

**Strengthening the Resilience
of the U.S.
Marine Transportation System**

*Identifying the Underlying Principles
& Courses of Action*

Marine Transportation System (MTS)

The U.S. Marine Transportation System encompasses a network of navigable waters, publicly and privately owned vessels, port terminals, intermodal connections, shipyards, vessel repair facilities, and a trained labor pool, which is capable of operating and maintaining this infrastructure and equipment.

MTS Functions

- The Marine Transportation System is a demand-derived activity with value.
- Its values (i.e., functions) are:
 - To provide global access for commercial and military purposes, and
 - To provide mobility for people and goods.

U.S. MTS Assets

- 361 deep-draft ports
- 25,320 miles of waterways
- 3,700 marine terminals
- 8,350 commercial facilities
- 97,000 aids-to-navigation
- 238 lock chambers at 192 sites
- 1,400 designated intermodal connections
- 45,000 miles of interstate highway
- 174,000 miles of rail connecting all 48 contiguous states, Canada, and Mexico



Presentation Outline

- Establishing relationships between the Marine Transportation System (MTS) and national economic security.
- Mapping the vulnerabilities of MTS public and private components.
- Building the knowledge for MTS resiliency planning in the face of terrorism and extreme natural events.

MTS Directly Connects to Our National Interest

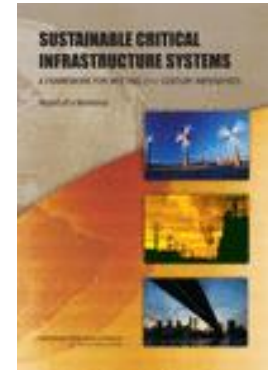
- “The ocean, our coasts, and the Great Lakes... play critical roles in our Nation’s **transportation, economy, and trade** as well as the global mobility of our Armed Forces and the maintenance of international peace and security.”
(Executive Order No. 13547, *Stewardship of the Ocean, Our Coasts, and the Great Lakes*)
- Supporting the President’s **National Export Initiative** goal to double exports within five years
(Executive Order No. 13534 - *National Export Initiative*)

MTS is Vital to Our Security

- It contributes to the Nation's economic security, in fact, it is the backbone of our commerce - enabling international and domestic goods movement.
- Nearly 80%, by weight, and 45%, by value, of all U.S. merchandise trade is handled by water.
- *In 2010, it is estimated that \$1,434 billion in foreign trade and approximately \$800 billion in domestic trade were transported by water.*
- Over 13 million American jobs are directly and indirectly provided by the activities of the water transportation industry (2010).

NRC's Life-line Sectors

- There are 4 networked sectors: power, communications, water, and **transportation**.
- They are subject to cascading failures.
- The transportation network must be viewed as a system because a change in capacity or level of service in any one segment of the network will result in a change in other segments of the system.



Hurricane Katrina's Impact

- Because of port closures following Katrina, more than \$800 million in imports were lost, and food costs in the U.S. rose 3%.
- Reason for this situation was the lack of a plan for re-routing maritime cargoes.
- The estimated additional port capacity need for re-routing Gulf Coast cargo was:
 - 50% (food & farm)
 - 26% (container)
 - 16% (petroleum)

We Have System Vulnerabilities

- Ships are easy targets...



