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

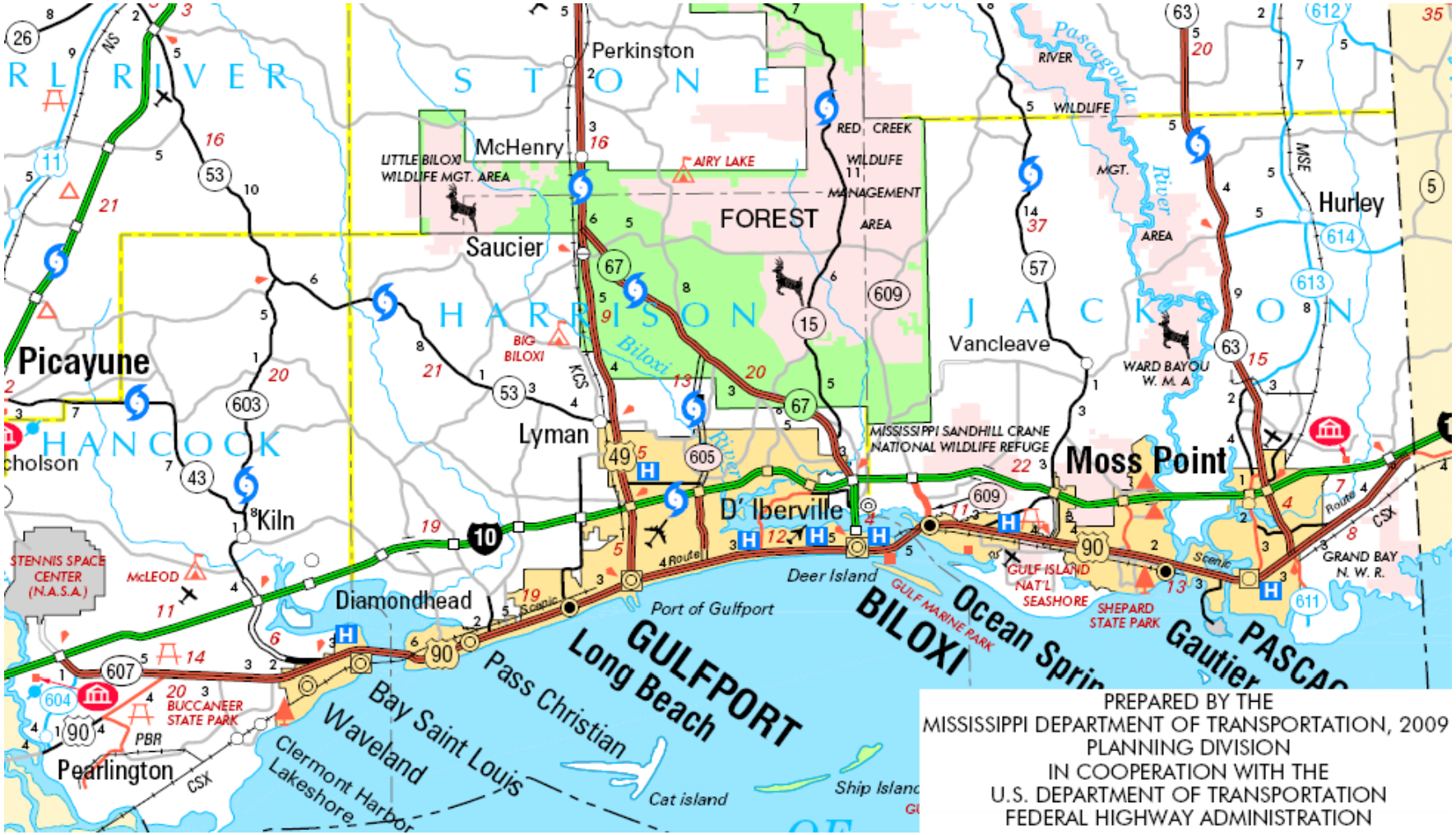


Figure 1 The Highway System of the Study Area

Source: Figure 2 is obtained from the Mississippi Department of Transportation (MDOT) website (http://gomdot.com/Divisions/IntermodalPlanning/Resources/Maps/StateHighwayMaps.aspx).

