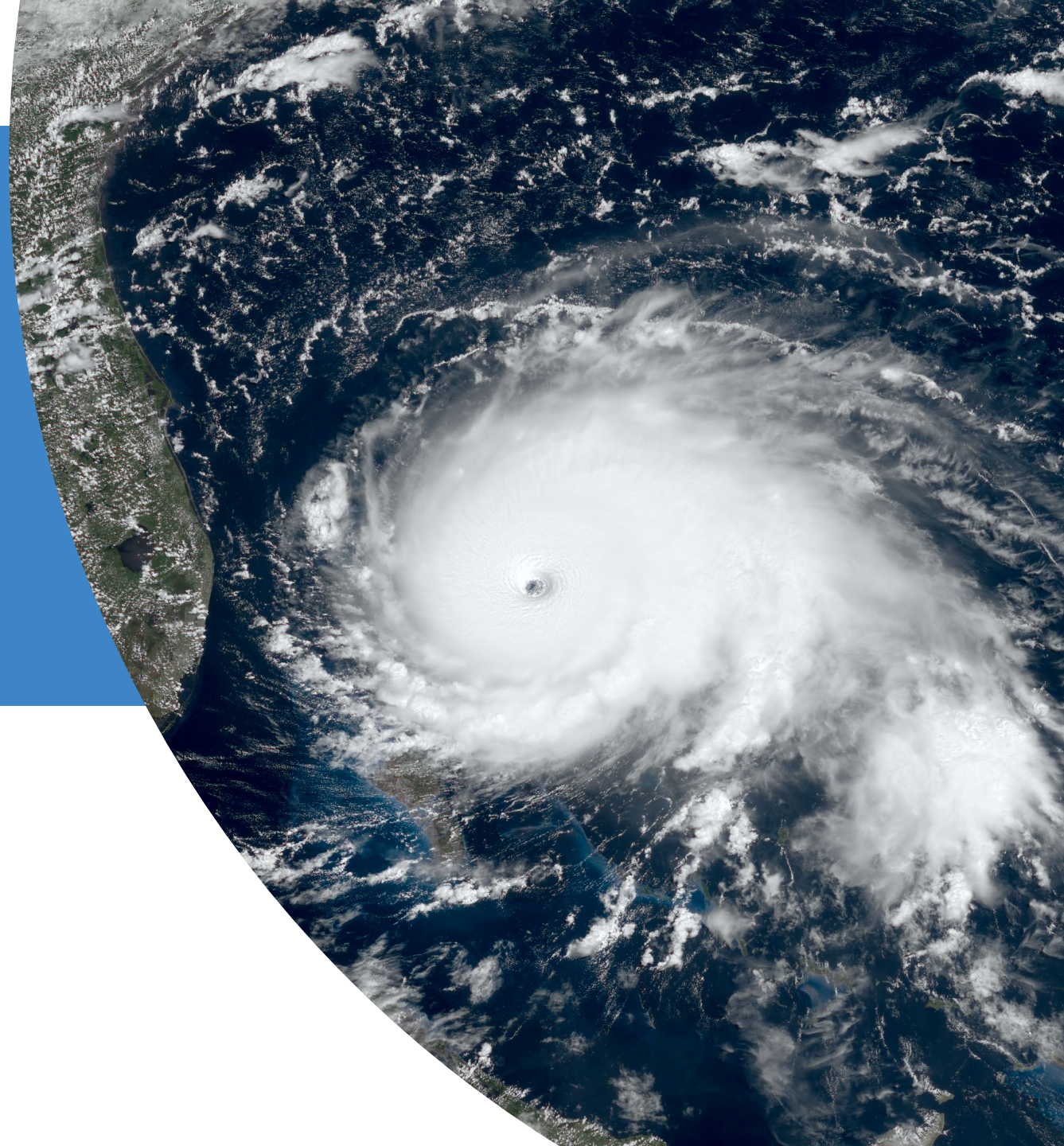
COASTAL RESILIENCE CENTER
A U.S. Department of Homeland Security Center of Excellence

The **R**hode **I**sland **C**oastal **H**azard, **A**nalysis, **M**odeling, and **P**rediction System (**RI-CHAMP**):

A planning and response tool for Rhode Island's critical infrastructure



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THE UNIVERSITY OF RHODE ISLAND
DEPARTMENT OF MARINE AFFAIRS

RIFMA 2023 Conference
May 25, 2023

Overview

- Project origins
- Nine years of developing a new decision support system
- Examples of implementation
- Next steps
- Questions

Coastal populations at risk from natural hazards

Nearly a third of the world's population lives within 100 km of the seacoast (Balica, Wright et al. 2012)

Exposed to storm hazards that include extreme wind, heavy rainfall, and storm surge from nor'esters, hurricanes, and tropical storms (Ellis, Sylvester et al. 2015)

Various forms of coastal flooding—storm surge, tidal inundation, etc.—are **often the most frequent and damaging**, and most likely to result in cascading consequences (Balica, Wright et al. 2012)

TOP: Narragansett Beach during Hurricane Henri. BOTTOM: Roy Carpenter's Beach, South Kingstown, RI. SOURCE: RI-CHAMP Project.

Climate change makes matters works

Global climate change is **increasing coastal communities' flood susceptibility** (IPCC 2007, IPCC 2019)

Rhode Island is particularly vulnerable (Ullman, Ginis et al. 2019, USACE 2022)

Emergency managers and resilience planners make impactful decisions in a resource-limited environment

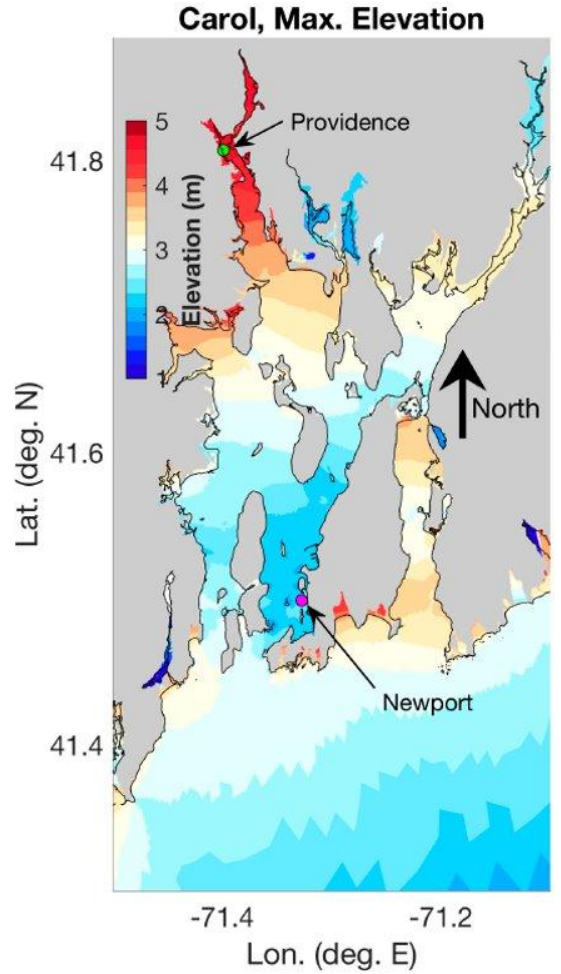
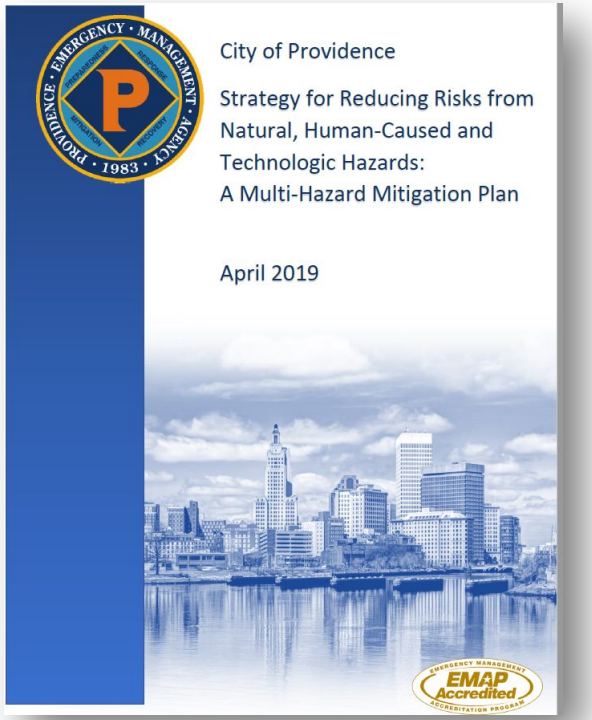
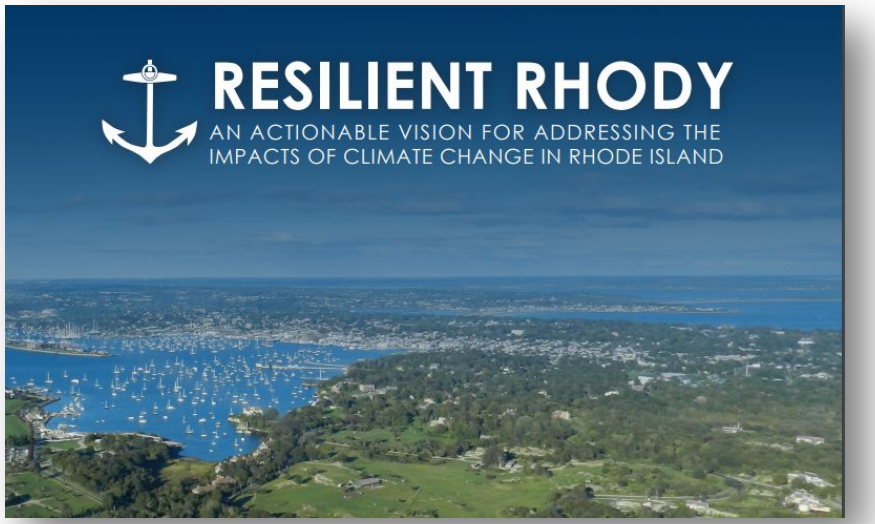
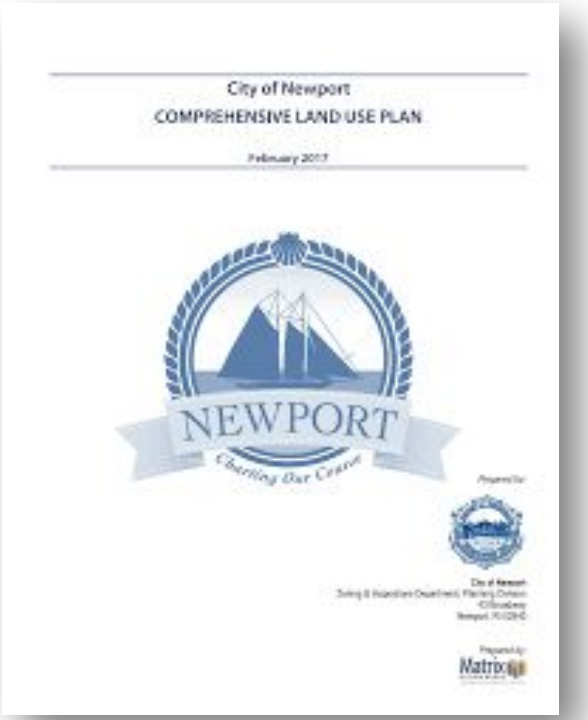


