SSPEED –
Storm Prediction and Global Climate Impact

Transportation and Climate Change in the Gulf Coast:

The Need is Now!

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How Will Climate Change Affect Transportation Decisions?

Climate Change and Variability

- Temperature change
- Precipitation change
- Accelerated sea level rise
- Increased storm surge and intensity

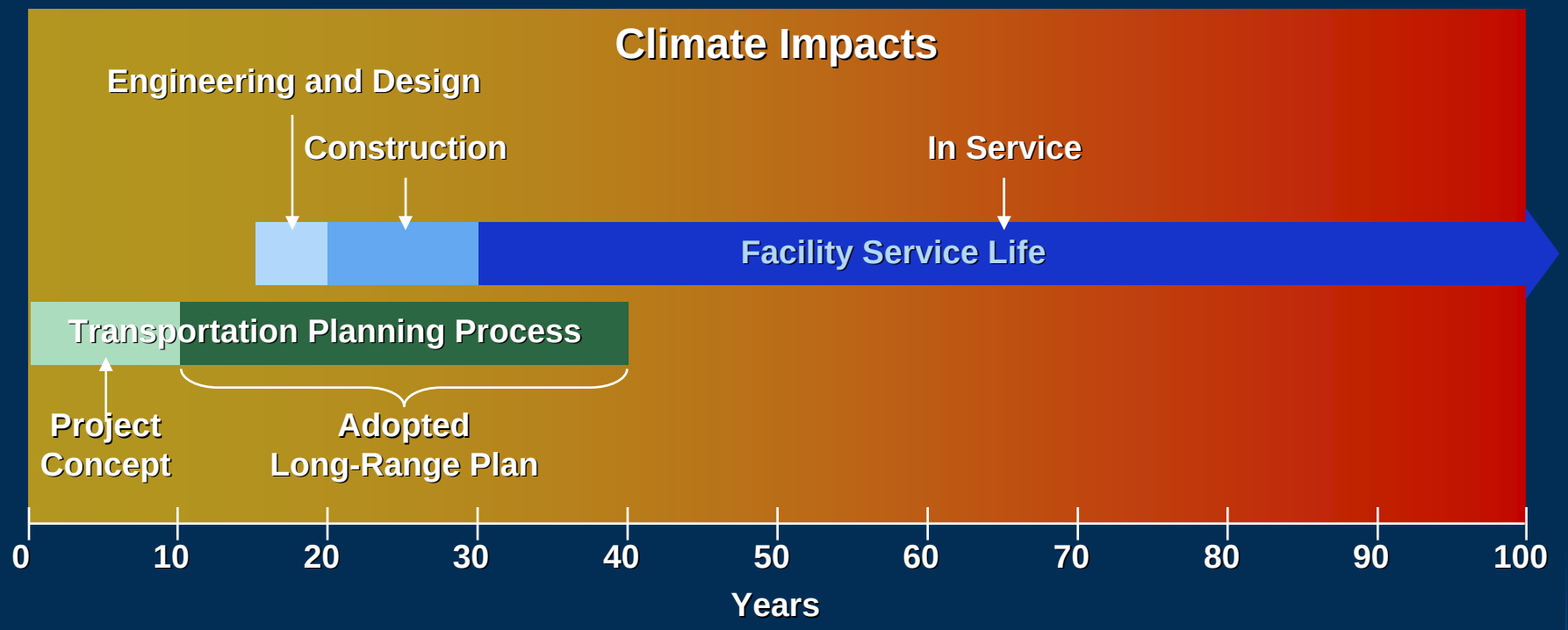
Transportation Decision-Making

- System planning and investment
- Project development
- Operations
- Maintenance
- System assessment

Transportation Impacts

- Location
- System design
- Design specifications
- Materials
- Safety
- Emergency management/ evacuation
- Replacement/ repair schedules
- Investment levels

Transportation Timeframes vs. Climate Impacts



Gulf Coast Study Team

- United States Department of Transportation (lead agency)
- United States Geological Survey (supporting agency)
- Cambridge Systematics, Inc.
- Texas A&M University
- University of New Orleans
- Louisiana State University
- Transportation Analysis Team
  - Cambridge Systematics, Inc.
  - Texas Transportation Institute
  - Wilbur Smith Associates

Federal Advisory Committee
Gulf Coast Study

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U.S. DOT / USGS Gulf Coast Study

Potential Impacts of Climate Change and Variability on Transportation Systems and Infrastructure

Why the Gulf Coast?