Framework

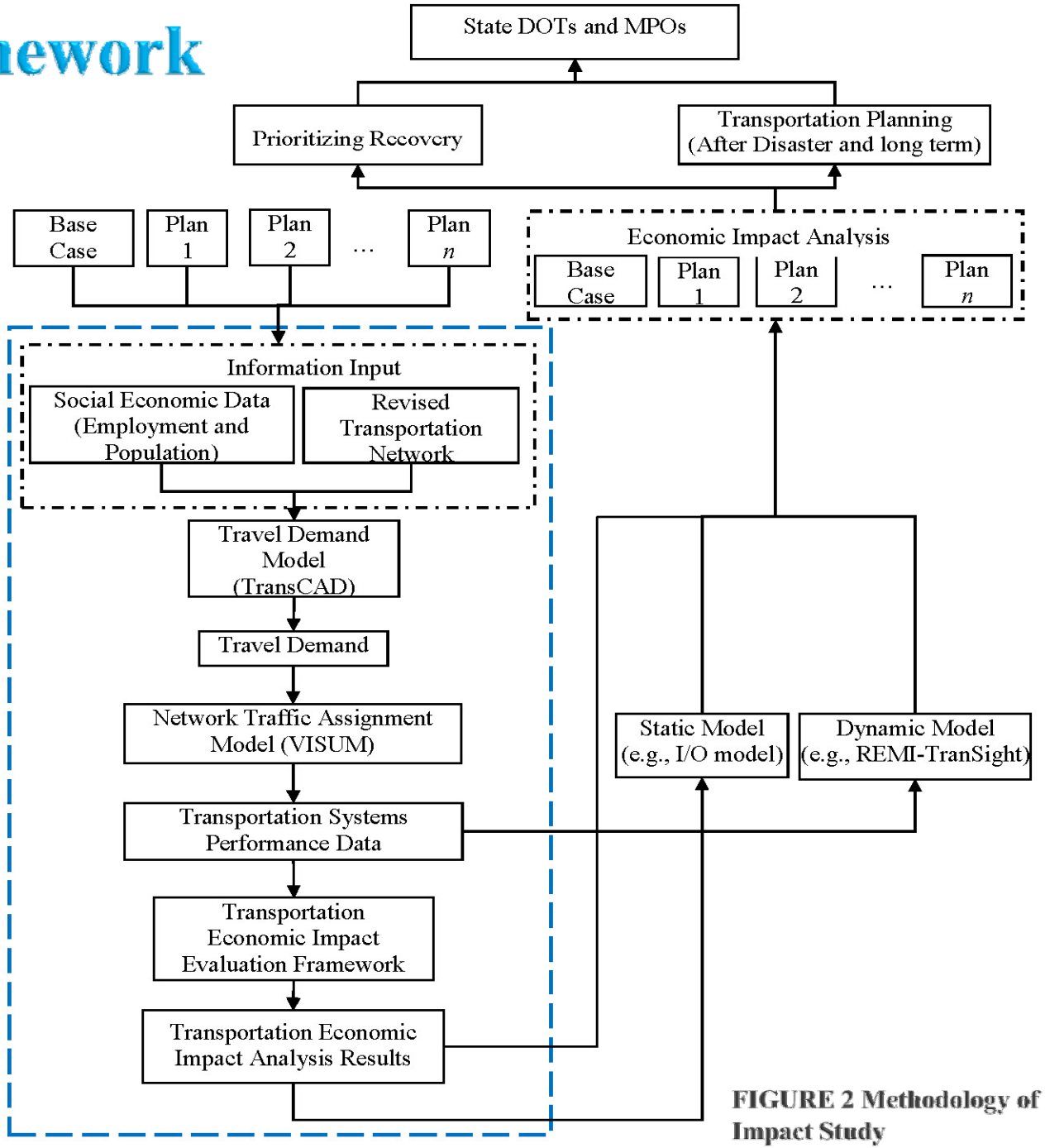
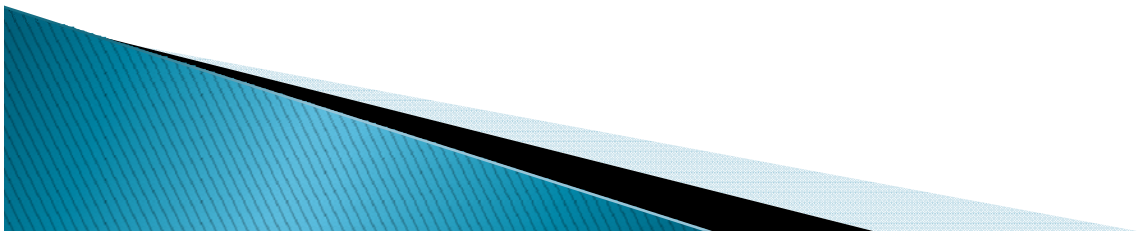


