UNCTAD National Workshop Saint Lucia

24 – 26 May 2017, Rodney Bay, Saint Lucia

"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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THE UNIVERSITY OF RHODE ISLAND
COLLEGE OF THE ENVIRONMENT AND LIFE SCIENCES
COASTAL INSTITUTE

THINK BIG WE DO

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Maritime Systems
Critical, complex, constrained

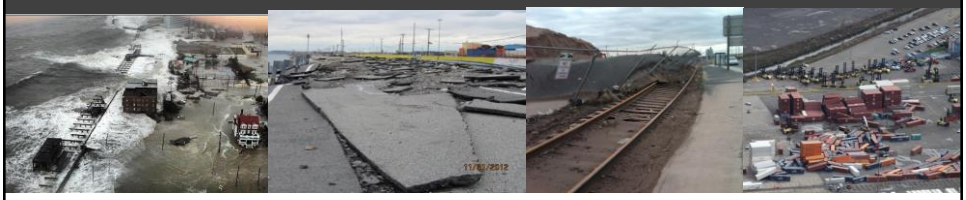
Critical - Economic engines at every scale; lifelines in small island states

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



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

Hurricane Sandy photos courtesy Mary Lee Clanton, Port of NYNJ

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

Coastal Adaptation: A Wicked Problem

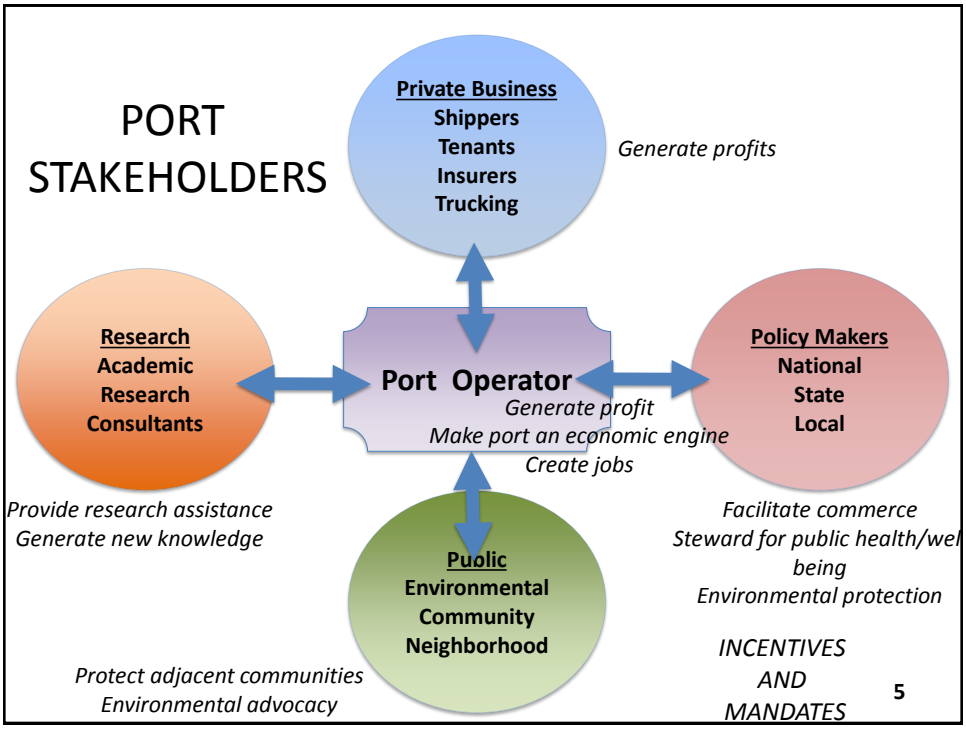
- *Complex issue that defies complete definition*
- *No formal solutions*
- *Any resolution generates further issues*
- *Solutions are neither good nor bad, but the best that can be done at the time.*

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

(Star 2010; Star and Griesemar 1989)

