Indicating Climate Change Vulnerabilities To Inform Seaport Resilience

Worldmaritimenews.com – Port of Oakland

THE UNIVERSITY OF RHODE ISLAND
DEPARTMENT OF MARINE AFFAIRS
COASTAL INSTITUTE
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US Army Corps of Engineers®

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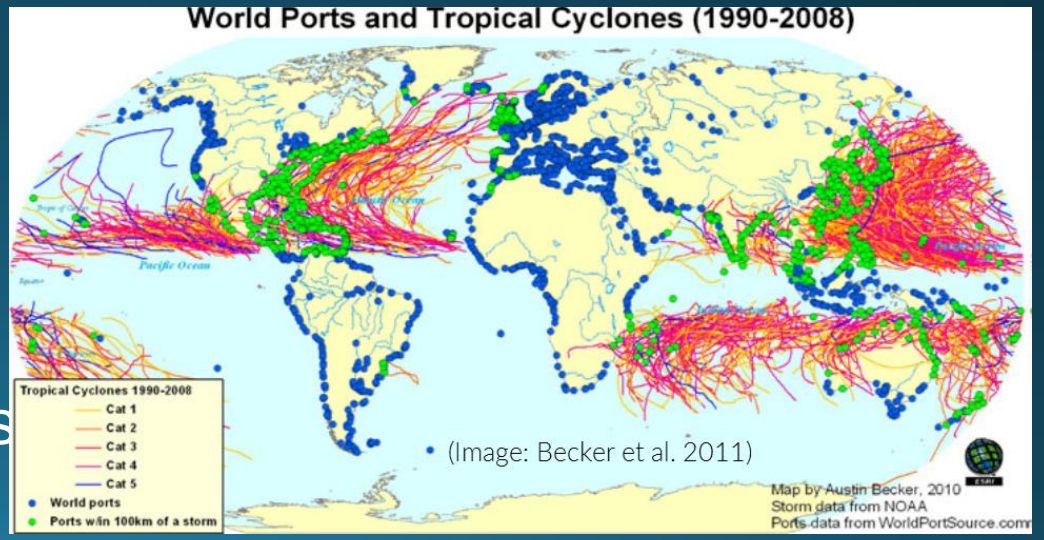
Workshop on Enhancing Resiliency of Maritime Ports, FAU 2016

Seaports are Critical, Constrained, & Exposed

- **Critical**: > 99% of the volume of overseas trade enters or leaves the U.S. by ship (MARAD 2016)
- **Constrained**: unable to retreat from water's edge
- **Exposed**: Ports face impacts from today's weather extremes & tomorrow's climatic changes in:
  - storm frequency & intensity
  - sea level
  - wave height
  - salinity and acidity
  - tidal regime
  - sedimentation rates
  - precipitation
  - temperature extremes



(Image: Becker et al. 2011)

Planning for a Resilient Marine Transportation System

Enhancing resilience begins with understanding vulnerabilities (IPCC 2012)

- *Vulnerability is a function of the character, magnitude, and rate of climate change and variation to which a system is **exposed**, its **sensitivity**, and its **adaptive capacity**.* (IPCC 2001)

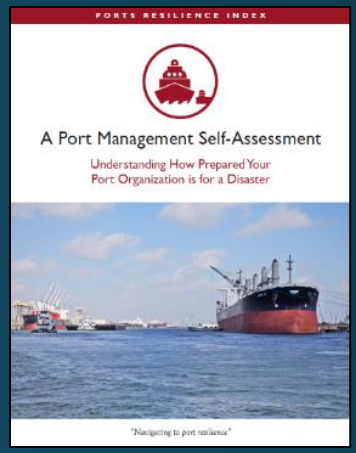
- Vulnerability and risk assessment are considered a first step for risk reduction & climate adaptation (IPCC 2012)

- Climate-vulnerability and risk assessments support climate-adaptation decisions by addressing the "*adapt to what?*" question

