FHWA Adaptation Research

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Activities

• **Regional Climate Change Effects: Useful Information for Transportation Agencies (2010)**

• *Impacts of Climate Variability and Change on Transportation Systems and Infrastructure – Gulf Coast Study, Phase 1 (2008)*

• Adaptation Peer exchanges (2008, 2009, future)

• **Pilots of Vulnerability / Risk assessment conceptual model**

• **Gulf Coast Study, Phase 2 – Mobile, AL**
Failure of a hydraulic structure
Regional Climate Change Effects Report

Three sections

• Report
• Regional maps (Appendix B)
• Climate Effects Typology (Appendix C)

Received assistance from Climate experts:

• NOAA, USGS, DOE, etc.

http://www.fhwa.dot.gov/hep/climate/climate_effects/
Regional Climate Change Effects Report

• Synthesizes information on climate change projections from multiple studies, for transportation decision makers
  ▪ Snapshot: Summarizes recent science

• Projected changes by region:
  ▪ Annual, Seasonal Temperature (change in °F)
  ▪ Seasonal Precipitation (% change)
  ▪ Where information exists:
    • Sea level rise, Storm activity

• Also includes information at local, state scales
Projections of Temperature Change

- **US**: Average annual temp projected to rise by 4 to 11°F by 2100

- **Variations of warming around the globe** (greatest warming over land, higher latitudes)

![Maps showing temperature projections](image)
Projections of Precipitation Change

Seasonally

• Northward – significant increase in winter/spring precip (more as rain)
• Southward – significant reductions in winter/spring precip

Extreme Events

• Increase in frequency and intensity
• Decrease in light precip events
• Events with a 5% chance of occurring in a given year are projected by end of century:
  ▪ 7 to 25% chance of occurring
  ▪ Expected to be 10% to 25% heavier
Projections of Sea Level Rise, Tropical Storms & Hurricanes

Local sea level rise may differ from global estimates due to:
- Subsidence/uplift of land
- Sedimentation and erosion
- Ocean circulation
- Gravitationally induced changes
- Ocean density (ocean salinity and temp)

<table>
<thead>
<tr>
<th>Study</th>
<th>Global Sea Level Rise, to 2100</th>
</tr>
</thead>
<tbody>
<tr>
<td>IPCC (2007a)</td>
<td>7” to 23”</td>
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<tr>
<td>Newer studies</td>
<td>20” to 79”</td>
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</tbody>
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Tropical storms & Hurricanes: Consensus today suggests projected global conditions by 2100:
- Increase in intensity, decrease in frequency
- Increase in frequency of most intense storms
Projections of regional temperature, precipitation changes

Projections of near-term, mid-term, end-of-century are provided for each region, based on USGCRP (2009) data

- Two emission scenarios (B1, A2)
- IPCC AR4 climate models
- Regionally processed

- Report also includes results of other studies
Collected Literature is also discussed in the text.
Regional Temperature Change, Great Plains

Projected Change in Summer Temperature (°F)

Projected Change in Fall Temperature (°F)
### Collected Literature is discussed in the text:

“By the end of the century, the intensity of any particular precipitation event is projected to increase, on average, by 12 to 13% (NECIA 2006). Additionally, the number of days in a given year with precipitation events of greater than two inches per day is projected to slightly increase by an additional 1.25 to 1.75 days per year (NECIA 2006).”
How can this information be applied?

• Can inform planning efforts
  ▪ Help understand which parts of the planning area may be susceptible to sea level rise, for example
  ▪ Serves as a starting point for discussion of potential future changes

• Can inform consideration of vulnerability of key assets
  ▪ Projections by definition are somewhat uncertain
  ▪ Regional projections mask differences within a region

• Some of the information is too broad / uncertain to make definitive decisions on projects

• Use of this information may vary by specialty (e.g., engineering, planning, etc.) and location
Ongoing / Future Research

Science agencies, academics, etc. (not FHWA, DOTs)