Port of Providence

1500 Acres
30 businesses
46th port in US
~3000 jobs

Methodology

Guided by steering committee

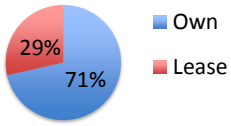
- *Initial Survey*
- *½ Day workshop*
- *Follow-up survey*

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

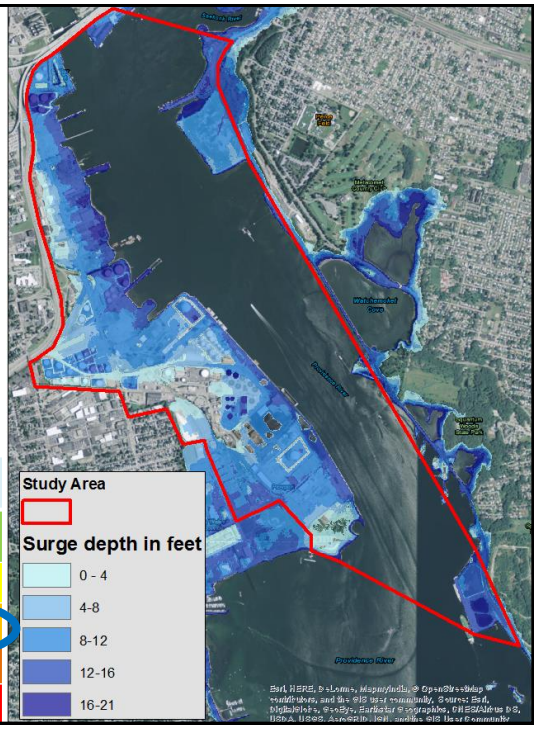


The Sea, Lake and Overland Surges from Hurricanes (**SLOSH**) **model**

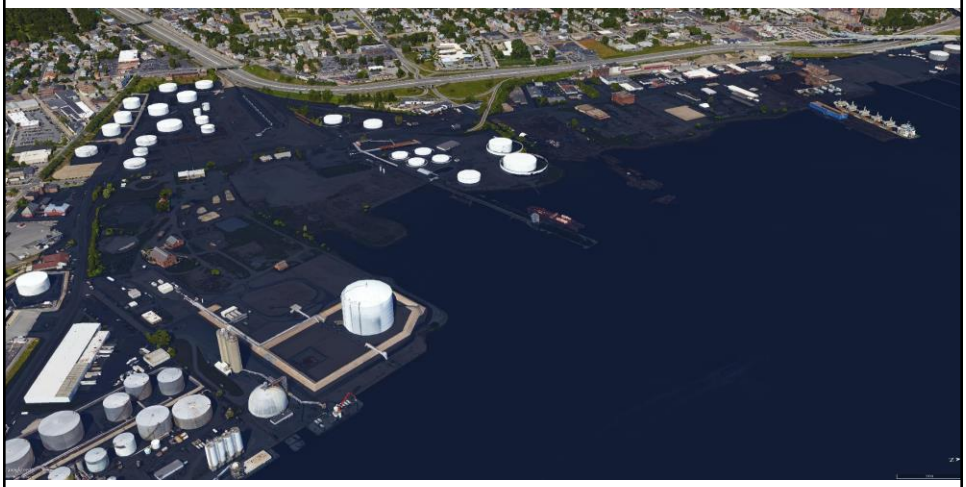
- **GIS Visualization of 21 ft "bathtub" inundation**
- **Assumes Fox Point Barrier not overtopped**
- **Only shows passive level of surge**
- **Does not show expected 6-10' wave action**

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

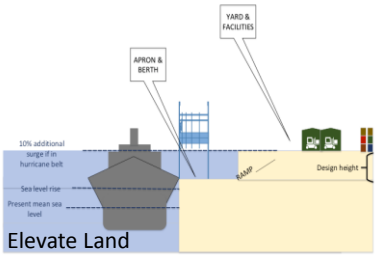


Support Tool 2 –
Transformative resilience planning concepts

(Kates, Travis, and Wilbanks 2012, p. 7156; Cheong 2011; J. Dronkers, J. Campbell, and Spradley 1990)

