Understanding Marine Transportation System Resilience – An Overview of Activities from the 2017 Hurricane Season

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Presentation Overview

• Report - The 2017 Hurricane Season: Recommendations for a Resilient Path Forward for the Marine Transportation System
• 2017 Hurricane Season Data Gathering
• Port Resilience Assessment and Decision Guide
Resilience Over Time

- Prepare; Anticipate
- Resist; Withstand
- Recover; Bounce Back
- Adapt; Evolve
- Rebuilding, new projects, community awareness, etc.

- Resilience increased:
  - Less loss in functionality
  - Faster recovery time
Through data and experts elicitation, we can gather information on how the MTS was able to Resist and Recover to inform future Adaptation and Preparation.

- Key actions or decisions
- Datasets to aid critical actions and decisions
- Interdependencies with non-feds
- Best practices
- Opportunities to increase resilience
Katherine Chambers (ERDC-CHL) presents hurricane analysis results to the U.S. Committee on the Marine Transportation System Coordinating Board.

- R-IAT requested by the Coordinating Board to ID lessons learned from 2017 hurricane season
- 12 member agencies
- 1 workshop with 35 workshop attendees
- Team co-lead by USACE-ERDC and NOAA
2017 Hurricane Season

- 17 named storms
- 7 U.S. landfalling storms
  - 3 major hurricanes: Harvey, Irma, Maria
- 25.8 million people affected
- 4.6 million registered for federal assistance with FEMA
- Weather events in 2017 amounted to $306.2 billion in cumulative costs which included hurricanes Harvey ($125B), Irma ($50B), and Maria ($90B)*

IMPACTED PORTS ACROSS TX, FL, PR, and VI

- Hurricane Harvey landfall: August 26
- Hurricane Irma landfall: September 10
- Hurricane Maria landfall: September 20

Port Count

- YANKEE
- WHISKEY
- X-RAY
- ZULU
Gulf Region

Hurricane Harvey Cargo and Tanker Vessel Signal Density Plots

Created with ERDC Automatic Identification System Analysis Package (AISAP)

August 1, 2017
Tropical Storm Harvey will be named August 16

August 24, 2017
USCG declares Port of Houston under condition Yankee

August 25, 2017
USCG declares Port of Houston under condition ZULU

August 26, 2017
Hurricane Harvey makes landfall at Rockport & becomes a tropical storm over inland Texas

August 28, 2017
Harvey recedes towards the Gulf, record rainfall recorded at 51.88 in

September 4, 2017
Vessels queue at anchorage areas. Port reopens with restrictions September 6th.

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

• **Challenges**
  • Flooding caused indirect impacts to supporting infrastructure
  • Lack of knowledge management and collaborative tools regarding port condition or status
  • Redundant information requests

• **Successes**
  • Early communication
  • Centralized information distribution
  • Pre-prioritized resource placement
  • Execution of drills and training
  • Early closure of energy facilities
  • Efficient restoration of ATONS following storm
  • Cross agency communication
  • Engagement with public sector for resource needs
  • Delegation of FEMA mission assignments
Hurricane Irma

• Challenges
  • Power outages
  • Debris removal between storms
  • Resource allocation between commerce, tourism, & EM
  • Equipment pre-positioning in FL
  • Availability of resources and funds

• Successes
  • Early communication on critical ports and supporting infrastructure
  • Critical Aids to Navigation identified in advance
  • Updated coastal imagery for fast surveys
  • Transportation and accommodation arrangements
  • Mobile integrated Survey Team kits when operating vessels of opportunity
  • Repurposing vessels directed to Texas
  • Coordination with local business advisory councils and initiatives
Hurricane Maria

• Challenges
  • Lack of space for shipping & seaport operations
  • Lack of supporting infrastructure (road, electric, water)
  • First responder challenges
  • Negative press
  • Balancing emergency supply with commercial supply

• Successes
  • First responders with Spanish language skills
  • Interagency collaboration and sharing of information
  • AIS-ATON utilized to help facilitate re-opening of San Juan by rapidly triaging ATONS in the field
Summary: Best Practices for MTS Response and Recovery

• Hurricane Season Kickoff Meeting
• Full Scale Hurricane Exercise
• Clear lines of communication
• Interagency efforts for navigation channel reopening
• Pre and post-storm port assessments
• ATON verification and resiliency
Summary: Opportunities to Enhance Response and Recovery

- Need for tools & protocols for prioritization at the regional or national level
- Pre-staging of survey teams & equipment
- Evaluating Port Status vs. Channel Status
- How to aid port employees returning to work
Data Analysis of Hurricane Impacts

• Automatic Identification System (AIS) Data can be used to understand more than just heatmaps!
• Captures recovery via observational data
• Can provide insights into MTS performance via the function of commodity movement on waterways
Single Port System

Maritime Transportation System

Commodity Supply Chain

Community

Port

Navigable Waterways

Intermodal Transportation

Supporting Infrastructure

Point of embarkation / debarkation

Point of origin / distribution

I.e., another port!

