RHODE ISLAND STATEWIDE PLANNING PROGRAM
TECHNICAL COMMITTEE MEETING

Friday, November 6, 2015
RIDOA, Conference Room A
One Capitol Hill, Providence, RI

DRAFT MINUTES

I. Attendance

1. Members Present

Mr. Michael DeLuca, Vice Chair	Town of Narragansett
Mr. Jared Rhodes, Secretary	RI Statewide Planning Program
Mr. John Chambers	Fuss & O'Neill, Incorporated
Ms. Ashley Hahn	Town of Exeter
Mr. Thomas Kogut	RI Public Utilities Commission
Ms. Eliza Lawson	RI Department of Health
Ms. Lisa Primiano	RI Department of Environmental Management
Mr. Arnold Robinson	Roger Williams University
Ms. Jennifer Siciliano	City of Woonsocket
Mr. Jeffrey Willis	RI Coastal Resources Management Council
Mr. Ronald Wolanski	Town of Middletown

2. Members Absent

Mr. Bob Azar, Chair	City of Providence
Mr. Steve Devine	RI Department of Transportation
Ms. Nicole LaFontaine	Town of North Kingstown
Ms. Nancy Letendre	Mason & Associates, Incorporated
Mr. Michael Walker	RI Commerce Corporation

3. Staff Present

Ms. Kimberly Crabill	RI Statewide Planning Program
Ms. Kirsten Bryan	RI Statewide Planning Program

4. Guests Present

Ms. Teresa Crean	URI Coastal Resource Center/RI Sea Grant
Mr. Grover Fugate	RI Coastal Resources Management Council
Mr. Malcolm Spaulding	URI/Ocean Engineering

II. Agenda Items

1. Call to Order

Vice-Chair DeLuca called the meeting to order at 9:05 a.m.

2. Approval of October 2, 2015 Meeting Minutes – *for action*

Vice-Chair DeLuca asked for a motion to approve the meeting minutes of October 2, 2015. Mr. Willis moved to approve and the motion was seconded by Mr. Wolanski. There was no discussion. The

following members voted aye DeLuca, Chambers, Hahn, Kogut, Lawson, Primiano, Rhodes, Robinson, Siciliano, Willis and Wolanski. There were no nay votes, abstentions or recusals.

3. Public Comment on Agenda Items – *for discussion*

   There was none.

4. STORMTOOLS Informational Presentation – *for discussion*

   Vice-Chairman Deluca introduced Grover Fugate, Malcolm Spaulding and Teresa Crean who delivered an informational presentation on STORMTOOLS (see attachment 1). Instances where the Committee engaged in discussion were as follows:

   Mr. DeLuca asked Mr. Spaulding to clarify why there was a 3' drop in flooding elevations reported between the National Flood Insurance Program's (NFIP) 2011 and 2013 flood insurance rate maps. In response, Mr. Spaulding explained that the drop in elevation did not appear to be relative to anything that was occurring in the natural world but was rather being driven by a change in the underlying methodology that was being used to predict the extent of flooding.

   Mr. Wolanski next asked if this was a concern just along the south shore or if it also pertained to areas within the Bay. Mr. Spaulding responded that there is a concern within the Bay, but that it is the opposite of that found along the southern coast. In his opinion the 2013 Bay methodology overestimates flooding elevations particularly relative to the effect of storm surge amplification.

   Mr. DeLuca then asked if the NFIP was going to take these concerns and the STORMTOOLS outputs under advisement. Mr. Spaulding responded that he reported the information to NFIP but did not know if it was being acted upon.

   Mr. Willis departed at 10:15 a.m.

   Mr. DeLuca next asked Mr. Fugate if a house built in a flood zone with a foot of freeboard is required to carry flood insurance. Mr. Fugate responded that it would only if it were federally financed. Mr. Fugate then went on to further explain that regardless of the financing status of the structure, the more freeboard you can provide the lower the insurance costs will be, and the more resilient the structure will remain in the face of pending sea level rise.

   There being no further discussion, Mr. DeLuca commended the CRMC team for their work and thanked them for taking the time to share it with the Committee.

5. 2016 Meeting Schedule - *for action*

   Vice-Chair DeLuca asked for a motion to approve the draft 2016 meeting schedule. Mr. Robinson moved to approve and the motion was seconded by Ms. Siciliano. There was no further discussion. The following members voted aye DeLuca, Chambers, Hahn, Kogut, Lawson, Primiano, Rhodes, Robinson, Siciliano, and Wolanski. Mr. Willis did not vote. There were no nay votes, abstentions or recusals.

6. Associate Director's Report – *for discussion*

   Mr. Rhodes addressed the following items under the Associate Director's report:

- Upcoming Coffee hour being held in honor of Kevin Flynn's pending retirement.
- Current Statewide Planning Program staffing vacancies
- The FY 17-25 Transportation Improvement Program (TIP) development process

Under discussion Mr. DeLuca asked if the TIP Solicitation process would allow for communities to submit projects that are not part of RIDOT's Ten Year Plan and to prioritize what it thinks is most important. Mr. Rhodes responded that it would.

7. Announcements

There were none.

8. Adjourn

Vice-Chairman DeLuca called for a motion to adjourn. Committee member Hahn made the first motion. The motion was seconded by Committee member Robinson. There was no further discussion. The following members voted aye DeLuca, Chambers, Hahn, Kogut, Lawson, Primiano, Rhodes, Robinson, Siciliano, and Wolanski. Mr. Willis did not vote. There were no nay votes, abstentions or recusals.

Respectfully Submitted,

Jared L. Rhodes, II
Secretary

Using STORMTOOLS to Assess Coastal Risk In Rhode Island

RI State Planning Council, Technical Committee – November 6, 2015

Teresa A. Crean, AICP, URI Coastal Resources Center / RI Sea Grant

CRMC Coastal Resources Management Council

The University of Rhode Island Graduate School of Oceanography | CRC Coastal Resources Center

Sea Grant Rhode Island

STORMTOOLS

Summary of Current Initiatives

STORMTOOLS TEAM

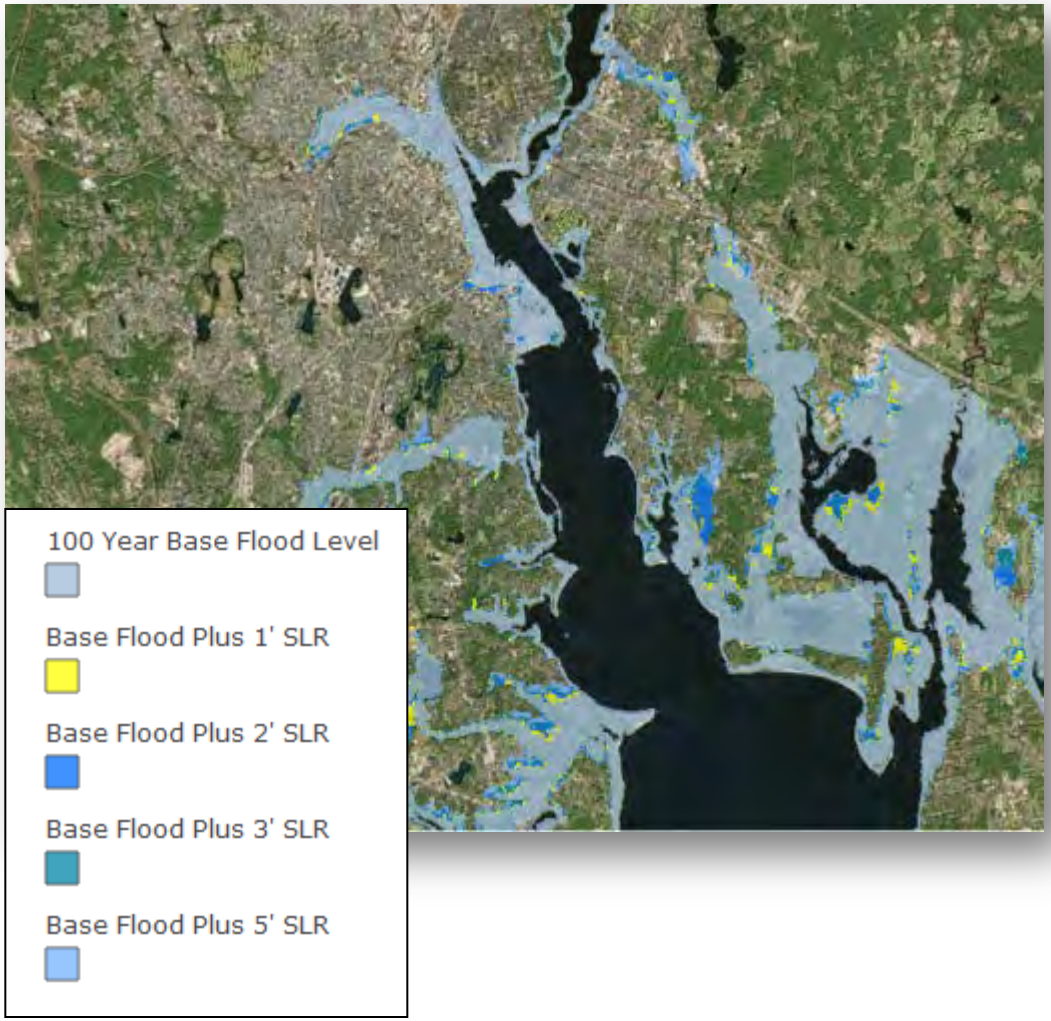
Malcolm L. Spaulding, Grover Fugate, Teresa Crean
Chris Damon, Annette Grilli, Reza Hashemi, Tatsu Isaji, Alex Shaw, and Lauren Schumbach

Ocean Engineer, University of RI, Narragansett, RI
Coastal Resources Center, University of RI, Narragansett, RI
Coastal Resources Management Council, Wakefield, RI
ASA RPS Group, Wakefield, RI

Rising Seas Summit, Boston, MA
November 5, 2015

STORMTOOLS:

Maps of Storms + Sea Level Rise



VISUALIZATIONS

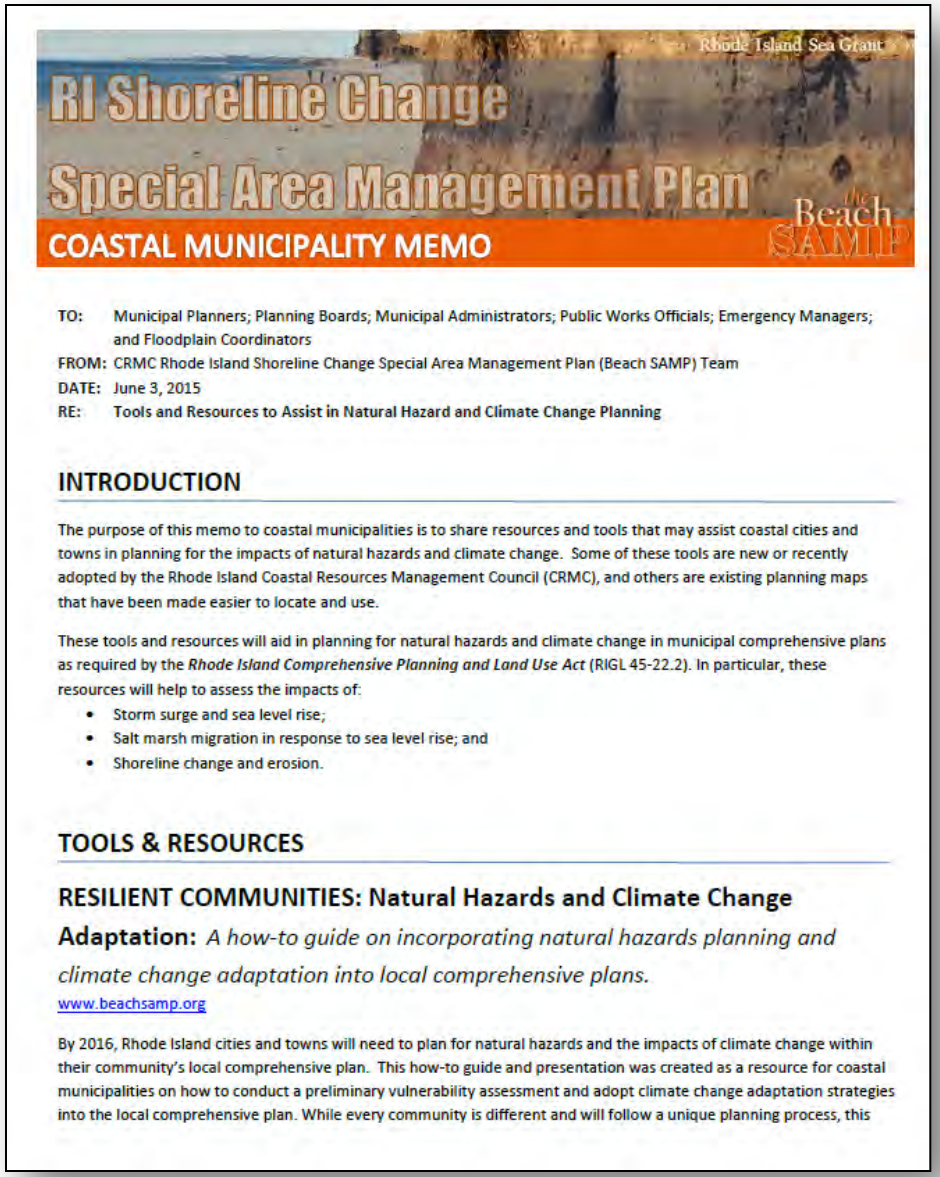
Maps flooding from a 10, 25, 50, 100-year storm PLUS Sea Level Rise on most recent LiDAR / Digital Elevation Models of Rhode Island

Provide accurate depiction of future flooding risk

APPLICATIONS

Day-to-Day operations

Long term planning/financing



Rhode Island Sea Grant

RI Shoreline Change

Special Area Management Plan

the Beach SAMP

COASTAL MUNICIPALITY MEMO

TO: Municipal Planners; Planning Boards; Municipal Administrators; Public Works Officials; Emergency Managers; and Floodplain Coordinators

FROM: CRMC Rhode Island Shoreline Change Special Area Management Plan (Beach SAMP) Team

DATE: June 3, 2015

RE: Tools and Resources to Assist in Natural Hazard and Climate Change Planning

INTRODUCTION

The purpose of this memo to coastal municipalities is to share resources and tools that may assist coastal cities and towns in planning for the impacts of natural hazards and climate change. Some of these tools are new or recently adopted by the Rhode Island Coastal Resources Management Council (CRMC), and others are existing planning maps that have been made easier to locate and use.

These tools and resources will aid in planning for natural hazards and climate change in municipal comprehensive plans as required by the *Rhode Island Comprehensive Planning and Land Use Act* (RIGL 45-22.2). In particular, these resources will help to assess the impacts of:

- Storm surge and sea level rise;
- Salt marsh migration in response to sea level rise; and
- Shoreline change and erosion.

TOOLS & RESOURCES

RESILIENT COMMUNITIES: Natural Hazards and Climate Change Adaptation: *A how-to guide on incorporating natural hazards planning and climate change adaptation into local comprehensive plans.*

www.beachsamp.org

By 2016, Rhode Island cities and towns will need to plan for natural hazards and the impacts of climate change within their community's local comprehensive plan. This how-to guide and presentation was created as a resource for coastal municipalities on how to conduct a preliminary vulnerability assessment and adopt climate change adaptation strategies into the local comprehensive plan. While every community is different and will follow a unique planning process, this

Current Beach SAMP Tools & Resources

- Memo to municipalities
  - Planners
  - Council Presidents
  - Emergency Managers
  - Boards/Commissions
- Series of memos to share Beach SAMP tools/resources , findings and recommendations

Differentiating between :

Storm Flooding

Periodic/Infrequent

- Coastal & Storm Surge Driven
- Precipitation Driven

Sea Level Rise Flooding

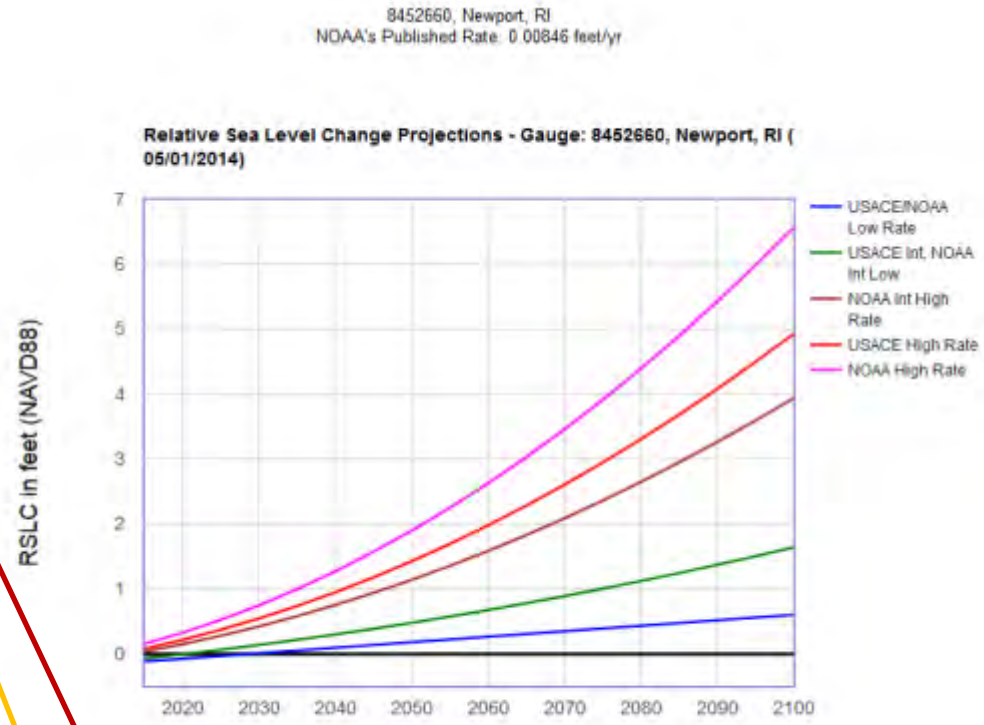
Daily; 2 times each day at high tide

Sea-Level Change Curve Calculator

Estimated Relative Sea Level Change from 2015 To 2100
8452660, Newport, RI
NOAA's Published Rate: 0.00846 feet/yr
All values are expressed in feet

Year	NOAA Low	USACE Low	NOAA Int Low	USACE Int	NOAA Int High	USACE High	NOAA High
2015	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2020	0.04	0.04	0.07	0.07	0.12	0.14	0.17
2025	0.09	0.09	0.13	0.13	0.25	0.29	0.37
2030	0.13	0.13	0.21	0.21	0.39	0.47	0.59
2035	0.17	0.17	0.29	0.29	0.55	0.66	0.84
2040	0.21	0.21	0.37	0.37	0.72	0.87	1.12
2045	0.25	0.25	0.46	0.46	0.91	1.10	1.42
2050	0.30	0.30	0.55	0.55	1.11	1.35	1.74
2055	0.34	0.34	0.64	0.64	1.32	1.61	2.10
2060	0.38	0.38	0.75	0.75	1.55	1.90	2.47
2065	0.42	0.42	0.85	0.85	1.80	2.20	2.88
2070	0.47	0.47	0.96	0.96	2.05	2.53	3.30
2075	0.51	0.51	1.07	1.07	2.33	2.87	3.76
2080	0.55	0.55	1.19	1.19	2.61	3.23	4.24
2085	0.59	0.59	1.31	1.31	2.91	3.60	4.74
2090	0.64	0.64	1.44	1.44	3.23	4.00	5.27
2095	0.68	0.68	1.57	1.57	3.56	4.41	5.83
2100	0.72	0.72	1.71	1.71	3.90	4.85	6.41

Print Table



20-year Comp Plan

30-year Mortgage

www.corpsclimate.us

www.beachsamp.org

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RI CRMC Shoreline Change Special Area Management Plan

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- Understand Risk
- Plan and Act
- Meeting Videos

STORMTOOL

STORMTOOLS For Beginners

STORMTOOLS for Beginners is a one-map stop for all residents of Rhode Island to better understand their risk from coastal inundation. This map allows you to enter an address in Rhode Island, and get answers to 3 questions about your property:

1. Is my property vulnerable to STORM SURGE?;
2. How DEEP will the water be on my property during a 100-year (1% chance) coastal storm?; and
3. Will projected SEA LEVEL RISE affect my property?

Open ▾ Details

Step-by-Step Quick Guide to accessing STORMTOOLS Mapping:

Search ...

Recent Posts

- Elevation Drowning Salt Marshes October 22, 2015
- Rhode Island Working to Adapt to Climate Change October 16, 2015
- Documentary takes dire look at sea level October 8, 2015
- NOAA Fisheries Celebrates Aquaculture Week September 28, 2015
- SEPTEMBER 29: Film Shored-up and Panel Discussion September 4, 2015
- OCTOBER 2: Salt Marsh Tour September 4, 2015
- SEPTEMBER 25: South Kingstown Coastal Erosion Walking Tour September 4, 2015
- Tracking changes to our shoreline August 26, 2015
- Nature or Nurture for Storm-Damaged Coastlines? August 7, 2015

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STORMTOOLS

STORMTOOLS is a simplified method to map storm inundation with and without sea level rise for varying return periods has been developed and implemented for RI coastal waters.

To view STORMTOOLS Flood Extent Maps, click here.

To view STORMTOOLS, Flooding Depth Maps, click here.

To view STORMTOOLS wave heights and water levels (based on NACCS data)

Or you can visit www.arcgis.com/home/ and search for "stormtools"

Learn about the science behind STORMTOOLS

Search ...

Recent Posts

- New tools give coastal communities a leg up on adaptation planning
- Start thinking now: Public comment period for Beach SAMP document opens
- Have a say in state guidance to help coastal communities adapt to climate change
- 2015 Lecture Series!
- DEM SEEK NOMINATIONS
- Adaptation Report Online: Newport Resilience Assessment Tour (NRAT)
- Adaptation Information: Guidance for Municipalities Powerpoint
- Visual Summary of Adaptation Practices
- Rescheduled Coastal State Discussion Series for April 28th, 2015
- New Pilot Projects in Rhode Island

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The Science Behind STORMTOOLS

Information about the maps:

A simplified method to map storm inundation with and without sea level rise for varying return periods has been developed and implemented for RI coastal waters. The method, described in Spaulding and Isaji (2014), is based on using the water level vs return periods at the NOAA gauging station at Newport, RI and scaling the values, based on the prediction of high resolution storm simulations performed by NOAA using their Sea, Lake and Overland Surges from Hurricanes (SLOSH) model, to estimate inundation levels for varying return periods for the coastal waters of the state. Predictions are provided for once in 25, 50, and 100 yr return periods (at the upper 95% confidence level), with sea level rises of 1, 2, 3, and 5 ft (0.3, 0.6, 0.9, and 1.52 m).
STORMTOOLS: Web tools to support coastal resilience analysis and planning for storms and sea level rise

STORMTOOLS Overview

The vision of this effort is to develop a system called STORMTOOLS that provides access to a suite of coastal planning tools (numerical models and others) available as a web service. This allows the Rhode Island user to select a coastal area of interest to access, use and apply high resolution model information. The initial suite of tools would include those used in existing operational models (e.g. Northeast Coastal Ocean Forecasting System, NECOFS) or hindcasts planned under the U.S. Army Corps of Engineers', North Atlantic Coast Comprehensive Study (NACCS)- CSTORM initiative to predict winds, waves, and currents. The models will link directly to the forecast or hindcast fields provided by these large scale models. The models and associated databases will reside on the web server site and run remotely via the web. Our goal is to pilot STORMTOOLS in Rhode Island, and then make it available to the rest of the Northeast, as the tools can be easily adapted to others in the region.

The system will either be hosted by a government agency, a regional collaborative organization (one of the recently formed Regional Ocean Councils, IOOS Regional Association), or reside on the cloud (cloud to coast). The system would allow new high resolution study domains to be developed and pre-established, high resolution grids could be made available for areas of particular interest.

Search ...

Recent Posts

- New tools give coastal communities a leg up on adaptation planning
- Start thinking now: Public comment period for Beach SAMP document opens
- Have a say in state guidance to help coastal communities adapt to climate change
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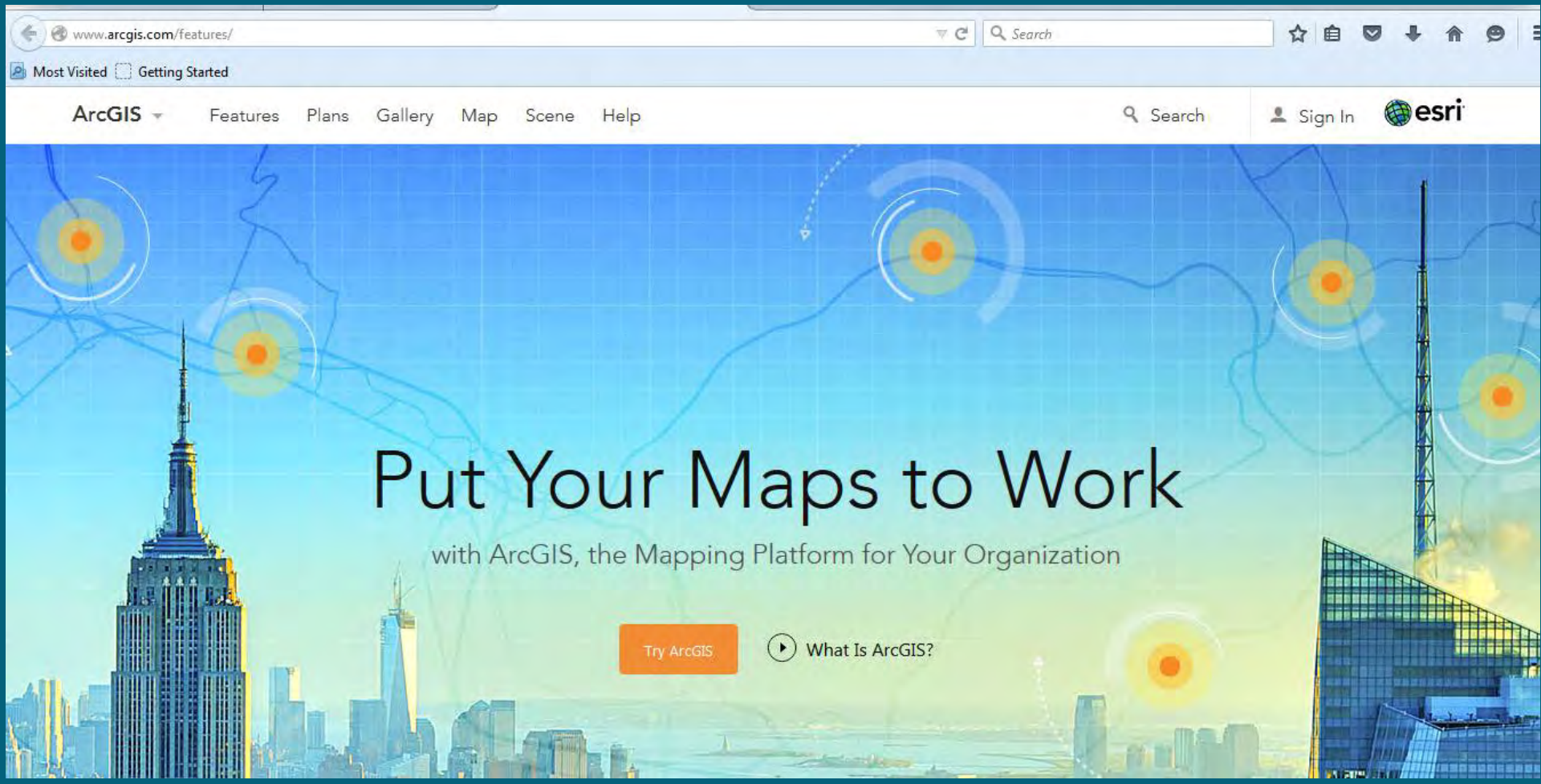
- New Pilot Projects in Rhode Island

www.arcgis.com



Cloud-based interactive map platform
Allows integration of LOCAL geospatial data

www.arcgis.com

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STORMTOOLS, Flood Extent Maps

These maps provide users with the ability to see the projected extent of flooding for multiple storm event and sea level rise scenarios.

created by URIEDC_cdamon on March 24, 2015

Details

STORMTOOLS, Flooding Depth Maps

These maps provide users with the ability to see projected water depths at specific locations. Click the map to retrieve the depth of water relative to NAVD88.

created by URIEDC_cdamon on March 24, 2015

Details

STORMTOOLS, NACCS Modeling Output and Products

Maps and documents using NACCS model output for Rhode Island

created by URIEDC_cdamon on May 15, 2015

Details

More Information

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STORMTOOLS, Flood Extent Maps

These maps provide users with the ability to see the projected extent of flooding for multiple storm event and sea level rise scenarios.

