Bayport Terminal Climate Change Study

Port of Houston Authority

Environmental Affairs Department

Lily Wells AICP

Presentation Content

INTRODUCTION
OVERVIEW
THE US DOT GULF COAST STUDY
BAYPORT TERMINAL CLIMATE CHANGE STUDY
CONCLUSIONS AND RECOMMENDATIONS
QUESTIONS AND ANSWERS

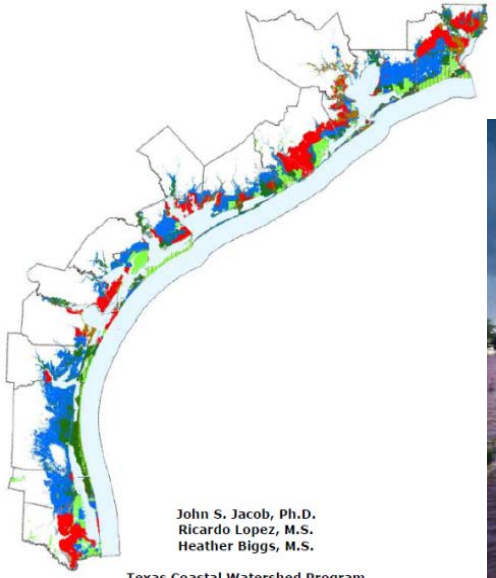
U.S. Department of Transportation
Federal Highway Administration

THE FEDERAL HIGHWAY ADMINISTRATION'S

CLIMATE CHANGE & EXTREME WEATHER VULNERABILITY ASSESSMENT FRAMEWORK

DECEMBER 2012

Anticipated Local Response to Sea Level Rise Along the Texas Coast:
A First Approximation

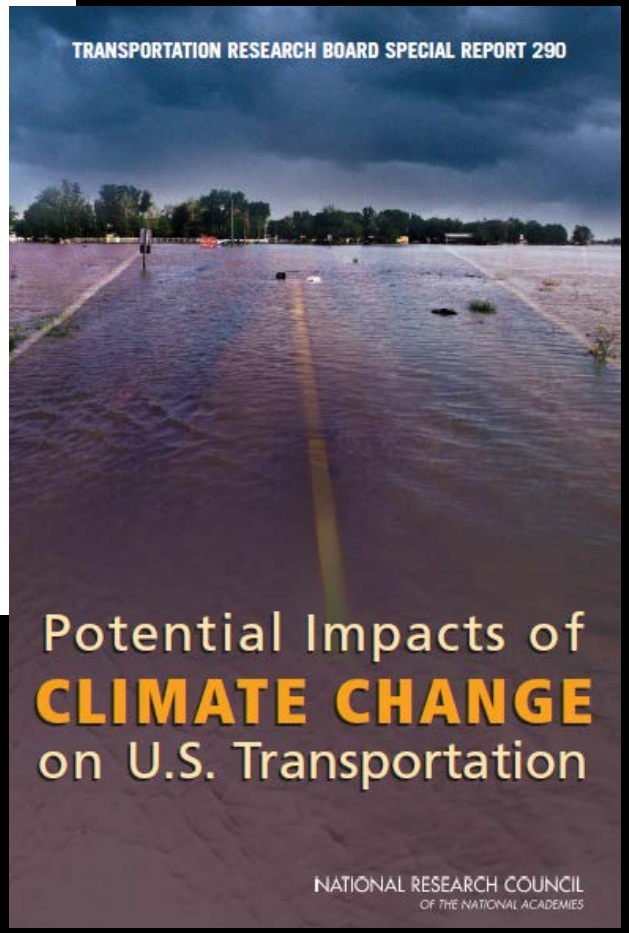


John S. Jacob, Ph.D.
Ricardo Lopez, M.S.
Heather Biggs, M.S.

Texas Coastal Watershed Program
Texas Sea Grant/ Texas Cooperative Extension
The Texas A&M University System

December 20, 2007

TRANSPORTATION RESEARCH BOARD SPECIAL REPORT 290



Potential Impacts of CLIMATE CHANGE on U.S. Transportation

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South Korea, Norway to Establish New Arctic Shipping Routes

Posted on Sep 12th, 2012 with tags Arctic, asia, establish, europe, News by topic, Norway, Routes, SHIP

South Korean President Lee Myung-bak is visiting Norway with an aim of establishing new shipping routes over the Arctic which might cut in half the current travelling times and upsurge trade exchange between Europe and Asia, Barents Observer informs.

BBC News Sport Weather Travel Future

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25 August 2011 Last updated at 12:42 ET

628 Share

Arctic sea routes open as ice melts

By Richard Black
Environment correspondent, BBC News

Two major Arctic shipping routes h opened as summer sea ice melts, European satellites have found.

Data recorded by the European Space A (Esa) Envisat shows both Canada's Nor Passage and Russia's Northern Sea Rou simultaneously.

This summer's melt could break the 2007 for the smallest area of sea ice since th era began in 1979.

Shipping companies are already eyeing if they remain open regularly.

The two lanes have been used by a nur recent years.

But the Northern Sea Route has been fr succession of tankers carrying natural port of Murmansk to sail along the Siberi

"They're often open at the same time in t you can get through them," observed Pe from the University of Cambridge

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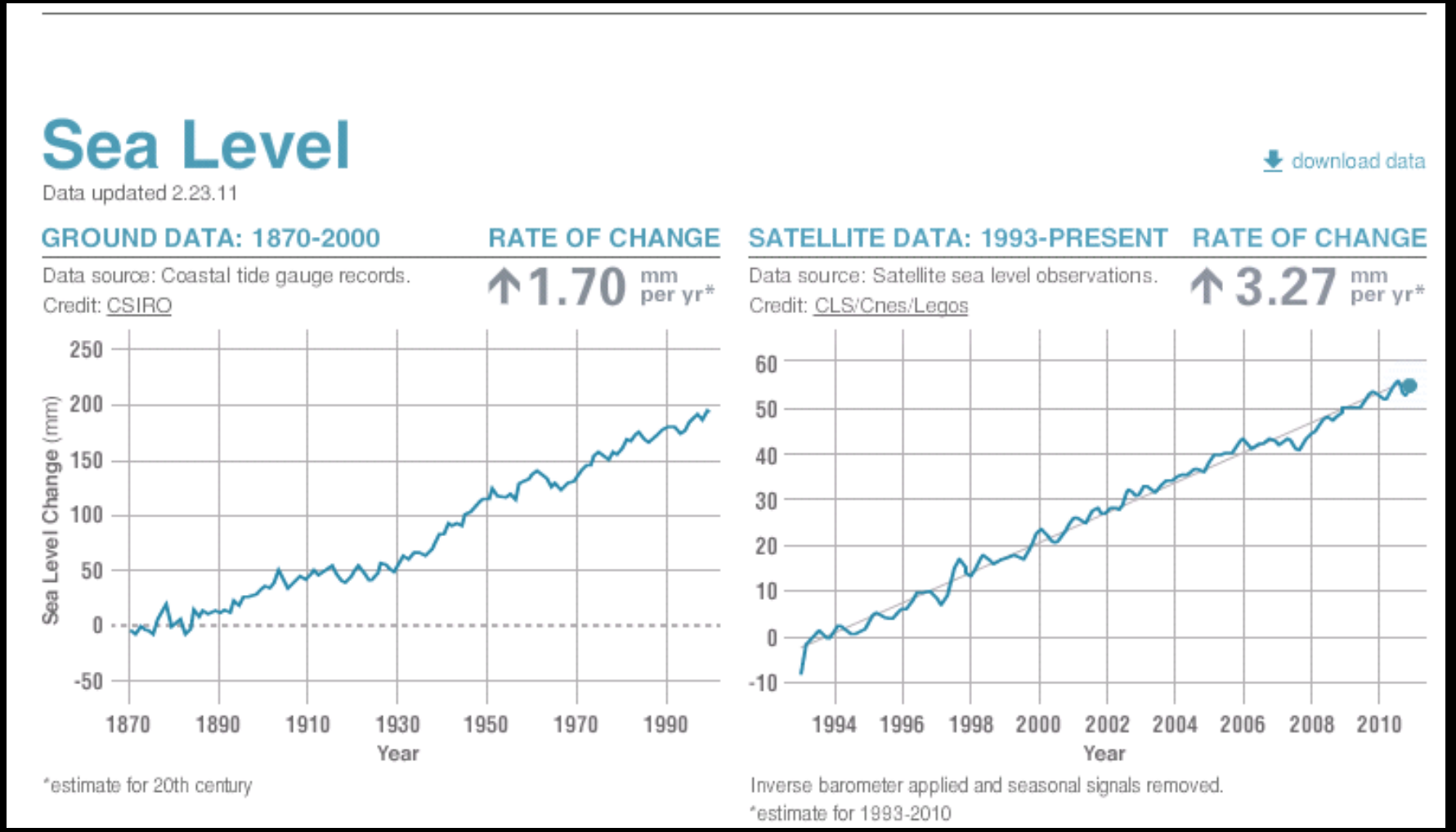
LATEST UPDATE: 26/08/2012 - ARCTIC OCEAN - CHINA - SHIPPING

Shipping developers eye up route through melting Arctic

While the rate of ice loss in the Arctic has alarmed environmentalists this summer, it has left maritime developers rubbing their hands with glee, as the prospect of a commercially viable Northern Sea Route looks increasingly likely.

