

Climate change and ports: Qualitative analysis of consequences, plans, and requirements

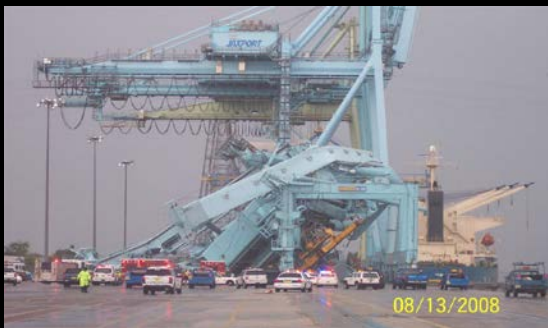


*International Conference on Adaptation of Transport Networks to Climate Change
UNECE – 25-26 June, 2012, Alexandroupolis, Greece*

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Emmett Interdisciplinary Program in Environment and Resources
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Agenda

- Brief background on ports and climate impacts
- Climate adaptation survey results
- Toward developing a lexicon –
 - Consequences
 - Strategies
- Conclusions



http://www.cargolaw.com/2008nightmare_jaxcrane.html



Photograph: Guy Reynolds/Dallas Morning News/AP

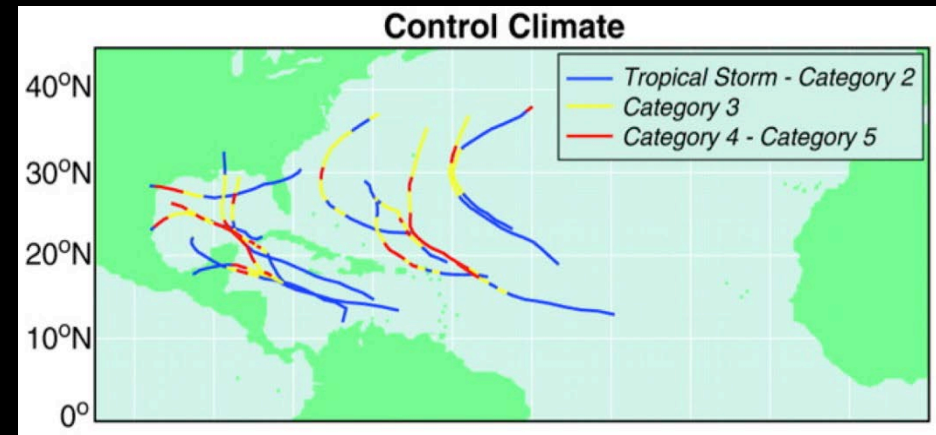
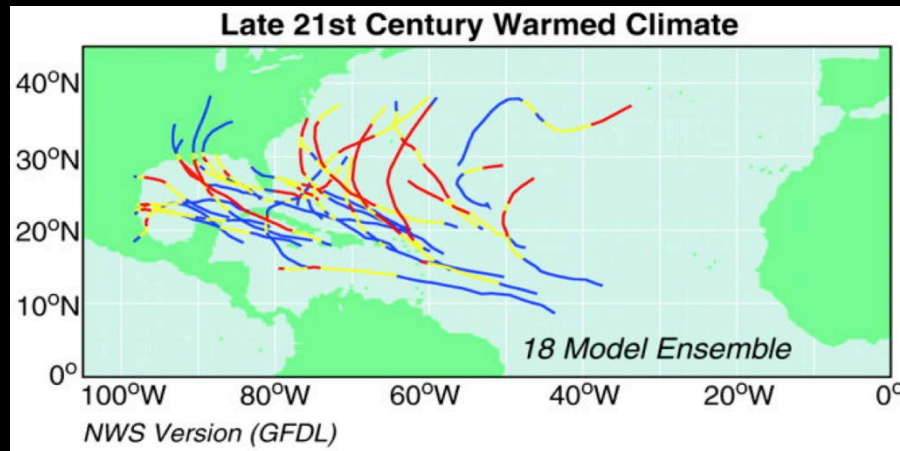


Seaport characteristics

- **Economic engines at every scale**
 - 80-90% of world freight moves by ship
 - Jobs, critical resources, facilitate trade of goods and energy
 - Profit centers for countless private firms
- **Dependent on specific locations**
 - Deep water, protective harbors, multi-modal connections
- **Highly vulnerable locations**
 - Often estuaries or river deltas that provide ecosystem services
 - Prone to flooding, storm surge, and SLR
- **Complex decision-making systems**
 - Overlapping jurisdictions, public/private nature,



Scenarios of concern to ports



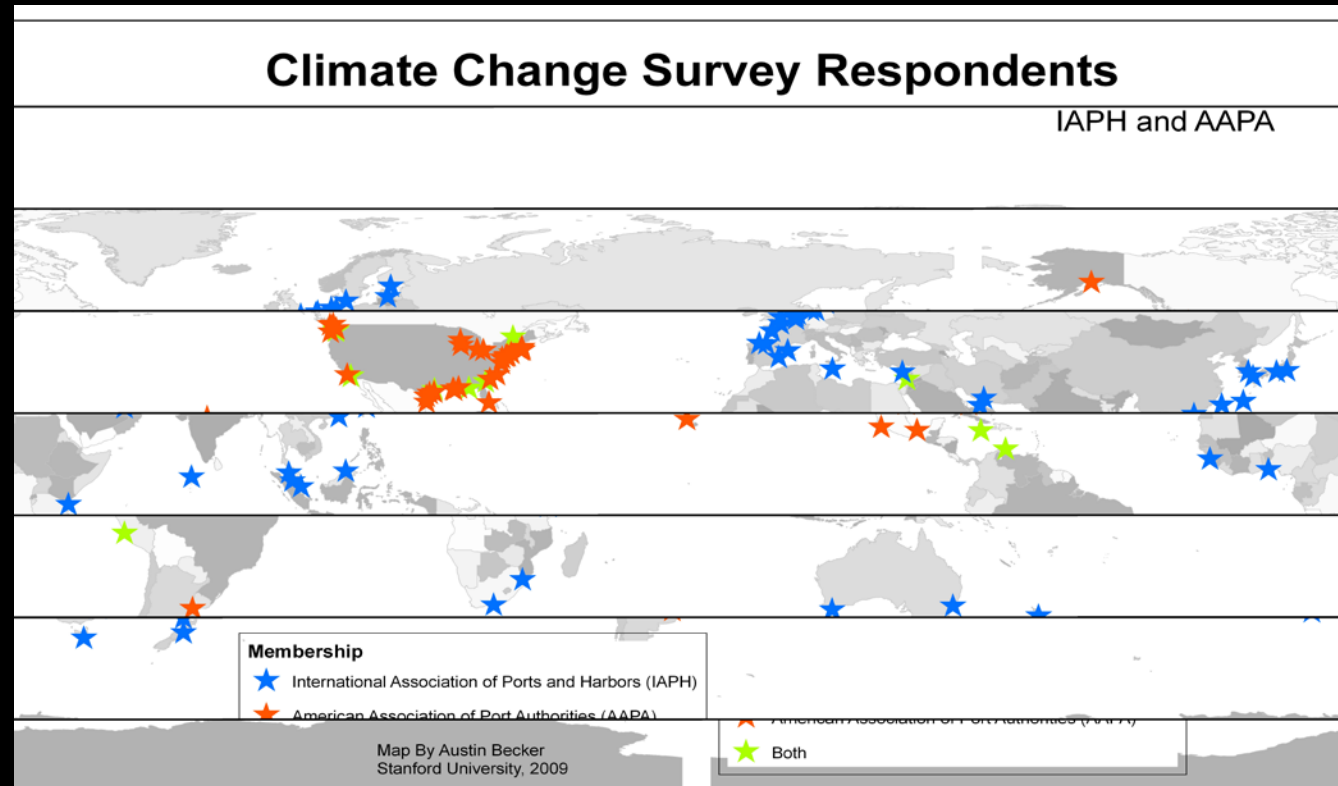
- Sea levels to rise 0.75 – 1.9 meters by 2100
+/- regional differences
- Doubling of Cat 4 and 5 tropical storms
Ocean storm tracks shifting
- Inland flooding

Today's 100-year flood = 2100's 3-year flood (NYC)?

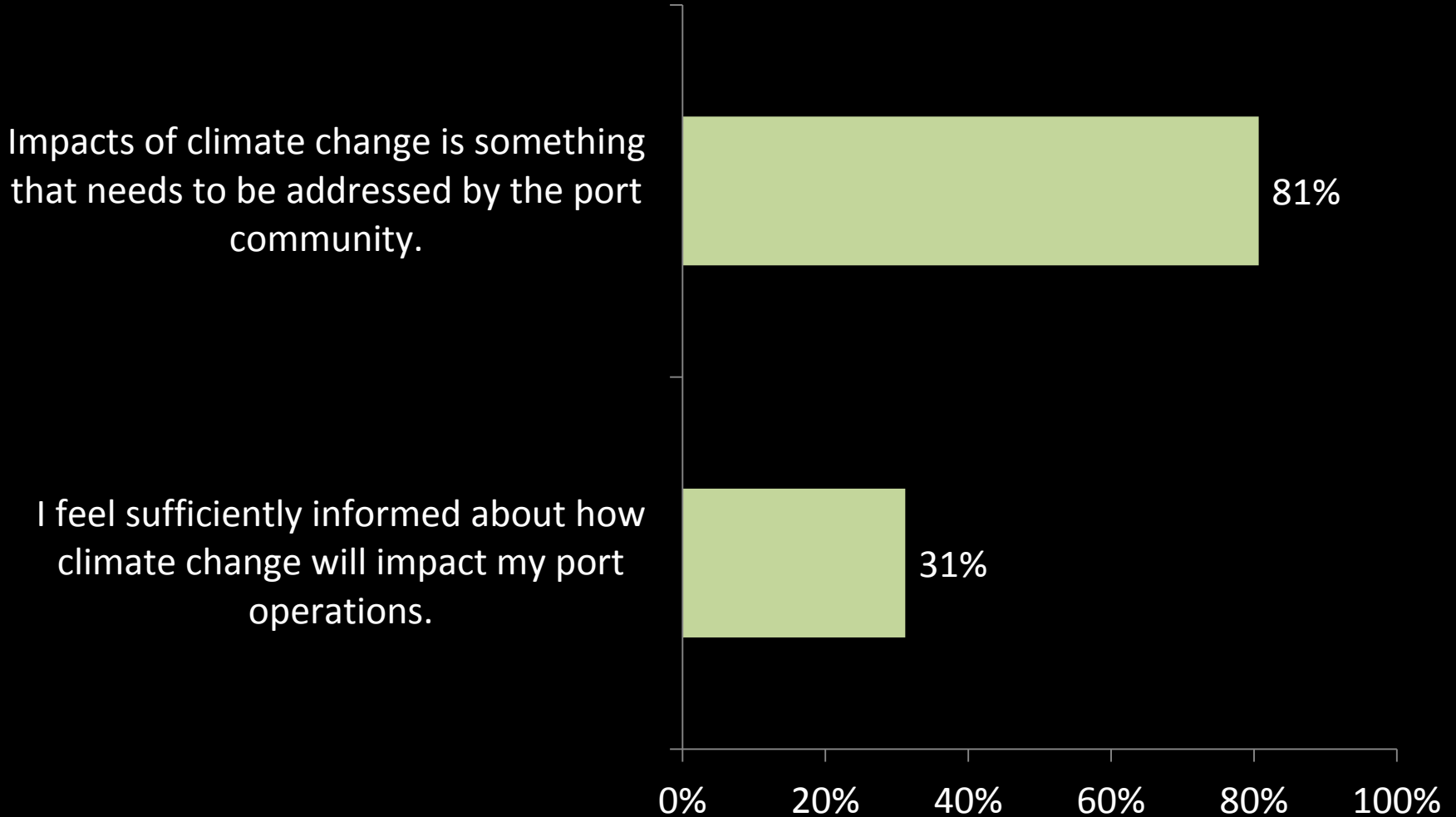
(Rhamstorf 2007; Bender, Knutson et al. 2010; NRC 2010; IPCC 2007, Lin et al. 2012))

