



The Impacts of Climate Change on Ports: Examples from the U.S. and Abroad

November 15, 2012

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ICF International

Defining Characteristics of Ports

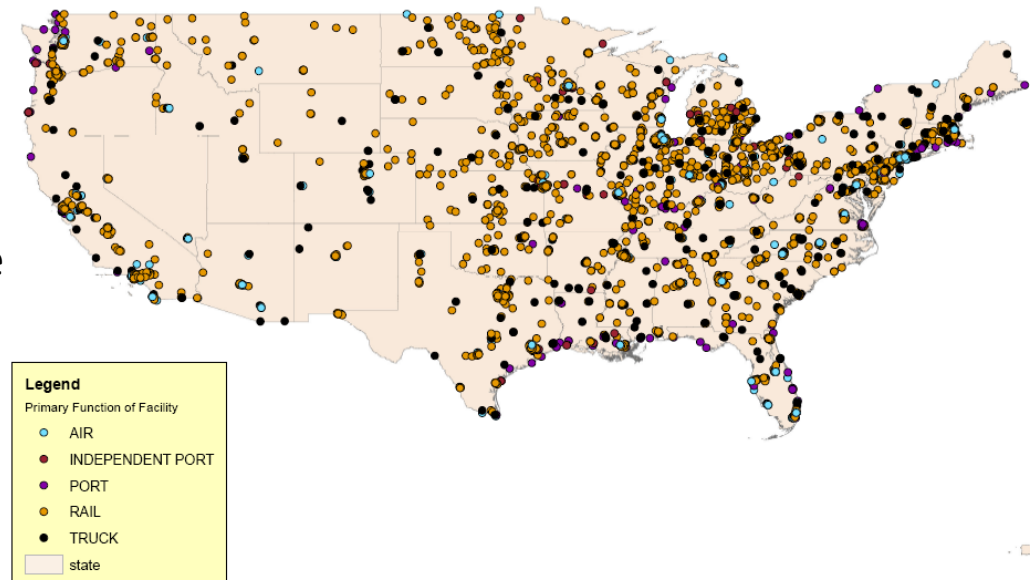
- **U.S. Freight System**

- Massive, multi-modal system including roads, airports, railroads, waterways, terminals, ports, and pipelines
- In 2007, freight system moved 51 million tons worth \$45 billion per day (*FAF3*); Waterborne freight was about 2.6 billion tons in 2007 (*BTS, 2012*)

- Terminal Assets and Operations:

- Facilities to accommodate ships
- Intermodal connections - trucks, and trains
- Handling gear
- Storage space (grain silos, storage tanks, refrigerated warehouses)
- Energy systems

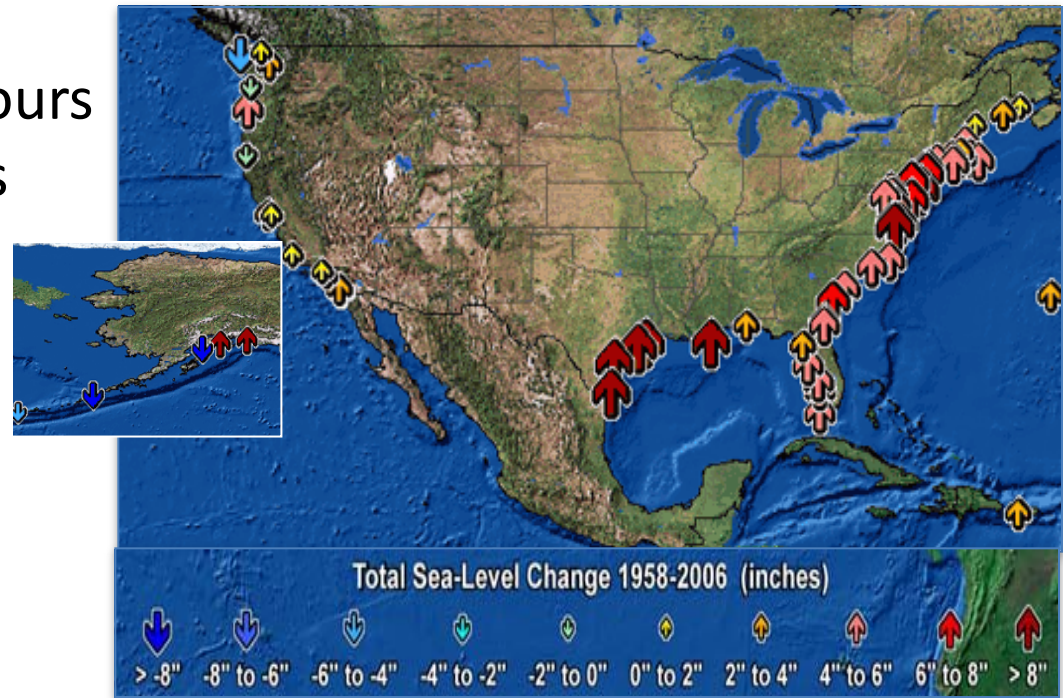
U.S. Intermodal Freight Facilities



Climate Changes are Underway in the U.S.