By Sébastian SEIBT (text)

Global Average Sea Level is Rising



(Data from NASA)

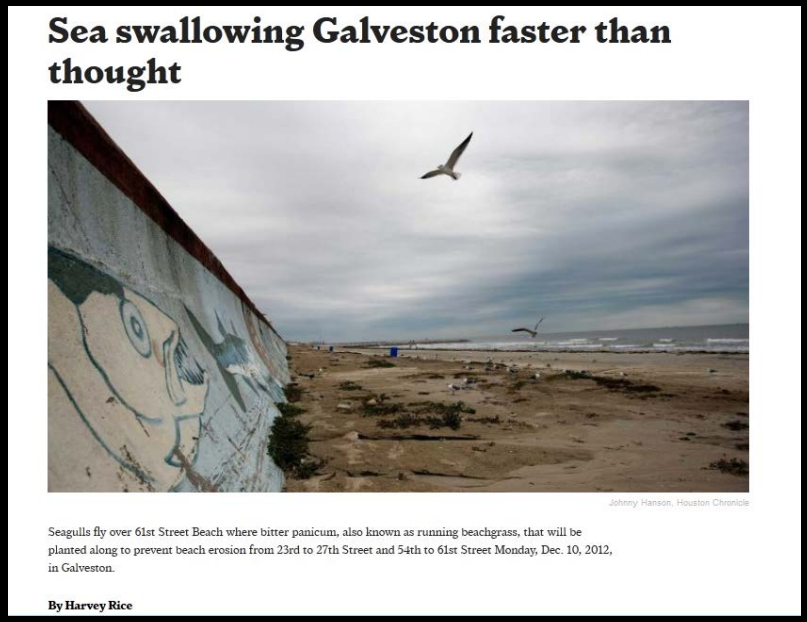
Vulnerabilities: Ports and Harbors

- Hoboken, New Jersey
  - a Hudson River Marina across New York City
- Staten Island, New York
  - a 168-foot water tanker, sits on the shore in the Stapleton neighborhood

Vulnerabilities: Coastal Infrastructure

- Storm Surge
  - Mirlo Beach, North Carolina
  - Oct. 30, 2012

- Sea Level Rise
  - Jan 2, 2013
  - Houston Chronicle



Sea swallowing Galveston faster than thought

Johnny Hanson, Houston Chronicle

Seagulls fly over 61st Street Beach where bitter panicum, also known as running beachgrass, that will be planted along to prevent beach erosion from 23rd to 27th Street and 54th to 61st Street Monday, Dec. 10, 2012, in Galveston.

By Harvey Rice

Vulnerabilities: Supply Chain

Warping Rail lines

- “Heat: train derailment”
  - July 2012, D.C. Metro
- “Extreme Texas Heat Threatens Rail Lines”
  - August 3, 2011
- “The Massachusetts Bay Transportation Authority has had to repair heat kinks"
  - July 7, 2010
- “Virginia Railway Express passengers can expect delays as the extreme heat forces trains to slow down.”
  - July 6, 2010

Vulnerabilities: Airports and Roadways

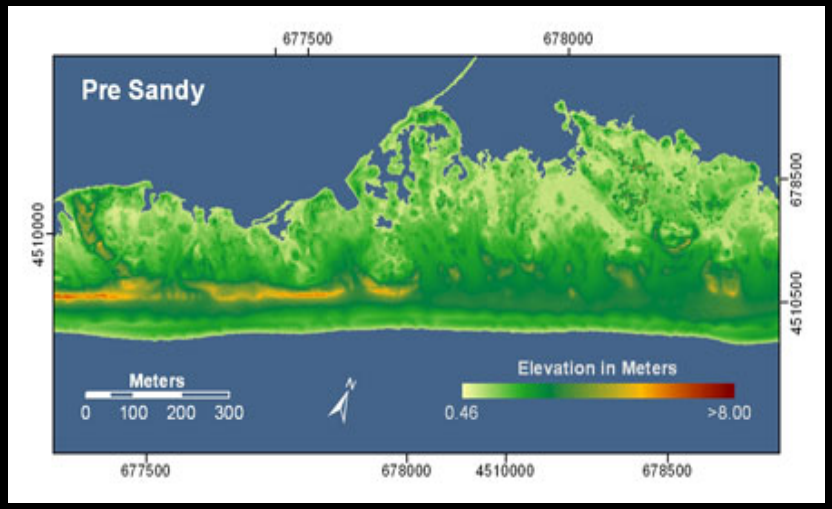
- "Airplane stuck in heat-softened tarmac"
  - Reagan National Airport, Washington DC, July 2012
- "SUV goes airborne after road buckles"
  - Eau Claire, Wis. , *Jul 3, 2012*
- "Heat wave expands, as do signs of the times: buckled roads"
  - Idaho, Wisconsin, Illinois Pennsylvania, Minnesota July 2012
- "Buckled road caused crash"
  - Oklahoma Turnpike Authority July 2011
- "In Minnesota, a state legendary for its cold winters, the heat and humidity is so high this week that highway pavement was buckling in the Minneapolis-St. Paul area. "
  - Jun 7, 2011

Vulnerabilities: Coastal Communities

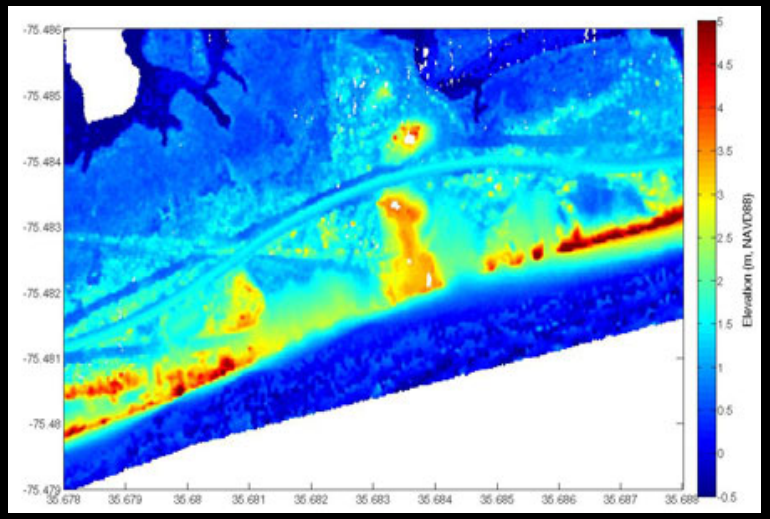
Before and After

Vulnerabilities: Coastal Communities

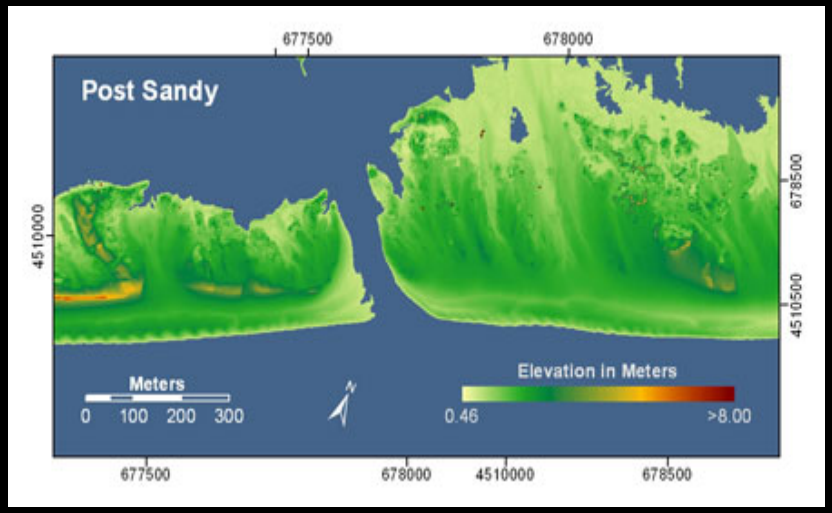
Before and After

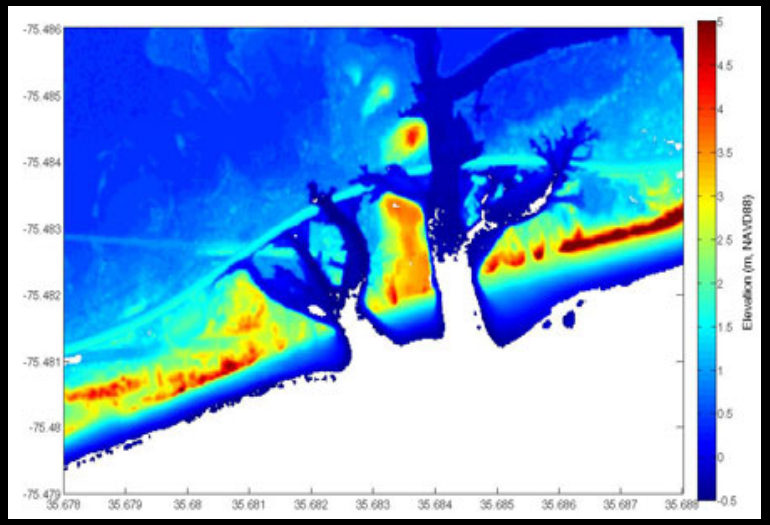


Fire Island, New York



Pea Island National Wildlife Refuge, NC.