- Comprehensive downscaled projections at the local level
- Inclusion of natural variability
- “All-inclusive” local sea level rise estimates
- Refining projections of precipitation (i.e., intensity/duration/frequency)
- Improve ability to project small scale events (e.g., local thunderstorms)
Comprehensive assessment of how climate change is expected to affect transportation in the Gulf Coast area

Phase 1

- Overview of climate change impacts on transportation infrastructure, and general options for addressing these challenges
- Houston to Mobile, completed in 2008
  (http://www.climatescience.gov/Library/sap/sap4-7/default.php)

Phase 2

- Seeks to develop:
  - More definitive information about multimodal impacts at the local level in a single MPO
  - Precise tools and guides on how to adapt to climate impacts; determine vulnerability for key links for each mode; assess risk
- Test in Mobile area; plan to make process transferable to other MPOs
- Timeframe: 2010-2012
Gulf Coast Study, Phase 2: Overview

• Focus on the Mobile, AL Metropolitan area
  ▪ Identify "critical assets" in Mobile region
  ▪ Evaluate projected climate change effects & stressors
  ▪ Determine vulnerability of key links and assets; conduct vulnerability assessment & detailed engineering analyses for selected assets
  ▪ Develop risk assessment & risk management tools
  ▪ Work with stakeholders in Mobile throughout project; take lessons learned & identify tools to make process, lessons learned, & methods accessible to other MPOs
  ▪ Include major findings in a final report
Task 1: Identify Critical Transportation Systems

- Determine Subset of Entire Transportation Network on Which to Perform Vulnerability Assessment and Identify Adaptive Measures
- Develop a process applicable to multiple transportation modes
- Conduct a careful review of relevant transportation models
- Develop GIS layers of critical transportation assets, for later study tasks
Three main areas of work:

1. Collect historical and projected weather and climate data

2. Conduct storm surge and wave modeling, SLR analysis, and estimate potential inundation of transportation assets (i.e., exposure)
   - Assistance from USGS

3. Assess the extent to which particular transportation systems are affected by climate variations (i.e., sensitivity)

Approach will be different than Phase I:
   - Focused on Mobile
   - Use of more advanced models (e.g., downscaling)
   - Estimation of near-term, mid-term, and end-of-century futures
Task 2: Projected Climate Data

• Projecting Variables:
  - USGS will provide statistically downscaled projections for temperature and precipitation:
    - Temperature: Daily minimum, maximum, average
    - Precipitation: Daily totals
    - Three time horizons (2010-2040, 2040-2070, 2070-2100)
    - 4 to 7 Climate models (PCM, Hadley, …)
    - 3 emission scenarios (A1fi, A2, B1)
    - Projected at the 5 observed station locations
  - Secondary variables will be calculated from daily temperature and precipitation (ex., monthly temperature, precipitation for 24-hour period with a 2%, 5%, 10%, 20% occurrence in any one year)
• **Task 3: Determine Vulnerability for Key Links & Assets in Each Mode**
  - Apply Task 2 results to critical infrastructure identified in Task 1, to determine vulnerability of links and assets
  - Assess role of key assets in system vulnerability
  - Multiply criticality & vulnerability scores to create a prioritized list of critical structures
  - Conduct engineering analysis of the most critical structures

• **Task 4: Develop Risk Management Tools**
  - Could include GIS maps of infrastructure overlaid with vulnerable infrastructure; Excel-based or web-based decision-support tool; or a document detailing best practices for MPOs to assess climate-related risks & identify adaptation options
  - Consistent with tools & approaches in use within region; developed in consultation with MPO, region, and state
Task 5: Working with Mobile

• Engage Mobile MPO, local and state partners, other key groups & the public throughout the project to ensure:
  ▪ The most important transportation assets & links are identified
  ▪ Analysis tools are developed in a way that will be most useful to transportation agencies and operators, and decision-makers
  ▪ The importance of planning for adaptation is understood & incorporated into MPO and partner agencies’ approach
  ▪ Public outreach incorporated at appropriate times
Thank you!

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