FIGURE: Simulated [ADCIRC/ SWAN] maximum surface elevation for Hurricane Carol (1954) (Ullman et al., 2019)

Many planning efforts address aspects of resilience and hazard response...







. . . few get into details at the site-specific scale

We set out to develop a system with emergency managers

- State and local hazard mitigation planning
- Floodplain management
- Facility emergency planning
- Real-time storm response and recovery preparation

Complex challenges require an interdisciplinary approach!

Emergency Management & Outreach

Sam Adams
URI Dept. of Marine Affairs
URI Public Safety

Pam Rubinoff
URI Coastal Resources Ctr

Model Storms & SLR

Isaac Ginis, Ph.D.
D. Crawley
URI School of Oceanography

GIS Interface for End-Users

Chris Damon,
Aimee Mandeville,
URI Env Data Ctr

Peter Stempel
Penn State

Social Sciences

Austin Becker, Ph.D
R. Fusco, N. Hallisey, K. McElroy
URI Dept of Marine Affairs

Leveraging state-of-the-art research to benefit society

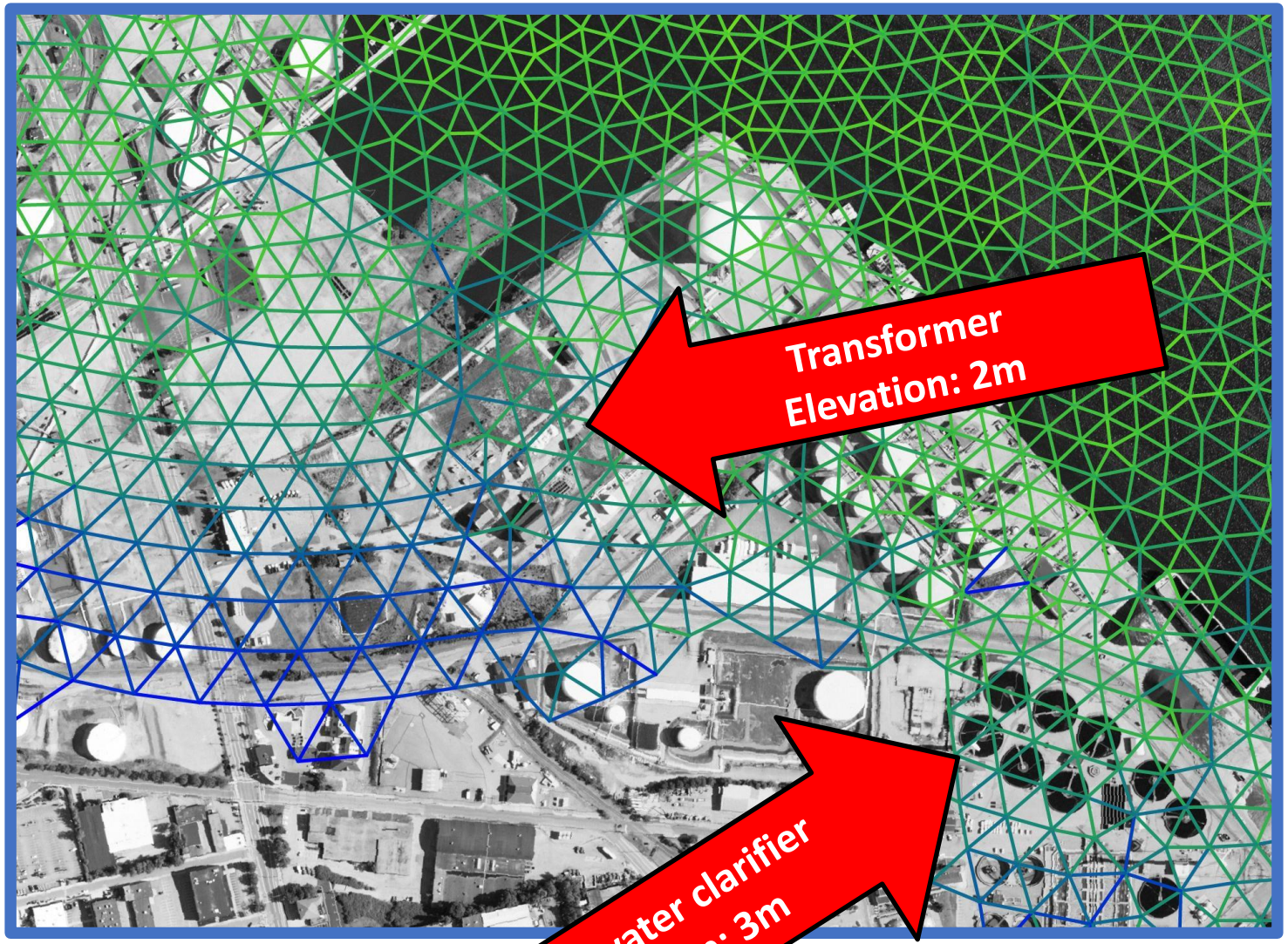
High-resolution ADCIRC modeling
(~20-40m unstructured grid)

+

Ground-truthed, locally derived,
consequences data

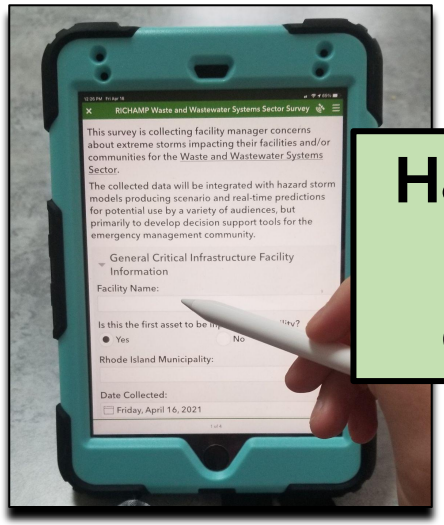
=

POWERFUL IMPACT PREDICTION OPPORTUNITY TO ENHANCE EMERGENCY MANAGEMENT & PLANNING



Providence, RI

Data collection from local experts



Hazard Consequence Thresholds (HCTs) complement other quantitative assessment tools

Specific, local, flexible

Infrastructure facility managers:

- Know their own local **vulnerabilities**
- Need to **understand model outputs on their own terms**
- Participation increases the **credibility and value** of the storm models outputs

The Infrastructure Asset Consequence Thresholds (IACT) database

Asset **name**

Asset x/y **location**

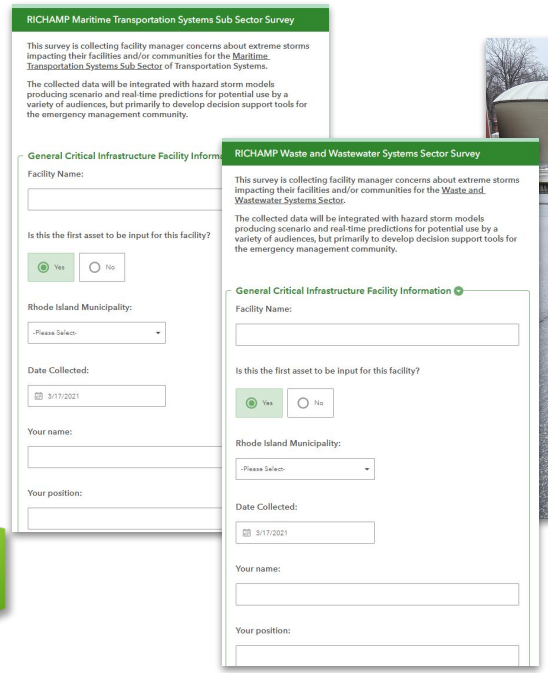
Thresholds at which flood and/or wind would impact the asset

