# UNCTAD National Workshop Jamaica

30 May – 1 June 2017, Kingston, Jamaica

# "Climate Change Impacts and Adaptation for Coastal Transport Infrastructure in Caribbean SIDS"

# Climate risk adaptation for ports: Research for transformational thinking

**By**

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# *Climate risk adaptation for ports: Research for transformational thinking*

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**UNCTAD National Workshop – Jamaica**

**"Climate change impacts and adaptation for coastal transport infrastructure in Caribbean SIDS", 30 May – 2 June, 2017**

THE UNIVERSITY OF RHODE ISLAND COLLEGE OF THE ENVIRONMENT AND LIFE SCIENCES

COASTAL INSTITUTE

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# Maritime Systems
# Critical, complex, constrained


**Critical - Economic engines at every scale; lifelines in small island states**

**Complex – Multiple stakeholders across space and time**

**Constrained - Dependent on specific and environmentally-sensitive locations, with few or no options for relocation or expansion**

*(Asariotis and Benamara 2012; Notteboon and Winkelmans 2003; EPA 2011; AAPA 2013)* 2

## Climate change challenge

Hurricane Sandy photos courtesy Mary Lee Clanton, Port of NYNJ

Doubling of Cat 4 and 5 tropical storms

1-in-100 year storm event of today

Sea levels to rise 0.[illegible]1.9 meters by 2100

1-in-3 year storm event of 2100

Inland flooding

*(Bender et al. 2010; Grinsted et al. 2013; Rahmstorf 2010; Emanuel 2013; IPCC 2012; Tebaldi et al. 2012)*

## Coastal Adaptation: A Wicked Problem

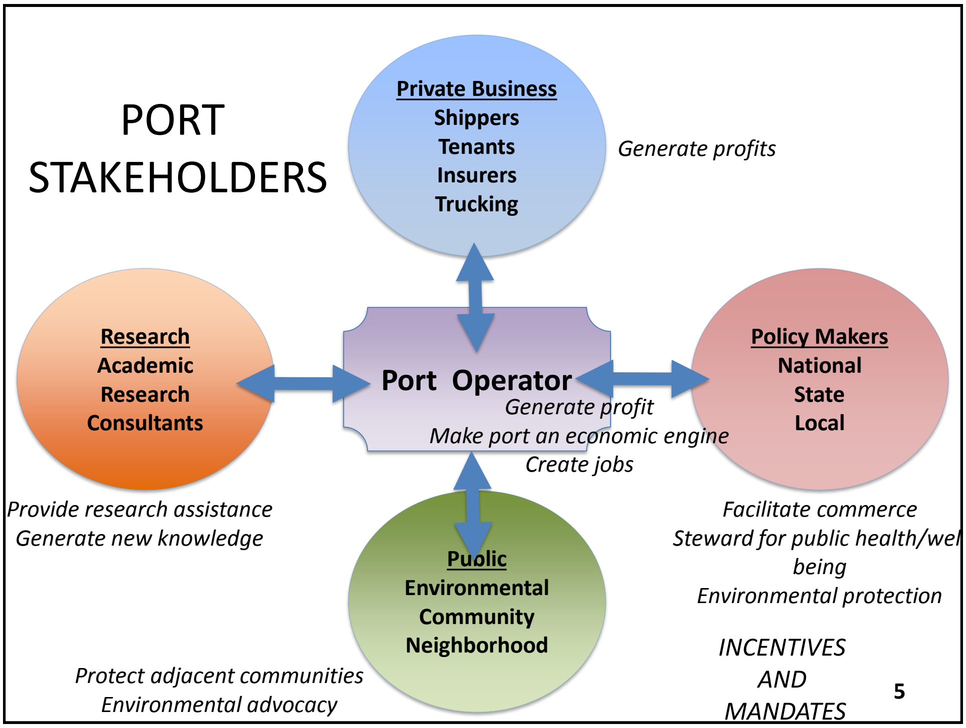
- *Complex issue that defies complete definition*
- *No formal solutions*
- *Any resolution generates further issues*
- *Solutions are neither good nor bad, but the best that can be done at the time.*

Uncertain rates of change
Feedback loops
Misaligned incentives
Unclear funding streams
Complex adaptation options

