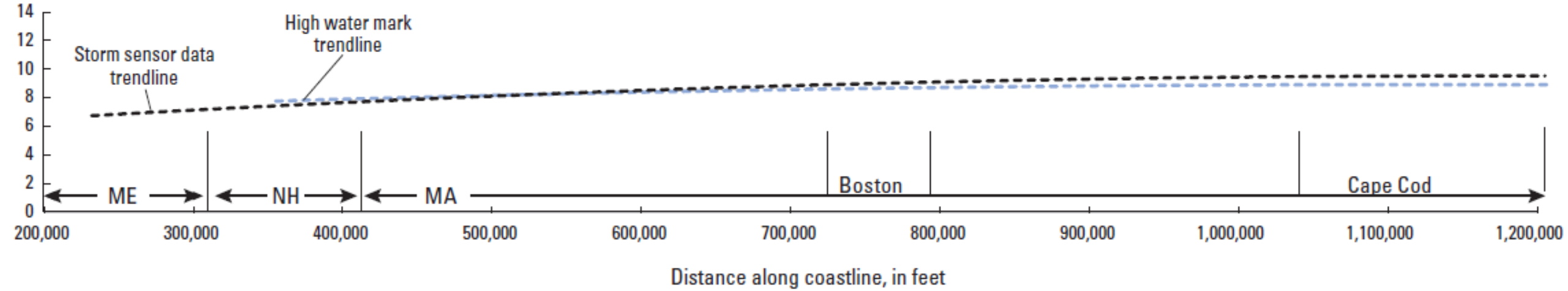
Coastal Profile March 2018 HWMs

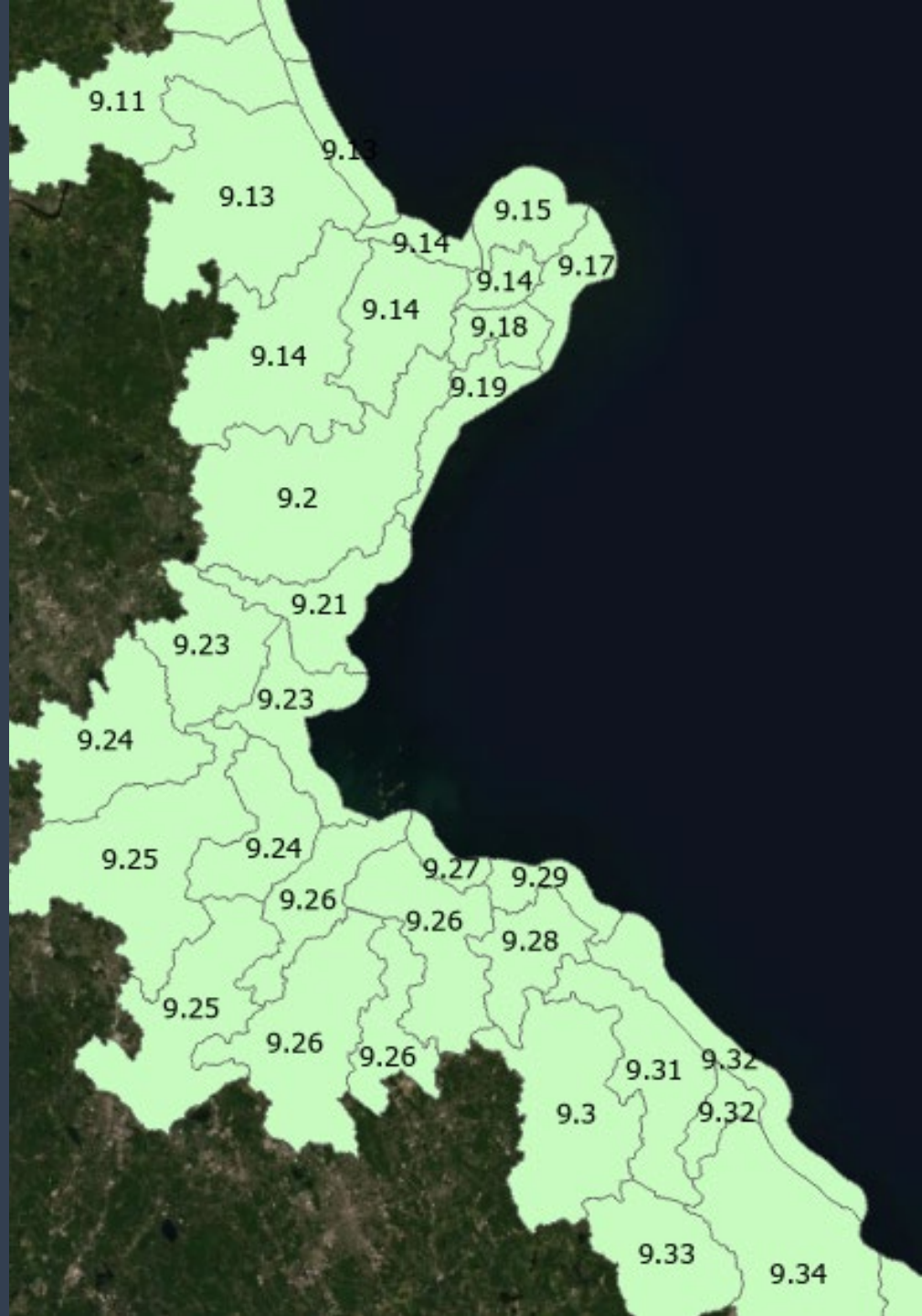
Coastal Profile March 2018 Storm Sensors