- **Nationally significant**
  - 60% nation's petroleum imports
  - Largest concentration of marine freight facilities in the U.S.
  - Major urban centers
- **Extensive intermodal network**
  - 17,000 miles of highway; 83.5B vehicle miles / year
  - 4 out of 5 top tonnage ports; 1,000 freight handling terminals
  - 6 of 7 Class I railroads
  - 3,800 aircraft at 61 airports
  - 56M passengers at 3 largest airports (2005)
- **Engaged decision-makers**

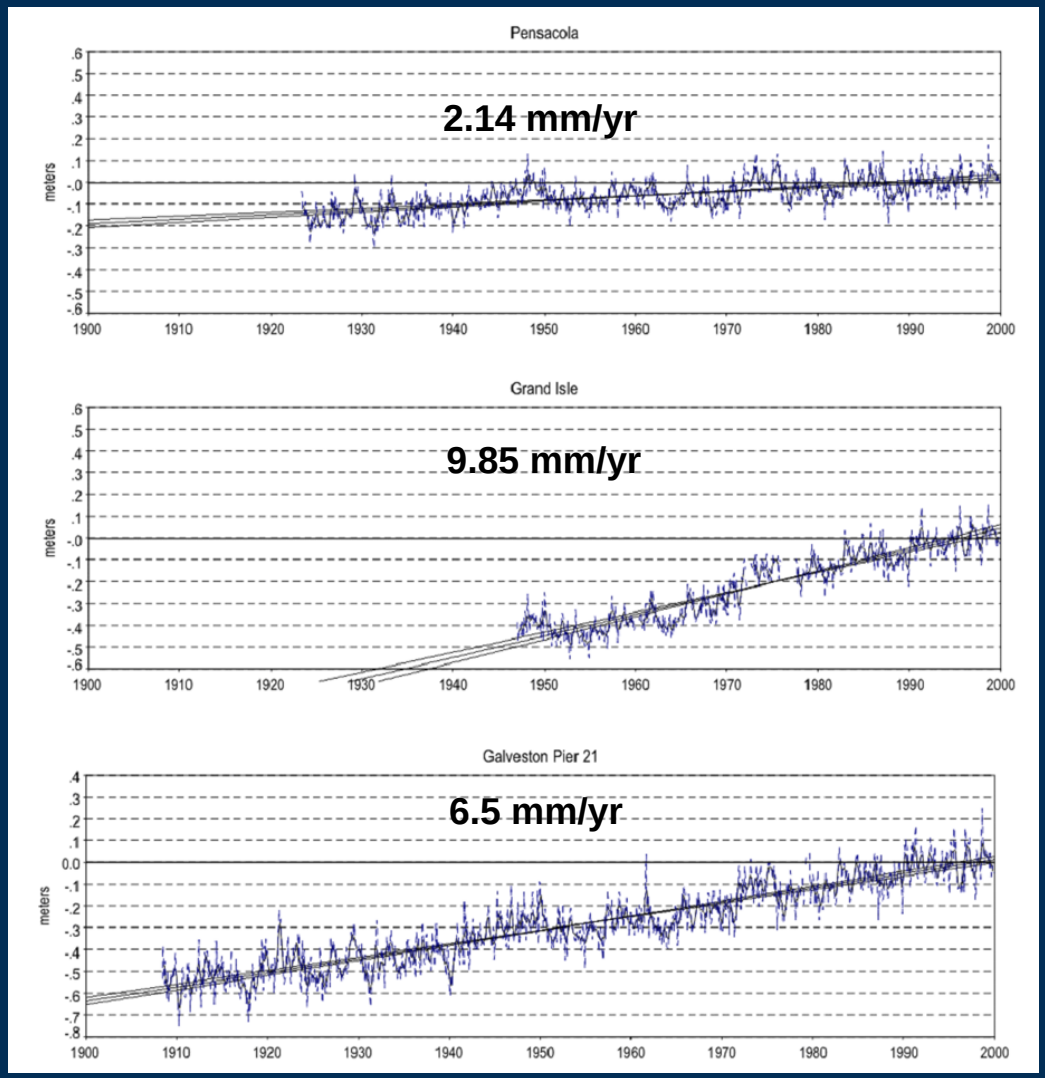
Land Surface Elevations Subject to Flooding in the Study Area under High, Mid, and Low Sea Level rise Scenarios (Ensemble of 7 GCMs under Four Emission Scenarios) *(SLRRP Model results in centimeters)*