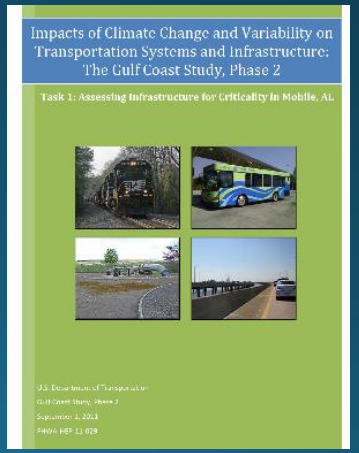
Measuring Climate Vulnerabilities to Inform Resilience

At the Individual port scale:

- **Self-assessment tools**, e.g., “Ports Resilience Index: A Port Management Self-Assessment”[1]



- **Case-studies**, e.g., DOT Gulf Coast Study: Assessing Infrastructure for Criticality in Mobile, Alabama[2]

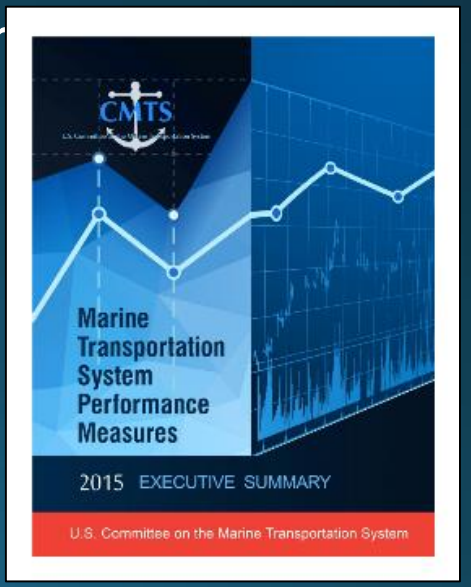


1 Morris, Lauren L., and Tracie Sempier. 2016. Ports Resilience Index: A Port Management Self-Assessment. U.S. Department of Commerce, Gulf of Mexico Alliance.
2 USDOT, 2014: Impacts of Climate Change and Variability on Transportation Systems and Infrastructure The Gulf Coast Study, Phase 2 Screening for Vulnerability Final Report, Task 3.1FHWA-HEP-14-033.

Measuring Climate Vulnerabilities to Inform Resilience

At the Multi-port scale:

- Assessments are often *indicator*-based
- ***Indicators*** are measureable, observable quantities that serve as proxies for an aspect of a system that cannot itself be directly, adequately measur
- The US Committee on the Marine Transportation System (USCMTS) has developed MTS *Performance Measures*[1] from Federal data sources
  - Only *two* measures of MTS "Resilience": *Age of Federal Locks, & Condition Rating of USACE-Infra*
  - Does not consider (private) container terminals or port facilities



1 CMTS, U. S., 2015: Marine Transportation System Performance Measures: Executive Summary.

Measuring Climate Vulnerabilities to Inform Resilience

Research Objective:

- To better understand the distribution of climate-vulnerabilities across ports and to inform transportation resilience policy, we are developing a comparative assessment method to measure the relative climate-vulnerabilities faced by a sample of ports.

