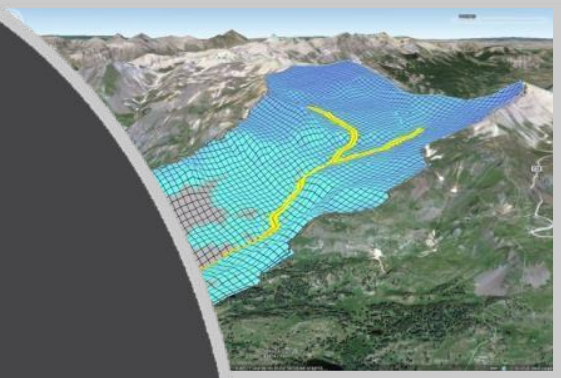
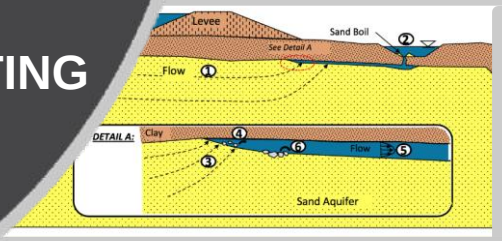
Port Resilience R&D: *using available resources for building better projects*



- **Katherine Chambers**
  ERDC Coastal and Hydraulics Laboratory



AAPA HARBORS & NAVIGATION COMMITTEE AND QPI MEETING
2-3 October 2019

US Army Corps of Engineers

FLOOD RISK MANAGEMENT RESEARCH & DEVELOPMENT
PREPARATION RESPONSE RECOVERY MITIGATION
Tools for Driving Down Risk

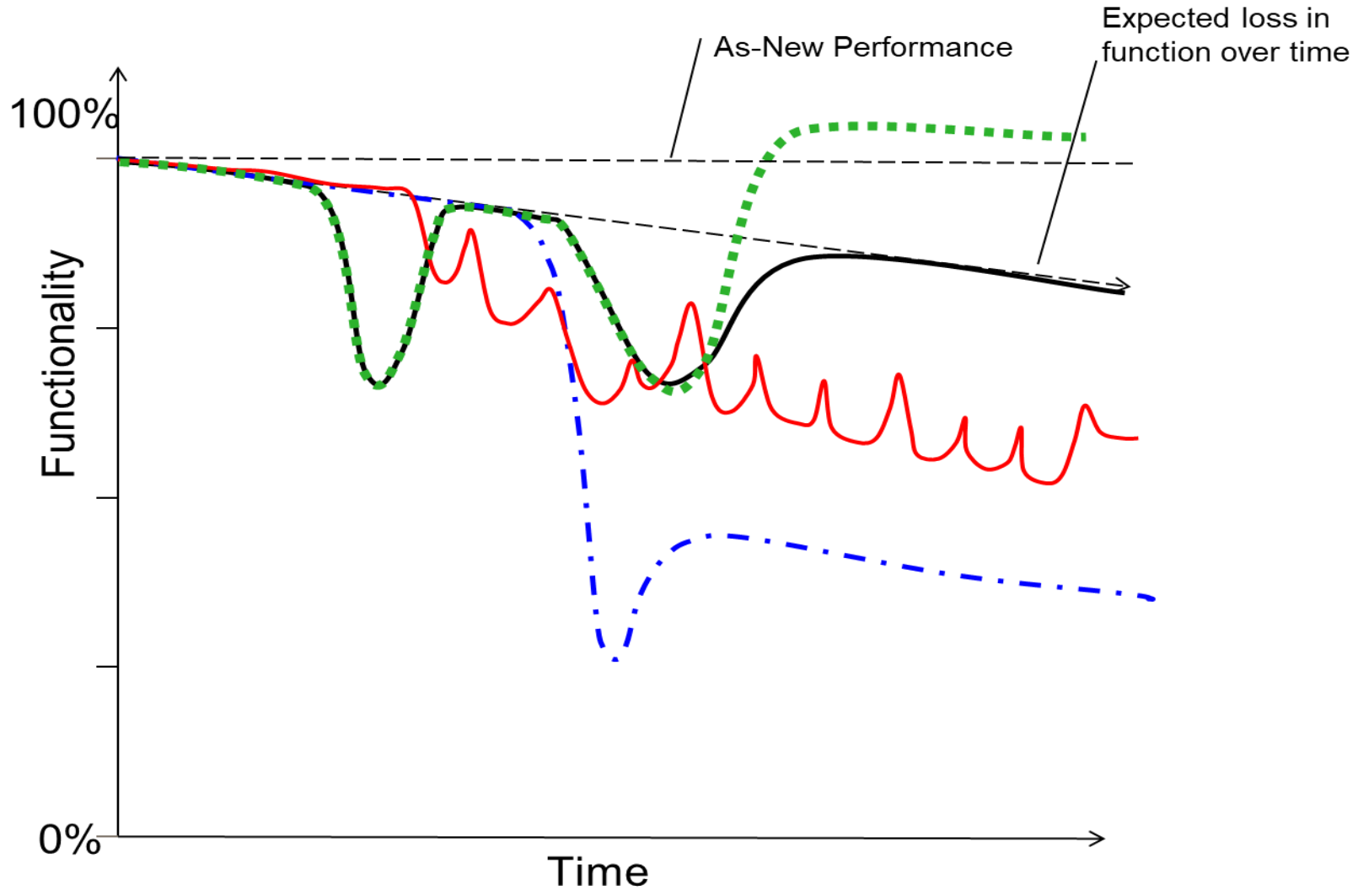
ERDC
ENGINEER RESEARCH & DEVELOPMENT CENTER

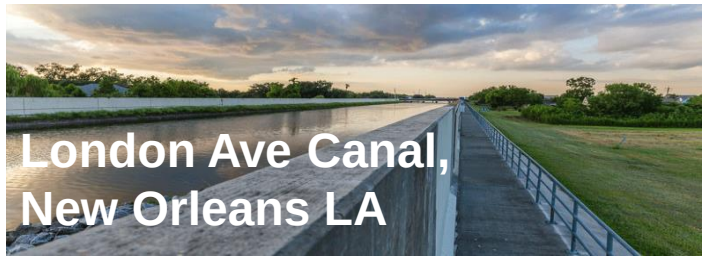
Resilience Definition

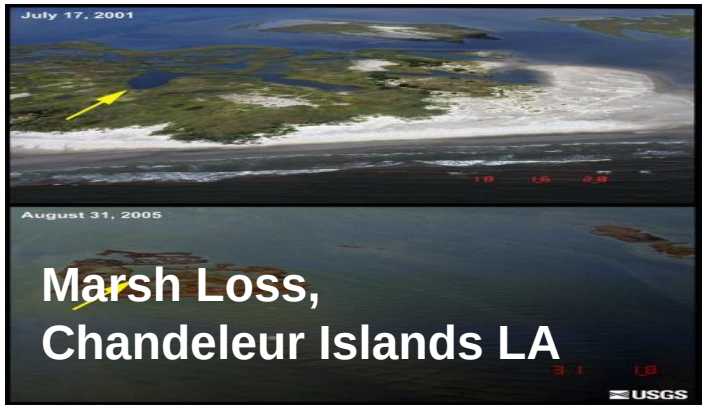
Resilience is a term that encompasses four general concepts: Prepare, Resist, Recover, and Adapt. These four concepts allow for flexibility in application across USACE business lines and project scales.

→ This lose definition can be a problem when applying these concepts to management or decisions. Assessment can be largely subjective and applied with varied meanings.

