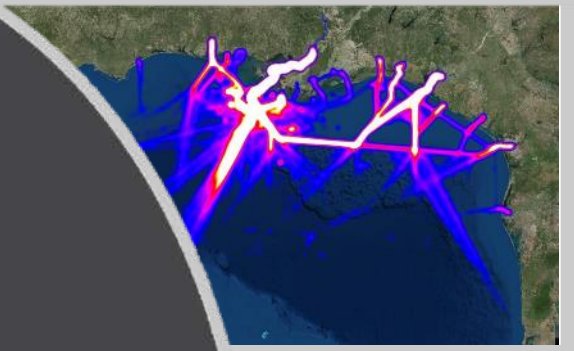
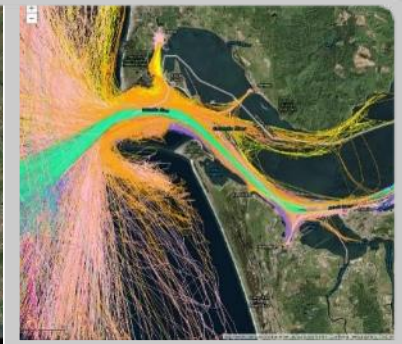
Port and Marine Transportation System Resilience Guide: using available resources for making better decisions





- USACE ERDC Lead: Katherine Chambers

Coastal and Hydraulics Laboratory/ Coastal Processes Branch

- CISA Lead: Jevon Daniel

Infrastructure Development and Recovery Branch

- Investing in Transportation Resilience: A Framework for Informed Choices Workshop. June 16-17, 2022.