Accommodate –
Site-specific improvements to increase resilience


Elevate Utilities and Generator



Elevate Land


Flood berms

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

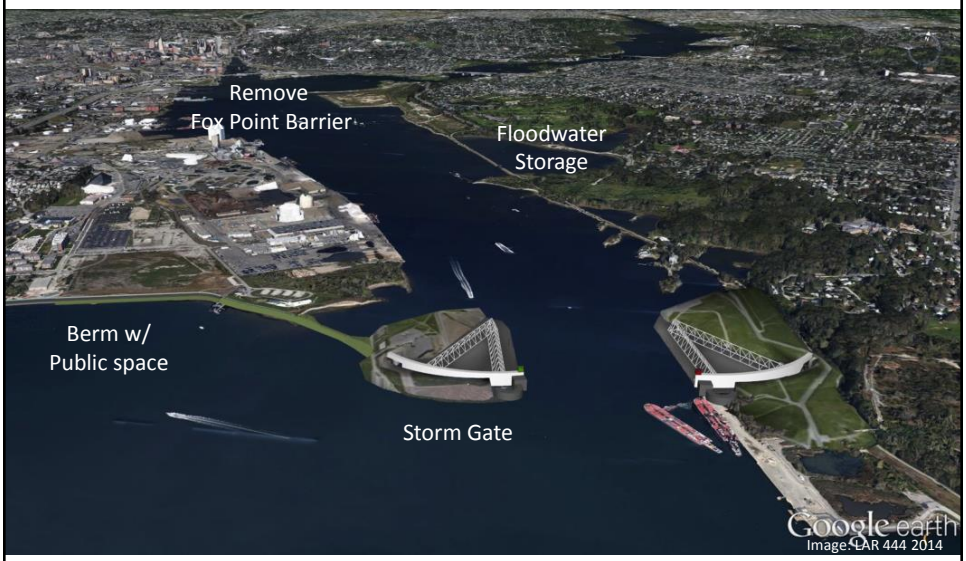

Flood proof

Relocate –

Move port uses to less vulnerable location.

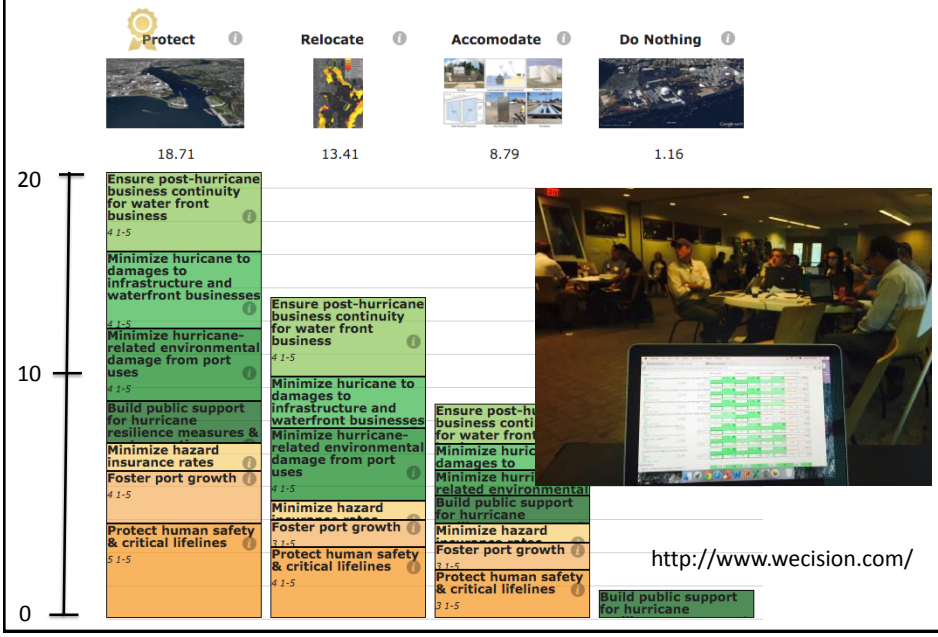
Protect –

New storm barrier for Providence Harbor.