FIGURE 2 Methodology of Transportation Economic Impact Study

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

Indirect Transportation Economic Impacts of Intermodal Transportation Systems (cont.)

- *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

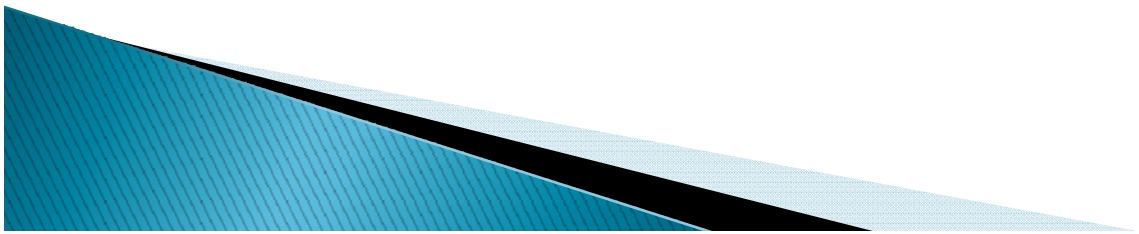
Background

- **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].

Analysis of Economic Impacts to the Highway System

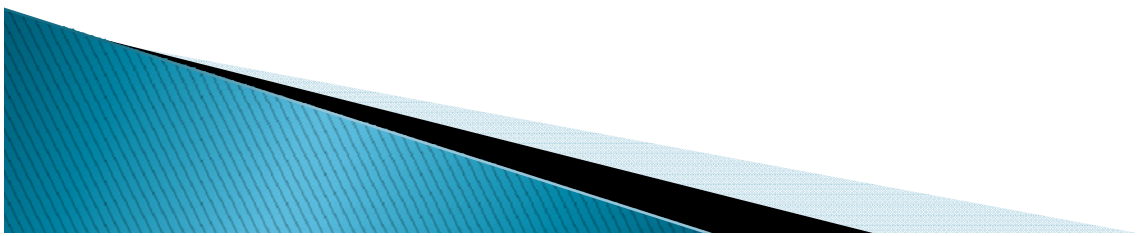
Network Modeling Tools

- **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

	Scenario 0	Scenario 1	Scenario 2	Daily Difference Between Scenario 1 and 2
POV (h)	186,050	181,329	196,486	15,158
Truck (h)	41,184	29,867	31,371	1,504

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

	Scenario 0	Scenario 1	Scenario 2	Daily Difference Between Scenario 1 and 2
(Miles)	10,576,234	9,901,950	10,087,136	185,187