Coastal Profile March 2018 HWMs & Storm Sensors



Mapping 2018 Events

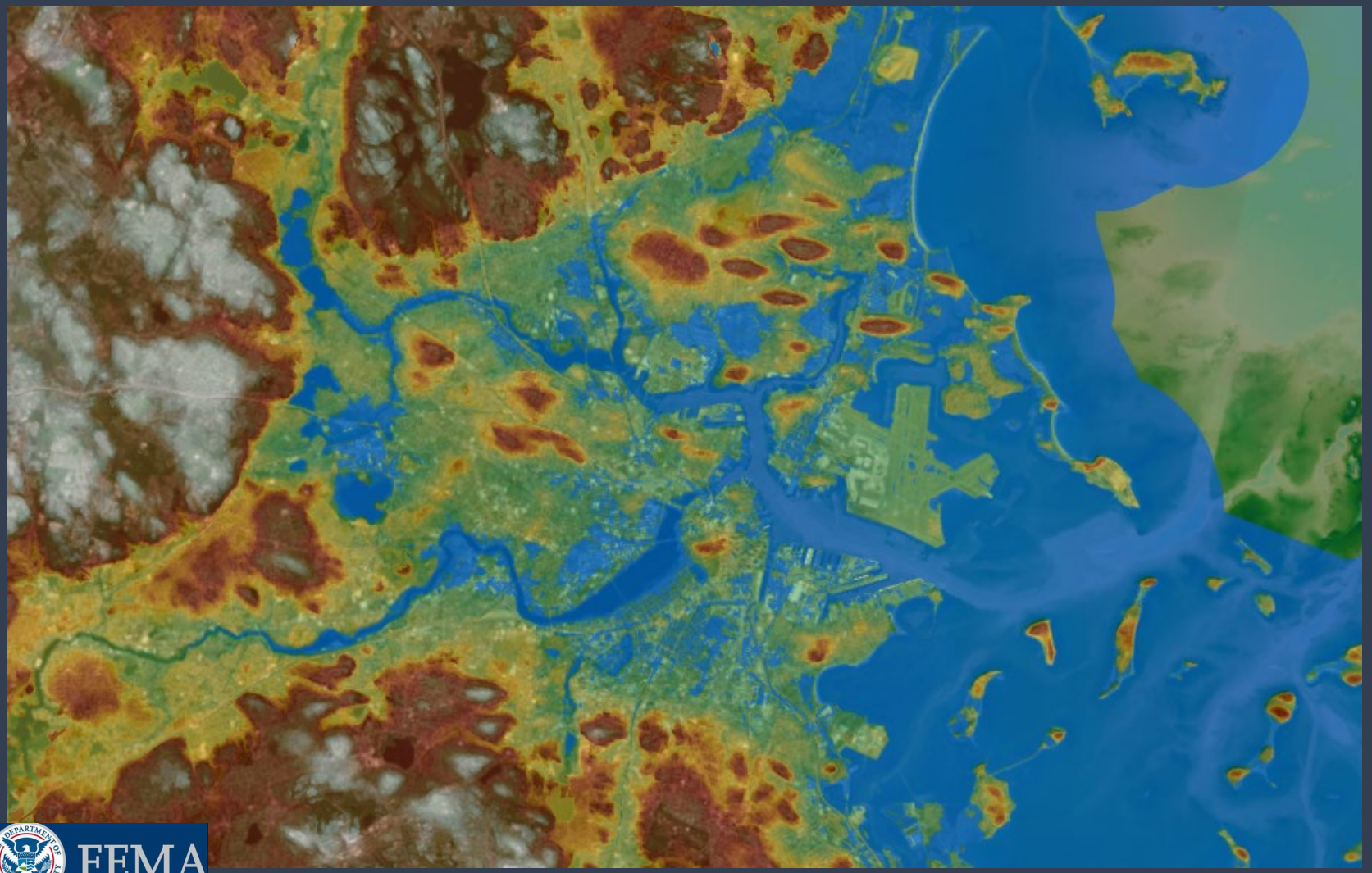
- Calculate Centroid of HUC 12 Coastal Watersheds
- Snap Centroids to Coastal Baseline
- Assign flood elev for each HUC based on best fit line