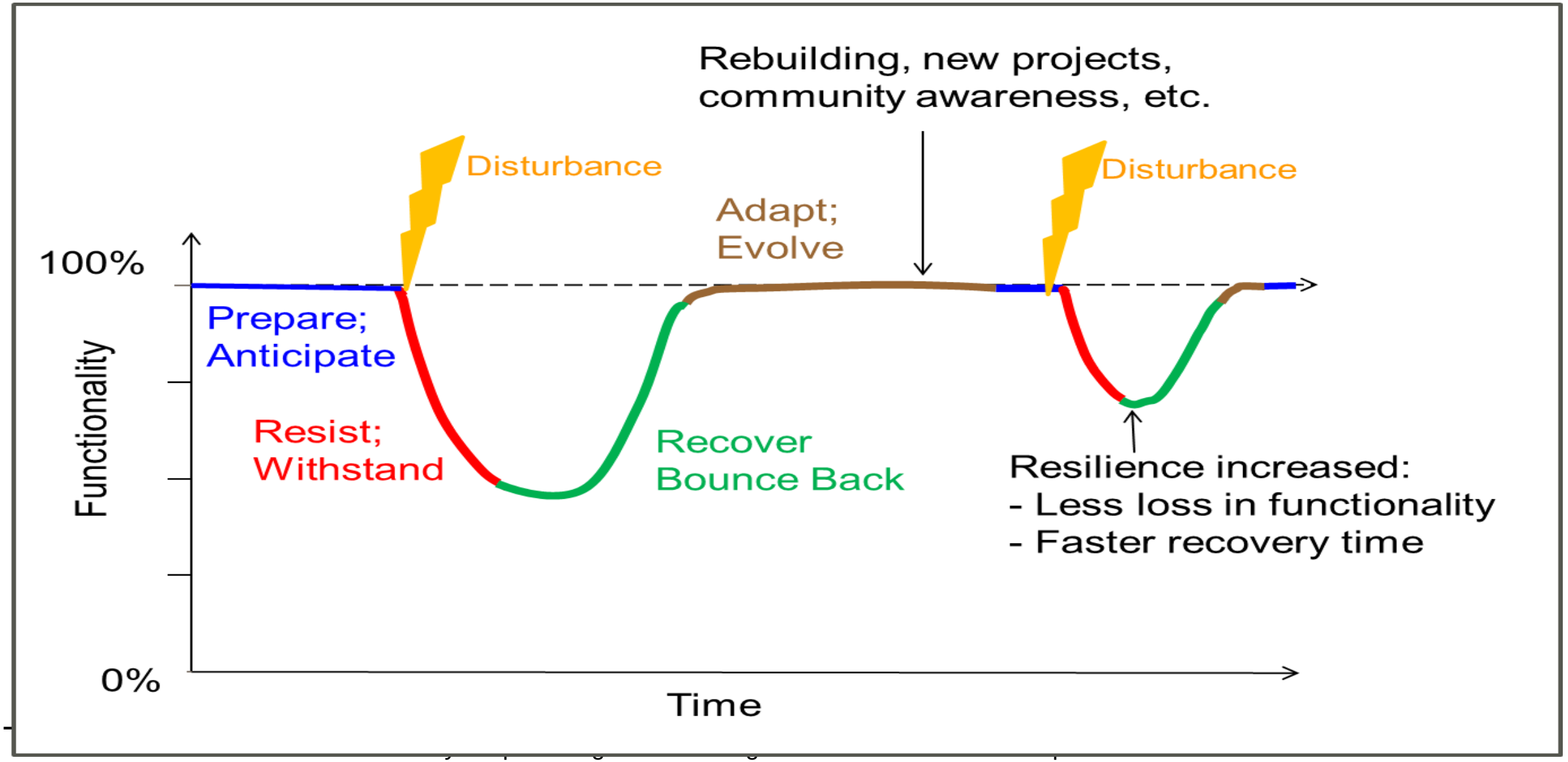
Resilience to multiple hazards







Resilience Over Time



Research Challenges

- RESILIENCE = call to action!
- SYSTEM-wide understanding is elusive

Need #1 - Assessment can be largely subjective and the definition of resilience is applied with variable meaning

Need #2 - A need exists for the development of objective tools and applications that Districts (& others) can use to quantify coastal system resilience.

MARAD Maritime Administration

FY19 Appropriations Act resulted in $292.7M for the Port Infrastructure Development Program to improve port facilities at coastal ports

Five Outcome Criteria:

1. advance technology-supported safety and design efficiency improvements;
2. bring facilities to a state of good repair and improve resiliency
3. promote efficient trade in energy resources
4. promote exports of manufacturing, agriculture, or other goods; and
5. Support the safe flow of agricultural and food products, free of pests and disease, domestically and internationally. Accordingly, the Department

5 September IG changes in red

Construction Supplemental 115-123, Resiliency Specific Line Items

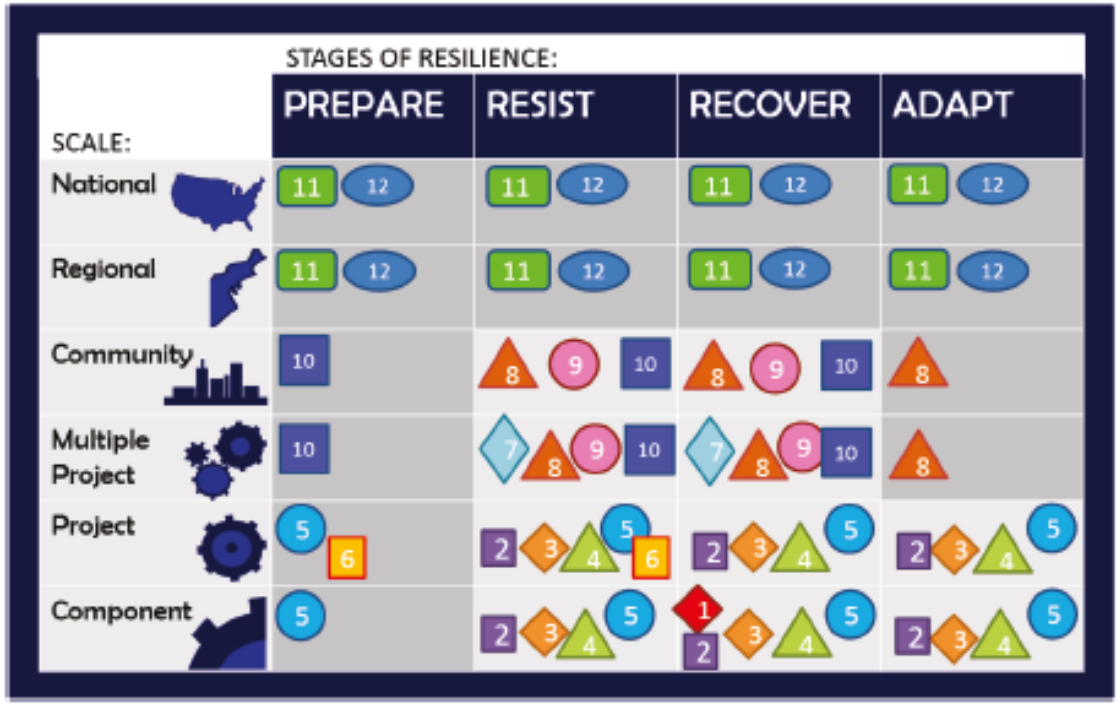
Project Name	Approved
BREVARD COUNTY	$2,000,000
BROWARD COUNTY	$2,000,000
DUVAL COUNTY	$2,000,000
LEE COUNTY	$2,000,000 NO
NASSAU COUNTY	$2,000,000
PALM BEACH COUNTY	$2,000,000 NO
SARASOTA COUNTY (VENICE)	$2,000,000 NO
ST. JOHN'S COUNTY	$2,000,000
Incorporated into C	
Dade County	$2,000,000
Manatee County	$2,000,000 NO
*All I projects will incorporate resiliency	NO=not ongoing

Research Approach

Need #1 – Assessment can be largely subjective and applied with varied meanings

→ **Develop assessment methodologies for understanding resilience**

1. Conduct an inventory of available methodologies and outstanding needs
2. Apply resilience definition to ID potential indices and metrics across different scales of analysis
3. Highlight outstanding needs for future research



