

# Indicating Climate Change Vulnerabilities To Inform Seaport Resilience



Worldmaritimenews.com –  
Port of Oakland

THE  
UNIVERSITY  
OF RHODE ISLAND  
DEPARTMENT OF  
MARINE AFFAIRS



US Army Corps  
of Engineers®



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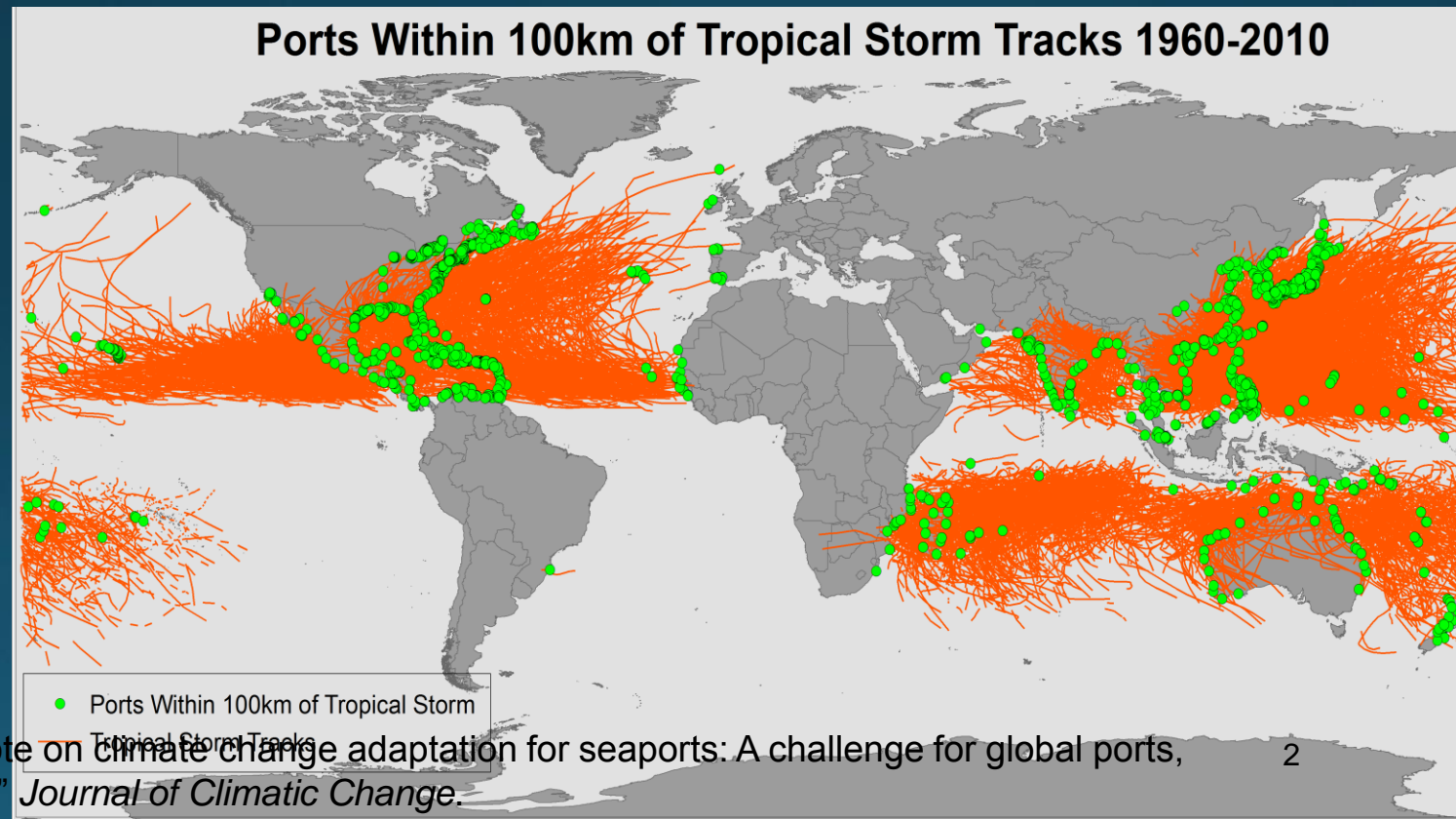
# Ports: Critical, complex, constrained, exposed

