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Institutionalizing Resilience: Insights from Assessment Initiatives at 10 U.S. Seaports

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ERDC

Homeland Security Challenge

Climate change presents complex problems for maritime infrastructure

Complex interdependencies between seaport infrastructure management and jurisdictional boundaries make resilience planning difficult.[1, 2] Seaports are:

- Critical: Seaborne trade volume = 11.1 billion tons in 2019[3]
- Constrained: functionally restricted to hazardous coastal environments[1]
- Exposed: to impacts from today's weather extremes & tomorrow's climatic changes[1]

Academics & practitioners advocate resilience assessments

Resilience assessment has been proposed as a new approach to complex systems management in the face of evolving risk and uncertainty associated with climate change[4]. Yet, there are thus far no best practices for undertaking resilience assessments and implementing the resilience-building actions they prescribe. As a contribution to the DHS/USACE *Resilience Assessment Guidebook for Ports & the Maritime Transportation System*[5], this study evaluates resilience assessments by:

1. Identifying **resilience enhancement strategies (RESs)** that seaports implement
2. Elucidating **key benefits & challenges** of resilience assessments for decision makers;
3. Analyzing resilience assessment impacts on **seaport adaptive capacity**

Methodology

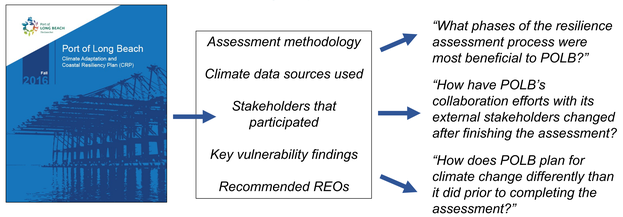
1) Case study selection

10 seaport resilience assessment case studies and three different resilience assessment approaches:

- Contractor Assessment: Consulting firm leads the assessment (*higher cost, more involved*)
- Hazard Mitigation Plan: Seaport develops plan under FEMA to qualify for disaster relief (*cost and involvement vary*)
- Ports Resilience Index (PRI): Qualitative assessment tool[5] to identify weaknesses and strengths in operations and management related to preparedness, recovery, and adaptability (*no cost, less involved*)

2) Survey and focus group interviews

- Content analysis of resilience assessment documents from each seaport
- Online survey administered to each informant prior to interview
- Semi-structured focus group interviews with each seaport; 12 total interviews
- Two to four informants from each seaport; 26 total informants



Assessment methodology
Climate data sources used
Stakeholders that participated
Key vulnerability findings
Recommended REOs

→ *"What phases of the resilience assessment process were most beneficial to POLB?"*

→ *"How have POLB's collaboration efforts with its external stakeholders changed after finishing the assessment?*

→ *"How does POLB plan for climate change differently than it did prior to completing the assessment?"*

Figure 1. Data collection workflow

3) Data analysis

- Qualitative coding of interview data – transcripts data coded line-by-line for benefits, challenges
- Resilience enhancement strategies from resilience assessment documents counted & categorized into six typologies

Results (note: key findings outlined in red)

1) Many RESs pursued after completing a resilience assessment

- 157 strategies counted in resilience assessment documents (**Fig. 2**)
- Construction & design strategies most frequently mentioned (Nm=60) & implemented (Ni=25)

Resilience Enhancement Category (# of Mentions)	Strategy (# of Mentions)	% Implemented	% May Be Implemented	% Will Not Be Implemented	% Unsure	Assessment Influenced Implementation: Yes	Assessment Influenced Implementation: No
CONSTRUCTION AND DESIGN (60)	Reinforce structures with more weather-durable materials (16)	13	6		81		
	Improve and/or install new stormwater management infrastructure (11)	82	9		9		2
	Elevate existing structures (9)	67	11	11	11	1	1
	Construct barriers around individual structures (9)	33	11		56		
	Replace or relocate buildings/structures (5)		20	20	60	1	
	Armor structures (4)	100				2	1
	Bury critical power infrastructure under the ground (2)	50		50			
	Implement (re)development projects (2)		100				
	Modify grades of important lands (2)		100				1
EMERGENCY PREPARATION, RESPONSE, AND RECOVERY (31)	Undertake measures to enhance redundancy in power supply (11)	27	9		64		
	Reinforce/identify location for emergency storage areas to house critical assets (8)	13			88		1
	Implement measures to allow employees to access work portal/systems during critical weather conditions remotely (5)	40			60		
	Continually update emergency response plans (2)	50	50				
	Develop an emergency operations and response plan that includes education and training materials (2)	50	50				
	Build safe room shelters in Port facilities to house the Port population during disasters (1)	100					
	Develop a warning system for notifying the Port personnel and tenants of an imminent natural hazard threat (1)	100					
	Upgrade surveillance monitoring equipment (1)	100					
RESEARCH (28)	Implement/upgrade environmental conditions or damage monitoring systems to evaluate risks to Port (10)	60	20	10	10	3	1
	Investigate any necessary infrastructure maintenance/upgrades/replacements (7)				100		
	Perform a critical system vulnerability/performance study (6)	50	17		33	1	3
	Create (vulnerable) asset inventory (2)	50	50				
	Identify funding streams to support adaptation (2)	50	50			1	1
	Monitor and inventory environmental assets/quality and identify strategies to protect, enhance, and adapt to future SLR (1)	100					1
NETWORKS AND NEW WAYS OF THINKING (19)	Participate in/establish climate-change-related working groups (6)	67	17		33	1	4
	Engage with external stakeholders on climate-change-resilience-building or planning endeavors (3)	67		33			2
	Engage with internal stakeholders on climate-change-resilience-building or planning endeavors (3)	67	33			2	
	Share climate change knowledge (inundation maps, vulnerabilities, report updates, etc.) with stakeholders (2)	100					2
	Develop leadership vision and goals for the Port that are resilience-focused (1)	100				1	
	Adopt an adaptive management approach to addressing climate change vulnerabilities (1)	100					
	Educate stakeholders on risks of climate change to port (1)		100			1	
	Engage with tenants on climate-change-resilience-building or planning endeavors (1)		100				1
LONG RANGE PLANNING (10)	Incorporate climate change resilience considerations into policies/official documents (6)	67	17	17		1	2
	Update terminal leasing requirements to reference resilience assessment/incorporate climate change considerations (1)		100			1	1
	Make map of port-wide vulnerability zone based on SLR projection of concern (1)	100					1
	Monitor climate science and revisit vulnerable asset inventory periodically (1)	100					1
	Add climate change language to future Port RFP's/RFQ's (1)		100			1	1
BUILDING CODES & LAND USE REGULATIONS (8)	Incorporate resilience considerations into design and permitting guidelines (6)	50	17		33		1
	Modify electrical installation best practices to ensure power system resilience (1)	100					1
	Modify stormwater drainage design parameters to include climate change (1)		100				1