Year 2050	Low				Year 2100	Low			
	A1FI	B1	A1B	A2		A1FI	B1	A1B	A2
Galveston, Texas	83.0	80.9	83.4	83.4	Galveston, Texas	130.7	117.0	124.9	127.0
Grand Isle, Louisiana	107.5	106.0	108.8	106.3	Grand Isle, Louisiana	171.2	159.7	168.7	167.6
Pensacola, Florida	48.0	47.8	48.4	53.7	Pensacola, Florida	83.9	70.1	78.2	75.2
Year 2050	**Mid**				**Year 2100**	**Mid**			
	A1FI	B1	A1B	A2		A1FI	B1	A1B	A2
Galveston, Texas	88.9	86.7	88.7	88.8	Galveston, Texas	146.0	129.5	137.1	140.8
Grand Isle, Louisiana	113.6	111.8	114.2	111.8	Grand Isle, Louisiana	185.3	171.4	180.2	181.3
Pensacola, Florida	53.9	53.6	53.7	60.0	Pensacola, Florida	99.2	82.6	90.3	89.3
Year 2050	**High**				**Year 2100**	**High**			
	A1FI	B1	A1B	A2		A1FI	B1	A1B	A2
Galveston, Texas	94.8	92.5	93.9	94.3	Galveston, Texas	161.3	142.0	149.3	154.5
Grand Isle, Louisiana	119.6	117.6	119.6	117.3	Grand Isle, Louisiana	199.6	183.1	191.7	195.1
Pensacola, Florida	59.8	59.4	58.9	66.3	Pensacola, Florida	114.5	95.0	102.5	103.5

Results – Gulf Coast Study

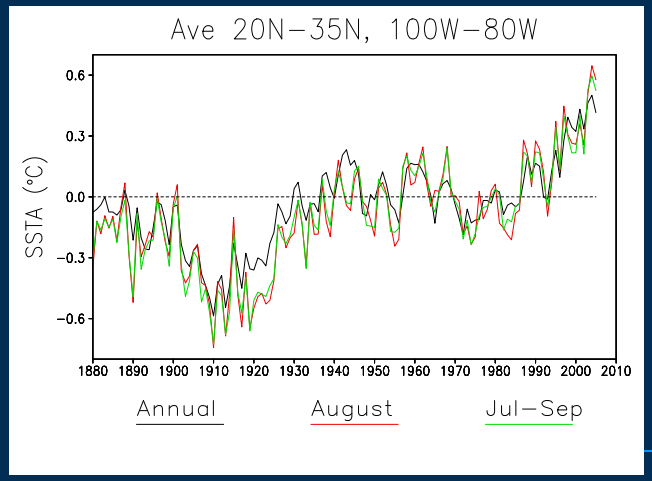
Trends in Climate and the Natural Environment

- **Historical rate of sea level rise relative to the land surface varied among tide gauges across the region**



Results – Gulf Coast Study
Trends in Climate and the Natural Environment

- **Relative sea level will likely increase 1 to 6 feet**
  - **Massive inundation due to relative sea level rise**
  - **Relative sea level includes:**
    - **Climate-induced impacts of thermal expansion and ice melt; and**
    - **Sinking land masses (subsidence) in the central Gulf Coast**
- **Hurricane vulnerability is high today and may worsen**
  - **Increase in storm intensity is likely**



Sea surface temperature trend in the Gulf of Mexico region (Source: Smith and Reynolds 2004)

Results – Gulf Coast Study
Trends in Climate and the Natural Environment (cont.)