Befuddled Decision makers

(Rittel and Webber 1973; Brown et al. 2010)

(Ward 2001; Bryson 2004; Few, Brown, and Tompkins 2007; Chapin et al. 2010; Tompkins, Few, and Brown 2008)




*How can we engage stakeholders in planning to reduce climate risks within the environmental, social, economic, and political landscape?*

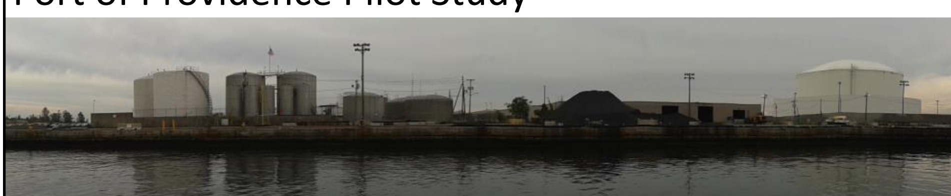
Stakeholder engagement tools
for ports and port communities

Two research projects

1. Transformative planning using decision support tools
2. Virtual Disaster Impacts Models using disaster visualizations

**Project 1** - Long-range planning

Three decision support tools to stimulate transformational thinking:
Port of Providence Pilot Study



- Understand and comment on storm scenario & consequences
- Review long-range transformational resilience concept
- Review possible long-range “resilience goals” for the port and weigh importance of each using multi-criteria decision support tool

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(Star 2010; Star and Griesemar 1989)

## Port of Providence

1500 Acres

30 businesses

46th port in US

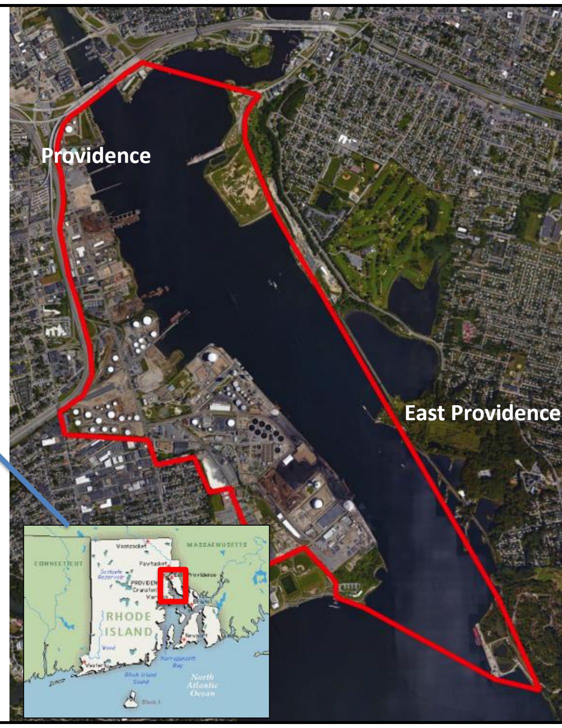
~3000 jobs

**Methodology**

Guided by steering committee

- *Initial Survey*
- *½ Day workshop*
- *Follow-up survey*

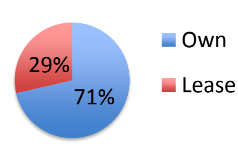
*USACE, 2013, 2012; FXM Associates, 2008; 4Ward Planning, 2015*




*8-3-15 workshop*

| *Private Firms* | *Local Government* |
|---|---|
| Sims Metal Management | Providence Emergency Management Agency |
| Moran Shipping | City of East Providence Planning |
| Providence Working Waterfront Alliance | City of Providence Planning* |
| Narragansett Improvement | ***State Government*** |
| McAllister Towing | RI Coastal Resources Management Council* |
| Exxon Mobil | RI Statewide Planning |
| Shnitzer Steel Industries | CommerceRI* |
| Rhode Island Oil Heat Institute | Narragansett Bay Commission |
| Quonset/Davisville Development Corporation* | ***Federal Government*** |
| FM Global | US Maritime Administration* |
| National Grid | Federal Highway Administration* |
| Hudson Asphalts | US Coast Guard* |
| Capital Terminals | US Army Corps of Engineers* |
| Motiva | ***Academia/NGO*** |
| Northeast Pilots | RI Coastal Resources Center/RI Sea Grant/GSO* |
| P&W Railroad | Save the Bay |