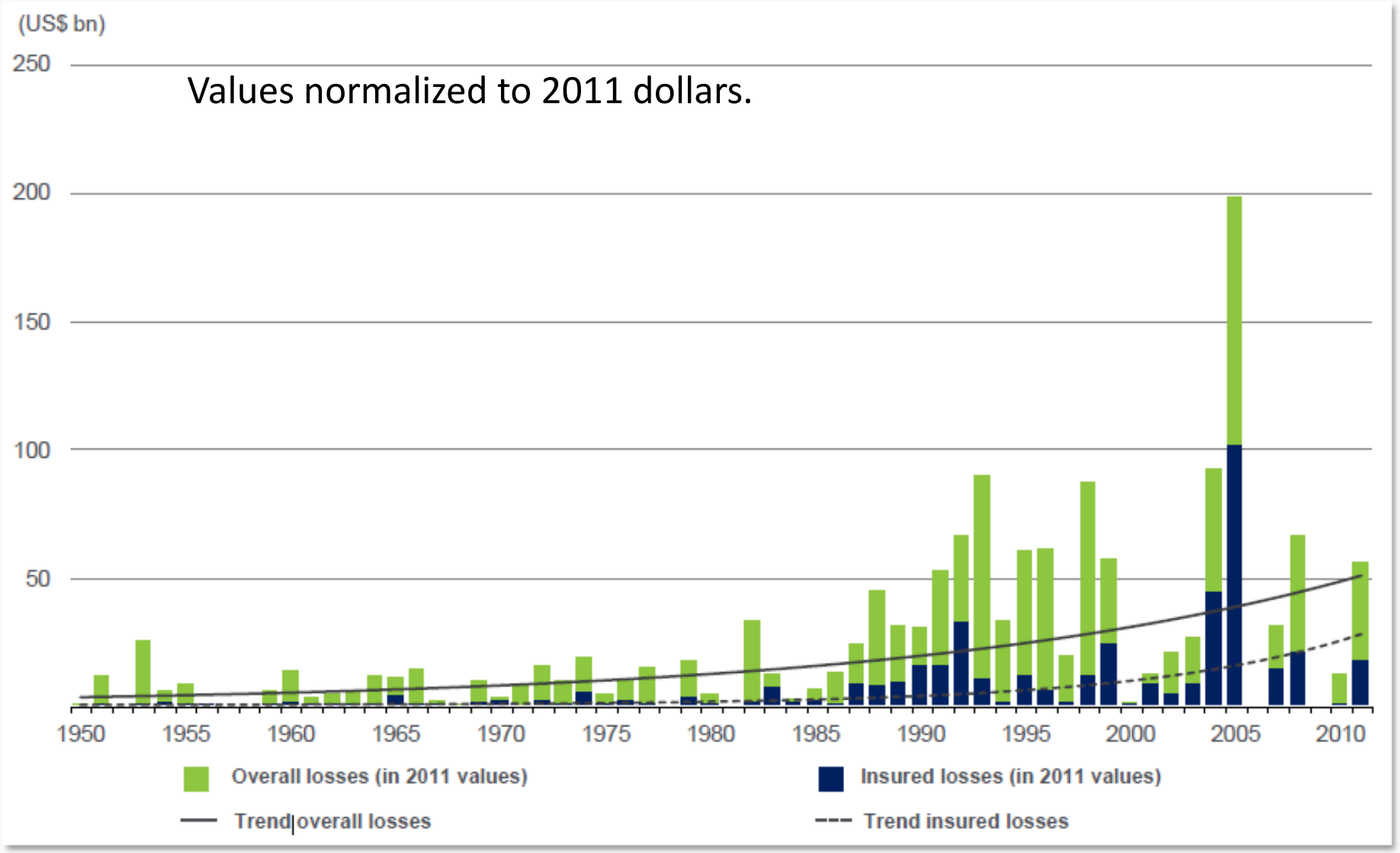


NatCatSERVICE

Great weather catastrophes worldwide 1950 – 2011

Overall and insured losses with trend

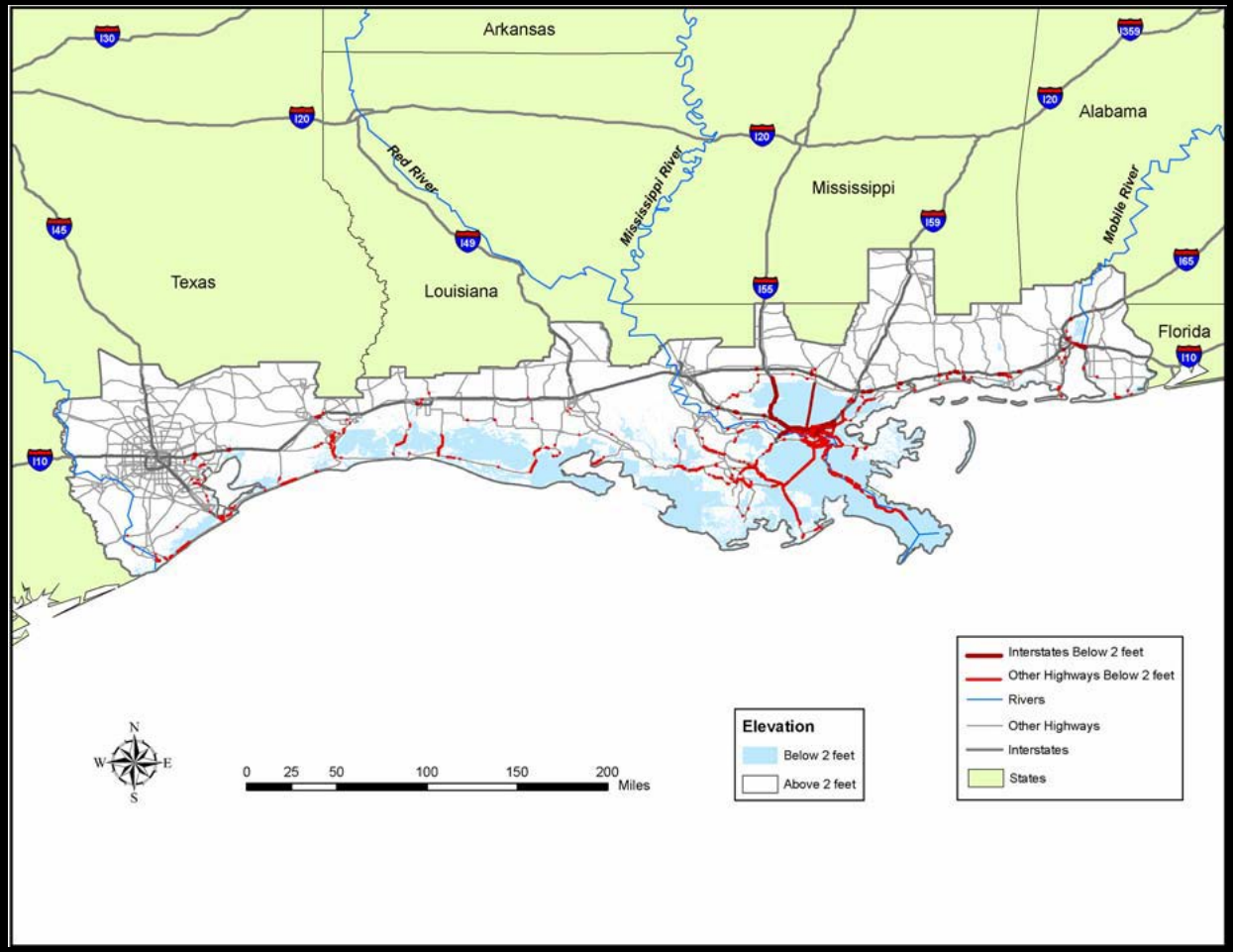
Munich RE



Impacts of Climate Change and Variability on Transportation Systems and Infrastructure: Phase I