- Temperature rise
- Sea-level rise
- Increase in heavy downpours
- Rapidly retreating glaciers
- Thawing permafrost
- Longer growing season
- Longer ice-free season in the ocean and on lakes and rivers
- Earlier snowmelt
- Changes in river flows

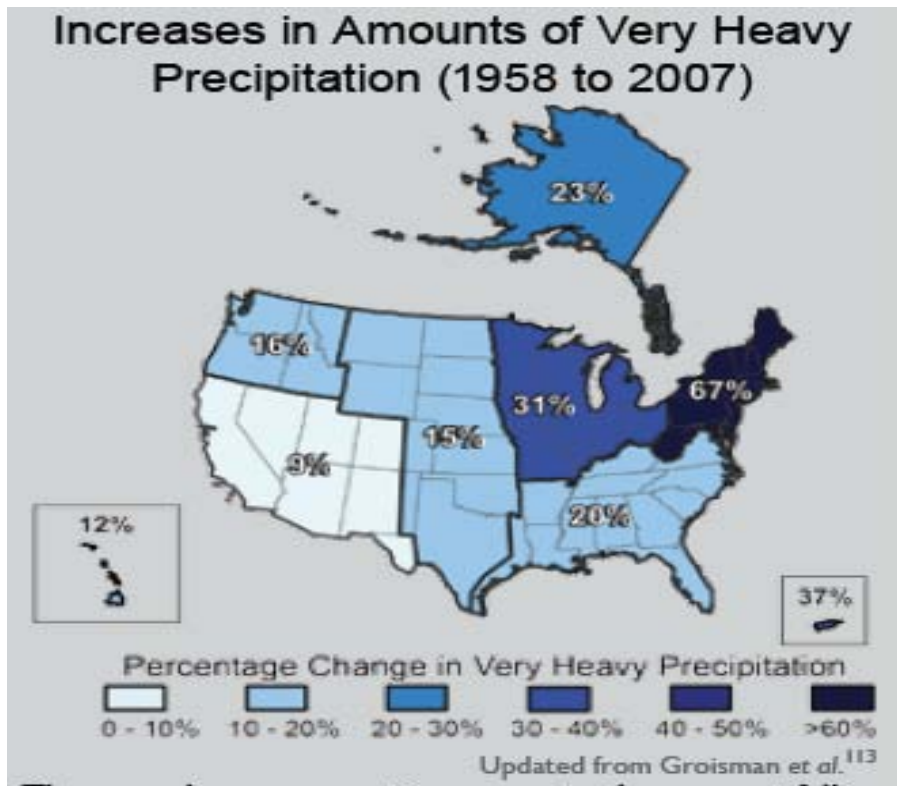
Observed U.S. Sea-Level Changes



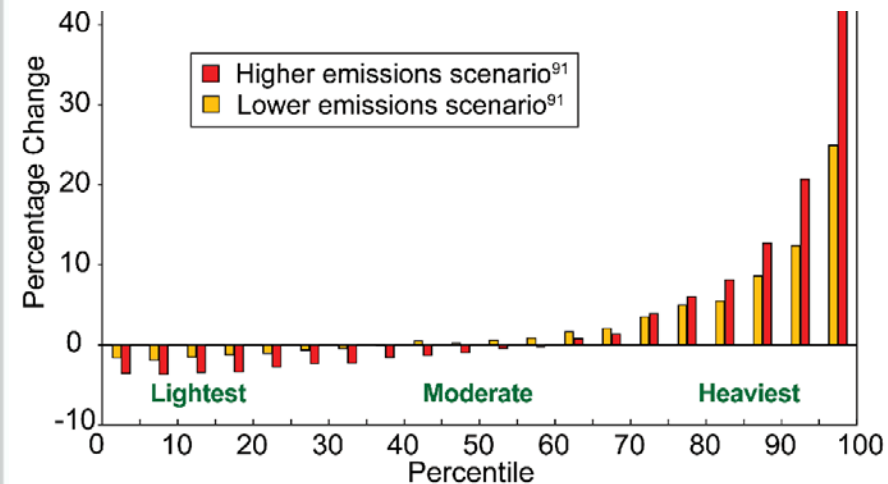
Source: USGCRP 2009

Floods and Droughts Have Become More Common

Increases in Very Heavy Precipitation Days, 1958-2007



Projected Change in Precipitation Intensity – 1990s vs 2090s



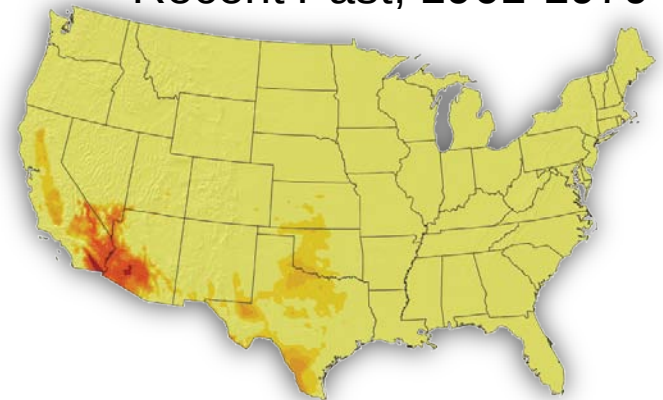
Source: USGCRP 2009

Increases in Extreme Heat will Limit Some Operations and Damage Roads and Rail

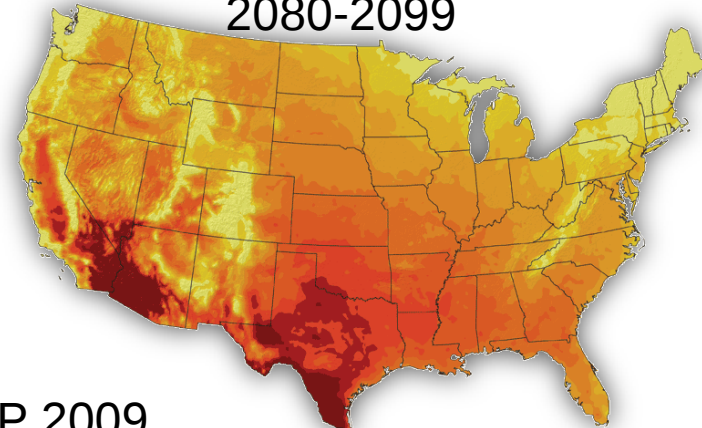


- Changes in maintenance and construction practices
- Rise in rail buckling
- Increased use of energy for refrigerated storage

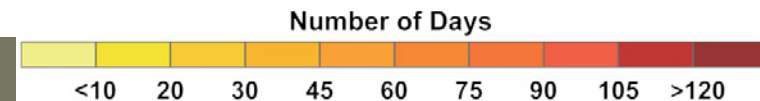
Number of Days Over 100°F