What are ports doing now?

- 350 IAPH/AAPA members
- Survey Monkey
- Designed/Pretested with IAPH/AAPA
- 30 Questions
- Distributed Summer 2009
- 93 Usable Responses



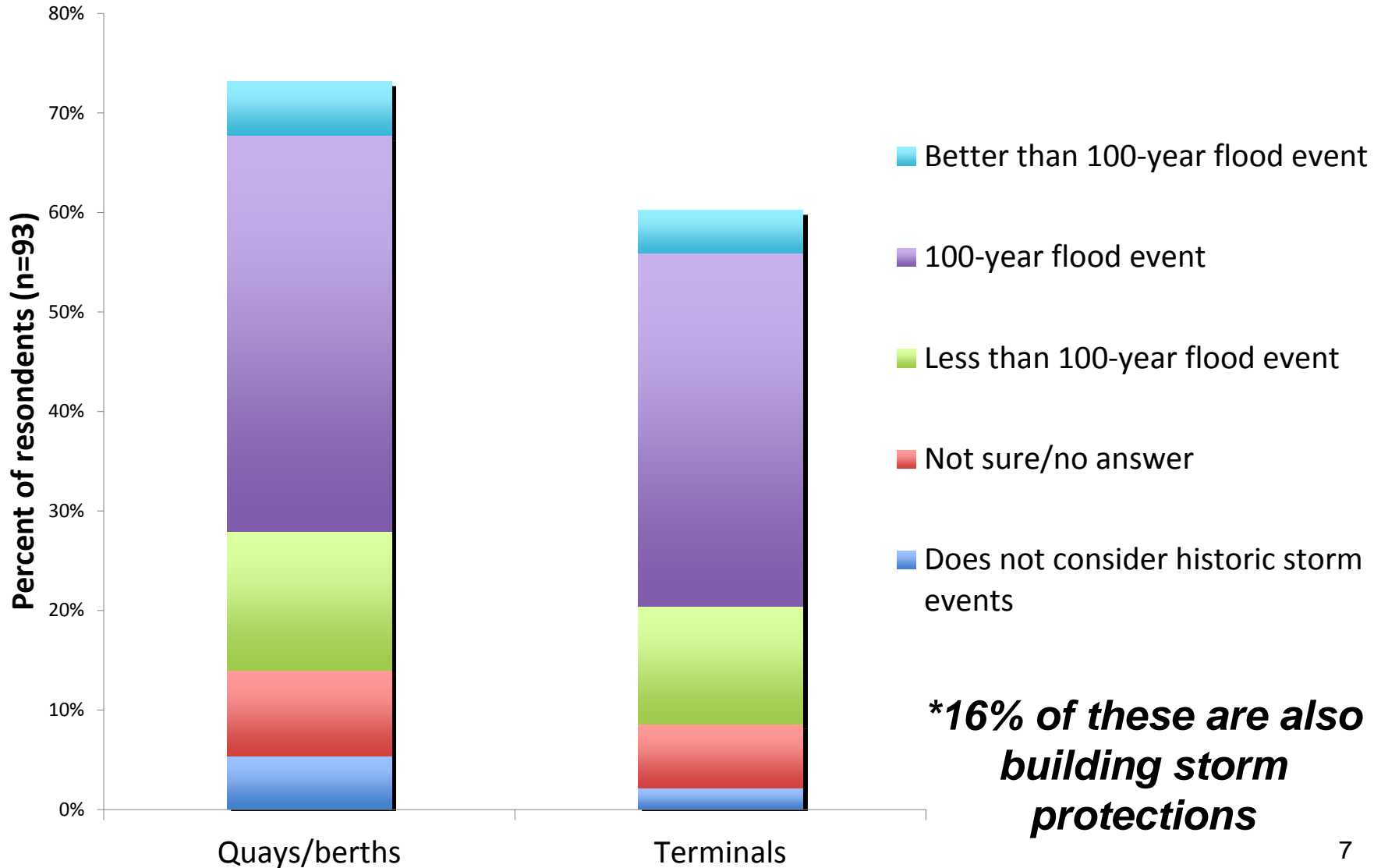
Survey respondents concerned, but felt uninformed



N=93

Ports are building infrastructure, but design standards do not include climate change

Plans for new construction in the next 10 years*



Concern for sea level rise

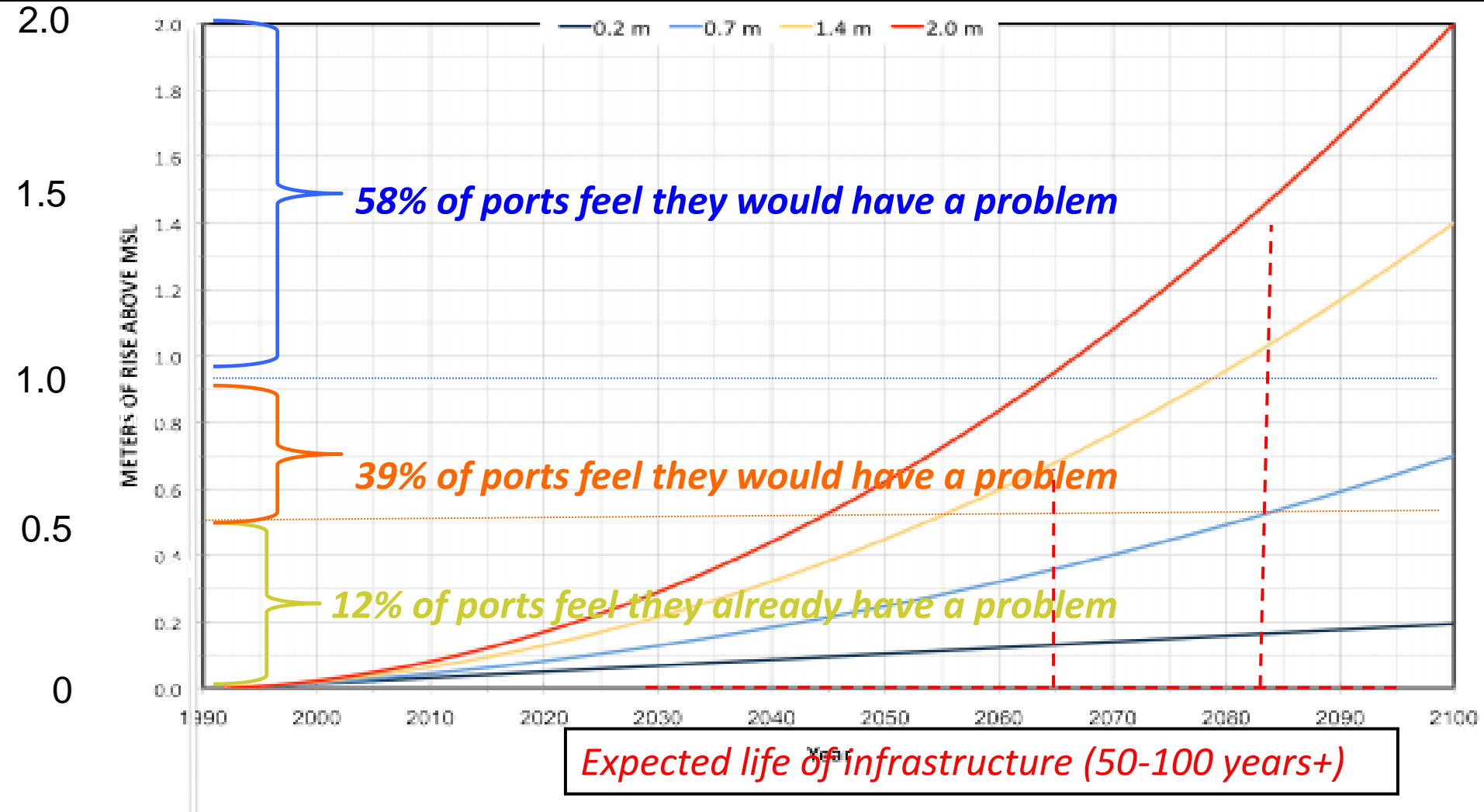


Figure 4. Global mean sea level rise curves for the 2013 NCA. Curves using a historic rate of 1.8 mm/yea and a start year of 1992

The path to action

What are the physical changes?

What are the direct impacts of these changes?

What are the consequences of these impacts and for whom?

What strategies can be implemented?

Which actors must take responsibility for implementation and on what timeline?

Impacts mostly understood, but what of consequences of impacts?

*Table 1. Climate Change Impacts on Port and Hinterland port infrastructure and operations**

<i>Climatic Factor</i>	<i>Impact</i>
Rising sea levels	↑ corrosion rate and degradation of materials designed for particular range of sea level conditions.
Change in wind conditions and higher waves	Effects on offshore loading and unloading operations. Change in overtopping and threat to stability of breakwaters.
Erosion or accretion of beaches protecting port structures	Risks for safety of such structures and ↑probability of flooding.
Changes in storm duration and/or frequency	↓regularity of ports, ↑downtime and requirements for more storage capacity at container terminals for use in times of closure. ↑construction and maintenance costs at ports and facilities.