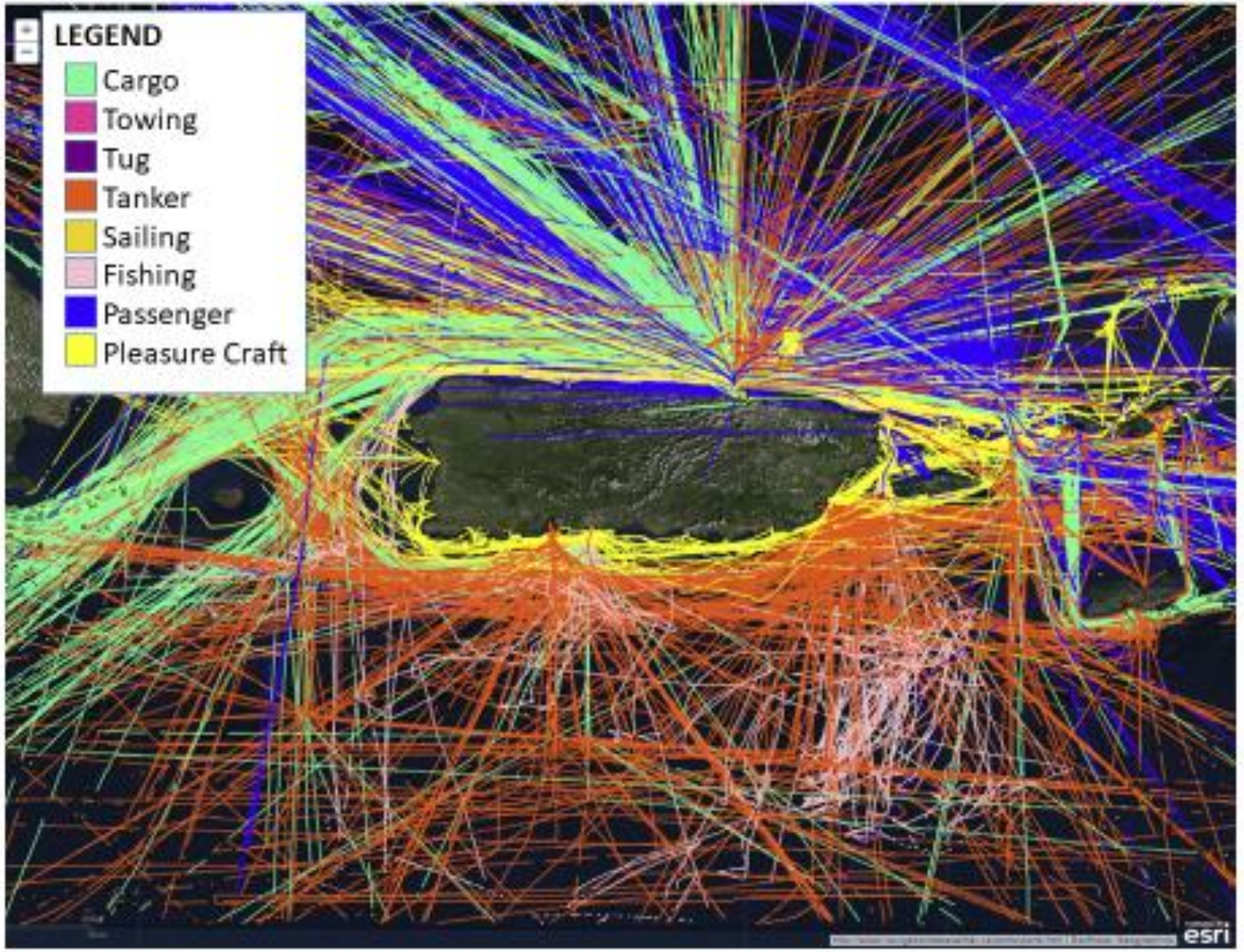
Twelve research projects were funded through the CSR Research Initiative.

ID Assessment Methods

Review Resources & Literature

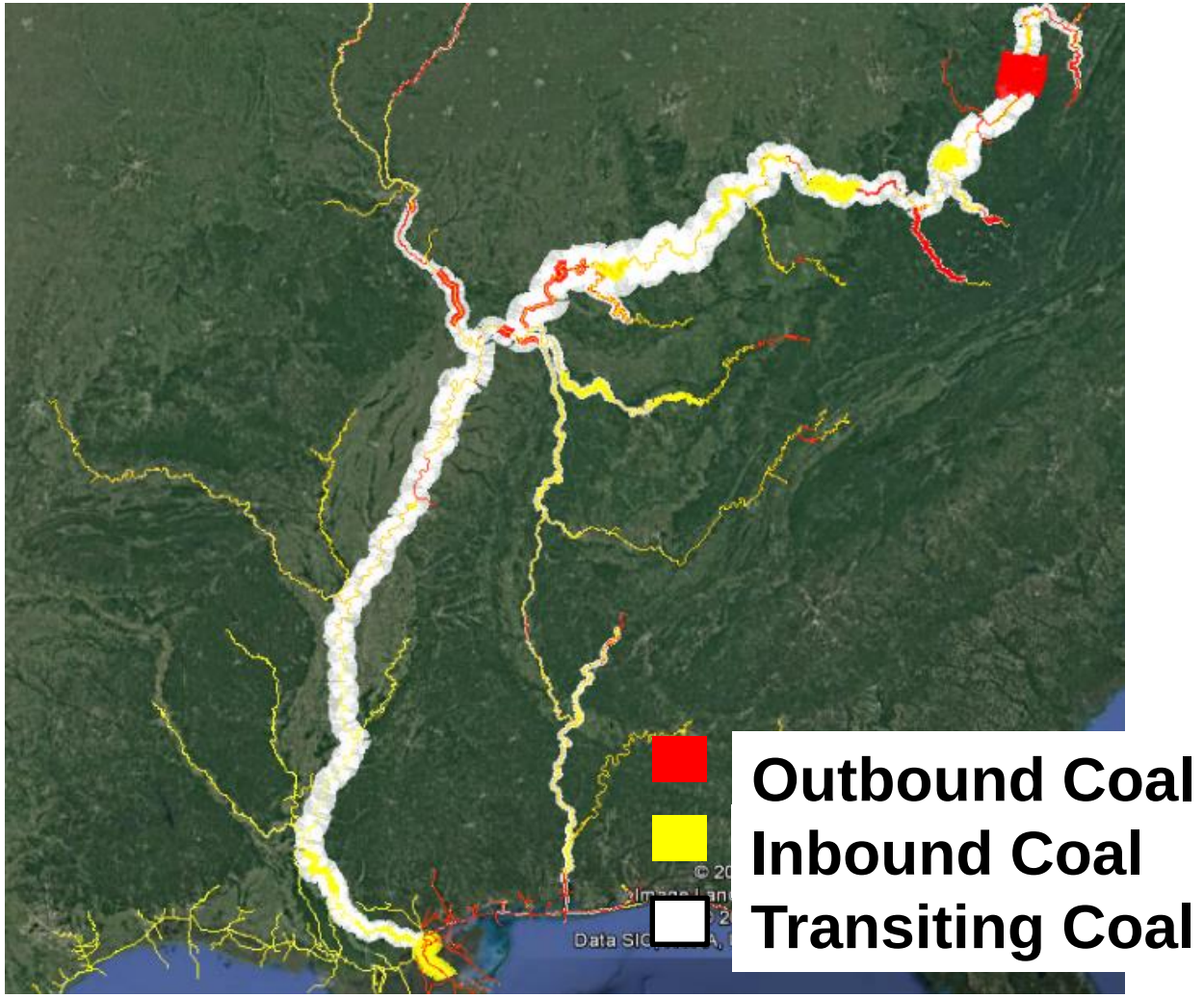
- Channel Portfolio Tool utilizing Waterborne Commerce Data
- Automatic Identification System Analysis Package utilizing USCG National AIS Database