**Property Status**

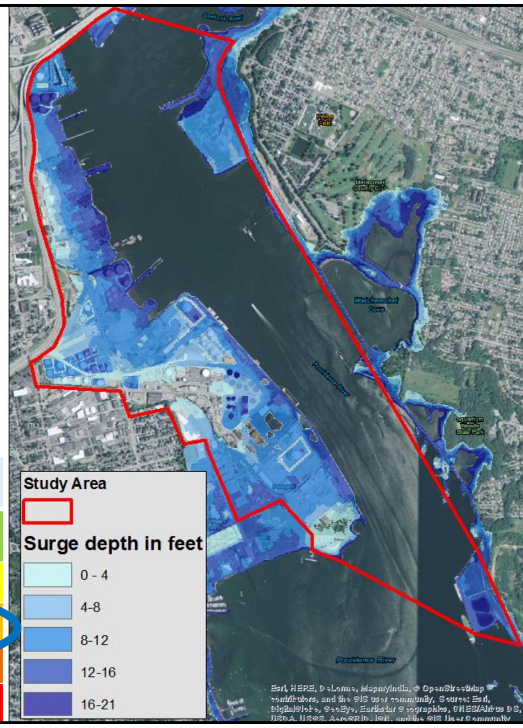


## The Sea, Lake and Overland Surges from Hurricanes (**SLOSH**) **model**

- **GIS Visualization of 21 ft "bathtub" inundation**
- **Assumes Fox Point Barrier not overtopped**
- **Only shows passive level of surge**
- **Does not show expected 6-10' wave action**

Based on RIGIS, 2013 DEM derived from a 1-meter resolution digital elevation model originally produced as part of the Northeast LiDAR Project in 2011.

| CAT | WIND | DAMAGE |
|---|---|---|
| 1 | 74-95 | some damage |
| 2 | 96-110 | extensive damage |
| 3 | 111-129 | Devastating damage |
| 4 | 130-156 | Catastrophic damage |
| 5 | >157 | Catastrophic damage |