Consequences of that asset being impaired

Data Collection Tools- Site Visits

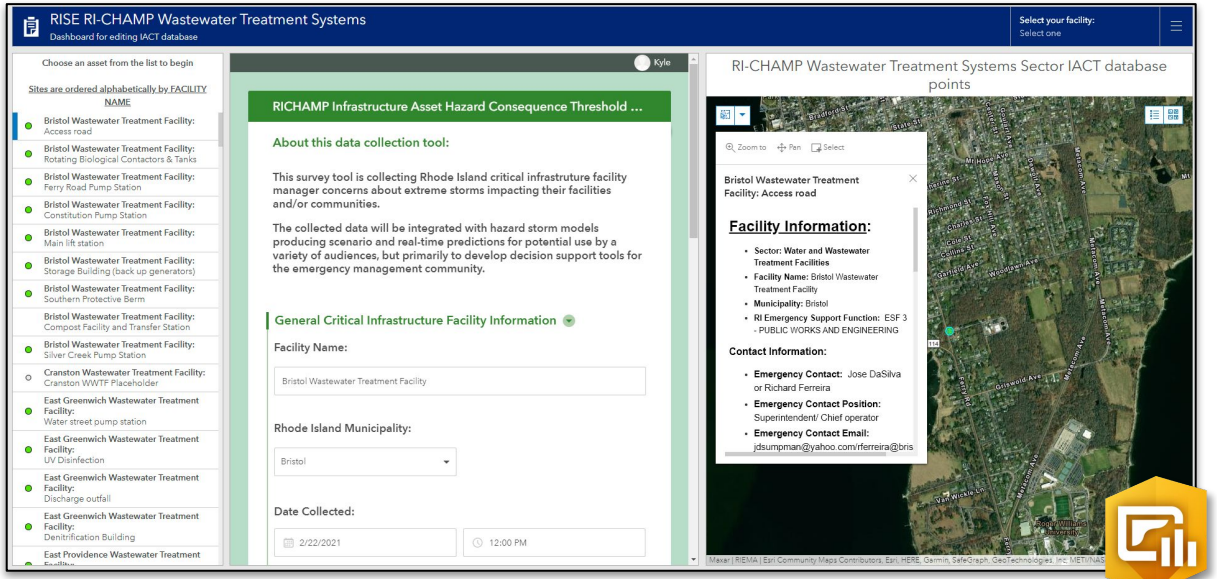
1) Initial field collection using Survey123 mobile app

Facility site visit, record asset location, take photos, discuss consequences and take notes (instructional video provided to assist)

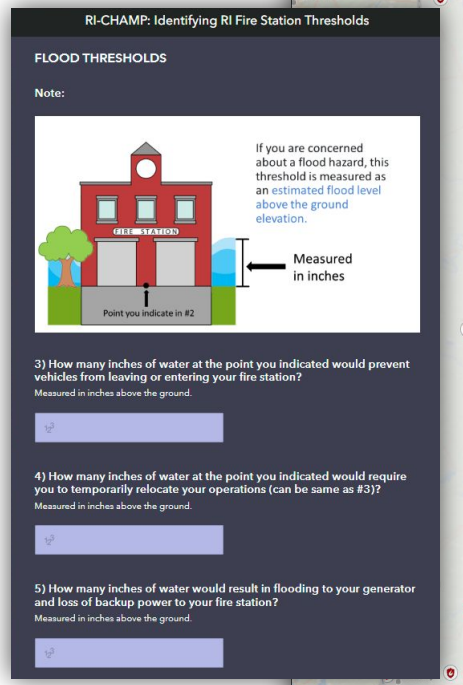


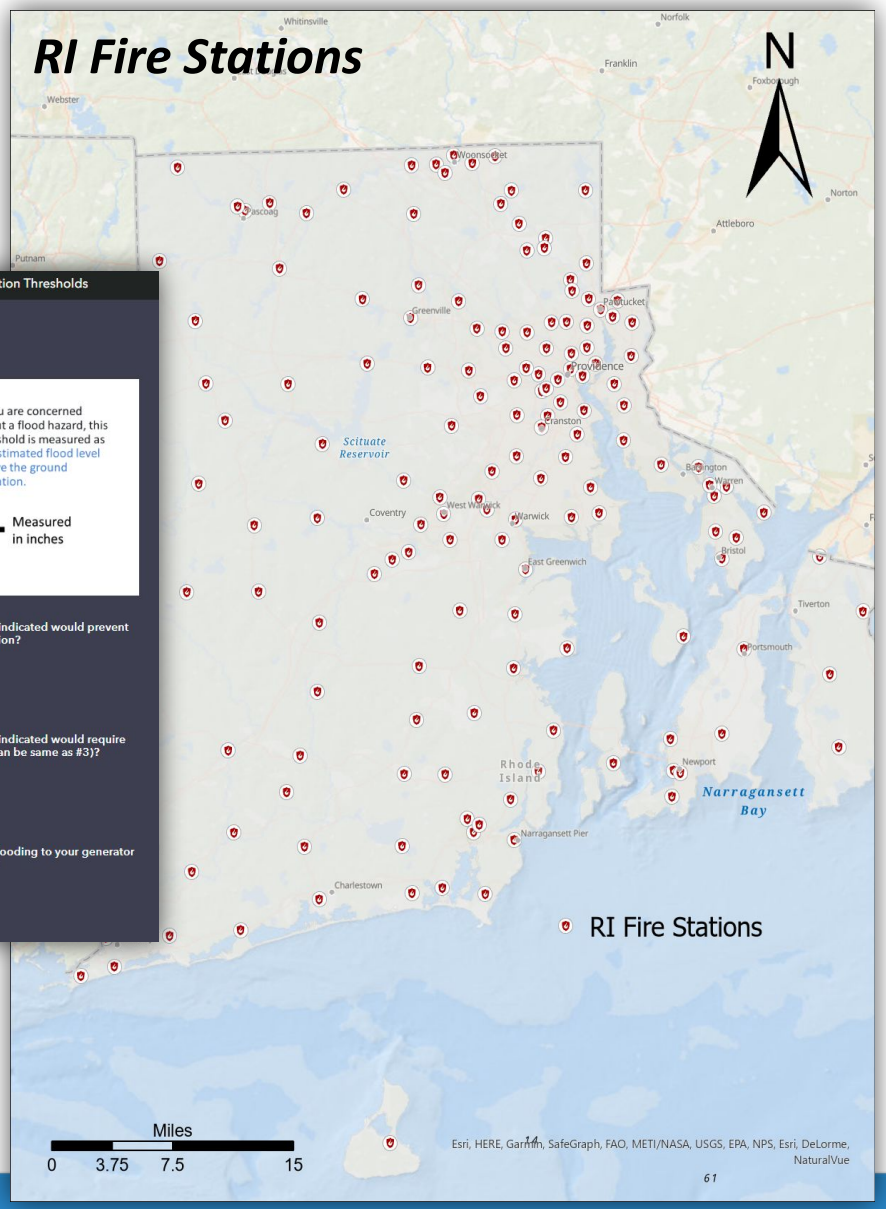
2) Review and revise via an online editing dashboard in ArcGIS Online

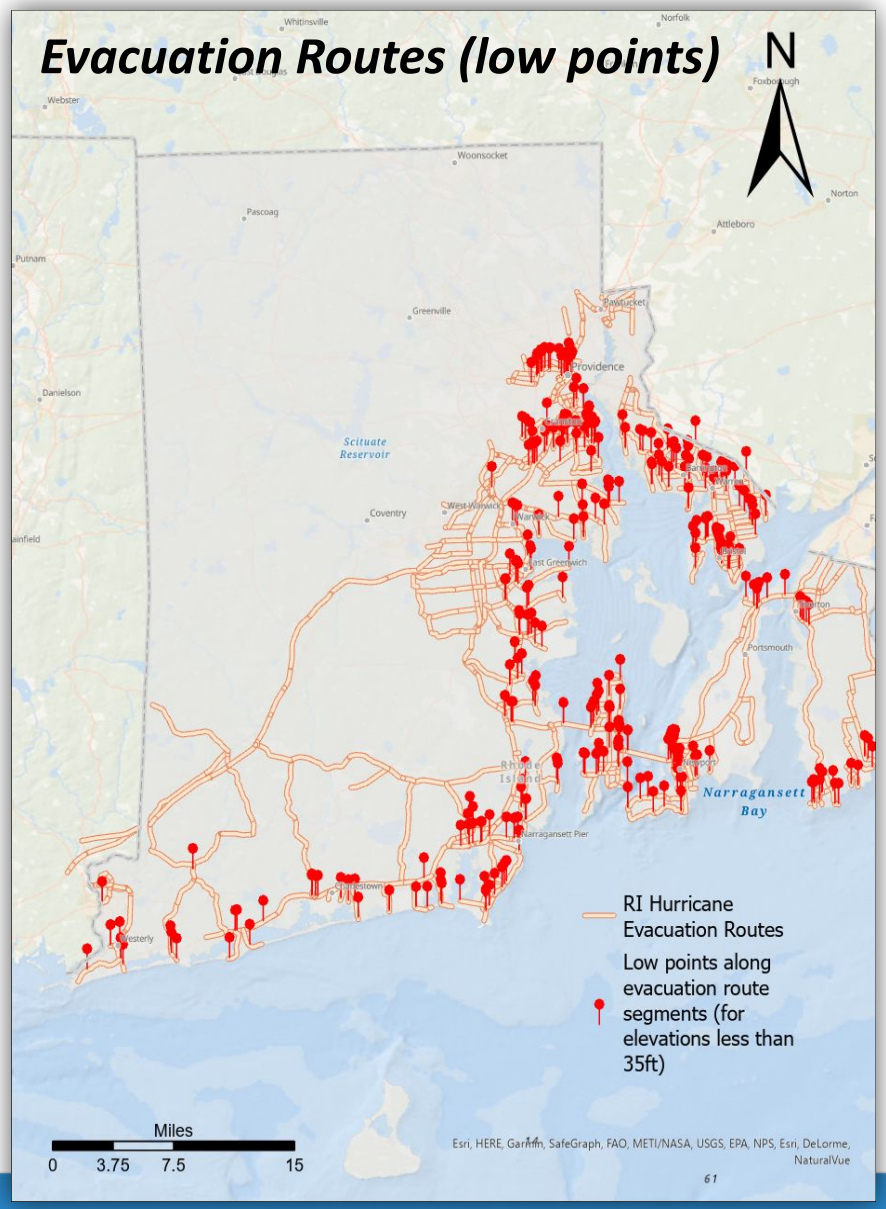
Facility manager access an editing dashboard to enter detailed information