*UNECE, 2011. "Climate Change and International Transport Networks: Overview of Main Concerns and Considerations;" Table 1.

The path to action

What are the physical changes?

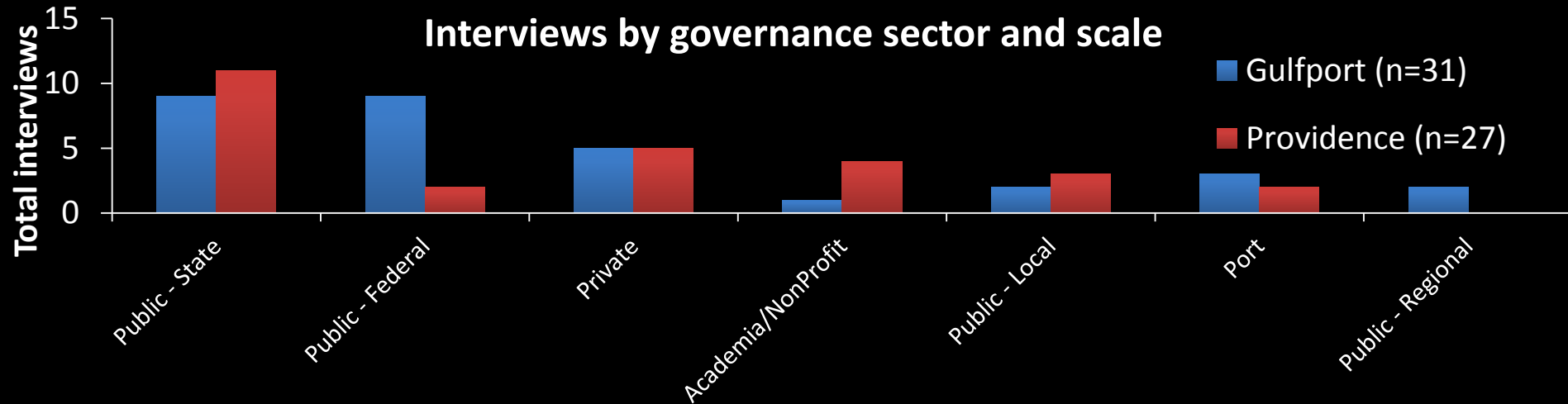
What are the direct impacts of these changes?

What are the consequences of these impacts and for whom?

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Which actors must take responsibility for implementation and on what timeline?

Consequences of storm impacts to port communities: Improving understanding through qualitative analysis



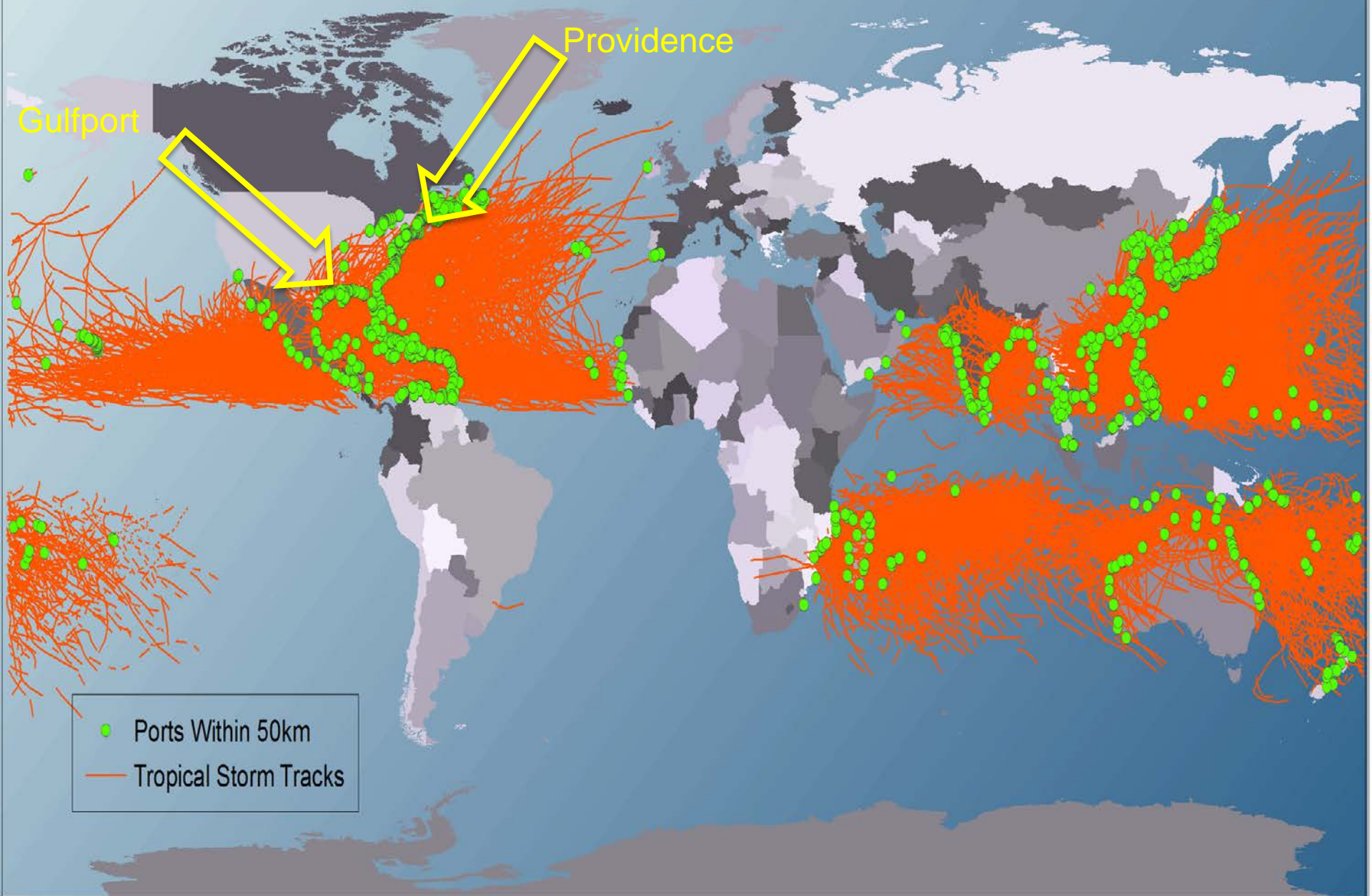
- “Seaport decision-making system” as unit of analysis
- Two highly-vulnerable US ports
 - Gulfport (Mississippi) and Providence (Rhode Island)
- Interviews of 57 key decision makers
- Focus on extreme storm scenarios - not climate change

Ports Within 50km of Tropical Storm Tracks 1960-2010

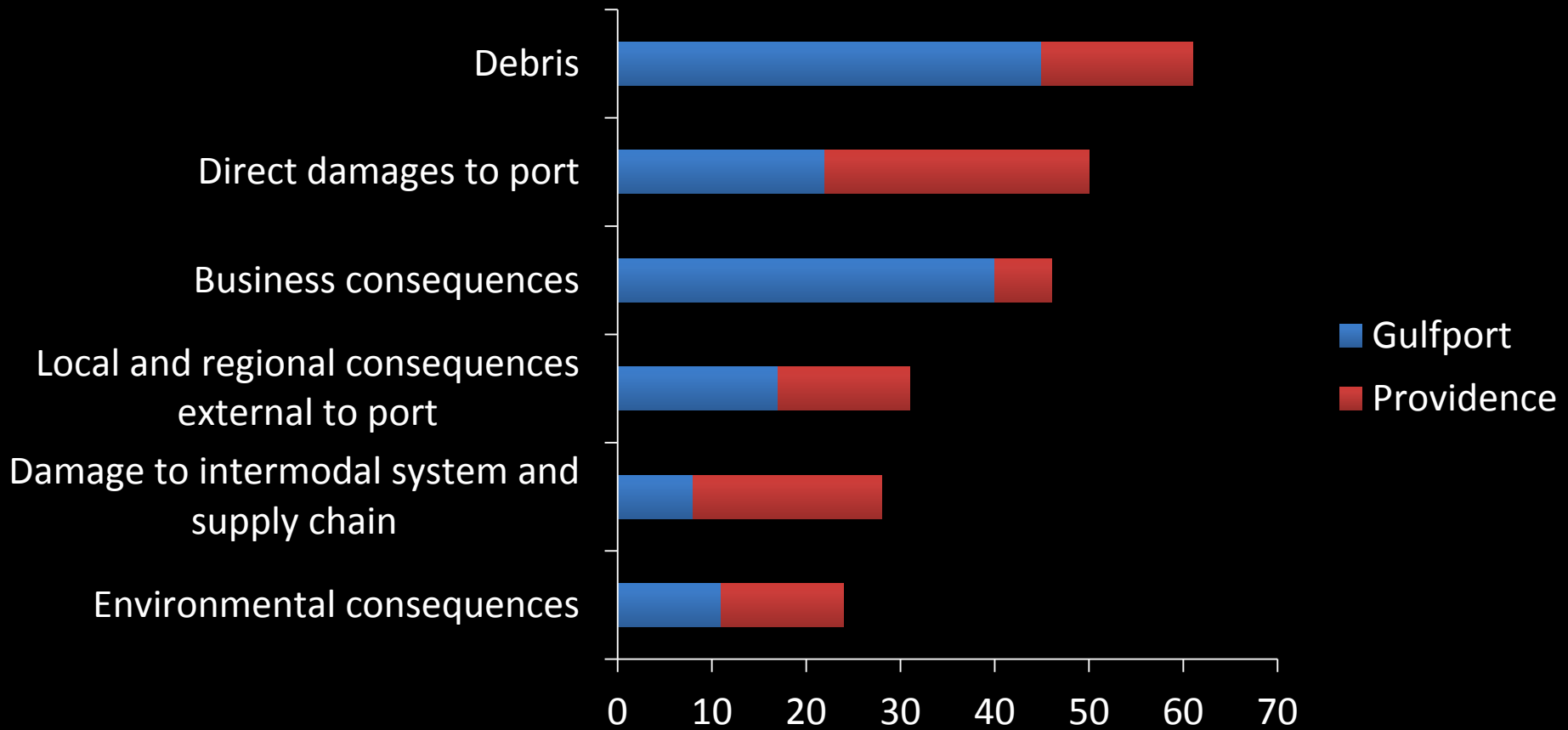
Gulfport

Providence

- Ports Within 50km
- Tropical Storm Tracks



Six categories of storm consequences (272 mentions – 96 unique items)