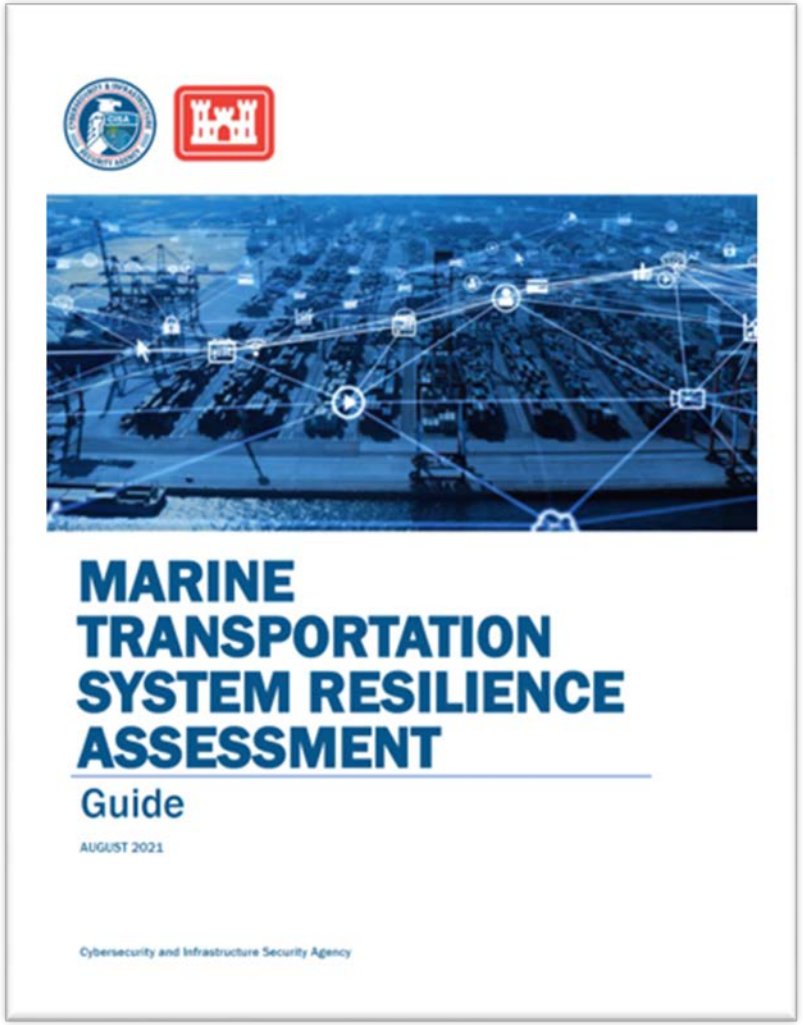
US Army Corps of Engineers

CISA CYBER+INFRASTRUCTURE

ERDC ENGINEER RESEARCH & DEVELOPMENT CENTER

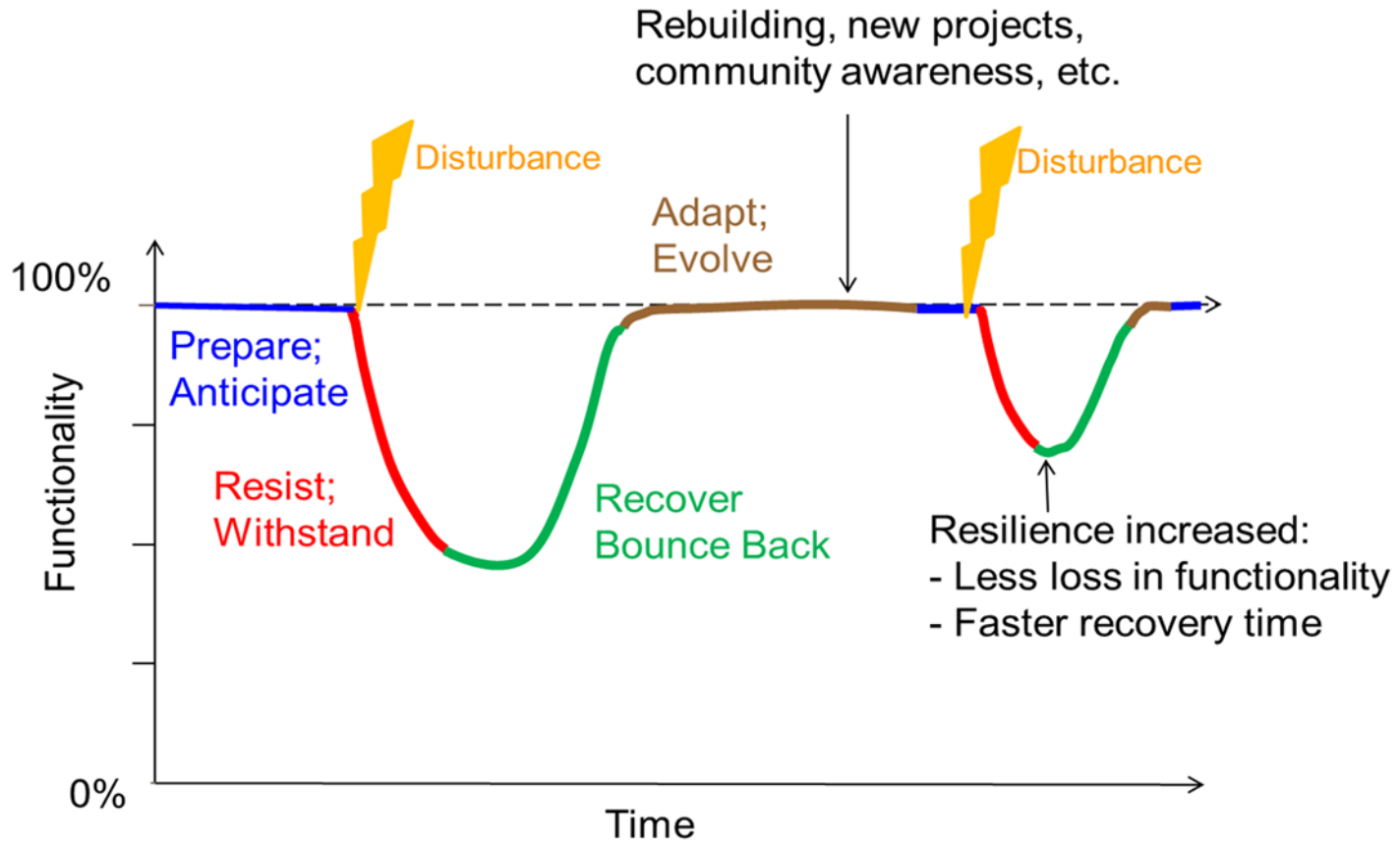
Joint Agency Marine Transportation System Resilience Guide