Support Tool 3

Wecision



http://www.wecision.com/

Key Findings
Long-term Hurricane Impacts

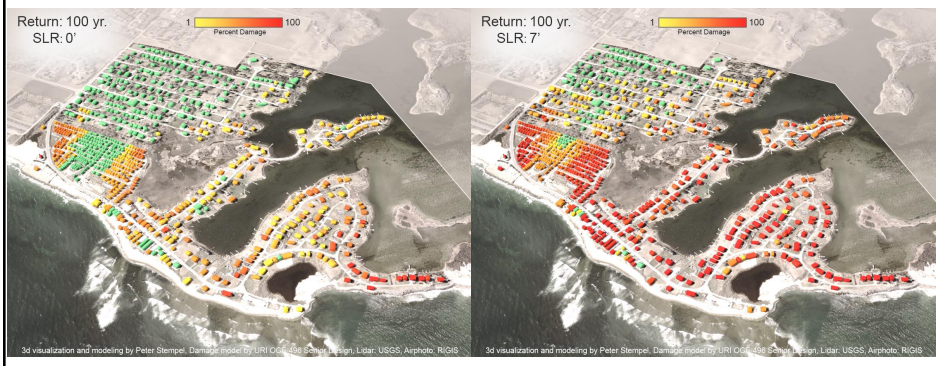
Weeks	Loss of critical facilities cripples business Energy supply compromised (hospitals, institutions, etc.) Raw wastewater discharge Debris cleanup, debris obstructions, debris as battering ram
Months	Damaged roads and rail disrupt commerce Debris/sedimentation require surveying, restrict navigation Bulkhead/pier damage result in permitting delays & repair Erosion of riverbank leads to sediment loading of deep channel
Years	Long-term environmental impacts to Narragansett Bay Economic impacts, but little clarity over their nature Risks to competiveness of port if perceived as vulnerable to storms Increase in insurance rates could force business to leave

Key Findings

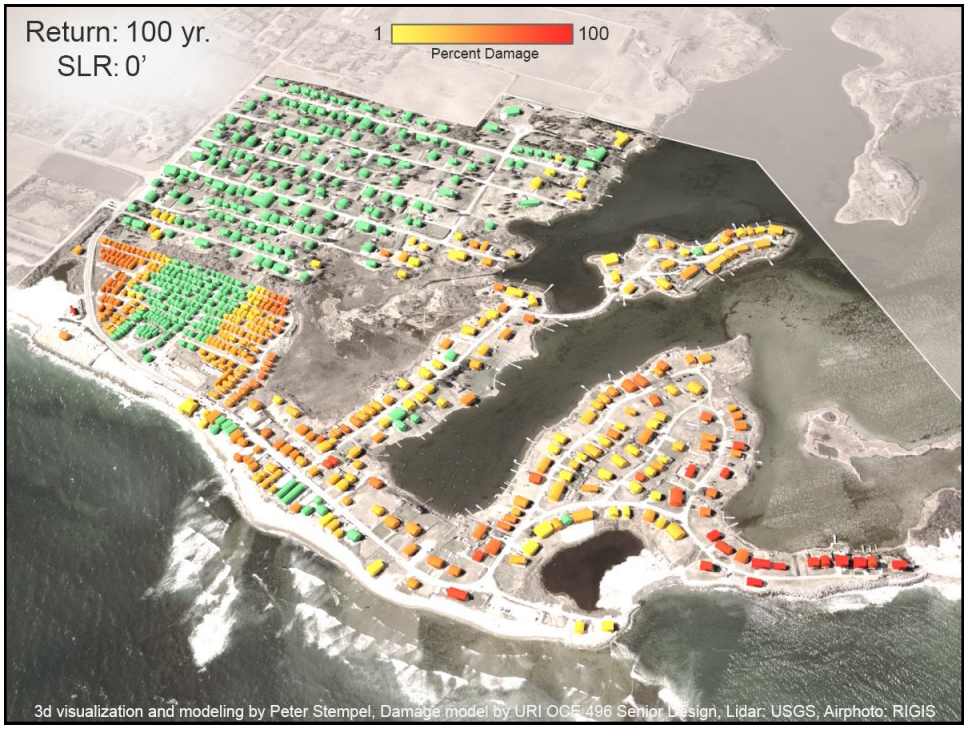
- **No long-term plan** for major hurricane events
- Difficult to entice private business to participate when **next steps are not clear**
- **No clear champion** (gov't or private) to take the lead on long-term planning
- Stakeholders found it difficult to engage, as **costs were not addressed**
- **Boundary objects effective,** percolating through system, need some improvements