AIS data to observe regional patterns in vessel traffic



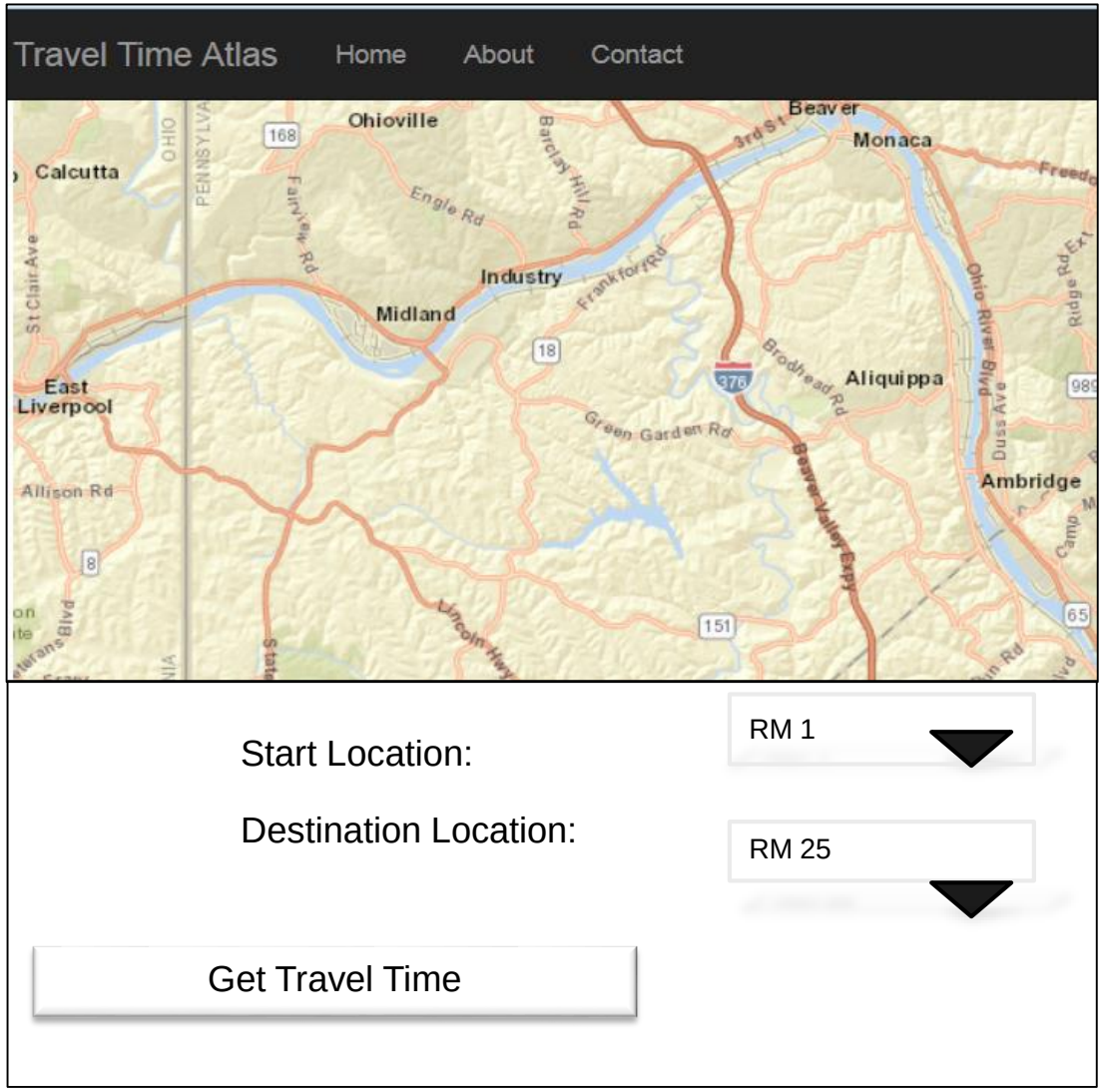
Waterborne Commerce Data

to understand major commodity flows, connectivity and timing



Travel Time Atlas for inland river systems

- Provides historical and near real-time waterway transit times between origins and destinations
- Publically accessible
- Example Applications:
  - Voyage planning
  - River Information Services
  - Multi-modal connectivity
  - Traffic monitoring



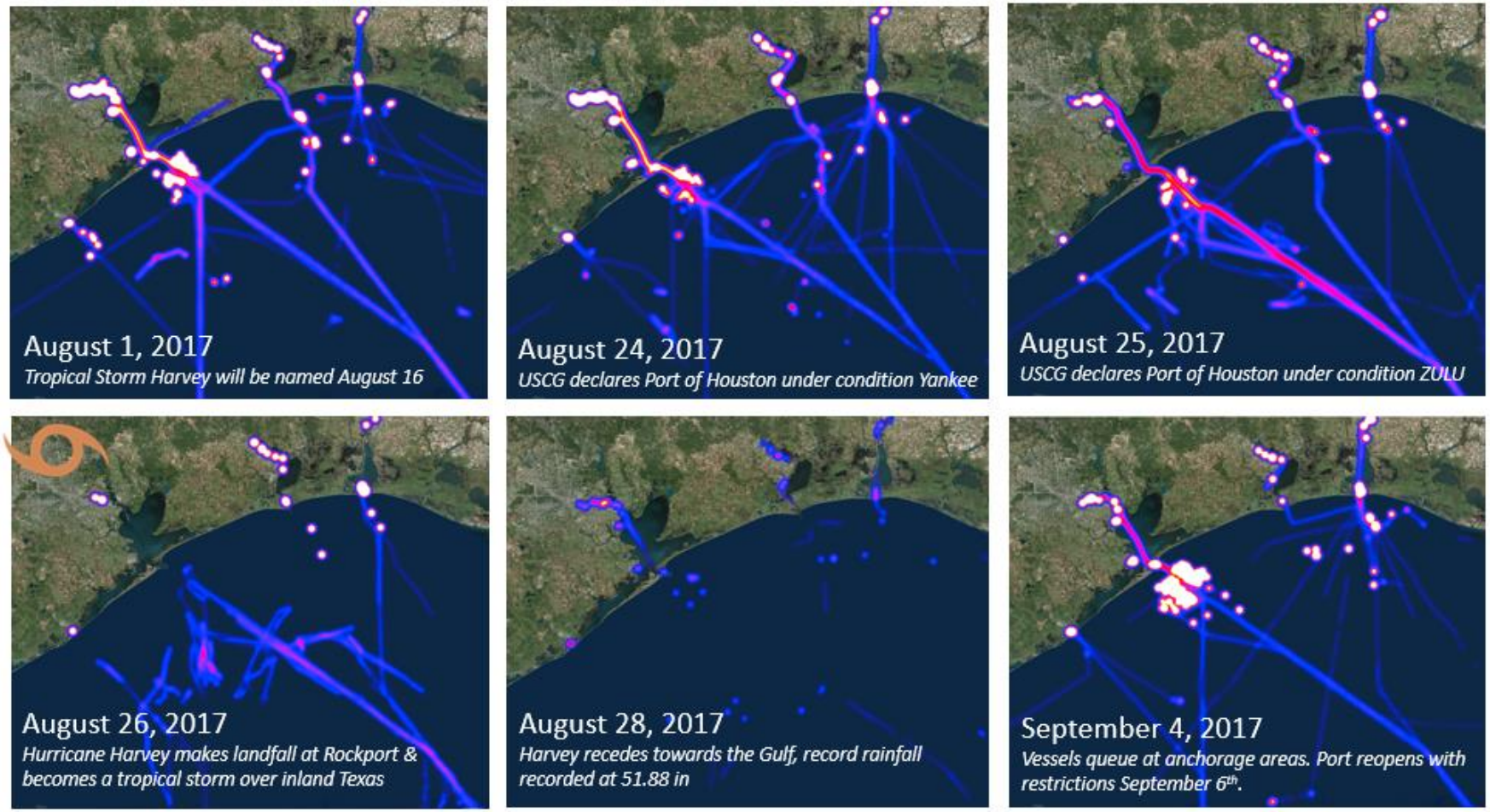
POC:
Patricia.K.Dijoseph@usace.army.mil

Regional Navigation Traffic During Disruptions

Hurricane Harvey Cargo and Tanker Vessel Signal Density Plots

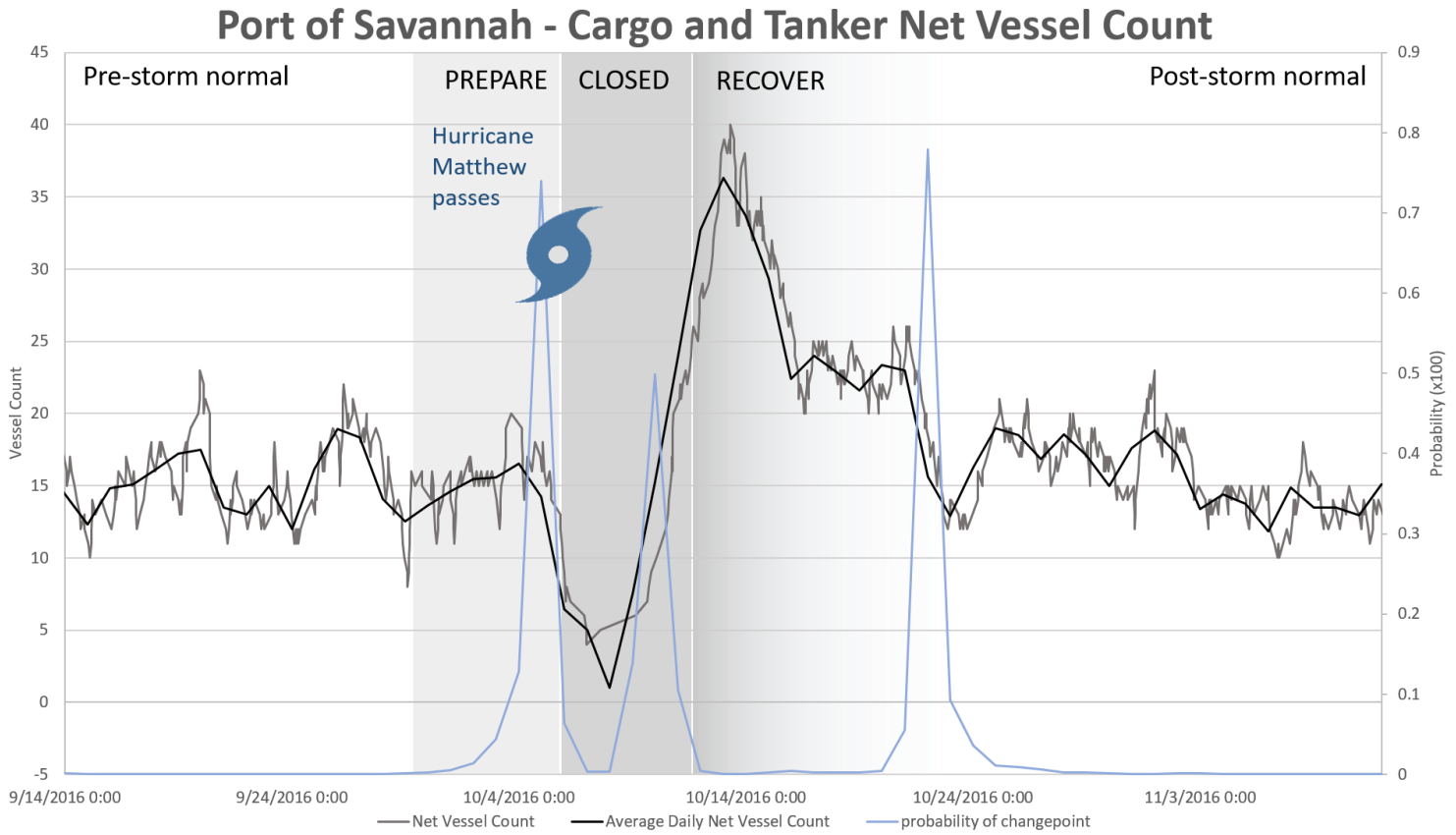
Created with ERDC Automatic Identification System Analysis Package (AISAP)