Status: Pre-decisional, preliminary findings. CISA/USACE are working on final MTS Resilience Guide with planned release at the end of FY22.



Functional Approach to Resilience

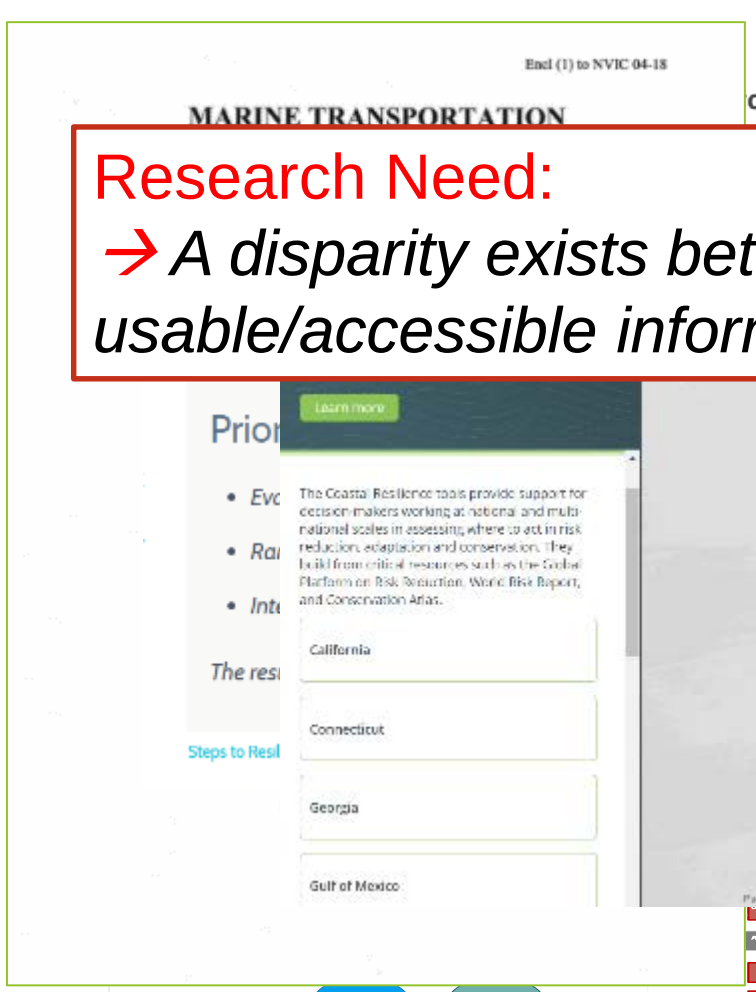
Goal: preserve the functions of a system of assets. In the case of the MTS - moving cargo and people