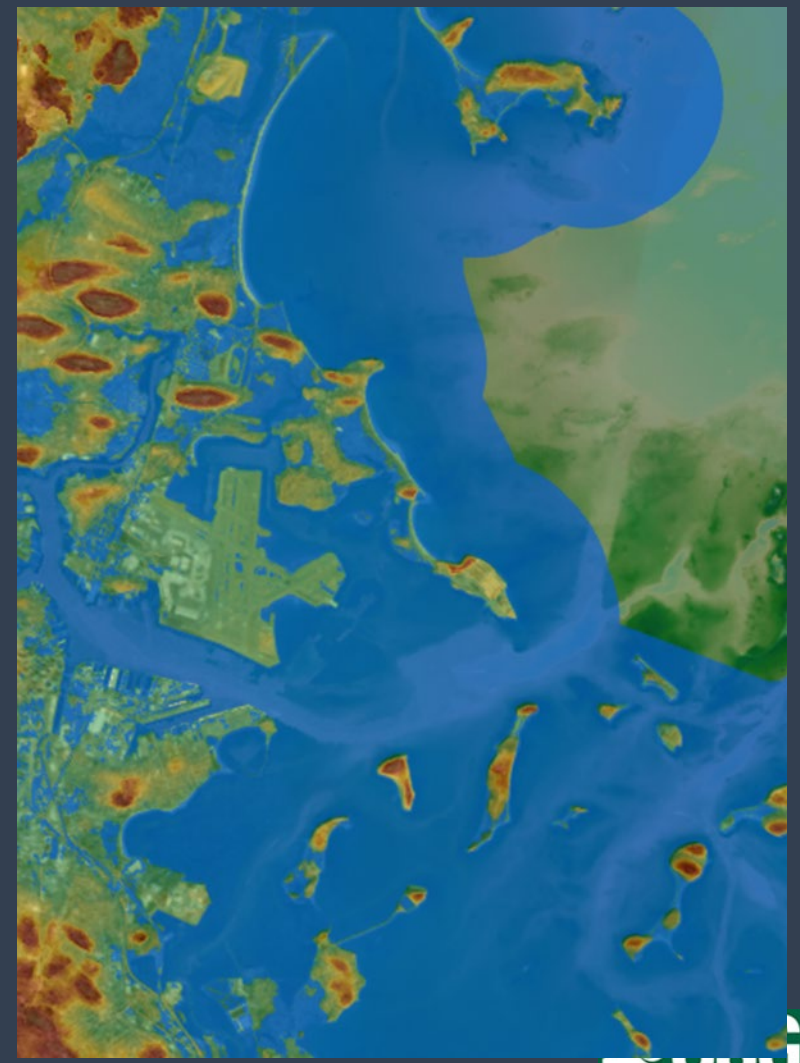


Technique developed by Maine Geological Survey for Coastal Sea Level Rise Scenario mapping
https://www.maine.gov/dacf/mgs/hazards/slr_ss/index.shtml

