Estimated Economic Impacts of Hurricane Katrina on Transportation Systems in Mississippi

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Summaries

- Introduction
- Introduce of This Research
- Categories of Transportation Economic Impacts
- Indirect Transportation Economic Impacts of Intermodal Transportation Systems
- Case Study
- Conclusions
Introduction

- Significant direct economic loss due to restoration of damaged or destroyed infrastructures.
- Significant indirect economic loss due to the additional rerouting cost of freight and passenger transportation.
- A framework is necessary to evaluate these direct and indirect economic costs.
- Objective: propose a framework for estimating transportation economic impacts due to disasters by transportation network modeling tools.
- Major Concern: the highway and railroad systems
Study Area

Figure 1 The Highway System of the Study Area

Source: Figure 2 is obtained from the Mississippi Department of Transportation (MDOT) website (http://gomdot.com/Divisions/IntermodalPlanning/Resources/Maps/StateHighwayMaps.aspx).
FIGURE 2 Methodology of Transportation Economic Impact Study
Categories of Transportation Economic Impacts

- **Direct transportation economic impacts**: economic losses because of restoration damaged or destroyed infrastructures

- **Indirect transportation economic impacts**: economic losses due to additional rerouting cost of detoured freight and passenger transportation
  
  - *The Highway System*
    - Cost of rerouting delays
    - Cost of congestion delays
    - Cost of additional emissions and pavement maintenance
  
  - *The Railroad System*
    - Cost of rerouting delays
Indirect Transportation Economic Impacts of Intermodal Transportation Systems

- The Highway System:
  - *Method: link-based method (easily identify volume change of a link)*
  
  1) *Cost of rerouting delays*
     - Measure the economic cost due to additional travel time of rerouted vehicles
     - Determined factors: additional VHTs of detoured vehicles and their value of time

  2) *Cost of congestion delays*
     - Measure the cost due to additional VHTs of resident vehicles
     - Determined factors: additional VHTs of resident vehicles and their value of time
3) Cost of additional emissions and pavement maintenance
   - Measure the cost due to extra emissions and pavement maintenance of detoured vehicles
   - Determined factors: additional VMTs of detoured vehicles and unit cost of emissions and pavement maintenance

The Railroad System:
- Method: a route-based calculation method
- Cost of rerouting delays
  - include costs of additional travel distance of rerouted trains and rent fee of right-of-way
  - Determined factors: detoured train volume, travel distances before and after a disaster, unit cost of operation and unit rent fee of right-of-way
Case Study

- Background

- Analysis of Economic Impacts to the Highway System
  - Network Modeling Tools
  - Scenarios Analysis in VISUM
  - Results

- Analysis of Economic Impacts to the Railroad System

- Results of Transportation Economic Impacts of the Intermodal Transportation Systems

- Analysis of Case Study


**Background**

- **Study area:** the Gulf Coast Region in Mississippi
- **Study period:** one week after Katrina occurred

**Major Disruptions in the Highway System:**
- 1) sections of U.S. 90 from the Bay St. Louis Bridge to the Biloxi Bay Bridge (including the two bridges) were disrupted [1];
- 2) the capacity of the section of I-10 over the Pascagoula River Basin was reduced by 50% due to the disaster [1].

**Major Disruptions in the Railroad System:** CSX tracks from Mobile (AL) to New Orleans (LA) [2].
Network Modeling Tools

- **TransCAD:**
  - Generated travel demand data: 2005 (pre-disaster) and 2006 (post-disaster).
  - Provided data for building VISUM network: such as number of lanes, link length, speed limits, etc.

- **VISUM:**
  - Traffic assignment method: the Equilibrium assignment in VISUM
  - Applied continuous equilibrium assignments for each hour of a day, i.e., 24 times, to capture hourly variations in daily traffic pattern.
Scenario Analysis in VISUM

- **Scenario 0** (original network before the disaster): complete highway network and pre-disaster demand data
- **Scenario 1** (original network after the disaster): a hypothetical scenario; complete highway network and the post-disaster demand data
- **Scenario 2** (disrupted network after the disaster): actual road network during the study period and the post-disaster demand data
## Results: Traffic Assignment

### Table 1 Daily Total VHTs of POVs and Trucks in the Three Scenarios

<table>
<thead>
<tr>
<th></th>
<th>Scenario 0</th>
<th>Scenario 1</th>
<th>Scenario 2</th>
<th>Daily Difference Between Scenario 1 and 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>POV (h)</td>
<td>186,050</td>
<td>181,329</td>
<td>196,486</td>
<td>15,158</td>
</tr>
<tr>
<td>Truck (h)</td>
<td>41,184</td>
<td>29,867</td>
<td>31,371</td>
<td>1,504</td>
</tr>
</tbody>
</table>

### Table 2 Daily Total VMTs of All vehicles in the Three Scenarios

<table>
<thead>
<tr>
<th></th>
<th>Scenario 0</th>
<th>Scenario 1</th>
<th>Scenario 2</th>
<th>Daily Difference Between Scenario 1 and 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>(Miles)</td>
<td>10,576,234</td>
<td>9,901,950</td>
<td>10,087,136</td>
<td>185,187</td>
</tr>
</tbody>
</table>
## Results: Daily Indirect Transportation Economic losses of the Highway System