**Critical** - Economic engines at every scale

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

**Constrained** - Dependent on specific and environmentally-sensitive locations

**Exposed** – Located in coastal areas that face sea level rise and storm impacts



# Coastal hazard challenges for Ports



Doubling of Cat 4 and 5 tropical storms  
1-in-100 year storm event of today



Sea levels to rise 0.7-1.9 meters by 2100

1-in-3 year storm event of 2100

Inland flooding

# Coastal Hazards - A Wicked Problem

Uncertain rates of change  
Feedback loops  
Misaligned incentives  
Unclear funding streams  
Complex adaptation options  
Winners & losers  
Limited resources to go around  
Limited information



**Resilience  
investment  
strategies**

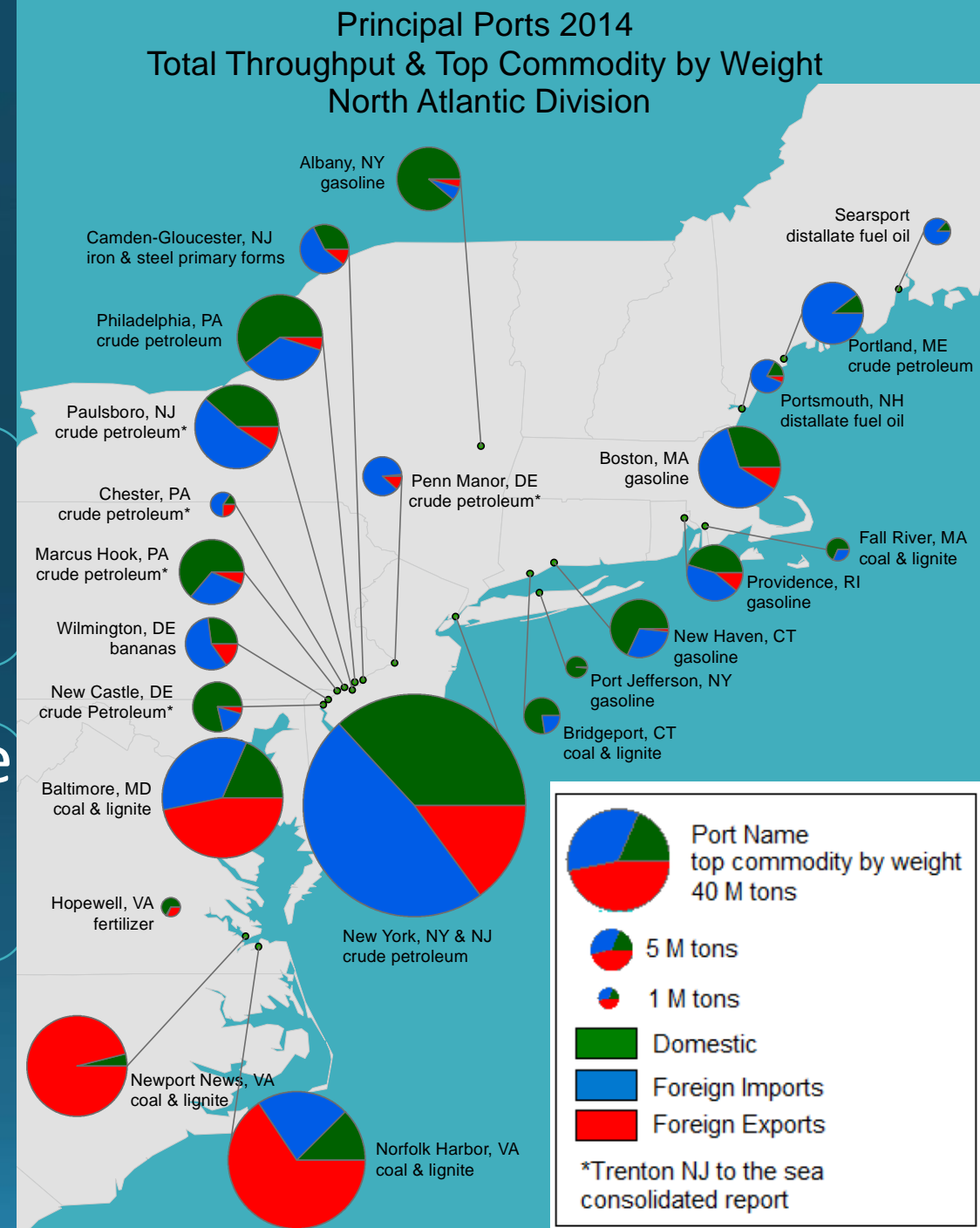
(Rittel and Webber 1973; Brown et al. 2010)