Asset/Component of System
Houston-Galveston Port Area - Cargo and Tanker Net Vessel Counts

ZULU 37' 40' Restrictions until 11/30

Houston-Galveston Port Cargo Tanker NVC
Houston-Galveston Anchorages - Cargo and Tanker NVC
Houston-Galveston Port PCP
Houston-Galveston Anchorage PCP
Linear (Houston-Galveston Port Cargo Tanker NVC)
Port of Savannah – Net Vessel Count for 2016 Hurricane Matthew

Net Vessel Count

Vessel Count

-5
0
5
10
15
20
25
30
35
40
45

9/15/2016 0:00
9/25/2016 0:00
10/5/2016 0:00
10/15/2016 0:00
10/25/2016 0:00
11/4/2016 0:00
11/14/2016 0:00

Net Vessel Count for 2016 Hurricane Matthew

Closed – 5 days
Post Storm Normal – 10 days

Port of Savannah - Net Vessel Count for 2017 Hurricane Irma

Net Vessel Count

Vessel Count

-5
0
5
10
15
20
25
30
35
40

2017-08-15
2017-08-25
2017-09-04
2017-09-14
2017-09-24
2017-10-04
2017-10-14

Net Vessel Count

Closed – 2 days
Post Storm Normal – 8 days

2017 Bayesian changepoint analysis
2 per. Mov. Avg. (Net Vessel Count)
Monthly Vessel Type Counts – Port of Ponce
1 Jan 2015 - 1 Jul 2018

Vessel Counts

- Cargo
- Fishing
- Passenger
- Port Tender
- Sailing
- Tanker
- Towing
- Tug

Hurricane Maria Makes Impact Data unreliable 20 Sept - 1 February

HSOAC 2018
Resilience for Port Stakeholders

**Where do we start** with understanding MTS resilience?

**What information best facilitates decisions** about resilience improvements?

How do we analyze critical infrastructure dependencies and cascading failures?

How do we benchmark progress?

How can this information best be disseminated to stakeholders?
Port Resilience Assessment and Decision Guide

Increasing cost and information

**TIER 3**

- Analyze the system’s key functions and structure throughout disruptions and drops in function.
- **Outcomes** – qualitative metrics and understanding of the recovery process in order to ID intervention opportunities and management plans.

**TIER 2**

- ID structure of the system including cascading events during disruption by utilizing both experts and observational data.
- **Outcomes** – reveal structure of system and interrelated components to be able to compare project or investments.

**TIER 1**

- Seek to understand and prioritize the critical functions of the system.
- **Outcomes** – quickly IDs critical functions, key sectors, and any easy wins. If more information is needed to control for resilience, ID’s necessary for Tier 2.

Proceed through tiers until there is adequate information for decision making.
<table>
<thead>
<tr>
<th>Tool Example</th>
<th>Single Port</th>
<th>MTS Supply Chain</th>
<th>Inland Waterway</th>
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| **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) | - 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) |
Questions?


Or contact -

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Federal Actions to Minimize Disruption and Enhance Resilience

Findings were identified by applying the Resilience Framework and separated into categories:

• Preparation actions
• Response and recovery actions
• Adaptation actions
PREPARATION ACTIONS

A Annual Exercises, Training, Drills
B Pre-stage recovery assets
C Proactive Port Assessments
D Pre-establish a contracting mechanism for response
E Promote proactive maintenance
F Consider long term plan for recovery
G Engage with FEMA in advance
H Promote mutual aid agreements
I Promote continuity of management
J Prioritize critical infrastructure
K Establish Port Advisory Teams
L Establish Surge Force w/ private industry
M Maintain facilities that supply redundancy
N Multi-agency GIS-based data viewer
O Establish Regional Port Advisory Teams
P Predetermine response and recovery priorities

Perceived Feasibility

Perceived Impact
Recommendations:

PREPARE

• **Prioritize key infrastructure systems**
• **Identify critical infrastructure interdependencies**

ABSORB/RESIST

• **Share data** across Federal agencies for recovery projects through interagency teams and data-sharing platforms

ADAPT

• Develop a **common operating picture** of the port system interdependencies and authorities and prioritizations of essential land and maritime functions
• Hold proactive **planning scenario exercises** and interagency training sessions where recommendations from the past season are communicated and incorporated
• Promote or consider new cutting-edge technologies to understand infrastructure redundancies and reduce vulnerabilities to multiple hazards and to improve port services or support in times of operational failure