Data Collection Tools- Incorporate Existing GIS Layers



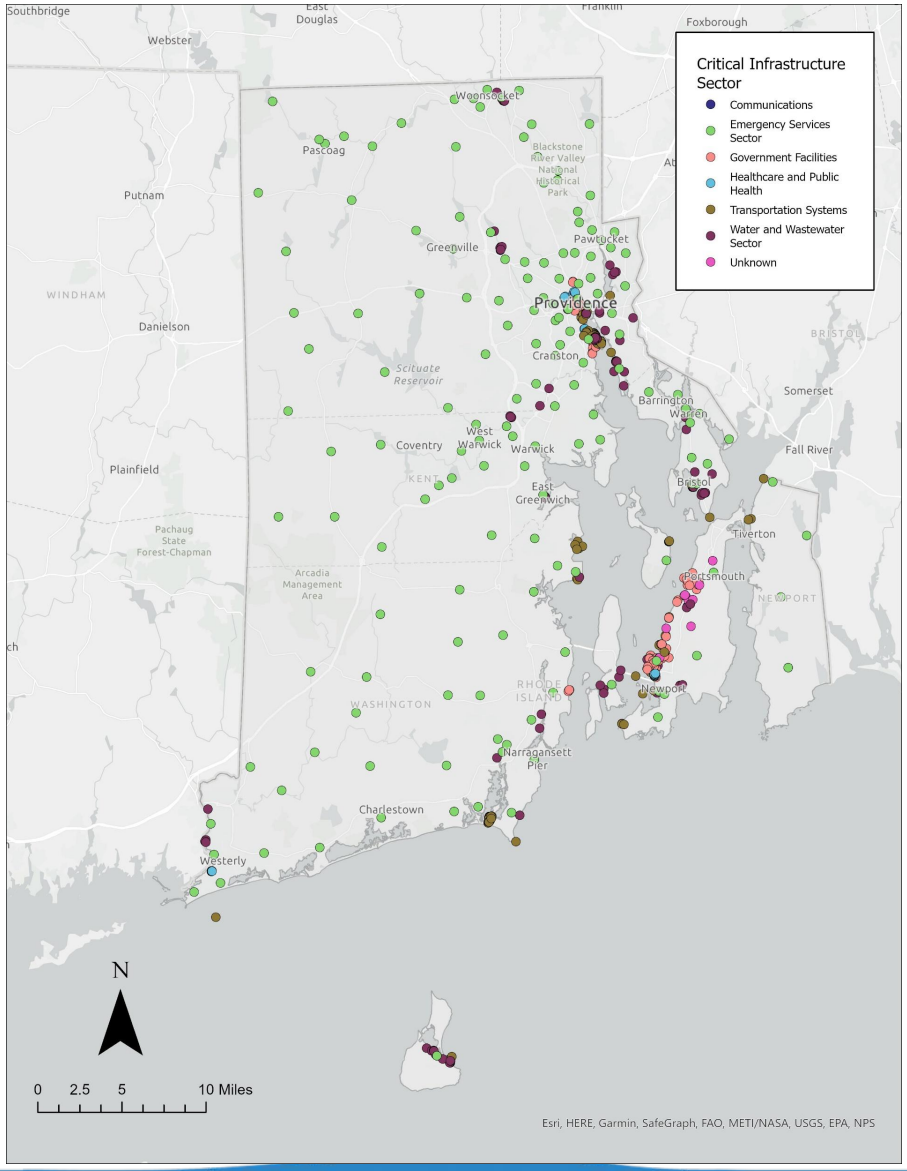




The Infrastructure Asset Consequence Thresholds (IACT) Database

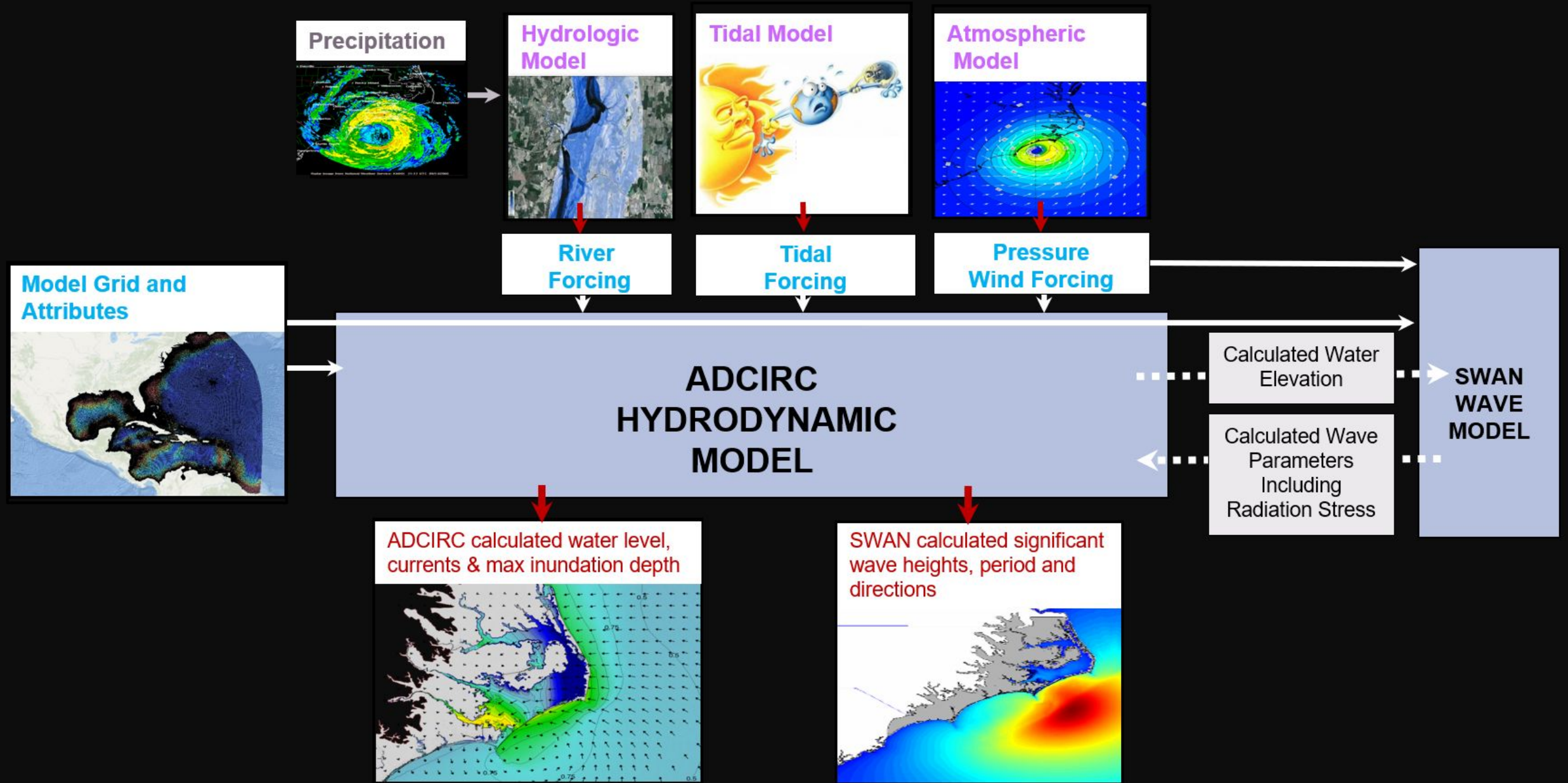
Data collected from 264 infrastructure facilities

- 1003 vulnerable assets
  - 974 flood hazard consequences
  - 580 wind hazard consequences



ADvanced CIRCulation (ADCIRC) Modeling System

THE UNIVERSITY OF RHODE ISLAND
GRADUATE SCHOOL OF OCEANOGRAPHY



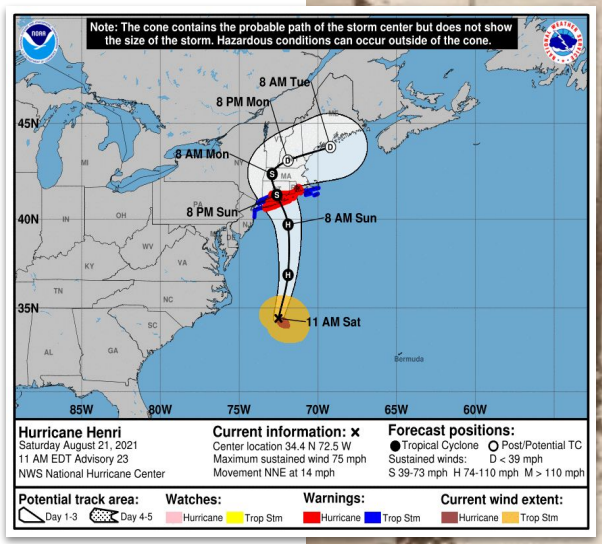
Current or Reference storm models from ADCIRC