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

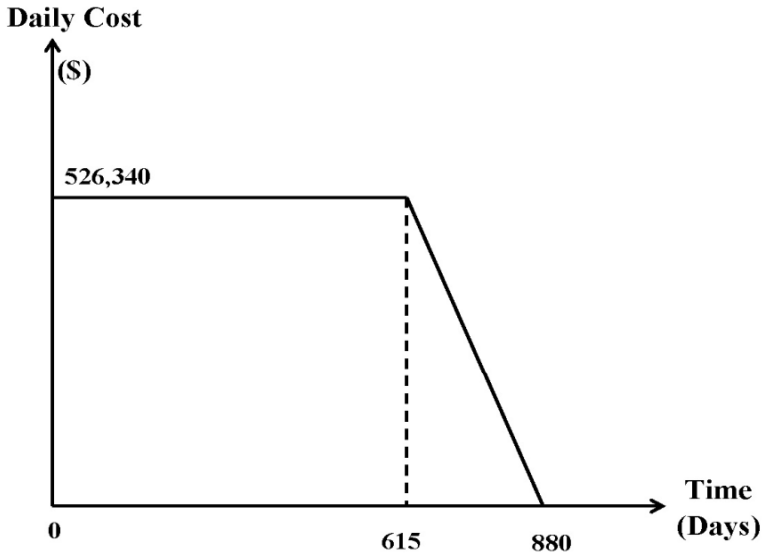
	Scenario 0			Scenario 1			Scenario 2		
	Operating Cost ($)	Emission Cost ($)	Pavement Maintenance Cost ($)	Operating Cost ($)	Emission Cost ($)	Pavement Maintenance Cost ($)	Operating Cost ($)	Emission Cost ($)	Pavement Maintenance Cost ($)
Daily Cost ($)	8,248,201	454,778	74,033	7,179,372	425,785	69,313	7,696,451	433,748	70,611
Total Cost ($)	8,777,012			7,674,470			8,200,810		
Travel Cost Per Veh-Mile ($)	0.83			0.78			0.81		

Table 4 Indirect Costs of Disruptions to the Highway System

	Cost of rerouting delay and congestion delay ($)	Cost of additional emission and pavement maintenance ($)	Indirect cost of the highway system impacted by Katrina ($)
Total (Daily)	517,079	9,261	526,340

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].