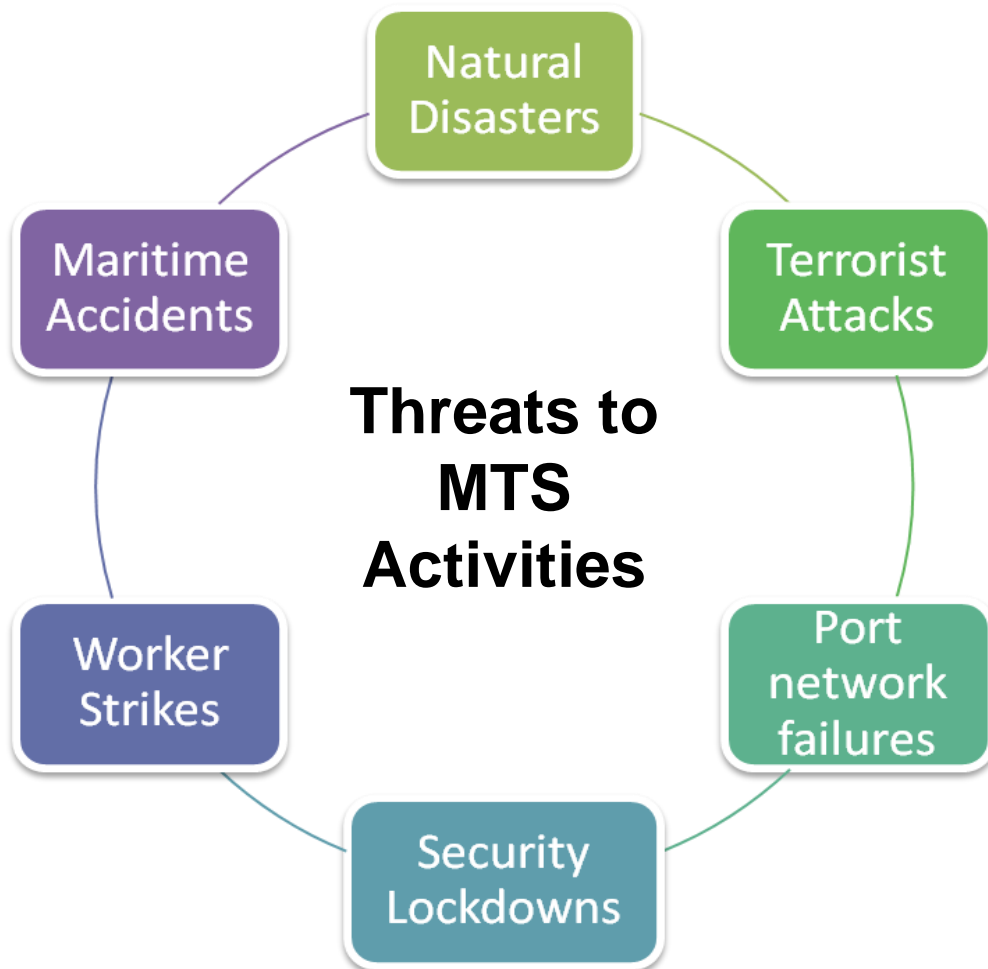
M/V Limburg attacked by a small boat on October 6, 2002.

Ports are Vulnerabilities Too!