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Individual Inundation Layers for a 10-Year Storm Event

Use these maps to turn on/off individual layers to visualize the potential impacts from storm events and sea level rise.

Web Map by URIEDC_cdamon

Last Modified: March 18, 2015

(0 ratings, 0 comments, 59 views)

Open ▼ Details

Individual Inundation Layers for a 100-Year Storm Event Plus Sea Level Rise

Use these maps to turn on/off individual layers to visualize the potential impacts from storm events and sea level rise.

Web Map by URIEDC_cdamon

Last Modified: March 18, 2015

(0 ratings, 0 comments, 3,073 views)

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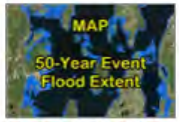
Individual Inundation Layers for a 25-Year Storm Event Plus Sea Level Rise

Use these maps to turn on/off individual layers to visualize the potential impacts from storm events and sea level rise.

Web Map by URIEDC_cdamon

Last Modified: March 18, 2015

(0 ratings, 0 comments, 2,019 views)



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Individual Inundation Layers for a 50-Year Storm Event Plus Sea Level Rise

Use these maps to turn on/off individual layers to visualize the potential impacts from storm events and sea level rise.

Web Map by URIEDC_cdamon

Last Modified: March 18, 2015

(0 ratings, 0 comments, 1,028 views)

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Individual Inundation Layers for Projected Sea Level Rise

Use these maps to turn on/off individual layers to visualize the potential impacts from sea level rise.

Web Map by URIEDC_cdamon

Last Modified: March 18, 2015

(0 ratings, 0 comments, 1,163 views)

Group Details

URIEDC_cdamon

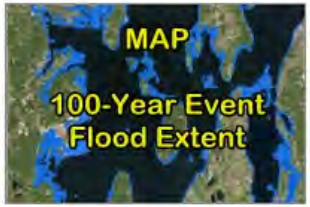
Status: public

Contributors: Only group owner

Tags:

stormtools, storm tools, flood, extent

Individual Inundation Layers for a 100-Year Storm Event Plus Sea Level Rise



Use these maps to turn on/off individual layers to visualize the potential impacts from storm events and sea level rise.

Web Map by URIEDC_cdamon
Last Modified: March 18, 2015

(0 ratings, 3,840 views)

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Description

A simplified method to map storm inundation with and without sea level rise for varying return periods has been developed and implemented for RI coastal waters. The method, described in Spaulding and Isaji (2014), is based on using the water level vs return periods at the NOAA gauging station at Newport, RI and scaling the values, based on the prediction of high resolution storm simulations performed by NOAA using their Sea, Lake and Overland Surges from Hurricanes (SLOSH) model, to estimate inundation levels for varying return periods for the coastal waters of the state. Predictions are provided for once in 25, 50, and 100 yr return periods (at the upper 95% confidence level), with sea level rises of 1, 2, 3, and 5 ft (0.3, 0.6, 0.9, and 1.52 m).

Additional Resources

Scaled Sea Level Rise Summary

Map Contents

Modeled Inundation Layers:

http://sandy.edc.uri.edu/arcgis/rest/services/ScaledSLR/MapService_100yr_Event/MapServer

Imagery:

http://services.arcgisonline.com/ArcGIS/rest/services/World_Imagery/MapServer

Properties

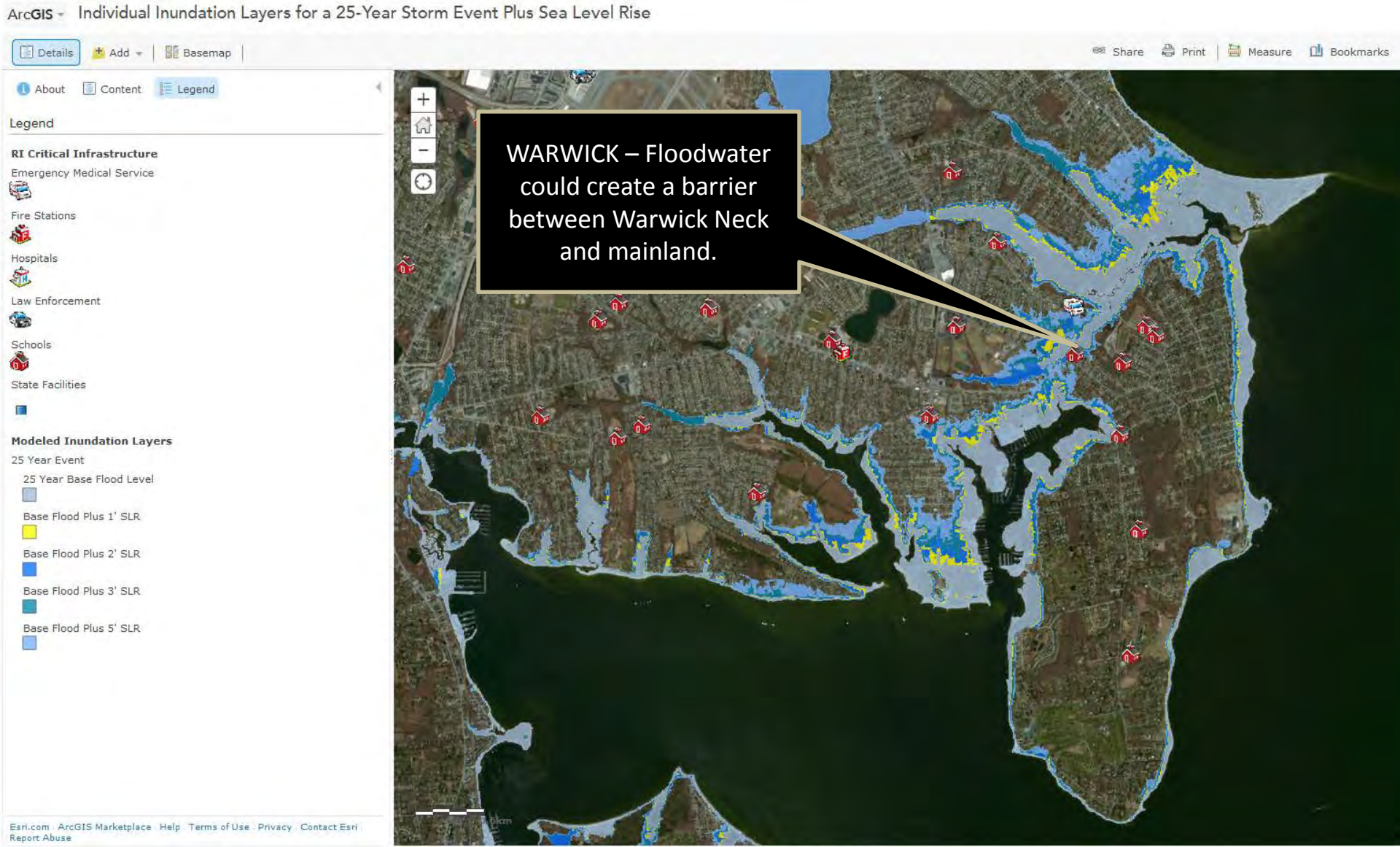
Tags	SLR, Sea Level Rise, MHHW, Scaled SLR, Inundation, storm tools, stormtools, extent
Credits	RI CRMC, URI OCE, URI EDC, URI CRC, NOAA
Size	1 KB
Extent	Left: -71.86 Right: -71.06
	Top: 41.78 Bottom: 41.34

STORMTOOLS

25-year Storm Event + sea level rise

Police / Fire / EMA

- Service areas cutoff or limited by flooding?
- Facilities at risk of being offline from flooding?



STORMTOOLS

25-year Storm Event + sea level rise

Police /Fire / EMA

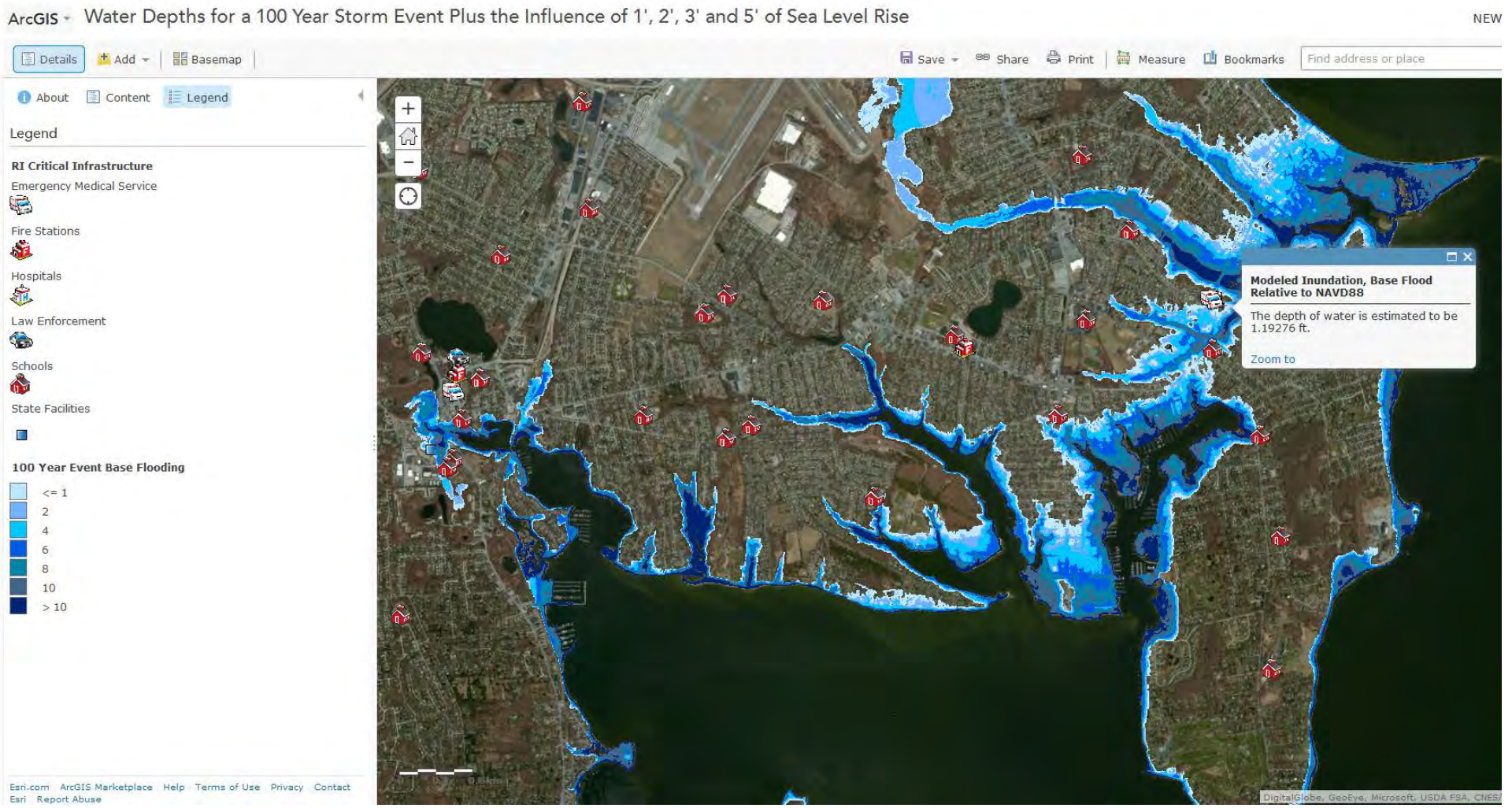
- First responders
- Recovery efforts

STORMTOOLS

100-year Storm Event, water depths

Police / Fire / EMA

- Service areas cutoff or limited by flooding?
- Facilities at risk of being offline from flooding?



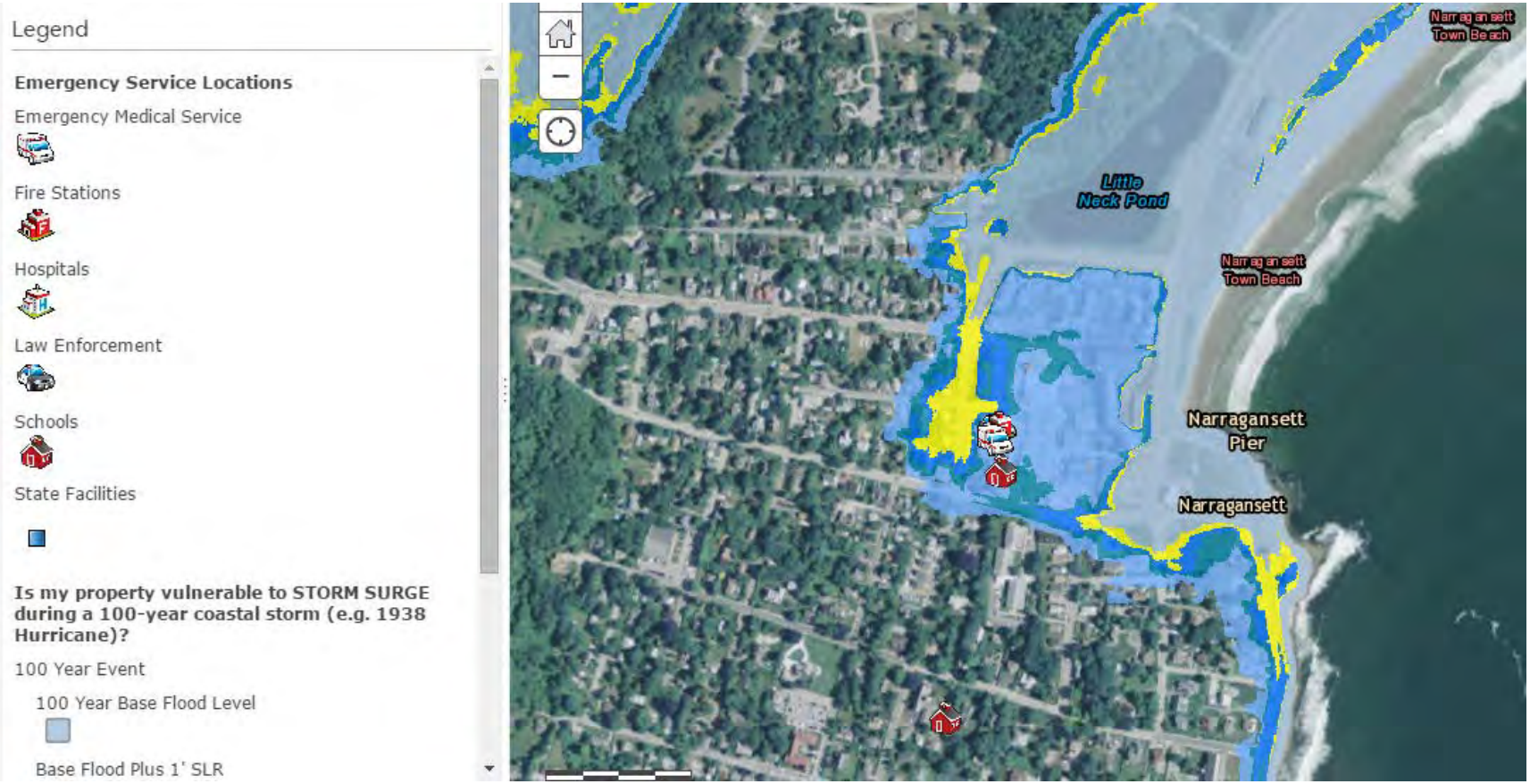
STORMTOOLS
100-year Storm Event
+SLR

Police / Fire / EMA

- Service areas cutoff or limited by flooding?
- Facilities at risk of being offline from flooding?

- Transportation

- Evacuation routes
- Functionality and service areas
- Alternate routes / road relocations
- Design life of infrastructure/assets



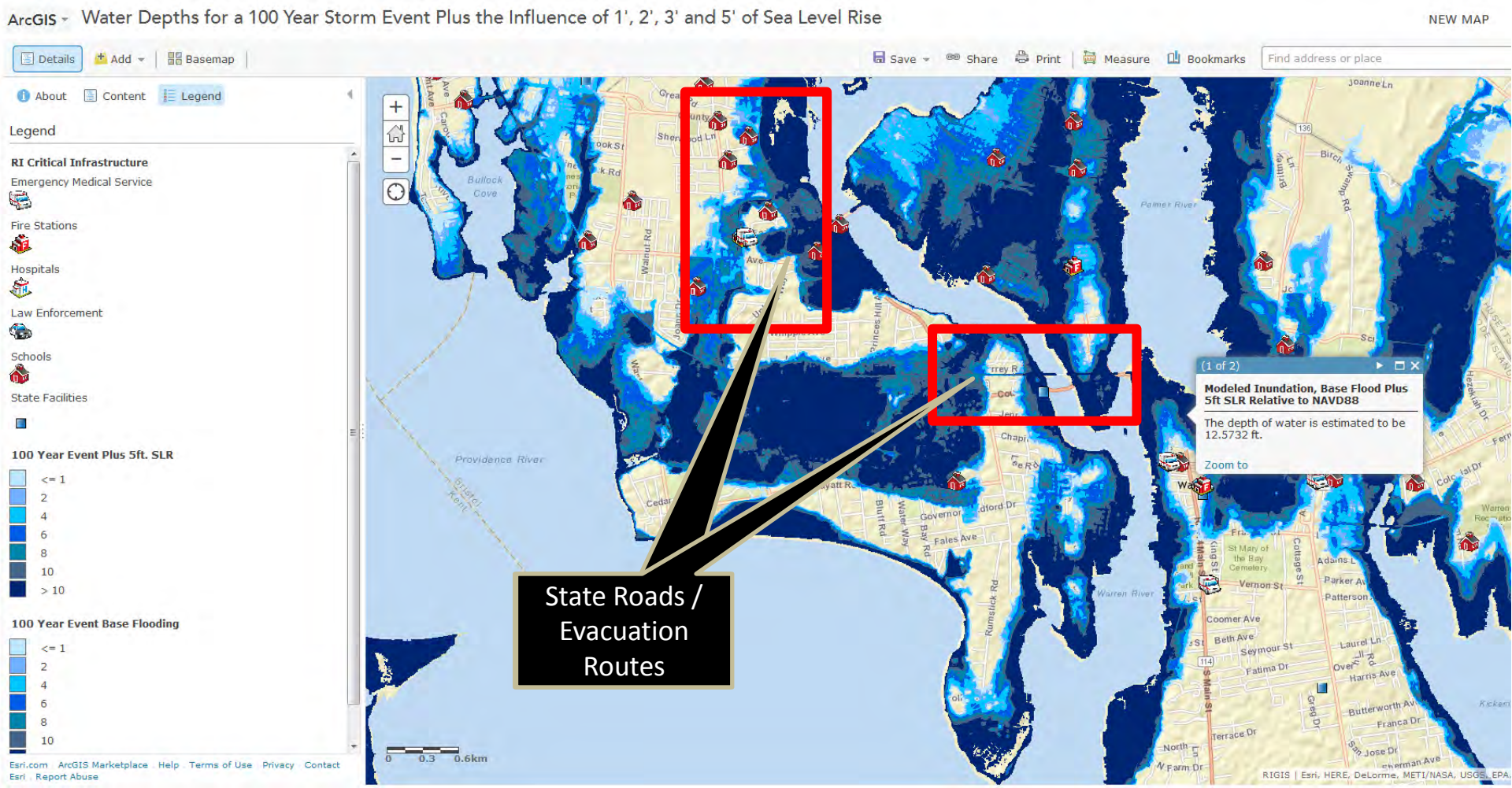
STORMTOOLS
100-year Storm Event +SLR

Critical Infrastructure -Wastewater Treatment Facilities

STORMTOOLS
100-year Storm Event
+ 5-feet SLR,
water depths

BARRINGTON / WARREN - Transportation

- Evacuation routes
- Functionality and service areas
- Alternate routes / road relocations
- Design life of infrastructure/assets



TITLE

Rhode Island Hurricane Evacuation Study
Hurricane Evacuation Mapping
June 2013
Barrington

Feet
4,000 2,000 0 4,000

US Army Corps of Engineers
New England District

FEMA

NOAA

BARRINGTON / WARREN - Transportation

- Evacuation routes
- Functionality and service areas
- Alternate routes / road relocations
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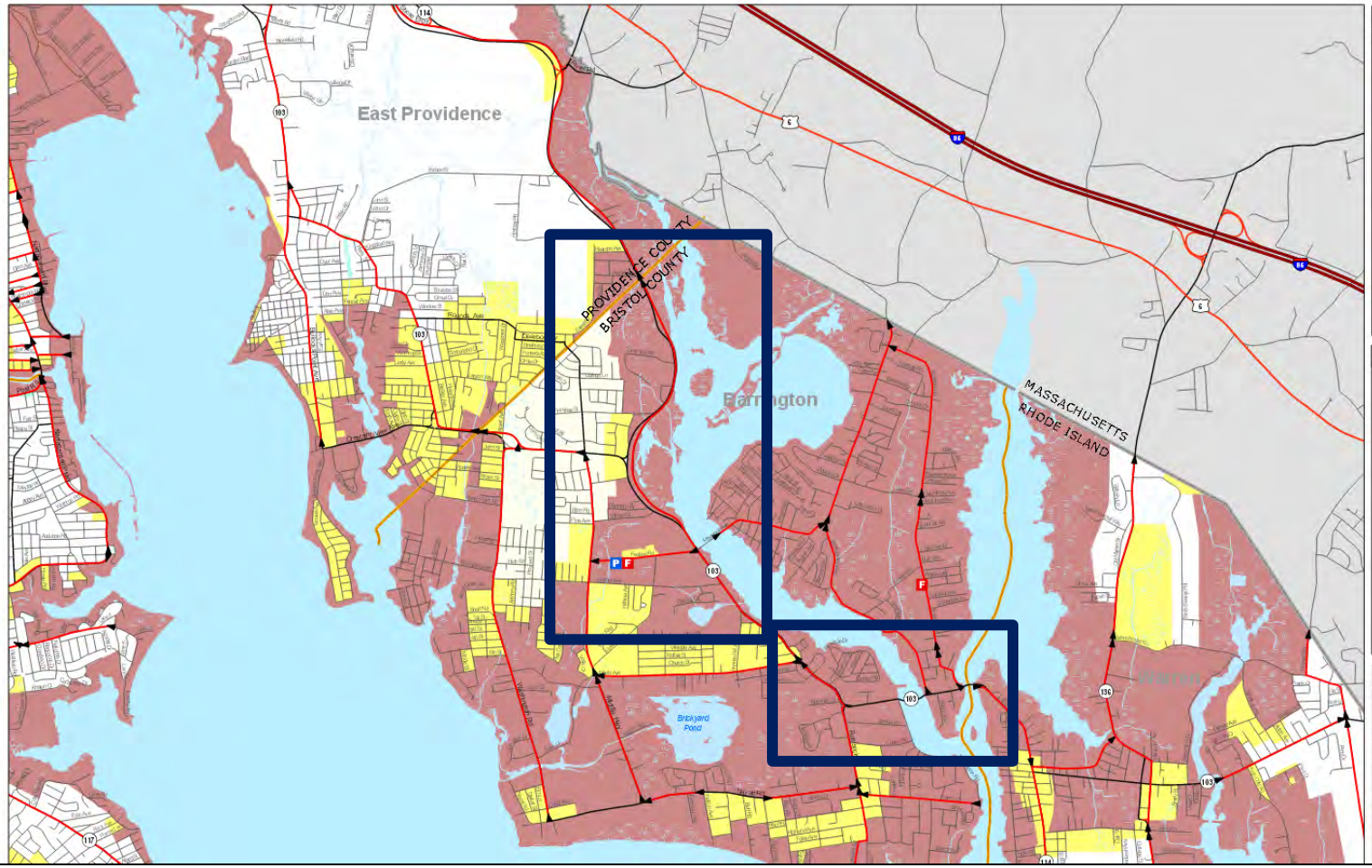

LEGEND

Hurricane Evacuation Zones
- Zone A
- Zone B

FEMA 100 year flood zone

Evacuation Route

Transportation
- Limited Access Highway
- US Highways
- State/Local Highways
- Local Road
- Railroad
- Airport

Facility Location Key
- Medical/Institutional Facilities
- Mobile Home/Trailer Park
- Fire Station
- Police Station

Hydrographic Features
- Water
- Wetlands

Political
- Town Boundary
- State Boundary

LOCATION MAP

NOTES & SOURCES

This map shows shaded Hurricane Evacuation Zones that are recommended to be evacuated from potential worst-case Hurricane Surge Inundation. Areas that may become isolated by worst-case Hurricane Surge Inundation are also included in the Evacuation Zones. Inland areas which may be exposed to fresh water flooding only are not included in the Evacuation Zones.

Evacuation Zone "A", shown in red, is recommended to be evacuated prior to an expected category 1 or 2 hurricane. Evacuation Zone "B", shown in yellow, is recommended to be evacuated prior to an expected category 3 or 4 hurricane.

Hurricane surge elevations were determined by the National

RIE911: Statewide Roads (20131231)

State of Rhode Island: E 9-1-1 Uniform Emergency Telephone System: Statewide Roads

Feature Layer by DOA_S.White_RIState

Source: Feature Service

Last Modified: January 30, 2014

(0 ratings, 1,208 views)

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Description

Mapping

The RI E 9-1-1 mapping project captures GIS (Geographic Information Systems) data consisting of information such as site location of buildings, streets, fire hydrants, public places, public telephones and driveway access points. In collecting the necessary data, employees drive a Jeep Grand Cherokee with lettering which identifies its 9-1-1 function. They drive every street and road in Rhode Island, stopping at each structure to obtain or verify an address, capture the latitude and longitude of each structure, and take a digital photograph of it. All of this information is displayed on a digital map at the RI E 9-1-1 Telecommunicator's console, enabling the call taker to assist emergency response agencies find locations of callers more quickly, whether it be a wireline or wireless call.