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

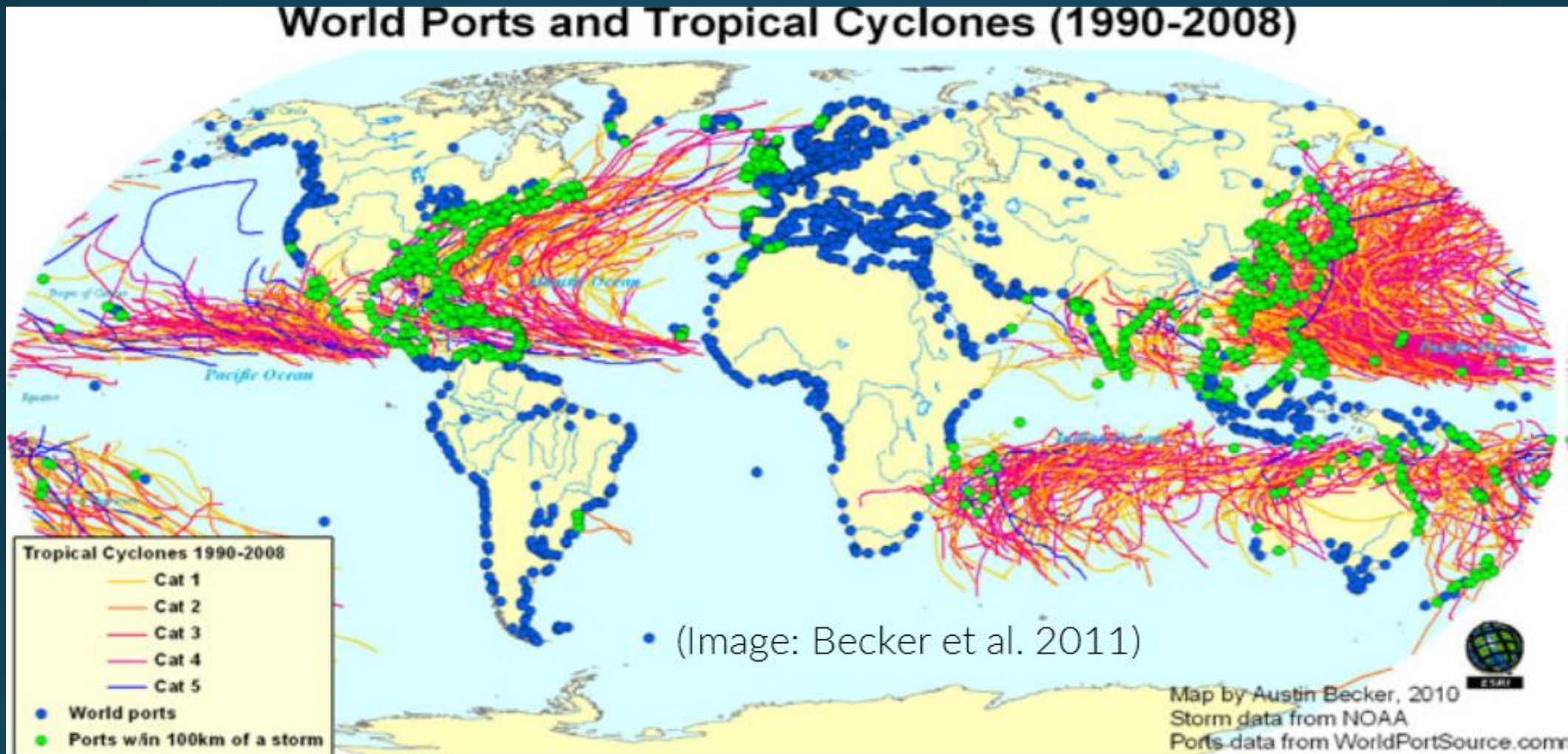
# Pilot study with USACE on 23 Ports

Is there available data to indicate climate vulnerability for the pilot studied ports?

What indicators represent three components of climate vulnerability for seaports?



# What is Seaport Exposure?



‘The presence of people, livelihoods, species or ecosystems, environmental functions, services, and resources, infrastructure, or economic, social, or cultural assets in places and settings that could be adversely affected.’  
(IPCC 2014)

# What is Seaport Sensitivity?



**‘The degree to which a system is affected, either adversely or beneficially, by climate-related stimuli.’ (IPCC 2011)**

# What is Seaport Adaptive Capacity (AC)?

## Low AC

- No port master plan
- Low operational flexibility
- Limited redundancy
- Site conditions not conducive to storm infrastructure
- Little available funding

## Neutral

## High AC

- Port master plan that considers climate
- Operational flexibility
- High operational efficiency
- Access to funding



‘The ability of systems, institutions, humans and other organisms to adjust to potential damage, to take advantage of opportunities, or to respond to consequences.’ (IPCC 2014)