Figure 2. Heat map of mentioned resilience enhancement strategies that respondents indicated had been/will be implemented, may be implemented, and will not be implemented after completing a resilience assessment. Strategy font size corresponds with frequency of mentions.

2) Key challenges included engaging stakeholders

- Most challenges were case-specific, but four main challenges existed (**Table 1**)
- Engaging stakeholders was most widespread challenge

Table 1 – Four main challenges mentioned in 12 interviews with 26 seaport decision makers

Challenge	Example
Engaging stakeholders (different priorities, scheduling conflicts, reluctance to disclose proprietary information, etc.)	*"It was difficult to talk to people, to get them to speak back to you, and give you information. Many of the commercial stakeholders think that everything they do is proprietary information..."*
	"The other thing that was really challenging is the areas that don't have a lot of good data…you start talking about sea level rise–I'm either going to be at 19 feet elevation…or I'm going to be four feet under. So, which do you start to try to plan for?".
Addressing vulnerabilities that lacked scientifically robust data	*"[The assessment] was a challenge because we were kind of starting fresh, with a new thing…I needed something to go on, some sort of adaptation plan template…and it just simply didn't exist…"*
The lack of an archetype resilience assessment model challenged the organization of the assessment	*"…some port leaders have felt like, 'If we start showing these maps of sea level rise, is that going to deter investment into our waterfront?'…are these investment groups going to say, 'Oh my gosh, [that port] is going to be flooded!'?".*
Communicating vulnerability findings to tenants or external stakeholders could negatively impact the seaports' marketability	

Results (cont.)

3) Informants valued enhanced understanding of vulnerabilities

- 102 statements grouped into eight benefits categories (**Fig. 3**)
- Informants valued a nuanced understanding of their vulnerabilities resulting from the assessment & assessments enhanced their seaports' social capital with internal and external stakeholders

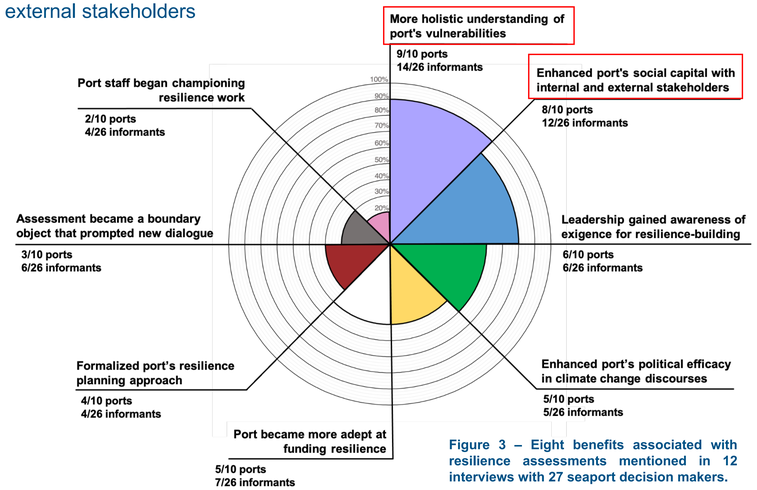


Figure 3 – Eight benefits associated with resilience assessments mentioned in 12 interviews with 27 seaport decision makers.

Conclusions

- We present a novel approach to evaluate resilience in practice through perceptions AND actual actions that come out of assessments
- Results suggest potential for resilience assessment interventions to breakdown documented institutional barriers to resilience building at seaports (and in other contexts) & build adaptive capacity (supported by findings in the literature)
- Difficult to glean insights from RES data that are supported statistically/in the literature
  - One proposition: Construction & design strategies were most frequently mentioned and implemented because infrastructure improvements will be pursued regardless of climate change → seaport has mission of facilitating trade
- This project gave me the opportunity to engage firsthand with high level decision makers on a topic of critical importance to America's future

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