The GIS Data Development Project

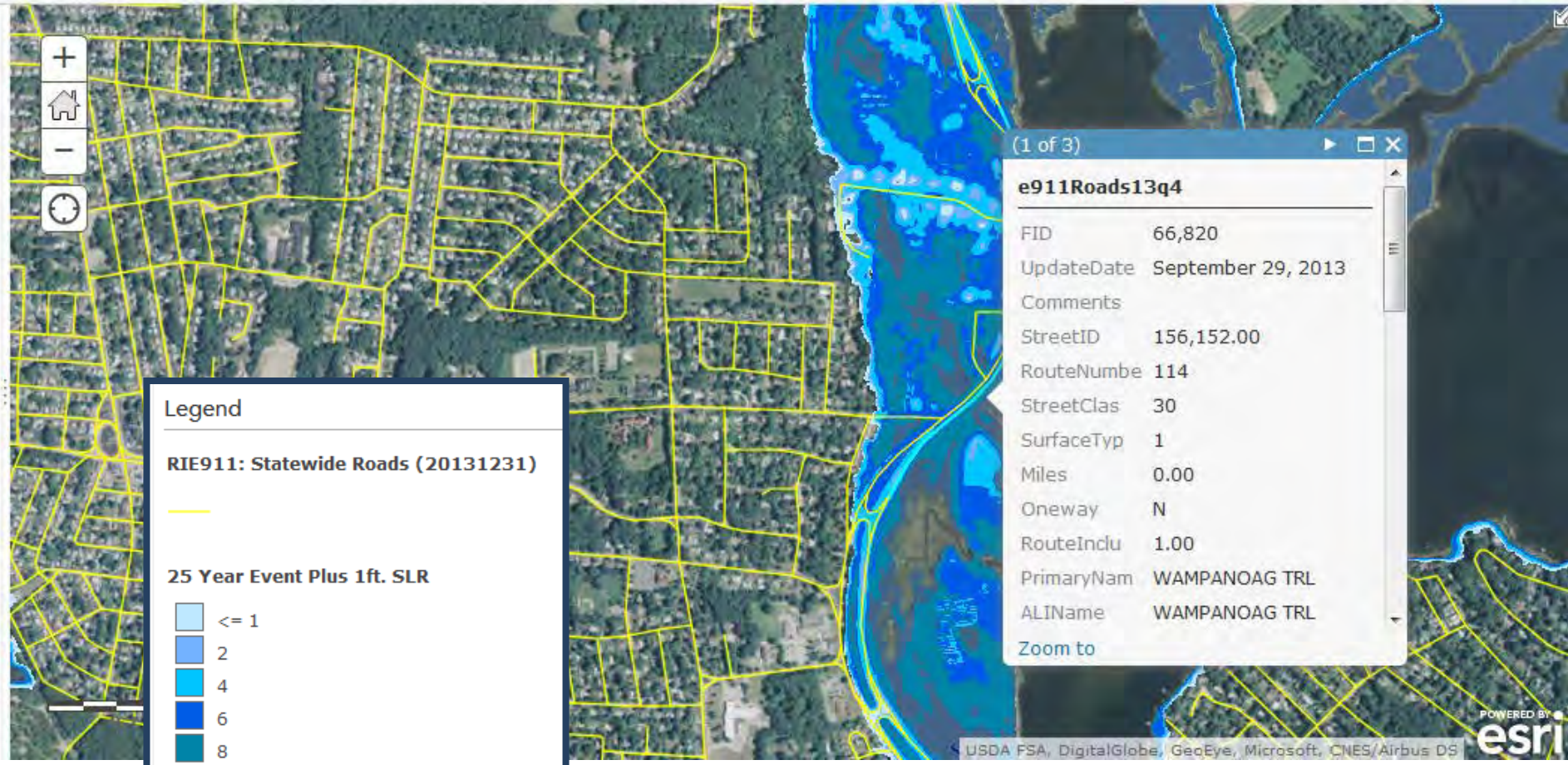
Rhode Island was the first statewide 9-1-1 system in the United States to be capable of receiving "Phase II" 9-1-1 wireless call location information. The system's GIS Data Development Project commenced in FY 2001. RI E 9-1-1 field-captures GIS data and this data is then integrated with other data layers on maps.

RI E 9-1-1 GIS data collection offers other benefits to State and local governments: the development or enhancement of databases that can be utilized for area-wide emergency notification, for

25 Year Storm Event Plus the Influence of 1', 2', 3' and 5' of Sea Level Rise

New Map Sign In

Save Share Print Measure Bookmarks Find address or place



Legend

RIE911: Statewide Roads (20131231)

25 Year Event Plus 1ft. SLR

- <= 1
- 2
- 4
- 6
- 8
- 10
- > 10

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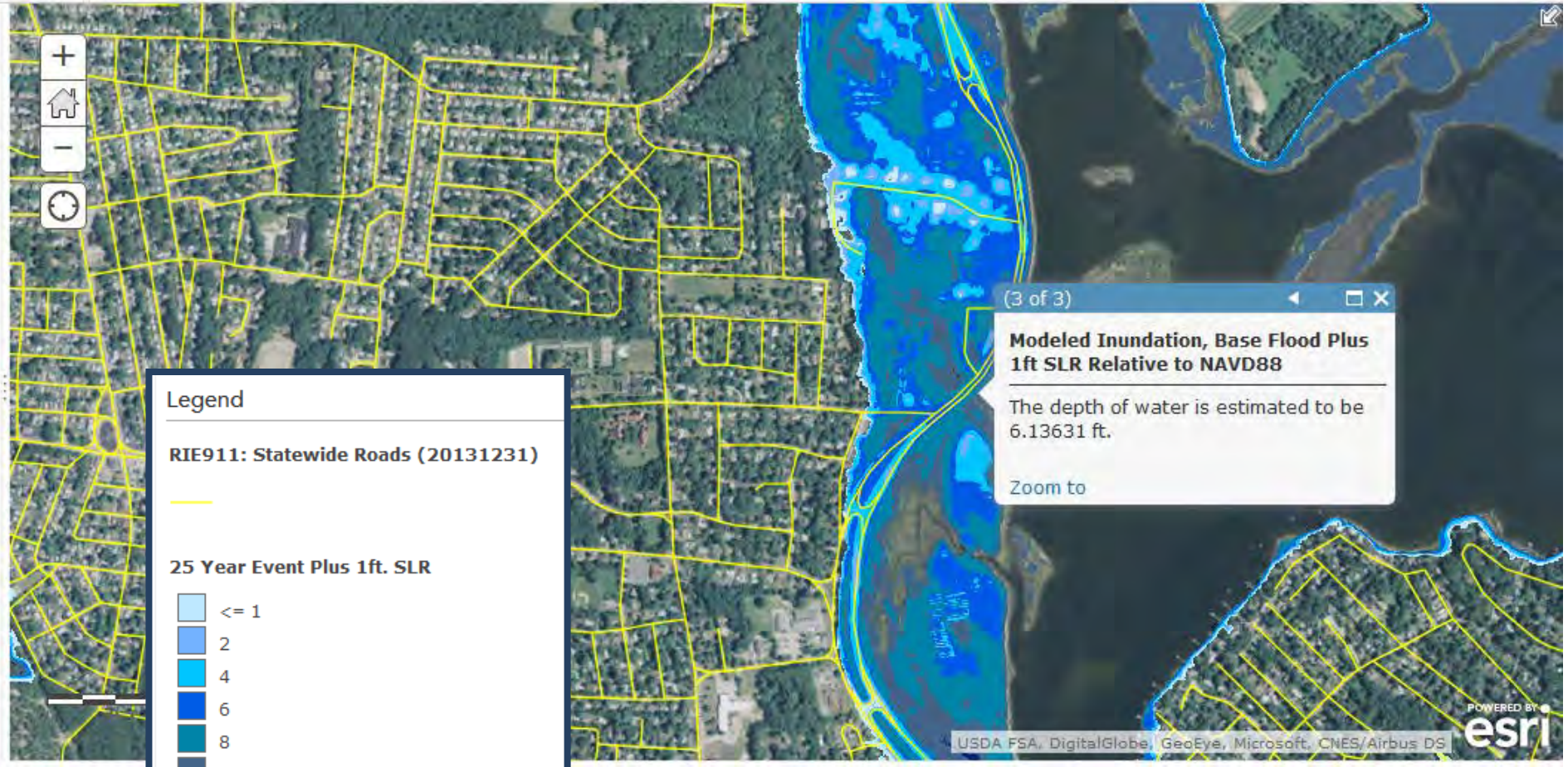
25 Year Storm Event Plus the Influence of 1', 2', 3' and 5' of Sea Level Rise

New Map Sign In

Save Share Print Measure Bookmarks Find address or place



Legend

RIE911: Statewide Roads (20131231)

25 Year Event Plus 1ft. SLR

- <= 1
- 2
- 4
- 6
- 8
- 10
- > 10

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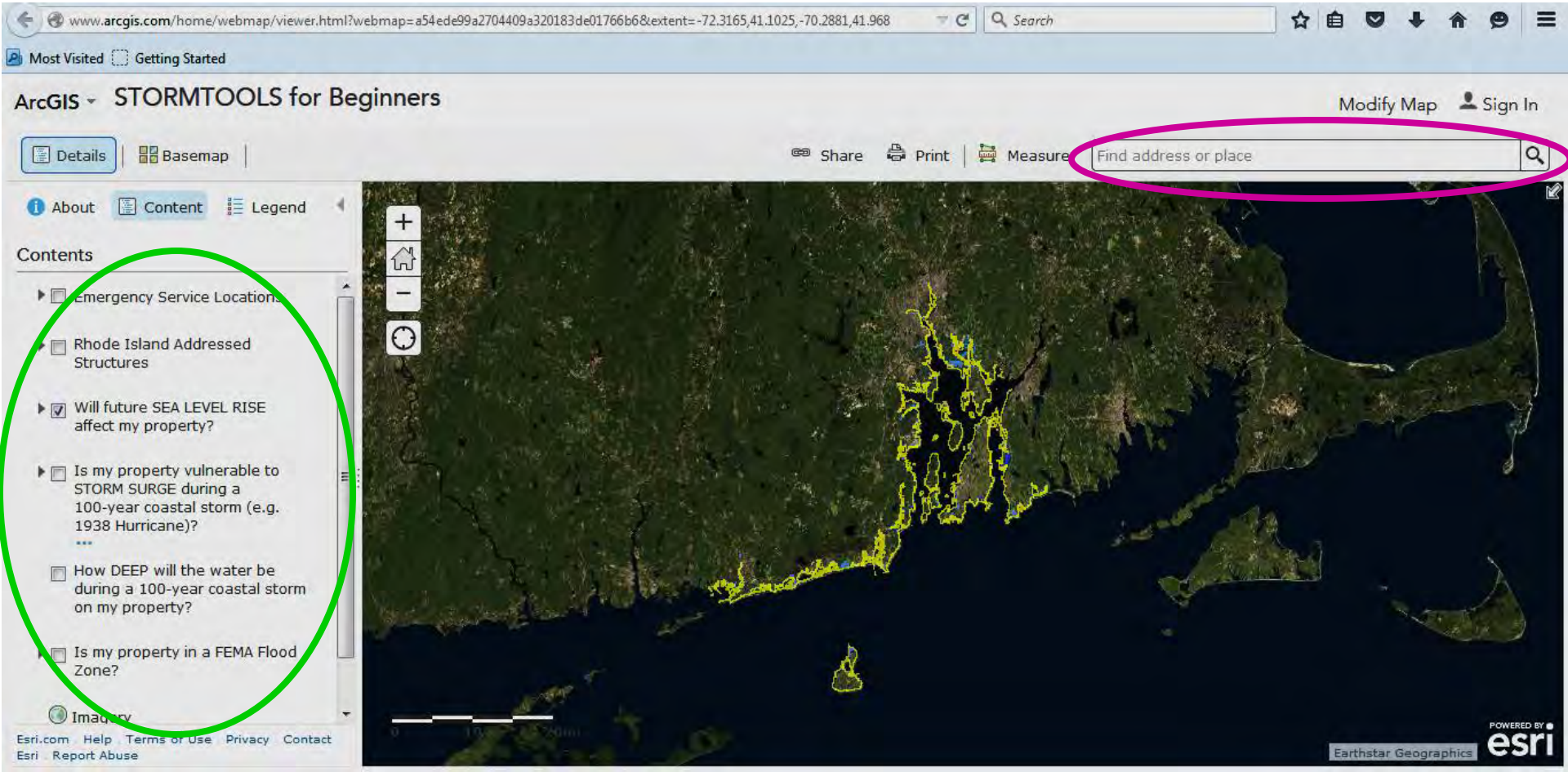
"STORMTOOLS FOR BEGINNERS"

STEP 1: Enter an address

STEP 2: Click on the question you want to answer



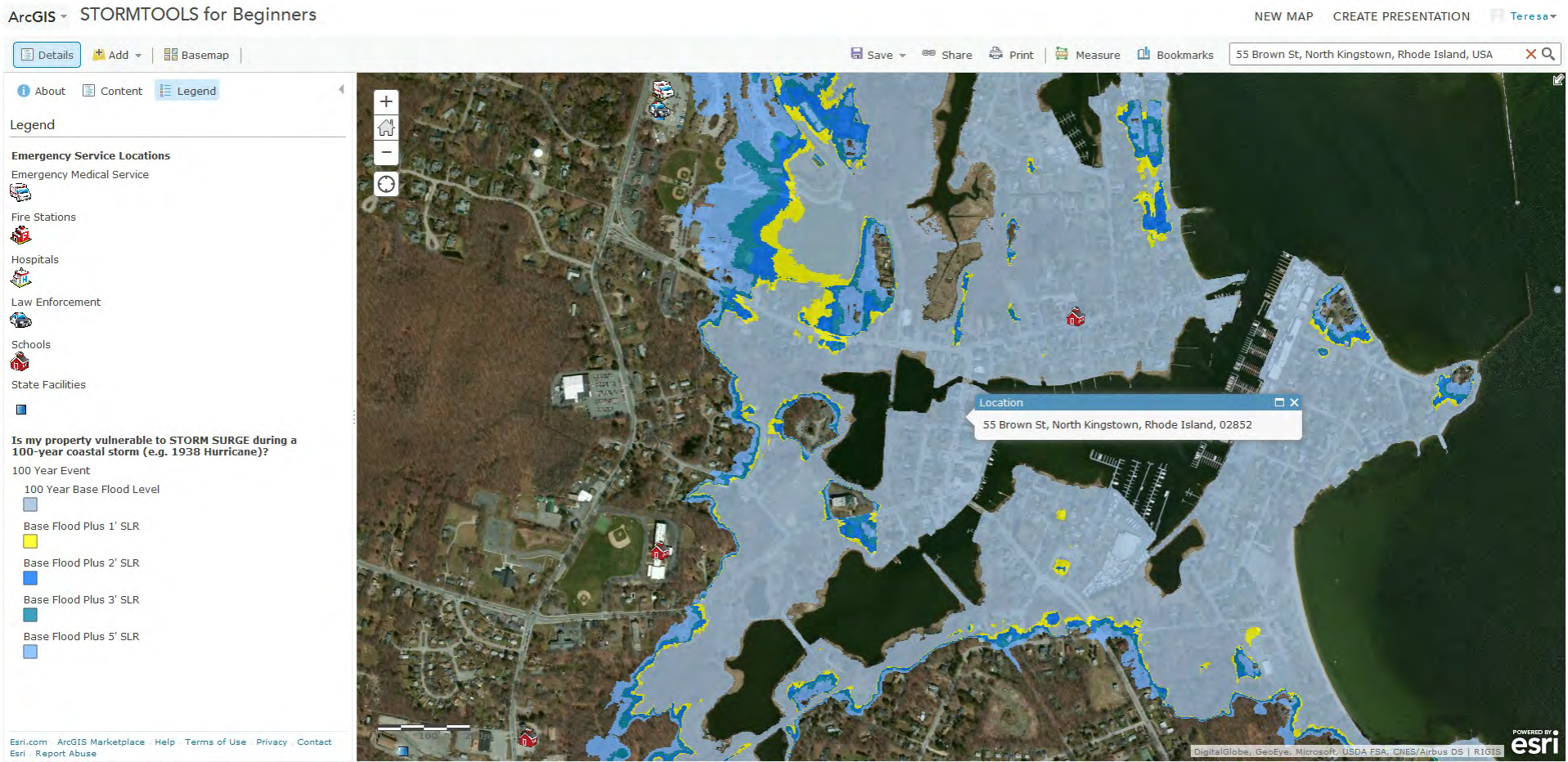
"STORMTOOLS FOR BEGINNERS"

Step 1: Enter an address

Step 2: Click on the question you want to answer

"Is my property vulnerable to STORM SURGE during a 100-year coastal storm (e.g. 1938 Hurricane)?"

(flood extent map)



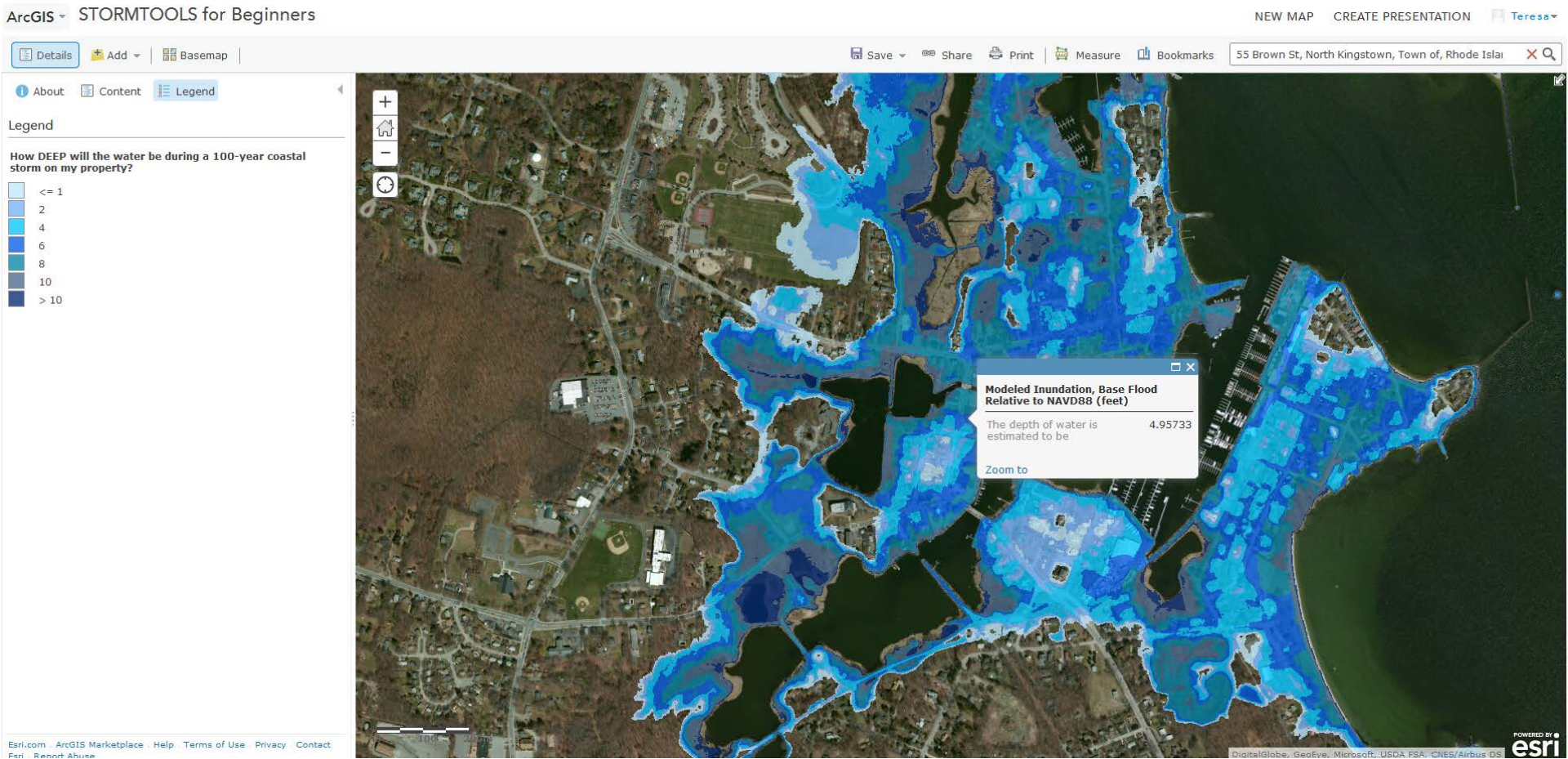
"STORMTOOLS FOR BEGINNERS"

Step 1: Enter an address

Step 2: Click on the question you want to answer

"How DEEP will the water be during a 100-year coastal storm on my property?"

(water depth map)



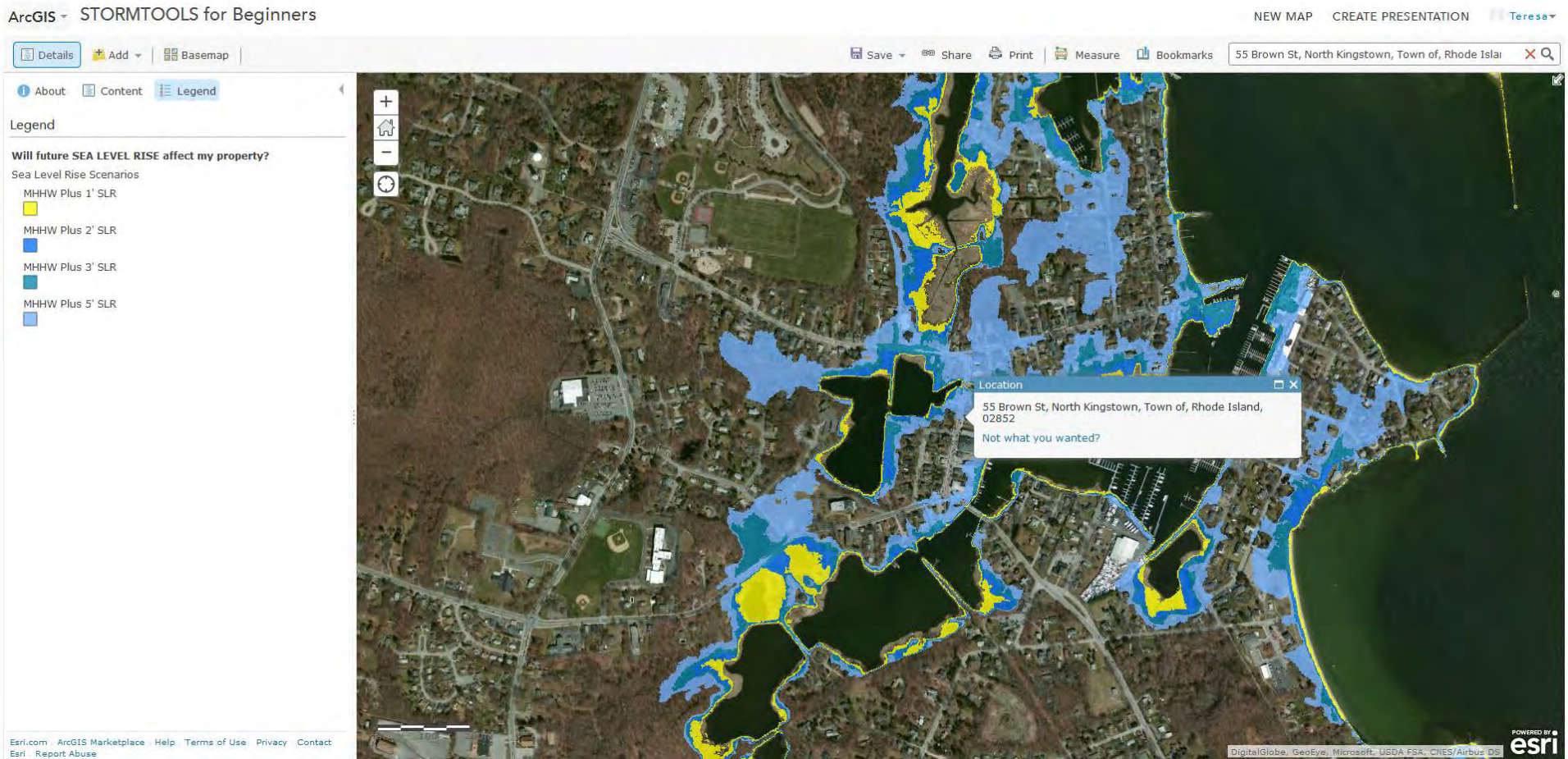
"STORMTOOLS FOR BEGINNERS"

Step 1: Enter an address

Step 2: Click on the question you want to answer

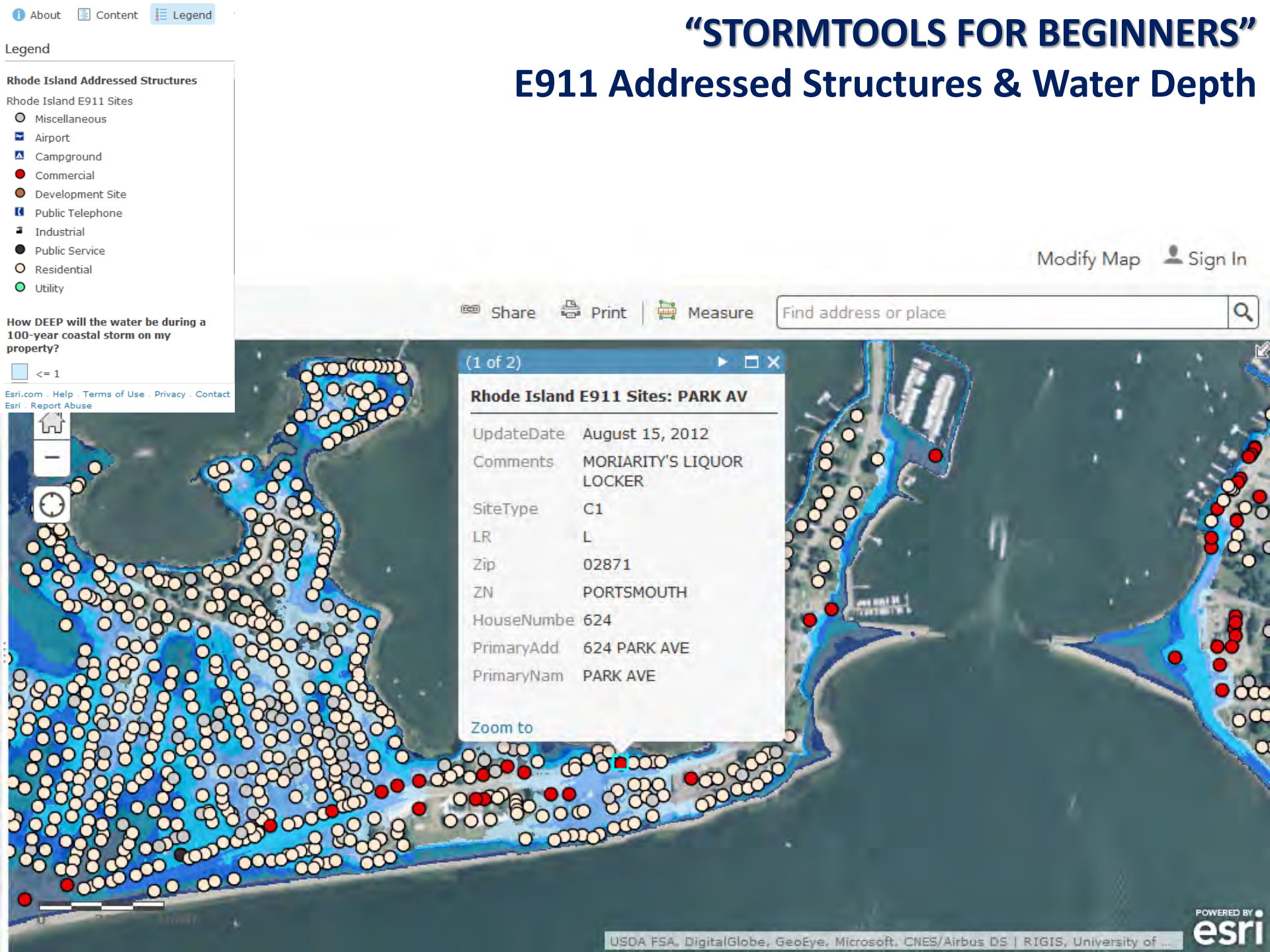
"Will future SEA LEVEL RISE affect my property (with 2 tides per day, every day)?"