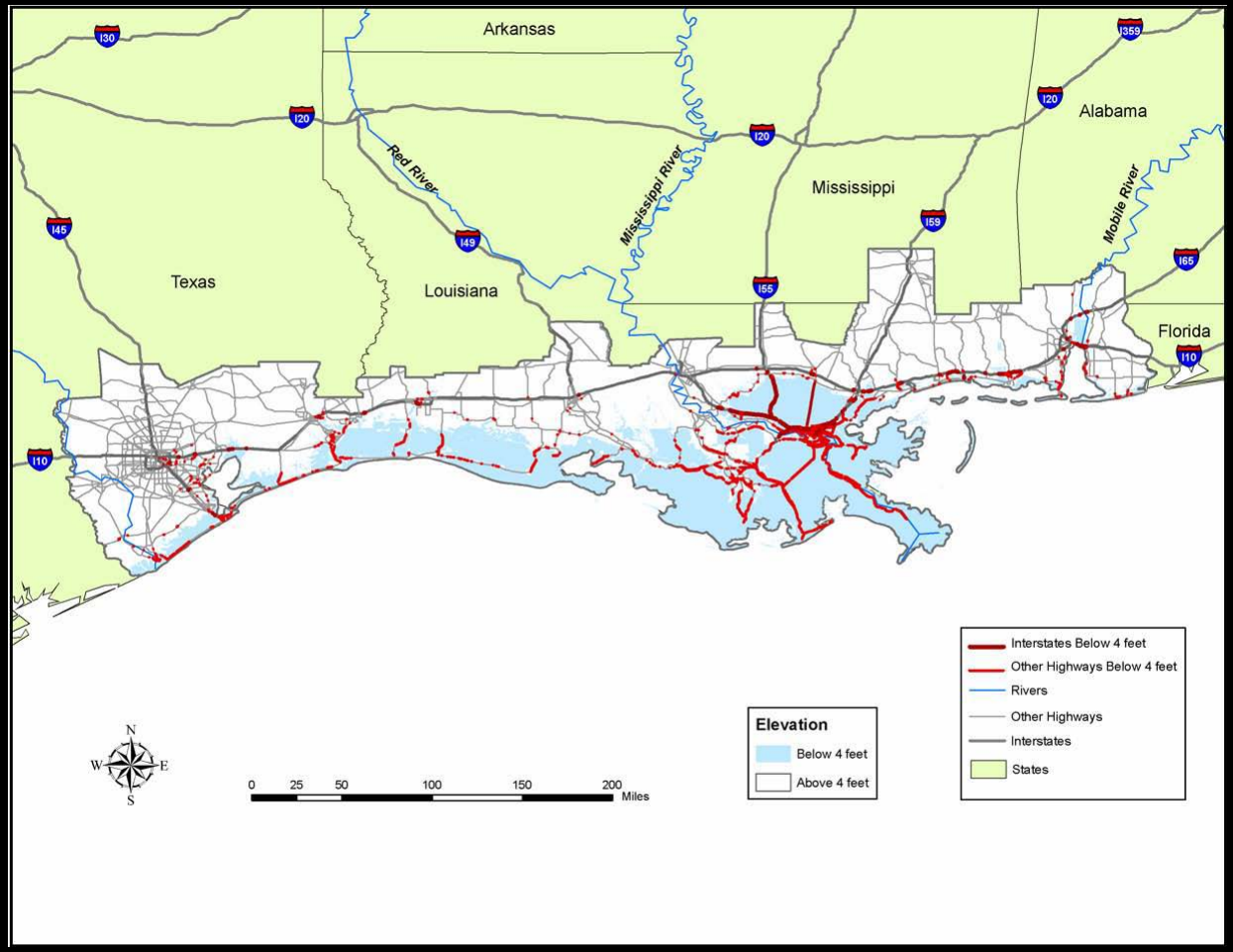
THE GULF COAST STUDY

Highways at risk from a relative SEA LEVEL RISE of 2 ft



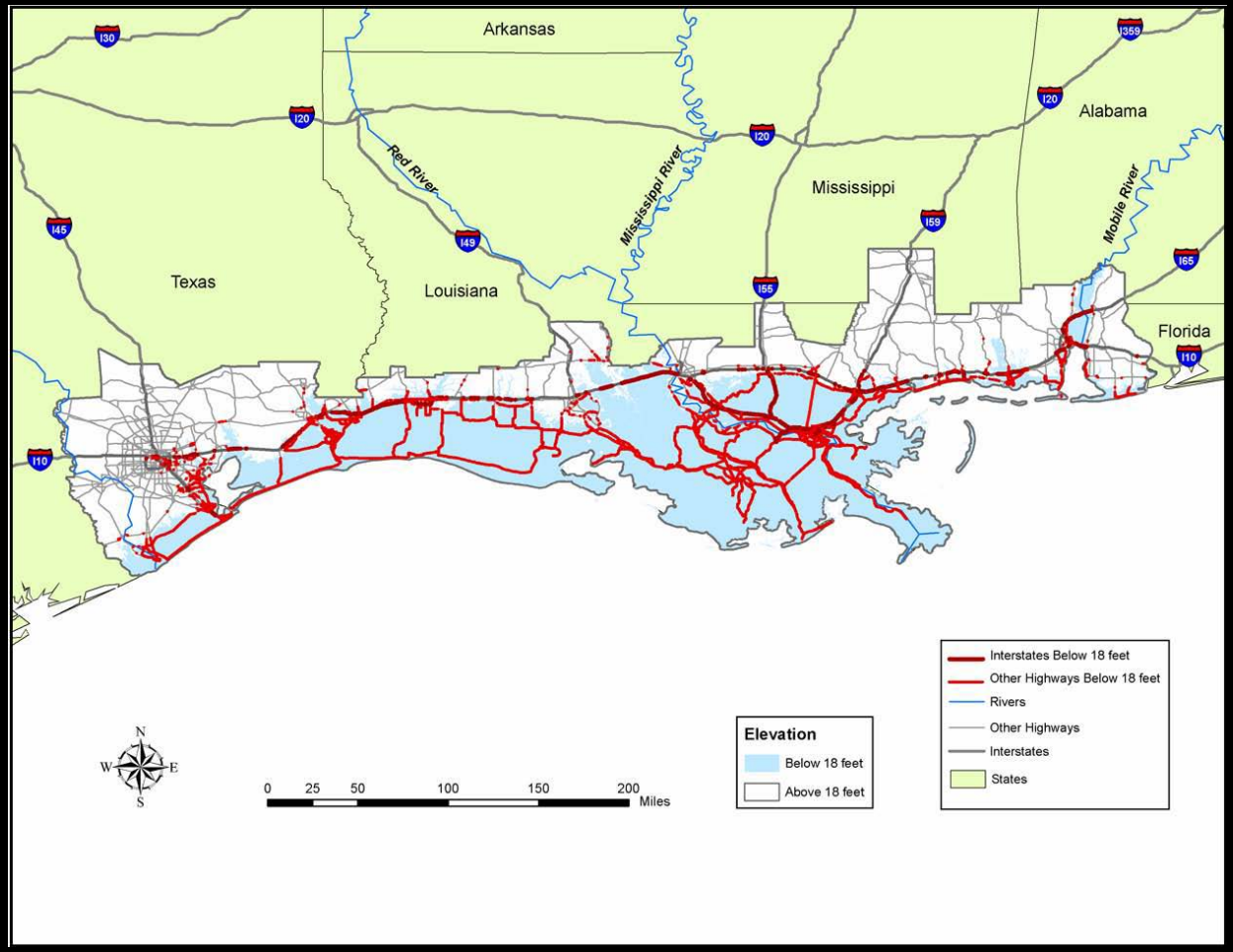
(Source: U.S. DOT data; *Cambridge Systematics analysis*)

Highways at risk from a relative SEA LEVEL RISE of 4 ft



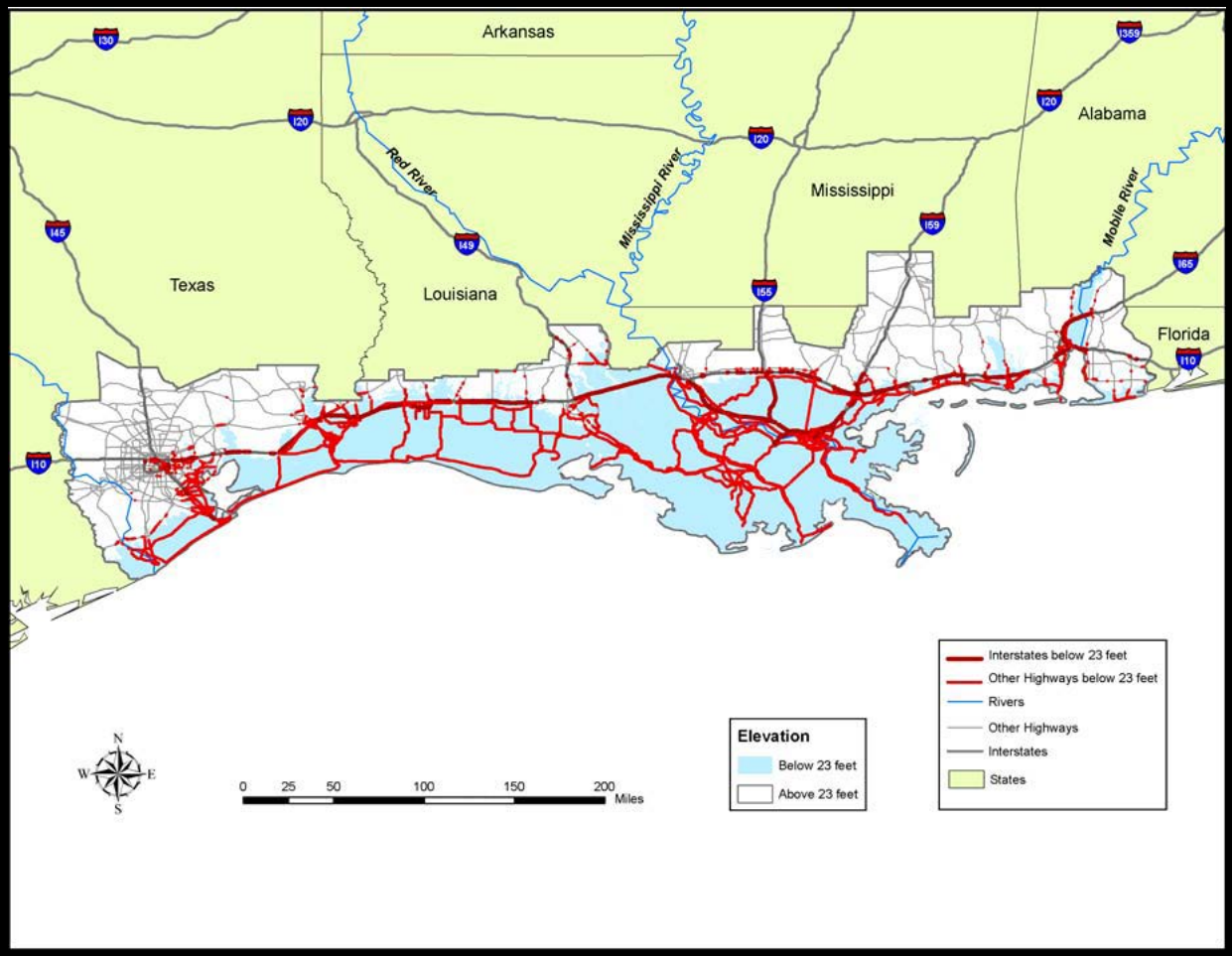
(Source: U.S. DOT data; *Cambridge Systematics analysis*)

Highways at risk from STORM SURGE at elevations currently below 18 ft



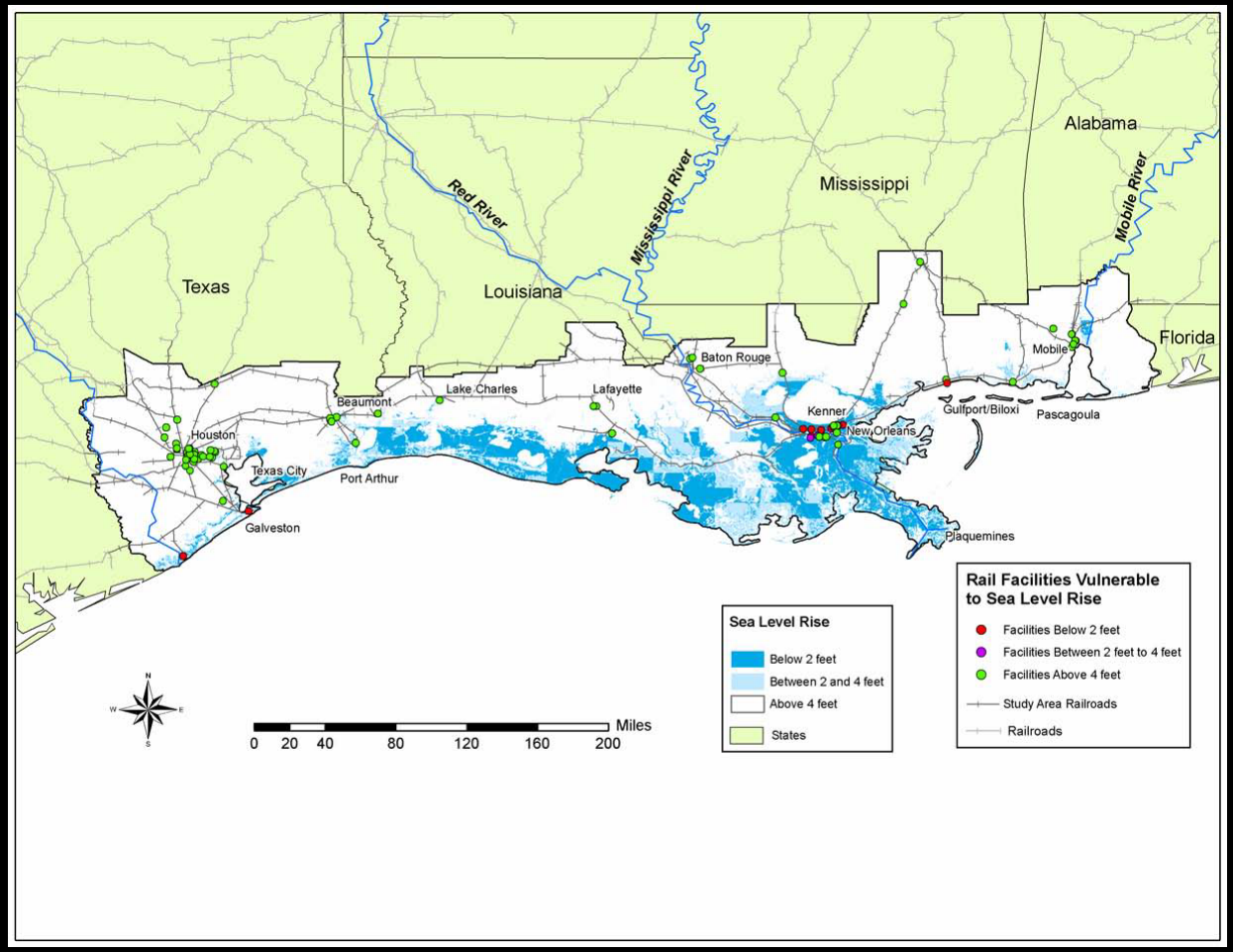
(Source: U.S. DOT data; *Cambridge Systematics analysis*)