- Ports are more complex targets with...
 - Public assets
 - Private assets

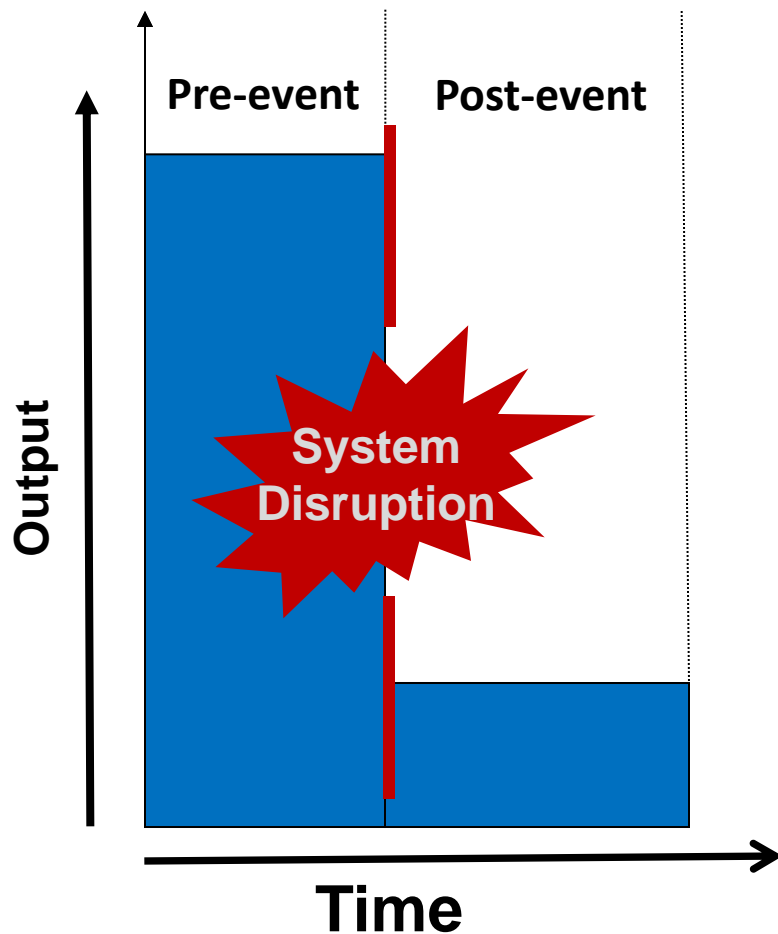


Operational Disruptions



There has been significant funding spent for protecting ports from terrorist attacks and natural events -- But resiliency strategies must respond to all types of threats.

Typical Pre- and Post-Strategies



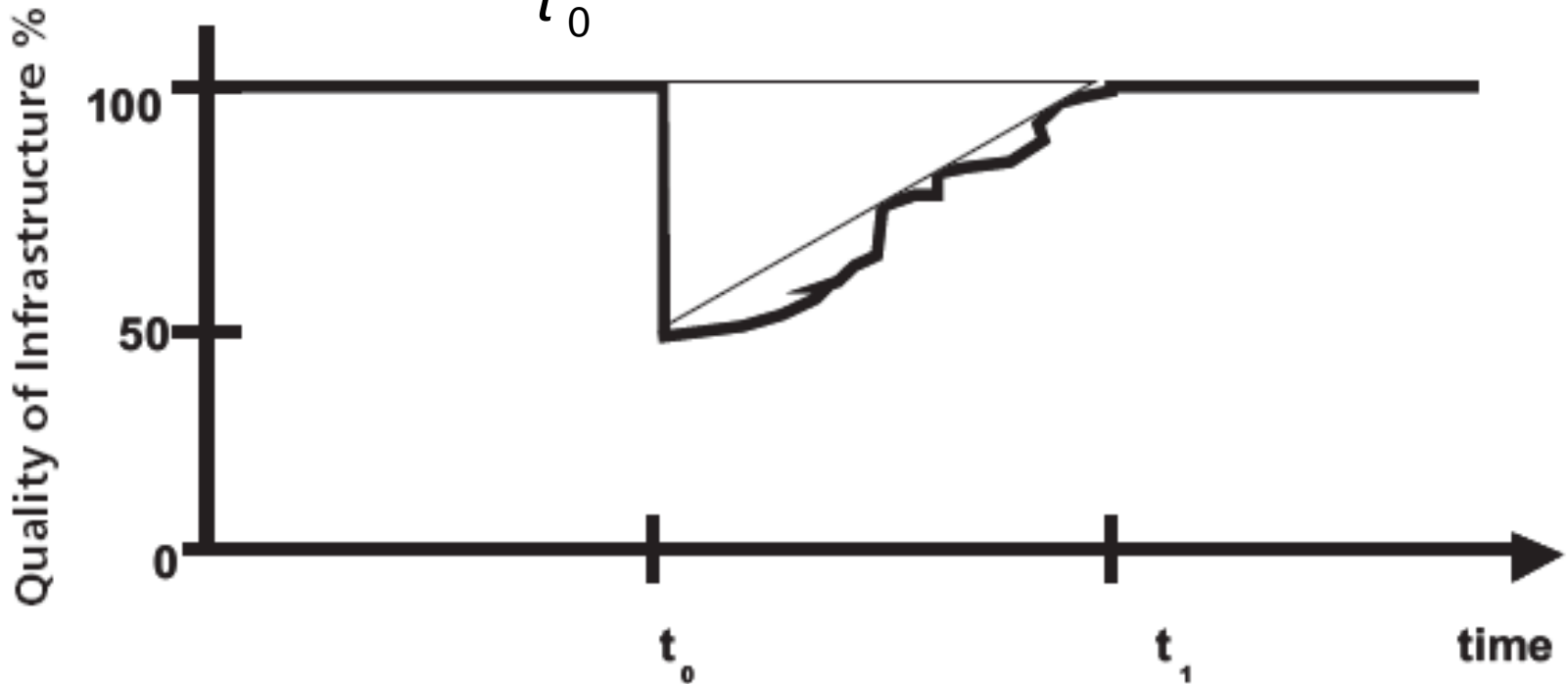
- Pre-Event
 - Protective measures and organizational preparations
- **Disruption**
- Post-Event
 - Triage, recovery, and restoration activities