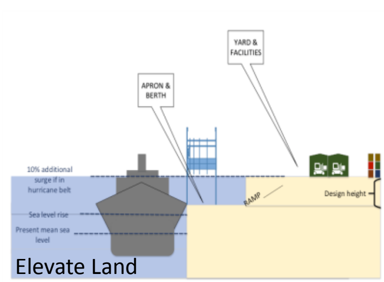

## *Support Tool 1-* Storm Visualizations

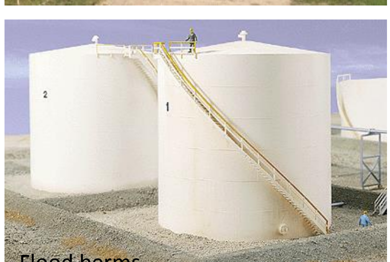
*Support Tool 2 –*

Three transformative resilience planning concepts

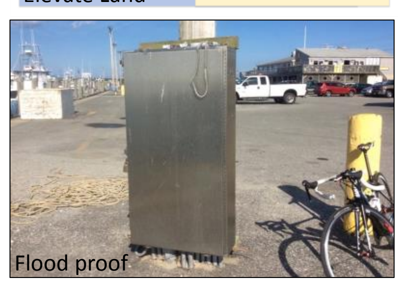
**Accommodate** –

Site-specific improvements to increase resilience


*https://www.walthers.com/prodimage/0933/09330000003168.gif*



## Relocate –

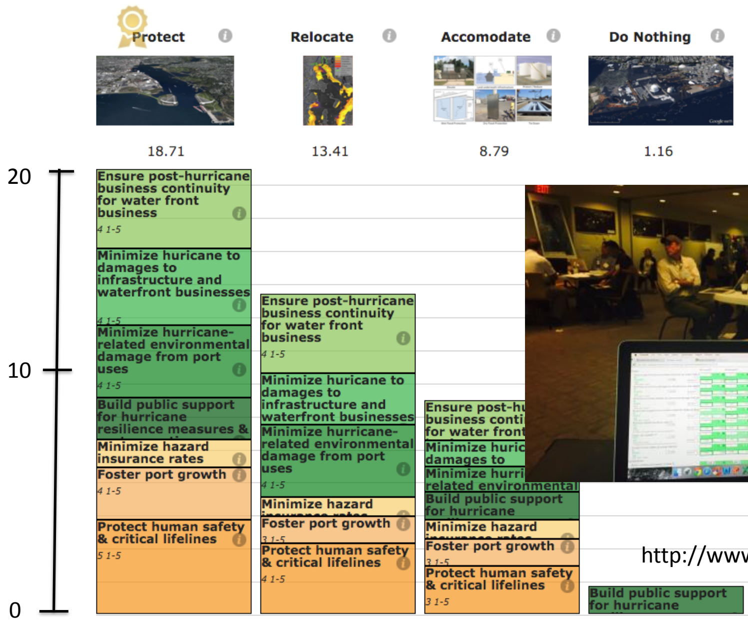
Move port uses to less vulnerable location.


## Protect –

New storm barrier for Providence Harbor.

## *Support Tool 3*

Wecision

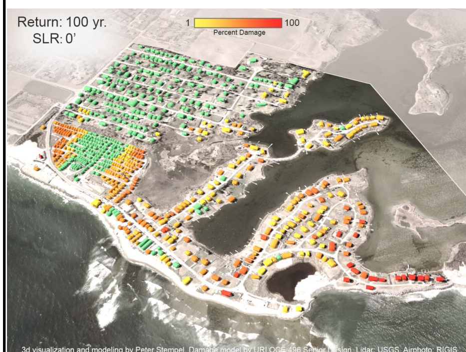


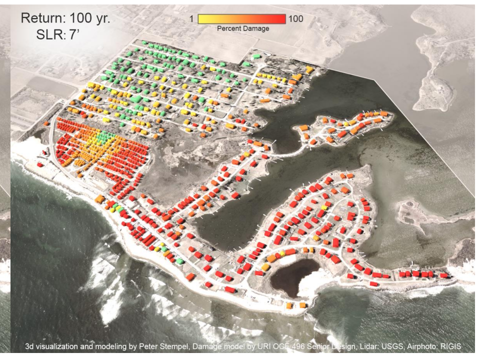