Highways currently at risk from STORM SURGE at elevations currently below 23 ft



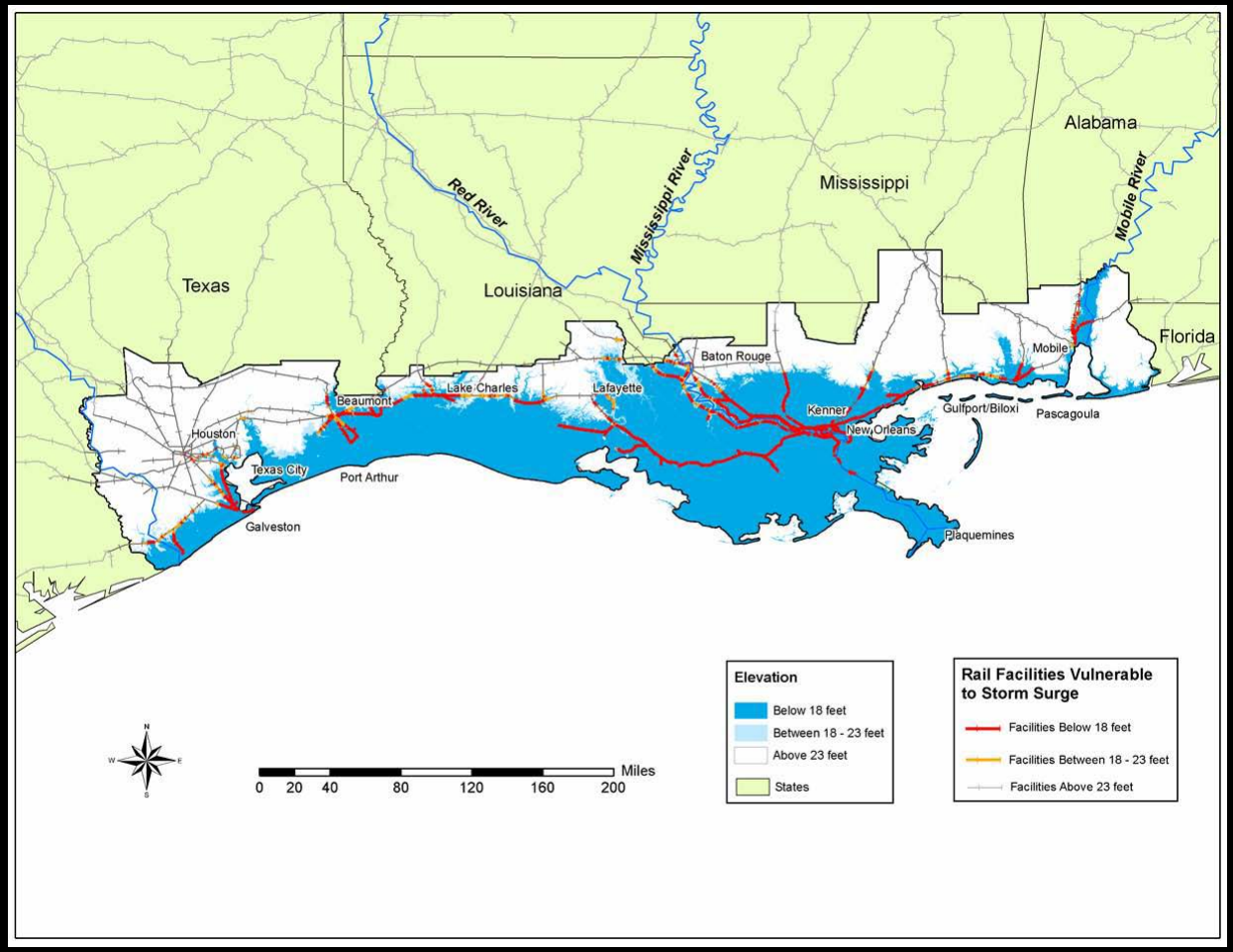
(Source: U.S. DOT data; *Cambridge Systematics analysis*)

Railroad-owned and -served freight facilities at risk due to relative SEA LEVEL RISE 2 and 4 ft



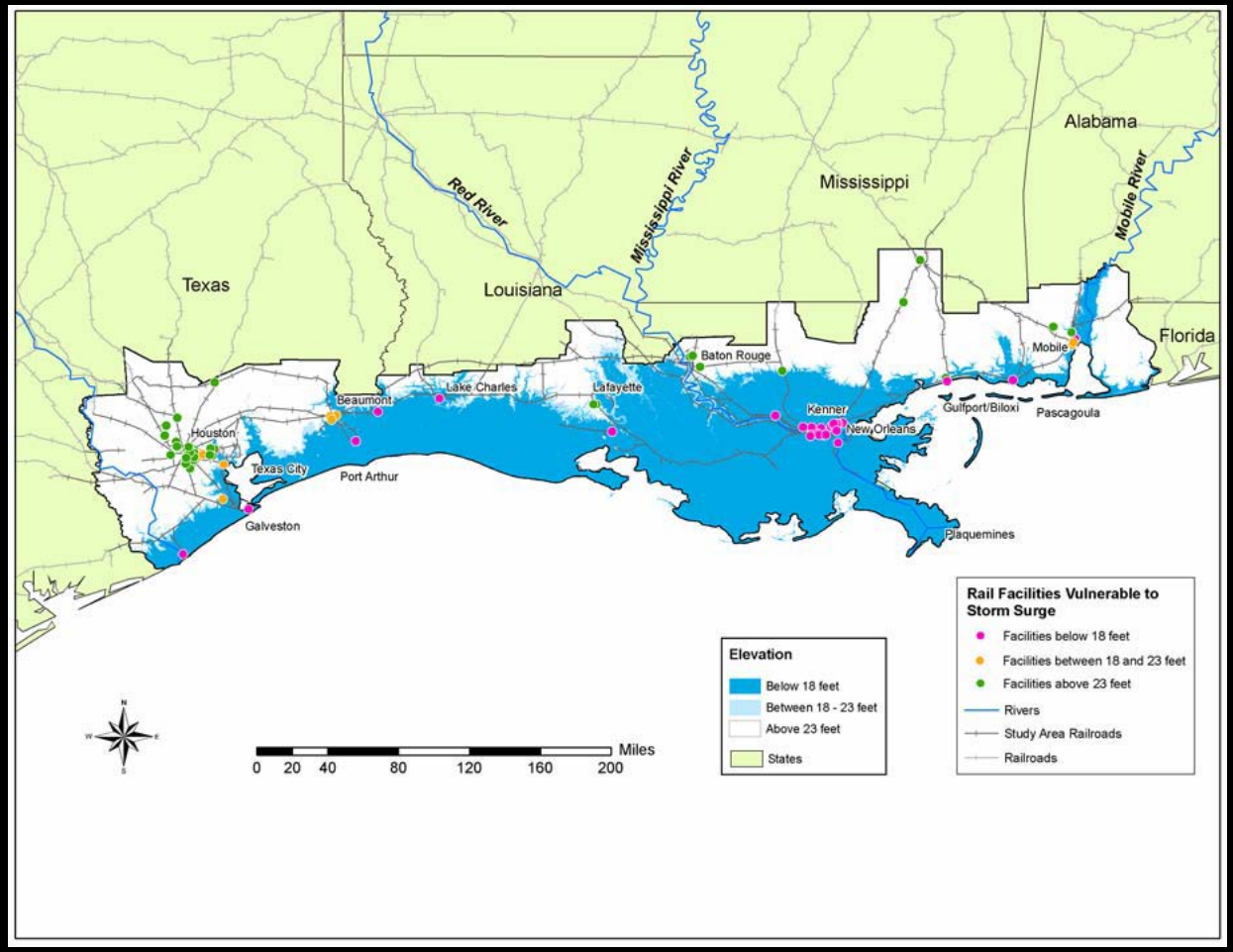
(Source: U.S. DOT data; *Cambridge Systematics analysis*)

