Gulf Coast Study

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

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Transportation leadership you can trust.
U.S. DOT / USGS Gulf Coast Study
Potential Impacts of Climate Change and Variability on Transportation Systems and Infrastructure
Gulf Coast Study Team - Phase I

- 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
Why Study the Gulf Coast?

- Nationally significant
  - 60% of nation’s petroleum imports
  - Major urban centers

- Extensive intermodal network
  - 17,000 miles of highway
  - 83.5 billion VMT per year
  - 6 of 7 Class I railroads
  - 56M passengers at 3 largest airports (2005); 3800 aircraft based at 61 airports

- Engaged decision-makers
Region is Critical to National Freight Network

40% of US marine tonnage, 60% of energy imports
Overall Climate Impacts - Key Drivers for Analysis

- Accelerated relative sea level rise
- Increased storm surge and storm intensity
- Changes in temperature
- Changes in precipitation
Climate Projections
Temperature and Precipitation

- Average temperature is likely to increase by 1 - 5 °F over the next 50 years
  - More hot days: # of days > 90 °F may increase by 50%
  - Extreme daily high temps will also increase – greater than 50% chance of 21 days annually exceeding 100 °F

- 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
Climate Projections
Relative Sea Level Rise and Storm Intensity

- 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;
    - 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)
The central Gulf Coast is particularly vulnerable to climate and other coastal changes over the next 50-100 years.

Climate change impacts need to be integrated with other coastal / environmental effects.

The timing of impacts is not clear; abrupt change cannot be ruled out.
Implications for…

- Highways and transit
- Rail
- Ports and waterways
- Airports
- Pipelines
- Emergency management
- Long-range planning and investment
Caveats –
Relative Sea Level Rise 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.)
- But given the connectivity of the intermodal system, even a small flooded segment may render much of the infrastructure inoperable or block access
  - Many transportation facilities depend on local roads (not elevated)
Vulnerability Due to *Relative Sea Level Rise*

Results

- 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 systems
    - More than 2,400 miles of roadway are at risk of permanent flooding
  - 72% of freight / 73% of non-freight facilities at ports
    - Changes in navigable water levels, lock/dam structures
    - Loss of landside connections, markets, workforce, etc.
  - 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
Highways Vulnerable to Relative Sea Level Rise

Baseline (Present Day) vs 4 Feet of Sea Level Rise

Source: Cambridge Systematics analysis of U.S. DOT Data.
Freight Handling Ports Facilities Potentially Vulnerable to Relative Sea Level Rise
Vulnerability Due to *Storm Surge*

Results

- 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

Freight Handling Ports Facilities Potentially Vulnerable to Storm Surge
Freight Rail Lines Vulnerable to Storm Surge of 18 feet

Source: Cambridge Systematics analysis of climate projections and Federal Railroad Administration data.
Vulnerability Due to Temperature and Precipitation Changes

Results

Temperatures increases:

- Potential change in maintenance and construction practices
- Increased energy consumption for refrigerated storage
- Potential rise in rail buckling
- May result in impacts to aircraft performance and runway utilization
- Changes in local, regional and national markets and travel demand

Precipitation and run-off changes:

- Changes in size of stormwater retention / treatment facilities
What Are The Implications for 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 climate impacts.
How Can We Prepare for Change?

- The future is uncertain

- So, to have robust transportation systems we need reliability under a range of conditions

- Use of new approaches to decision-making
  - Scenario planning
  - Probabilistic rather than deterministic approach
  - Consider both incremental and abrupt change
  - Integration of climate change with other regional dynamics
Need A Risk Assessment Approach to Transportation Decisions…

- Risk Assessment
  - Exposure
  - Vulnerability
  - Resilience

- Adaptation Response
  - Accommodate
  - Protect
  - Redundancy
  - Retreat

Greater Resilience
But Need More Than Just Degree of Risk to Prioritize Investments...

- High Risk / Low Importance
- Low Risk / Low Importance
- Low Risk / Critical Importance
- Highest Priority: High Risk / Critical Importance
New and Traditional Data Need to be Integrated for a Risk Assessment Approach

Data for assessing exposure, vulnerability, and resilience:
- Local climate projections and historic trends (temp, precip, SLR)
- Assessment of how these changing climate factors affect local infrastructure
- Traditional measures determine criticality (volume, VMT, etc)
- Monitoring thresholds for climate and infrastructure becomes important

Adaptation for infrastructure preservation
- Effect on new design (structures, pavement, bridges)
- Operations impacts (weather, maintenance, evacuation)
- New performance measures needed to maintain facilities most effectively
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

- Climate Change Science Program

- DOT Center for Climate Change and Environmental Forecasting

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