Flood Inundation Mapping

- Drape Flood Elevation Layer over Lidar
- Bathtub Inundation method for mapping





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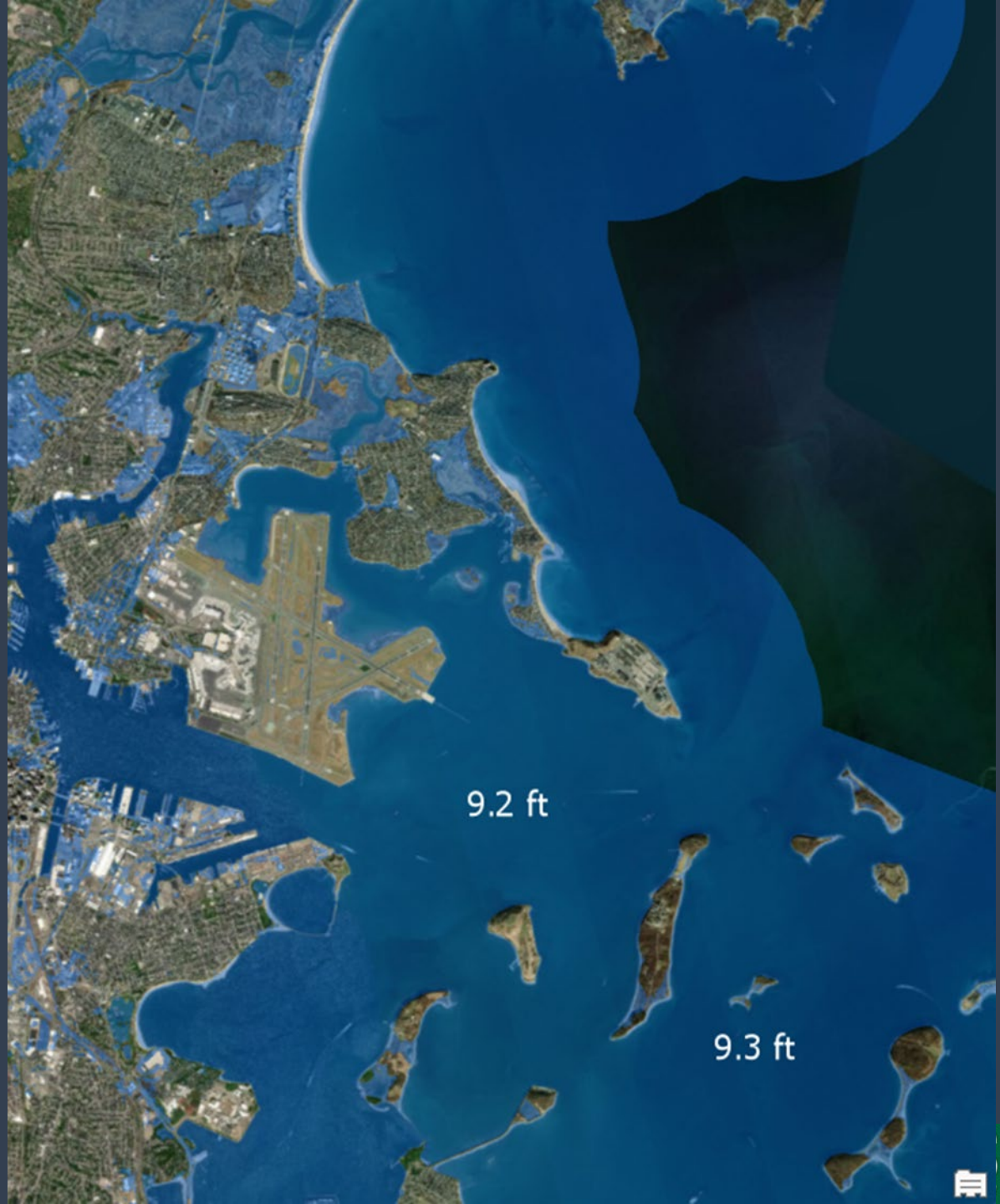
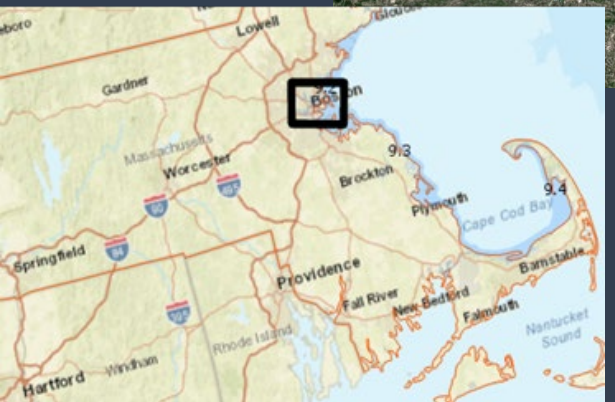
Jan 2018
Inundation Map