Rail lines at risk due to STORM SURGE of 18 and 23 ft



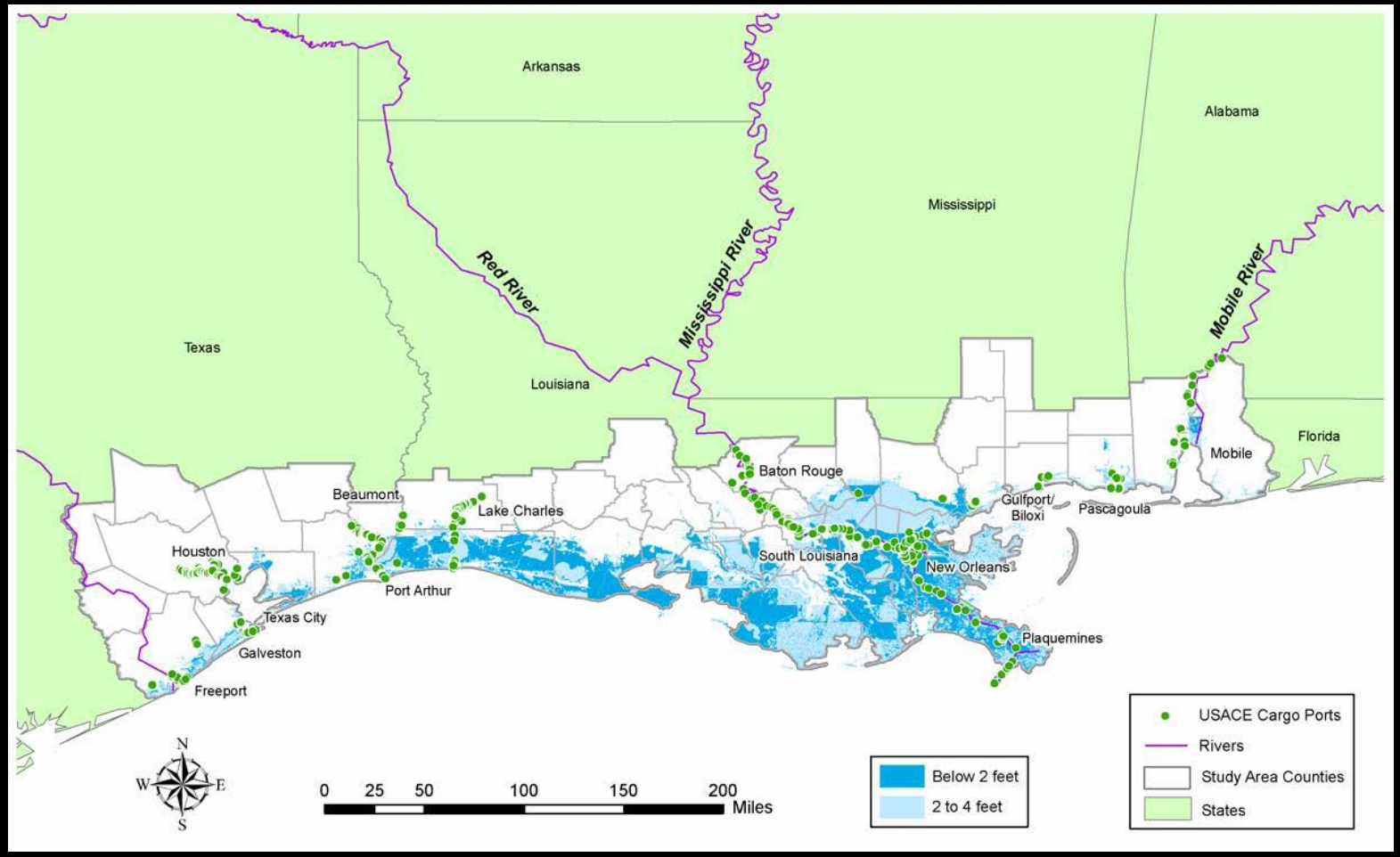
(Source: U.S. DOT data *Cambridge Systematics analysis*)

Railroad-owned and -served freight facilities at risk due to STORM SURGE of 18 and 23 ft



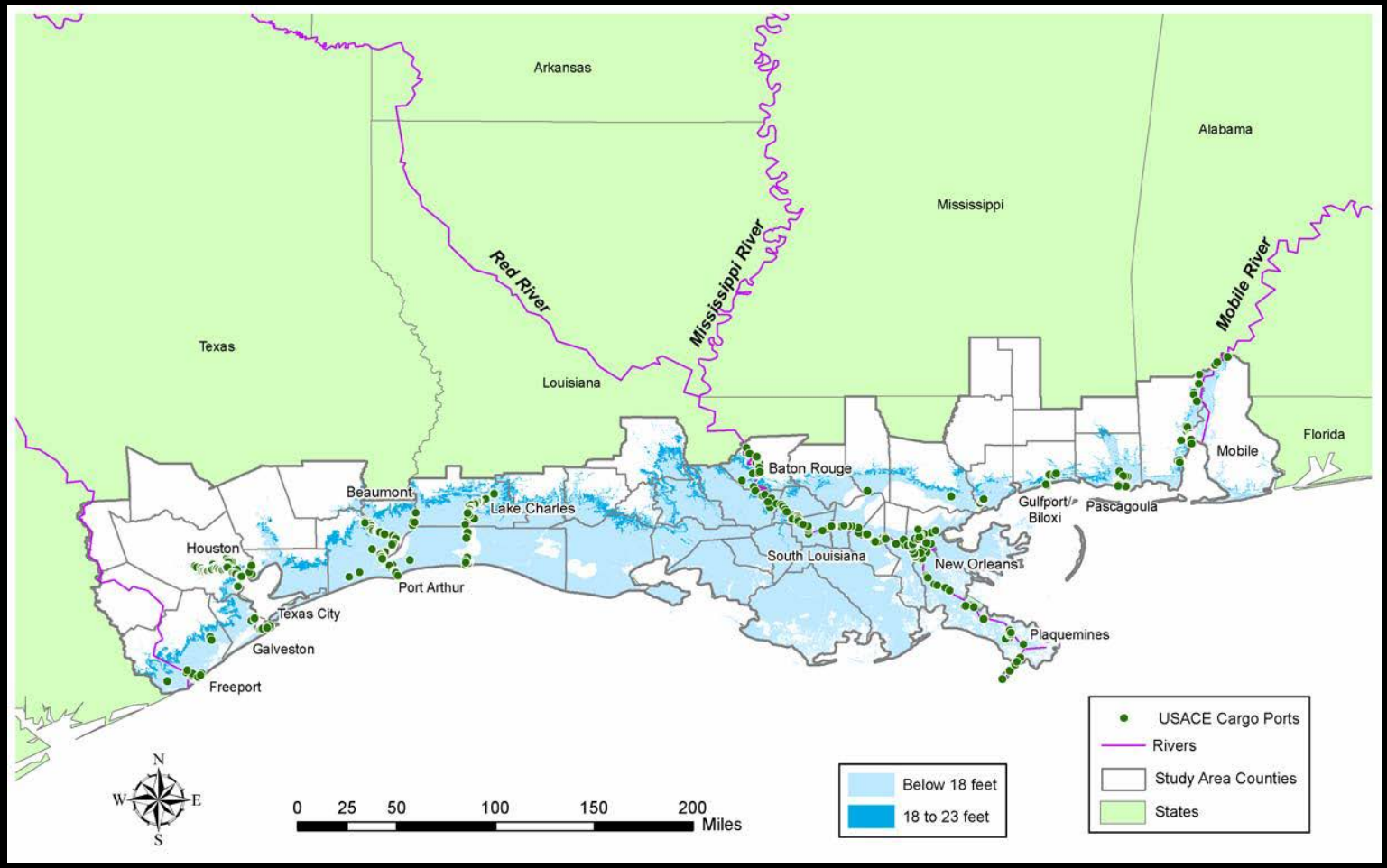
(U.S. DOT data; *Cambridge Systematics analysis*)

Freight handling port facilities at risk from relative SEA LEVEL RISE of 2 and 4 ft



(Source: U.S. Army Corps of Engineers data; *Cambridge Systematics analysis*)

Freight handling port facilities at risk from STORM SURGE of 18 and 23 ft



(Source: U.S. Army Corps of Engineers data; *Cambridge Systematics analysis*)

URS

BAYPORT TERMINAL CLIMATE CHANGE STUDY

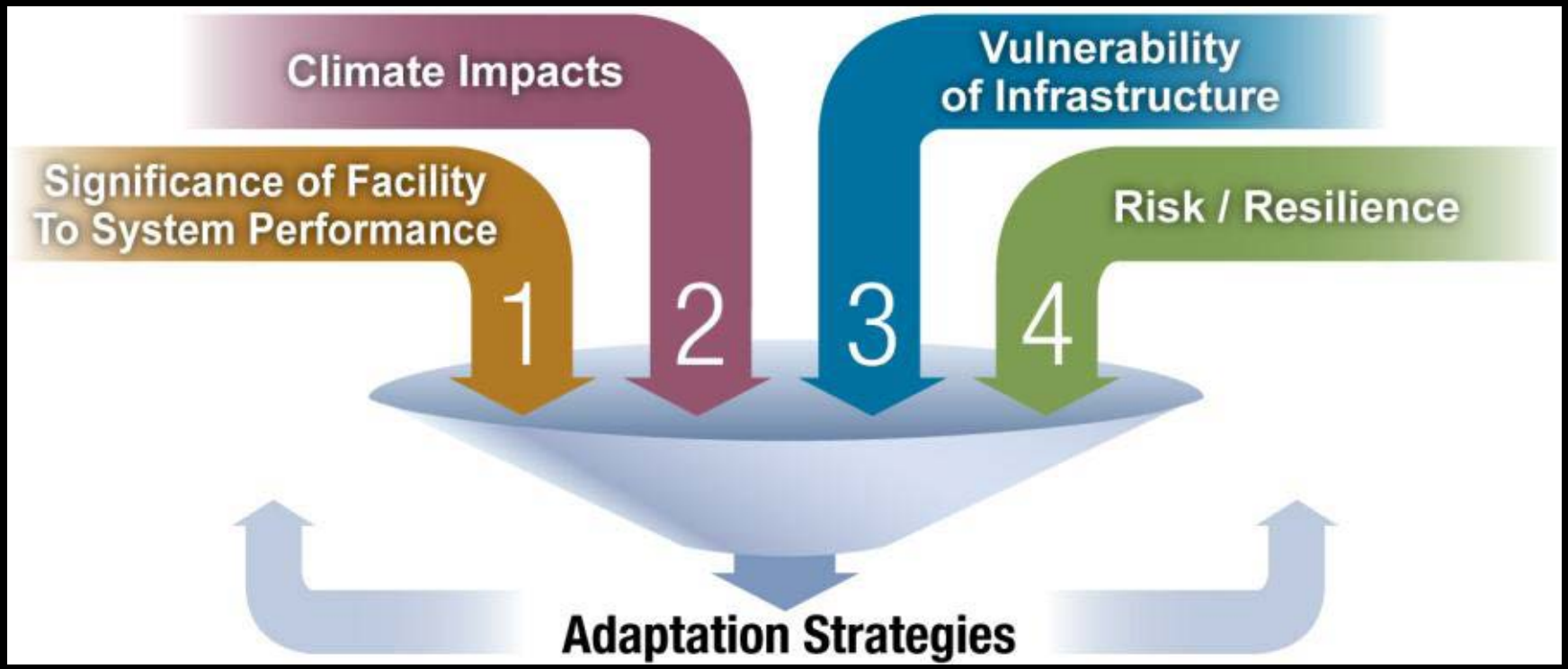
PHA Bayport Terminal: Climate Change Risk and Vulnerability Assessment

- Key objectives of this study:
  - Identify climate change threats
  - Develop inventory of at-risk facilities and operations
  - Prioritize high risk facilities and operations
  - Assess risk and vulnerability for high priority facilities ACCA
  - Evaluate adaptation measures