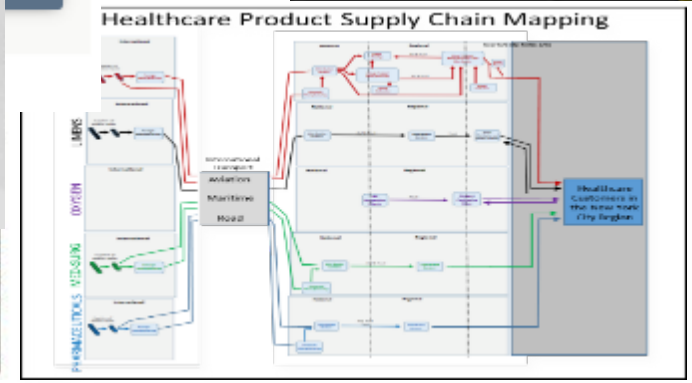


Problem: Resilience Resource Overload!

Research Need:

→ *A disparity exists between published resources on resilience and usable/accessible information for decision support and project planning.*





Assessing Interdependencies

Hazard & Impact Modeling and Simulation

Analyzing Supply Chain Risks

MTS Resilience Assessment Guide

- Outline a process for assessing resilience
- Lead users to relevant datasets, methods, and tools according to their scope, resources, and objectives

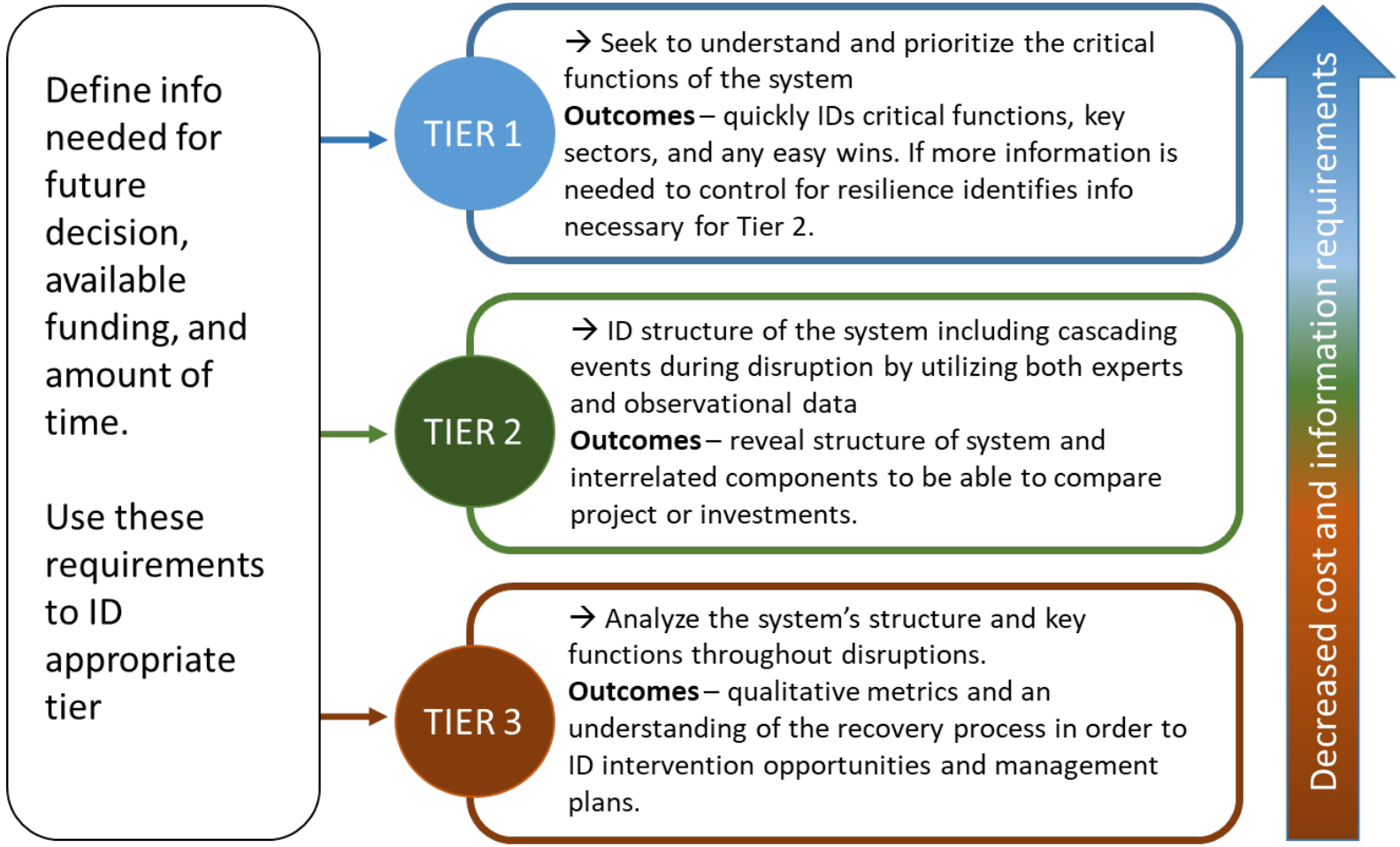
ID & Organize Assessment Methods

Compile 100+ references, methods, guidebooks, and data resources.