March 2018 Inundation Map



Hydraulic Connectivity of High-Water Marks

- Modeling storm-water surface elevation attenuation as it moves inland using simple 1D model
- Bjerklie et al., 2013

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Flood Documentation and Inundation Mapping of the January and March 2018 Nor'easters in Coastal Massachusetts

COMPLETED

By New England Water Science Center October 5, 2021

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Below are publications associated with this project.

NOVEMBER 17, 2021

Documentation and mapping of flooding from the January and March 2018 nor'easters in coastal New England

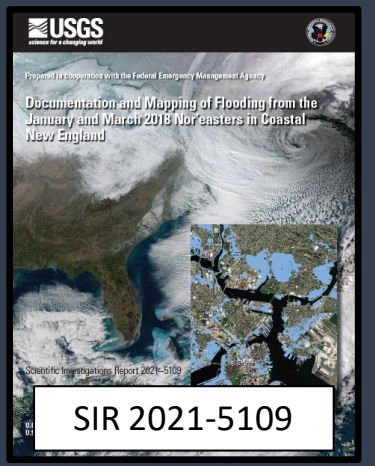
In January and March 2018, coastal Massachusetts experienced flooding from two separate nor'easters. To put the January and March floods into historical context, the USGS computed statistical stillwater elevations. Stillwater elevations recorded in January 2018 in Boston (9.66 feet relative to the North American Vertical Datum of 1988) have an annual exceedance probability of between 2 and 1 perce

By: Water Resources, New England Water Science Center, New England Water Science Center

SEPTEMBER 22, 2020

Total water level data from the January and March 2018 nor'easters for coastal areas of New England

During winter 2017–18 coastal areas of New England were impacted by the January 4, and March 2–4, 2018, nor'easters. The U.S. Geological Survey (USGS), under an interagency agreement with the Federal Emergency Management Agency (FEMA), collected total water level data (the combination of tide, storm surge, wave runup and setup, and freshwater input) using the North American Vertical Datum of 1988



SIR 2021-5109

SIR 2020-5048

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Data & Map Layers

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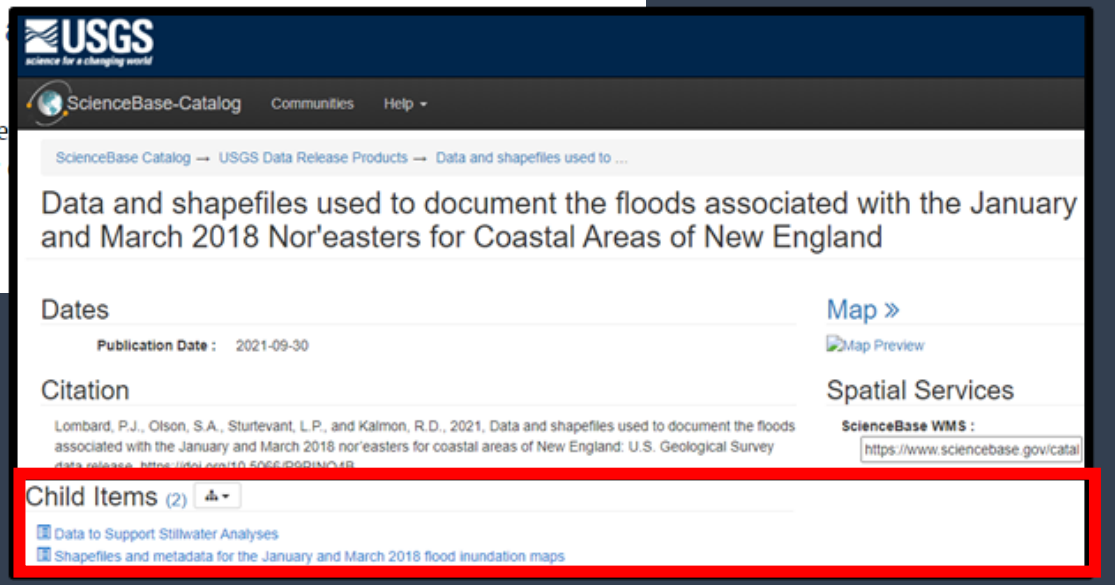
OCTOBER 18, 2021