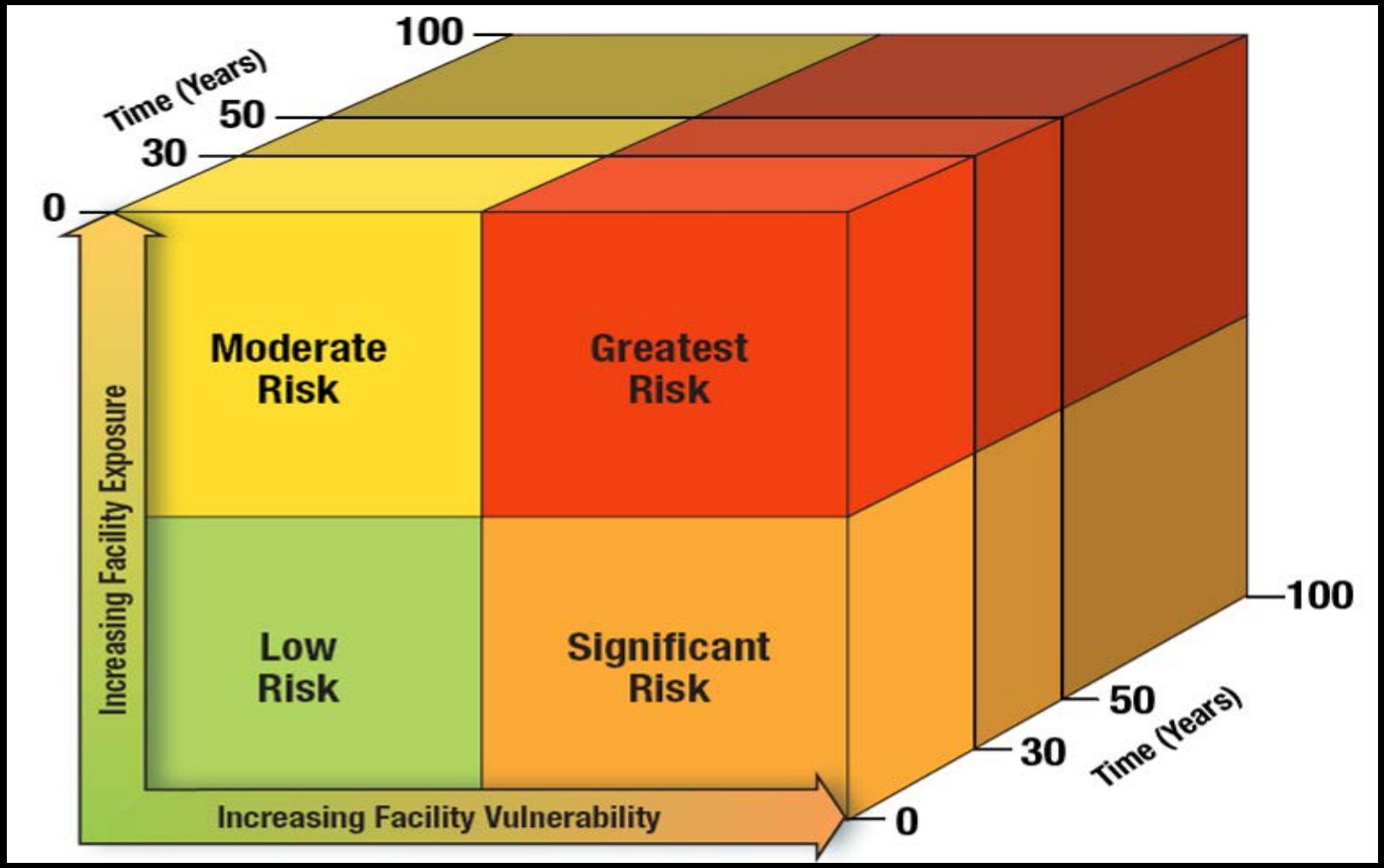
A Mechanism and Framework for Continuous Evaluation

- Capital infrastructure investments
- Integration with existing risk management activities
- Evaluate the potential business and operational risks
- Develop adaptive measures to reduce risks
- Establish a long term climate change strategy

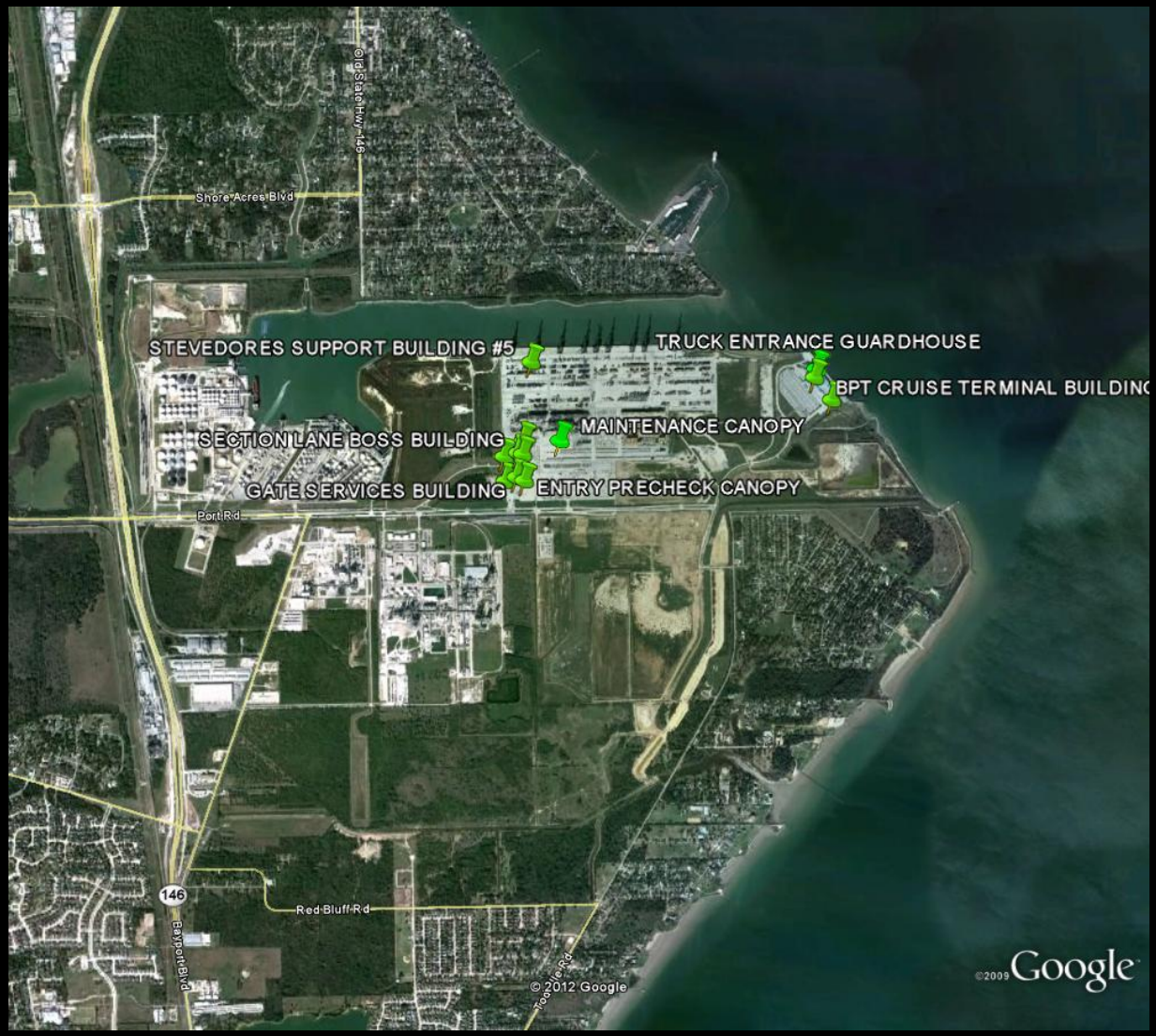
Systematic Risk Management Approach of Climate Change Impacts



Climate Change Risk Universe



Step 1: Identify Potentially At-Risk Infrastructure and Services



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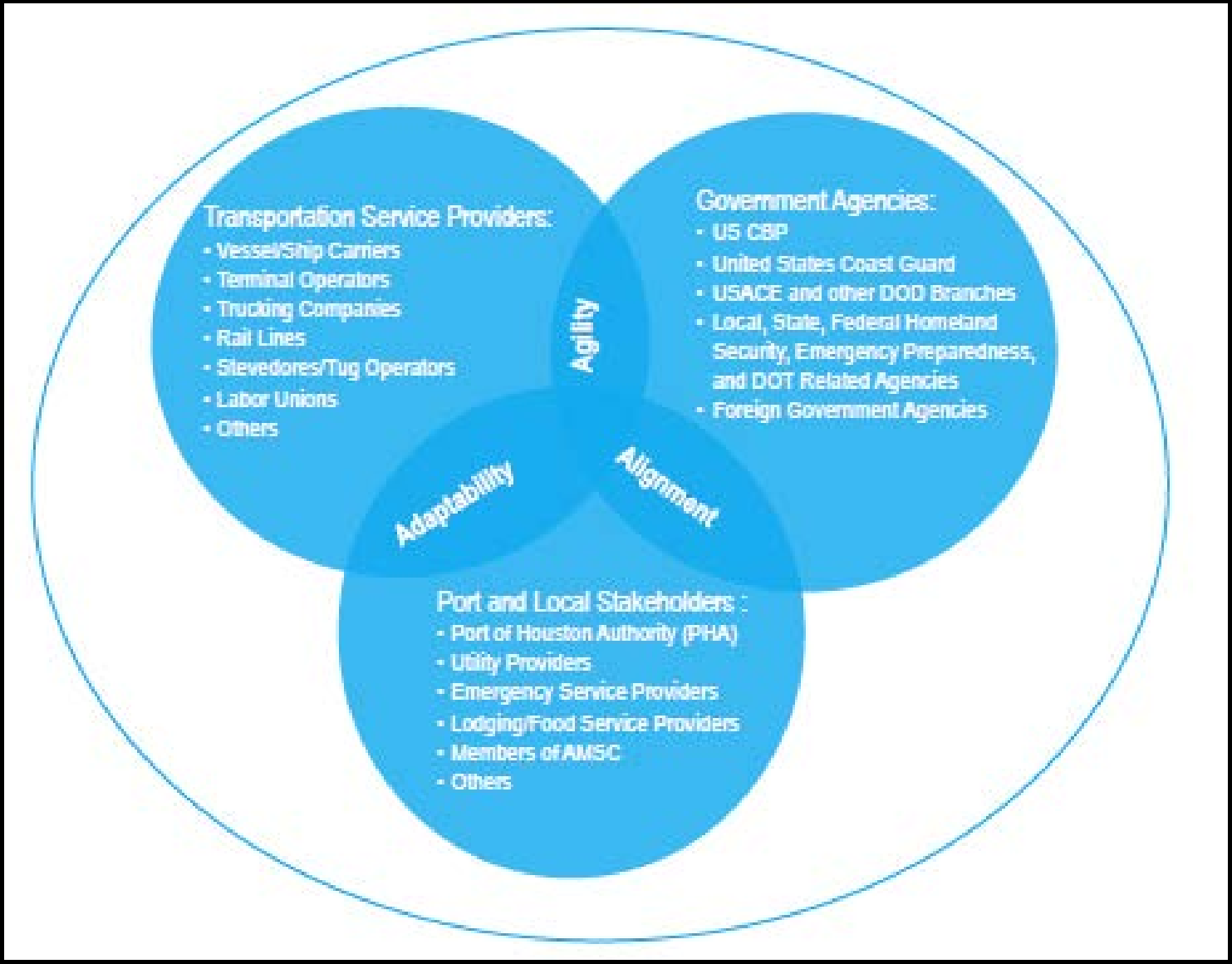


