SSPEED – Storm Prediction and Global Climate Impact

Transportation and Climate Change in the Gulf Coast:

The Need is Now!

Alan Clark, HGAC
Mike Savonis, FHWA
October 30, 2008
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
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

<table>
<thead>
<tr>
<th>Name</th>
<th>Title/Position/Institution</th>
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<tbody>
<tr>
<td>Vicki Arroyo</td>
<td>Director of Policy Analysis, Pew Center on Global Climate Change</td>
</tr>
<tr>
<td>Philip B. Bedient</td>
<td>Professor of Engineering, Rice University</td>
</tr>
<tr>
<td>Leigh B. Boske</td>
<td>Associate Dean, Lyndon B. Johnson School of Public Affairs, University of Texas</td>
</tr>
<tr>
<td>Alan Clark</td>
<td>Director of Transportation Planning, Houston-Galveston Area Council</td>
</tr>
<tr>
<td>Fred Dennin</td>
<td>Regional Administrator, Region 3, Federal Railroad Administration</td>
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<tr>
<td>Paul S. Fischbeck</td>
<td>Professor of Social and Decision Sciences, Carnegie Mellon University</td>
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<tr>
<td>Anthony Janetos</td>
<td>Director, Joint Global Change Research Institute, Pacific Northwest National Laboratory / University of Maryland</td>
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<tr>
<td>Thomas R. Karl</td>
<td>Director, National Climatic Data Center, National Oceanic and Atmospheric Administration</td>
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<tr>
<td>Robert Lempert</td>
<td>Senior Scientist, RAND Corporation</td>
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<tr>
<td>Gilbert Mitchell</td>
<td>Chief, Geodetic Services Division, National Geodetic Survey, National Oceanic and Atmospheric Administration</td>
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<tr>
<td>Chris C. Oynes</td>
<td>Gulf of Mexico Regional Director, Minerals Management Service</td>
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<tr>
<td>Harold “Skip” Paul, P.E.</td>
<td>Associate Director of Research, Louisiana Department of Transportation and Development</td>
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<tr>
<td>Tom Podany</td>
<td>Assistant Chief, Planning, U.S. Army Corps of Engineers, New Orleans District</td>
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<tr>
<td>Burr Stewart</td>
<td>Strategic Planning Manager, Port of Seattle</td>
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<tr>
<td>Elaine Wilkinson</td>
<td>Executive Director, Gulf Regional Planning Commission</td>
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<tr>
<td>John Zamurs</td>
<td>Head, Air Quality Section, Environmental Analysis Division, New York State Department of Transportation</td>
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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)*

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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.
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.
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

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.
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

Risk Assessment
- Exposure
- Vulnerability
- Resilience

Adaptation Response
- Protect
- Accommodate
- Retreat

Greater Resilience
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/