- **Average temperature is likely to increase by 2°- 4° F**
  - **More hot days: # of days > 90 °F may increase by 50%**
  - **Extreme daily high temps will also increase**
- **Models show mixed results for changes in average precipitation**
  - **Intensity of rainfall events, however,**

  will likely increase

- **The magnitude of impacts worsen as emissions increase under the IPCC scenarios**

Caveats – Relative SLR and Storm Surge

- Analysis of impacts is based on land elevation rather than the height of facilities
- Analysis does not consider the presence of possible protective structures (levees, sea walls, etc.)
- Given the connectivity of the intermodal system, a small flooded segment may render much of the infrastructure inoperable

Results - Gulf Coast Study

Vulnerability Due to…Relative Sea-Level Rise

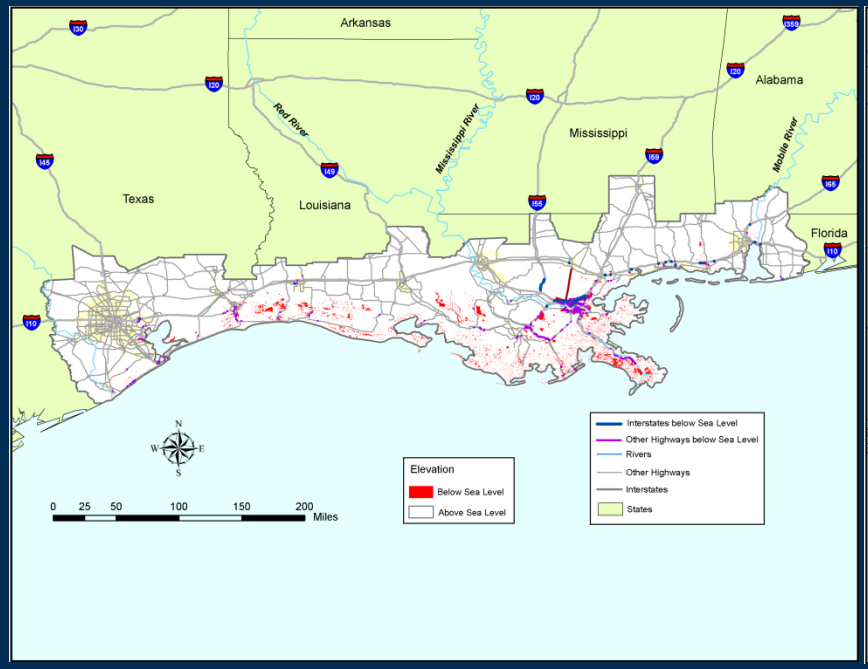
- **Relative sea level rise (due to climate change and subsidence) of 4 feet could permanently flood:**

- ✓ **24% of interstate miles, 28% of arterial miles, New Orleans Transit**
  - ✓ ***More than 2,400 miles of roadway are at risk of permanent flooding***
- ✓ **72% of freight / 73% of non-freight facilities at ports**
- ✓ **9% of the rail miles operated, 20% of the freight facilities, no passenger stations**
- ✓ **3 airports**
- ✓ **Temporary flooding in low-lying areas due to increased heavy downpours will broaden affected areas**