Resiliency – What Is It?

- Engineering definition:
 - The ability of a material to bounce back into its original shape or position, etc. after being hit, pressed, or stretched.
 - It is a function of the materials elasticity.
 - Definition is derived principally from the material sciences and geotechnical disciplines.

Seismic Resilience Concept

$$R = \int_{t_0}^{t_1} [100 - Q(t)] dt$$



(Bruneau et al., 2003)

Systems Perspective

- Department of Homeland Security's definition of resilience:
 - The ability of systems, infrastructures, government, business, and citizenry to resist, absorb, and recover from, or adapt to an adverse occurrence that may cause harm, destruction, or loss of national significance.

(www.dhs.gov/xlibrary/assets/dhs_risk_lexi_con.pdf)

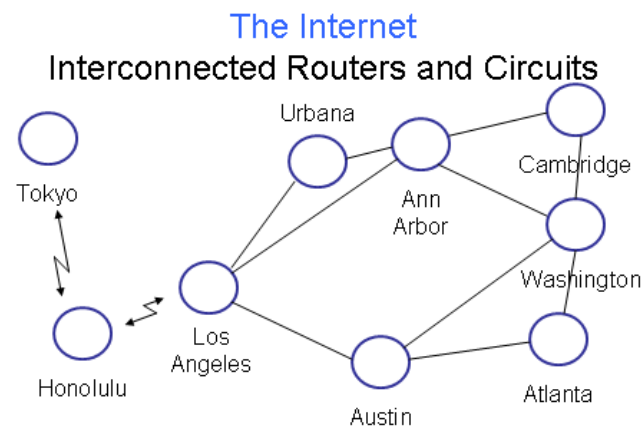
Relationship Between **DHS Security Planning** and Resilience Planning

- DHS (USCG) Facility and Vessel Security Plans:
 - Analyze threat **scenarios** for your facility or vessel
 - Determine the **vulnerability** to attack for each scenario
 - Determine the **consequences** of a successful attack
 - If the **vulnerability/consequence** score is high, adopt a plan to **mitigate** the threat.
- Resilience plans focus on continuity of operations following the attack or disruption.
- Both plans are risk-based: They reduce the risk (probability) of a successful attack or disruption, but they do not eliminate it.