ADCIRC Current Storm Forecast Models

- Used for an actual storm threatening the area
- May include multiple iterations
- Basis for near-real-time consequence predictions
- Updated at set intervals (e.g., every 6 hrs)

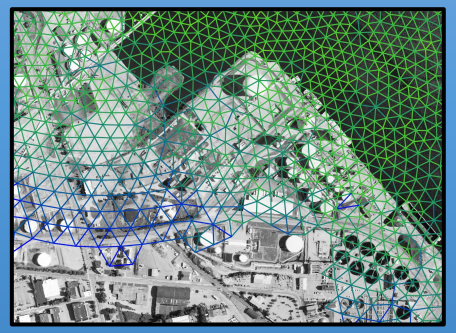
ADCIRC Reference Storm Models

- Used for planning purposes
- Simulate actual historical storm or a hypothetical model
- Can include Sea Level Rise



Integrate Hazard Consequence Thresholds with Model Outputs

ADCIRC Storm Model
NetCDF surge and wind file(s)



Infrastructure Assets Consequence Threshold (IACT) Database

RI State Enterprise

Survey123

ArcGIS Data Store

ArcGIS Server
ArcGIS Image Server

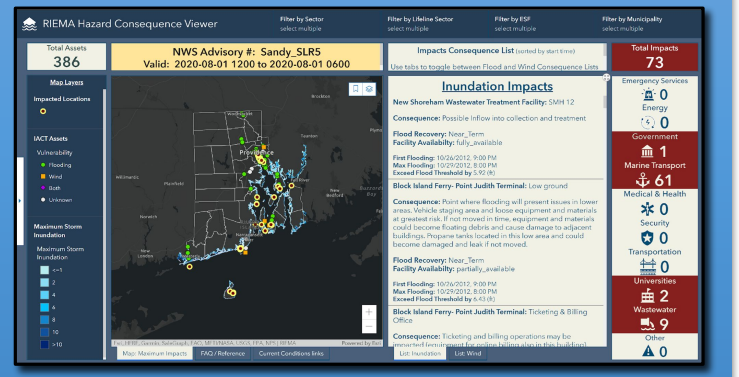
python® scripting
and
arcpy.mapping

Reporting

Impact Analysis

Map and Image Services

RI-CHAMP Dashboard

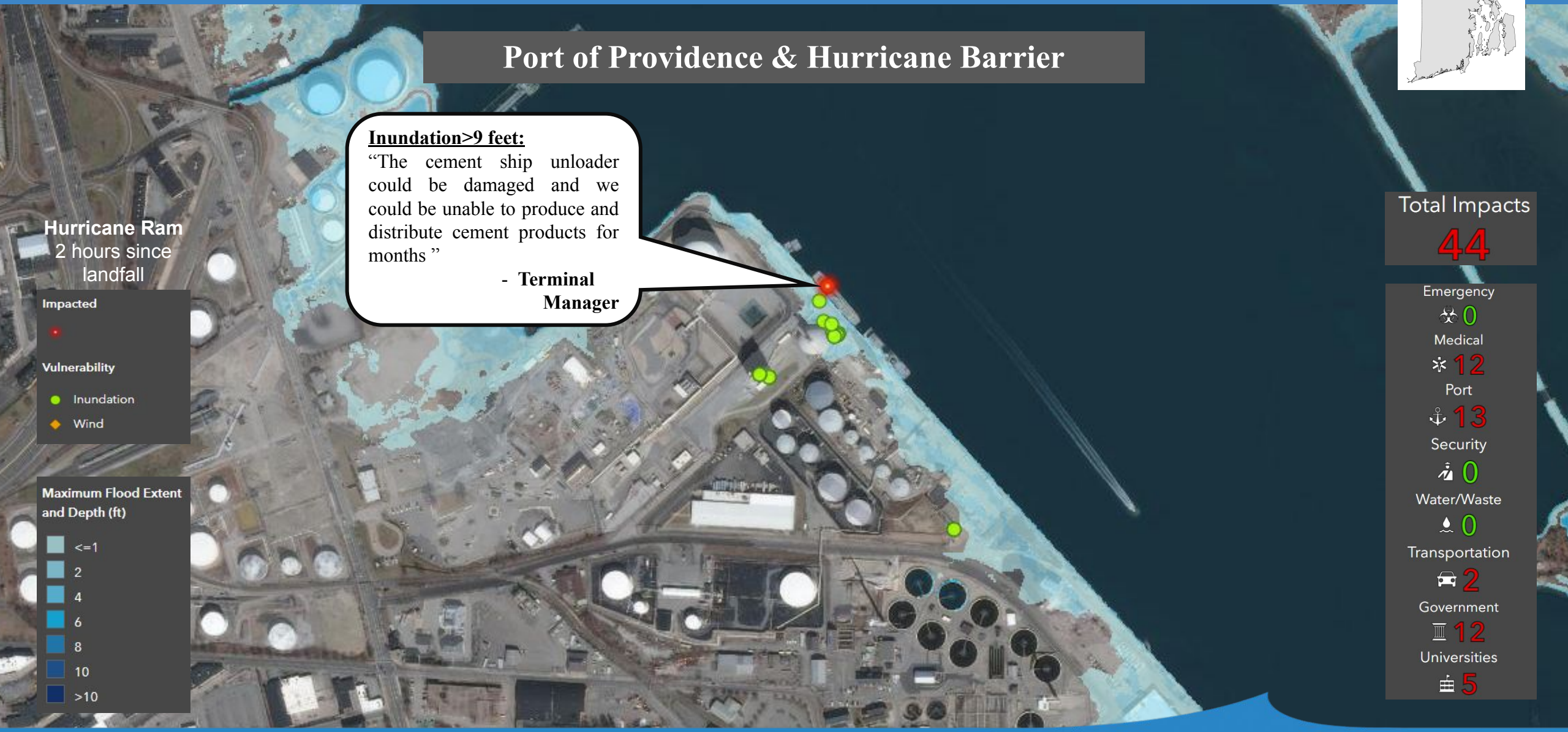


Operations Dashboard

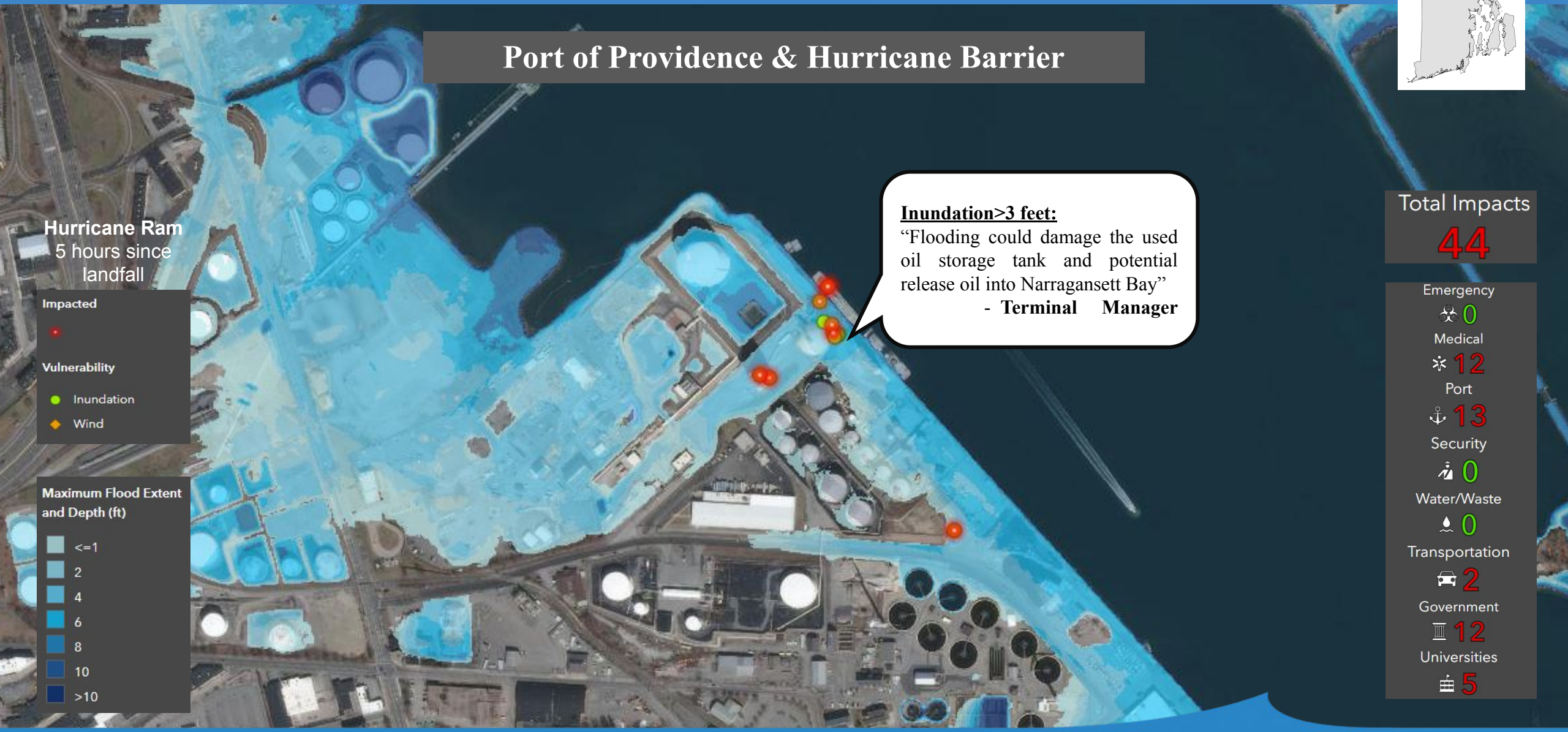
MANUSCRIPT: Stempel, P., Ginis, I., Ullman, D., Becker, A., & Witkop, R. (2018). Real-Time Chronological Hazard Impact Modeling. *Journal of Marine Science and Engineering*, *6*(4), 134.

www.RICHAMP.org

Triggered consequence threshold



Triggered consequence threshold



ArcGIS interactive dashboard

Storm scenario/forecast

Filters

Total impacts in current view

nsequence Viewer | Filter by Sector: select multiple | Filter by Lifeline Sector: select multiple | Filter by ESF: select multiple | Filter by ...pality: select m...