Step 2: Identify Climate Change Threats

Hazard/ Climate Change Indicator	Historical range Time period	Range of possible change Time period		Impact to the region	Impact on the Bayport Terminal
	1900-2000	2020	2050		
Precipitation and storm frequency	Annual precipitation ranged from 1.76 inches to 109.38 inches with a mean of 37-55 inches	No change in total precipitation but more frequent storms and heavy downpours expected	No change in total precipitation but more frequent storms and heavy downpours expected	Damage to the natural and built environment	Direct economic impact
Sea level rise	+0.1 to +0.2 ft	+0.7 to +1.7 ft	+1.0 to 3.0 ft	Decrease in protection to infrastructure from storm surges	Direct economic impact
Temperature	Rise of 0.4°F to 0.9°F in SE Texas	+1.0°F to +2.0°F	+3.0°F to +4.5°F	Deterioration of infrastructure and the natural environment	Direct economic impact

Step 2: Identify Climate Change Threats (cont.)

Impacts	Risks
Increased frequency of storms, hurricanes, cyclones and heavy precipitation events	• Increased dredging requirements due to changes in siltation patterns caused by sea level rise, wave patterns and storm surge frequency and severity • Increased timetable delays and, during extreme storm/ hurricane conditions, port closure due to reduced berth operability and safety issues
Rising sea levels and storm surge	• Increased damage to wharf structures, terminal buildings, storage buildings, and containers from flooding and storm damage Berthing difficulties during high tide
Increased summer temperatures, incidences of drought, and frequency/severity of heat waves	• Water shortages and increased water demand for cooling, washing and dust suppression
Changes to trade patterns, impacts on the supply chain and interdependencies	• Increased variability in season-to-season and year-to-year shipping conditions

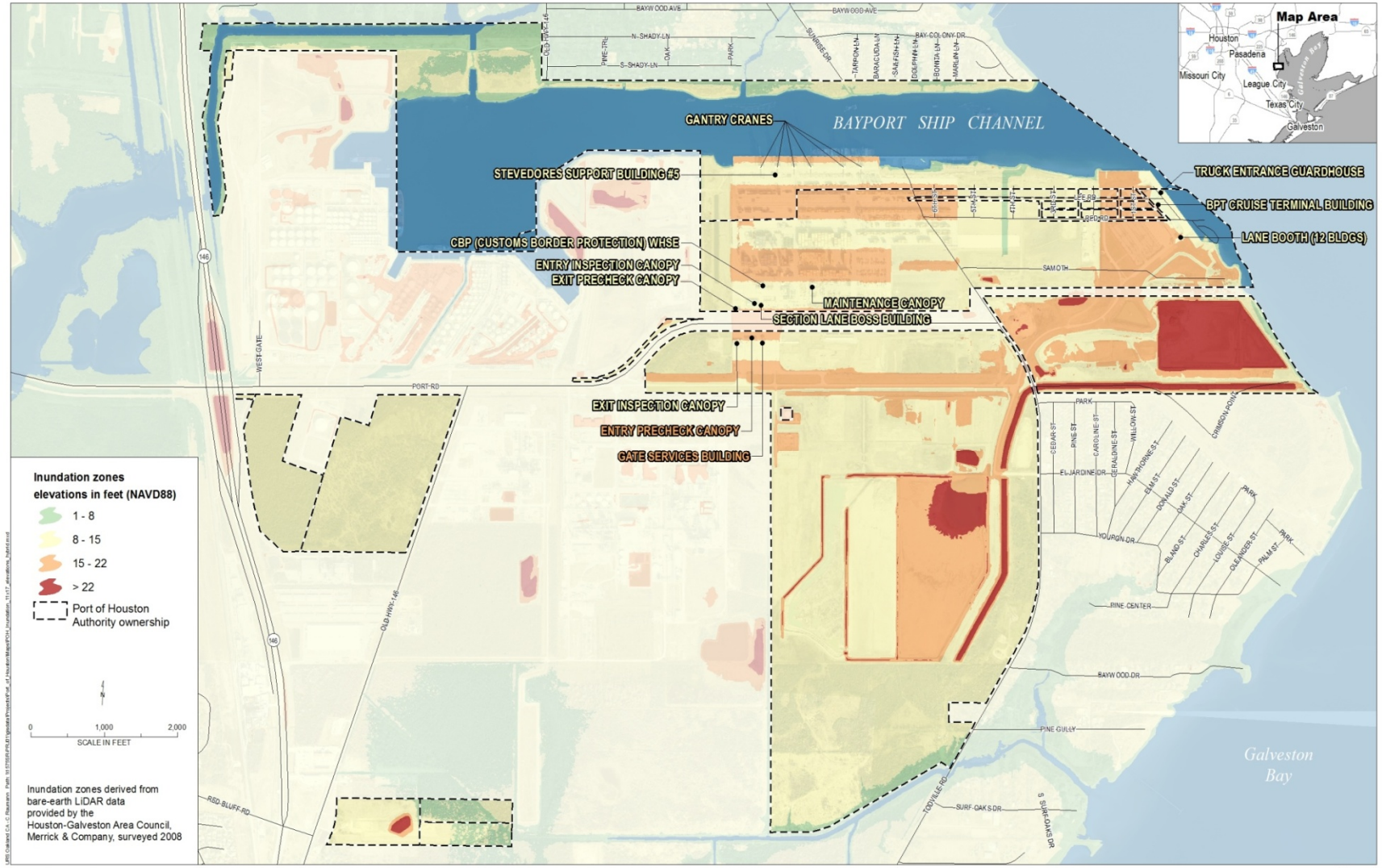
Step 3: Risk Assessment

Risk/ Opportunity	When will it become a 'Very High' risk?
Increased damage to wharf structures, terminal buildings and storage buildings and containers from flooding and storm damage	2050s
Increased dredging requirements following storms	2050s
Increased timetabling delays due to extreme weather events	2050s
Loss and erosion of land from sea level rise and storm surge	2080s
Water shortages and increased water demand for cooling, washing and dust suppression	2050s
Infiltration or submersion of storm and sewer drainage systems and pollution risk from overwhelmed drainage	2080s
Increased variability in season-to-season and year-to-year shipping conditions	2050s
Failure to secure products and services vital to keeping the terminal operating at the required level (e.g. chemicals and diesel) during extreme weather events	2080s

Step 3: Risk Assessment (cont.)

Infrastructure and Operations Component	Potential Climate Change Impacts
Vehicle movements inside the port	▪ Increased flood risks to port due to sea level rise
Demand, trade levels and patterns	▪ Impacts on total trade through PHA's Bayport Terminal ▪ Changes in trade flows due to effects on other ports and trade dynamics
Goods storage	▪ Impacts of heavier rainfall on the PHA's Bayport Terminal drainage system, flood risk to storage areas due to sea level rise, water used for the facility, refrigeration impacts due to rising temperatures or power loss and impacts on storage of containers; impacts from high wind
Environmental performance	▪ An inundated waste treatment or holding facility could be significant in disturbing the ecological balance ▪ Under the scenario of 1.5 meters sea level rise, a total of 33 sites would be impacted or threatened with 16 being wastewater treatment plants and 9 being solid waste sites in the Galveston bay region.
Navigation and berthing	▪ Navigation, berthing, and dredging issues associated with sea level rise and increased storm events

Step 3: Risk Assessment (cont.)



URS Port of Houston Authority
Greenhouse Gas and Climate Change Adaptation Project

Figure 1
Bayport Terminal areas of inundation

Step 4: Potential Adaptation Responses

- Identify critical assets to business continuity, where these are located, and how sensitive they are to extremes of weather
- Undertake regular and on-going programmes of maintenance and repair of all assets under PHA's ownership or responsibility
- Upgrade refrigeration equipment to less temperature sensitive solutions as technology improves
- Increase drainage capacity in line with future design standards
- Consider introducing more flexible working hours and stress test contingency planning during extreme weather events
- Strengthening of infrastructure to protect it from storm surge, flooding and wave damage

Efforts to adapt to climate change should be proportionate to the risks.

CONCLUSIONS AND RECOMMENDATIONS

Conclusions

- There are numerous economic, environmental, social, legal and legislative drivers to adaptation and resilience building
- Climate change impacts will likely impact other PHA terminals and the port sector across the world
- As an inland port, it is possible that the Bayport Terminal may be less vulnerable to the impacts of some of these hazards compared to other ports in the region that are projected to experience greater levels of subsidence
- Risks to the landside supply chain, and the interdependent sectors such as energy, water, and telecommunications/ Information Technology, may have greater vulnerabilities and as a result could impact Bayport efficient operations as well

Recommended Future Studies

- A port-wide assessment (all PHA assets)
- A regional assessment (all Houston Shipping Channel assets)
- A detailed assessment for a particular key hazard/threat to include engineering performance analysis
- A detailed assessment of the adaptation strategies (i.e. benefit-cost-analysis, feasibility study of strategies)
- Periodic updates to the studies/plans as science and operating conditions change