Recommend and organize according to scope, level of effort and resilience assessment objectives

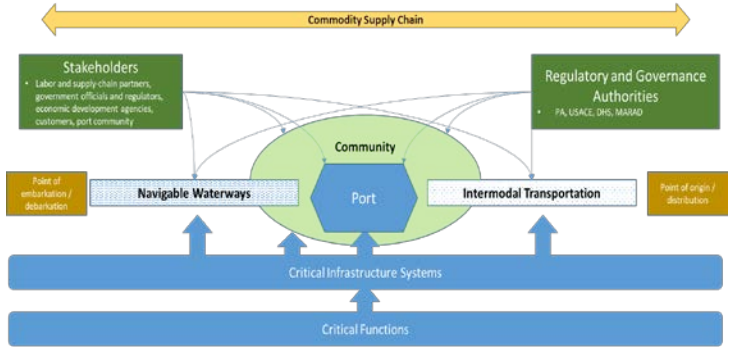
Resource Name	Scope	Tier	Resource Type	Information Available	Tool Review	Developers and Partners
ADCIRC Model	All scopes	3	Generic Model	Nationwide	useful	UNC
ADCIRC-Surge Guidance System (ASGS)	All scopes	3	Tool	Nationwide	useful	USACE
Analysis of Critical Infrastructure Dependencies and Interdependenci	All scopes	2,3	Methodology; Guidebook		Useful	Argonne National Library
AnyLogic	Single port, inland w	3	Generic Model	Worldwide	useful	AnyLogic Co.
Aquaplot	MTS network, inland	1,2,3	Tool	Worldwide	needs more inv	Private company
Assessment and Measurement of Port Disruptions Project (Gabe Wea	Single port	3	Methodology; Mod	Nationwide - tested i	ongoing	CIRI, TRANSCOM
Automatic Identification System Analysis Package (AISAP)	All scopes	1,2,3	Data Source	Nationwide	restricted acces	USACE ERDC
Automatic Identification System Data Analysis and Pre-Processor (A-D	All scopes	2	Tool	Nationwide	useful	USACE IWR
Baseline Resilience Indicators for Communities (BRIC)	All scopes	2	Data Source	Tested in SE, compare	Omit; academic	U of SC, HVRI
Bayesian Network Analysis	Single port	3	Generic Model	N/A	useful	N/A
CDC Social Vulnerability Index (SVI)	All scopes	2	Data Source	Nationwide - U.S. cen	useful	CDC
Channel Portfolio Tool (CPT)	All scopes	1,2,3	Data Source	Nationwide	restricted acces	USACE ERDC
Climate Hydrology Assessment Tool	Inland	2,3	Tool	Nationwide	useful	USACE
Coastal Adaptation to Sea Level Rise Tool (COAST)	Single port	2	Generic Model	Nationwide	useful	Blue Marble Geographics
Coastal Change Hazards Portal	Single port, MTS netw	2	Tool	Coastal contiguous U	useful	USGS
Coastal Emergency Risks Asessment (CERA)	All scopes	2,3	Tool	Nationwide	useful	Several universities and par
Coastal Hazards System (CHS)	All scopes	2,3	Data Source; Tool	Northeast and Gulf	useful	ERDC ERDC
Coastal Resilience Mapping Portal	Single port, MTS netw	1,2	Tool	Select locations in th	useful	The Nature Conservancy
Common Access and Reporting Tool (CART)	All scopes	1,2,3	Other	Nationwide	restricted acces	USCG
Community Resilience Economic Decision Guide for Buildings and Inf	Single port	2	Methodology; Guid	Nationwide	useful	NIST
Community Resilience Planning Guide for Buildings and Infrastructur	Single port	1,2	Methodology; Guid	Nationwide	useful	NIST
Corps Shoaling Analysis Tool (CSAT)	All scopes	2,3	Tool	Nationwide	useful	USACE ERDC
COTP Zone Area MTS Recovery Plan Guidelines	Single port	2,3	Tool; Guidebook	Nationwide	useful	USCG
Cyber Resilience Reviews (CRRs)	Single port	2,3	Tool; Guidebook	N/A	useful	DHS
Cyber-physical Disruption, Mitigation, and Response Catalog (Gabe W	All scopes	1	Tool	N/A	ongoing	CIRI
DoD Regionalized Sea Level Change & Extreme Water Level Scenario	All scopes	2,3	Data Source	Worldwide DoD	useful	DoD SERDP-ESTCP
DHS Resilience Baseline Assessment Tool (Version 2.4)	All scopes	1,2,3	Methodology	N/A	restricted acces	DHS
Disaster Recovery Tracking Tool	Single port	2	Tool	Nationwide	useful	University of Texas A&M, Sup
e-Hydro (USACE Hydrographic Surveys)	All scopes	2	Data Source	Nationwide	useful	USACE
Earthquake Hazards	All scopes	1	Data Source	Nationwide	useful	USGS
Economic Decision Guide Software (EDGeS)	Single port	2,3	Tool	Nationwide	useful	NIST
Economic Framework for Coastal Community Infrastructure	Single port	2,3	Guidebook	N/A	useful	Eastern Research Group, Inc.
Economics: National Ocean Watch (ENOW)	MTS network	2	Data Source	Nationwide (coastal	useful	NOAA - OCM
Environmental Response Management Application (ERMA)	Single port	2	Tool	Nationwide	useful	NOAA with University of New
Federal Funding Handbook for Marine Transportation System Infrastr	All scopes	1,2,3	Data Source	Nationwide	useful	CMTS
FEMA Flood Mapping Products	All scopes	1,2,3	Data Source	Nationwide	useful	FEMA
FEMA Supply Chain Resilience Guide	MTS network	1	Guidebook	Nationwide	useful	FEMA
FigureGen	All scopes	2,3	Tool	Nationwide	useful	NCSU