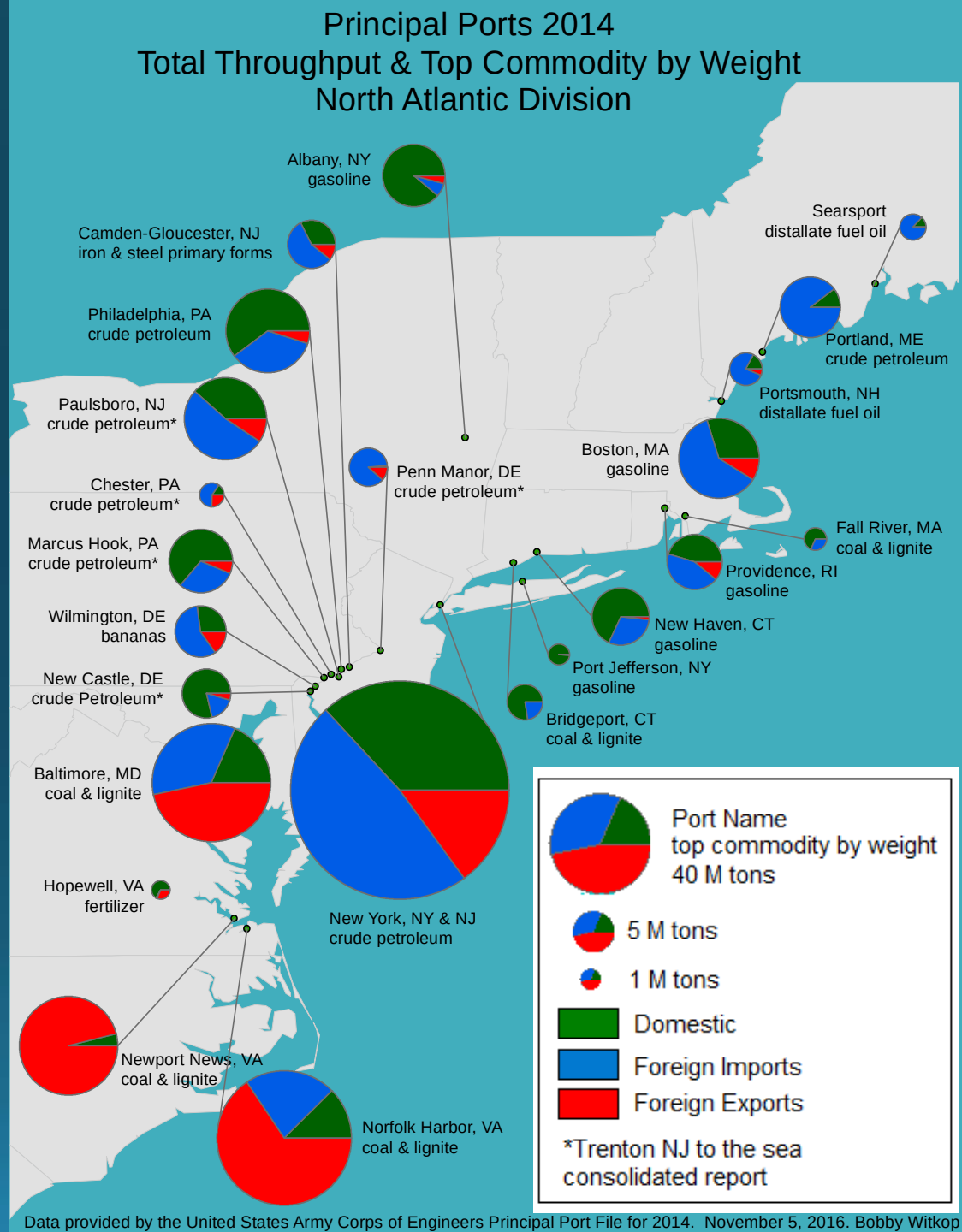
Research Questions:

- How to describe the *distribution* of climate-vulnerabilities across the ports in a region?
- How suitable is available data to develop indicators of port climate-vulnerability that