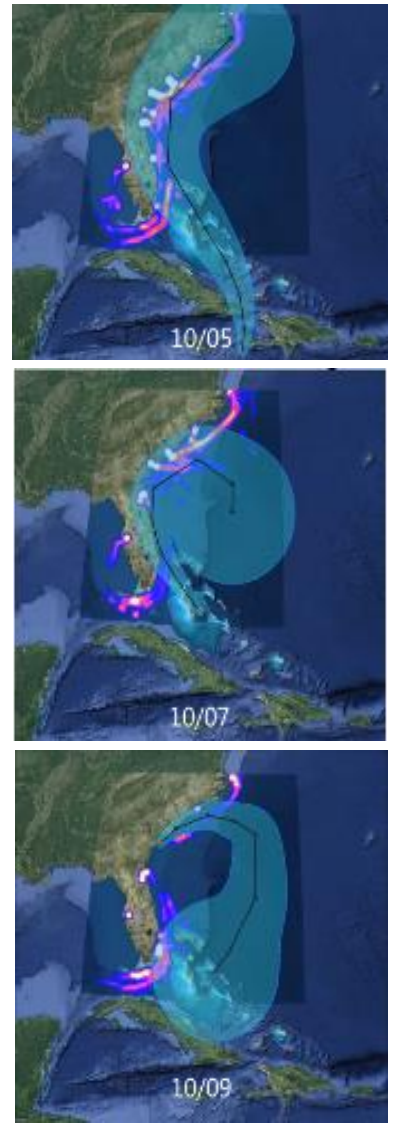
COASTAL & HYDRAULICS LABORATORY ERDC INNOVATIVE SOLUTIONS for a safer, better world



ERDC Navigation Data Performance Team: Katherine Touzinsky, Kenneth N. Mitchell, Patricia Dijoseph, Marin Kress