(sea level rise scenario map)



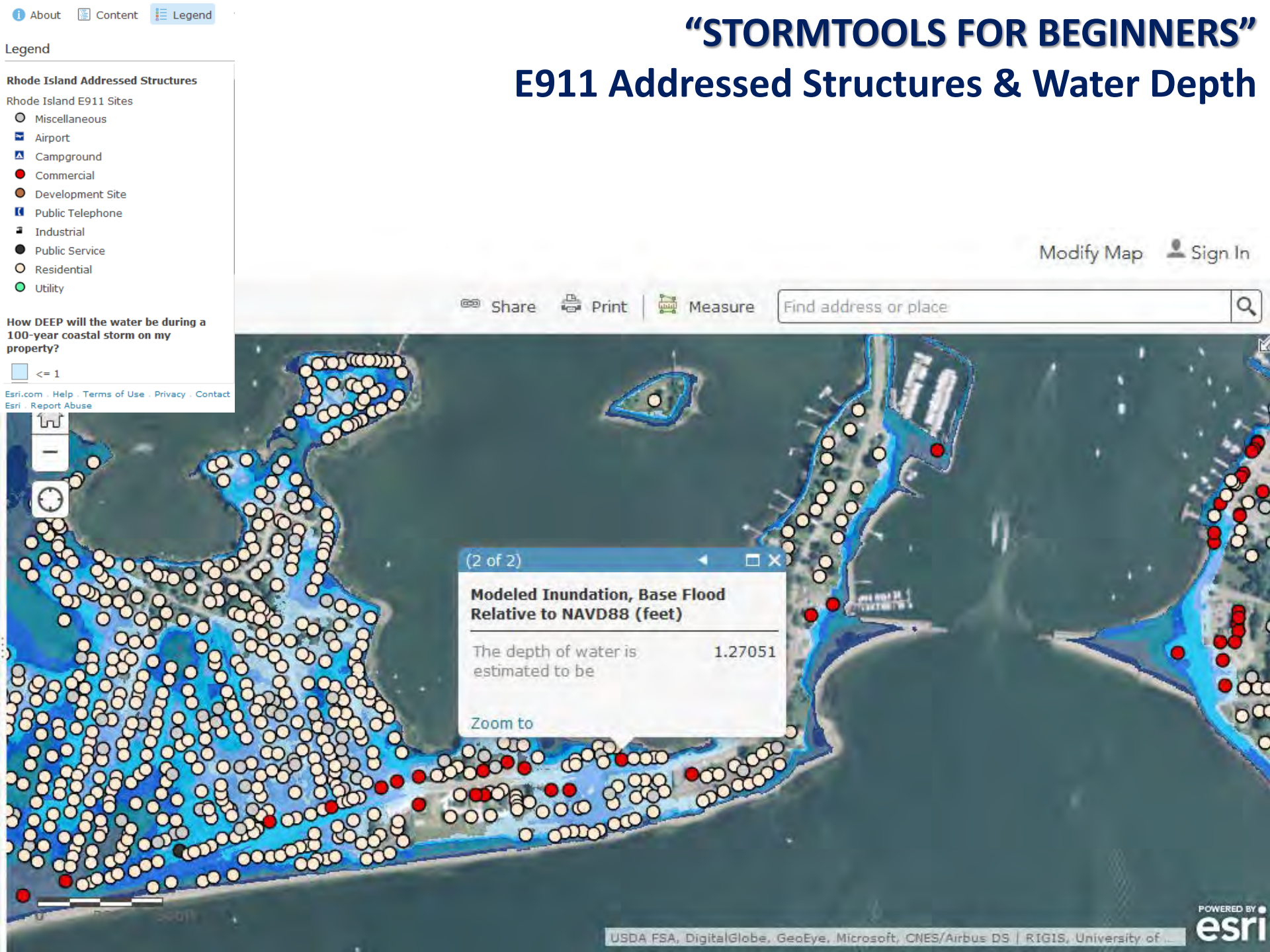
"STORMTOOLS FOR BEGINNERS"

E911 Addressed Structures & Water Depth



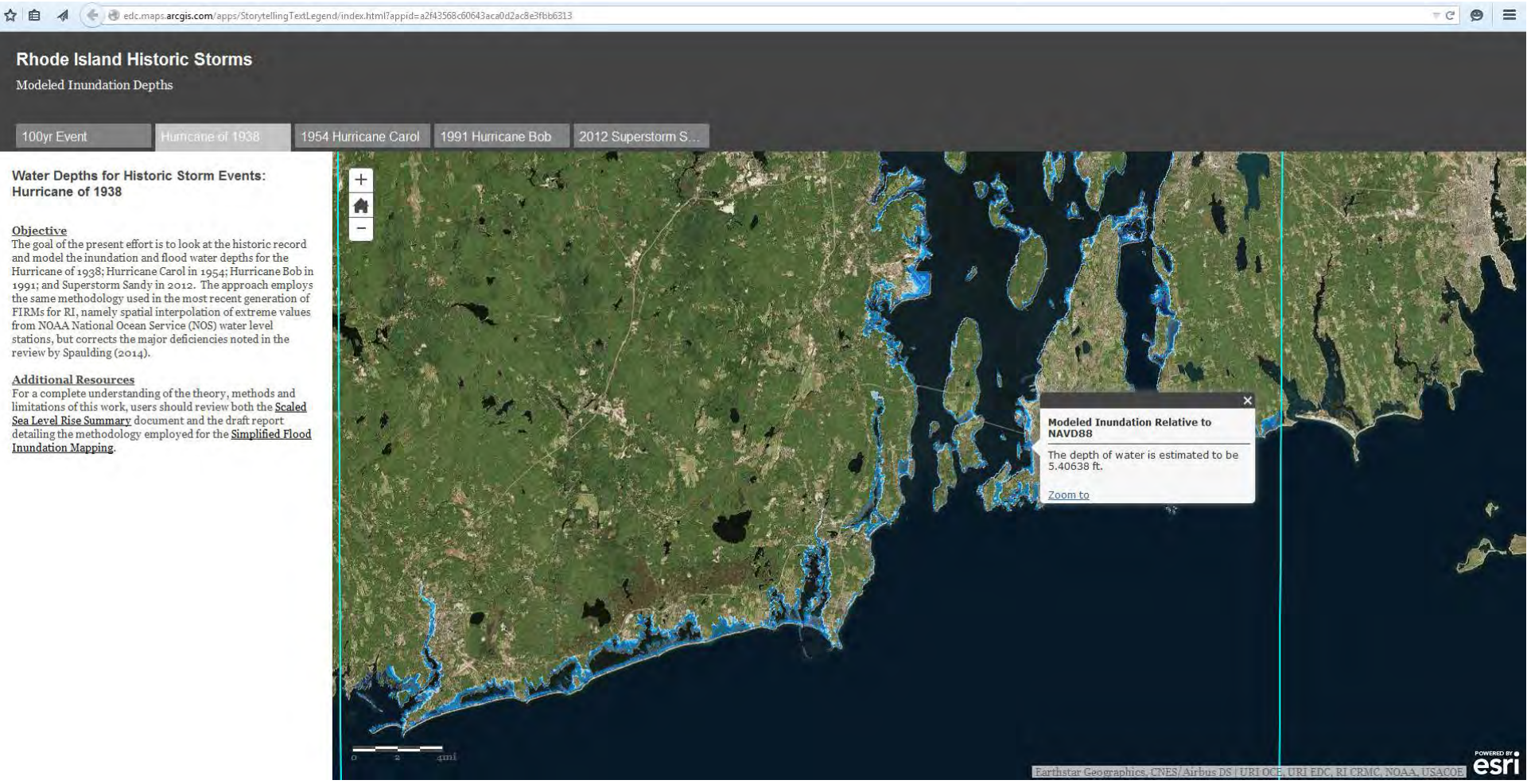
"STORMTOOLS FOR BEGINNERS"

E911 Addressed Structures & Water Depth



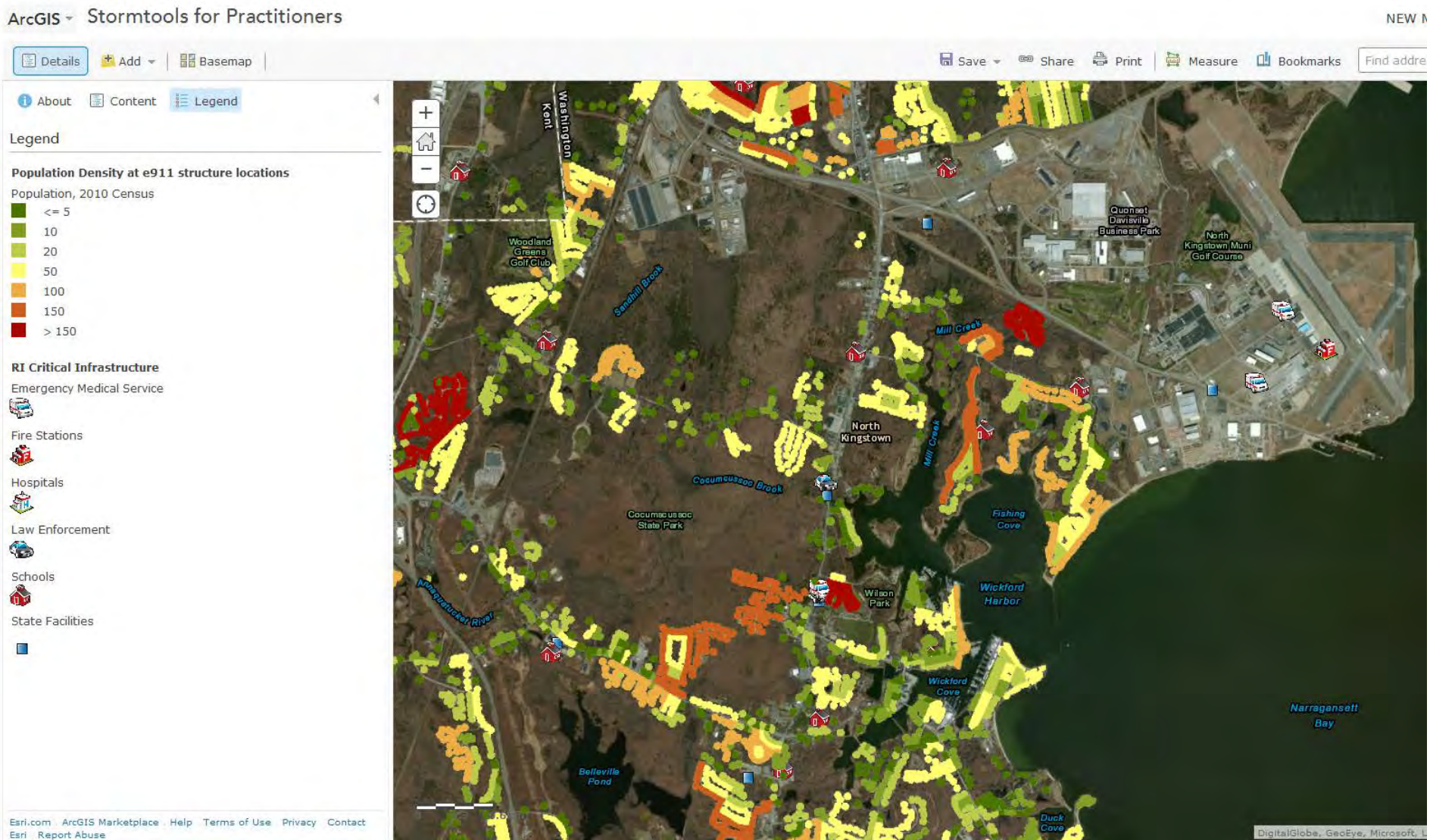
STORY MAPS (a.k.a. ArcGIS Online "Apps")

- **Allows** user to view similar areas with pre-defined scenarios
- **Doesn't allow** user to turn layers on/off
- Provides text box for descriptions, explanations, and links



"STORMTOOLS FOR MUNICIPALITIES"

Train professionals who will use the tool to access and import data sets for more advanced analysis



“STORMTOOLS FOR MUNICIPALITIES”

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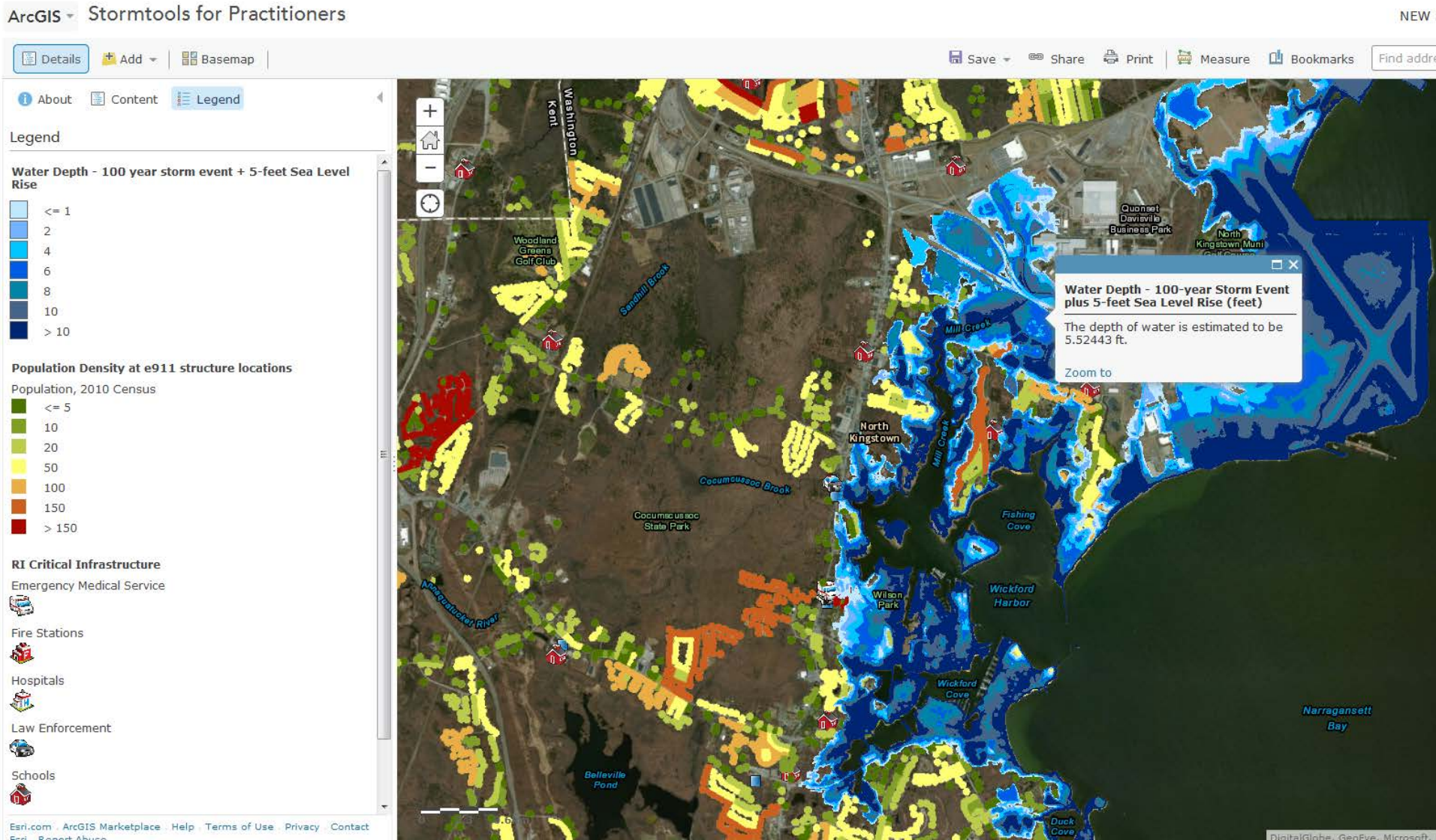
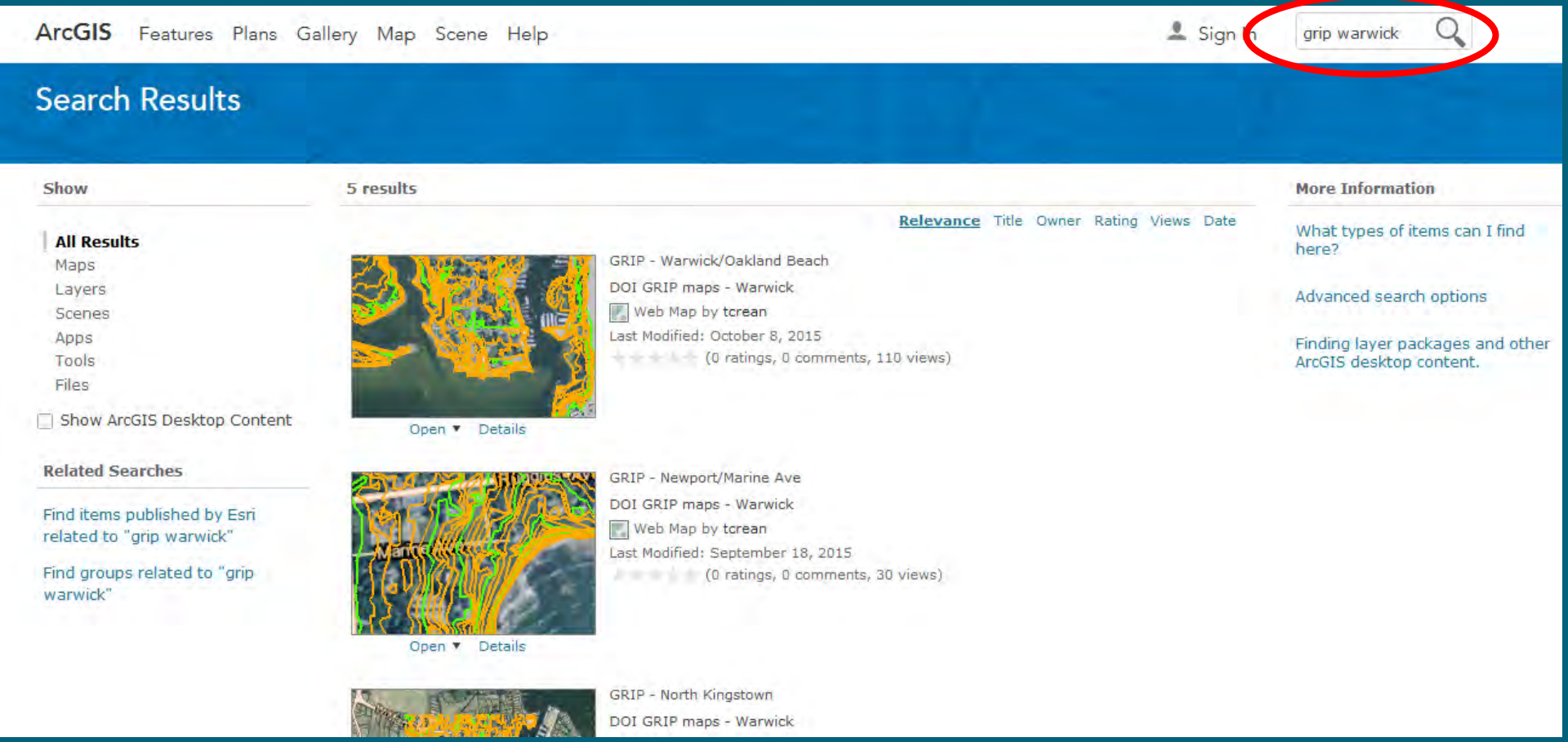
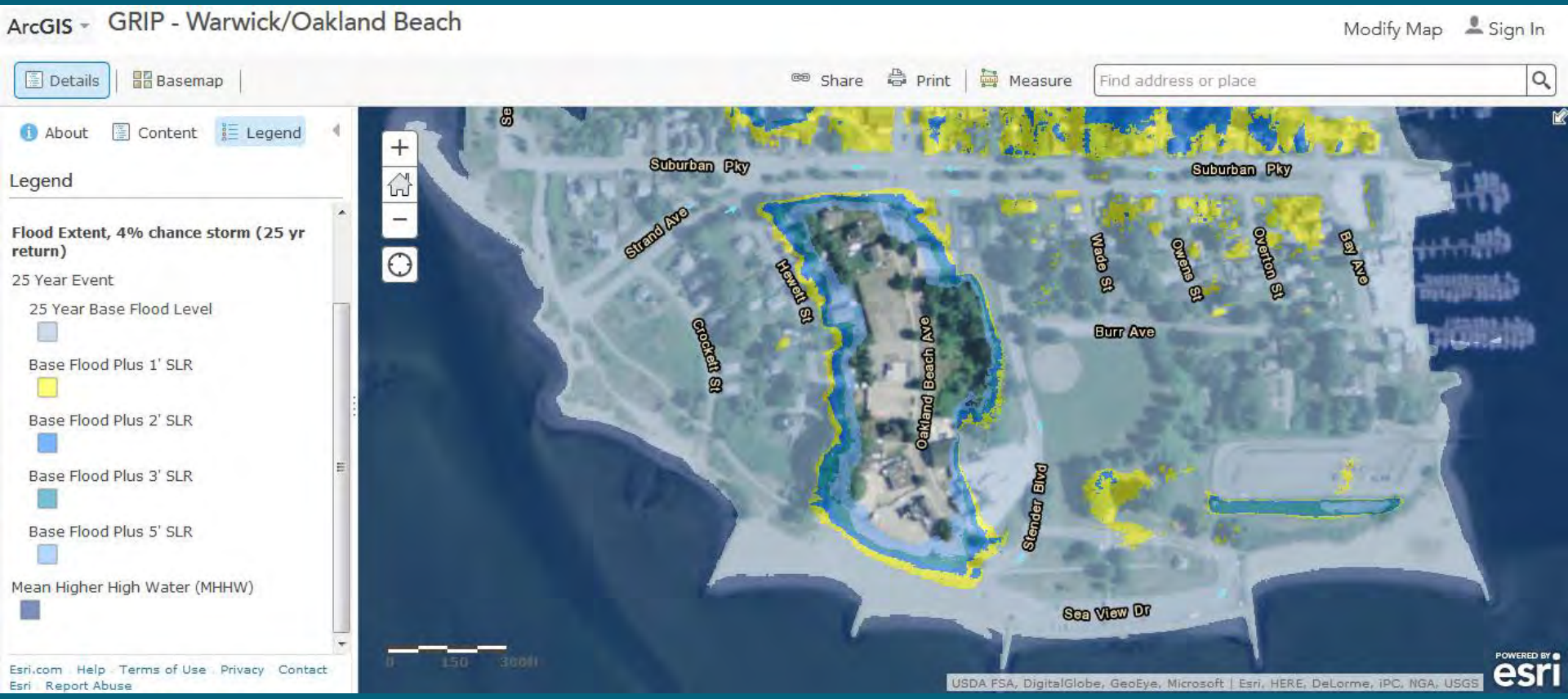


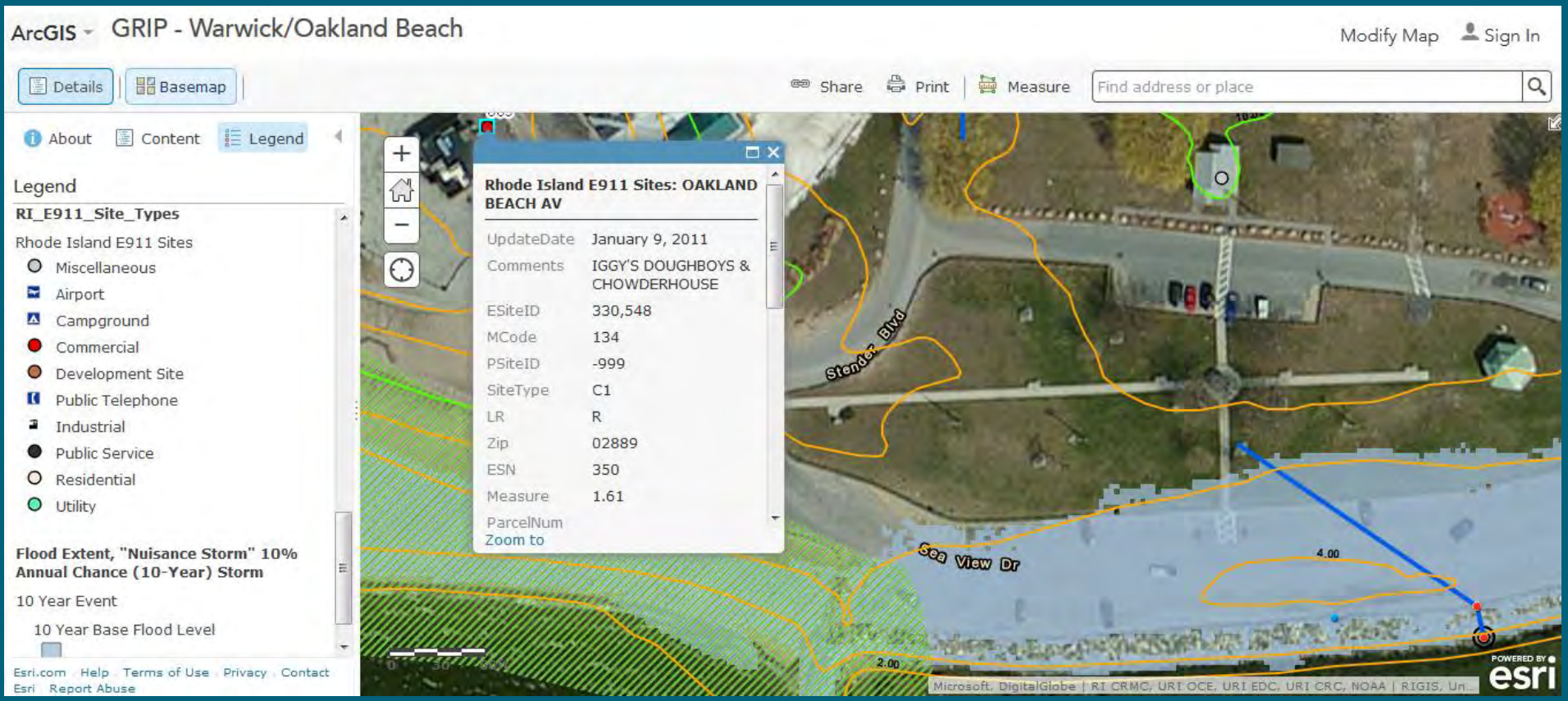
Using STORMTOOLS for Projects:
Green & Resilient Infrastructure Program (GRIP)

