The Role of GIS in a Disaster Recovery Plan

2010 GIS-T CONFERENCE

SANDY MEHLHORN
Introduction

- Four phases of disaster related planning
  - Mitigation
  - Preparation
  - Response
  - Recovery
- Considerable emphasis on response phase
- Recovery plans are vital to a region after a natural disaster
  - The recovery phase is characterized by activity to return life to normal or improved levels
- This presentation will discuss the use of GIS as an integral part of a transportation recovery plan after a natural disaster
Current Role of GIS in Disaster Recovery

- GIS is an integral tool in supporting damage assessment, network prioritization, and public education after a disaster.
- Establish an extensive database in GIS, so that information is readily available when a disaster strikes.
  - The use of GIS software is ideal for handling all of the data necessary for modeling after a natural disaster because an extensive database, including information such as system facilities, year they were built and current condition, is needed.
- Widespread use of GIS by emergency management agencies to enhance the efficiency and productivity of their efforts.
  - GIS enables an emergency manager to visualize and analyze natural disaster situations more accurately.
- The visualization capabilities also make GIS ideal for natural disaster modeling.
  - HAZUS-MH
  - REDARS
- GIS needs to become a more integral tool pre-disaster.
Developing a Disaster Recovery Plan

1) Identify key facilities to be given priority for reconstruction
   - Examples are industry, hospitals, residential areas, schools

2) Once facilities have been identified as a priority for reconstruction, roadways between those facilities and the edge of the damage perimeter are identified (“paths”)
   - Network Analyst tool is used to determine the paths
   - Each path can contain any number of transportation components

3) Develop a database for all transportation components along a path
   - Each transportation component has a replacement cost and replacement time associated with it
   - A GIS database is ideally suited for the amount of data and the manipulation of the data

4) Assign a “benefit” associated with the repair of each path

5) Run data through mathematical model to prioritize routes for reconstruction
Data Description and Sources

- **Benefit**
  - Weighting factor based on the facilities importance to local and regional goals

- **Paths**
  - Section of roadway between a key facility and the edge of the damage perimeter

- **Budget**
  - Determined by state and local agencies

- **Time period allowed for repairs**
  - Determined by state and local agencies

- **Transportation components**
  - Include the roadway, bridges over water, overpasses, tunnels
  - Classified by 5 damage levels: none, slight, moderate, extensive and complete
## Data Description and Sources

### Repair Costs of Transportation Components
- **Replacement Cost Ratio (REDARS)**

<table>
<thead>
<tr>
<th>Damage State</th>
<th>Mean Repair Cost Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>None</td>
<td>0.0</td>
</tr>
<tr>
<td>Slight</td>
<td>0.03</td>
</tr>
<tr>
<td>Moderate</td>
<td>0.08</td>
</tr>
<tr>
<td>Extensive</td>
<td>0.25</td>
</tr>
<tr>
<td>Complete</td>
<td>1.0</td>
</tr>
</tbody>
</table>
Data Description and Sources

- Repair Time of Transportation Components
  - Replacement Time Ratio (REDARS)

<table>
<thead>
<tr>
<th>Damage State</th>
<th>Duration</th>
</tr>
</thead>
<tbody>
<tr>
<td>None</td>
<td>1-5 days*</td>
</tr>
<tr>
<td>Slight</td>
<td>2-3 weeks</td>
</tr>
<tr>
<td>Moderate</td>
<td>2-4 weeks</td>
</tr>
<tr>
<td>Extensive</td>
<td>4-12 weeks</td>
</tr>
<tr>
<td>Complete</td>
<td>3-10 months</td>
</tr>
</tbody>
</table>
Recovery Plan Example

- Shelby County, Tennessee
  - “America’s Distribution Center”
- For a quick recovery, local industry must be given accessibility
  - Top 25 revenue producing industries
  - Assume the damage perimeter is the edge of the county
  - Benefit of each path is the cumulative revenue of the industries along the path
### Locations of Paths and Industries

<table>
<thead>
<tr>
<th>Path #</th>
<th>Roadway</th>
<th>Benefit (million $)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Interstates 240 &amp; 55</td>
<td>13,500</td>
</tr>
<tr>
<td>2</td>
<td>Interstate 40</td>
<td>44,500</td>
</tr>
<tr>
<td>3</td>
<td>Interstate 55</td>
<td>3,400</td>
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<tr>
<td>4</td>
<td>US 61</td>
<td>9,600</td>
</tr>
<tr>
<td>5</td>
<td>US 72</td>
<td>81,600</td>
</tr>
<tr>
<td>6</td>
<td>US 64</td>
<td>5,700</td>
</tr>
<tr>
<td>7</td>
<td>US 61</td>
<td>6,200</td>
</tr>
<tr>
<td>8</td>
<td>US 78</td>
<td>166,298.3</td>
</tr>
<tr>
<td>9</td>
<td>US 78</td>
<td>116,025.5</td>
</tr>
</tbody>
</table>

Compiled by: Sandy Mehlhorn April 8, 2009
Location of Bridges

Legend

- Bridges: path1
- Businesses: path2
- Interstate: path3
- US Highways: path4
- Path 1: path5
- Path 2: path6
- Path 3: path7
- Path 4: path8
- Path 5: path9
- Path 6: path10

Compiled by: Sandy Meihorn October 26, 2009
Damage Levels for Planning Scenario

- 15% not damaged
- 17% slightly damaged
- 22% moderately damaged
- 22% extensively damaged
- 22% completely damaged
## Scenario Output

<table>
<thead>
<tr>
<th>Time</th>
<th>Paths</th>
<th>Recognized Benefit (million $)</th>
</tr>
</thead>
<tbody>
<tr>
<td>6 months</td>
<td>5,6</td>
<td>87300</td>
</tr>
<tr>
<td>1 year</td>
<td>5,6,9</td>
<td>203325.5</td>
</tr>
<tr>
<td>1.5 years</td>
<td>5,6,8</td>
<td>253598.3</td>
</tr>
<tr>
<td>2 years</td>
<td>8,9</td>
<td>282324</td>
</tr>
<tr>
<td>2.5 years</td>
<td>8,9</td>
<td>282324</td>
</tr>
<tr>
<td>3 years</td>
<td>8,9</td>
<td>282324</td>
</tr>
<tr>
<td>3.5 years</td>
<td>8,9</td>
<td>282324</td>
</tr>
<tr>
<td>4 years</td>
<td>8,9</td>
<td>282324</td>
</tr>
<tr>
<td>4.5 years</td>
<td>8,9</td>
<td>282324</td>
</tr>
<tr>
<td>5 years</td>
<td>8,9</td>
<td>282324</td>
</tr>
</tbody>
</table>

**Budget**: $10,000,000

Compiled by Sandy Melhorn, April 8, 2009
Conclusion

- GIS should play a more integral role in planning for recovery from a disaster
- Network Analyst can be a valuable tool in planning for disaster reconstruction
- Time should be taken to prioritize routes for reconstruction
- There are advantages to prioritizing routes
  - Spending of maintenance money
  - Shorter time between response and beginning recovery
Questions or Comments?

Contact Information:
- smehlhorn@utm.edu
- 731-881-7253