# Candidate Vulnerability Indicators By Source



World Port Index (Pub 150)

U.S. DOT Maritime Administration

U.S. DOT Climate Data Processing Tool

U.S. DOT Pipeline and Hazardous Materials Safety Administration

U.S. DOT Federal Highway Administration: National Bridge Inventory

USACE Navigation Data Center

USACE: Waterborne Commerce of the US

NOAA Office for Coastal Management: Economics: National Ocean Watch

NOAA Office for Coastal Management: Coastal County Snapshots

NOAA Extreme Water Levels

NOAA Historical Hurricane Tracks Tool

NOAA National MPA Center: MPA Inventory

NOAA Office for Coastal Management: Quick Report Tool for Socioeconomic Data

NOAA Office of Response and Restoration

NOAA Storm Events Database

NOAA Tides and Currents- Sea Level Trends

EPA Air Quality Index Report

FEMA Hist. Disaster Housing Assistance

FEMA Historical Disaster Declarations

U.S. Fish & Wildlife Service, Critical Habitat Portal

U.S. Fish & Wildlife Service, Endangered Species

US Census Bureau: USA Trade Online

Social Vulnerability Index Data

Exposure	Sensitivity	Adaptive Capacity
	7	1
		8
2		
	2	
	1	
		5
	1	
	3	
	2	
1	1	
1		
	1	
	1	
	1	
2		
1		
	1	
1		
1		
	1	
	1	
	2	
	1	