Assessment Tiers (Level of Effort)

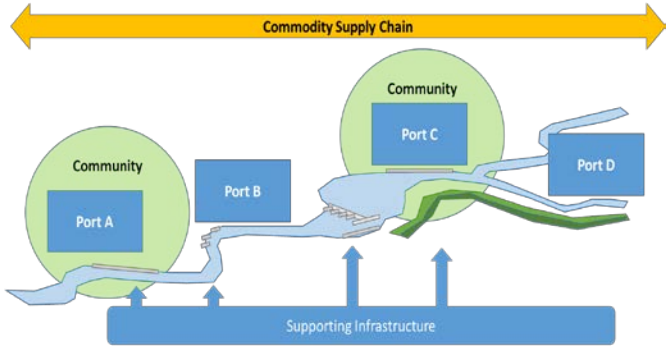


Assessment Scopes

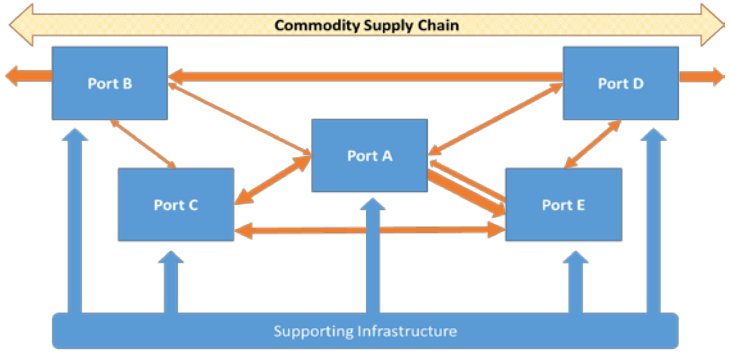
Single Port



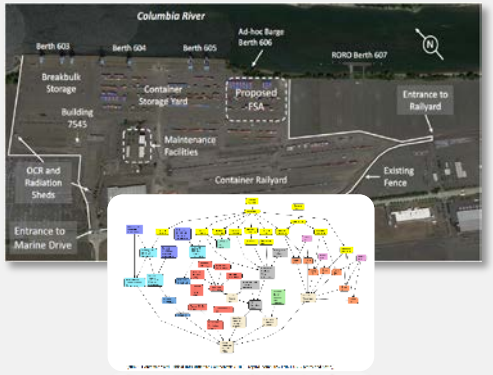
Inland Waterway



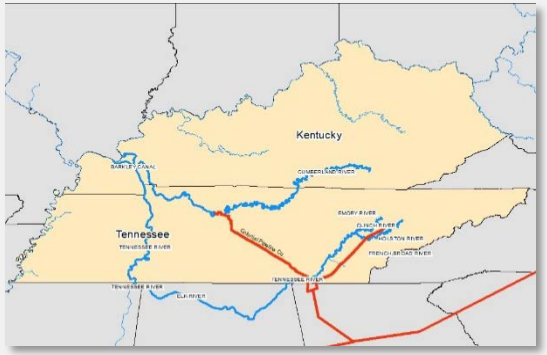
MTS Network



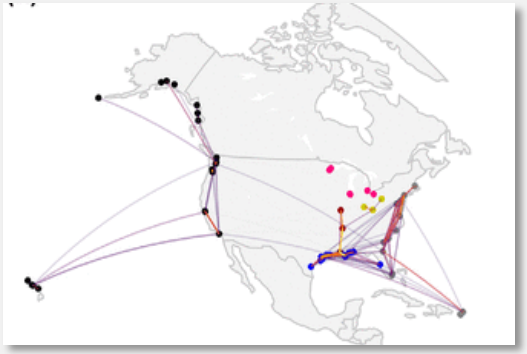
Port of Portland



TN/Cumberland Rivers



Caribbean Supply Chain



Foundational Resilience Assessment Objectives

1. Define functions & characterize the system in steady state

2. Analyze critical infrastructure & dependencies

3. Understand the impacts of disruptive events

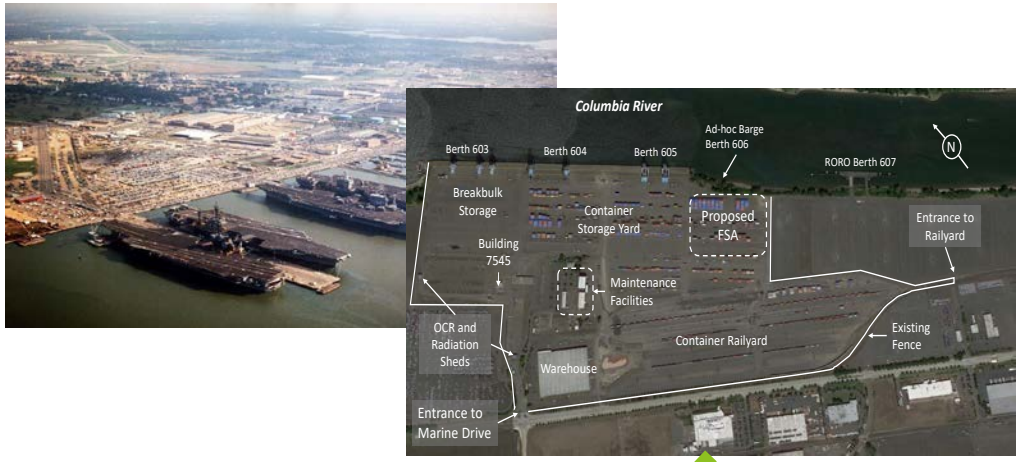
4. ID & evaluate resilience enhancement alternatives

Seismic Resilience Assessment at a Navigation Terminal

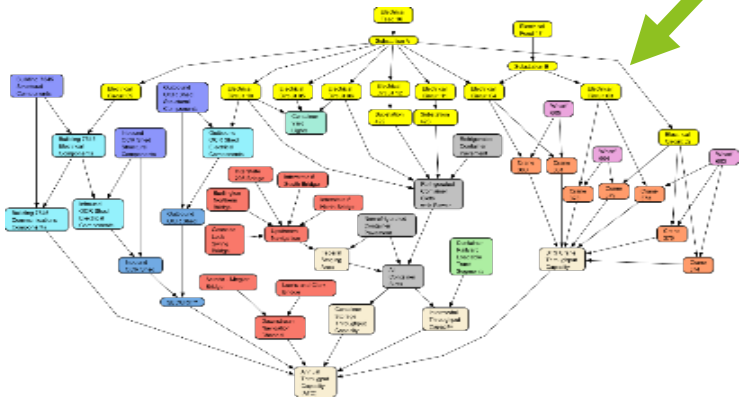
Lead: Dr. Martin Schultz, ERDC EL

Goal: to identify the best alternatives strengthen the resilience Port of Portland's Terminal 6 for cargo throughput & a FEMA staging area after a seismic event.

1. **Define functions & characterize system**
   - GIS model infrastructure inventory
   - Performance metric - Annual Throughput Capacity (ATC)



2. **Analyze critical infrastructure and dependencies**
   - Model ATC as a function of critical infrastructure component availability (e.g. electrical, buildings, channels, wharfs, cranes, rail lines).



3. Understand impacts of disruptive events

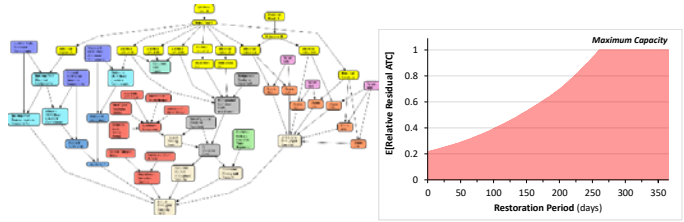
- USGS Seismic Hazard Mapping Website, ODGMI Interpretive Map Series
- FEMA HAZUS MH 2.1 Earthquake Model– damage states, fragility curves, rest. funct. of CIC

4. Develop and evaluate alternatives

- Recovery trajectories are calculated based on resilience strengthening alternatives versus status quo.

Probabilistic Seismic Hazards Analysis

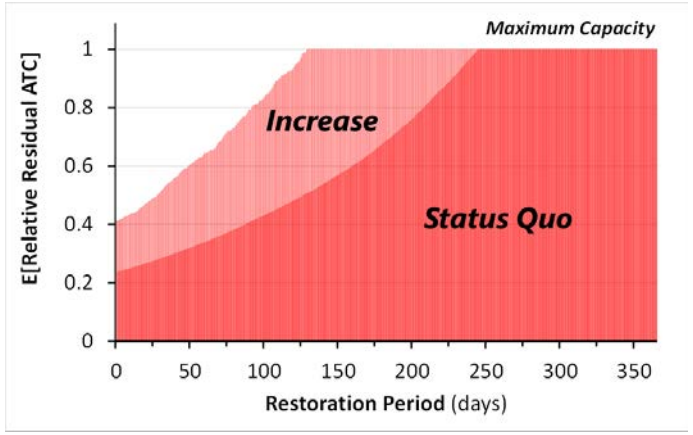
Model ATC as a function of component availability, define status quo resilience through many recovery trajectories (Monte Carlo simulation)