Table 3 Daily Costs of Operation, Emission and Pavement Maintenance in Scenarios 0, 1 and 2

<table>
<thead>
<tr>
<th></th>
<th>Scenario 0</th>
<th>Scenario 1</th>
<th>Scenario 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Operating Cost ($)</td>
<td>8,248,201</td>
<td>7,179,372</td>
<td>7,696,451</td>
</tr>
<tr>
<td>Emission Cost ($)</td>
<td>454,778</td>
<td>425,785</td>
<td>451,433</td>
</tr>
<tr>
<td>Pavement Maintenance Cost ($)</td>
<td>74,033</td>
<td>69,313</td>
<td>70,611</td>
</tr>
<tr>
<td>Total Cost ($)</td>
<td>8,777,012</td>
<td>7,674,470</td>
<td>8,200,810</td>
</tr>
<tr>
<td>Travel Cost Per Veh-Mile ($)</td>
<td>0.83</td>
<td>0.78</td>
<td>0.81</td>
</tr>
</tbody>
</table>

Table 4 Indirect Costs of Disruptions to the Highway System

<table>
<thead>
<tr>
<th></th>
<th>Cost of rerouting delay and congestion delay ($)</th>
<th>Cost of additional emission and pavement maintenance ($)</th>
<th>Indirect cost of the highway system impacted by Katrina ($)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total (Daily)</td>
<td>517,079</td>
<td>9,261</td>
<td>526,340</td>
</tr>
</tbody>
</table>
Results: Transportation Economic Losses of the Highway System (Entire Disaster Period)

- **Total Direct Cost**: used $700 million
  - the obtained reconstruction cost: the Biloxi Bay Bridge ($347,214,473) and the Bay St. Louis Bridge ($283,543,242) (B.B. House, unpublished data).

- **Total Indirect Cost**: $393.4 million
  - **880 days**: total detour period
  - **615 days**: the period that both Bay St. Louis Bridge and Biloxi Bay Bridge were completely closed due to disruptions.
Analysis of Economic Impacts to the Railroad System

- Daily Detoured Train Volume: 20 trains per day [3]
- Two parts of a rerouting route from Mobile to New Orleans: route A (95 miles) and route B (110 miles) [3].
- Original route of CSX tracks: route C (140 Miles) [3].

![Rail Map of the Gulf Coast Region in the State of Mississippi](http://www.gomdot.com/Divisions/IntermodalPlanning/Resources/Maps/pdf/Rails.pdf)

Source: Figure 3 is obtained from the MDOT website
Results of Transportation Economic Impacts to the Railroad System

- **Daily indirect cost for the railroad system**: $530,855
  - Additional operating cost: $197,730
  - Rent cost of right-of-way: $333,125

- **Cost of entire disaster period for the railroad system**: more than $379.6 million
  - Direct cost: $300 million [2].
  - Indirect cost (diversion cost): over $79.6 million for the entire rerouting period (over five months [2])
## Results of Transportation Economic Impacts of the Intermodal Transportation Systems

### Table 5 Transportation Economic Impacts of Hurricane Katrina in the State of Mississippi

<table>
<thead>
<tr>
<th></th>
<th>The Highway System</th>
<th>The Railroad System</th>
<th>Intermodal Transportation Systems</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Direct Cost ($)</strong></td>
<td>700 million</td>
<td>300 million [2]</td>
<td>1 billion</td>
</tr>
<tr>
<td><strong>Indirect Cost ($)</strong></td>
<td>Daily 526,340</td>
<td>530,855</td>
<td>1,057,195</td>
</tr>
<tr>
<td></td>
<td>Total 393.4 million</td>
<td>79.6 million</td>
<td>473 million</td>
</tr>
<tr>
<td><strong>Total Cost ($)</strong></td>
<td>1.1 billion</td>
<td>379.6 million</td>
<td>1.5 billion</td>
</tr>
</tbody>
</table>
Analysis of the Case Study

- Two major factors for economic loss of highways: rerouting delays and congestion delays ($517,079 (daily); 98.24% of the total daily indirect cost)

- Detoured POVs is the major factor of the costs of rerouting delays and congestion delays:
  - Three times more than the trucks; account for 75.66% of total
  - Reason: account for 90.1% of post-disaster daily travel demand

- Cost of emissions and pavement maintenance: did not significantly impact the economy; however, would impact air quality.
  - Additional emissions of all rerouted vehicles: 164.8 kg of total HC, 1,735.2 kg of CO and 240.7 kg of NOx

- For the railroad system, the rent cost of right-of-way ($333,125) is the major component of the total daily indirect cost ($530,855).
Conclusions

- In this study, we presented a framework that incorporated transportation network modeling tools for estimating the economic impacts on intermodal transportation systems due to system disruptions by a disaster.

- The major component of the daily indirect cost: the highway system (rerouting and congestion delays); the railroad system (rent cost of right-of-way).

- A major factor need to be considered for transportation economic impact study: economic losses due to the rerouting passenger cars and non-freight vehicles.
Thanks!
Reference