Recent Past, 1961-1979



Higher Emissions Scenario,
2080-2099



Source: USGCRP 2009



“Superstorm” Sandy



**Daily
Press**

Port of Virginia picking up slack for storm-damaged Port of New York/New Jersey

By Michael Welles Shapiro,
1:17 p.m. EDT, November 1, 2012



Due to inclement weather in the New York and New Jersey region, the Port Authority is working to restore services at all of its facilities.

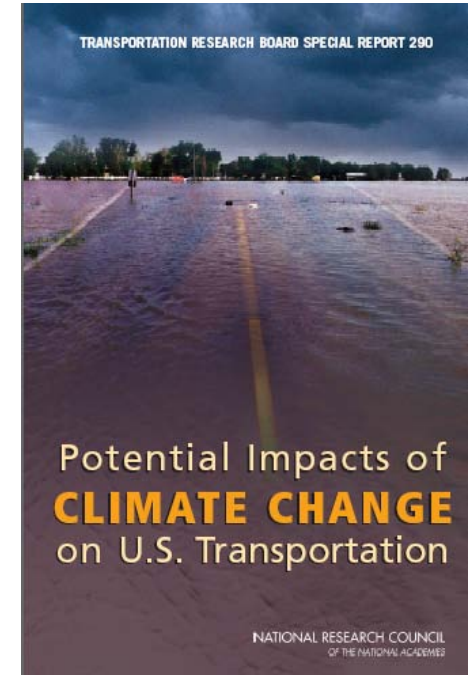
More information [▶](#)

Exposure of Freight Terminals to Climate Change

Special Report 290, Transportation Research Board (2008)



- Six of the nation's top 10 U.S. freight gateways are at risk from sea level rise
- Dry conditions could lead to low water levels, requiring additional dredging to keep shipping channels open
- Extreme weather threatens structures, power supply and supply chain
- Heat events increase need for refrigerated storage and transport