Define desired alternatives

#	Function
1	SECURITY (SEC)
2	COMMUNICATION (COMM)
3	ELECTRICAL (ELEC)
4	BERTH 603 (B603)
5	NAVIGATION (NAV)

Recovery trajectory of "status quo" versus alternative & combo

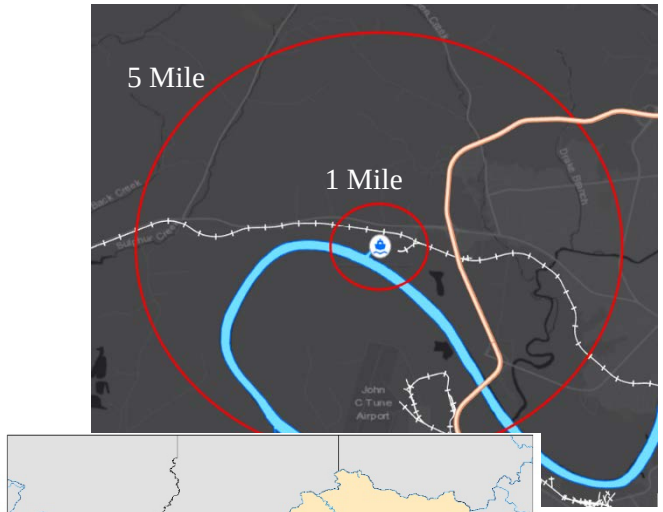


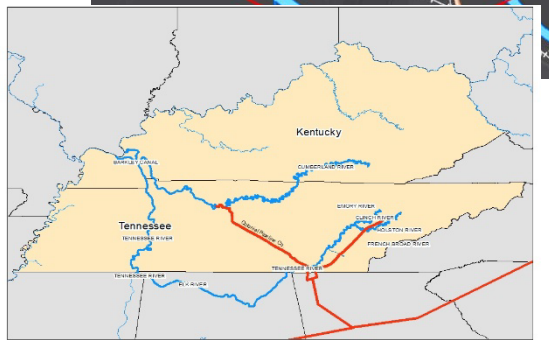
Inland Waterway

Leads: Drs. Janey Camp and Craig Phillip, Vanderbilt University

Goal: to understand the role of the inland waterway and interacting intermodal transportation systems in improving the supply chain resilience of petroleum products

1. **Define functions & characterize system**
   - Geolocate and characterize ports key attributes (e.g. historical commodities LPMS, intermodal connectivity metric, location)
   - Define with stakeholder groups
2. **Analyze critical infrastructure and dependencies**
   - Intermodal dynamics (e.g. colonial pipeline and refined product terminals)



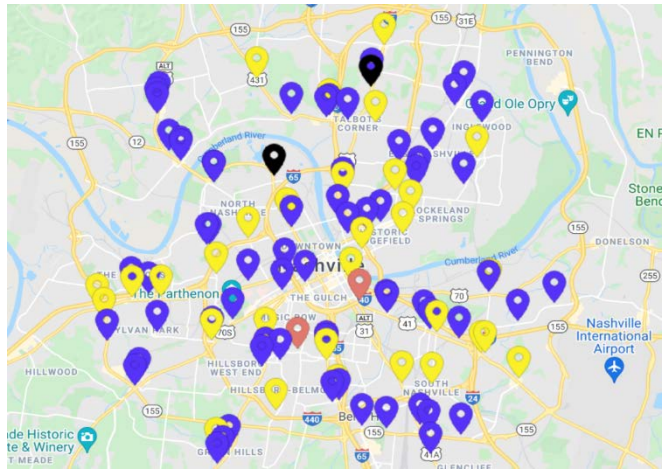


- Proximity to rail and road metric (ArcGIS)
- USACE Lock Monitoring Performance System Data

- Validated by 40 stakeholders, 2 workshops

3. Understand impacts of disruptive events

- Stakeholders select and discuss the impacts of 3 disruptive events
  - Colonial Pipeline interruption (2021 ransomware attack)
  - Lock Maintenance Outage
  - New Madrid Fault Event



Has Fuel & Power Has No Power Limited Fuel Options Has No Fuel

- Impacts, concerns, response, and preparations for all 3 scenarios.
- LPMS fuel volumes
- Gas outages via GasBuddy
- New Madrid liquefaction zones

4. Develop and evaluate alternatives

- Stakeholders build on related Resilience Enhancement Options gathered from CISA Regional Resilience Assessment Program

Expand Chattanooga and Knoxville terminals to accept fuel barges

Increase Traffic on Tombigbee River

Update Building Codes

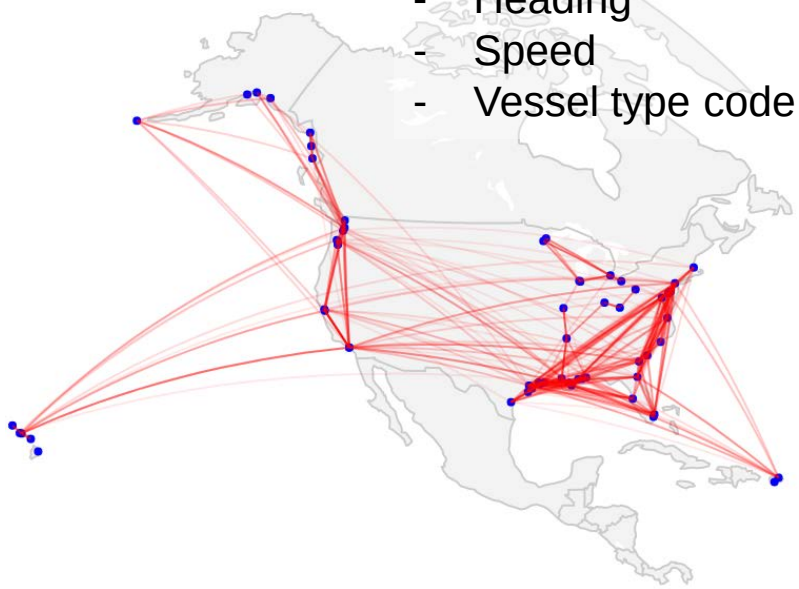
Caribbean MTS Network Analysis

Lead: Dr. David Young, CHL

Goal: to understand the port network structure and identify clusters of related ports to understand their role and potential redundancies in responding to disruptions.