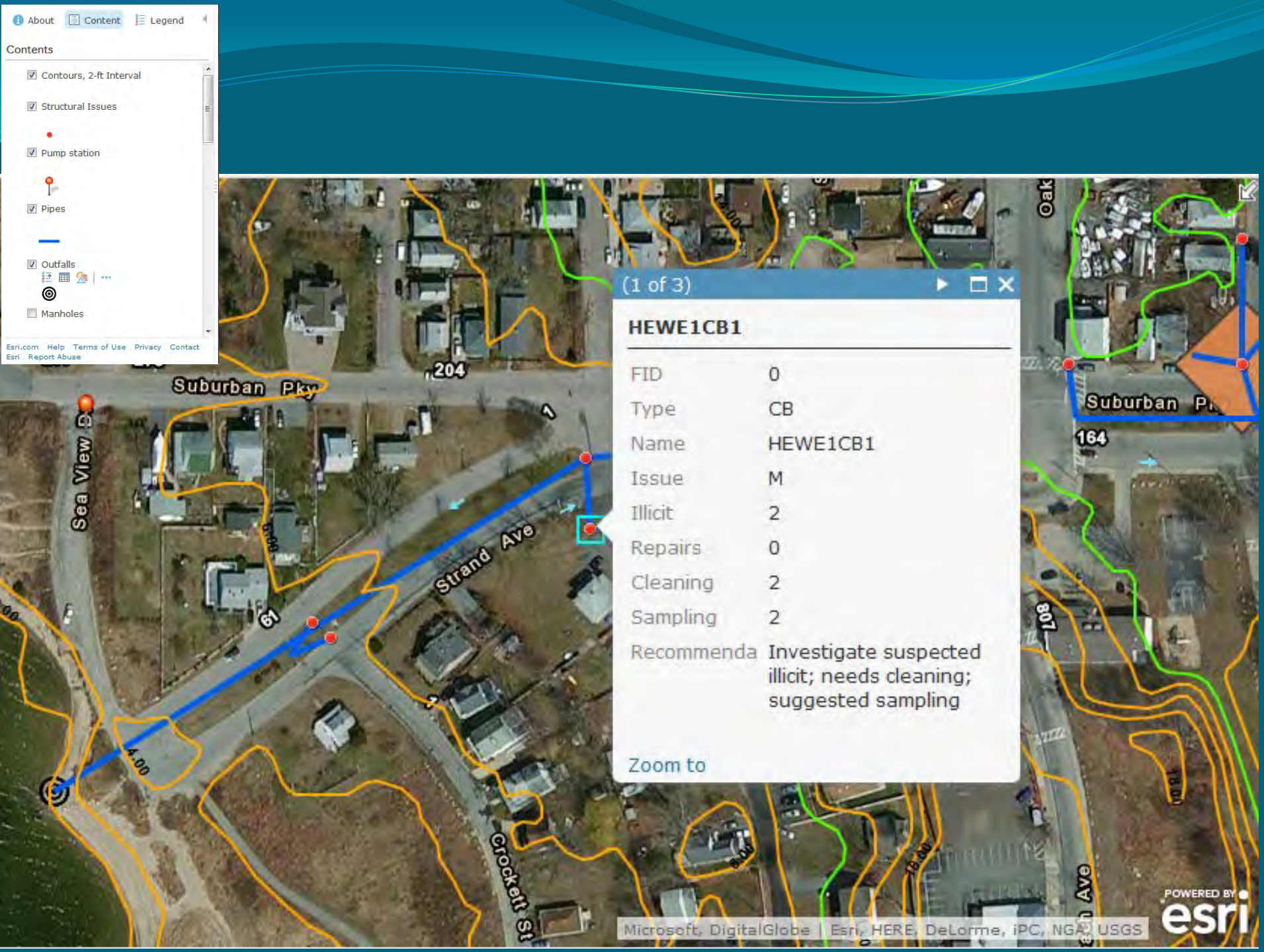


Using STORMTOOLS for Projects:
Green & Resilient Infrastructure Program (GRIP)



Using STORMTOOLS for Projects:
Green & Resilient Infrastructure Program (GRIP)




About
Content
Legend
Contents
Contours, 2-ft Interval
Structural Issues
Pump station
Pipes
Outfalls
Manholes
Esri.com Help Terms of Use Privacy Contact Esri Report Abuse
(1 of 3)
HEWE1CB1
FID 0
Type CB
Name HEWE1CB1
Issue M
Illicit 2
Repairs 0
Cleaning 2
Sampling 2
Recommenda Investigate suspected illicit; needs cleaning; suggested sampling
Zoom to
Suburban Pky
Sea View Dr
Strand Ave
Crockett St
Oak
Suburban Pl
204
164
807
61
Microsoft, DigitalGlobe | Esri, HERE, DeLorme, iPC, NGA, USGS
POWERED BY esri

STORMTOOLS, Phase 2: Coastal Environmental Risk Index

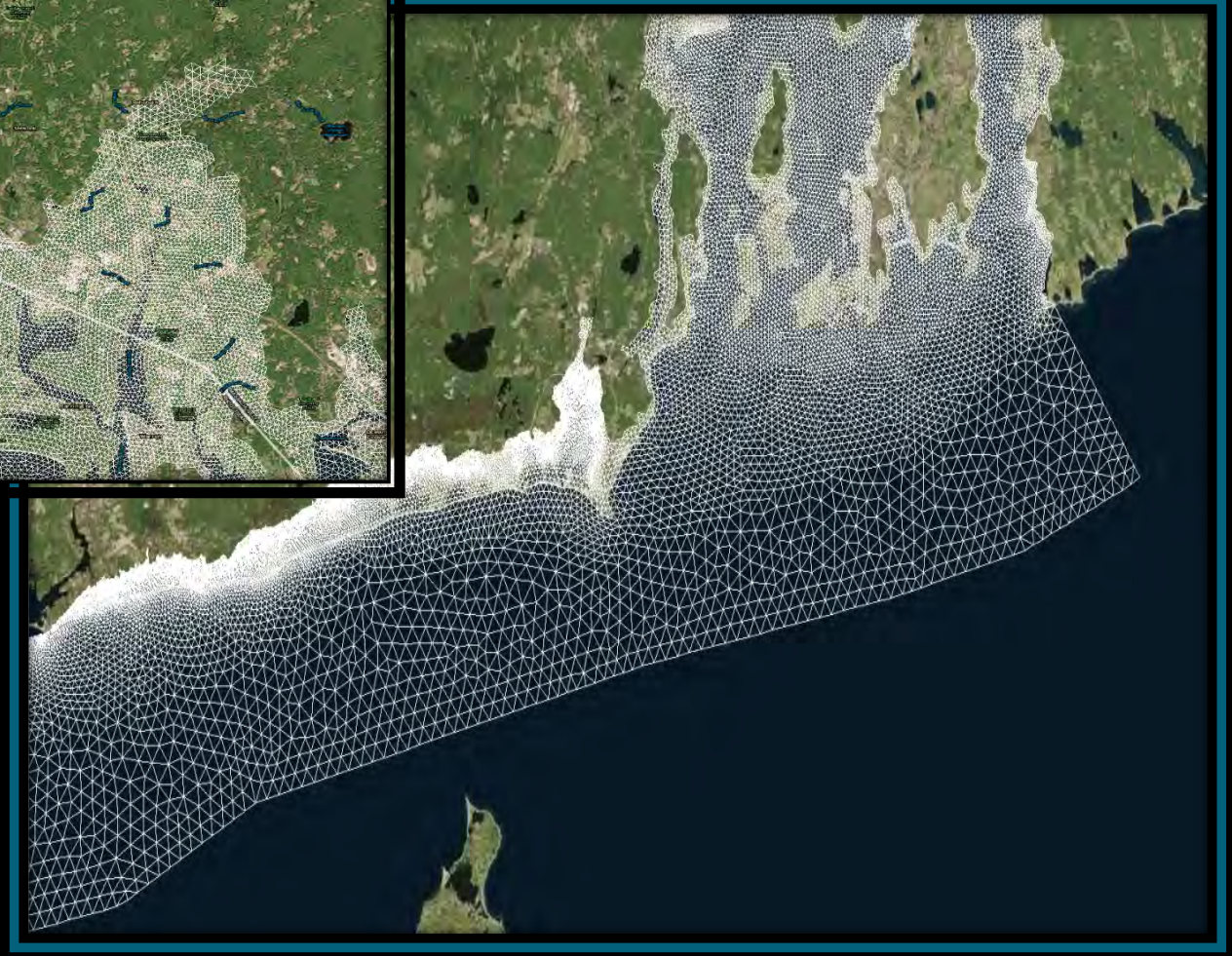
Goal: Develop a Coastal Environment Risk Index (CERI) that provides a summary of the risk coastal areas face from the environment; specifically storm included flooding and the associated wave environment, sea level rise, and shoreline erosion/accretion and apply it RI coastal waters.

Building Blocks

STORMTOOLS flood inundation and wave height maps

RI Shoreline Change Maps (erosion/accretion) and transects

STORMTOOLS Future Phase – Real time flood forecasting system for RI



QUESTIONS?

Using STORMTOOLS to Assess Coastal Risk In Rhode Island

RI State Planning Council, Technical Committee – November 6, 2015

Teresa A. Crean, AICP, URI Coastal Resources Center / RI Sea Grant

CRMC Coastal Resources Management Council

The University of Rhode Island Graduate School of Oceanography | CRC Coastal Resources Center

Sea Grant Rhode Island

Overview of STORMTOOLs Initiatives

Malcolm L. Spaulding et al

Ocean Engineering, University of RI, Narragansett, RI

Statewide Planning Program Technical Review
Department of Administration Office

November 6, 2015

Overview of Presentation

- ***STORMTOOLS*** ™ vision
- **Developments completed or in progress**
  - ***Flooding Maps for RI***
  - FIRMS for Washington County(including Block Island)
  - Return period analyses for water levels and waves to support design of structure and infra structure in flood impacted areas
  - Artificial Intelligence Neural Network (AINN) based prediction tool for storm surge
  - High resolution forecasting system for RI coastal waters including flooding
  - Hydrological model for Pawtuxet River watershed

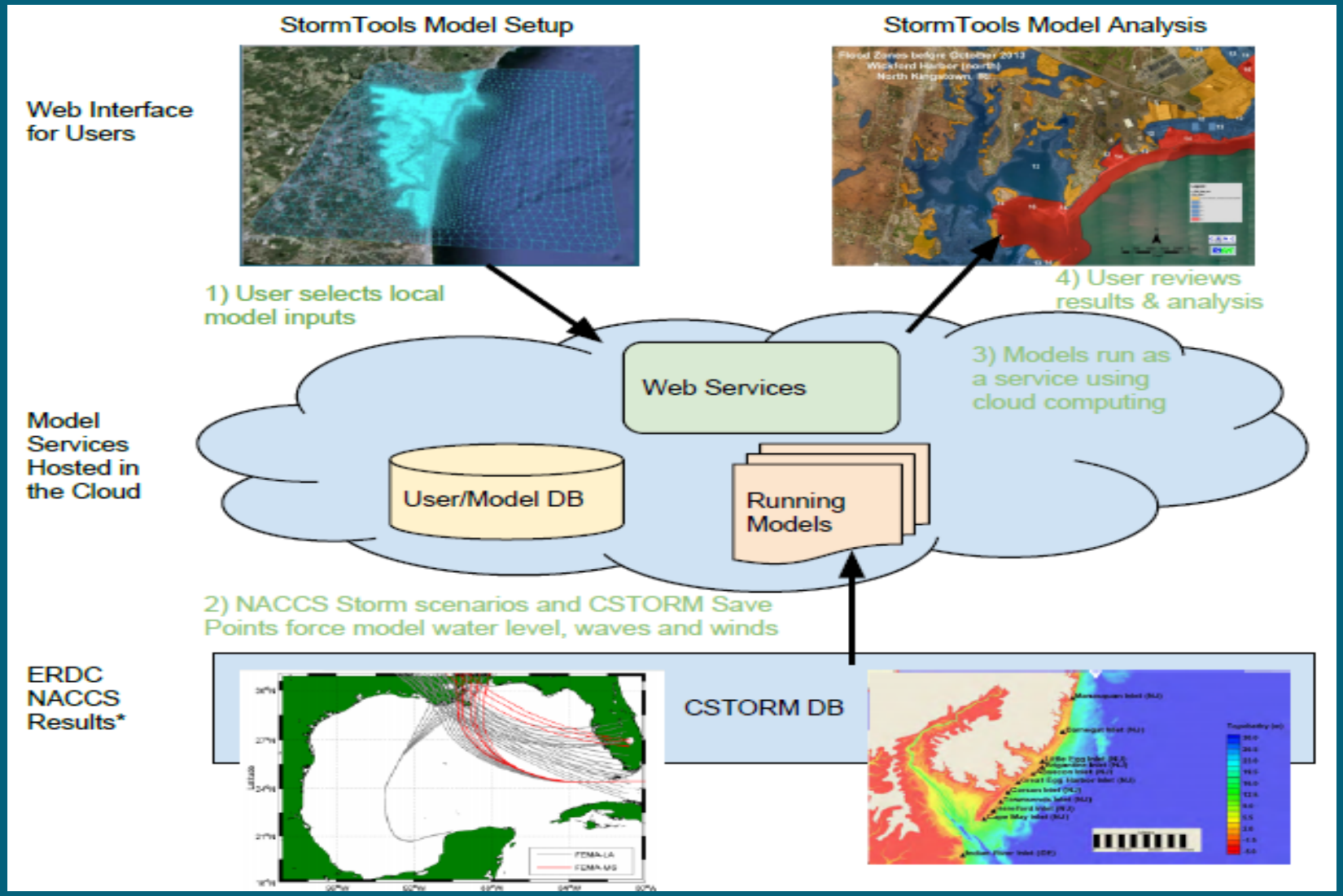
Overview (cont'd)

- **Planned**

  Development of Coastal Environmental Risk Index (CERI), application to Charlestown and Warren/Barrington, as case examples.

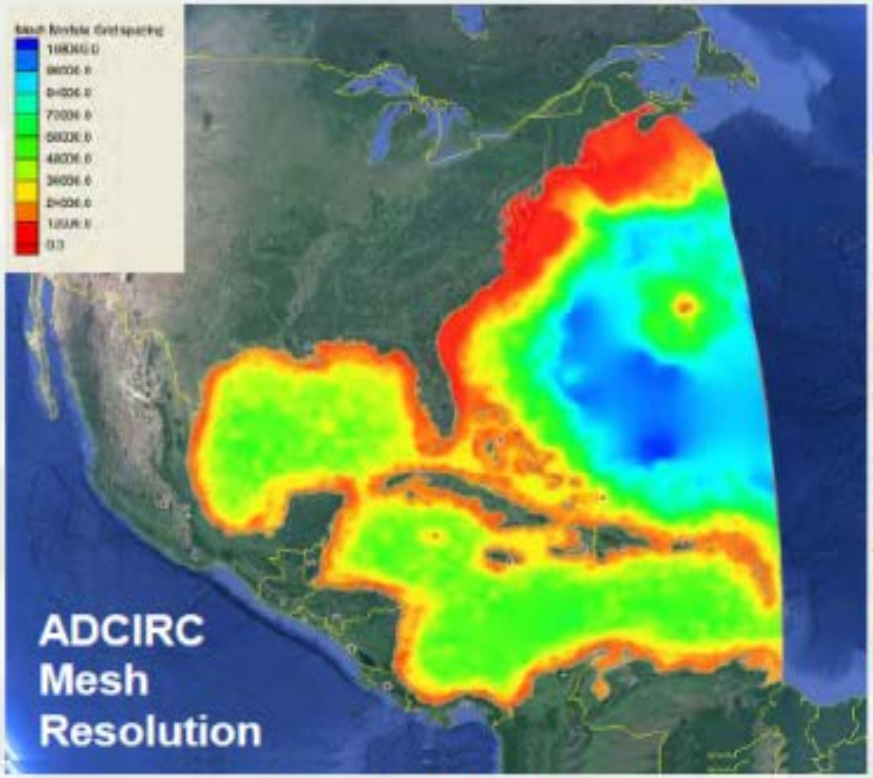
  Assess risk coastal areas face from flooding and waves, sea level rise, and shoreline erosion/accretion
- **Proposals or white papers**
  - Extension of hydrological model of Pawtuxet River watershed to include effects of climate change
  - Extension of CERI to Washington County
  - **STORMTOOL's** *Flood Risk* app

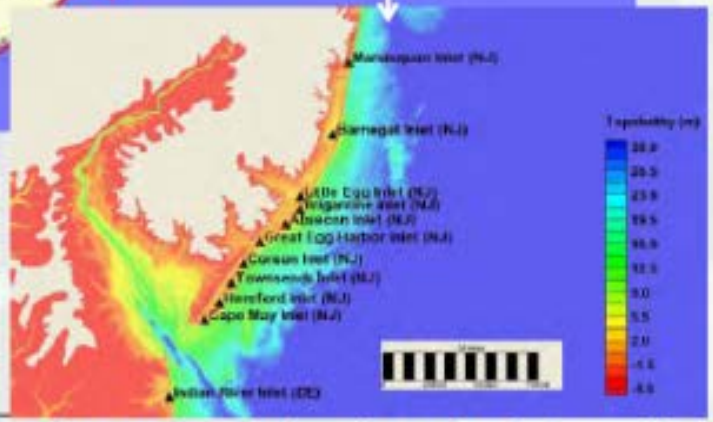
STORMTOOLS™


StormTools Model Setup
StormTools Model Analysis
Web Interface for Users
1) User selects local model inputs
4) User reviews results & analysis
Web Services
3) Models run as a service using cloud computing
Model Services Hosted in the Cloud
User/Model DB
Running Models
2) NACCS Storm scenarios and CSTORM Save Points force model water level, waves and winds
ERDC NACCS Results*
CSTORM DB

CSTORM-MS COASTAL STORM MODELING SYSTEM

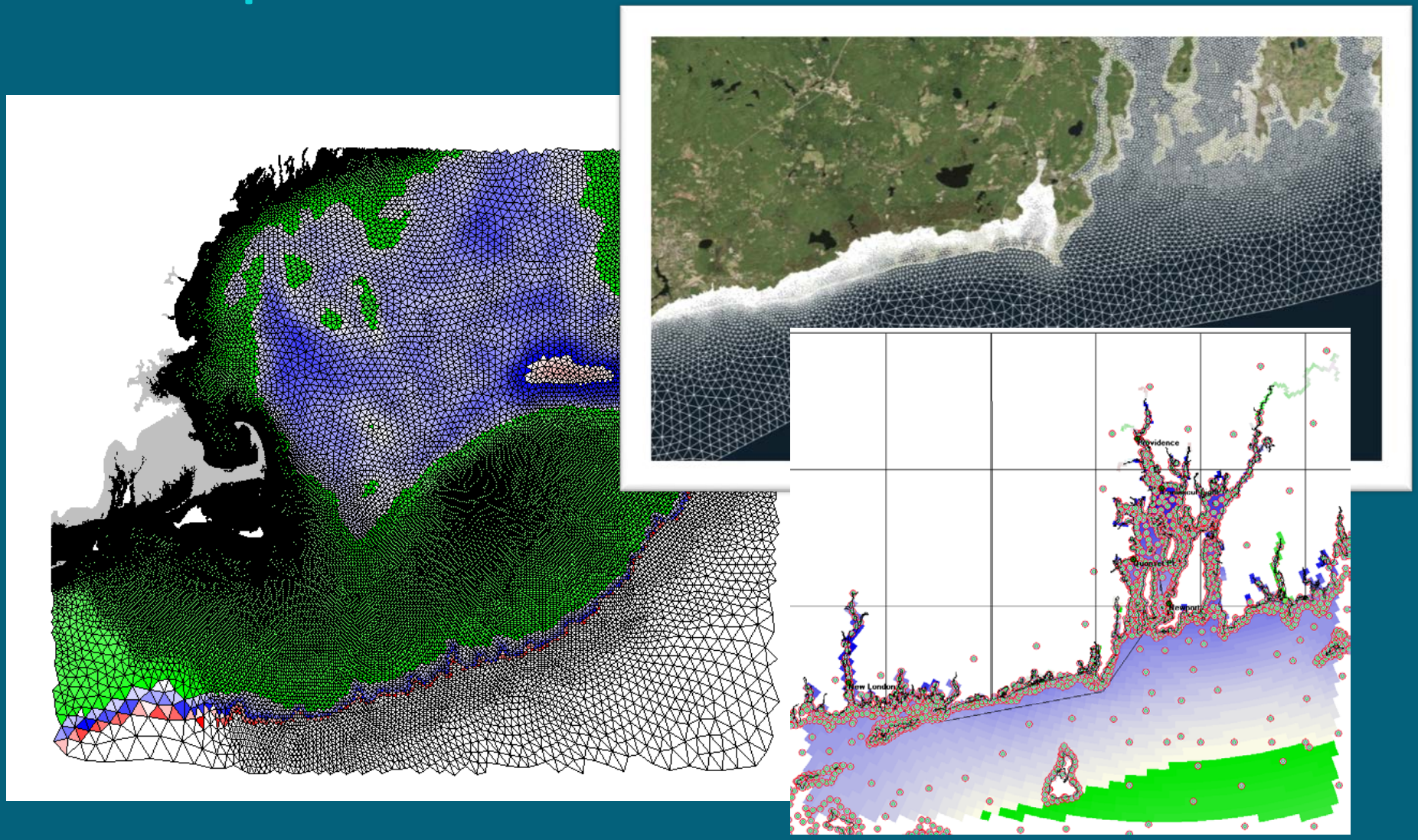
Grids and Save Points

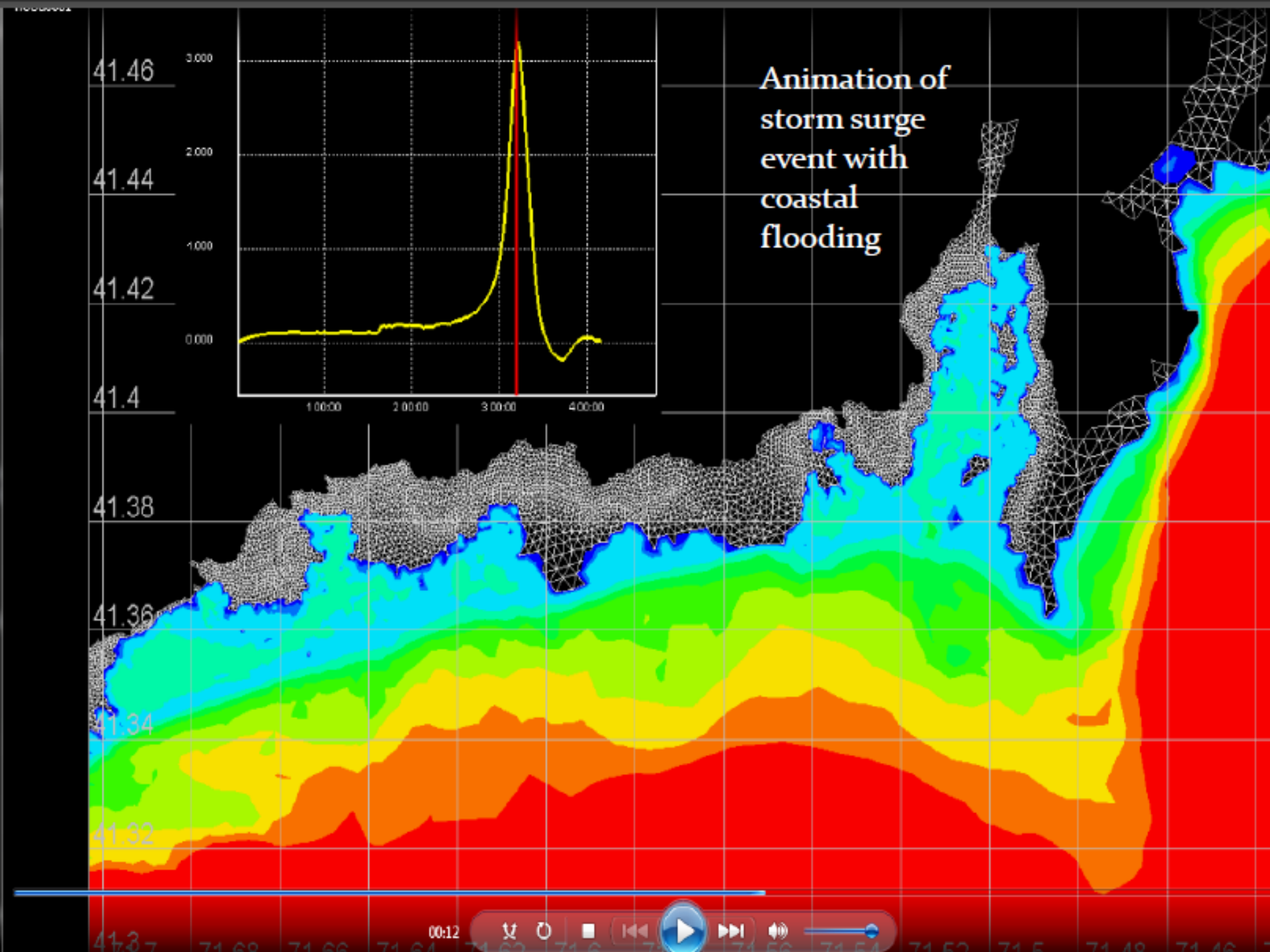




~ 6.2 million nodes
Resolution from 10 m to 100 km

Army Corp of Engineers(ACOE), NACCS grid and save point for Northeast and southern RI coast




Animation of storm surge event with coastal flooding
41.46
41.44
41.42
41.4
41.38
41.36
41.34
41.32
3.000
2.000
1.000
0.000
1 00:00
2 00:00
3 00:00
4 00:00
00:12