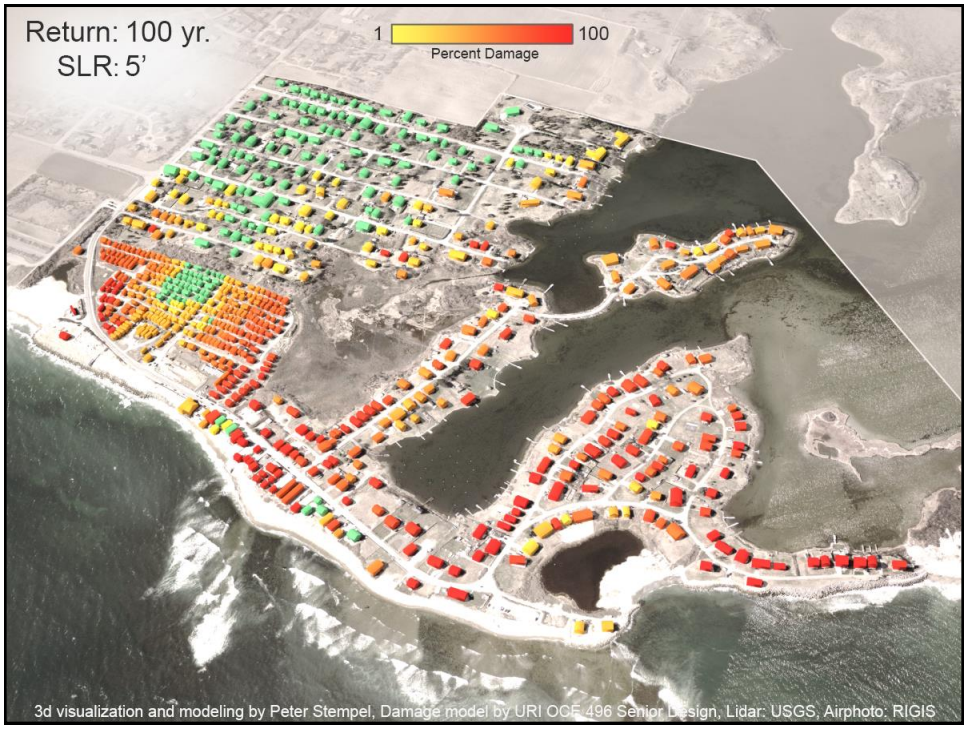
Project 2

Disaster visualizations
and the Virtual Disaster Impacts Model



PhD Candidate: Peter Stempel


Return: 100 yr.
SLR: 0’
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: 5’
1
100
Percent Damage
3d visualization and modeling by Peter Stempel, Damage model by URI OCE 496 Senior Design, Lidar: USGS, Airphoto: RIGIS