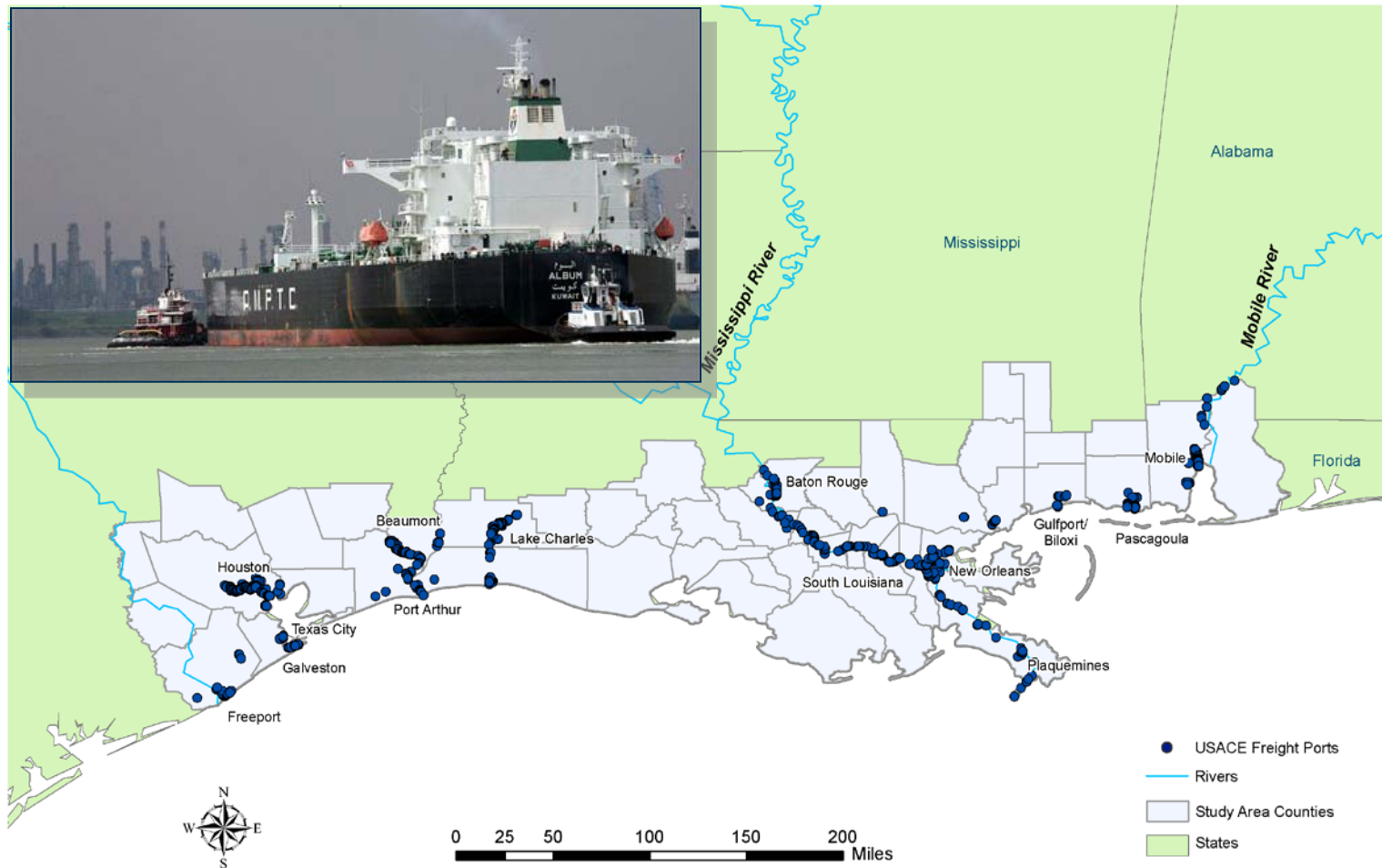
Why this matters: Port Impacts*

CLIMATE EFFECT	IMPACTS
More hot days	• Asphalt deterioration • Thermal expansion of bridge joints, paved surfaces • Pavement & structural design changes
Wind speeds	• More frequent sign damage • Need for stronger materials
More frequent, intense precipitation	• Increased flooding • Increased peak stream flow could affect scour rates • Standing water could affect structures adversely
Increased coastal storm intensity	• Increased storm surge and wave impacts • Decreased expected lifetime of structures • Erosion of land supporting coastal infrastructure
Sea level rise	• Permanent inundation • Erosion of road base • May amplify storm surges in some cases • Changes in port competitiveness

*Sources: “*The Gulf Coast Study, Phase 1*,” Climate Change Science Program, 2008 and “*Assessing the Need for Adaptation*,” Courtesy of Carter Atkins, 2011.

Example: Gulf Coast

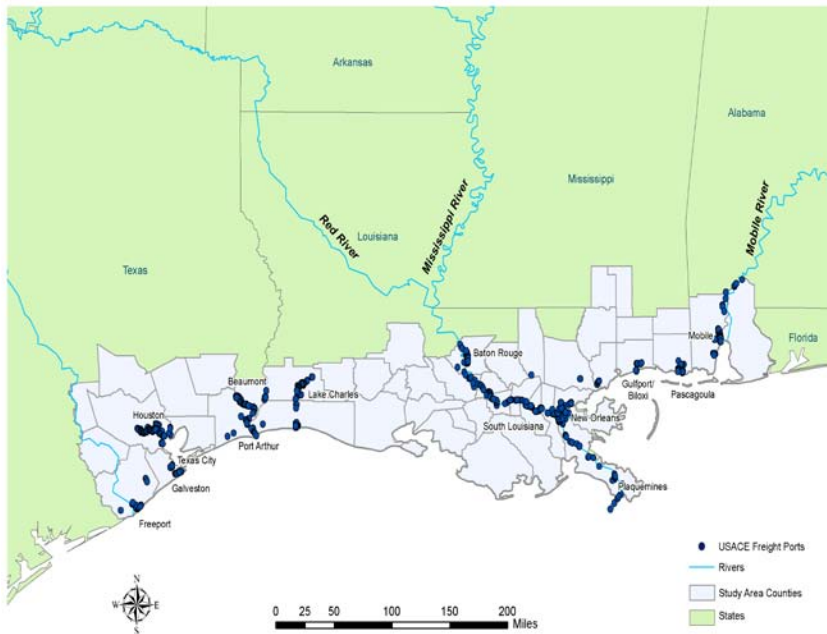
40% of US marine tonnage, 60% of energy imports