Frequency mentioned

Example 1: Debris

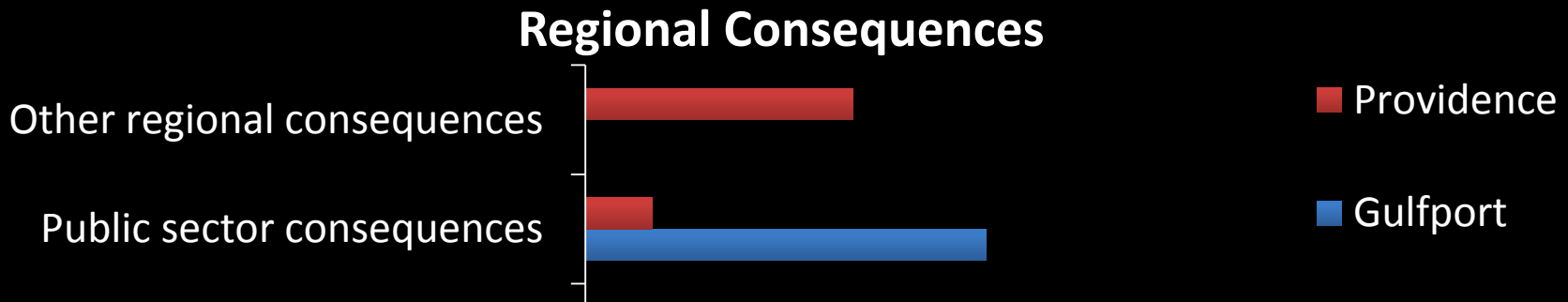


One respondent described shipping containers literally surfing down the faces of waves. Containers “*went flying into neighborhoods, breaking up houses that may have been repairable from flooding alone, but instead were just pulverized.*”

Specifics:

- Chickens and pork products from port washed up and rotting throughout city
- Containers from port scattered all over city
- Debris causing damage to structures on the port
- Debris in the channel impacting navigation
- Floating casino business carried away
- General debris
- Marine debris
- Rail cars ended up in ship berths
- Tree debris

Example 2: Regional impacts



“The average salary at the Port is about 70 or 80 thousand dollars a year. Some folks have high school diplomas and some probably don’t have high school diplomas. But they are middle class taxpayers. And when you pull that kind of money out of your economy, it can have a drastic impact. From an economic standpoint, it’s devastating.”

treatment plant issues

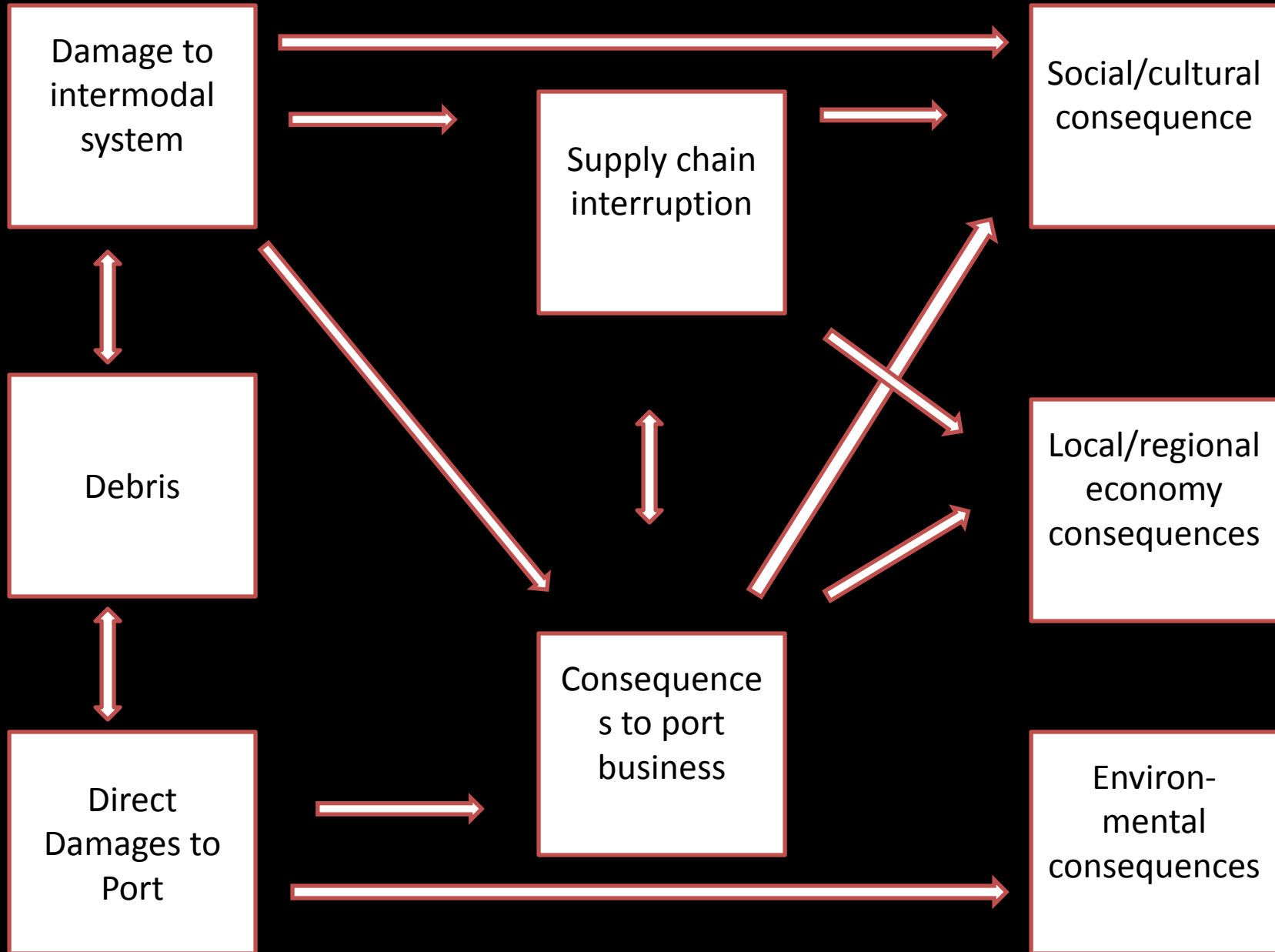
- Employment issues
 - Lost jobs, housing for relief workers, overtime pay, workers stranded at port, fluctuations in labor pool
- Public sector impacts
 - Cost of cleanup, local economy suffers, military reserve forces recalled for duty,
- New business can also result from catastrophic event
- Delays in commerce and cleanup due to loss of capacity of port

Major storm impacts and consequences

Direct impacts

Private sector consequences

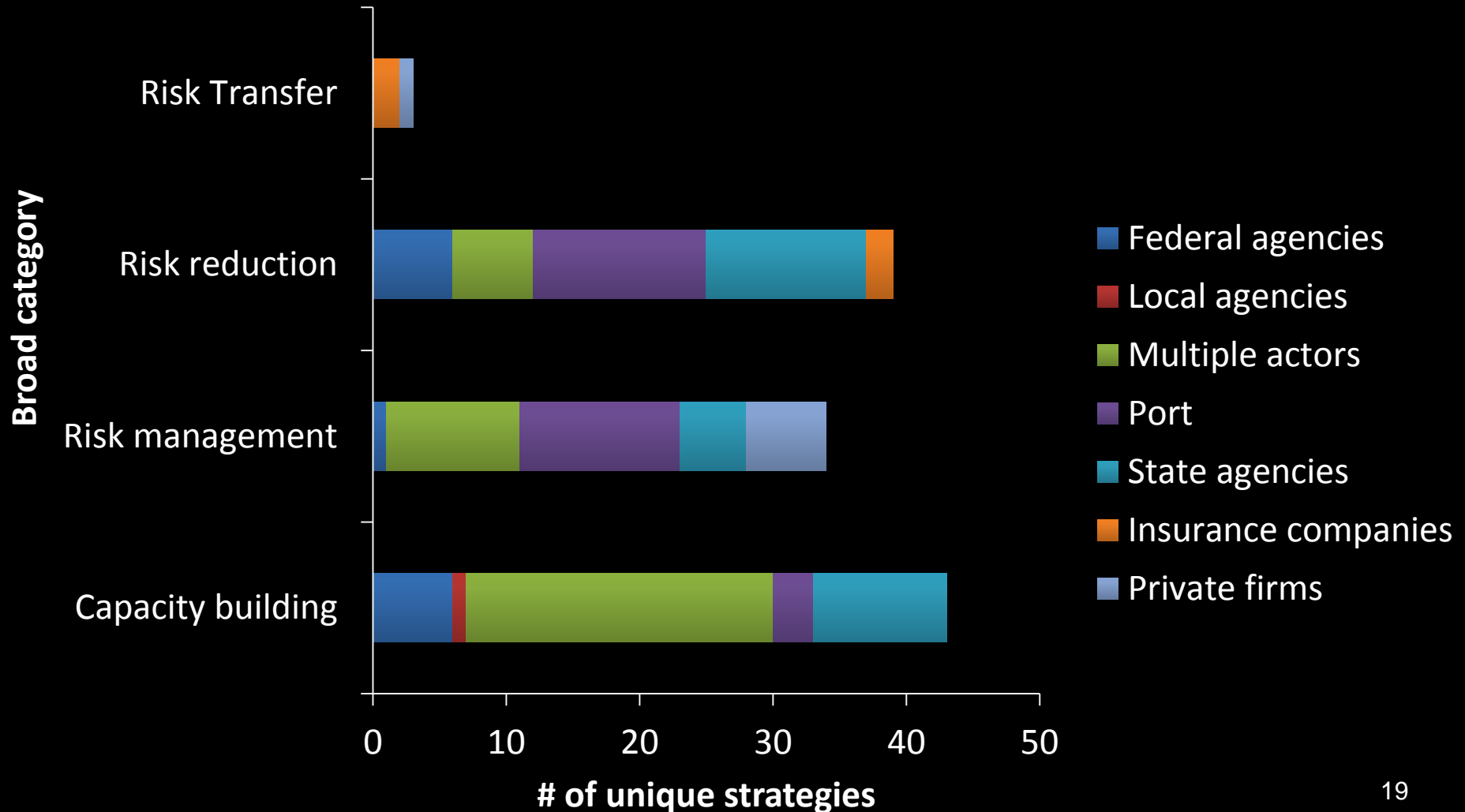
Public sector consequences



Port resilience-building strategies (125 unique strategies mentioned)