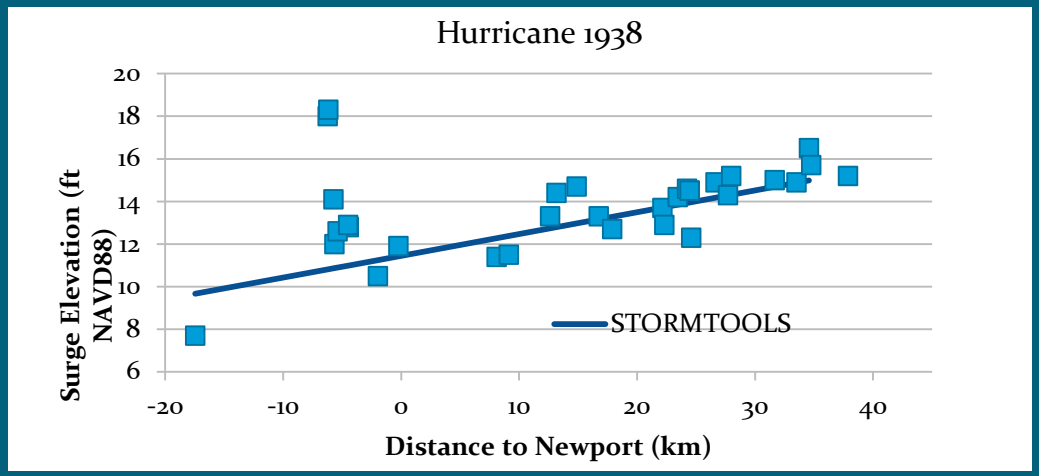
Flooding Maps for RI

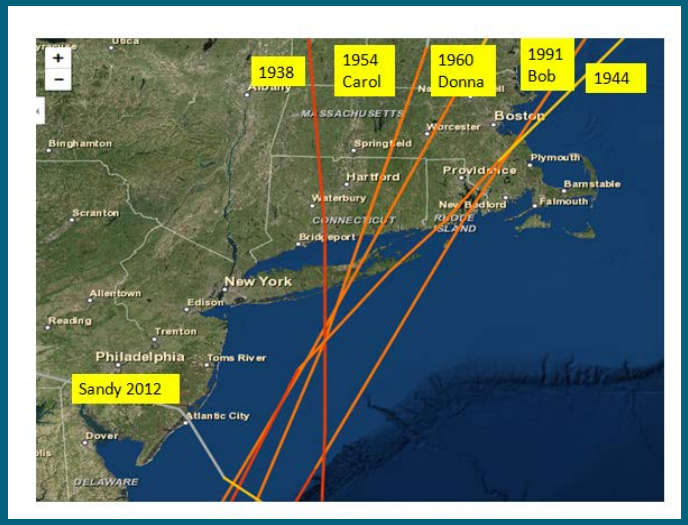
Goal: Develop simplified flooding maps for RI, with and without sea level rise, to assist in coastal planning

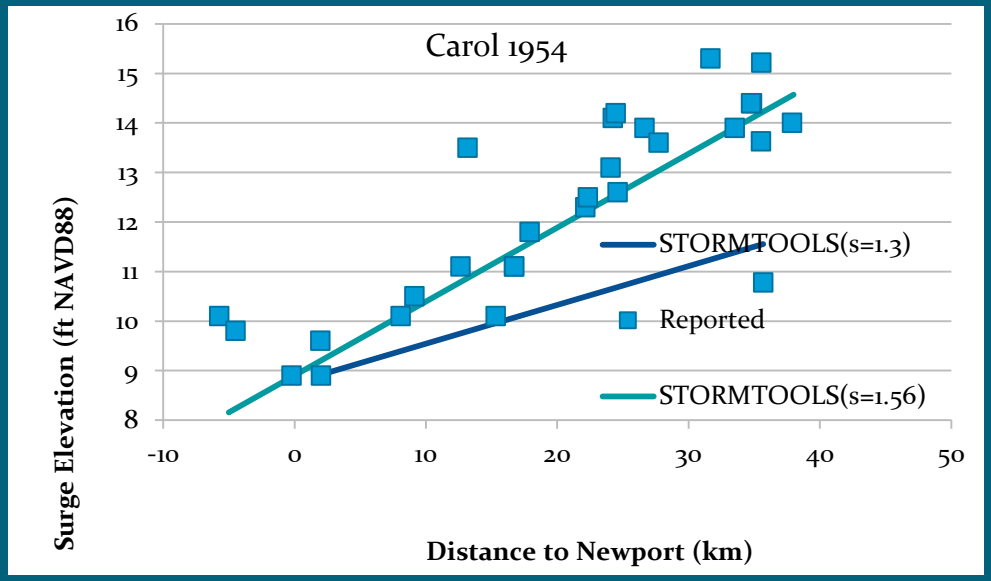
Method:

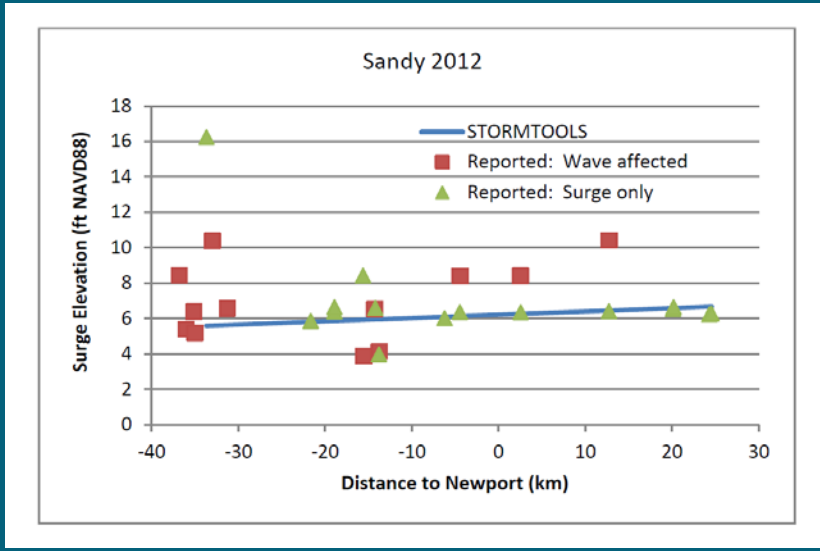
- Use NACCS synthetic tropical storms to scale water levels
- NOAA NOS/ACOE return period analyses
- Make maps accessible via web based, map viewer

Validation with 1938, 1954, and 2012 hurricanes

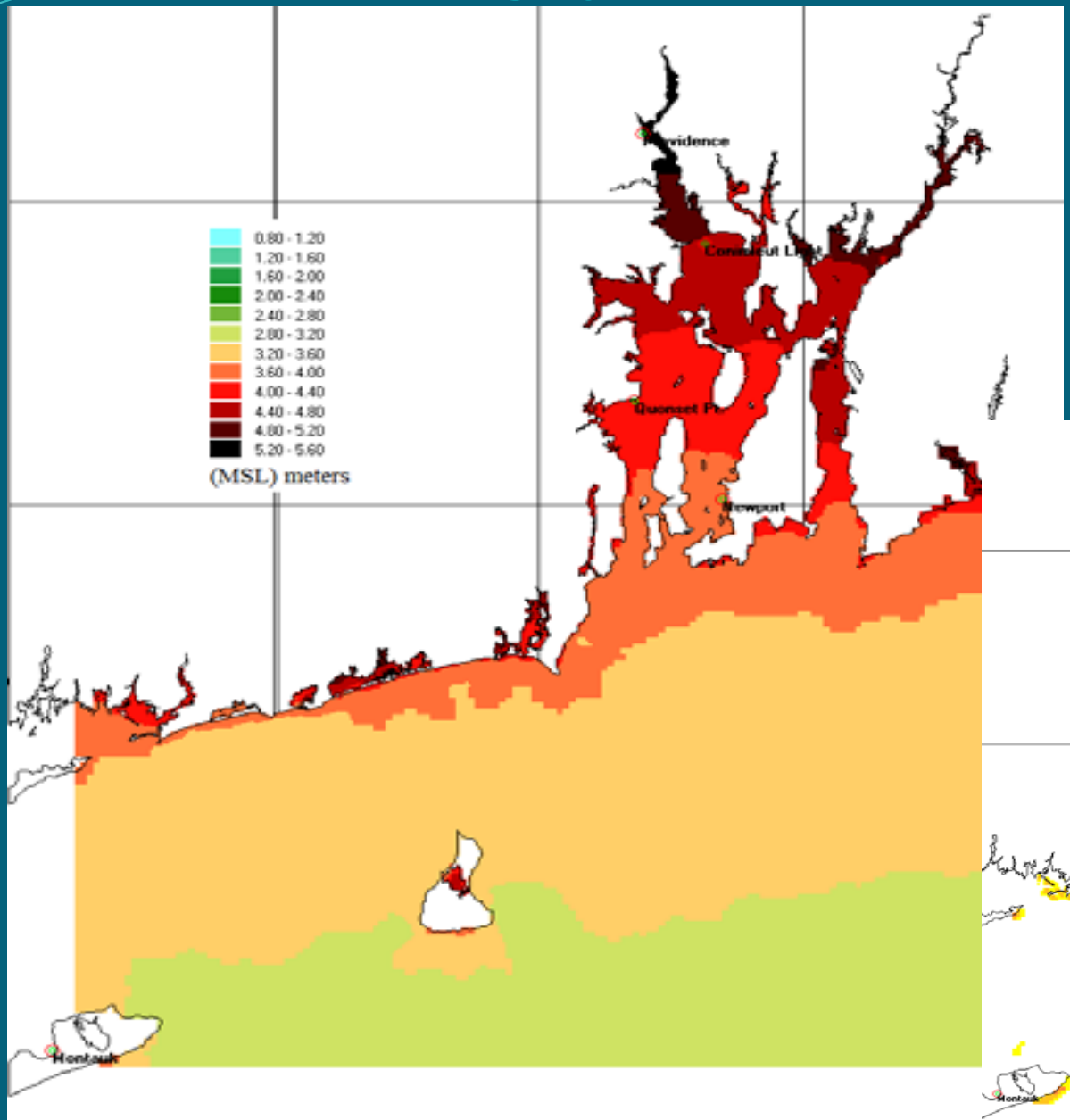


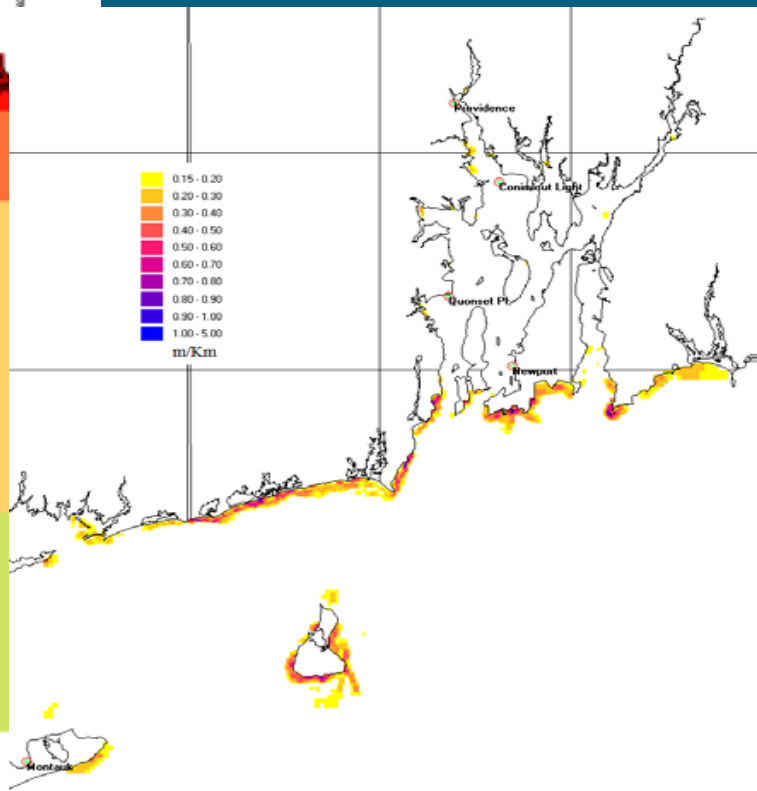




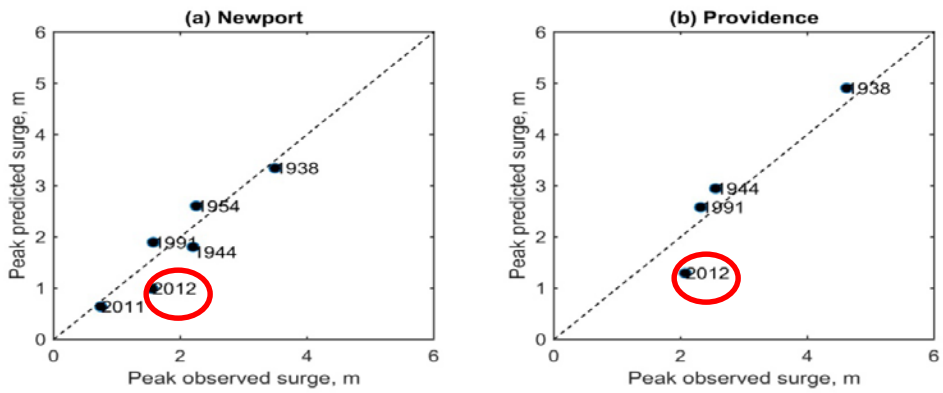


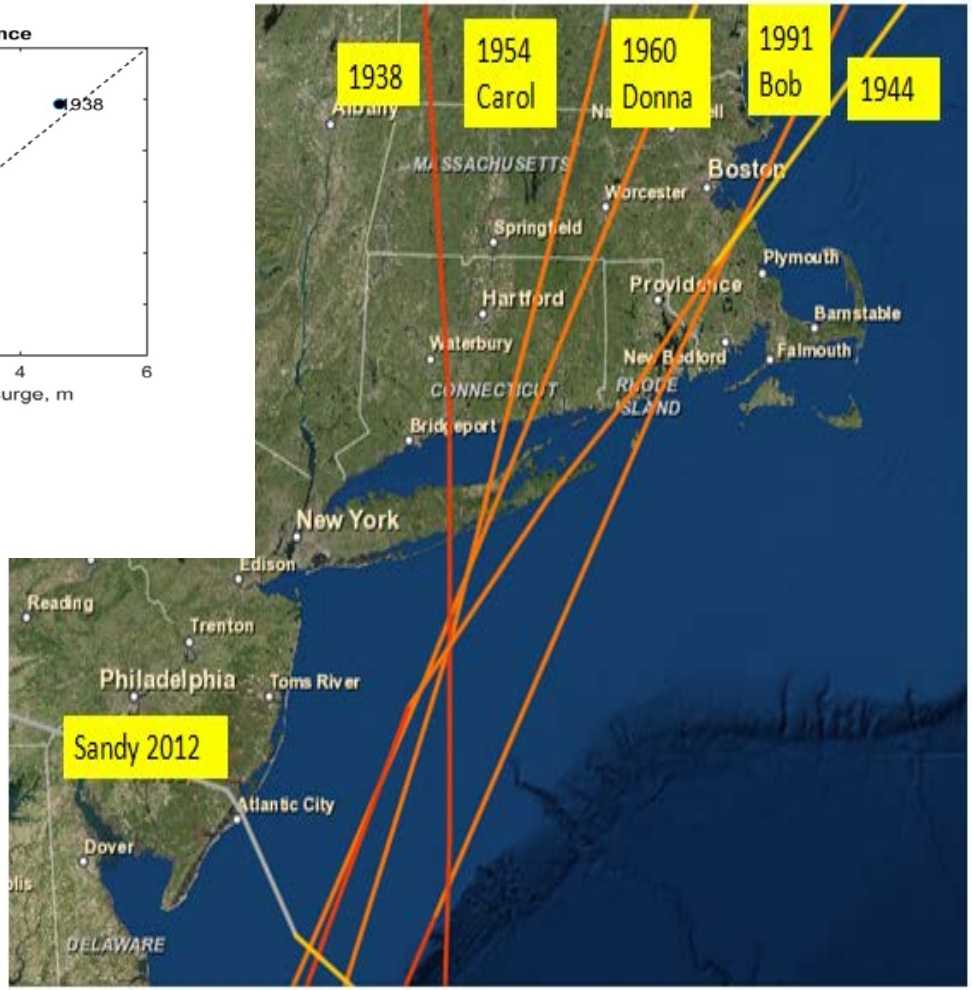
100 yr water level for upper 95% confidence limit for surge plus tide case NACCS





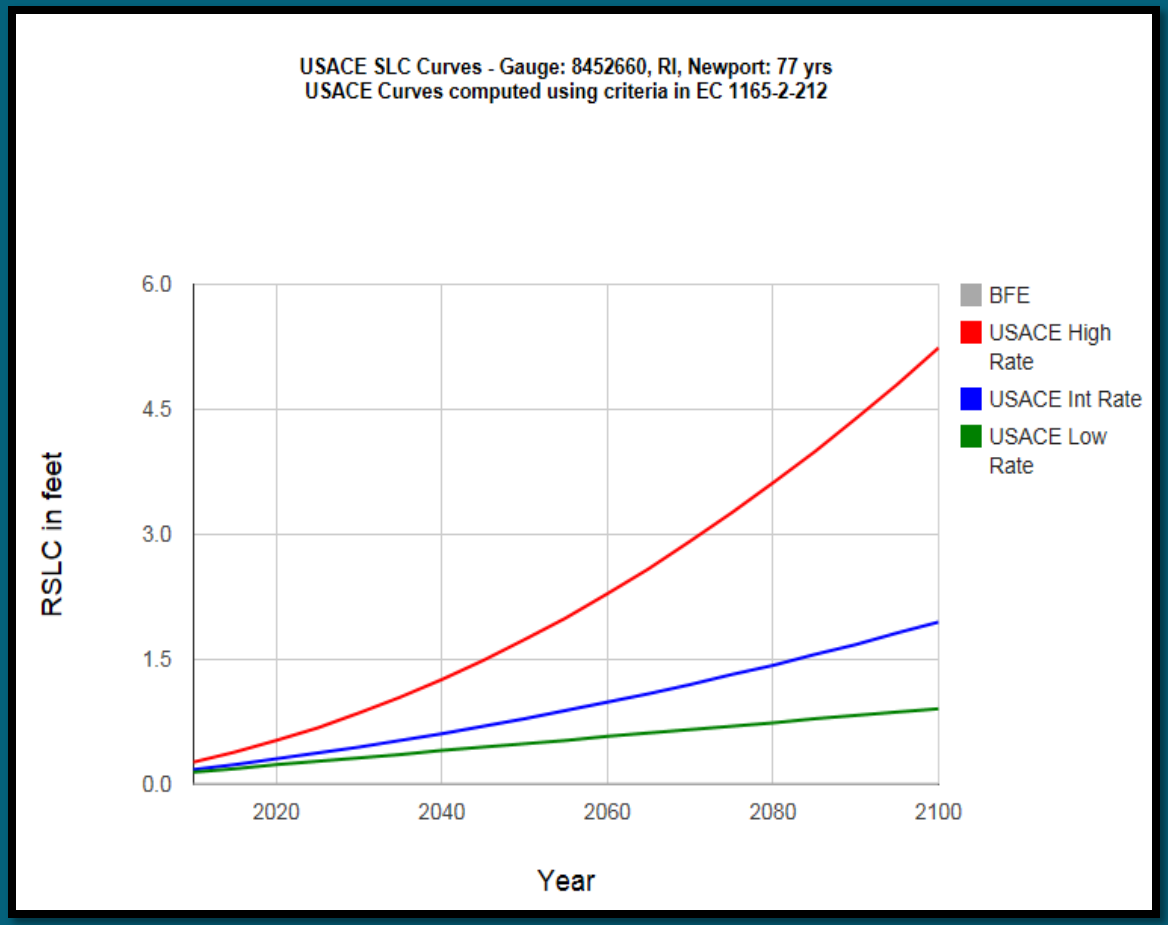
Model predictive performance for peak surge height for hurricane events





Sea Level Rise Estimates for Newport, RI

Gauge: 8452660, RI, Newport: 77 yrs All values are in feet			
Year	USACE Low	USACE Int	USACE High
2010	0.15	0.18	0.27
2015	0.19	0.24	0.39
2020	0.24	0.31	0.53
2025	0.28	0.38	0.68
2030	0.32	0.45	0.86
2035	0.36	0.53	1.05
2040	0.41	0.61	1.26
2045	0.45	0.7	1.49
2050	0.49	0.79	1.74
2055	0.53	0.89	2
2060	0.58	0.99	2.29
2065	0.62	1.09	2.59
2070	0.66	1.2	2.92
2075	0.7	1.32	3.26
2080	0.74	1.43	3.62
2085	0.79	1.56	3.99
2090	0.83	1.68	4.39
2095	0.87	1.82	4.8
2100	0.91	1.95	5.24



http://www.corpsclimate.us/ccaceslcurves(superseded).cfm

Summary of STORMTOOLs Flooding Maps Available for Rhode Island

Return period(yrs) and sea level rise (ft)

Return period (yrs)	Sea level rise(ft) None	1	2	3	5	In land Flooding
0	X	X	X	X		
25	X	X	X			
50	X		X			
100	X	X	X	X		
100	X	X	X	X		X

Nusiance Flooding Return periods(yrs)

1 3 5 10

Historical Storms (NOAA top ranked for RI, hurricanes)

1938 1954 1991 2012

Matched Pairs, flooding return period and corresponding sea level rise

Return Period (yrs)	25	50	100
Sea level rise (ft)	1	2	5

Conclusions

- Predictions of flooding with SLR rise available at high resolution (1 m) based on state of the art storm surge modeling (NACCS, 2015)
- Employ extremal analysis methods in conjunction with maps to determine values for various return period
- Maps available via web based map viewer for use by planners and the public.
- Tools available to support coastal engineering (water level and wave height vs return period, on line AI based water level and wave height prediction system)
- Extensions in progress (CERI and STORMTOOLs Flood Risk app)

STORM TOOLS™ Web Based Mapping Viewer Access

Web address:

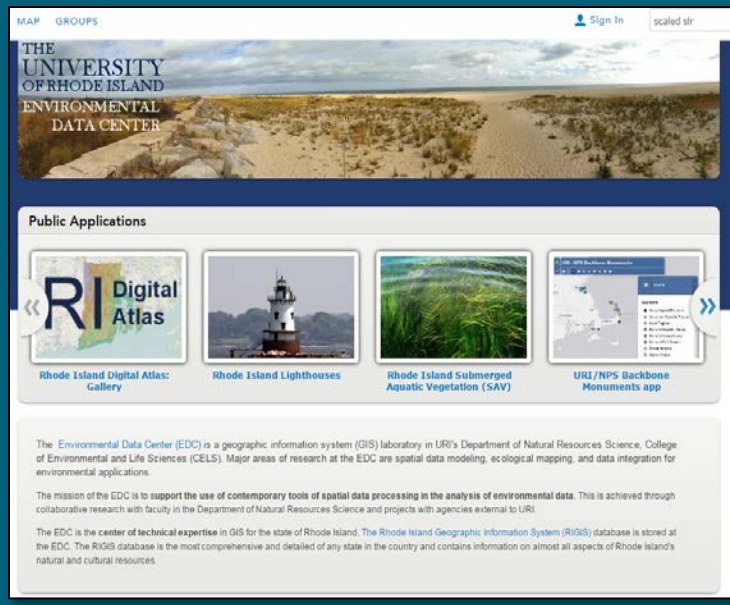
http://www.beachsamp.org/resources/stormtools/

Contacts:

Teresa Crean, URI CRC, tcrean@crc.uri.edu

Chris Damon, URI Environmental Data Center, cdamon@edc.uri.edu

Malcolm Spaulding, URI Ocean Engineering, spaulding@egr.uri.edu



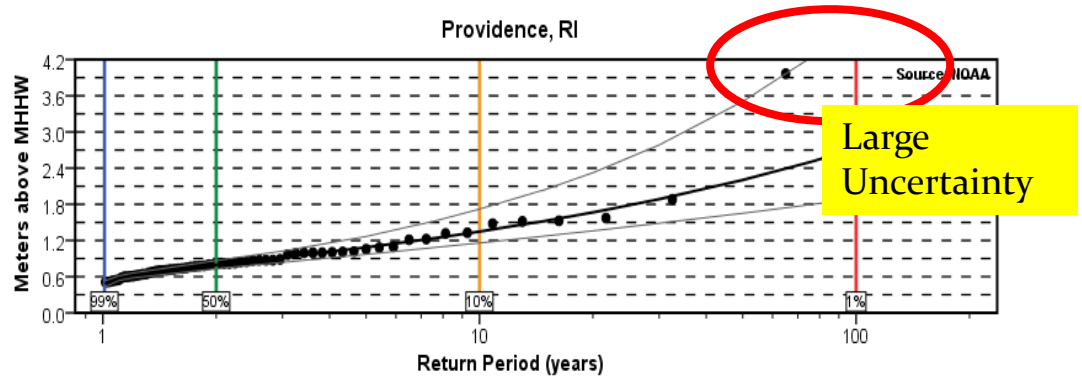
QUESTIONS

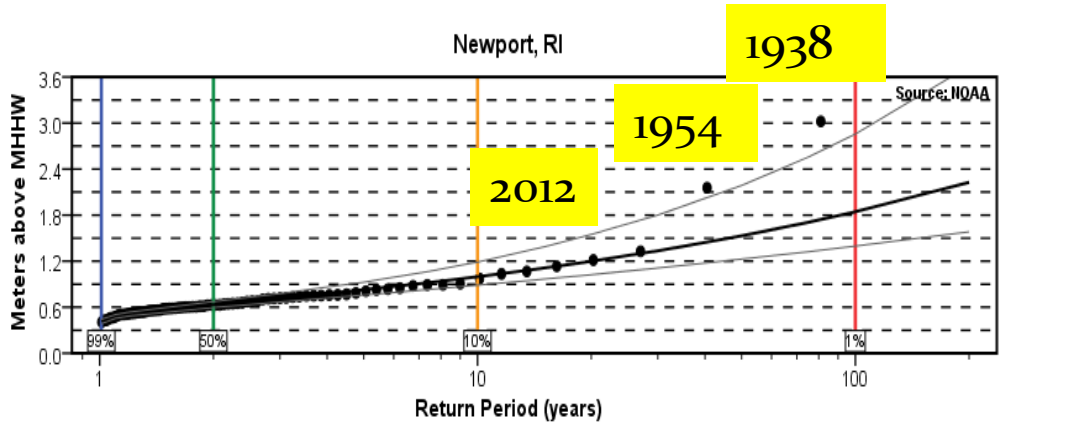
Extremal Analysis based on storm water level data at NOAA NOS stations

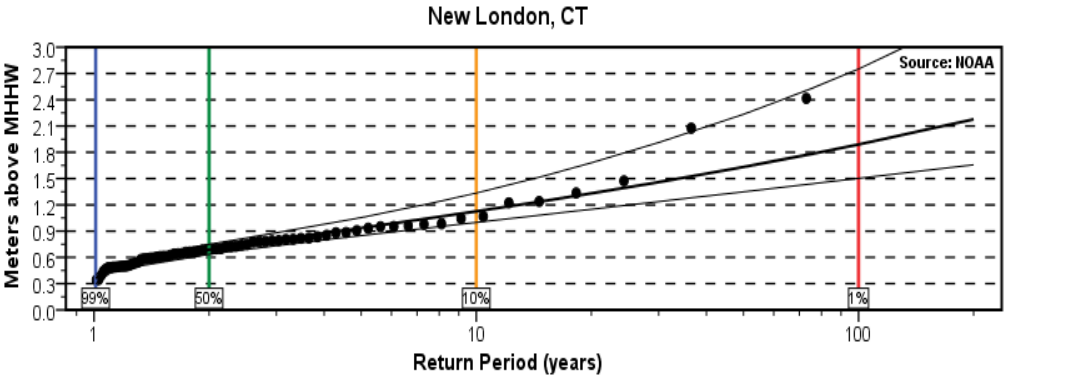
Storms in rank order (relative to MHHW) Newport, RI

1938 – 2.88 m (9.44 ft)
1954 -2.06 m (6.75 ft)
2012 -1.284 m (4.21)
1991-1.212 m (3.97 ft)
1944-1.206 m (3.95 ft)
1978 -1.1 m (3.6 ft)