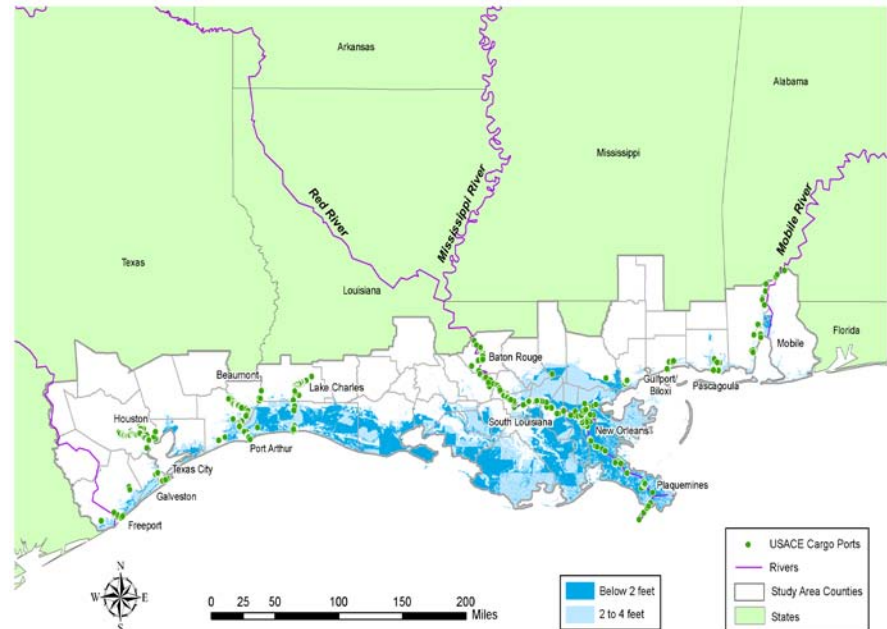
Gulf Coast Study

Ports Vulnerable to Relative Sea Level Rise

Baseline (Present Day)



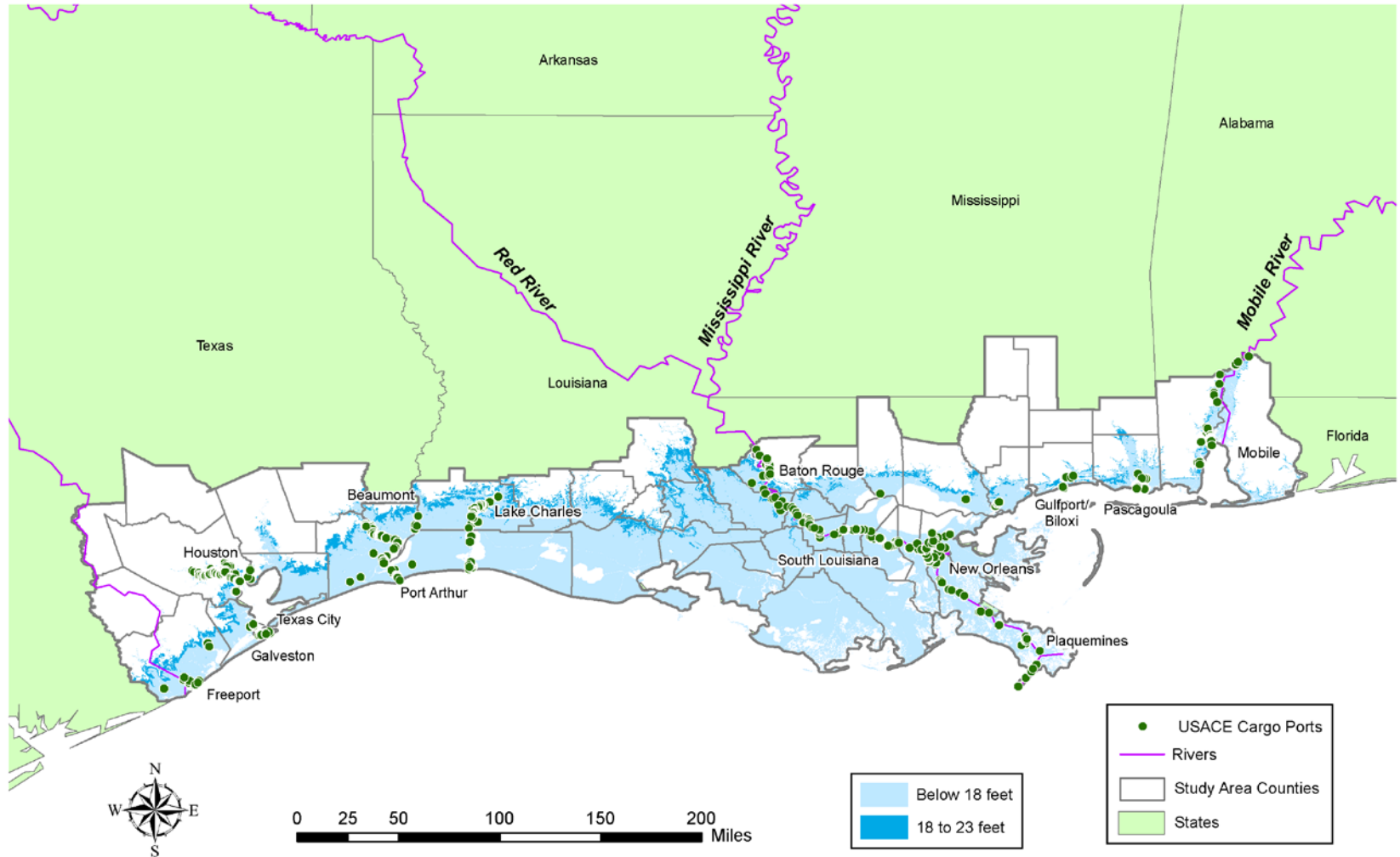
2 - 4 Feet of Sea Level Rise



Study ('08) results based on IPCC4: 7 – 23" SLR
Global Climate Change Impacts in US ('09): 36 – 48"