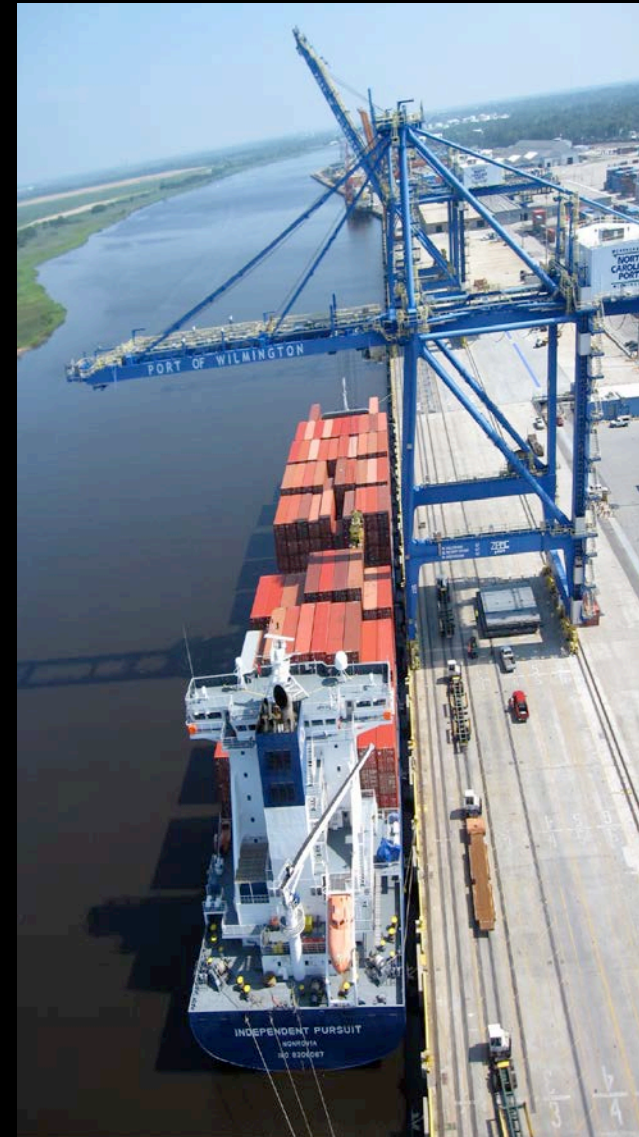
<i>Type of strategy</i>	<i>Time horizon</i>	<i># of strategies mentioned</i>	<i>Examples</i>
Capacity building	Ongoing	46	Vulnerability assessments, climate commissions, improve forecasting, collaborate between agencies, map flood-prone areas, streamline permitting process, hire more staff...
Risk Reduction	Long	39	Breakwaters, storm barriers, elevate land, move port, create seasonal facilities, harden structures, incentivize resilience building, restore barrier islands...
Risk management	Medium	37	Emergency drills, port evacuations, business continuity plans, secure equipment in place, conduct emergency drills, shut down the waterway...
Risk transfer	Short	3	Increase insurance coverage, disaster relief, adjust insurance premiums incrementally...

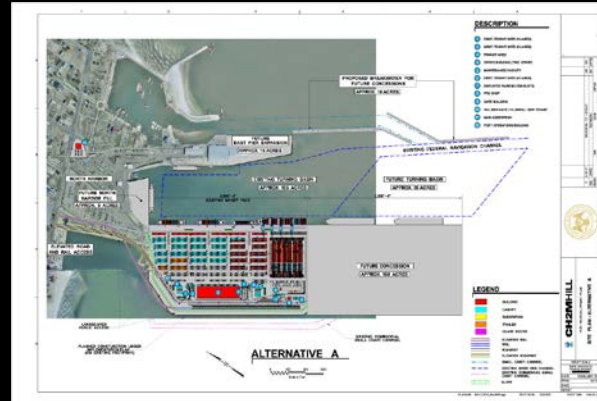
Port resilience strategies and likely candidates to take the lead on implementation



Conclusions

- Many actors - Public, private, public/private
- Difficult to quantify true consequences
- Impacts/consequences can occur out of the career or lifetime of decision makers
- Not always clear responsibility
- Next steps: strategies, timetables, and implementation responsibility



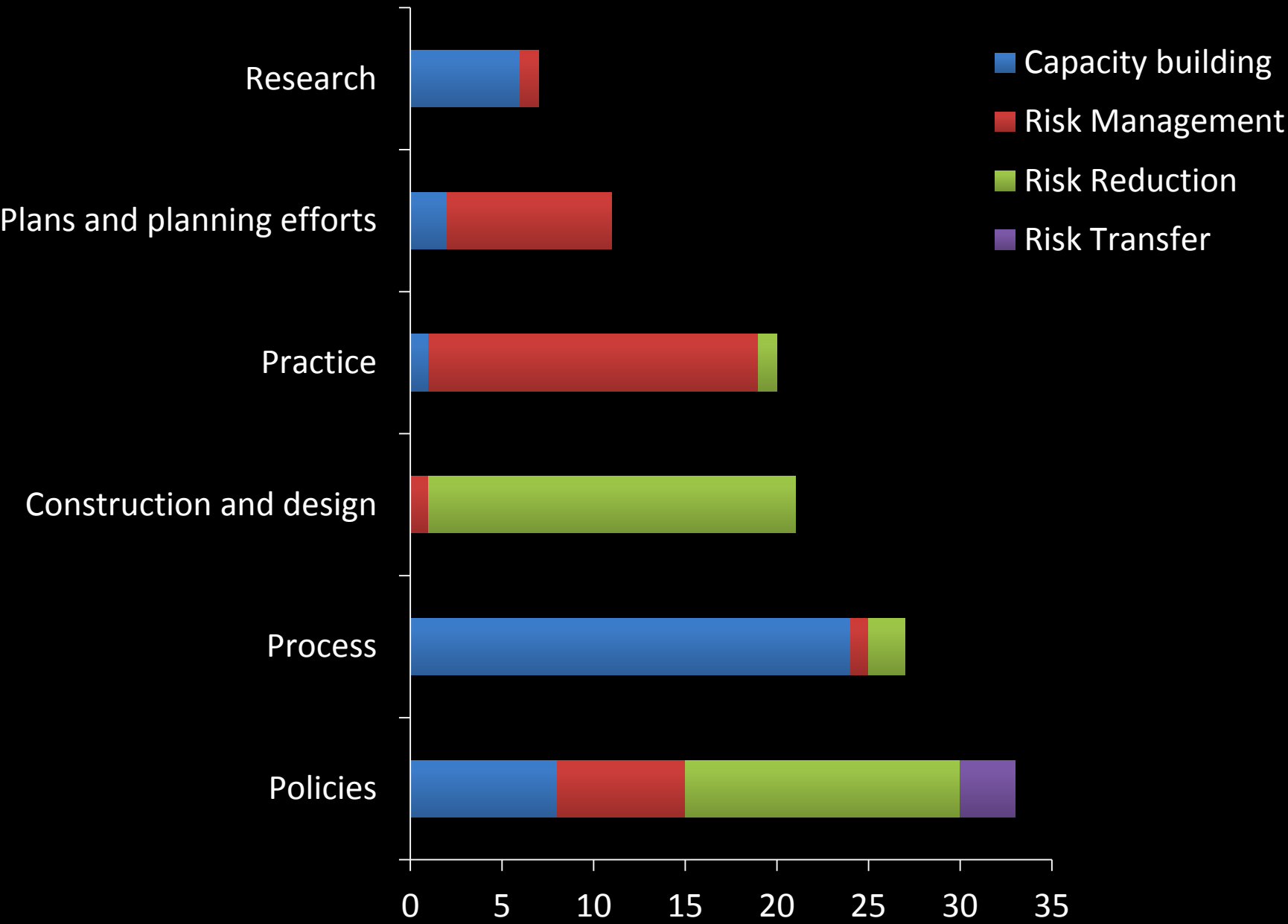


Many thanks to:

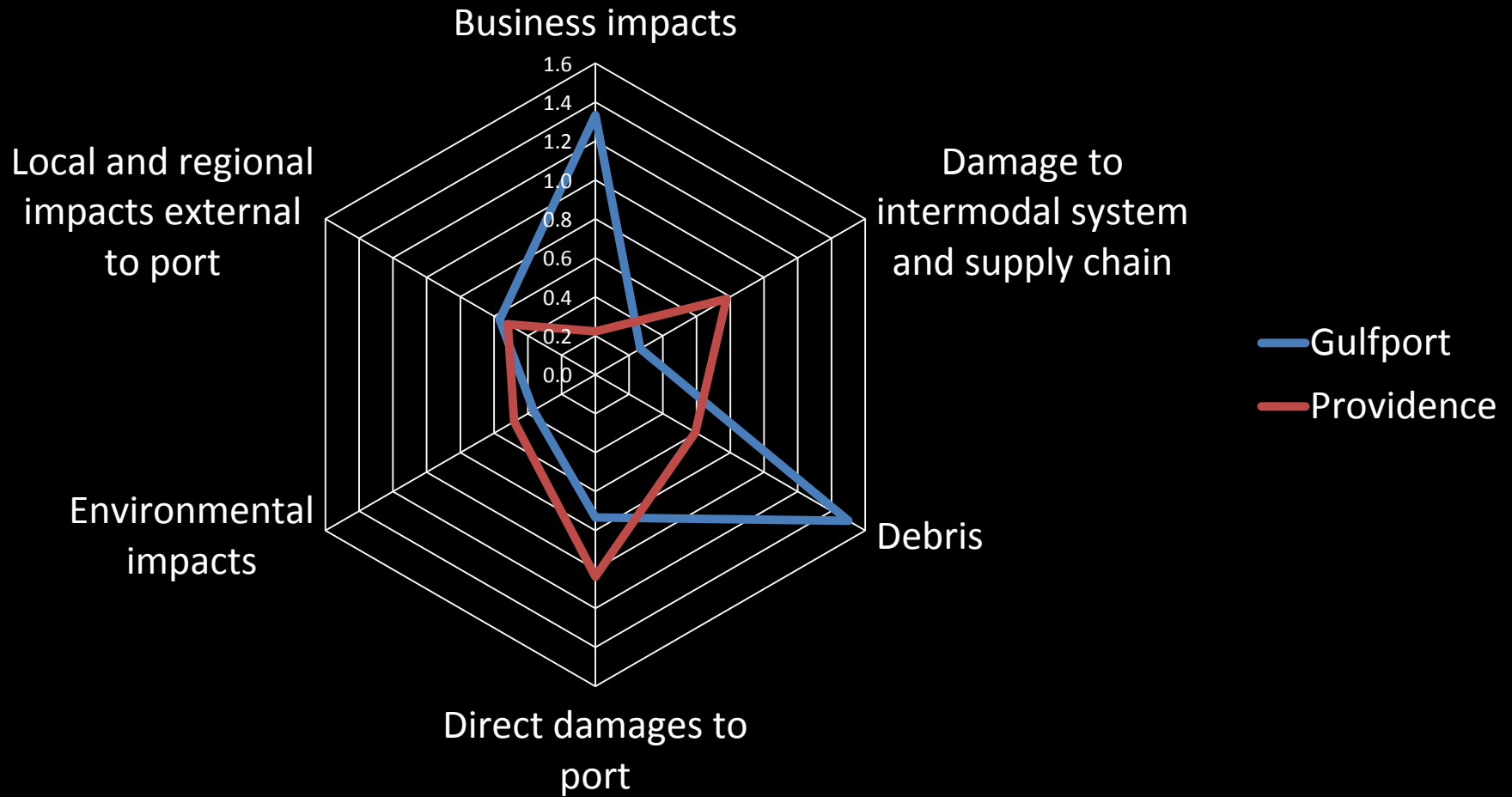
Prof. Martin Fischer (Civil and Environmental Engineering)
and Prof. Pamela Matson (School of Earth Sciences)