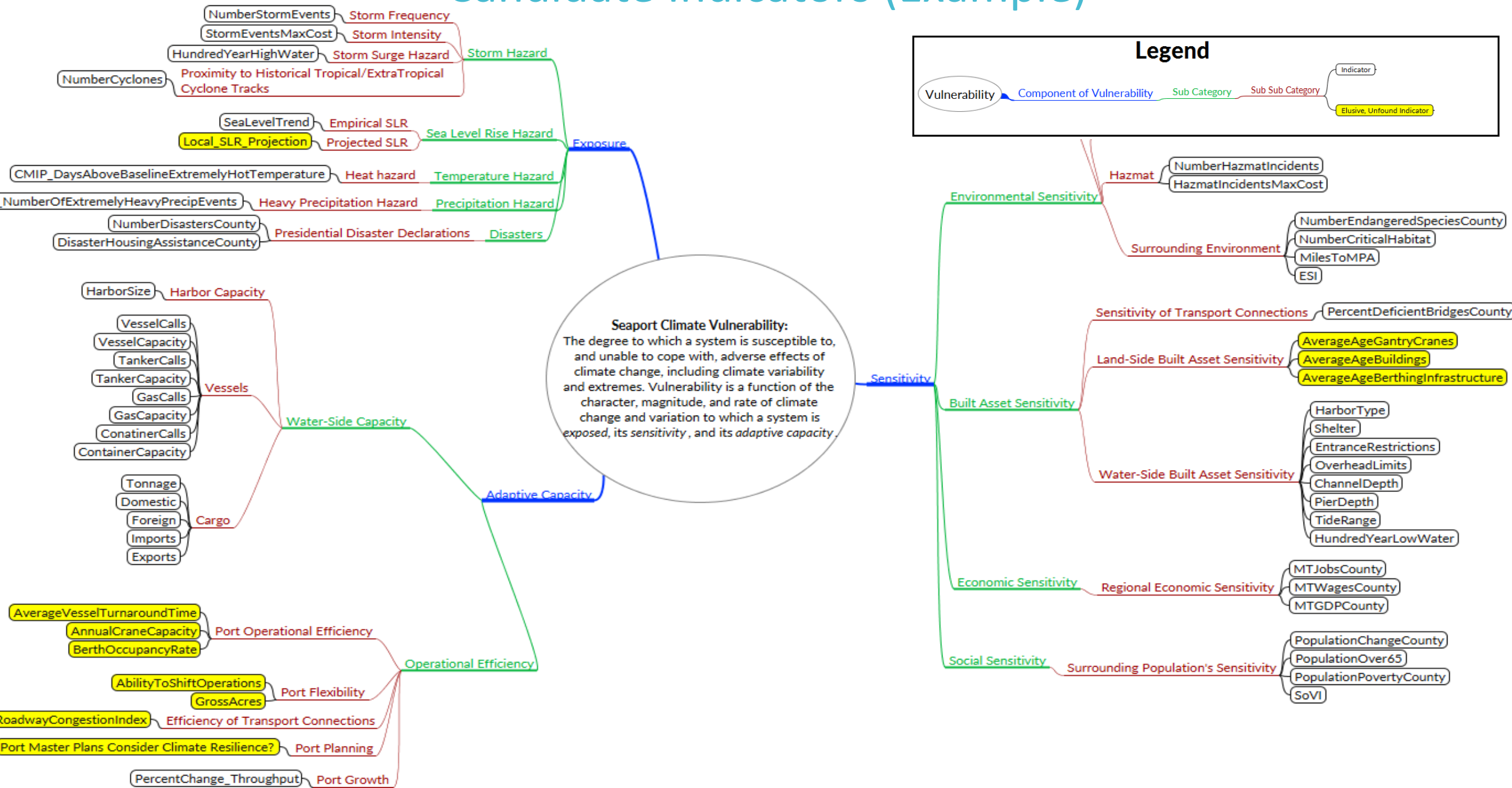
ENOW Explorer  
NOAA Coastal Services Center



FEMA



# Candidate Indicators (Example)



# Selecting Indicators



## Delphi method

- Iterative response type survey of expert elicitation
- Obtains “opinion consensus” of a group of experts
- Questionnaires interspersed with feedback in the form of a statistical representation of the group response (Dalkey & Helmer 1963)