1954 missing at Providence





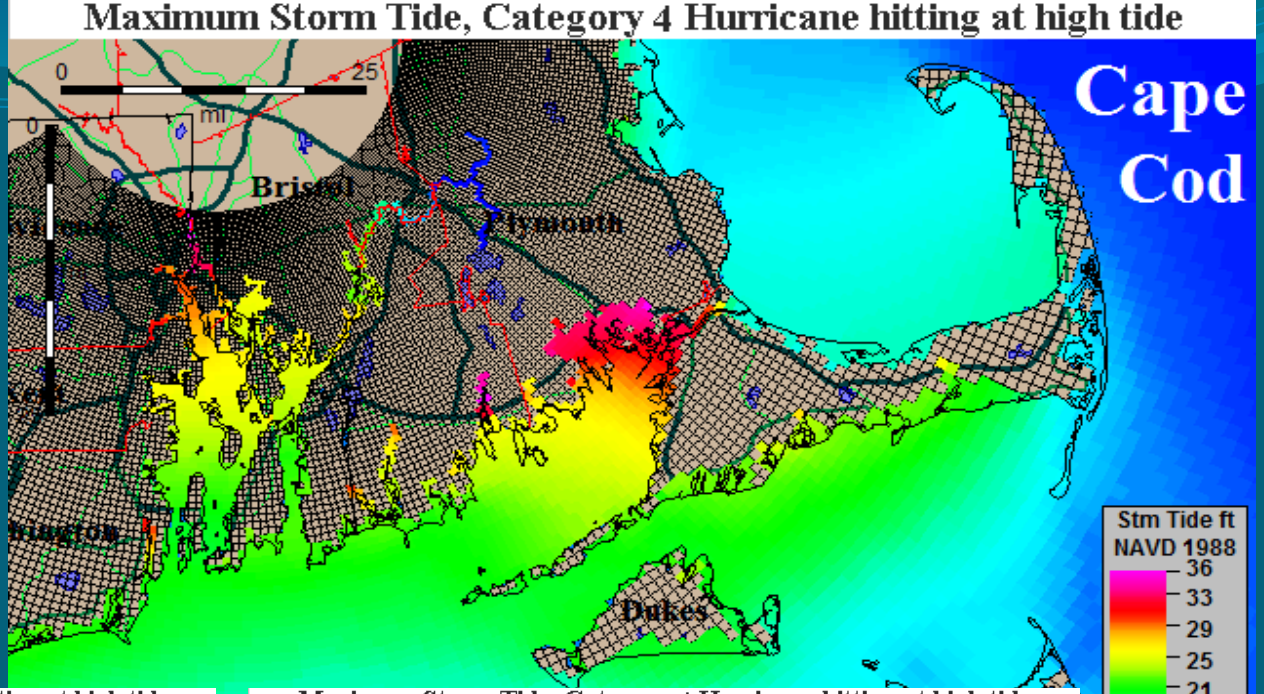


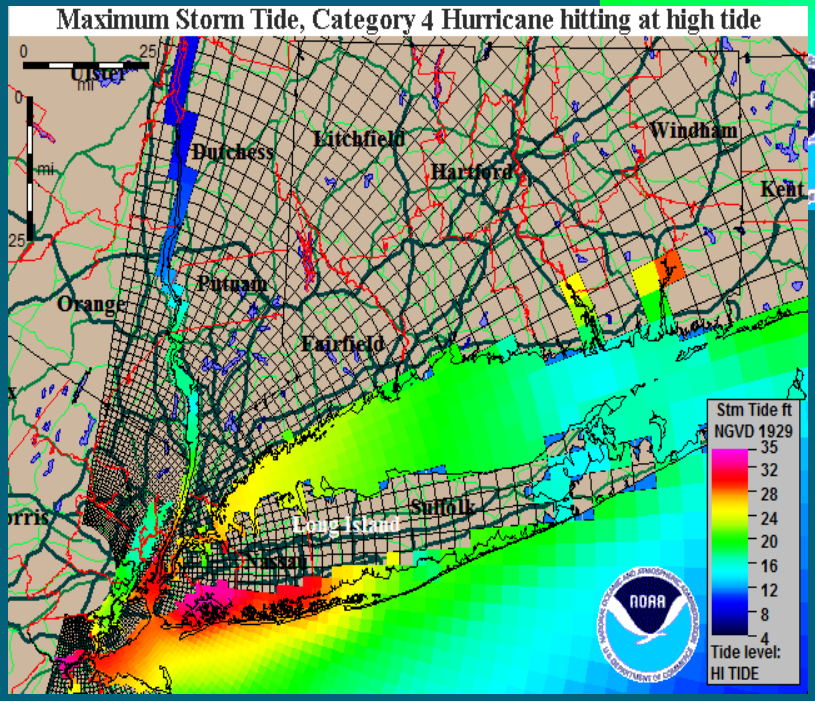
Storm Scaling
Providence to Newport, RI

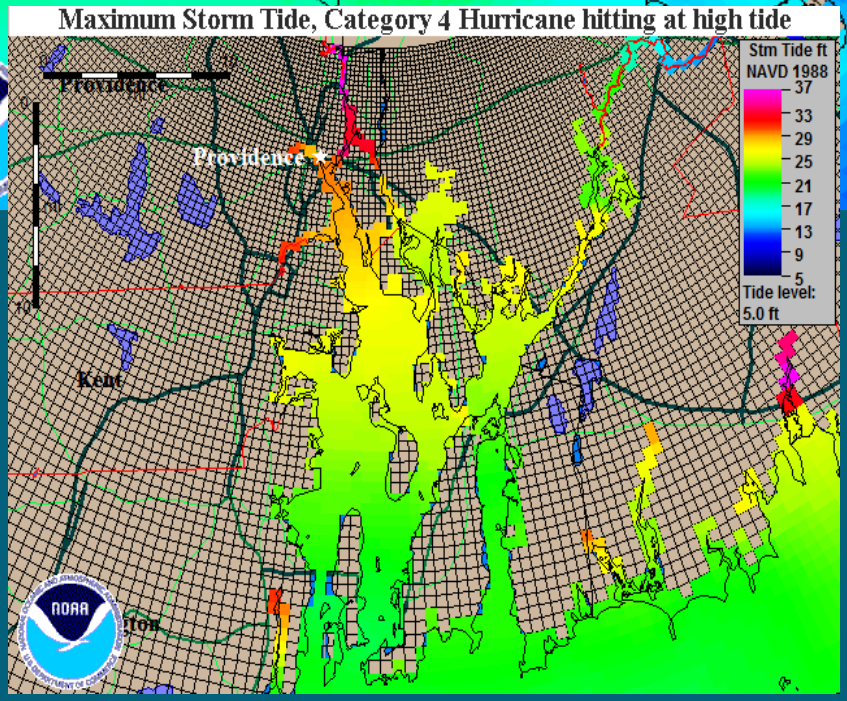
Scaling of peak storm water level							
			MHHW levels (m)		NAVD88(m)		Ratio
Storm	Storm Name	Storm Type	Newport	Providence	Newport	Providence	PVD/ NPT
		Tropical/Extratropical					
9/21/1938	1938	Cat 3	2.88	3.86	3.49	4.62	1.32
10/29/2012	Sandy	Cat 1-2	1.28	1.33	1.89	2.09	1.10
8/19/1991	Bob	Cat 2	1.21	1.57	1.82	2.33	1.28
9/14/1944	Great Atlant	Nor'easter	1.21	1.79	1.82	2.55	1.40
1/9/1978	Great Blizzar	Nor'easter	1.10	1.50	1.71	2.26	1.32
11/30/1963	Helena	Tropical storm	0.99	1.42	1.60	2.18	1.36
						Average	1.30
				MHHW (NAVD88)			
			Newport	0.61			

Scaling strongly dependent on storm parameters

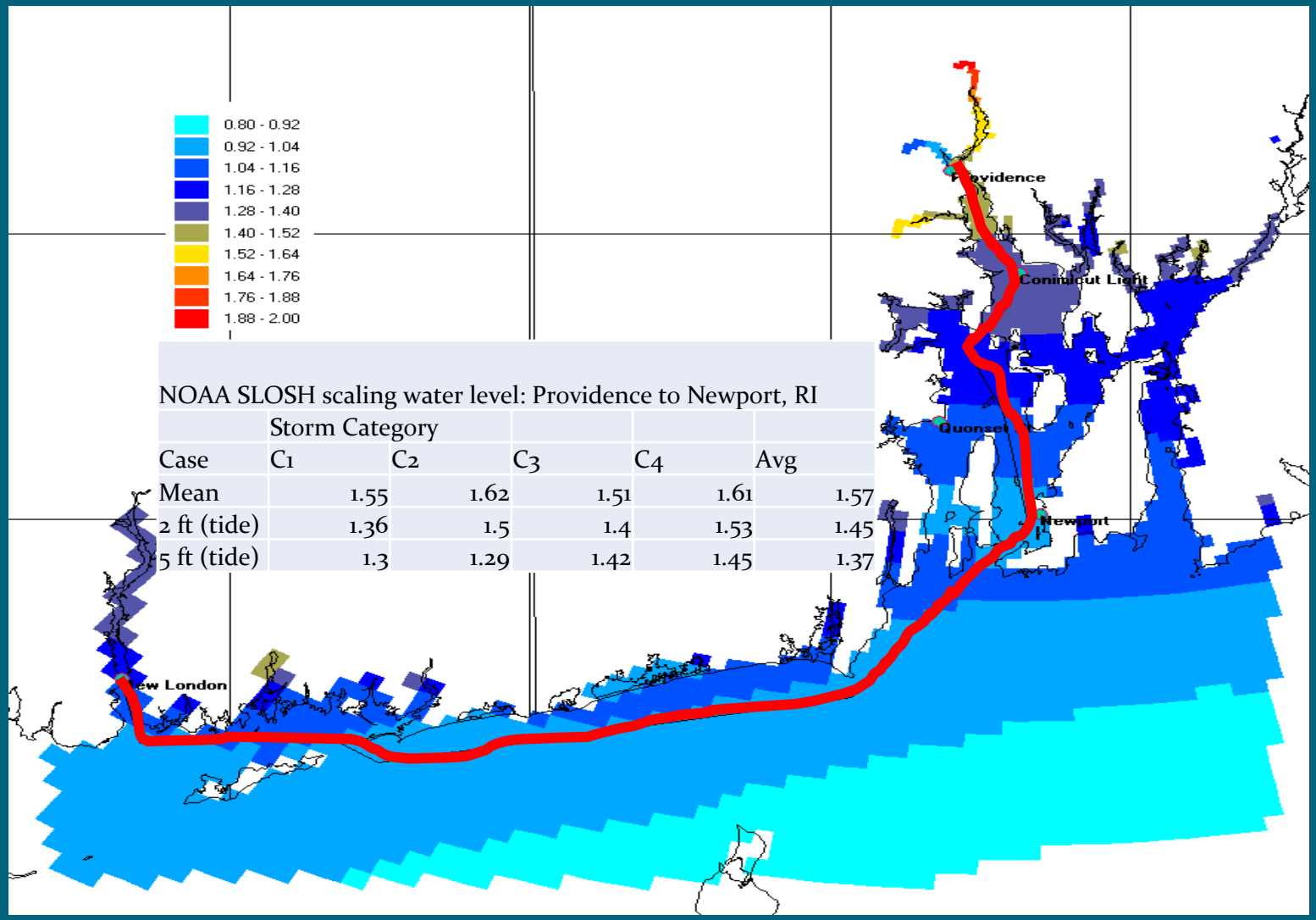
Maximum Envelope Of Water (MEOWS)- Cat 4 storm with 1.52m (5 ft) tides (SLR)







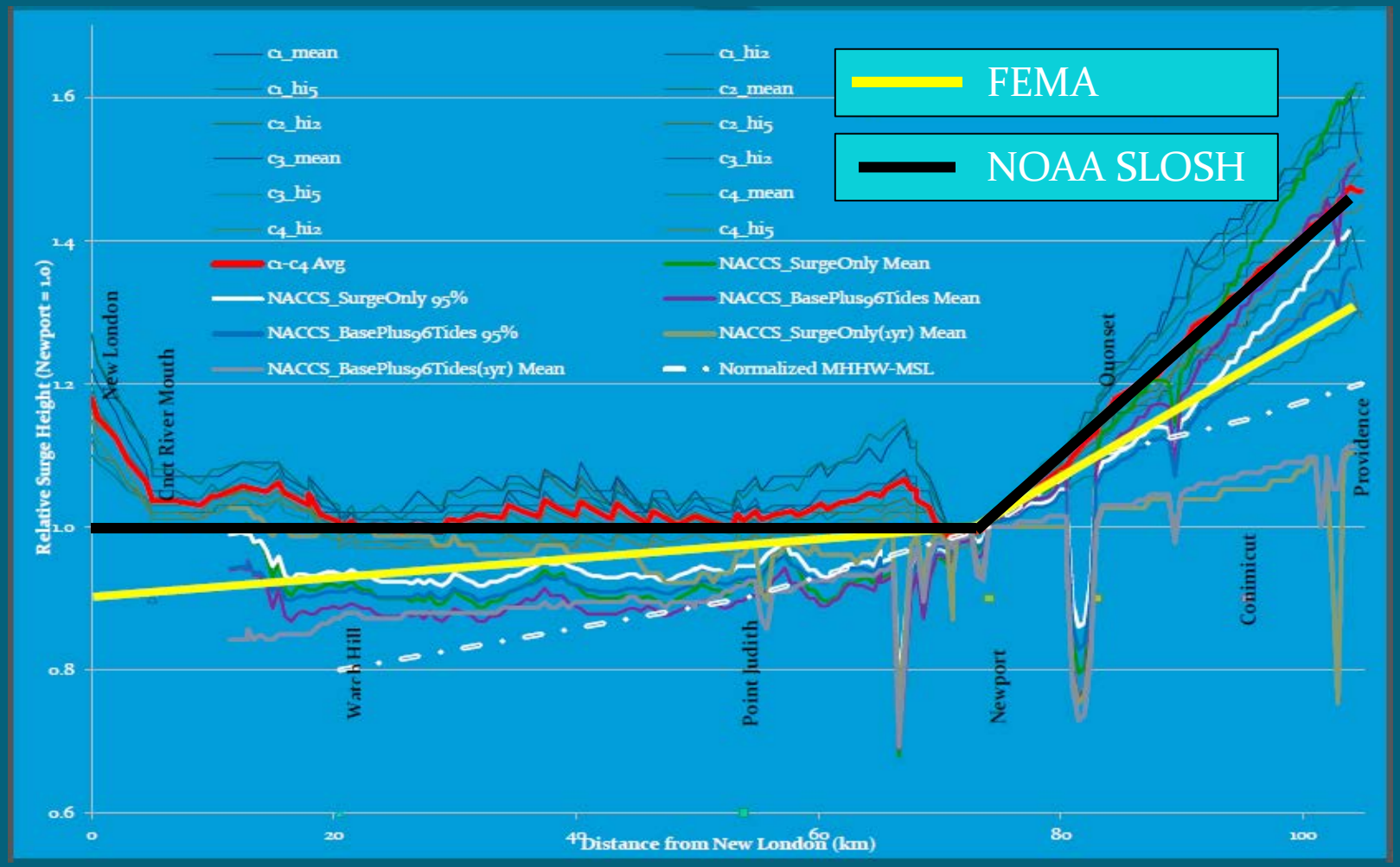
Mean scaling value for all MEOWs cases relative to Newport, RI



NOAA SLOSH scaling water level: Providence to Newport, RI

	Storm Category				
Case	C1	C2	C3	C4	Avg
Mean	1.55	1.62	1.51	1.61	1.57
2 ft (tide)	1.36	1.5	1.4	1.53	1.45
5 ft (tide)	1.3	1.29	1.42	1.45	1.37

NOAA SLOSH Scaling Method

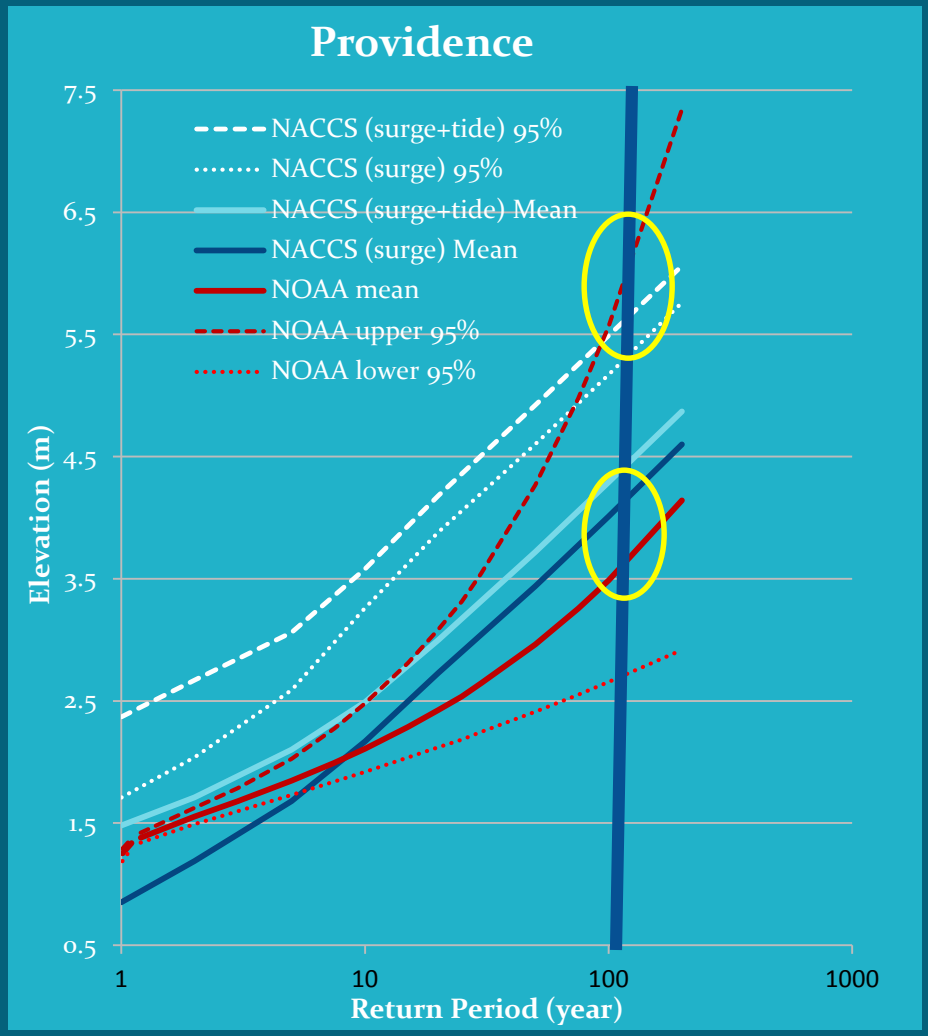


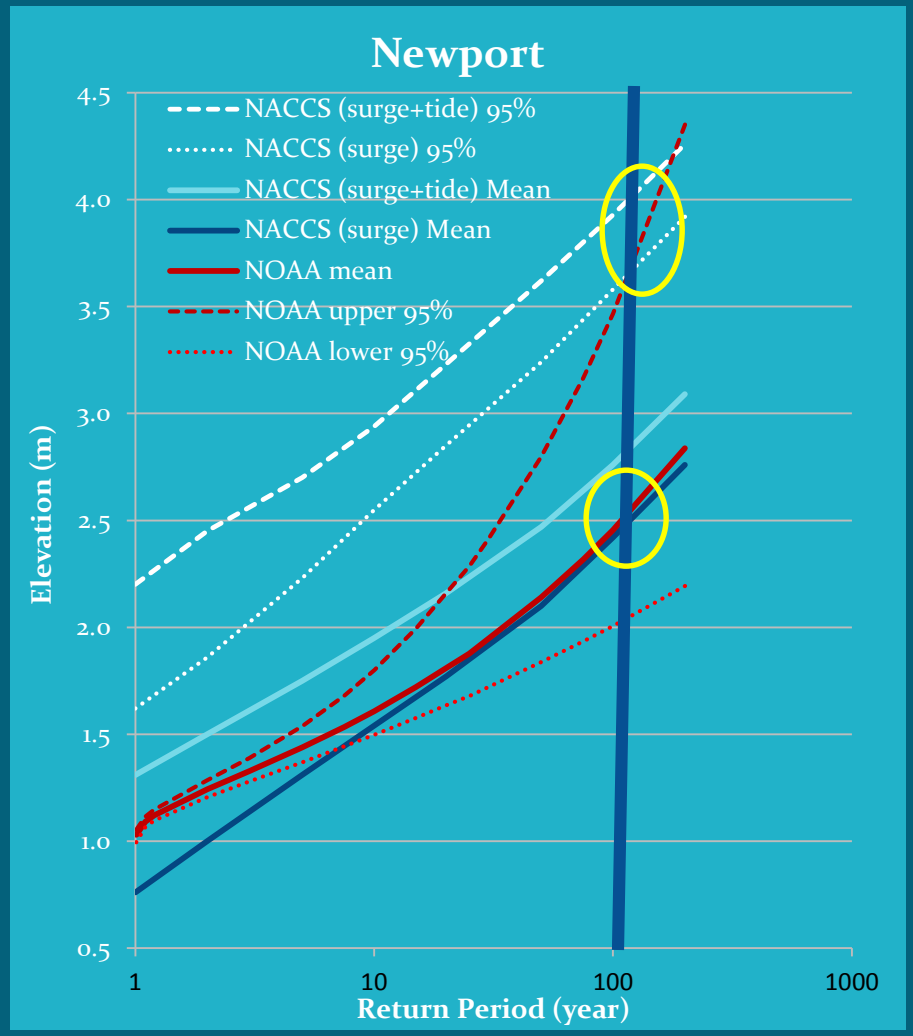
Category of hurricane- C1, 2, 3, and 4; with tidal water level of 2 and 5 ft (hi_2,hi_5)

NACCS simulations using high resolution coupled ADCIRC and STWAVE

- Simulations performed for surge only and surge plus tide cases, for both water levels and waves
- 1050 synthetic tropical storm, 100 extra tropical storms (historical events)
- Predictions archived at selected save points(18,000, about 1000 in RI)and web accessible for future use.
- Time series and peak values stored at save point for each storm
- Return period analysis performed for tropical storms using ACOE method

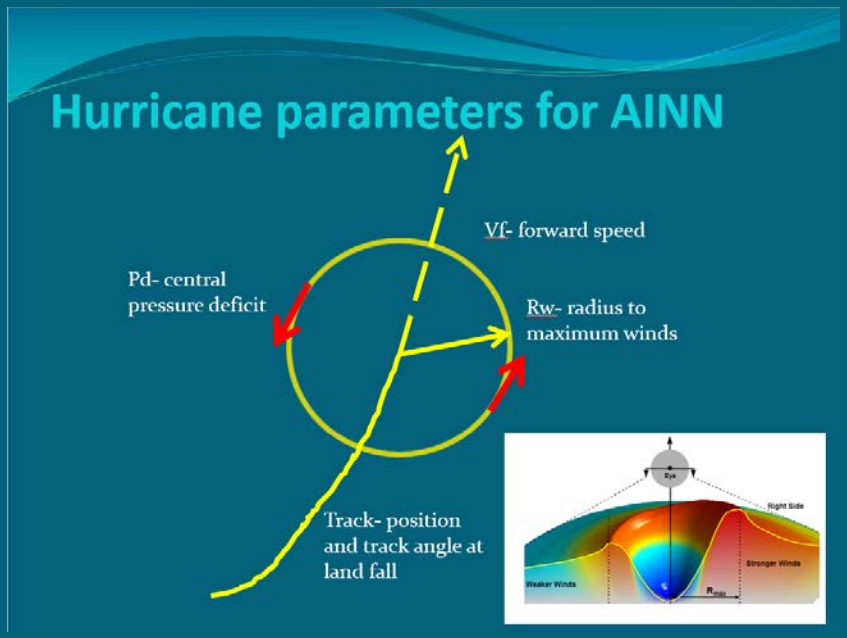
NOAA & NACCS water level vs return period for Providence and Newport, RI



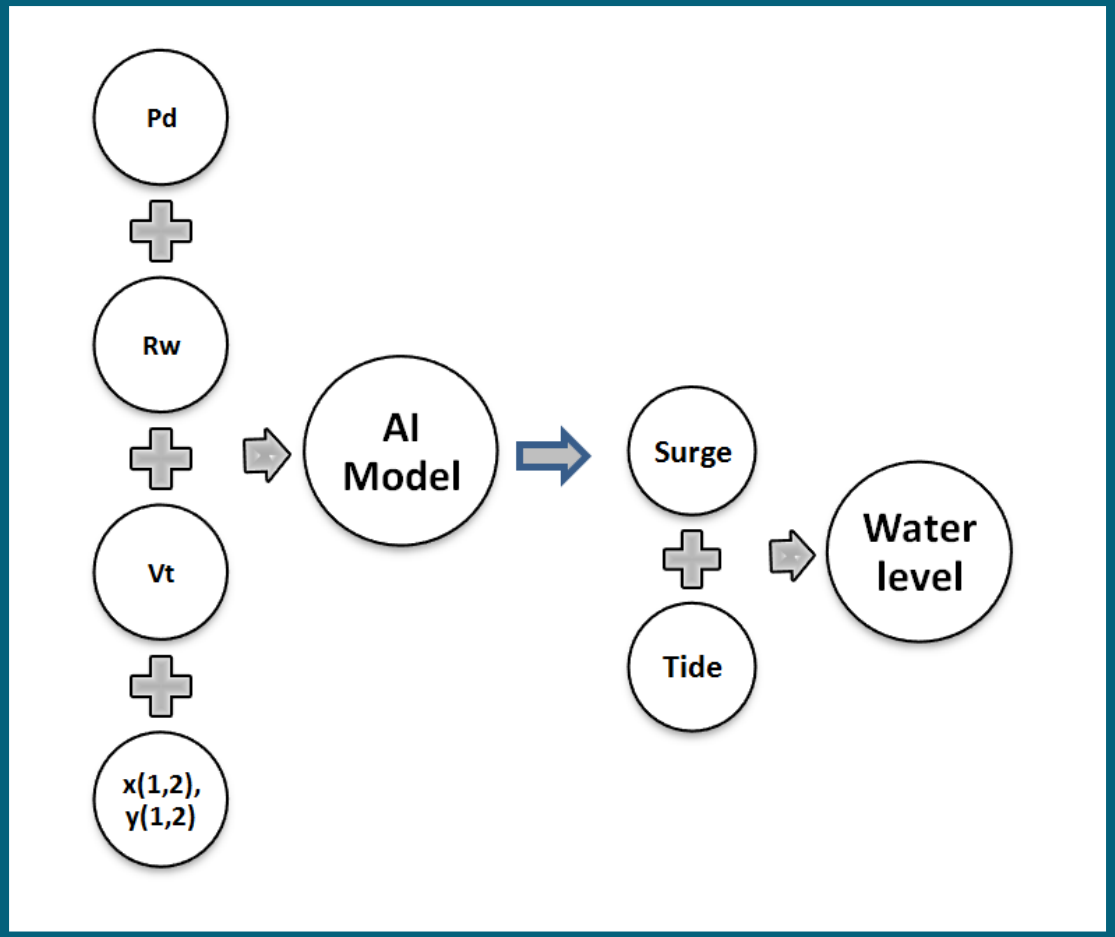


Artificial Intelligence Neural Network Based Tool to Predict Storm Surge

Goal: Use artificial intelligence based tool that will allow prediction of water level (and wave height) at a given location based on input of key variables describing tropical storms (central pressure, forward speed, radius to maximum winds, and storm track) to validate NACCS model predictions