*Transport Facilitation and Economics Section, Transport Division, UNECE; Evros Chamber of
Commerce and Industry; Hellenic Chambers Transport Association*

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Providence and Gulfport RDS Mental Models



1. Policies (includes insurance, design standards, zoning)

- Federal – E.g., Incentivize resilience, commission studies
- Local – Create regional mitigation plans, consider resilience in local comp plans
- State – Create SLR policies, enhance building codes, create cleanup agreements
- Port – Mandatory evacuations, build resilience into ops/maintenance
- Private/insurance – Adjust premiums incrementally, conduct insurance inspections

2. Process (includes coordination, commissions, outreach, education)

- Collaborations
- Increase staffing
- Improve informational flows
- Increase planning horizons
- Shift in thinking toward prioritization of resilience

3. Construction and design

- Construct/modify ON port lands
 - Elevate structures, elevate port lands, harden structures...
- Construct/modify OFF port lands
 - Breakwaters, flood barriers, move the port...

4. Practice (current and potential)

- Drills and re-event trainings
- Post-storm actions
- Storm preparations

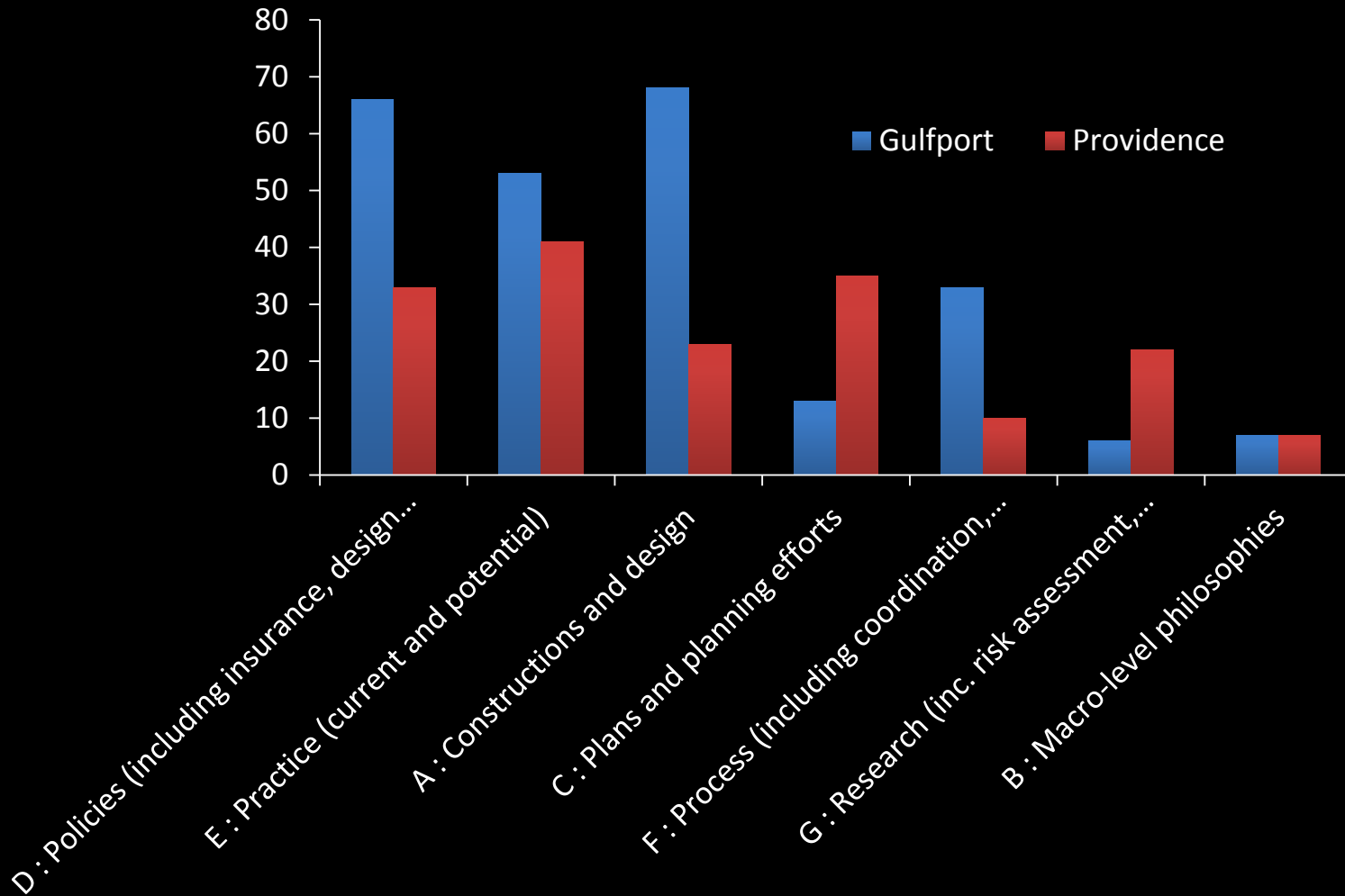
5. Plans and planning efforts

- Data storage plans
- Emergency response and recovery plans
- Work to ID funding streams

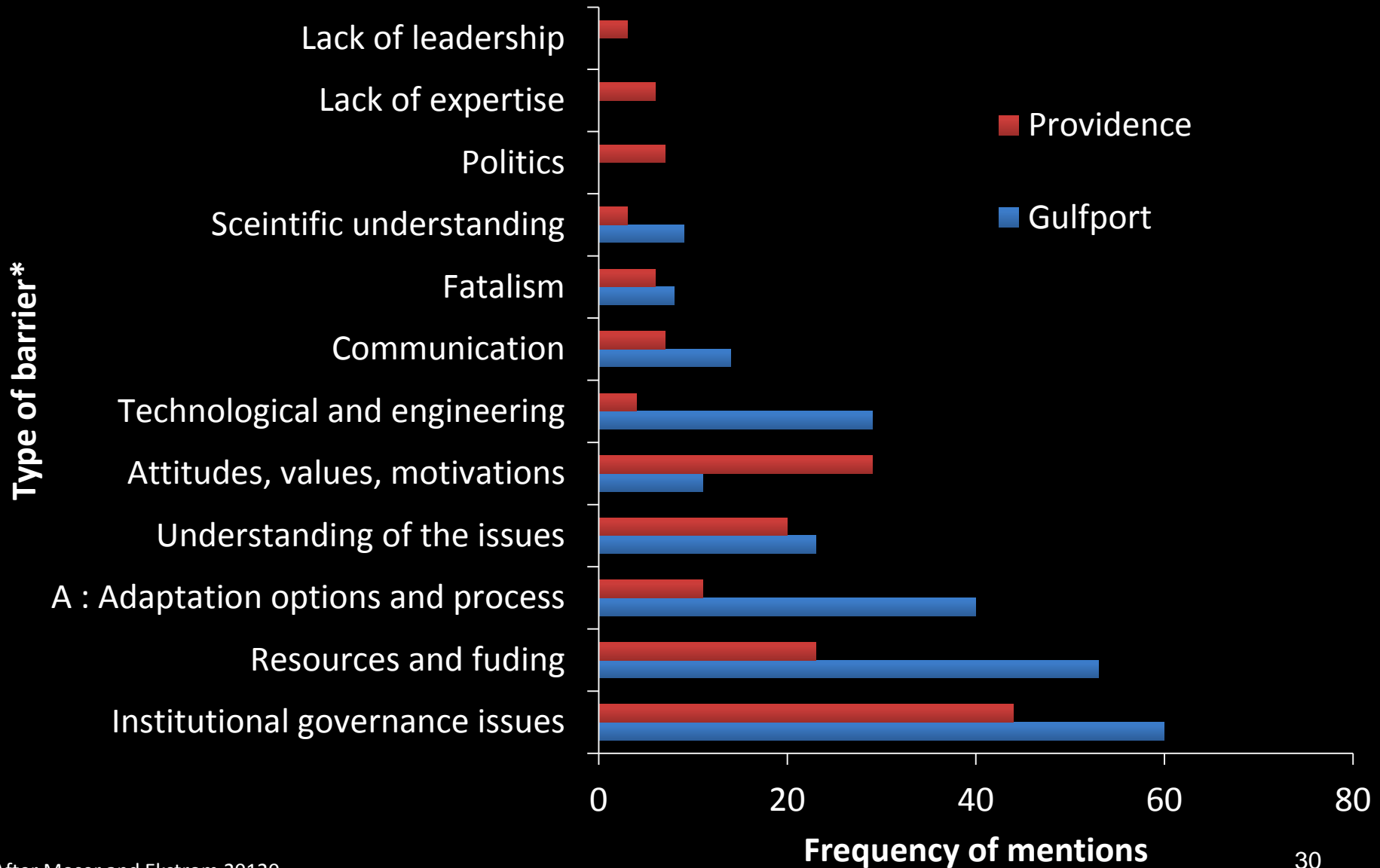
6. Research (inc. risk assessment, forecasting, projections)

- Damage assessments
- Risk/vulnerability assessments
- Improve forecasting abilities
- Map flood-prone areas
- Utilize gaming, simulations, and scenarios
- Partner with academic institutions and NGOs

What do decision makers perceive as strategies to build resilience?