Data and shapefiles used to document the floods associated with the January
Coastal Areas of New England

The U.S. Geological Survey (USGS) New England Water Science Center worked with the Federal Emergency Manage
January 4, 2018 and March 2–4, 2018, in coastal Massachusetts. USGS conducted a frequency analysis of stillwater
Atmospheric Administration coastal gages following the coastal floods of 2018. The data for these an

By: New England Water Science Center, New England Water Science Center



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January and March 2018 Nor'easters

Flood documentation and mapping of two large storm events in coastal Massachusetts

A geonarrative by the U.S. Geological Survey

November 19, 2021

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Nor'easter storm events in coastal New England January 4 and March 2-4, 2018

Use the data filter options below to filter storm data points by storm event, data type, town/city, and water-surface elevation range.

The filter options allow for multiple selections from the drop down menus. To turn data filter selections on, single click any item or items from the drop down menu. The selected data filters will filter data points and content in the map and charts. To turn data filters off, select the "Reset" option or single click on any highlighted items in the menus.

Select by storm event
Show all data

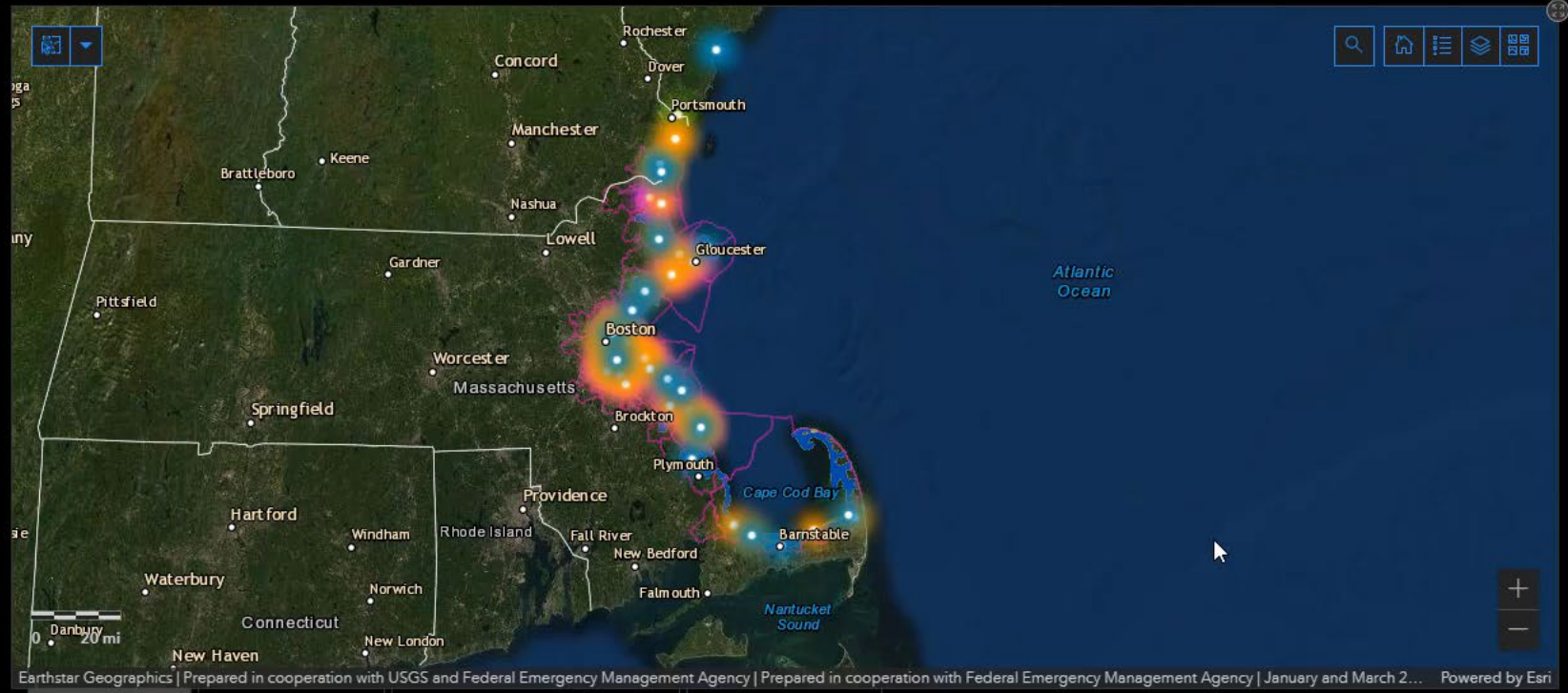
Select by data type
Show all data

Select by Town/City
Show all data

Filter data by elevation range
6 - 11

11
6
Reset

NOTE: These data filters only filter data points and associated content. They do not filter the inundation maps viewed in the map extent. The inundation maps can be turned off and on using the layer options in the upper right menu of the map.



2 of 91

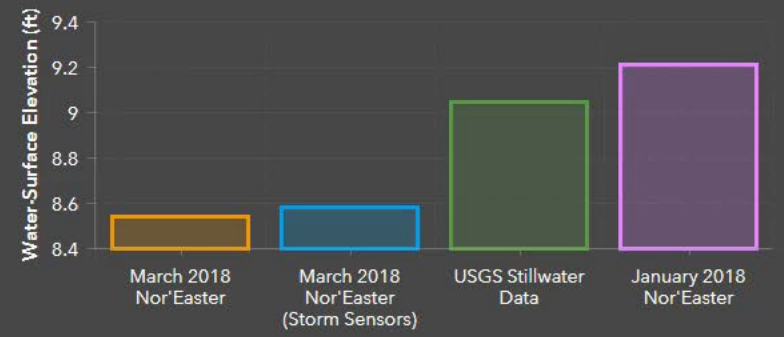
March 2018 Nor'Easter - HWM-518

Water-Surface Elevation (ft)	8.5
Data Type	High-Water Marks

HWM_518.JPG

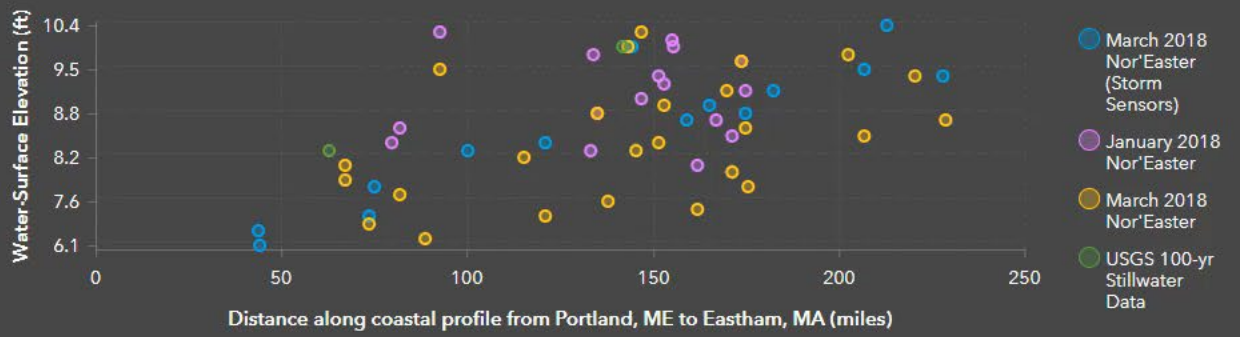
Storm Event Map | Related Publications | USGS High-Water Mark Guidance | Additional Resources

Mean Water-Surface Elevation Graph



Water-surface elevations are in feet above NAVD88

Coastal Profile Elevation Graph



Water-surface elevations are in feet above NAVD88

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Questions?

Photo by Dale Tom Houghs Neck Maritime Center
Quincy, MA 1/6/2018

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https://pubs.er.usgs.gov/publication/sir20215109

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