# Example of expert group representation:

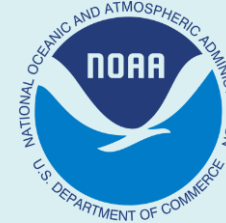
## Practitioners



## Government officials



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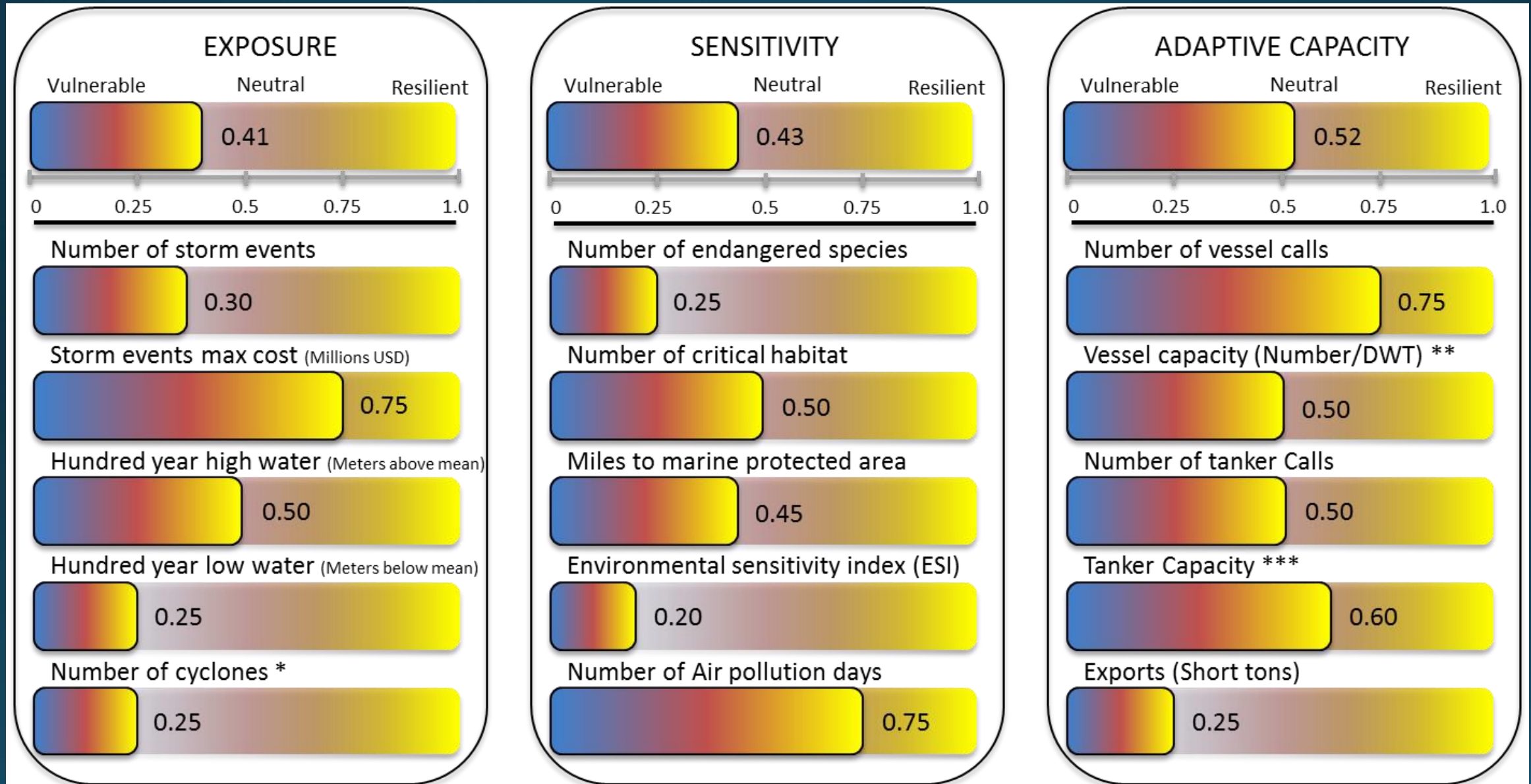
## NGOs



## Academics



# Hypothetical projected outcome for Port 'A'



# Research Gaps

How to prioritize resilience investments?

Engage ALL stakeholders in dialogue to better understand risk.

Start conversations about transformational approaches early (now).

# Thank You!

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# Timeline

Jul. 2016 –  
Dec. 2017

Jan. – Jun.  
2017

Jul. – Dec.  
2017

Jul. – Sep.  
2017

Jul. 2017 –  
Mar. 2018

Apr. – Nov.  
2018