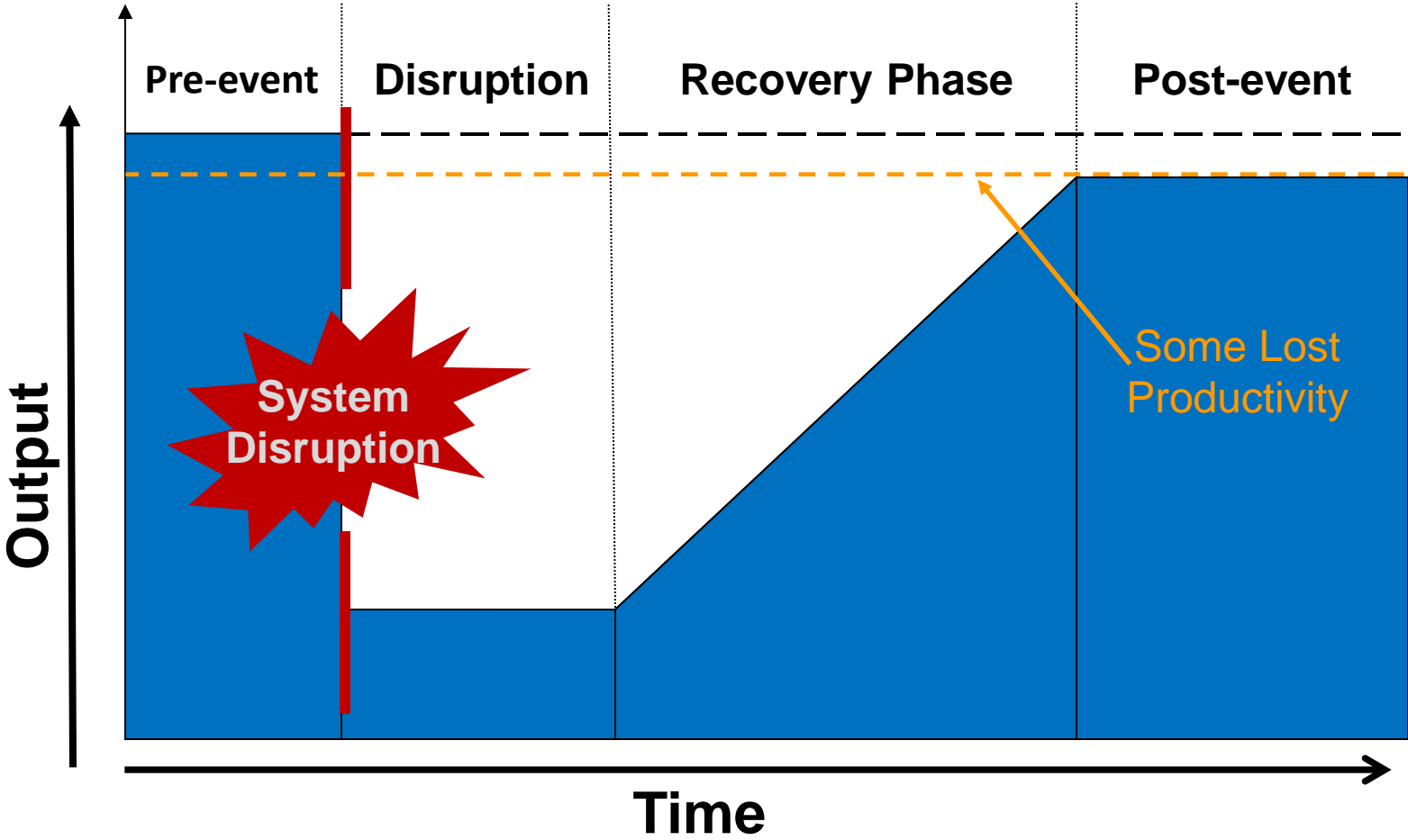
Examples of Resilience Planning

- Design of buildings, bridges to withstand earthquakes in earthquake-prone areas.
- Design of buildings, including port structures, to withstand hurricanes in hurricane-prone areas.
- Design of telecommunications networks to withstand major failures due to disasters, including war, terrorism, and continue to provide communications.