Total Assets
386

NWS Advisory #: Sandy_SLR5
Valid: 2020-08-01 1200 to 2020-08-01 0600

Impacts Consequence List (sorted by start time)

Use tabs to toggle between Flood and Wind Consequence Lists

...otal Impacts
73

Map Layers

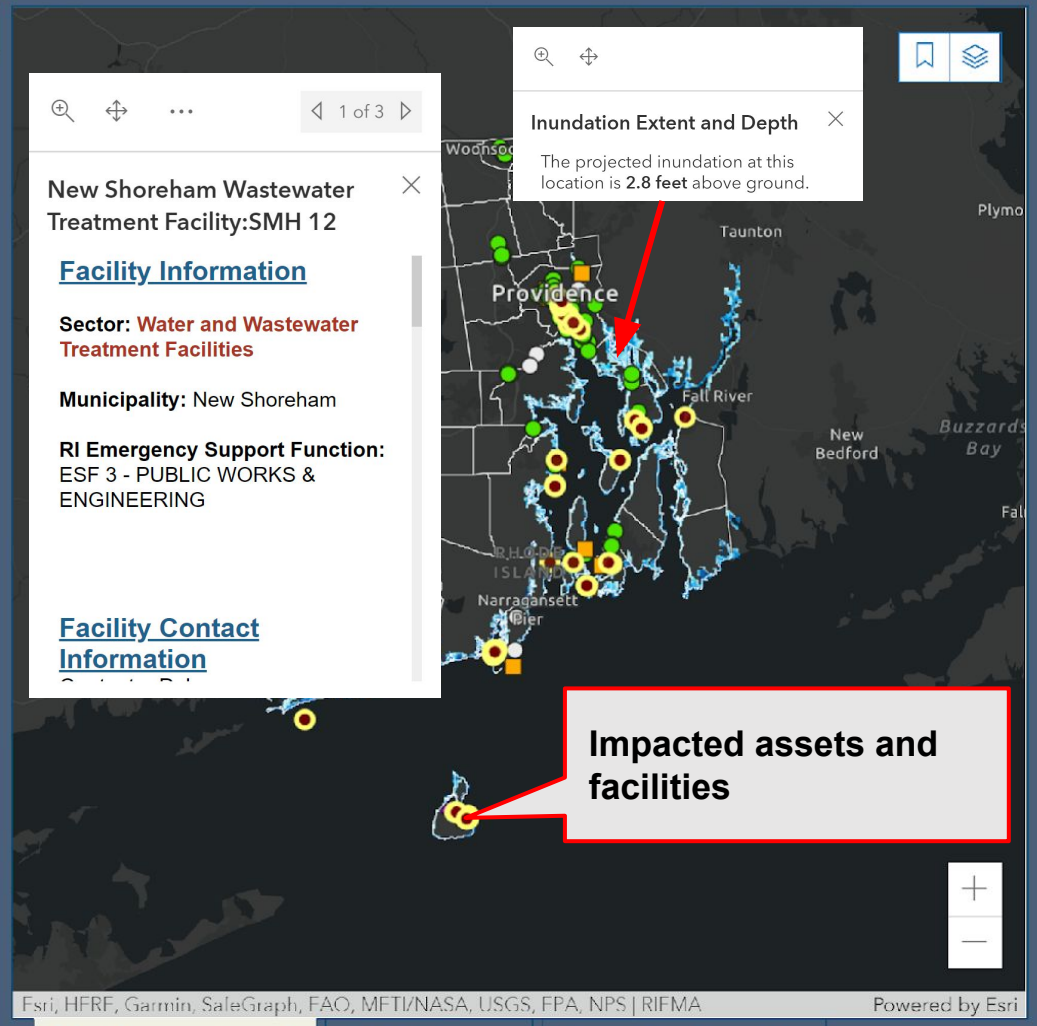
Impacted Locations

IACT Assets

Vulnerability
- Flooding
- Wind
- Both
- Unknown

Maximum Storm Inundation

Maximum Storm Inundation
- <=1
- 2
- 4
- 6
- 8
- 10
- >10



Impacted assets and facilities

Inundation Impacts

New Shoreham Wastewater Treatment Facility: SMH 12

Consequence: Possible Inflow into collection and treatment

Flood Recovery: Near_Term
Facility Availabilty: fully_available

First Flooding: 10/26/2012, 9:00 PM
Max Flooding: 10/29/2012, 8:00 PM
Exceed Flood Threshold by 5.92 (ft)

Block Island Ferry- Point Judith Terminal: Low ground

Consequence: Point where flooding will present issues in lower areas. Vehicle staging area and loose equipment and materials at greatest risk. If not moved in time, equipment and materials could become floating debris and cause damage to adjacent buildings. Propane tanks located in this low area and could become damaged and leak if not moved.

Flood Recovery: Near_Term
Facility Availabilty: partially_availab...

First Flooding: 10/26/2012, 9:00 PM
Max Flooding: 10/29/2012, 8:00 PM
Exceed Flood Threshold by 6.43 (ft)

Block Island Ferry- Point Judith Ter...
Office

Consequence: Ticketing and billing operations may be impacted (equipment for online billing also in this building)

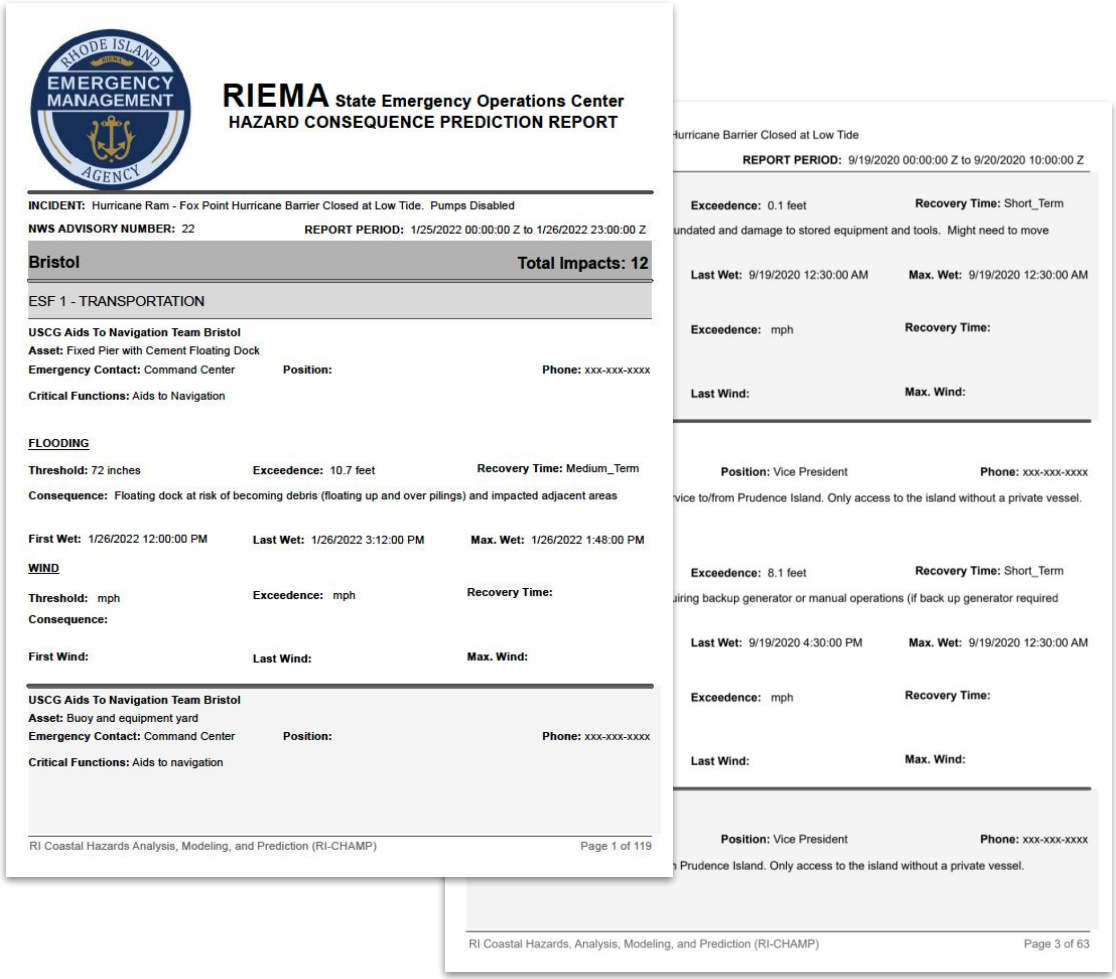
List of brief consequence details in current view