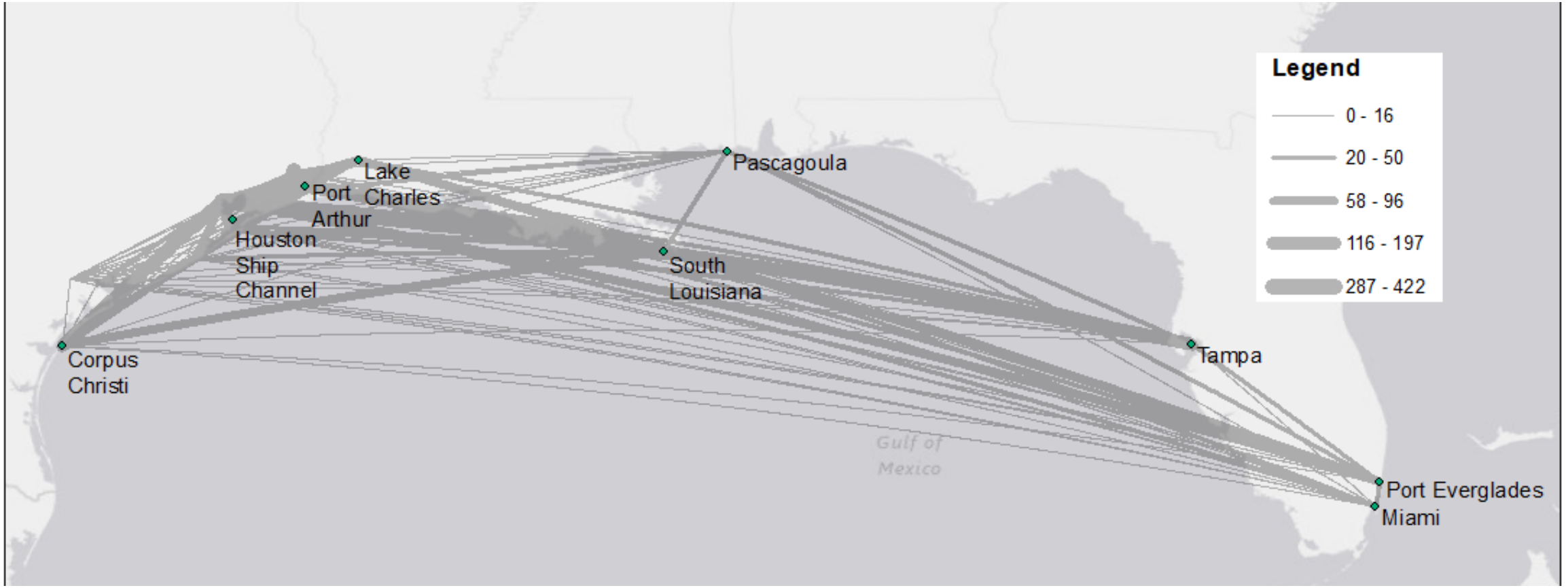
Port Resilience Indices



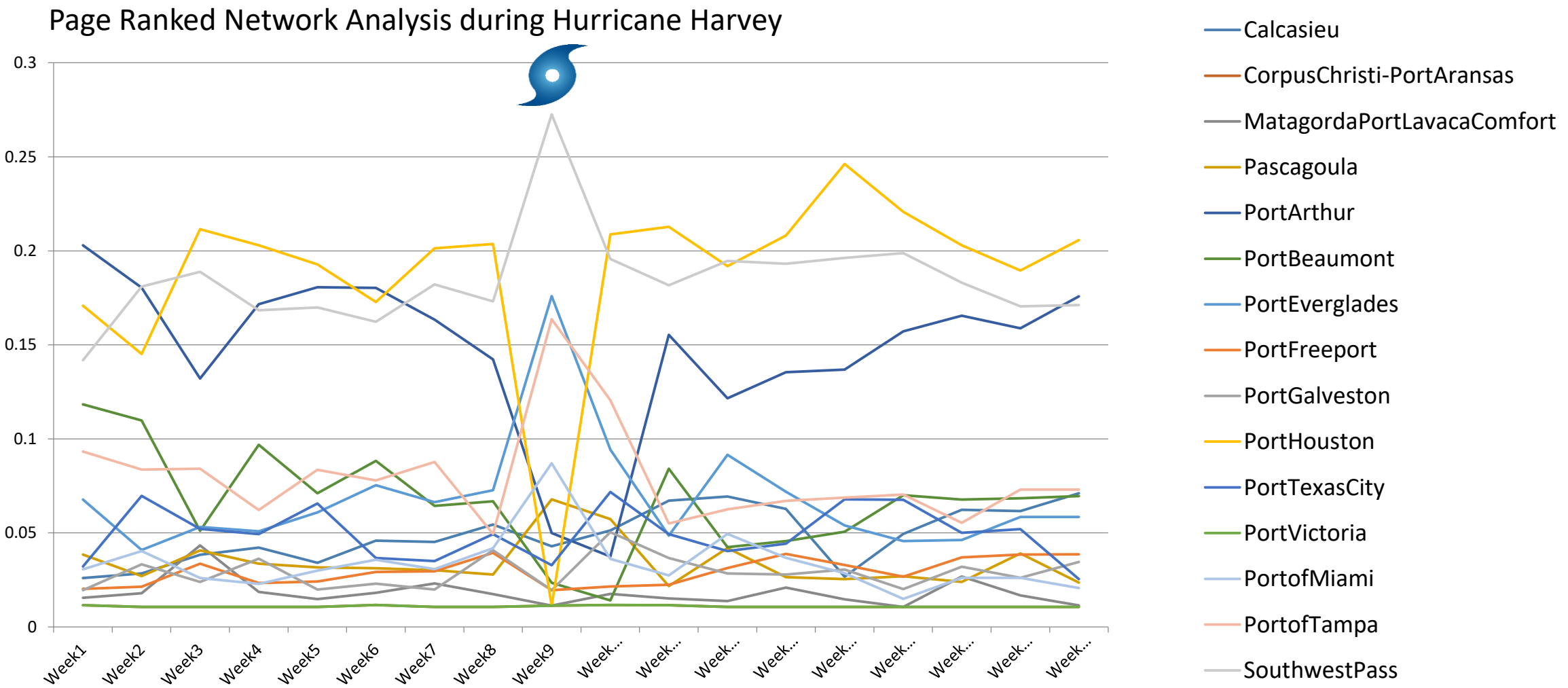


- Understand baseline function of our navigation systems and the impacts of disruptions
- Evaluate and monitor project performance in real-time

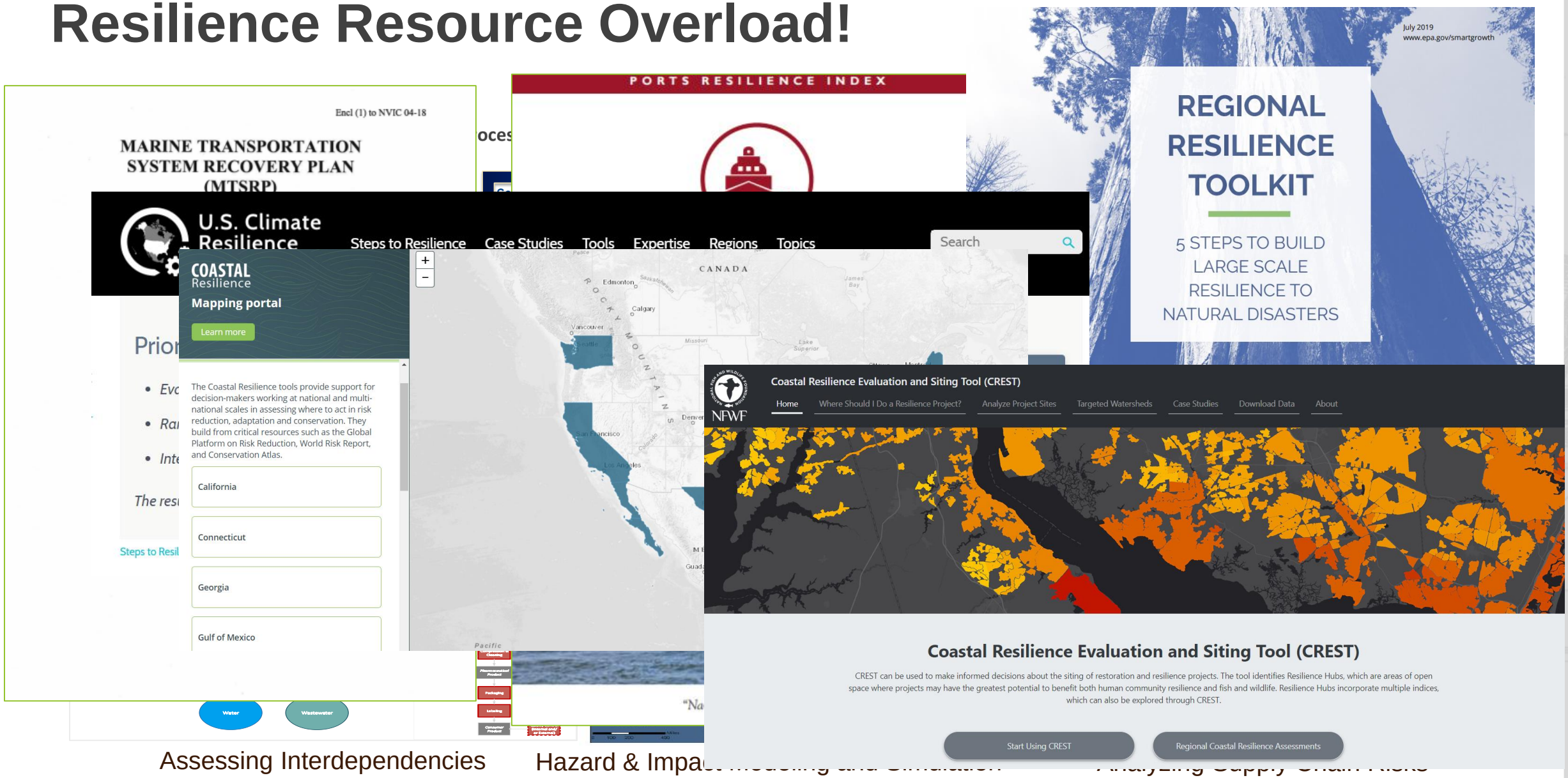
Visualize inter-port flows and connectivity



Understand disruption impacts to networks



Resilience Resource Overload!



Assessing Interdependencies

Hazard & Impact modeling and Simulation

Analyzing Supply Chain Risks

Research Approach

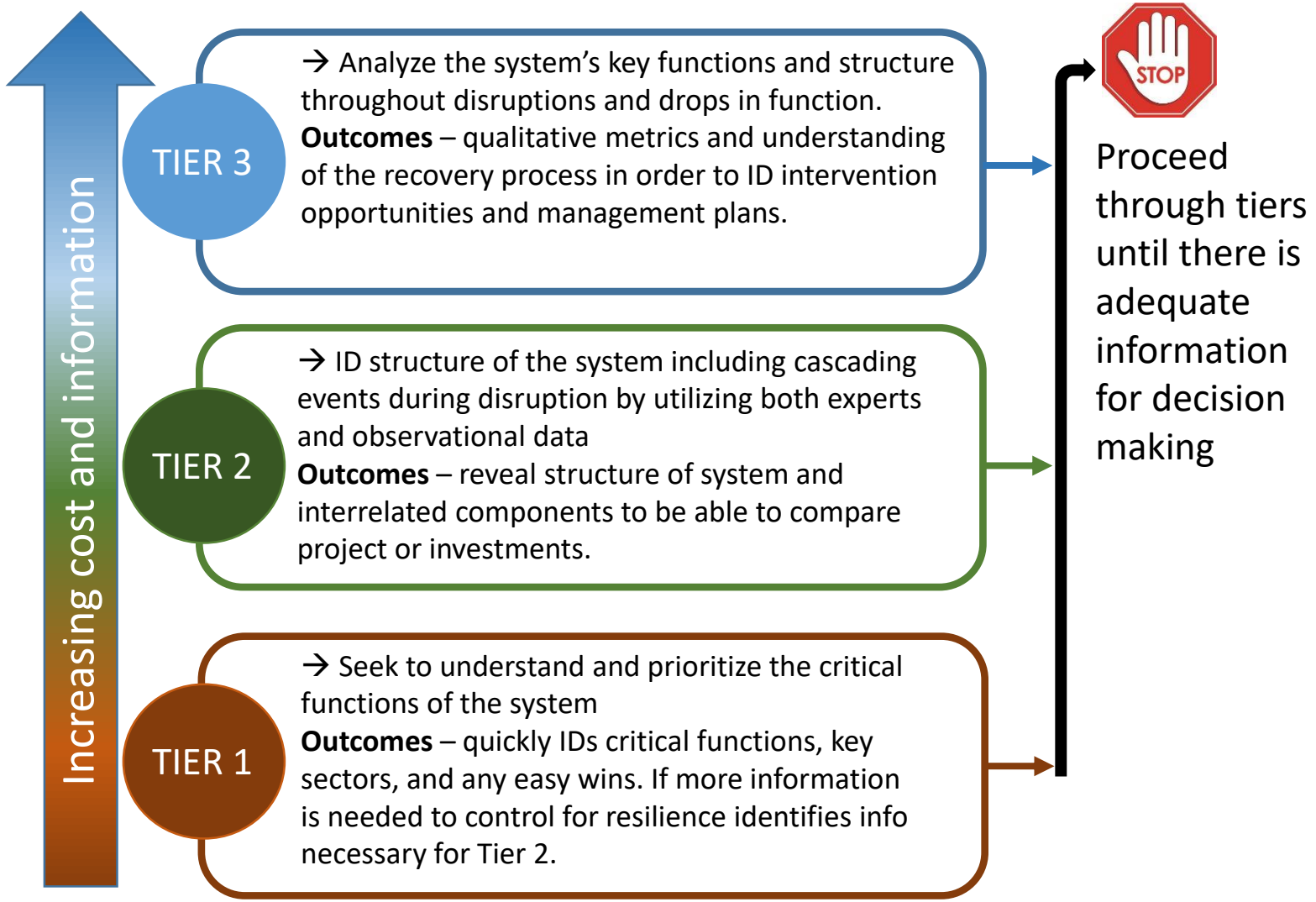
Need #2 – A disparity exists between published resources on resilience and usable/accessible information for decision support and project planning.