– Example:



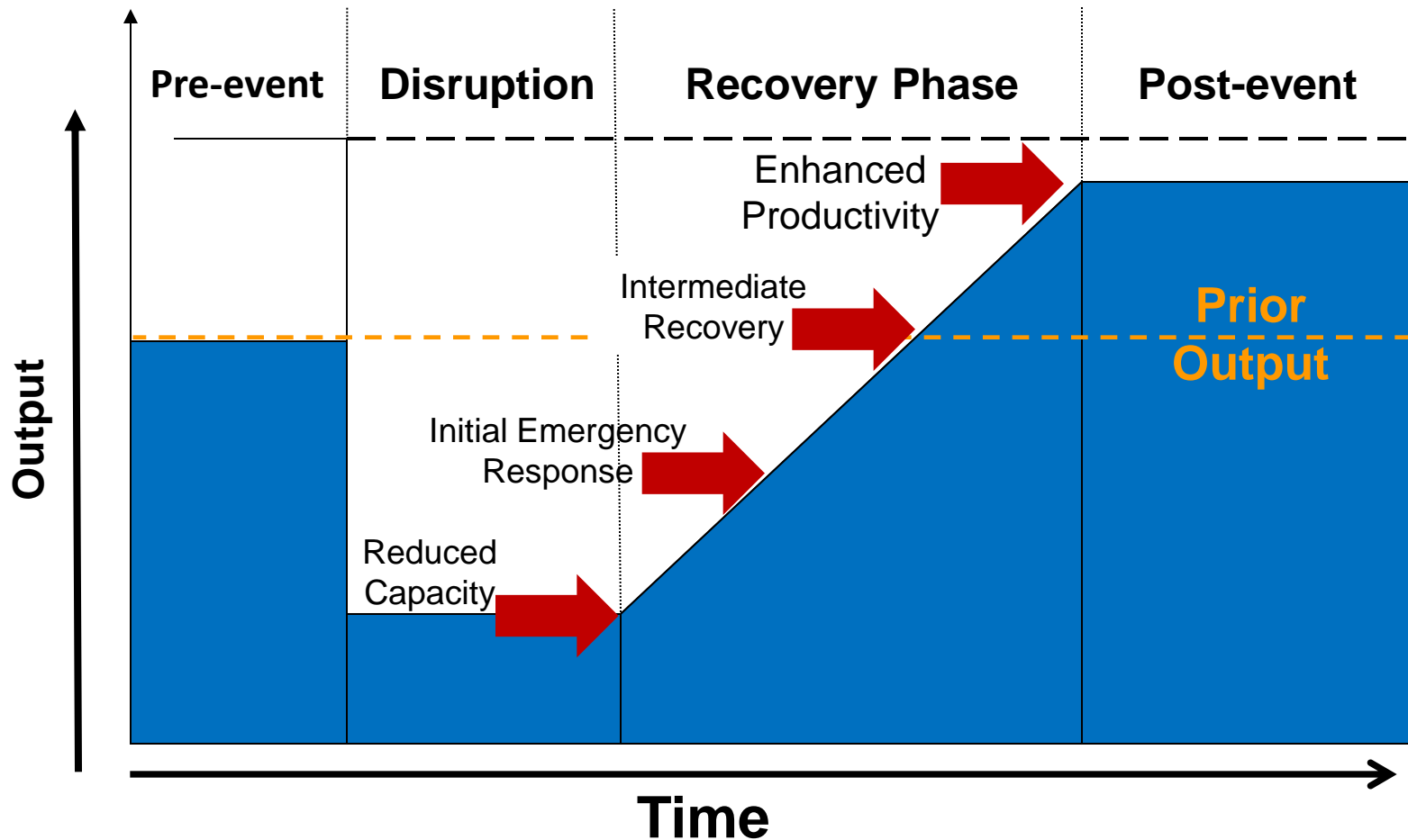
Disruption & Recovery Curve



Immediately After the Event

- The speed and effectiveness of post-disruption resilience efforts directly correspond to the strength of existing cooperativeness and the depth of a ***shared commitment*** of the impacted stakeholders to achieving a common goal.
- *Cooperativeness* is the catalysis to the rapid implementation of restorative activities.
- If their actions embody a spirit of productive *collaboration* towards all victims and lacks any sense of destructive competition, it will typically spawn resource contributions by third-parties.