Emergency Services
0
Energy
0
Government
1
Marine Transport
61
Medical & Health
0
Security
0
Transportation
0
Universities
2
Wastewater
9
Other
0

Map: Maximum Impacts | FAQ / Reference | Current Conditions links

List: Inundation | List: Wind

Printed impact prediction reports



RIEMA State Emergency Operations Center
HAZARD CONSEQUENCE PREDICTION REPORT

INCIDENT: Hurricane Ram - Fox Point Hurricane Barrier Closed at Low Tide. Pumps Disabled
NWS ADVISORY NUMBER: 22 **REPORT PERIOD:** 1/25/2022 00:00:00 Z to 1/26/2022 23:00:00 Z

Bristol **Total Impacts: 12**

ESF 1 - TRANSPORTATION

USCG Aids To Navigation Team Bristol
Asset: Fixed Pier with Cement Floating Dock
Emergency Contact: Command Center **Position:** **Phone:** xxx-xxx-xxxx
Critical Functions: Aids to Navigation

FLOODING
Threshold: 72 inches **Exceedence:** 10.7 feet **Recovery Time:** Medium_Term
Consequence: Floating dock at risk of becoming debris (floating up and over pilings) and impacted adjacent areas
First Wet: 1/26/2022 12:00:00 PM **Last Wet:** 1/26/2022 3:12:00 PM **Max. Wet:** 1/26/2022 1:48:00 PM

WIND
Threshold: mph **Exceedence:** mph **Recovery Time:**
Consequence:
First Wind: **Last Wind:** **Max. Wind:**

USCG Aids To Navigation Team Bristol
Asset: Buoy and equipment yard
Emergency Contact: Command Center **Position:** **Phone:** xxx-xxx-xxxx
Critical Functions: Aids to navigation

RI Coastal Hazards Analysis, Modeling, and Prediction (RI-CHAMP) Page 1 of 119

Hurricane Barrier Closed at Low Tide
REPORT PERIOD: 9/19/2020 00:00:00 Z to 9/20/2020 10:00:00 Z

Exceedence: 0.1 feet **Recovery Time:** Short_Term
undated and damage to stored equipment and tools. Might need to move
Last Wet: 9/19/2020 12:30:00 AM **Max. Wet:** 9/19/2020 12:30:00 AM
Exceedence: mph **Recovery Time:**
Last Wind: **Max. Wind:**

Position: Vice President **Phone:** xxx-xxx-xxxx
vice to/from Prudence Island. Only access to the island without a private vessel.

Exceedence: 8.1 feet **Recovery Time:** Short_Term
iring backup generator or manual operations (if back up generator required
Last Wet: 9/19/2020 4:30:00 PM **Max. Wet:** 9/19/2020 12:30:00 AM
Exceedence: mph **Recovery Time:**
Last Wind: **Max. Wind:**

Position: Vice President **Phone:** xxx-xxx-xxxx
Prudence Island. Only access to the island without a private vessel.

RI Coastal Hazards, Analysis, Modeling, and Prediction (RI-CHAMP) Page 3 of 63

- PDF format
- Organized by
  - Facility
  - CI sector
  - ESF
- Summary of dashboard results

Decision support for endusers…

State and local **hazard mitigation planning**

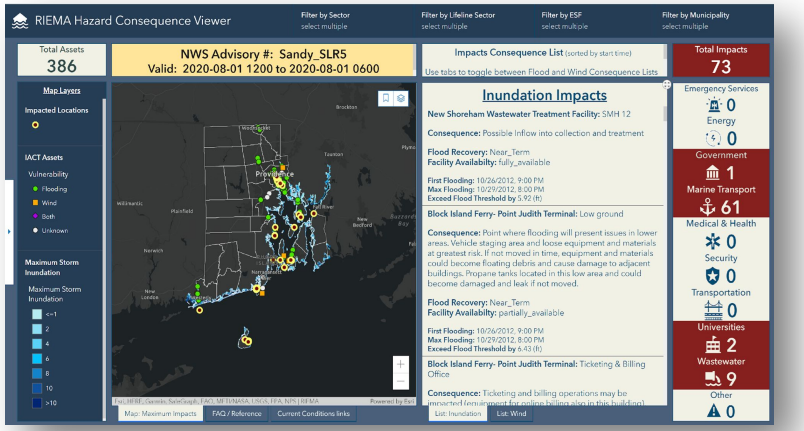
Floodplain management

Facility emergency planning

Real-time storm **response and recovery** preparation

Three examples…

1) RI-CHAMP for Emergency Management

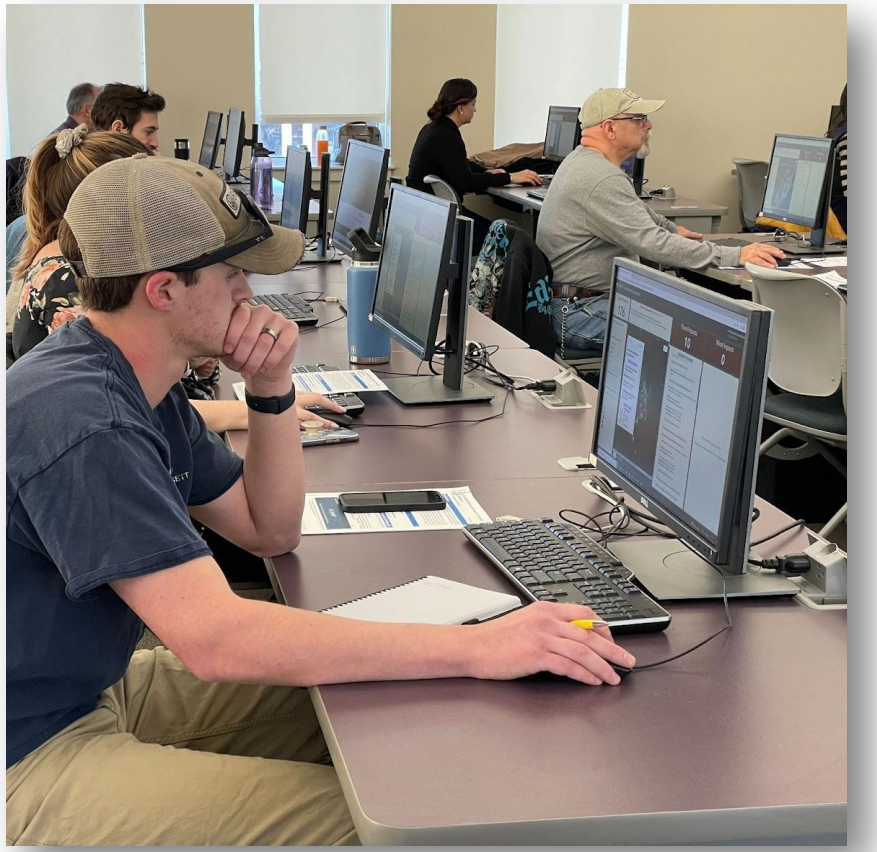


State of Rhode Island emergency management **operationalizing the system** at the Emergency Operations Center

Public dashboard at: https://tinyurl.com/2sr5z26r

www.RICHAMP.org

2) RI DEM-CHAMP for training and engagement



Developing a deeper understanding of storm risks through a customized CHAMP for RI Wastewater Treatment

DEM
RHODE ISLAND

3) NAVSTA Newport MIRR-CHAMP for resilience planning

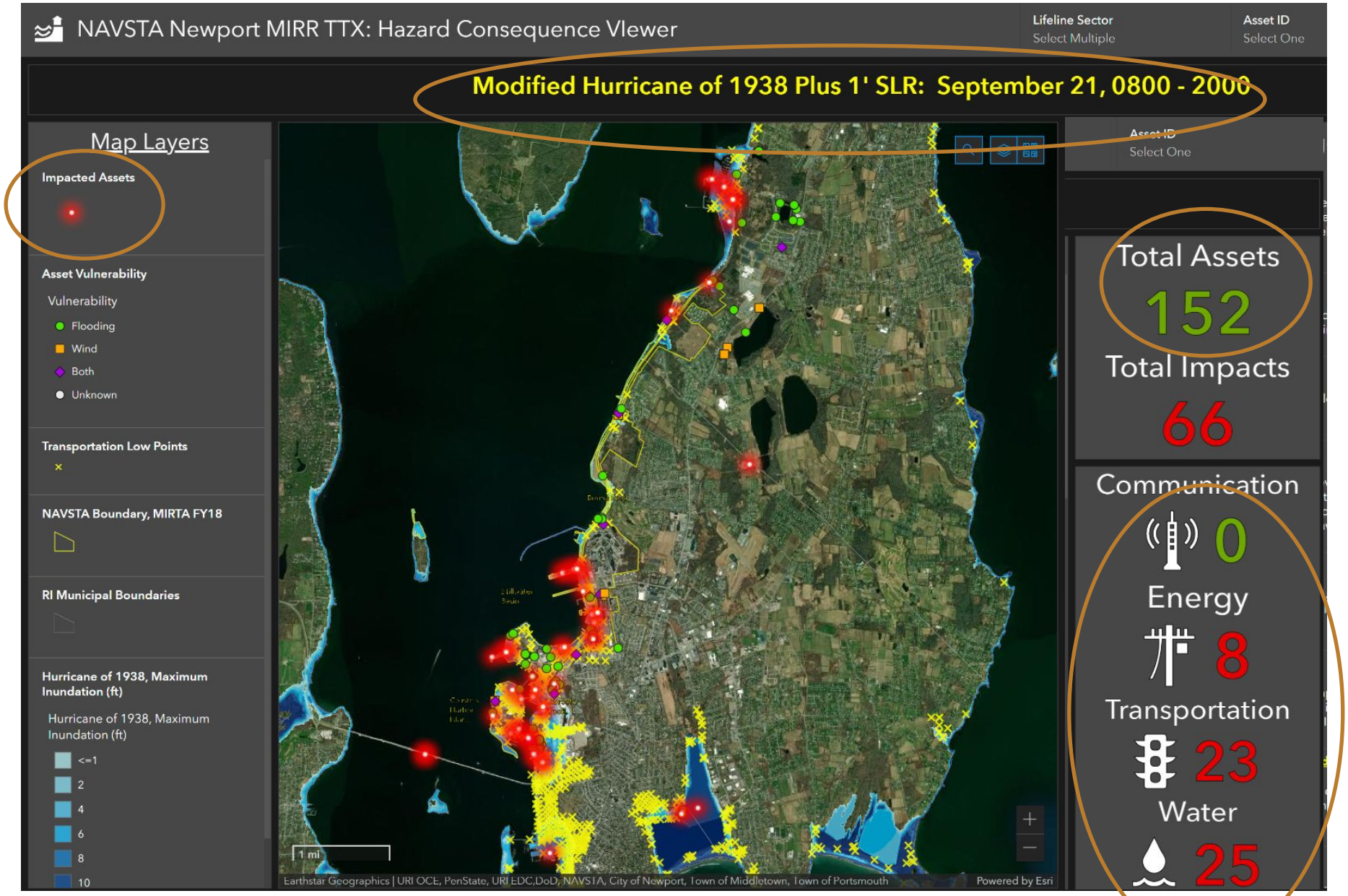
A hazard resilient future for Naval Station Newport within its coastal community