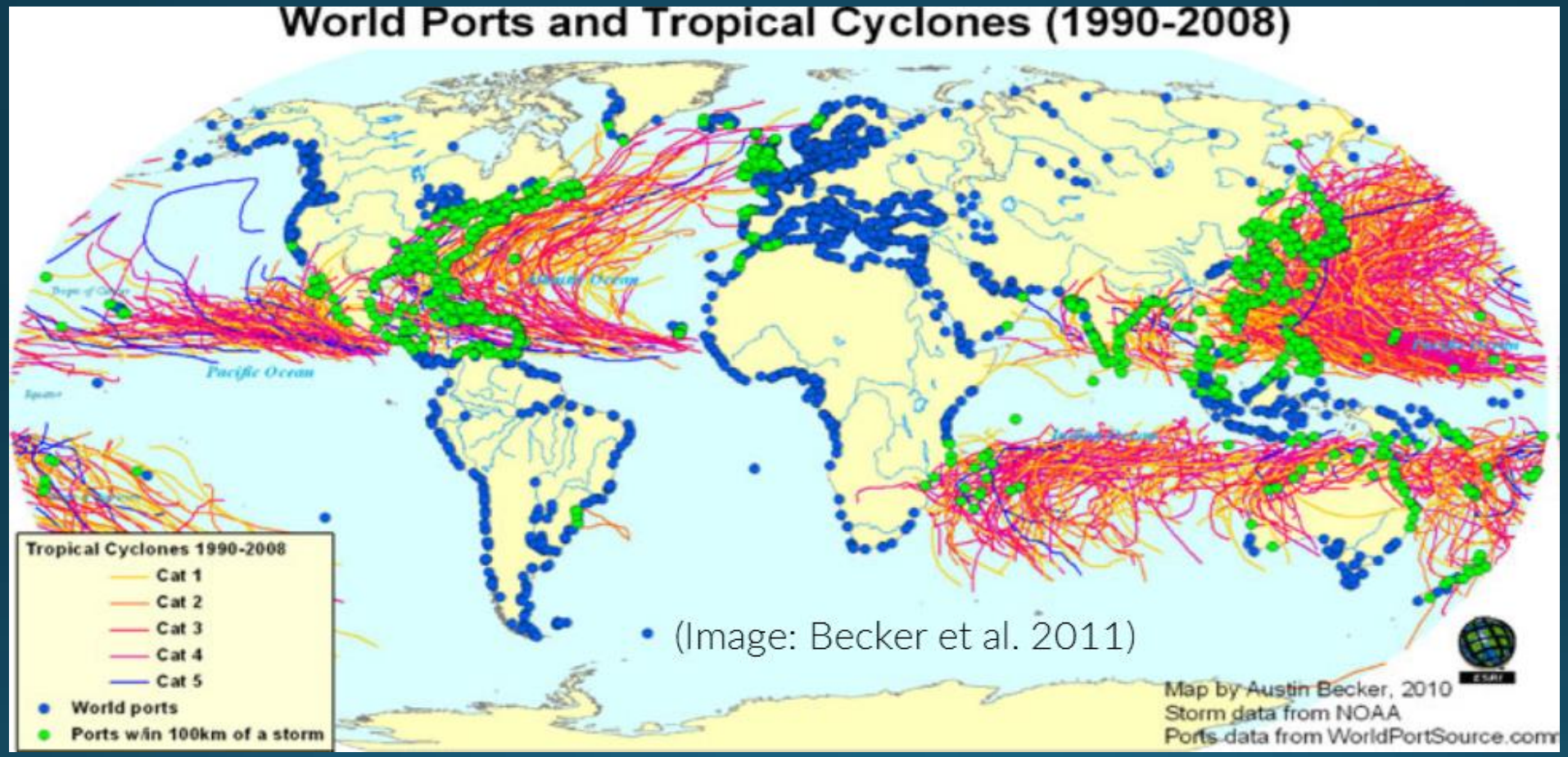
Pilot study: North Atlantic Ports

What indicators represent three components of climate-vulnerability for seaports?

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



Seaport Climate-Exposure



(Image: Becker et al. 2011)

'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)