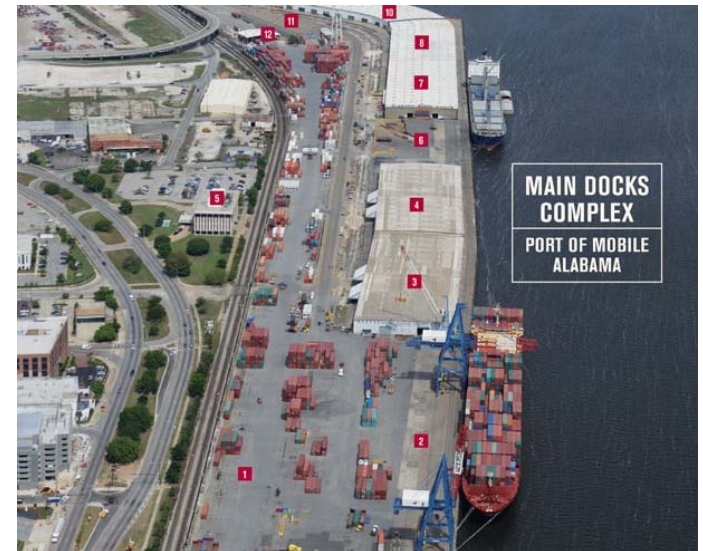
Gulf Coast

Freight Handling Ports Facilities Vulnerable to Storm Surge Surge



Port of Mobile, Alabama

- 67.5 million short tons of cargo in 2008
 - Container, break/bulk/dry bulk, liquid bulk, seafood, ship building and repair services
- Intermodal connectivity and access issues are a key concern for ports
- Sensitivity differs by service:
 - Containers can flood during storms
 - Refrigerated goods & equipment require electricity
 - Wind can kick up dust at coal terminal
 - High temperatures can trigger workforce safety restrictions
 - Rains can increased dredging costs



Credit: Alabama State Port Authority

Port of Mobile, Alabama

- Major concern is impacts from hurricanes
 - May cause damage to cargo, piers, buildings
 - Generally, they are used to big storms and begin operating again quickly
 - Biggest fear is a crane or major structure getting knocked over and damaging other facilities in its path



Credit: Minerals Management Service, via
http://home.versatel.nl/the_sims/rig/h-katrina.htm

Credit: Alabama State Port Authority

Example: Port of Los Angeles*

Rand corporation

- Founded in 1907
- 69 km of waterfront
- 3,035 hectares of land and water
- 26 major cargo terminals



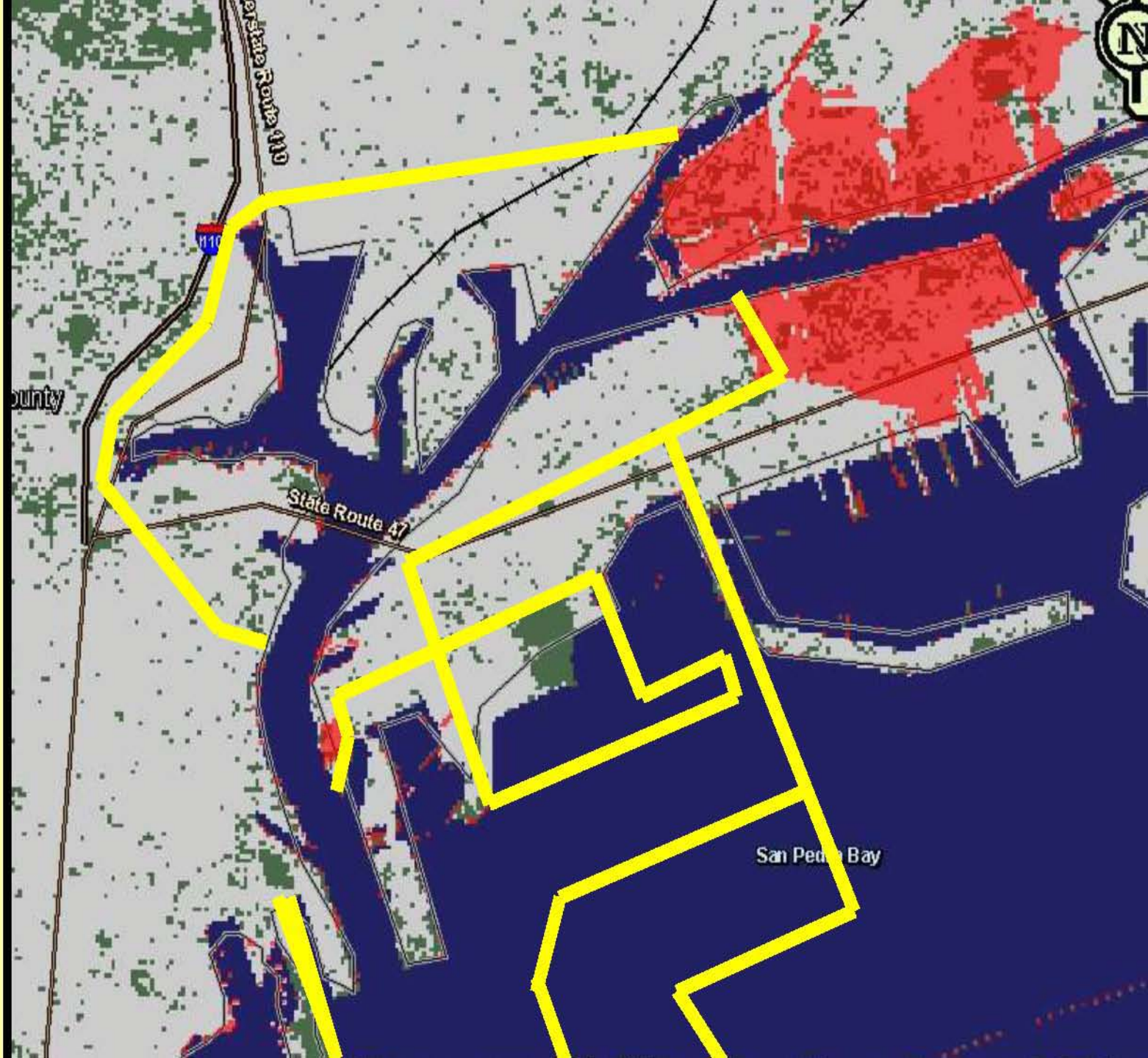
*Adapted from "Assessing the Need for Adaptation: The Port of Los Angeles/ RAND Corporation Study," Courtesy of Carter Atkins, 2011.