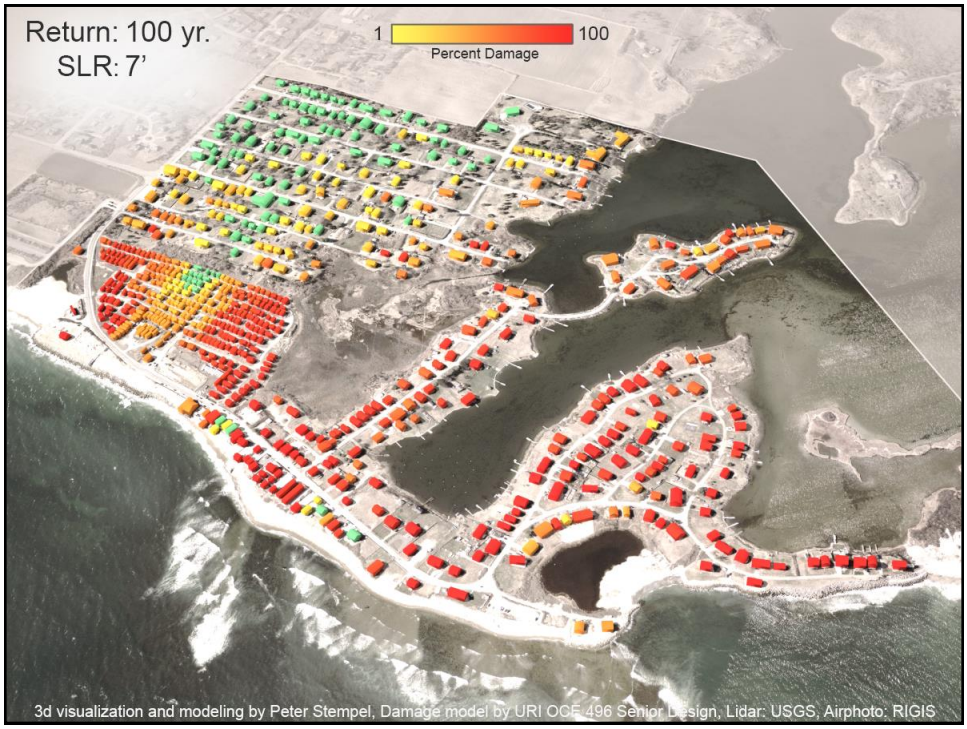

Return: 100 yr.
SLR: 7'
1
100
Percent Damage
3d visualization and modeling by Peter Stempel, Damage model by URI OCE 496 Senior Design, Lidar: USGS, Airphoto: RIGIS