Seaport Climate-Sensitivity

High Sensitivity

Low Sensitivity

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

Seaport Climate Adaptive Capacity

Low AC

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

High AC

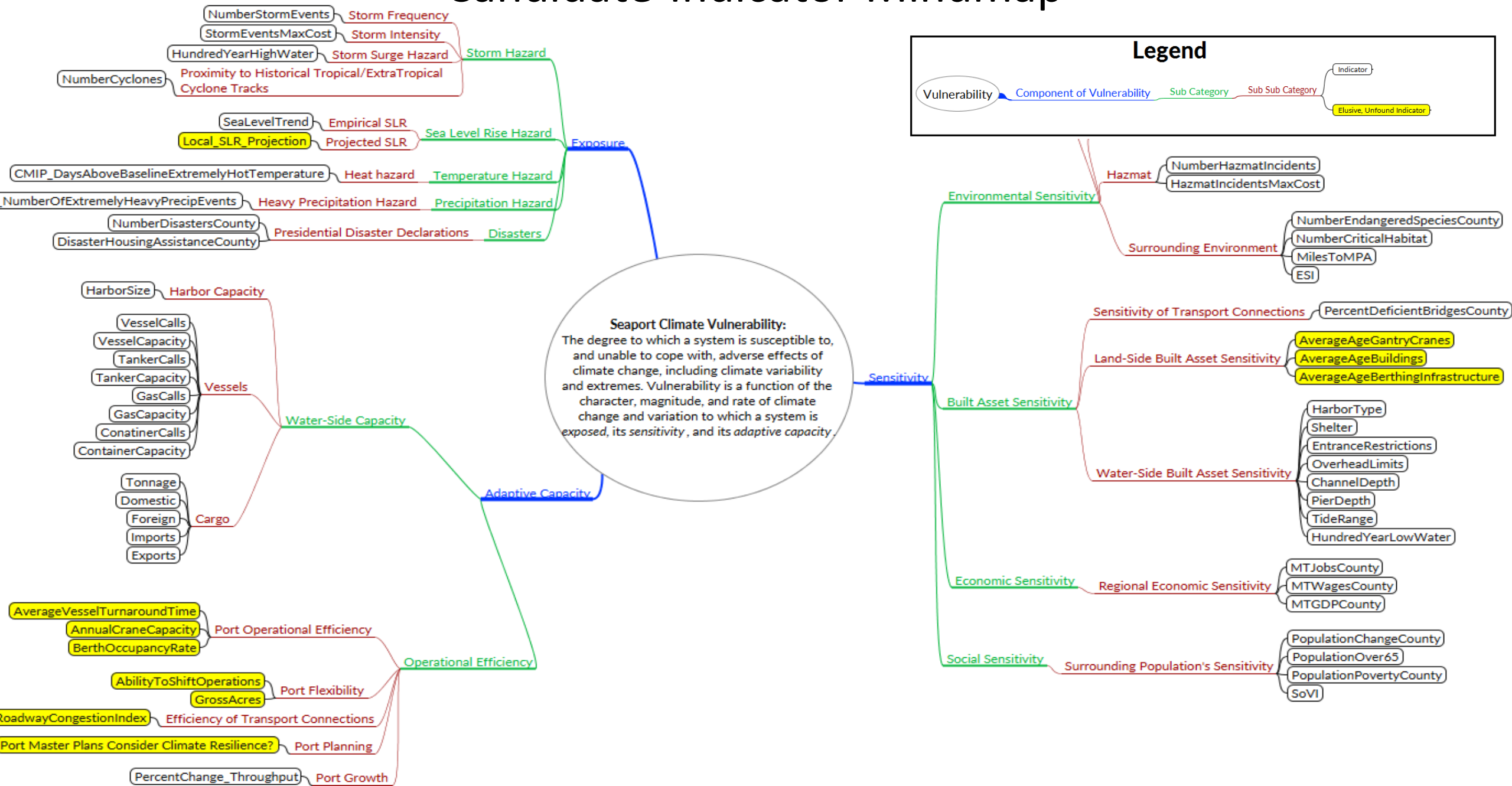
- Port master plan that considers climate
- Operational flexibility
- High operational efficiency
- Access to funding