http://www.wecision.com/

# Key Findings

- Impacts of major storm at the port affect **many stakeholders for months and years after the event**
- Difficult to entice private business to participate when **next steps are not clear**
- **No clear champion** (gov't or private) to take the lead on long-term planning
- Stakeholders find it difficult to engage, as **costs were not addressed**
- Stakeholder engagement with these tools **results in new dialogue and ideas** that percolate through the broader decision-making system

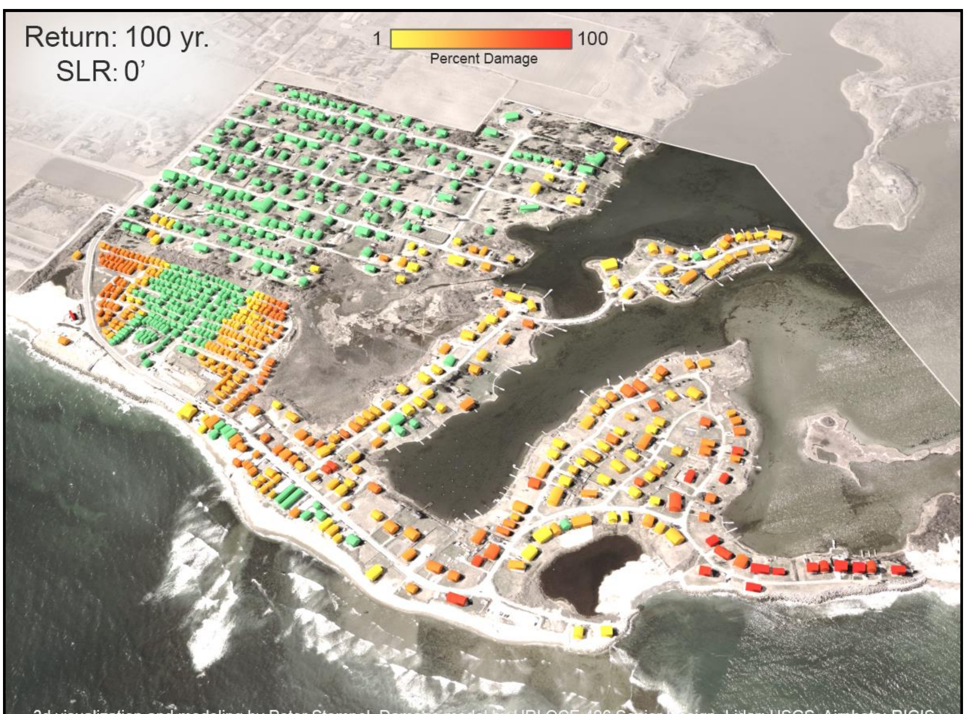
**Project 2**
Disaster visualizations
and the Virtual Disaster Impacts Model