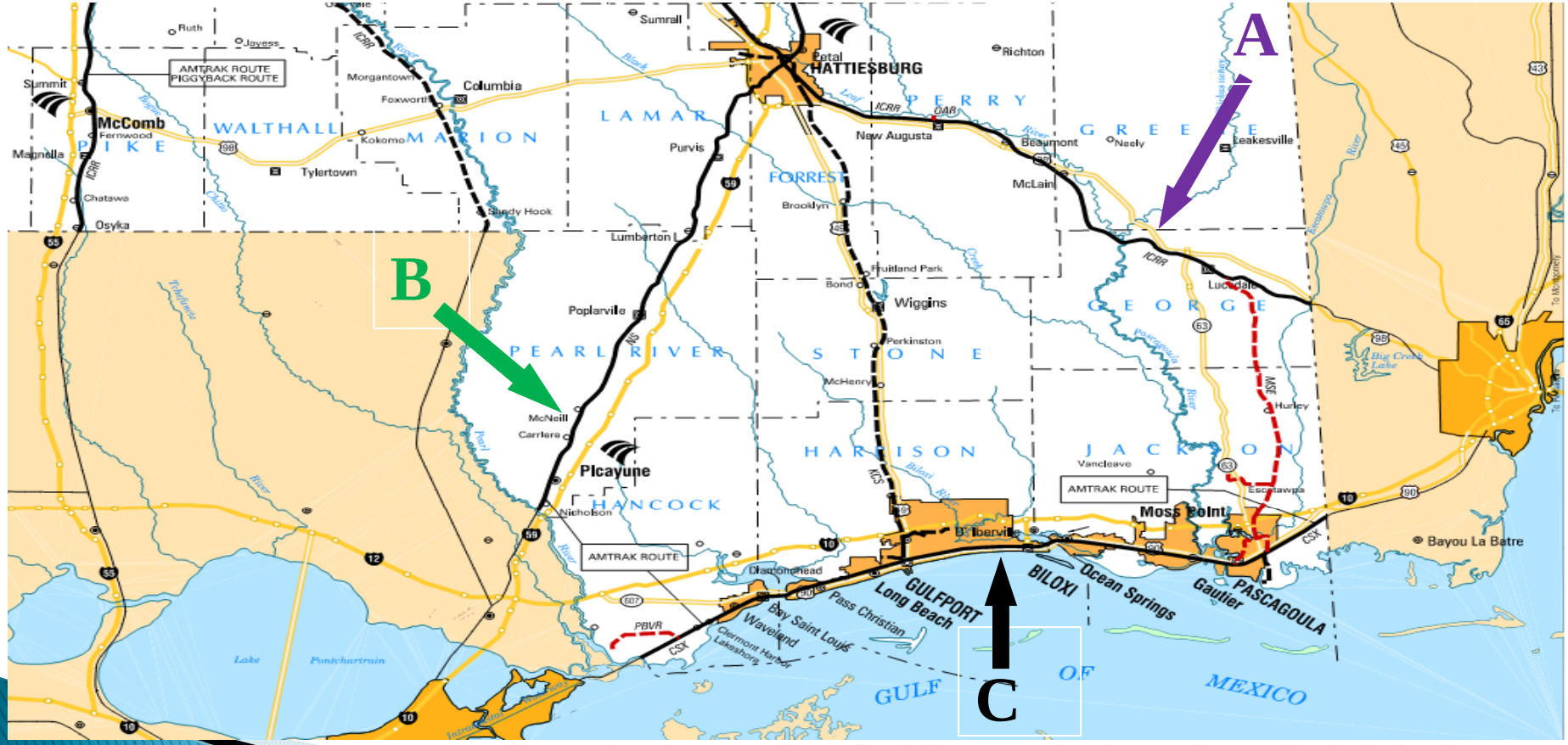


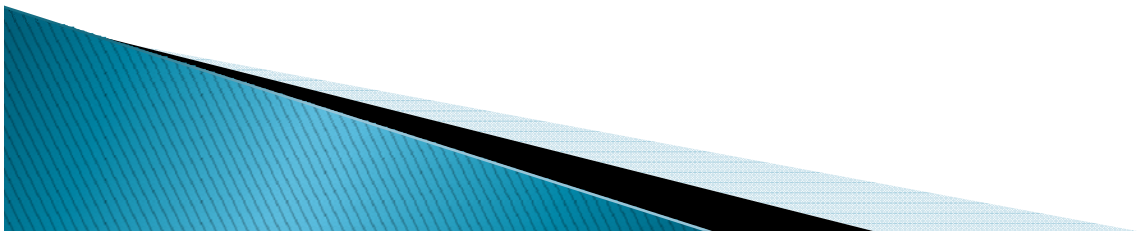
FIGURE 3 Rail Map of the Gulf Coast Region in the State of Mississippi

Source: Figure 3 is obtained from the MDOT website (http://www.gomdot.com/Divisions/IntermodalPlanning/Resources/Maps/pdf/Rails.pdf).

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

		The Highway System	The Railroad System	Intermodal Transportation Systems
Direct Cost ($)		700 million	300 million [2]	1 billion
Indirect Cost ($)	Daily	526,340	530,855	1,057,195
	Total	393.4 million	79.6 million	473 million
Total Cost ($)		1.1 billion	379.6 million	1.5 billion

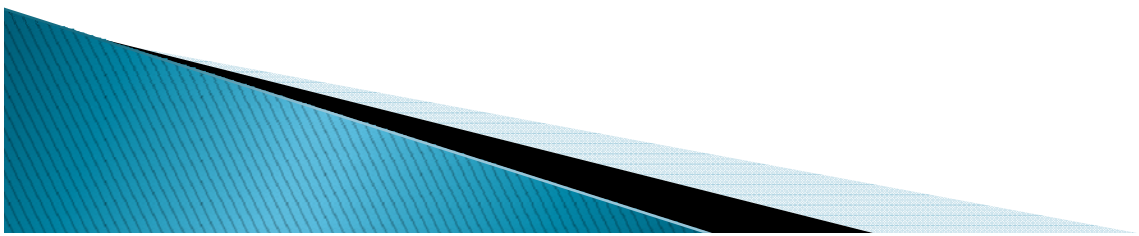
Analysis of the Case Study

- 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

- [1] Zhang, L., et al., *Framework of Calculating The Measures of Resilience(MOR) For Intermodal Transportation Systems*. 2010, Mississippi State University. p. 65.
- [2] Grenzeback, L.R. and A.T. Lukmann, *Case Study of the Transportation Sector's Response to and Recovery from Hurricanes Katrina and Rita*, in *Transportation Research*. 2009, Cambridge Systematics Inc.
- [3] DMJM Harris, *Statewide Rail Needs Assessment, Phase 7 - CSXT Relocation Assessment in Response to Hurricane Katrina, Task 1: Alternative Temporary CSXT Rerouting*. 2005.