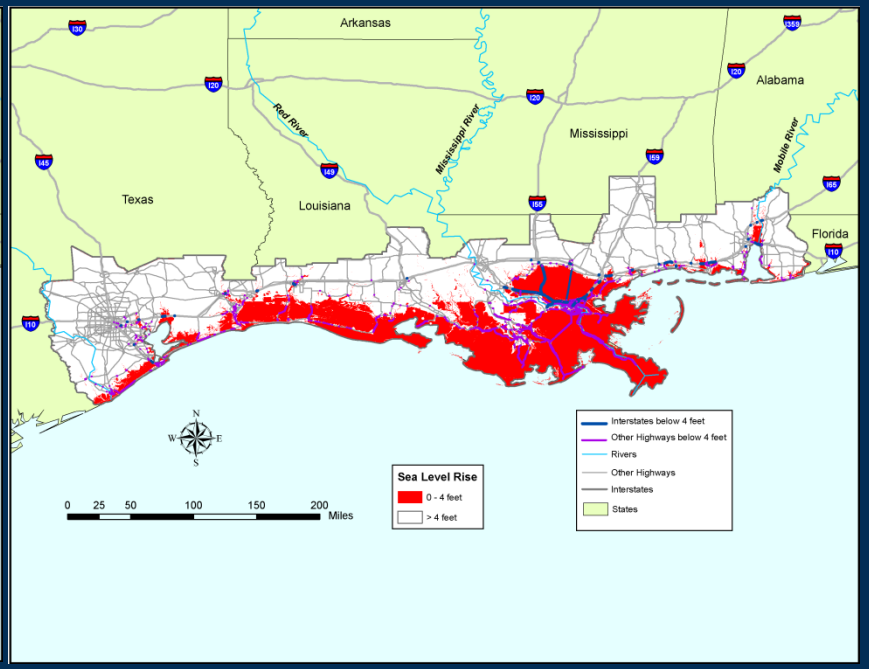
Results – Gulf Coast Study

Highways Vulnerable to Relative Sea Level Rise

Baseline (Present Day)



4 Feet of Sea Level Rise



Source: Cambridge Systematics analysis of U.S. DOT Data.

Results – Gulf Coast Study
Vulnerability Due to…Storm Surge

- As witnessed by the 2005 hurricane season, transportation in the central Gulf Coast is already vulnerable to large hurricanes

- That vulnerability will be exacerbated if hurricane intensity increases, absent adaptation strategies