- → **Create user-driven resources for approaching resilience across different systems**
- → **DHS & ERDC– Joint Agency Port Resilience Assessment Guide**
  1. How can the existing body of knowledge on port and maritime resilience be integrated and expanded to create a holistic guide for assessing and improving the resilience of a the MTS?
  2. Gain insight on key issues and user objectives of stakeholders who work on the system
  3. Develop a user-friendly Guides to resources for assessing the resilience of complicated infrastructure (grey and green) systems

Resource Review

Resource Name	Scope	Assessment Tier	Resource Type	Resilience Phases
Self Assesssment - Improving Freight Transportation Resilience in F	MTS Network	1	Methodology	Prepare, Absorb, Recover, Adapt
Freight Analysis Framework (FAF)	MTS Network	3	Data Source	Prepare
Freight Fluidity Study	MTS Network	3	Generic Model	Prepare
State of Hawaii Navigation Information System	Single port	3	Tool	Prepare
Resilience Matrix (Linkov 2015)	Single port	2	Methodology; Academic	Prepare, Absorb, Recover, Adapt
Port Resilience Index	Single port	1	Tool	Prepare, Adapt
INRIX City Guide	All scopes	3	Data Source	Prepare, Absorb, Recover, Adapt
National Performance Management Research Data (NPMRDS)	All scopes	3	Data Source	Prepare, Absorb, Recover, Adapt
Bayesian Network Analysis	Single port	3	Generic Model	Prepare, Absorb, Recover, Adapt
ADCIRC model	All scopes	3	Data Source	Prepare, Absorb, Recover, Adapt
Functional Resonance Analysis Method (FRAM; Hollnagel 2015)	All scopes	2	Methodology; Academic	Prepare, Absorb, Recover, Adapt
Agent-based models	All scopes	3	Generic Model	Prepare, Absorb, Recover, Adapt
Multicriteria Decision Analysis (MCDA)	All scopes	2	Generic Model	Prepare, Absorb, Recover, Adapt
Disaster Resilience Indictators for Benchmarking Baseline Condition	Communities	1	Data Source (?)	Prepare, Absorb, Recover, Adapt
Water Resource Information System (WRIS) Portal	Inland waterway	2,3	Data Source	Prepare, Absorb, Recover, Adapt
Social Vulnerability Index for Disaster Management (SOVI; Flanagan	All scopes	1	Data Source (?)	Prepare, Recover
Disaster Resilience Scorecards (Sands 2015; Williams et al. 2014)	Communities	1	Tool	Prepare, Recover
Marine Cadastre	All scopes	2,3	Data Source	Prepare, Recover
HAZMUS-MH	Single port	3	Tool	Prepare, Recover
Rapid Assessment of Hurricane Damage and Disruption to Interdep	Single port, MTS Network	3	Methodology; Academic	Prepare Absorb, Recover
Assessment and Measurement of Port Disruptions Project (Gabe W	Single port	3	Methodology; Model	Prepare, Absorb, Recover
Disaster Recovery Tracking Tool	Single port	2	Tool	Recover
Community Resilience Planning Guide for Buildings and Infrastructu	Single port	1,2	Tool	Prepare, Absorb, Recover, Adapt
Method to Measure Climate and Extreme Weather Variability to In	MTS Network	2	Methodology	Prepare, Absorb
Economic Decision Guide Software (EDGe$)	Single port	2,3	Tool	Prepare, Absorb, Recover, Adapt
Cyber-physical Disruption, Mitigation, and Response Catalog (Gabe	All scopes	1	Tool	Prepare, Absorb, Recover
Infrastructure Resilience Quantification Initiative	Single port	3	Example	
COTP Zone Area MTS Recovery Plan Guidelines	Single port	1	Tool	Prepare, Absorb, Recover
Common Access and Reporting Tool (CART)	All scopes	1,2,3	Other	
Predictive Port Resilience Tool to Assess Regional Impact of Hurrica	MTS Network	2	Tool	Prepare, Absorb, Recover

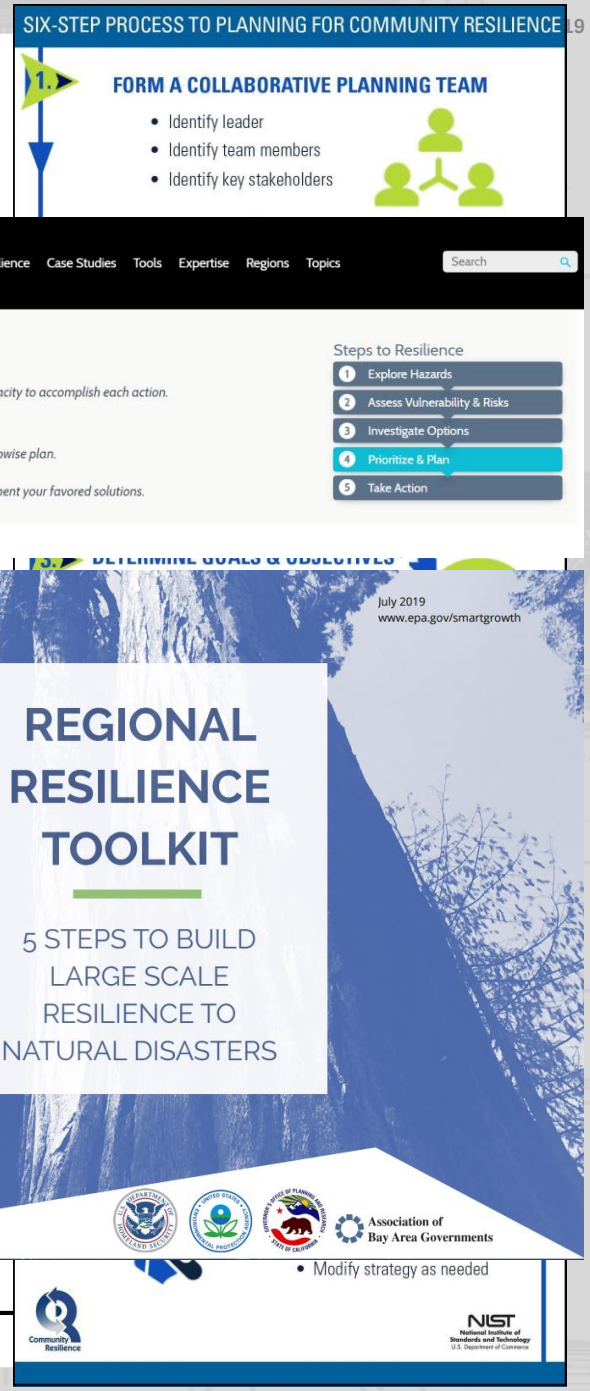
Assessment Method Selection - Tiered Framework