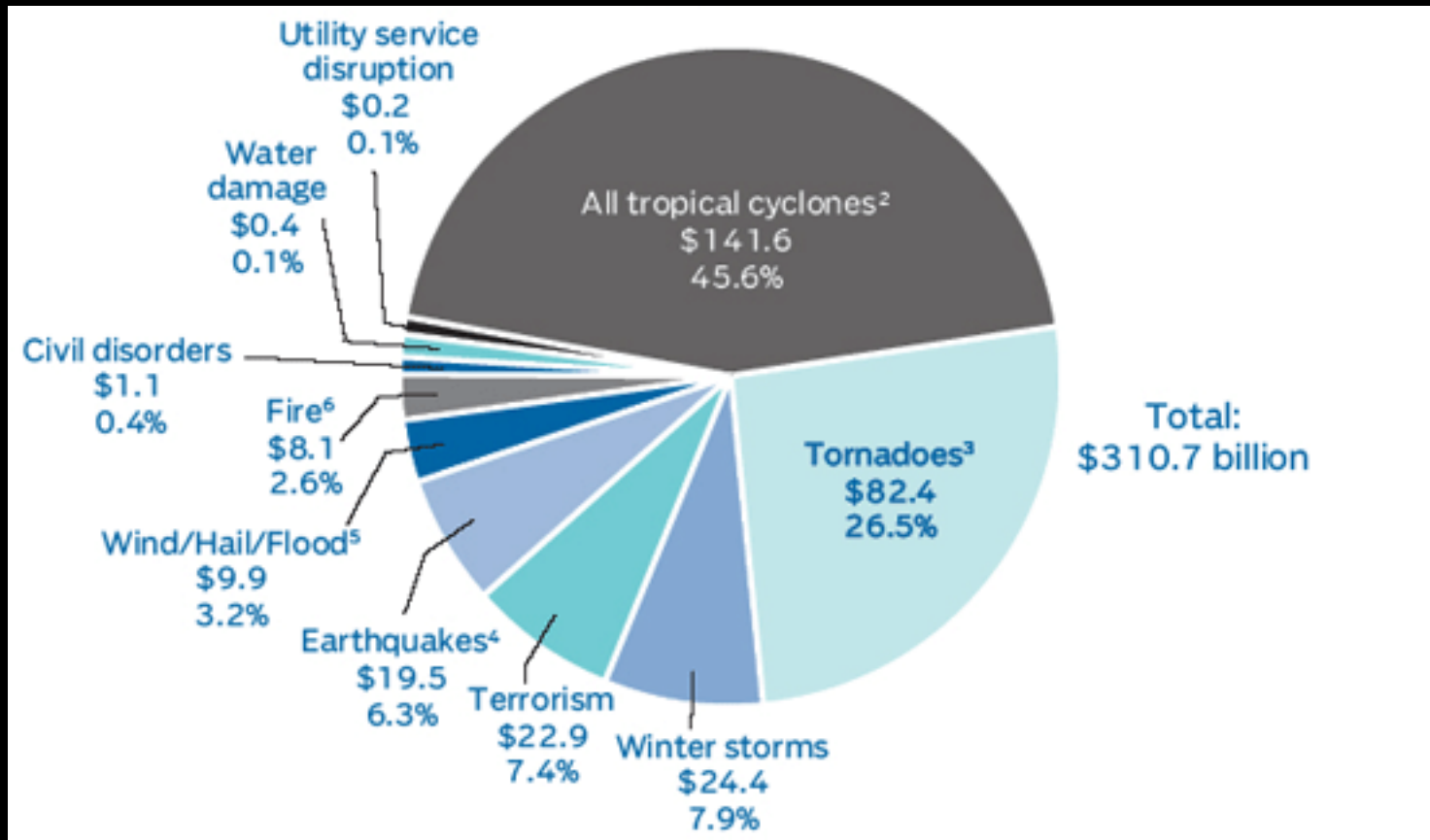
What are the barriers to implementing resilience measures?