Image by Peter Stempel, Marine Affairs Visualization Lab


Image by Peter Stempel, Marine Affairs Visualization Lab

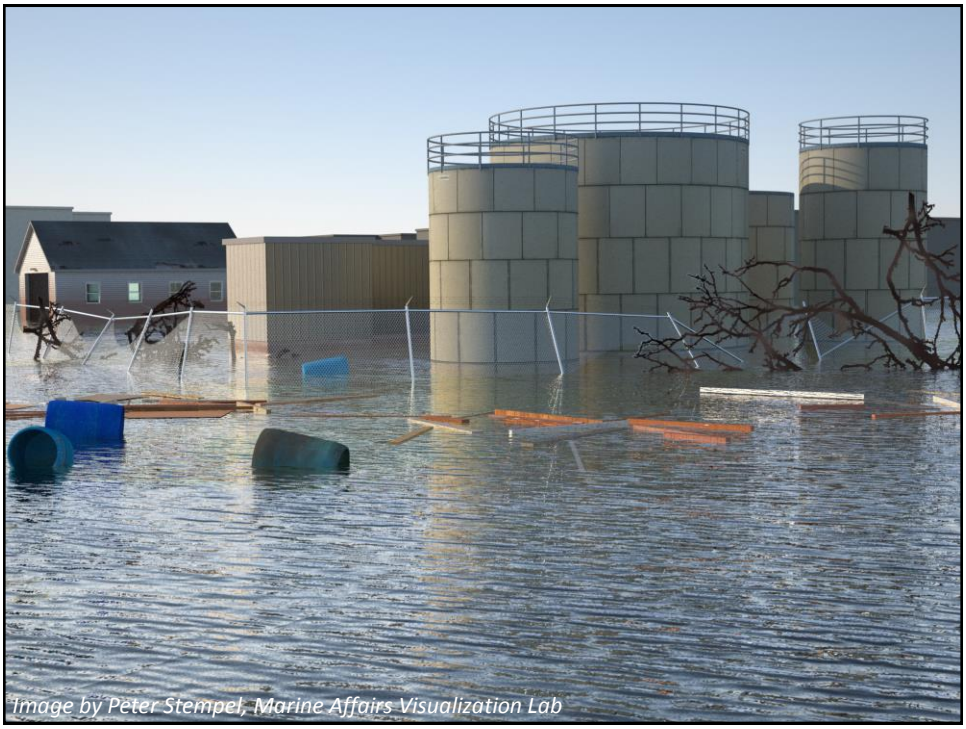
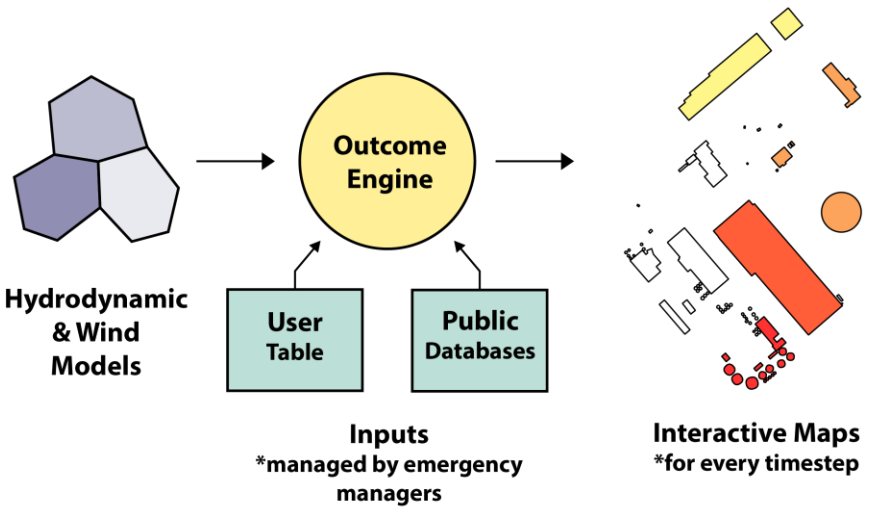


Image by Peter Stempel, Marine Affairs Visualization Lab

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..

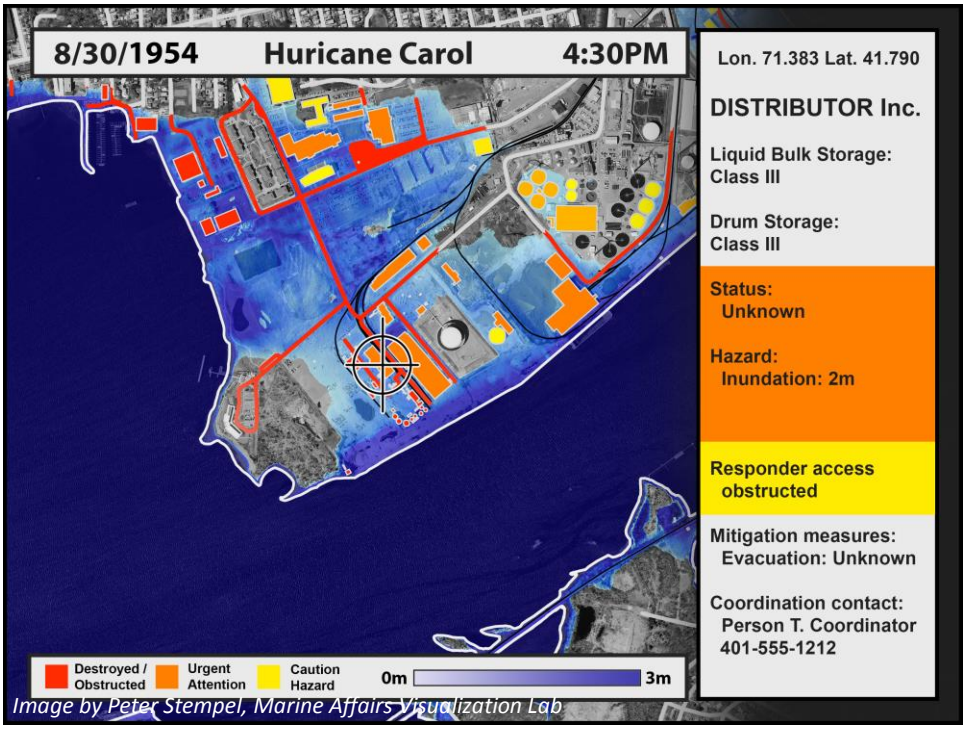
Example:

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.



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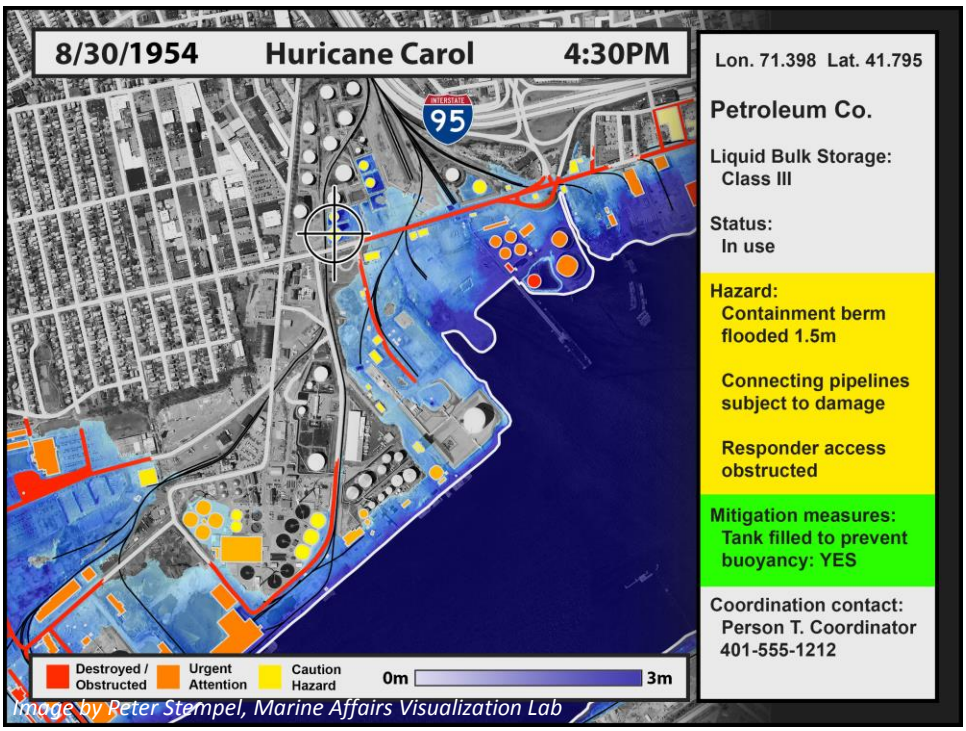


Image by Peter Stempel, Marine Affairs Visualization Lab

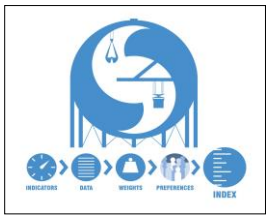
Coastal Adaptation: Resolving the Wicked Problem

- *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
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