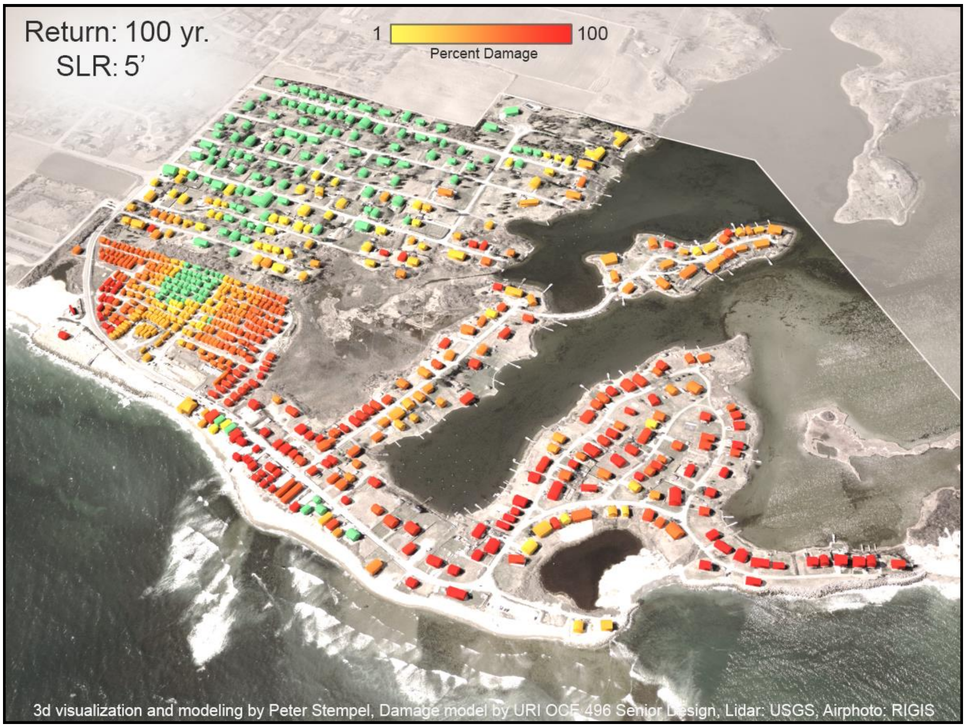



PhD Candidate: Peter Stempel

CRMC Coastal Resources Management Council
Sea Grant Rhode Island
Coastal Institute




Return: 100 yr.
SLR: 5'
1
100
Percent Damage
3d visualization and modeling by Peter Stempel, Damage model by URI OCE 496 Senior Design, Lidar: USGS, Airphoto: RIGIS