‘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 Indicator Data Sources

	Exposure	Sensitivity	Adaptive Capacity
World Port Index (Pub 150)		**7**	1
U.S. DOT Maritime Administration			**8**
U.S. DOT Climate Data Processing Tool	2		
U.S. DOT Pipeline and Hazardous Materials Safety Administration		2	
U.S. DOT Federal Highway Administration: National Bridge Inventory		1	
USACE Navigation Data Center			**5**
USACE: Waterborne Commerce of the US		1	
NOAA Office for Coastal Management: Economics: National Ocean Watch		**3**	
NOAA Office for Coastal Management: Coastal County Snapshots		2	
NOAA Extreme Water Levels	1	1	
NOAA Historical Hurricane Tracks Tool	1		
NOAA National MPA Center: MPA Inventory		1	
NOAA Office for Coastal Management: Quick Report Tool for Socioeconomic Data		1	
NOAA Office of Response and Restoration		1	
NOAA Storm Events Database	2		
NOAA Tides and Currents- Sea Level Trends	1		
EPA Air Quality Index Report		1	
FEMA Hist. Disaster Housing Assistance	1		
FEMA Historical Disaster Declarations	1		
U.S. Fish & Wildlife Service, Critical Habitat Portal		1	
U.S. Fish & Wildlife Service, Endangered Species		1	
US Census Bureau: USA Trade Online		2	
Social Vulnerability Index Data		1	

Candidate-Indicator Mindmap



Expert Elicitation

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)