Results – Gulf Coast Study

Vulnerability Due to…Storm Surge

- **Transportation infrastructure that is vulnerable to 18 feet of storm surge includes:**

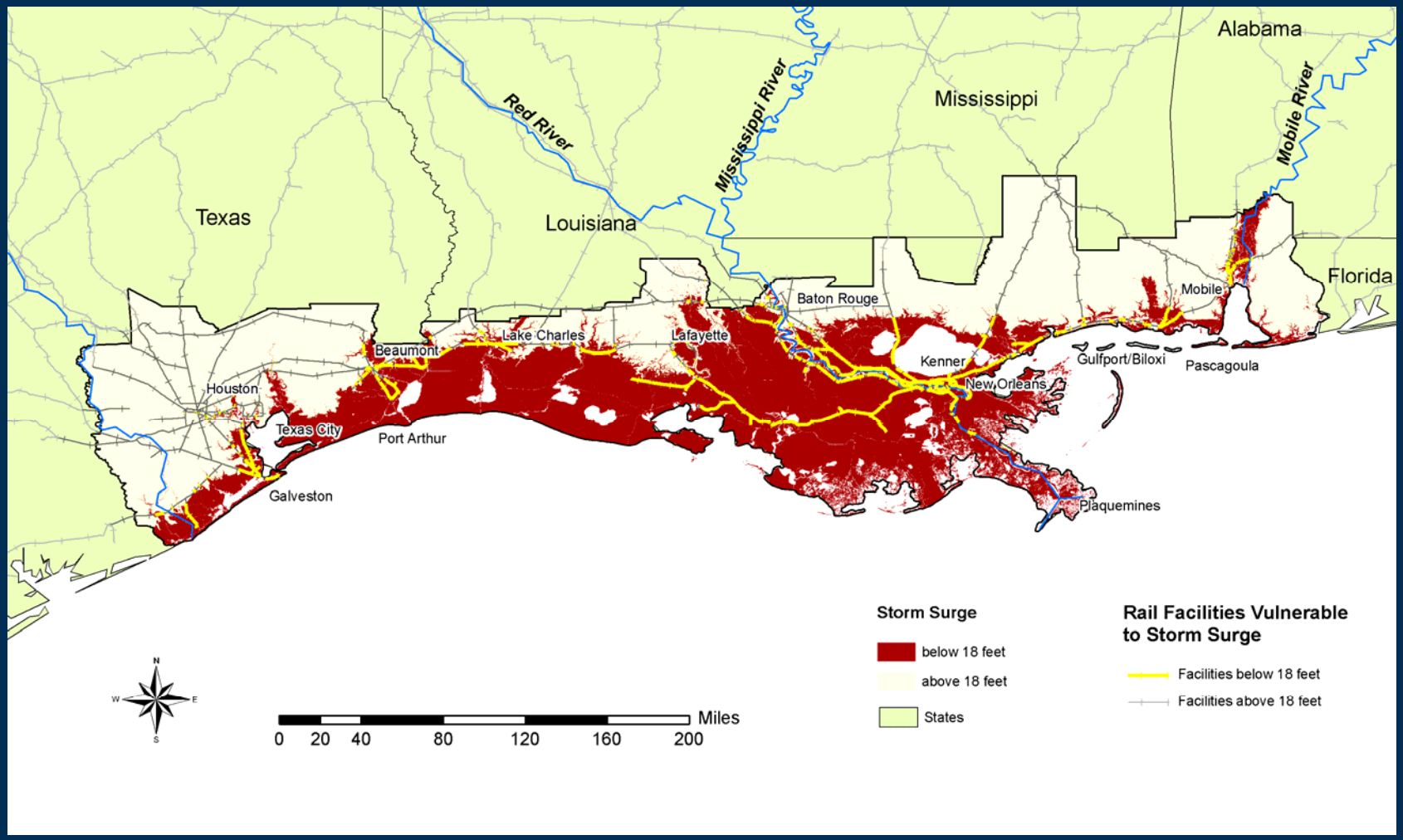
- ✓ **51% of interstate miles, 56% of arterial miles, and most transit authorities**
- ✓ **98% of port facilities vulnerable to surge and 100% to wind**
- ✓ **33% of rail miles operated, 43% of freight facilities**
- ✓ **22 airports in the study area at or below 18 feet MSL**
- ✓ **Potentially significant damage to offshore facilities**