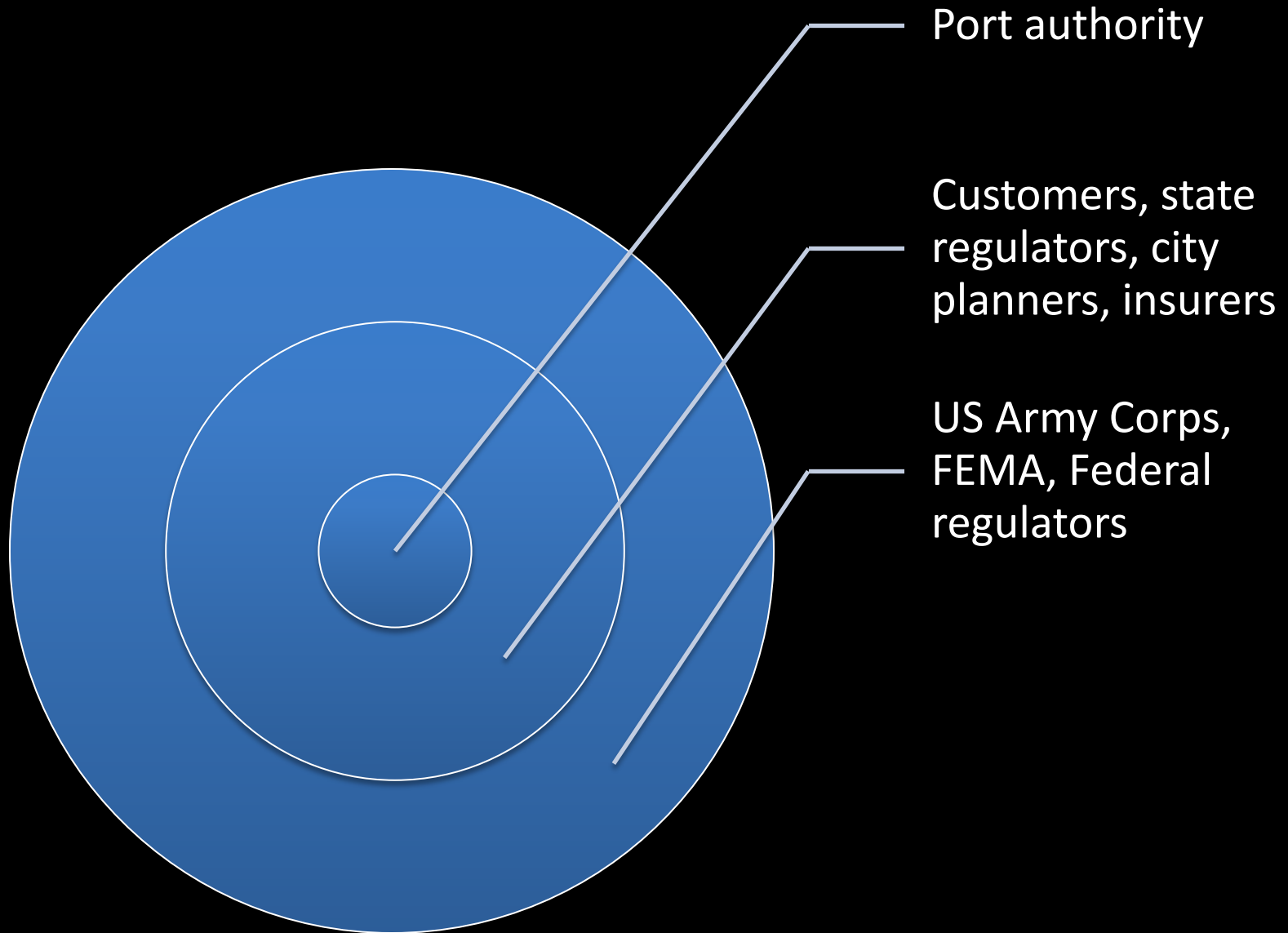
* After Moser and Ekstrom 20120

Extra Slides Below

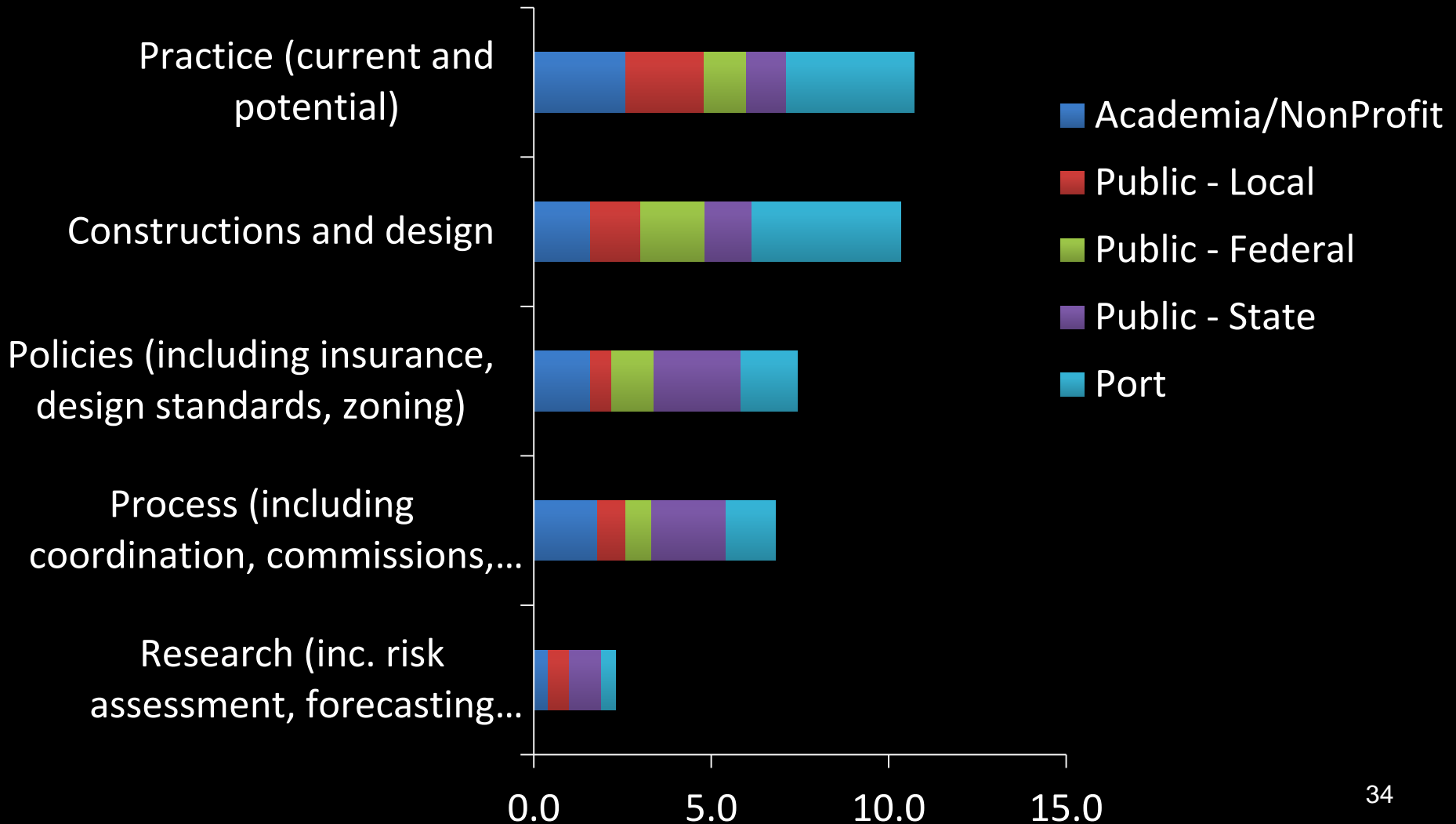
INFLATION-ADJUSTED U.S. CATASTROPHE LOSSES BY CAUSE OF LOSS, 1988-2007



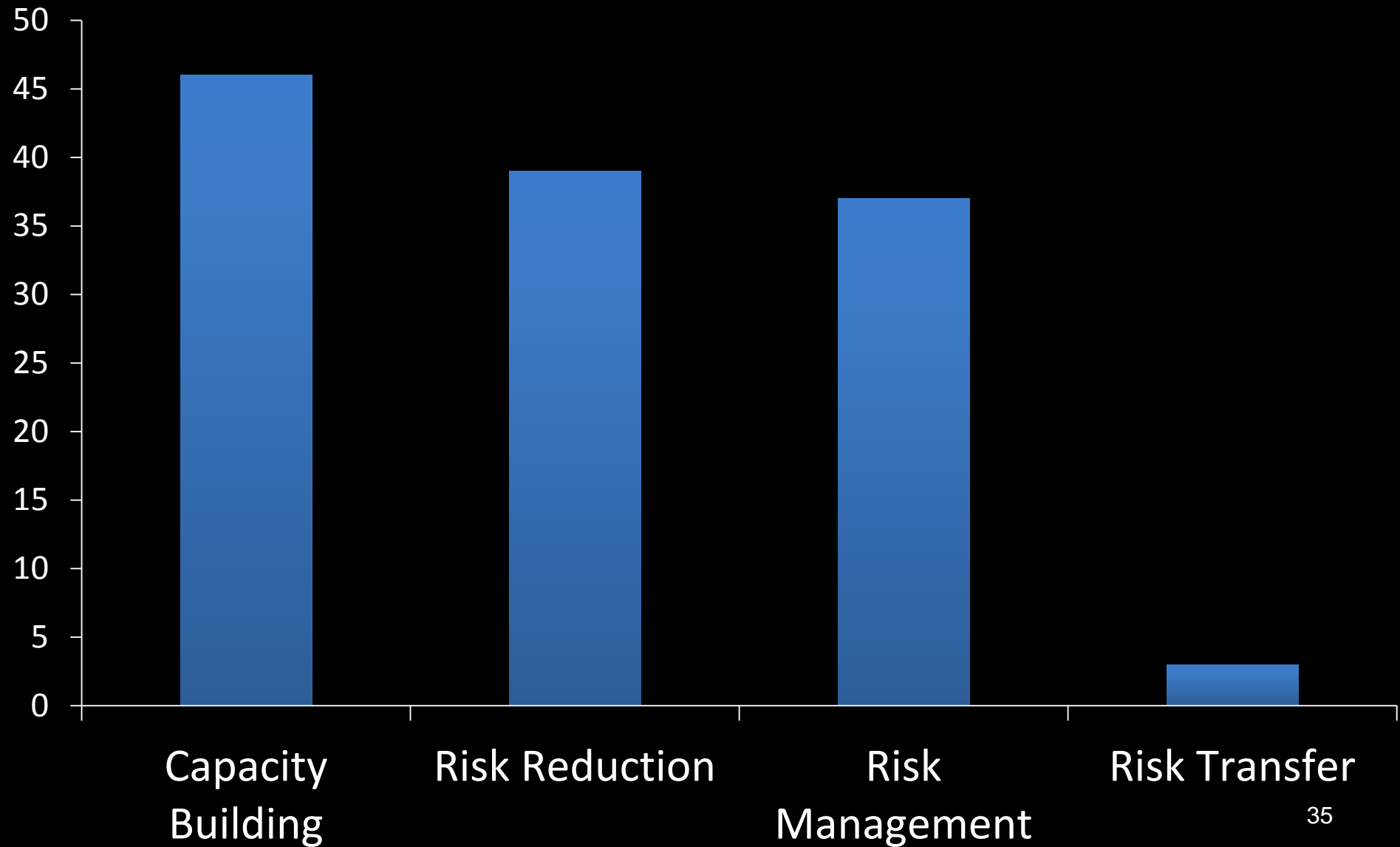
The port decision-making system



Six categories of resilience strategies (125 unique items)

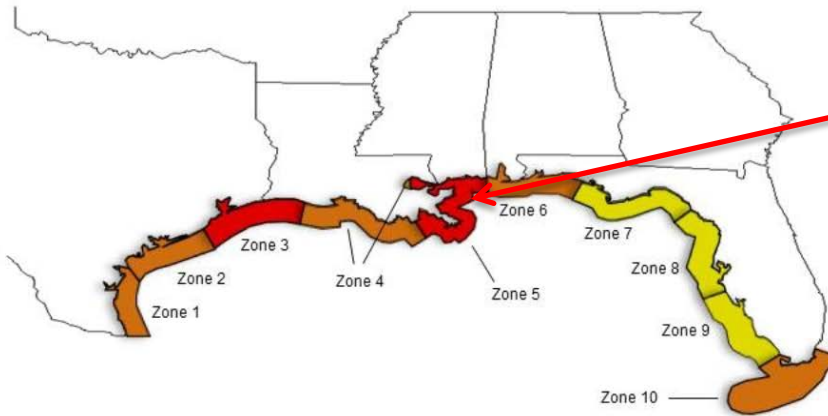


Strategies to build resilience



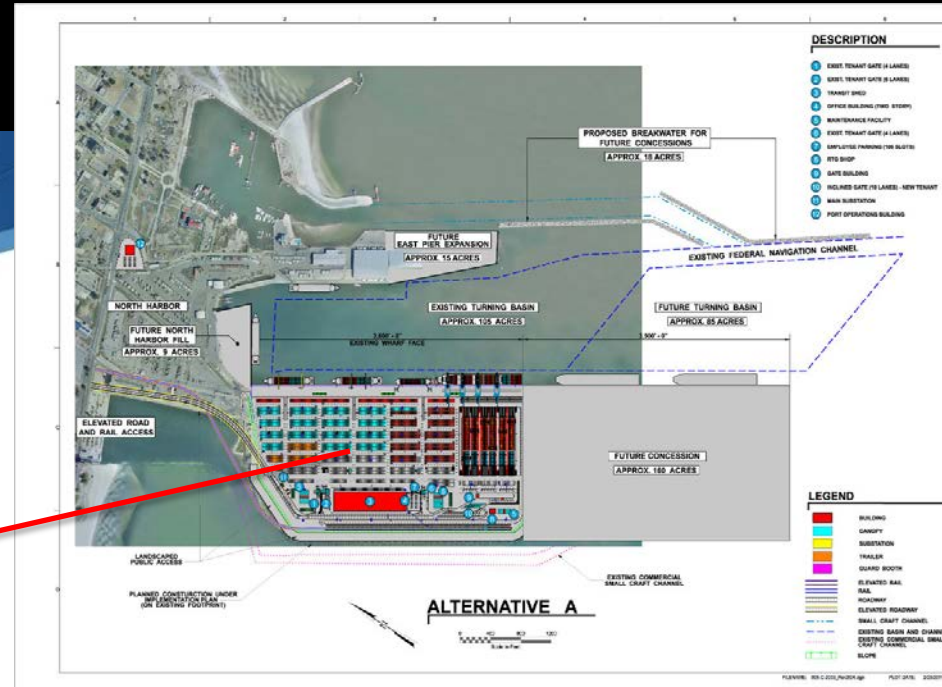
Gulfport's plan to elevate to 25 feet

100-year Storm Surge Heights



Zone #	1	2	3	4	5	6	7	8	9	10
Height (ft)	18.1	18.7	20.7	15.2	25.2	19.9	11.6	10.9	12.9	18.9

Surge Color Code	10-15 feet	15-20 feet	20+ feet



Providence, RI: Achilles heel of the Northeast



Surge Height 4.5 m (MLLW) Image MassGIS, Commonwealth of Mass. MSEA
Image © 2005 MDA EarthSat
© 2005 Sanborn

Direct damages to port

- Buildings and structures
- Docks and berthing areas
- Equipment
- Freight and cargo
- Land areas
- Utilities

Local and regional impacts

- Public sector impacts
- Employment losses
- Damage to ancillary services

Environmental impacts

- Coastal land damages
- Hazards to human health
- Ecosystem damages
- Waterway contamination

Debris

- Originating at port (off-port or on-port consequences)
- Originating off port (on-port consequences)
- General

Damages to intermodal system

- Road and rail
- Supply chain
- Navigation system

Business impacts

- Business continuity
- Difficulty in planning/development
- Employee and staffing issues
- Increased costs
- Insurance problems
- Loss of port functionality
- Operational burdens