Expert Elicitation

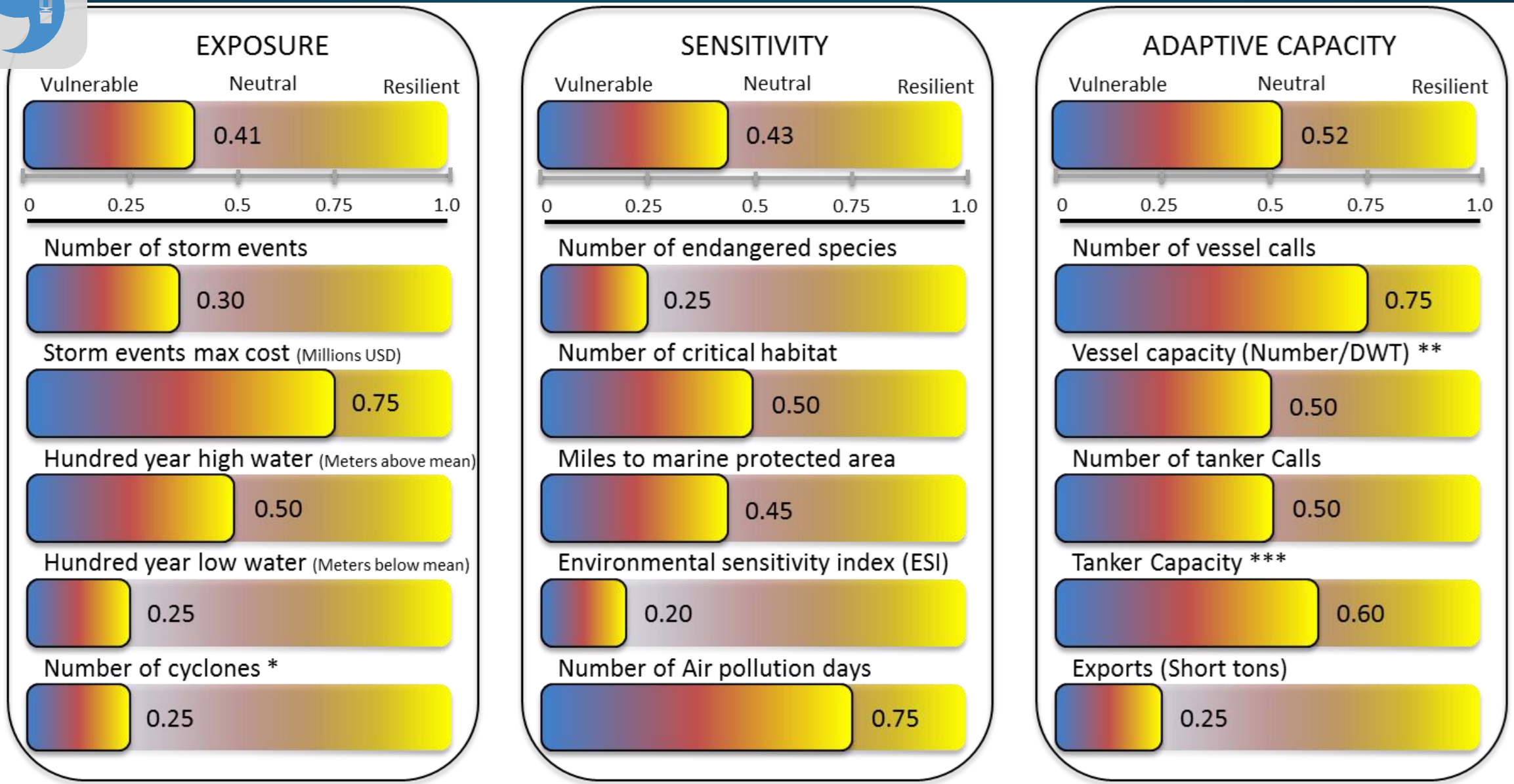
Practitioners

Government officials

NGOs

Academics

Projected Output



Thank You!

Help Suggest Candidate Experts Online:

goo.gl/VSTUEN

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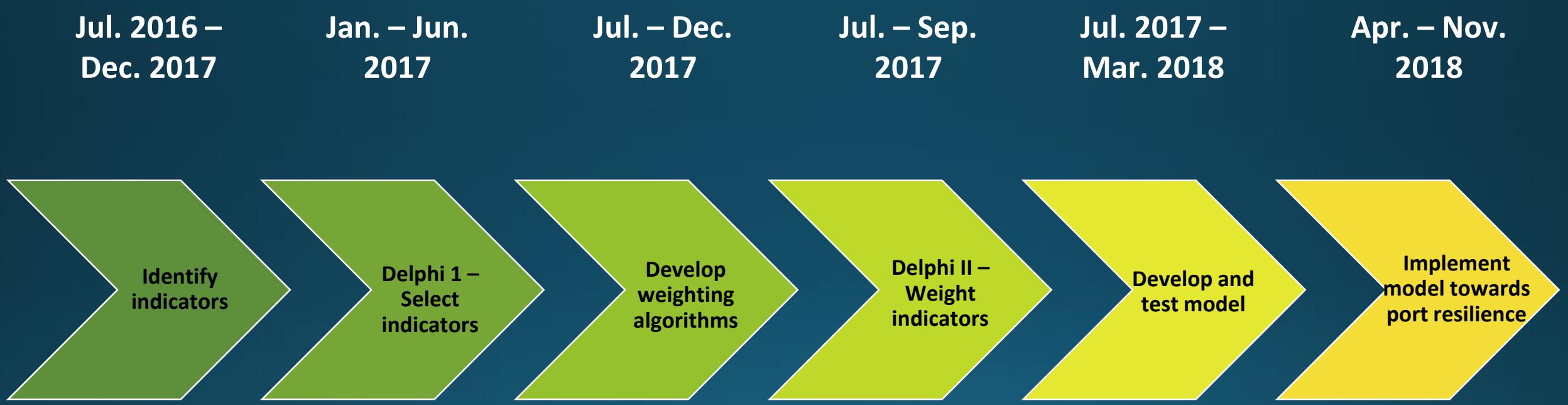
Timeline


Jul. 2016 – Dec. 2017
Identify indicators
Jan. – Jun. 2017
Delphi 1 – Select indicators
Jul. – Dec. 2017
Develop weighting algorithms
Jul. – Sep. 2017
Delphi II – Weight indicators
Jul. 2017 – Mar. 2018
Develop and test model
Apr. – Nov. 2018
Implement model towards port resilience

Findings of the Third U.S. National Climate Assessment (NCA)[1]

"Infrastructure is being damaged by sea level rise, heavy downpours, and extreme heat; damages are projected to increase with continued climate change." [p. 16]

"Sea level rise, coupled with storm surge, will continue to increase the risk of major coastal impacts on transportation infrastructure, including both temporary and permanent flooding of airports, **ports and harbors**, roads, rail lines, tunnels, and bridges." [p. 134]