Future Issues of Risk within the Marine Transportation System

Dr. Ty V. Wamsley, PhD, SES

Director, Coastal and Hydraulics Laboratory
U.S. Army Engineer Research and Development Center

November 2019
USACE: Cross-Mission Value to the Nation

- Commercial waterways convey 98% of U.S. Imports & exports
- 10,000+ acres wetlands restored/year
- #1 Provider of outdoor recreation, contributing $16B to local economies
- 25% of U.S. hydropower capacity, 3% of total electricity

3% of Nation’s Electricity: $800 M+ in sales

Stewardship of 11.7 M Acres Public Lands

926 Harbors

Environmental Restoration

~11,750 miles of Levees

12,000 miles of Commercial Inland Waterways

68,800 Regulatory Permit Actions

400 miles of Shoreline Protection

370 M visitors/yr

Recreation Areas

Emergency Responses

3% of Nation’s Electricity: $800 M+ in sales

Environmental Restoration

~11,750 miles of Levees

12,000 miles of Commercial Inland Waterways

400 miles of Shoreline Protection

370 M visitors/yr

Recreation Areas

Emergency Responses

68,800 Regulatory Permit Actions
USACE: Water Resource Challenges

R&D is Key to Addressing Challenges

Need integrated, cross-mission solutions that quantify present & future impacts, benefits
**Engineer Research & Development Center**

**ERDC Vision:** To be a World Class Research & Development Organization that Discovers, Develops & Delivers New Ways to Make the World Safer and Better Every Day

![Map of Field Offices and Laboratories](image)

- **Civil Works R&D**
  - Navigation
  - Flood & Coastal Risk Management
  - Environment

- **2,150 Strong**
- **60% E&S**
- **66% E&S Advanced Degrees**
- **31% PhD**
Navigation Risk - Continuum

• Measuring
  • Identifying types of risk, locations, behaviors, and areas for further study. Quantitative methods exist for certain types of navigational risk.

• Monitoring
  • Establishing systems to reliably monitor and provide situation reports at the necessary time scale.

• Managing
  • Intelligently combining monitoring data with historically-informed situational understanding to minimize risk when possible.

• Anticipating
  • Forward-looking and worst-case scenario exploration to inform planning, practice, and investment.
Measuring Maritime Risk: Historical

- Traditional approaches to maritime risk assessment are subjective and qualitative.
- Quantitative assessments of risk are needed to identify priorities and justify investment.
- Ship domain violations (SDV) can be quantified using Automatic Identification System (AIS) data from the USCG Nationwide AIS archive.
- Ship’s domain is a pre-defined perimeter area around the actual ship itself, user-defined

Ship domain violations occur when two domains overlap – no fault is implied.

![Diagram showing ship domains and domain violations](image-url)
Risk Assessment: Historical → Future

- A year of AIS data was used to locate SDVs and calculate a risk metric: **Probability that a vessel operating in a reach will be involved in an SDV.**
- Compare and rank channel reaches based on the probability of an SDV.
- In Charleston Harbor, a vessel transiting in a **RED** reach is about 10 times more likely to be involved in an SDV than a vessel transiting in a **GREEN** reach.

**AIS records**

Identify risk ‘hot spots’
Monitoring Risk in Real-Time: multiple factors

Challenges:
- Data Availability and suitability for analytics
- Processing capability
- How to communicate risk

Overall risk “heat map”

- Vessel density
- Shoal water
- High currents
- Low visibility
Monitor+Manage: Communicating and Anticipating Risk in Real-Time

“Virtual” AtoN mark new channel
Managing Maritime Risk – Making Improvements Over Time → Resilience

Functionality

Time

- **Black**: Built or natural recovery to previous state
- **Red**: Small impacts inhibit function through time
- **Blue**: Large impact; new equilibrium state
- **Green**: Improved performance; resilient

Expected loss in function over time

As-New Performance

- *Wave reduction*
- *Long Beach Breakwater*
- *Nuisance flooding*
- *Naval Station Norfolk*
- *Port of Gulfport*
- *Hurricane Katrina*
Resilience Metrics and Indices: Matthew (2016)

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

Port of Savannah – 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

- Closed – 2 days
- Post Storm Normal – 8 days
US Marine Transportation System

- MTS and national freight network are both characterized by a relative handful of dominant cargo arteries and traffic chokepoints.
- Prolonged disruptions at these key locations could dramatically impact overall system response.
Anticipating Risk: Golden Ray Capsizing

8 Sep 2019

Source: Savannah Morning News

- Pilot’s decision to guide vessel out of channel credited with keeping the Port of Brunswick open during months-long salvage operation.
- Among U.S. coastal ports, Brunswick ranks 67th overall for tonnage, but is the 8th largest port for vehicle (roll-on/roll-off) cargo.
- Bad situation, but could have been so much worse...
Anticipating Risk: What if capsizing happened in Houston’s Navigation Channel?

- Houston is largest U.S. coastal port for exports, close second for imports and total tonnage.
- Houston Ship Channel is only about 600-ft wide
- GOLDEN RAY length = 656-ft

GOLDEN RAY, actual size

Houston is largest U.S. coastal port for exports, close second for imports and total tonnage.

Houston Ship Channel is only about 600-ft wide

GOLDEN RAY length = 656-ft

GOLDEN RAY, actual size
Future: Improve First-Responder Coordination to High-Impact Maritime Events

- Utilize coupled multiple ship simulators
- Evaluate multi-vessel natural disaster & terrorism threats
- Apply to high-use MTS bottlenecks and choke-points
- Build best practice protocols for multi-agency response