Hurricane Katrina Damage to Highway 90 at Bay St. Louis, MS

Source: NASA Remote Sensing Tutorial.

Results – Gulf Coast Study

Freight Rail Lines Vulnerable to Storm Surge of 18 feet



Source: Cambridge Systematics analysis of climate projections and Federal Railroad Administration data.

Results – Gulf Coast Study

Vulnerability Due to…Temperature increases

- **As temperatures increase, operations will be affected:**
  - **Potential change in maintenance and construction practices**
  - **Increased use of energy for refrigerated storage**
  - **Potential rise in rail buckling**
  - **May result in impacts to aircraft performance and runway utilization**

Results – Gulf Coast Study Transportation Planning

- Climate change is rarely considered today, but the longevity of infrastructure argues for its integration
- Current practice focusing on a 20-year time frame is not well-suited to the assessment of impacts due to the natural environment
- It is useful to examine the vulnerability of the intermodal system in addition to specific facilities

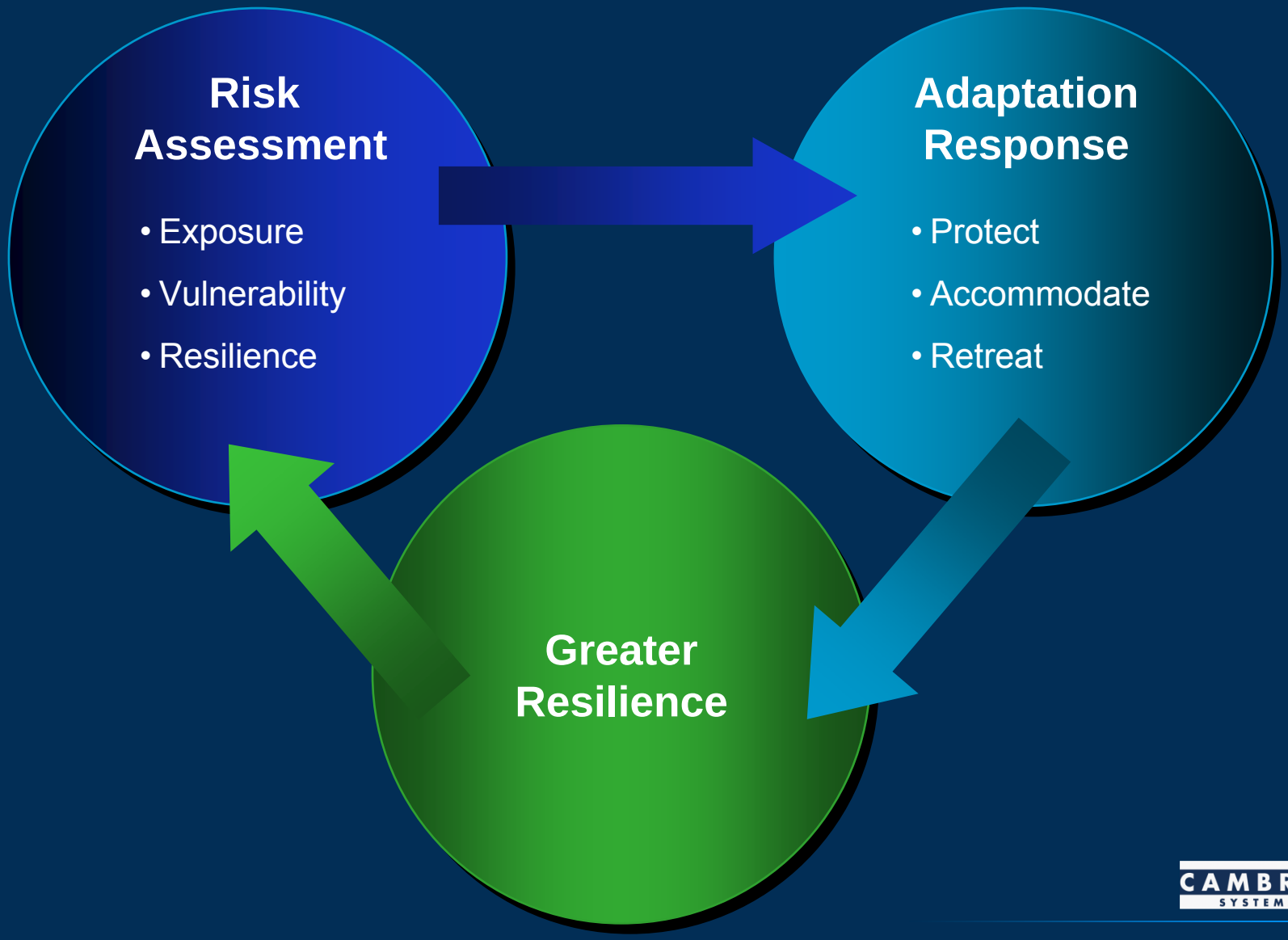
Implications…
Range of Adaptation Responses

- **Maintain and manage**
  - **Absorb increased maintenance / repair costs**
  - **Improve real-time response to severe events**
- **Strengthen structures / protect facilities**
  - **Design changes when rebuilding / new investment**
  - **Promote buffers**
- **Enhance redundancy**
  - **Identify system alternatives**
- **Relocate / avoid**
  - **Move or abandon existing facilities**
  - **Site new facilities in less vulnerable locations**

Preparing for change…

- Robust transportation systems – reliability under a range of conditions
- Use of new approaches to decision-making
  - Scenario planning
  - Integration of climate change with other regional dynamics
  - Probabilistic rather than deterministic approach
  - Consider both incremental and abrupt change
  - Risk assessment approach

A Risk Assessment Approach to Transportation Decisions



CAMBRIDGE SYSTEMATICS

For More Information

"The Potential Impacts of Climate Change and Variability on Transportation Systems and Infrastructure – The Gulf Coast Study, Phase I"

Synthesis and Assessment Product 4.7
http://www.climatescience.gov/Library/sap/sap4-7/final-report/

Climate Change Science Program
http://climatescience.gov/

DOT Center for Climate Change and Environmental Forecasting

http://www.climate.dot.gov/