No SLR



1 Meter
SLR

SLR
Affected
Areas



2 Meter
SLR

SLR
Affected
Areas



Example: Felixstowe Dock and Railway

UK Climate Impacts Programme

- **Location:** Port of Felixstowe, UK
- **Facility Type:**
 - Largest container port in the UK
 - Port owns and operates intermodal rail terminals in addition to port
- **Activity:**
 - Directed by the Climate Change Act of 2008 to report on the current and future predicted impacts of climate change
 - Conducted a risk assessment in collaboration with UKCIP
- **Key Climate Risks Identified:**
 - Power outages
 - Increased frequency of crane and pilot delays
 - Port closure



Felixstowe Dock and Railway

Risk Assessment Methodology

Climate variable		Impact	Consequence of impact	Likelihood	Magnitude	Risk
				Current		
				2030's		
				2060's		
1	Increased frequency of high winds or other extreme weather	Power supplies disrupted owing to off-site disruption to the network	All work would stop. Loss of Business. Reputation damage.	2	5	10
				1	5	5
				1	5	5
2	Increased frequency of high winds or other extreme weather	Ships break loose from moorings	Damage to ship, quay and cranes; disruption costs; insurance premiums rise.	1	2	2
				1	2	2
				1	2	2

Risk = **likelihood** of an impact occurring x **magnitude** of the consequences if it occurs

Likelihood	Magnitude	Consequence
1 = Negligible	1 = insignificant	20 - 25 = Very High
2 = Rare	2 = minor	15 - 20 = High
3 = Unlikely	3 = moderate	10 - 15 = Medium
4 = Possible	4 = significant	5 - 10 = Low
5 = Probable	5 = catastrophic	0 - 5 = Inconsequential

The results of the risk assessment are shown in Table 1.

- **Key Thresholds:**
 - Wind speeds > 45mph
 - 1 day work stoppage
 - 3 day closure

The background of the slide is a photograph of a port area with several large cargo ships docked at a pier. A vibrant rainbow is visible in the sky above the ships, adding a hopeful or resilient tone to the image. The text is overlaid on this image.

UNITED NATIONS CONFERENCE ON TRADE AND DEVELOPMENT

UNCTAD

Ad Hoc Expert Meeting on
**“Climate Change Impacts and Adaptation:
A Challenge for Global Ports”**

29-30 September 2011- Room XXVI, Palais des Nations, Geneva

UN Conference on Trade and Development

- Meetings of “Experts”
 - September 2011
 - September 2010
 - February 2009
- Presentations on ports in:
 - Durban, South Africa
 - Hamburg, Germany
 - Mauritius
 - Caribbean
 - Tokyo
 - San Diego
 - Gulf Coast
 - Cartagena