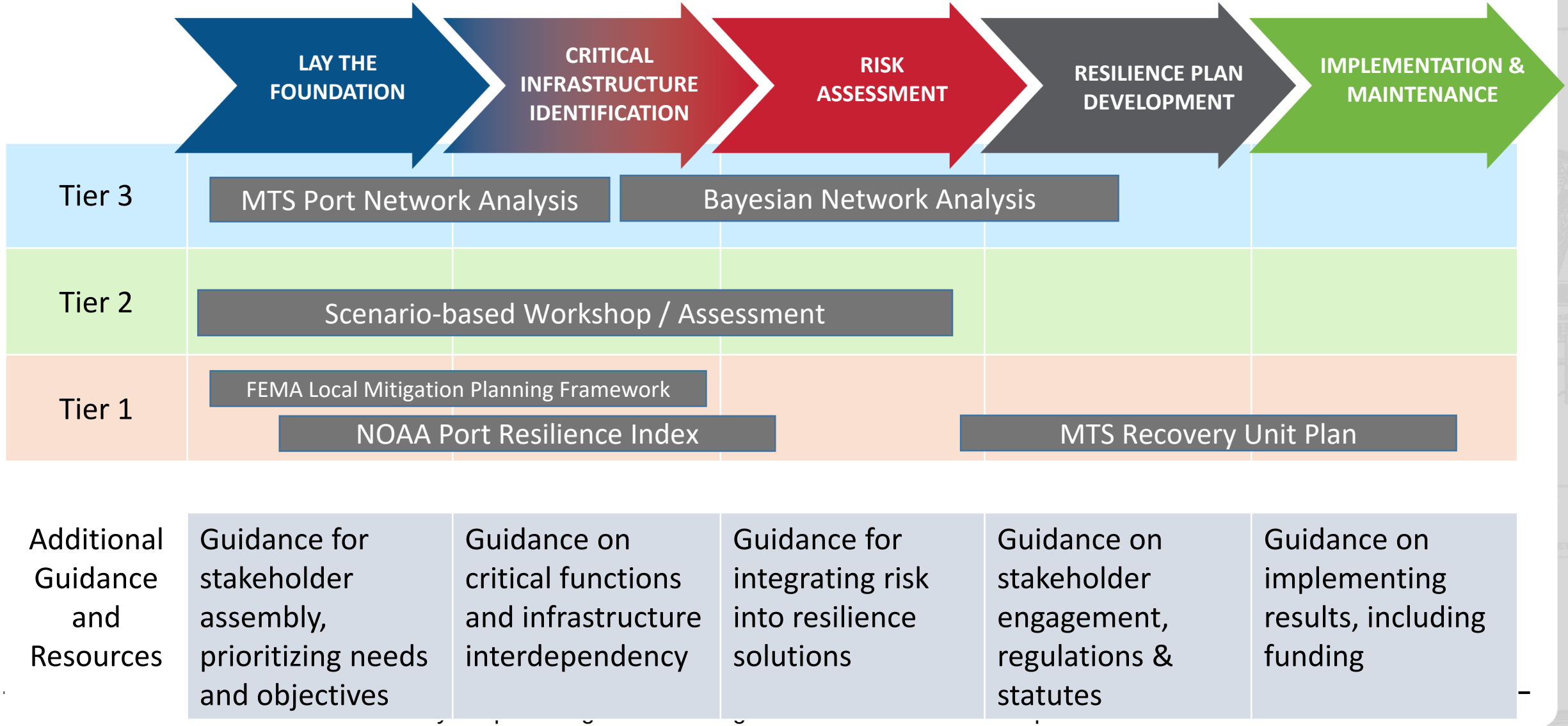
Navigation Resources	Single Port	MTS Port Network	Inland Waterway
Tier 3	- Bayesian Network Analysis (Schultz et al 2016) - Assessment and Measurement of Port Disruption (Weaver 2019)	Outstanding Need for methodologies!	- Bayesian Kernel Critical Infrastructure Analysis of L&D (Baroud 2014)
Tier 2	- Scenario-based exercise with expert elicitation (many examples)	- PORT MAPPER (Trepte and Kai 2014) - Multiple Port Vulnerability Indicators Methodology (Becker 2018) - Regional Resilience Toolkit	- Collaborative Modeling to Support Adaptive and Resilient Water Resource Governance in the Inland Northwest (King and Thorton 2016)
Tier 1	- Port Resilience Index (NOAA 2016) - MTS Recovery Plan Guidelines (USCG 2018)	- Supply chain resilience planning - Dredge Optimization Scheduler (USACE 2018)	- Improving Freight Transportation Resilience in Response to Supply Chain Disruptions (NCRFP 2019)

Essential Elements of a Resilience Framework

1) **ENGAGE – Lay the Foundation**
   - Form a collaborative team with leader, team members, key stakeholders
   - Understand the situation/system and interdependencies
2) **ASSESS – Conduct a Resilience Assessment**
   - Define goals and objectives of effort (long term performance vs expected performance)
   - Select a methodology according to the goals and system
3) **ACT – ID and Prioritize Strategies and Decisions**
   - Evaluate costs, benefits, and value of each action
   - Create a stepwise plan
4) **FUND – Fund for Action**
   - Resilience Dividend – enable better withstand and recover from disruptions AND improves normal operations by lessening chronic stressors
5) **MEASURE – Evaluate Results and Refine Methods**
   - Revisit actions to see if they are improving the system



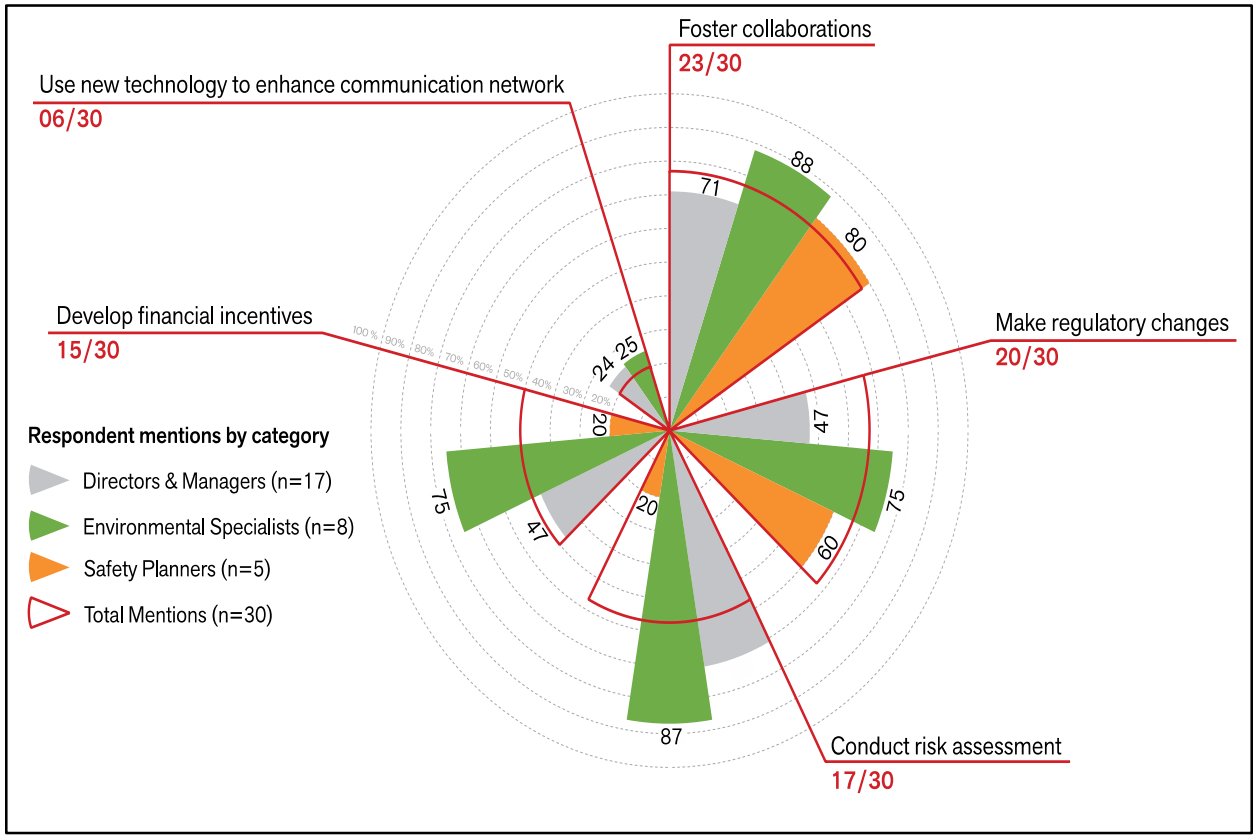
Combining Assessments and Resources with Existing Frameworks



Future Work

- Learning and data availability is enhanced through collaborations (organizations, academics, government, etc.) (McLean and Becker 2019)
- Need more understanding of adaptation (adaptive capacity) between disruptions
- “Hybrid” approaches is often cited to provide optimal benefits for the resilience of the entire system; need formal understanding
- More research is warranted to draw connections between resilience concepts and inland waterway processes (Echevarria-Doyle and Chambers 2019)

Five strategies to overcome barriers to climate and extreme weather adaptations (McLean and Becker 2019)



Questions?

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