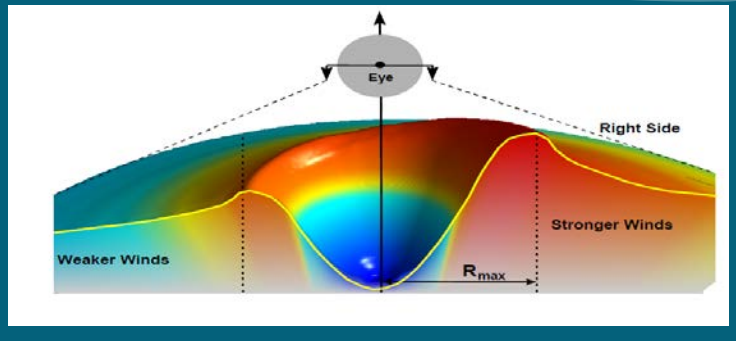


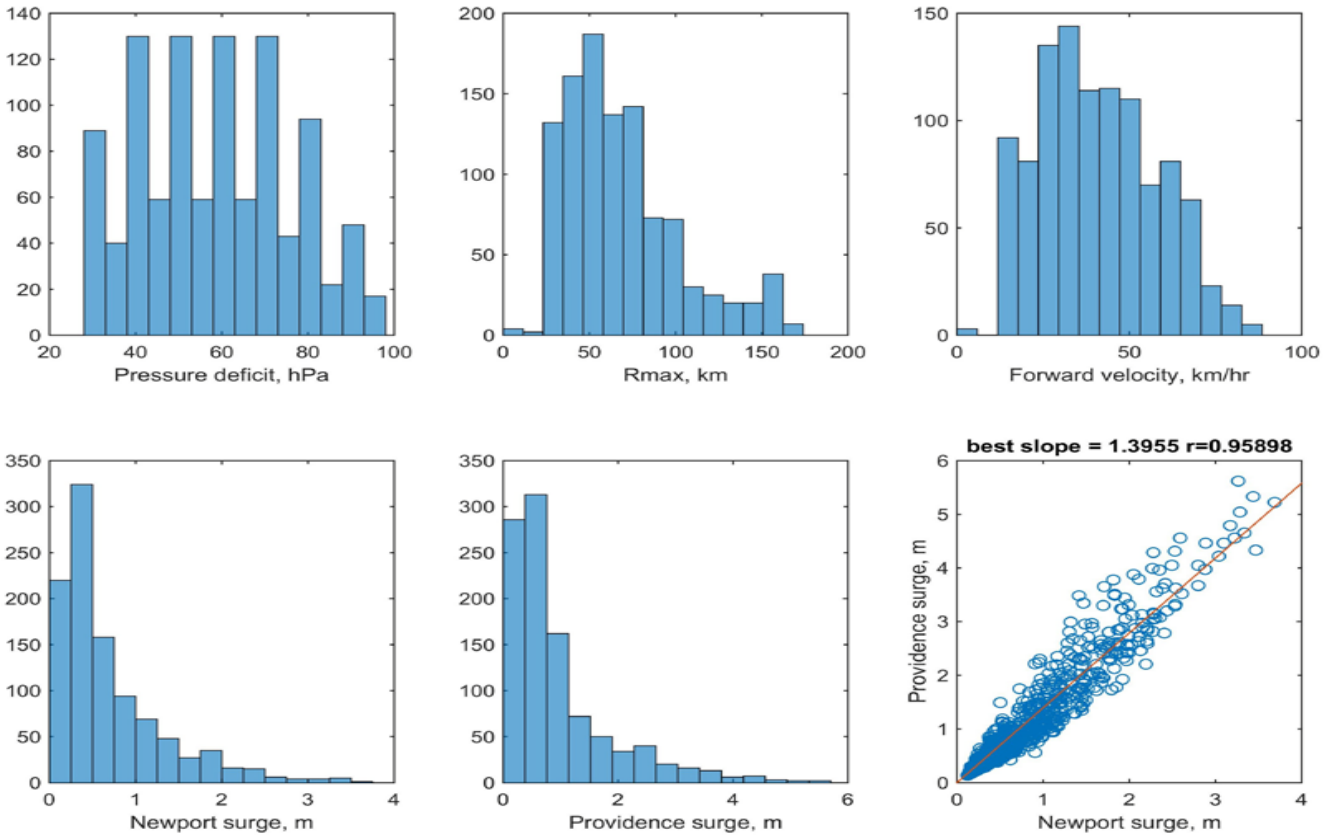
Artificial Intelligence Neural Network: Conceptual Model



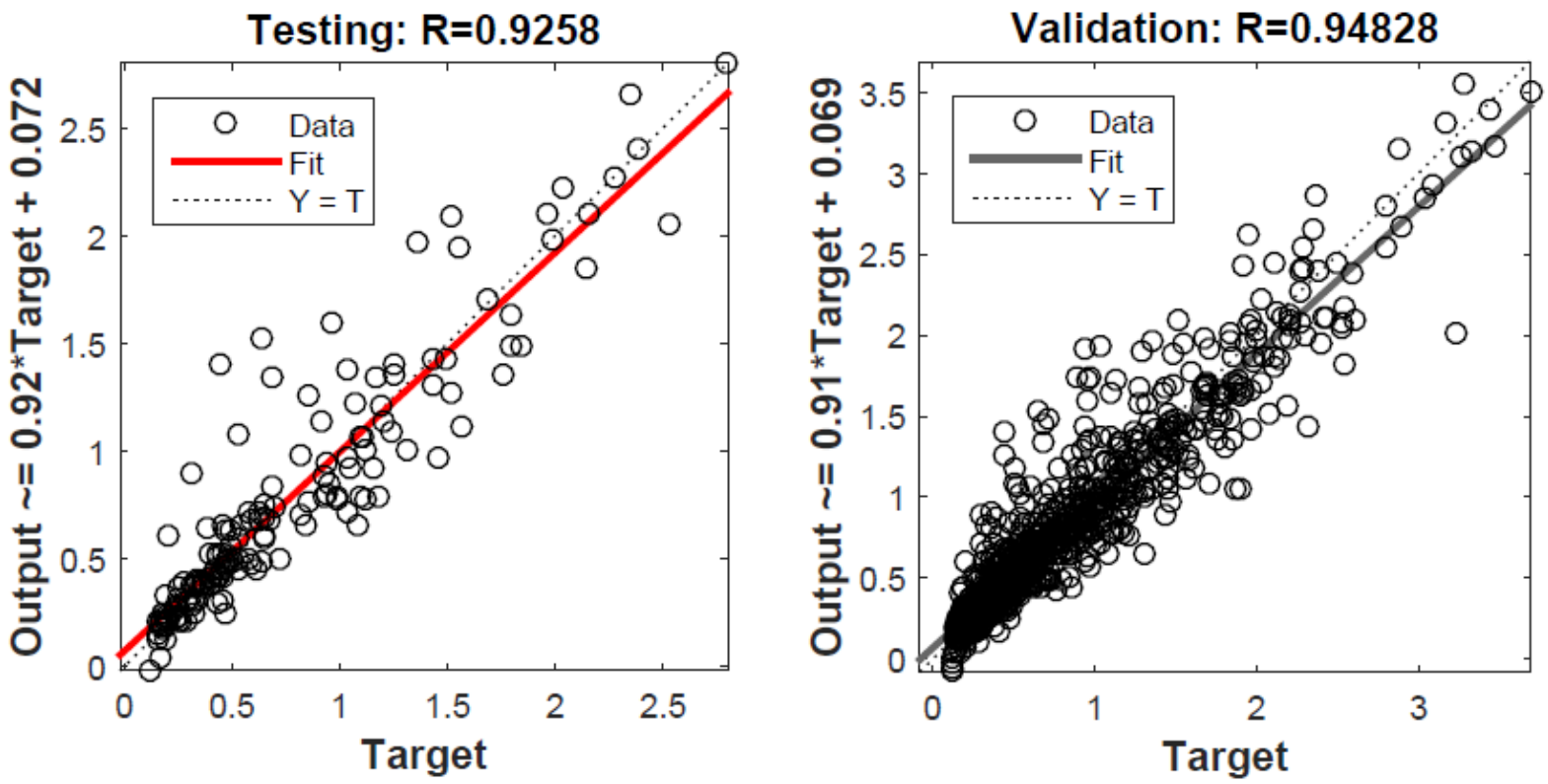
Pd- Central pressure deficit
Rw- radius to maximum winds
Vf- forward speed,
P1(x,y) and
P2(x.y) -storm location immediately before and after landfall

NACCS storm parameters and surge results



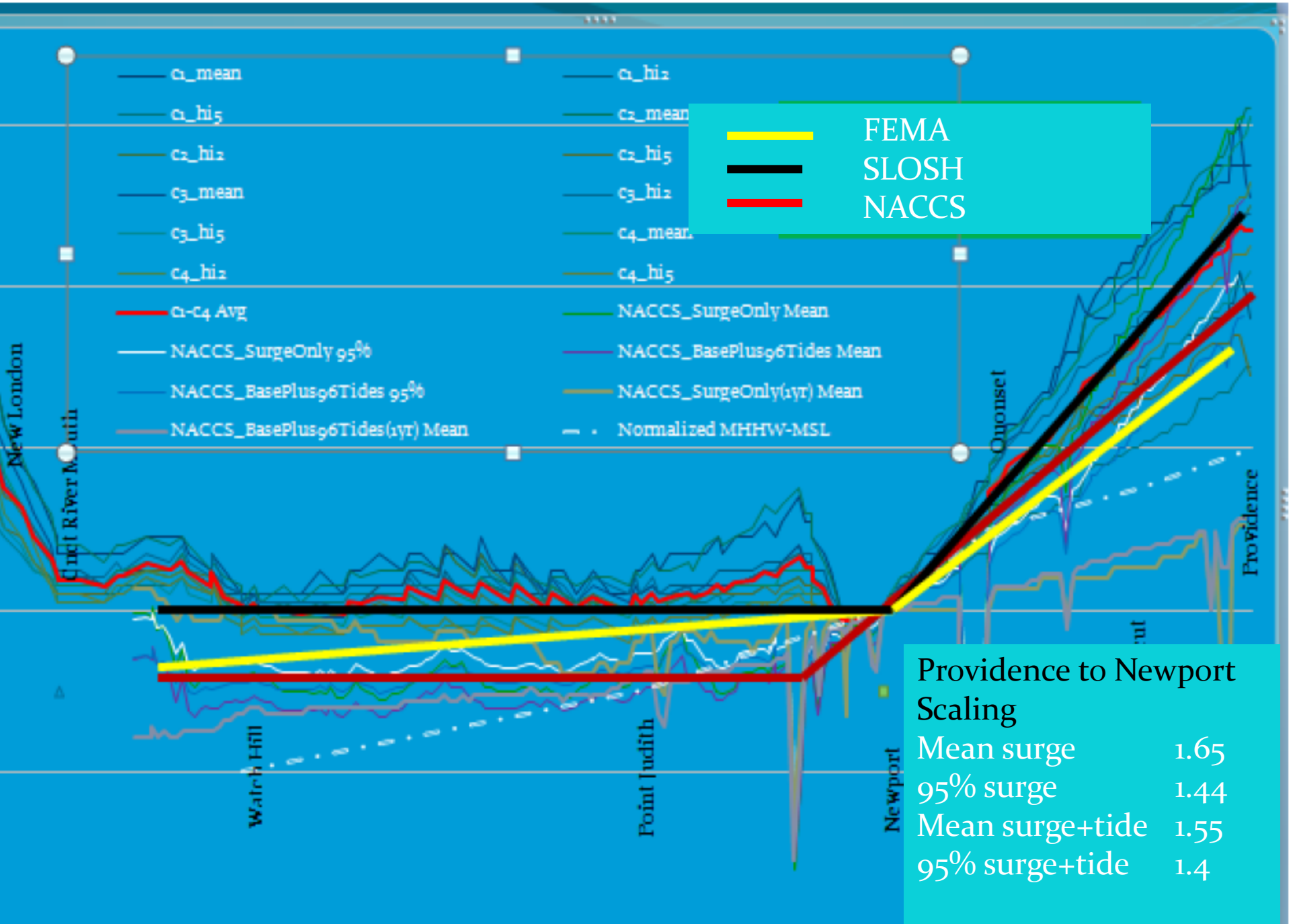


AI ANN model training and validation performance at Newport, RI



NACCS, NOAA, and FEMA, water level and scaling for New London, CT; and Providence and Newport, RI

Water levels(m) for 100 yr return period for Providence, Newport, and New London							
	from NOAA, NACCS, and FEMA						
	NACCS						
	Surge+ Tide		Surge		NOAA		FEMA FIS
Station	Mean	Upper	Mean	Upper	Mean	Upper	
		95%		95%		95%	
Providence	4.29	5.49	4.01	5.17	3.48	5.56	4.2
Newport	2.76	3.93	2.42	3.58	2.47	3.47	3.21
New London	2.86	4.37	2.78	3.92	2.31	3.17	2.87
		NACCS				NOAA	FEMA
Scaling Relative to Newport							
Providence	1.55	1.40	1.66	1.44	1.41	1.60	1.31
Newport	1	1	1	1	1	1	1
New London	1.04	1.11	1.15	1.09	0.94	0.91	0.89



Providence to Newport Scaling

Mean surge	1.65
95% surge	1.44
Mean surge+tide	1.55
95% surge+tide	1.4

Simplified Flooding Maps for RI

Summary of STORMTOOL Flooding Maps Available for Rhode Island							
	Return period (yrs) and sea level rise (ft)						In land
	Return period	Sea level rise (ft)					flooding
	(yrs)	none	1	2	3	5	
	0	X	X	X	X	X	
	25	X	X	X	X	X	
	50	X	X	X	X	X	
	100	X	X	X	X	X	
	100	X	X	X	X	X	X
		Inundation depth interrogation tool					
	Flooding	Return period (yrs)					
	Nuisance Storms	1	3	5	10		
	Historical Storms (NOAA top ranked for RI, hurricanes)						
		1938	1954	1991	2012		
	Matched pairs, flooding return period(yr) and corresponding sea level rise(ft)						
	Return period (yrs)	25	50	100			
	Sea level rise (ft)	1	2	5			

Coastal Environmental Risk Index

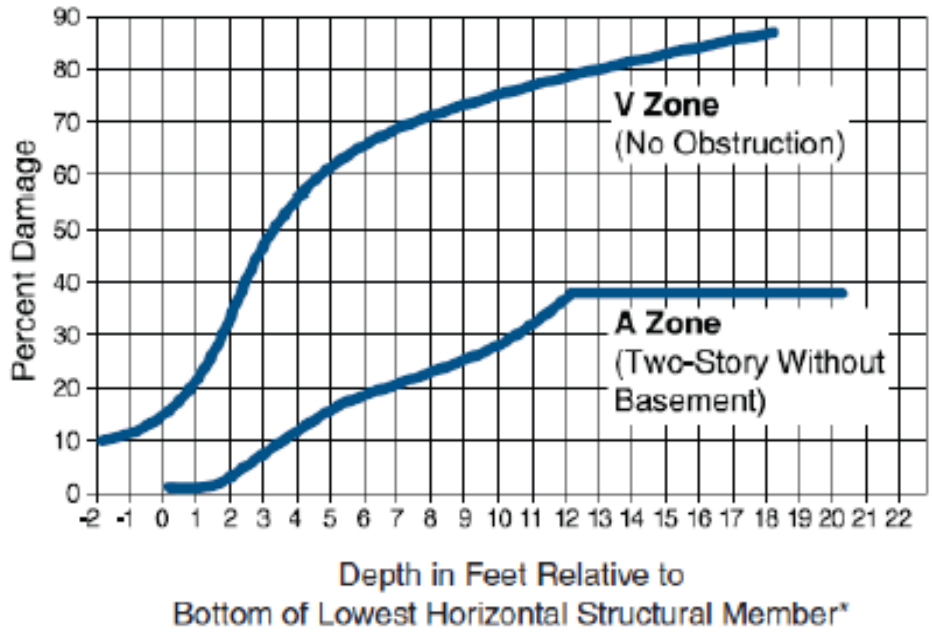
Goal: Develop a Coastal Environment Risk Index (CERI) that provides a summary of the risk coastal areas face from the environment; specifically storm included flooding and the associated wave environment, sea level rise, and shoreline erosion/accretion and apply it RI coastal waters.

Building Blocks

STORMTOOLS flood inundation and wave height maps

RI Shoreline Change Maps (erosion/accretion) and transects

Damage vs depth of inundation



* Assumes distance between top of floor and bottom of lowest horizontal structural member = 2' for A Zone buildings.

Figure 4. Flood depth versus building damage curves for V Zones and riverine A Zones.

(SOURCE: FEMA 55, *COASTAL CONSTRUCTION MANUAL*).

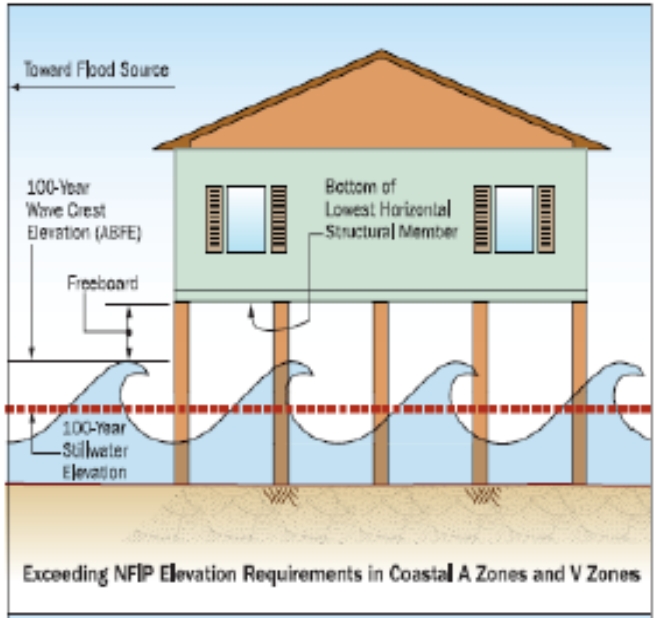
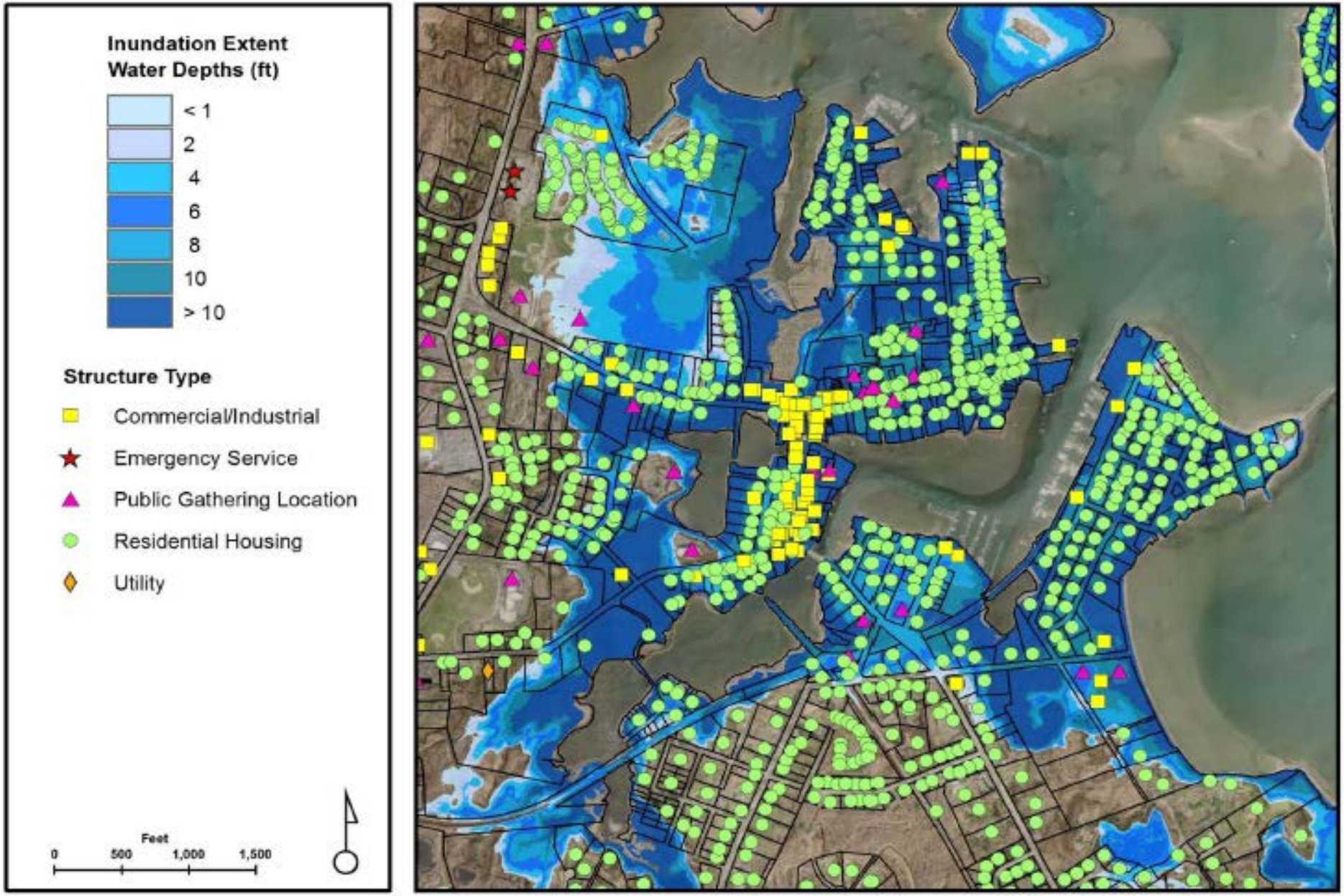


Figure 7. Recommended construction in Coastal A Zone and V Zone.

Structure Two or More Stories-No Basement		
Depth	Mean of Damage	Standard Deviation of Damage
-2	0%	0%
-1	3.0%	4.1%
0	9.3%	3.4%
1	15.2%	3.0%
2	20.9%	2.8%
3	26.3%	2.9%
4	31.4%	3.2%
5	36.2%	3.4%
6	40.7%	3.7%
7	44.9%	3.9%
8	48.8%	4.0%
9	52.4%	4.1%
10	55.7%	4.2%
11	58.7%	4.2%
12	61.4%	4.2%
13	63.8%	4.2%
14	65.9%	4.3%
15	67.7%	4.6%
16	69.2%	5.0%

Wickford, Rhode Island:
Inundation Extent for a 100yr Event With 5' Sea Level Rise



Wickford, Rhode Island:
Inundation Extent for a 100yr Event With 5' Sea Level Rise

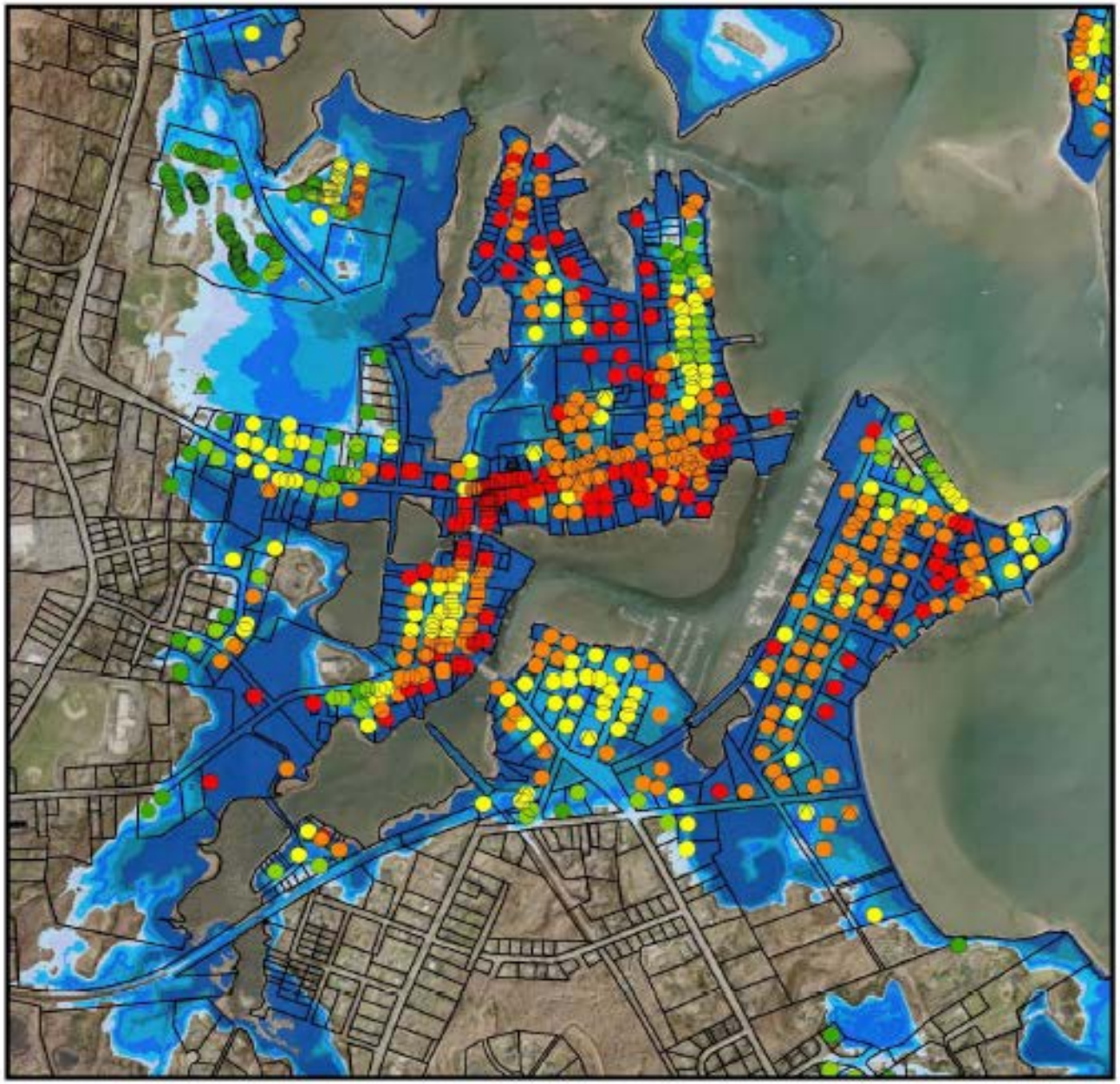
Inundation Extent
Water Depths (ft)

- < 1
- 2
- 4
- 6
- 8
- 10
- > 10

Structure Type

- Commercial/Industrial
- Emergency Service
- Public Gathering Location
- Residential Housing
- Utility

Percent Damage

- < 10%
- 30%
- 40%
- 60%
- > 60%

Feet
0 500 1,000 1,500