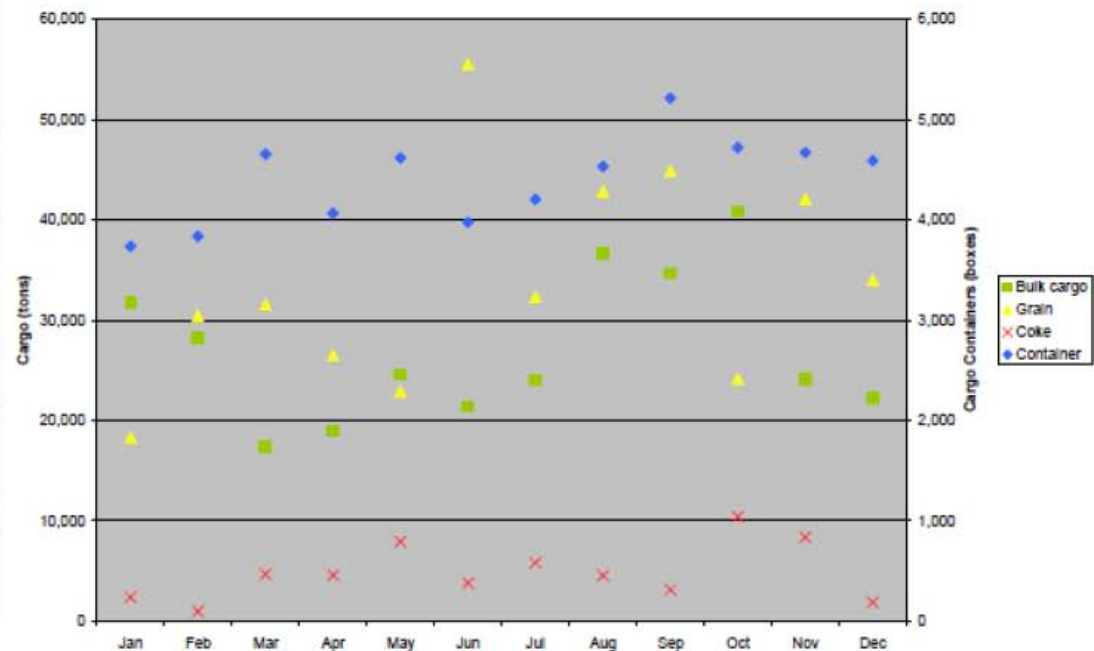
Port Muelles el Bosque (MEB), Cartagena, Colombia



Cartagena: 12% of Colombia's international trade
MEB: 1% of Colombia's international trade (in tonnage)

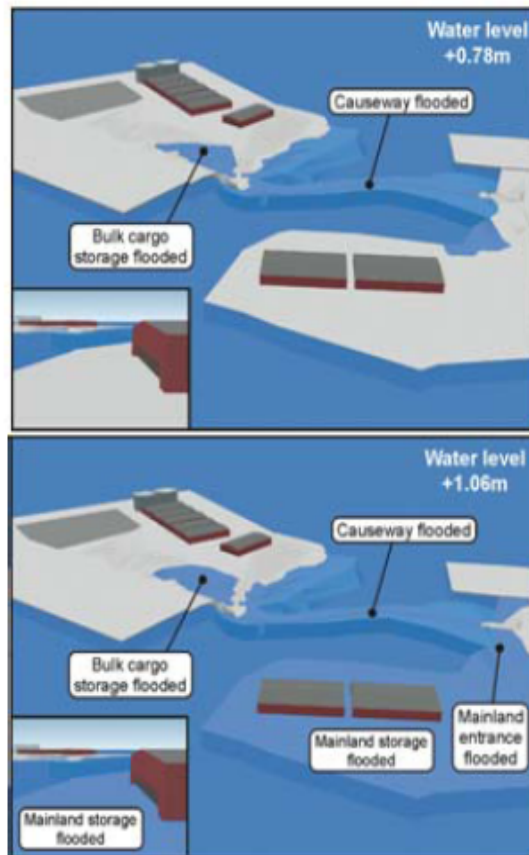
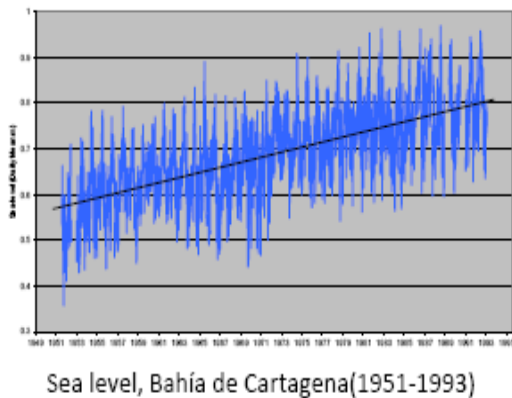
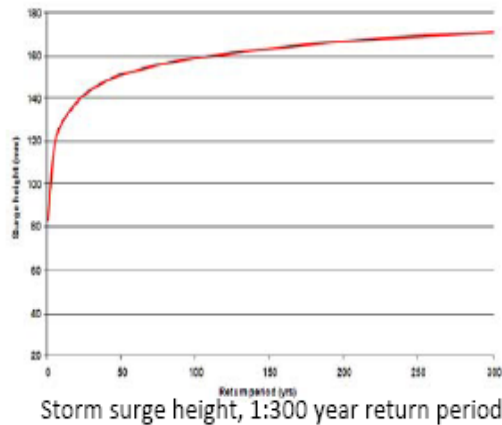


Source: IFC, MEB 2011



Port Muelles El Bosque: Cartagena, Colombia

International Finance Corporation



Seawater flooding, 2050, observed and accelerated SLR scenarios



Financial analysis of the impacts

Thank you!