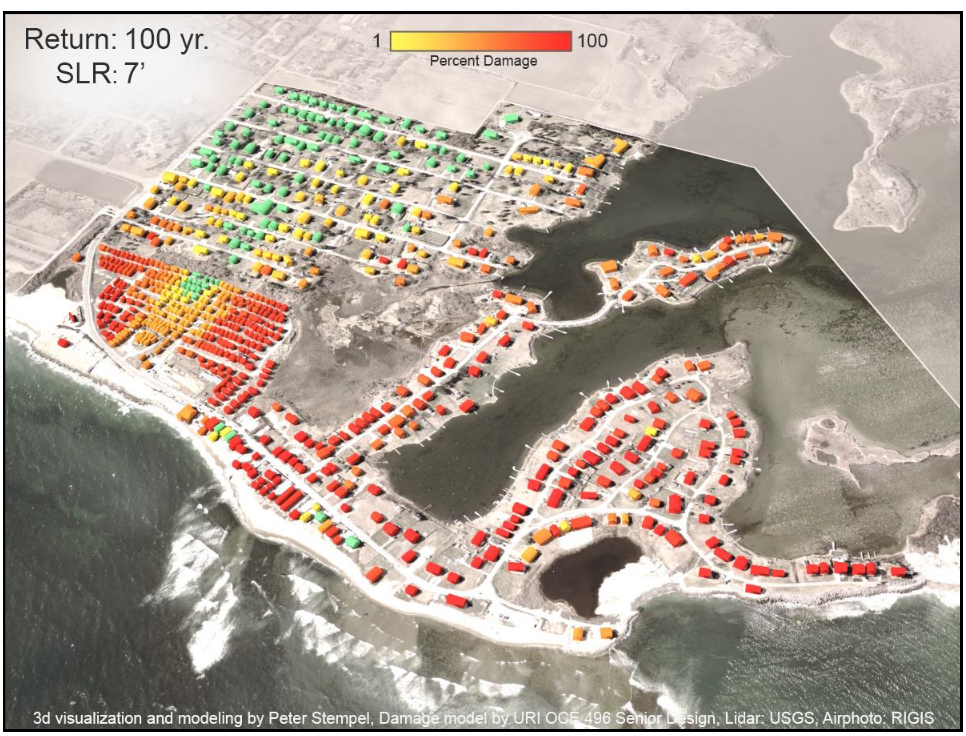
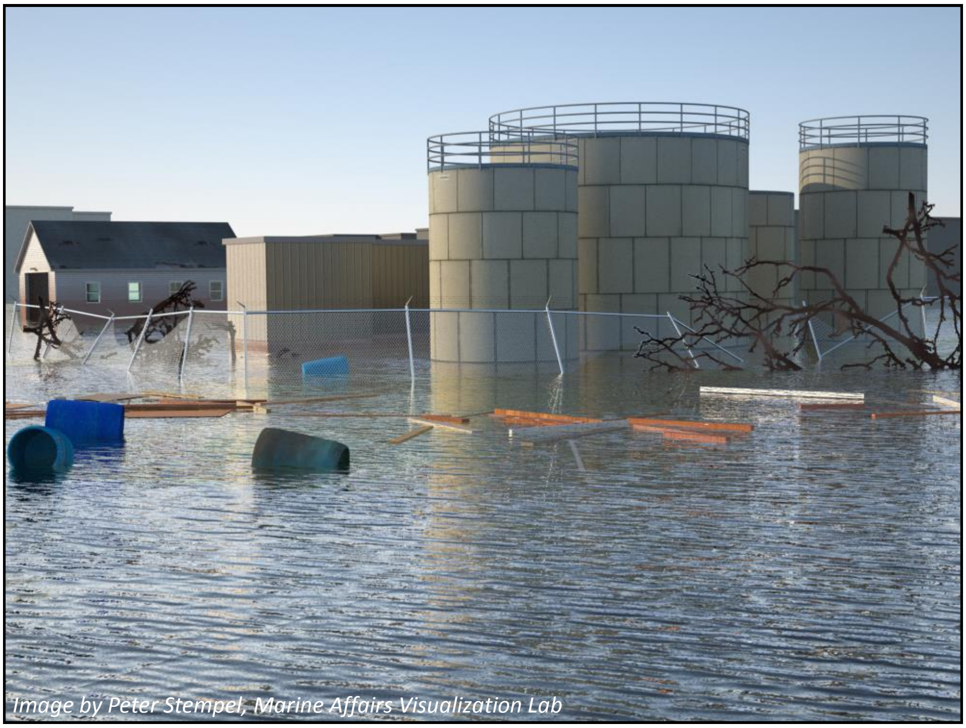
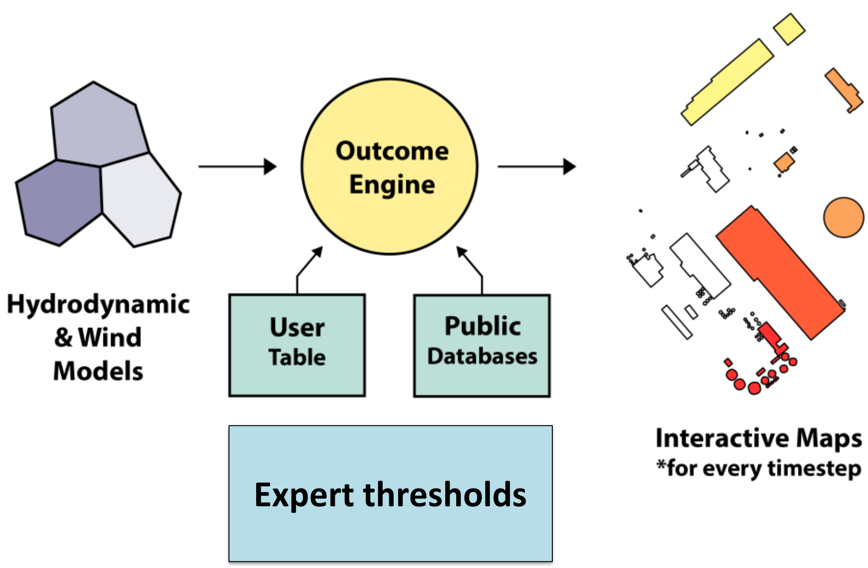