1. **Define functions & characterize system**
   - Detailed nationwide AIS data: 325 North American Ports, 2015-2020
   - Map vessel traffic across US – trip chains, ship type, count, size, dwell time
2. **Analyze critical infrastructure and dependencies**
   - Map US maritime commerce network
     - Detect communities
     - Quantify port importance to network traffic flow
     - Examine regions

Automatic Identification System Data
- Position
- Course over ground
- Heading
- Speed
- Vessel type code

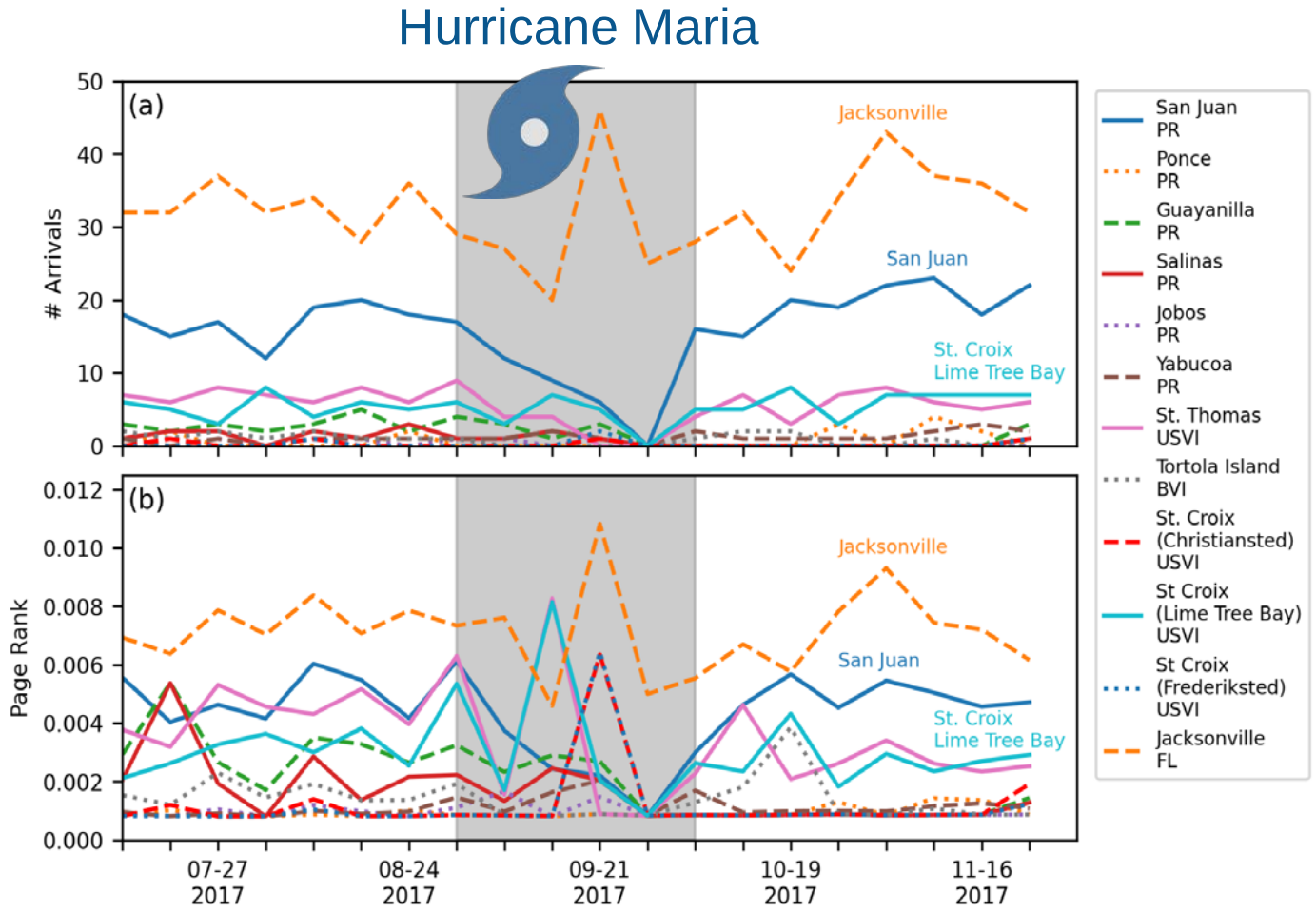


3. Understand impacts of disruptive events

- Quantify disruptions with port criticality metric

4. Develop and evaluate alternatives

- Compare port criticality metrics with total tonnage metrics to balance preventative maintenance and resilience.



Conclusions

- Stakeholders are key in validating results – much greater benefit than data alone
- Success is based on on existing databases of hazard impacts – nationwide is preferable, even better if level of detail is customizable
  - e.g. HAZUS MH Earthquake Model, New Madrid study by Tuttle et al. 2002, MarineCadastre AIS database
- Data on dependencies is important, however historical hazard impacts are often not recorded or available for analysis and it's hard to ID responsible party for "intermodal data"
- Resilience alternatives may be additive or detractive, consider multiple!
- A function metric is necessary to assess resilience & alternatives
  - e.g. Annual Throughput Capacity, LPMS tonnage/commodity type movement, net vessel count, port criticality metric

Questions?

Port Resilience Assessment Co-Leads

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