Enhanced Recovery Curve

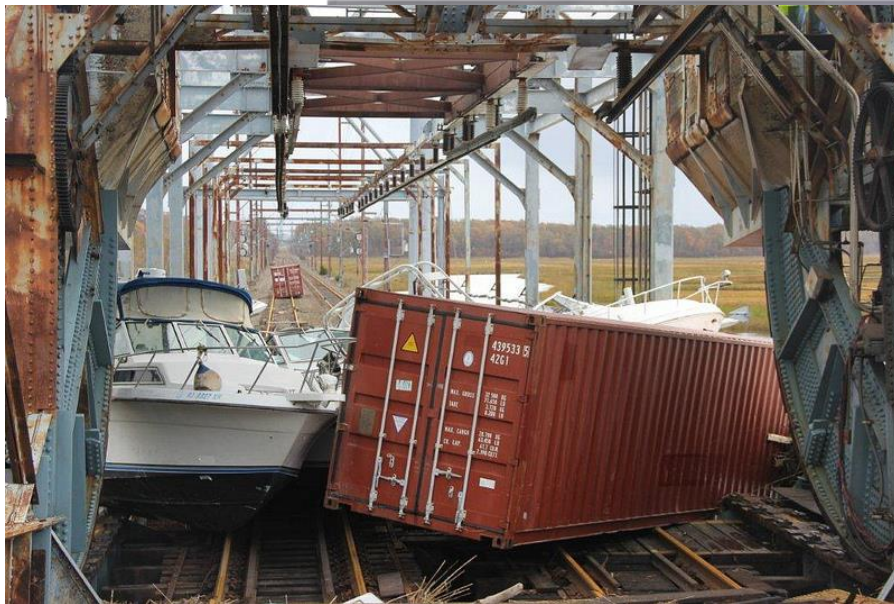


Relationship of Pre & Post Efforts

- **Resilience planning** recognizes that natural or man-made disasters will occur, and plans for the systems, facility, building, network, etc. to be resilient (i.e., bounce back) from an occurrence.
- It is formulated to enhance the ability of systems, infrastructure, government, businesses, and citizenry to resist, absorb, recover from, or **adapt to an adverse occurrence or failure**.
- Where mitigation planning stops and adaptive resiliency activities begin is at the moment of the extreme event of disruption.

Lessons from Hurricane Sandy for Port Resilience

Solving the maritime problems is not enough to bring the supply chain back on-line.



Super Storm Sandy Summary

- Super Storm Sandy made landfall in southern New Jersey, near Atlantic City, on 29 October 2011, devastating the coastline.
- The unique course taken by Sandy placed the communities and infrastructure of the Port of NY and NJ directly in the pathway of the storm.
- Many of the port's facilities were destroyed, and the port was closed for a week costing billions of dollars and impacting everything from the availability of fuel to consumer goods.
- The storm caused cascading system failures including power, communications, transportation and interruption of water supplies.

Findings the Study

- Extreme events are unpredictable and can overrun our existing engineered defenses.
- If protective measures are insufficient, then recovery must depend on adaptive responses and innovation to meet the immediate crises and unfolding events.
- Unity of effort is critical (e.g., NJ ROC).
- Trust among public and private stakeholders is a crucial element for the speed of responses and coordinating their effectiveness.

General Comments

- The purpose of the MTS is to provide for the mobility of maritime passengers and cargo.
- Planning to maintain mobility in the face of disruptions is essential for economic security.
- Security plans are not resilience plans.
- Resilience plans must anticipate all potential failures including loss of engineered defenses.
- Plans must emphasize both pre- and post-event courses of action to regain functionality including cargo re-routing at ports, if necessary.

Research Questions

- Should supply chain resiliency plans must include all stakeholders involved in logistics (terminal, carrier, & intermodal connectors) and transaction (shippers, 3PLs, brokers, freight forwarders)?
- Do we need both a theoretical (or conceptual) model and an applied (or operational) model to describe MTS resiliency and to plan our courses of action pre- and post-event?
- Should the planning be divided into the pre- or proactive preparations (physical/infrastructure based) and post- (human/organizational based) activities?