Return: 100 yr.
SLR: 7'
1
100
Percent Damage
3d visualization and modeling by Peter Stempel, Damage model by URI OCE 496 Senior Design, Lidar: USGS, Airphoto: RIGIS


Image by Peter Stempel, Marine Affairs Visualization Lab


Image by Peter Stempel, Marine Affairs Visualization Lab




## Virtual Disaster Impacts Model



# Expert thresholds (pilot)

1. CONCERN:

What is the specific place or item that is of concern (e.g., a generator, storage tank) and where is it located?

2. HAZARD:

What is the event that causes damage or interruption (e.g. surge, wind, wave, flood)?

3. IMPACT:

What impacts are you concerned with? (e.g., generator gets flooded and stops operating, residents evacuate, road becomes impassible).

4. INCREMENT:

The level(s) at which various impacts occur? This is a specific measurement (e.g., wind speed, water level). Ideally, three increments..

**Example:**

**CONCERN: Wind generator at x location**

**HAZARD: Extreme wind**

**IMPACT: Wind generator out of service or destroyed, damage to surrounding structures.**

**INCREMENT: 20 knots, windmill shut down; 50 knots blades damage; 75 knots, severe danger of collapse.**

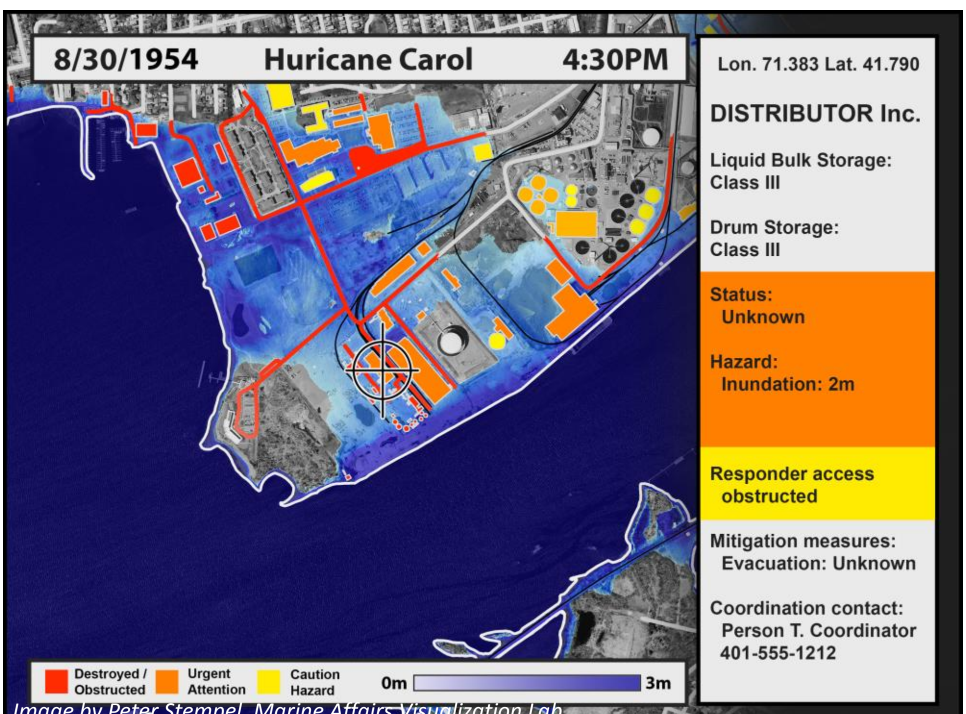
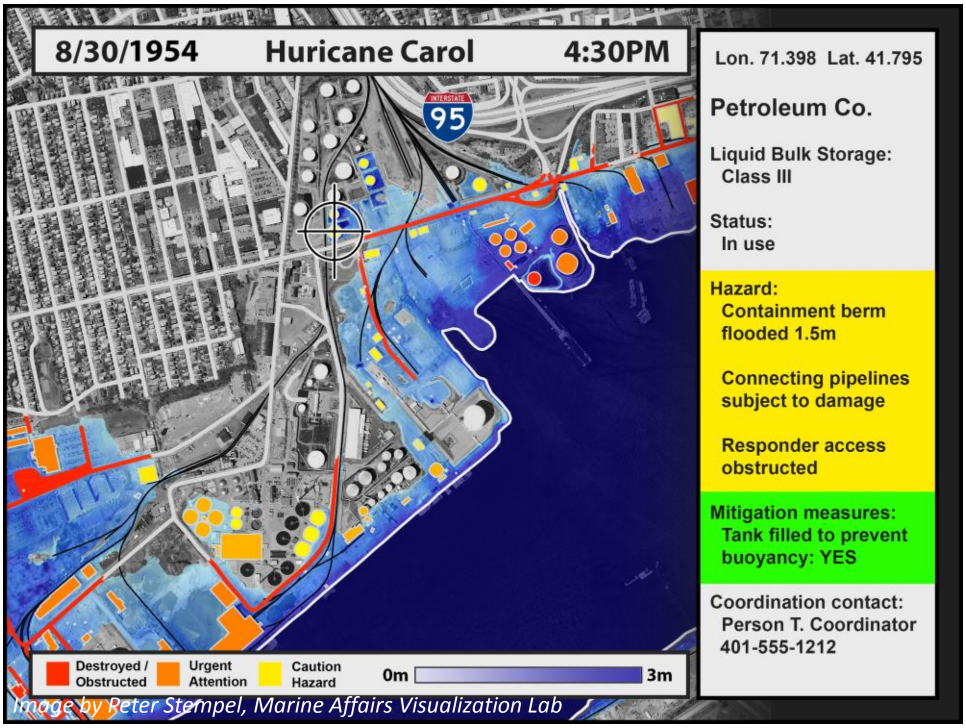



*Image by Peter Stempel, Marine Affairs Visualization Lab*



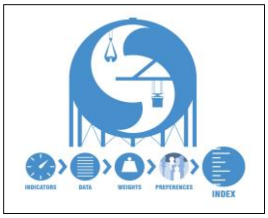

# Coastal Adaptation: Resolving the Wicked Problem

- *Complex issue that defies complete definition*
- *No formal solutions*
- *Any resolution generates further issues*
- *Solutions are neither good nor bad, but the best that can be done at the time.*

- Understand risks
- Think long term
- Engage stakeholders broadly
- Plant seeds for transformational change
- Find consensus

*Protect/enhance quality of life for this and future generations*

# Questions?




**Project 1 – Decision Support Tools to Stimulate Transformational Thinking**

- Dr. Austin Becker, PI
- Dr. Rick Burroughs, Co-PI
- Eric Kretsch, Masters Student
- Duncan McIntosh, PhD Canddiate
- Dr. John Haymaker, Wecision

**Project 2– Disaster Visualizations**

- Dr. Austin Becker, PI
- Peter Stempel, PhD Candidate
- Robert Witkop, Masters student

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