Military Installation Resilience Review (MIRR) for

short-term preparedness and long-term planning

- Field based data collection
- Steering & Technical Committees
- Tabletop Exercise with US Naval War College
- Naval Postgraduate School for Evacuation Modeling
- Decision-makers briefing

NAVSTA Newport MIRR-CHAMP Dashboard

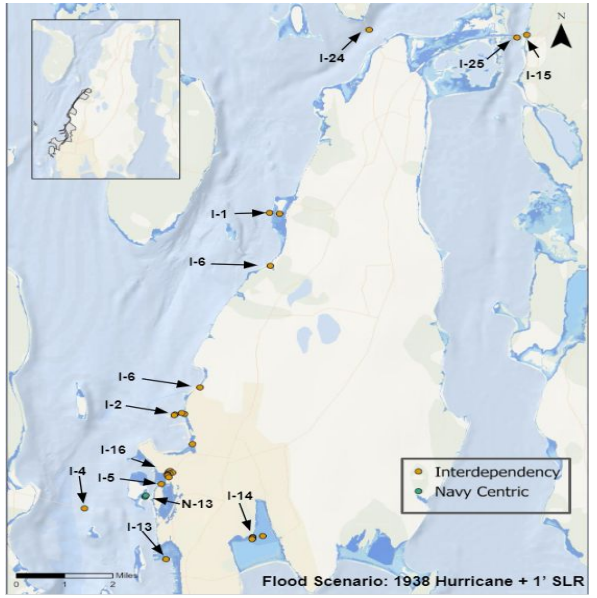


86 facilities

152 assets

65% on base

35% off base



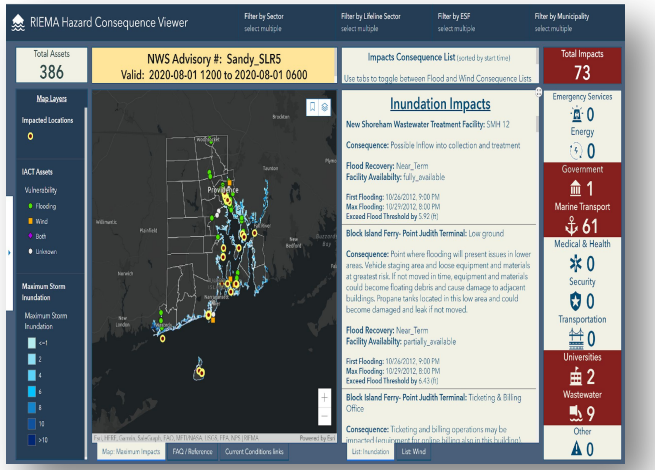
Next steps for RI-CHAMP

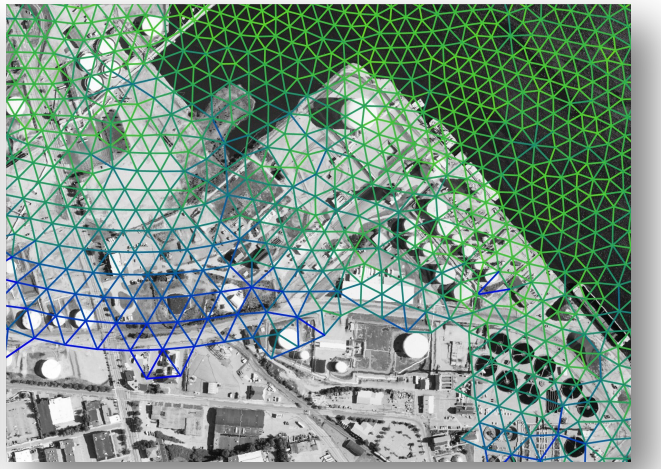
Continue transition to operations at RIEMA

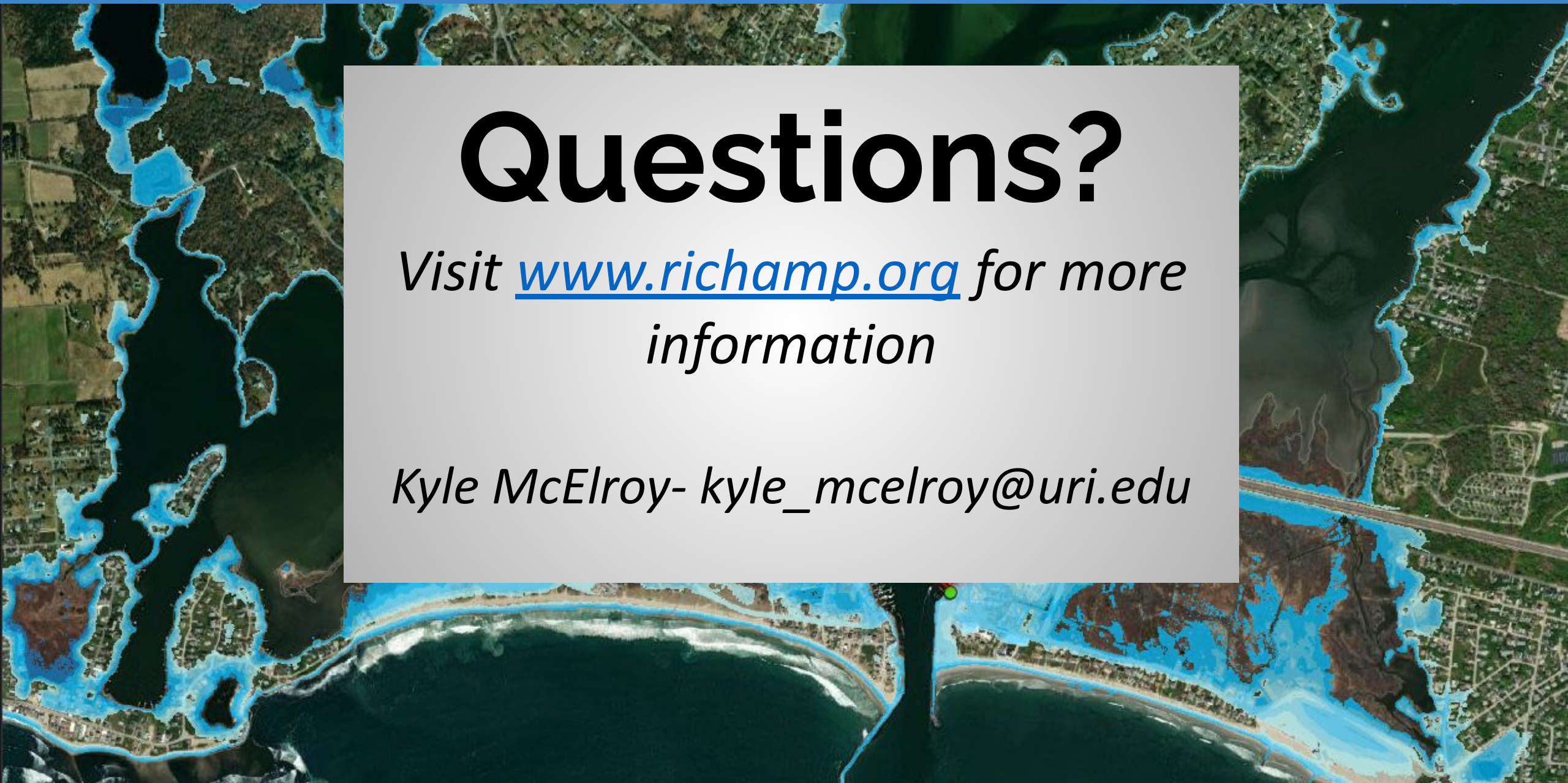
Expansion to other geographic areas (CT and/or USVI)

Expansion to new enduser groups (US Coast Guard, NOAA)

Reflections and best practices for implementing and operationalizing applied research







Questions?

Visit www.richamp.org for more information

Kyle McElroy- kyle_mcelroy@uri.edu