Using Geographic Information Systems to Evaluate Freight Transportation Routes Experiencing Disruption

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Introduction

Disasters have consequences; and freight transportation is not immune from effects of such disruptions. In the aftermath of disruptions, freight may be diverted as a result of damaged infrastructure, as was the case during Hurricane Sandy with the closure of the Port of New York/New Jersey. Geographic Information Systems (GIS) can help planners determine routes for getting freight to its destination, taking into account modal restrictions. Using WebTRAGIS, a transportation routing program developed at Oak Ridge National Laboratory (ORNL), we illustrate the various available routes for freight that was diverted as a result of the port closure in New York.

Freight Transportation as Critical Infrastructure

- Transportation is one of the 16 Critical Infrastructure Sectors as listed under Presidential Policy Directive 21
- U.S. Department of Transportation (DOT) defines resilient transportation systems as having the "ability to resist, absorb, recover from, of successfully adapt to adversity or a change in conditions" [1]
- Freight Transportation builds on DOT definition, but emphasizes resilience of physical infrastructure, users, and managers of freight transportation systems

Hurricane Sandy-October 2012

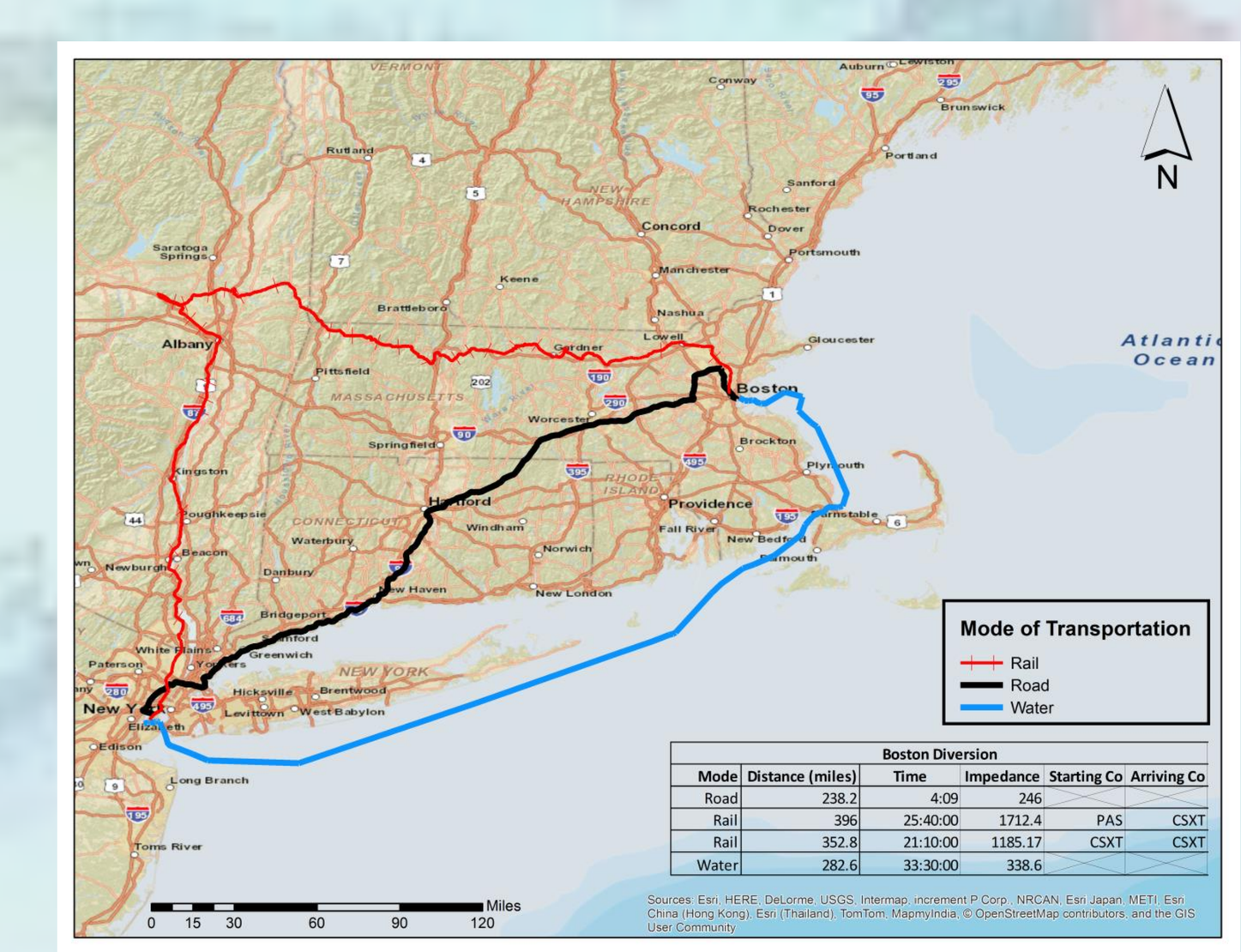
- Category 3 Storm
  - 233 Fatalities
  - $65 Billion in damage
- Made landfall October 29 at Atlantic City, NJ
- Port of New York/New Jersey Suspended Operations [2][3]
  - 15,000 Containers diverted
  - 9,000 Automobile imports diverted
- Damage [3]
  - Debris in waterways/navigational aids destroyed
  - Drayage vehicles damaged/washed away
  - Rail relays and switches flooded
  - CSX Kearney yard flooded with 4 feet of water

Web Transportation Routing Analysis GIS (WebTRAGIS)

- GIS based application used for developing route options for Spent Nuclear Fuel Shipments in support of current DOE objectives [4]
- Multimodal (Road, Rail, Water) routes based on data from U.S. Geological Survey, Army Corp of Engineers, and U.S. Census
- Route generation based on shortest path algorithm with impedance factors built in for specific modes
- Output is a GIS shapefile and text-based description of the route

Results

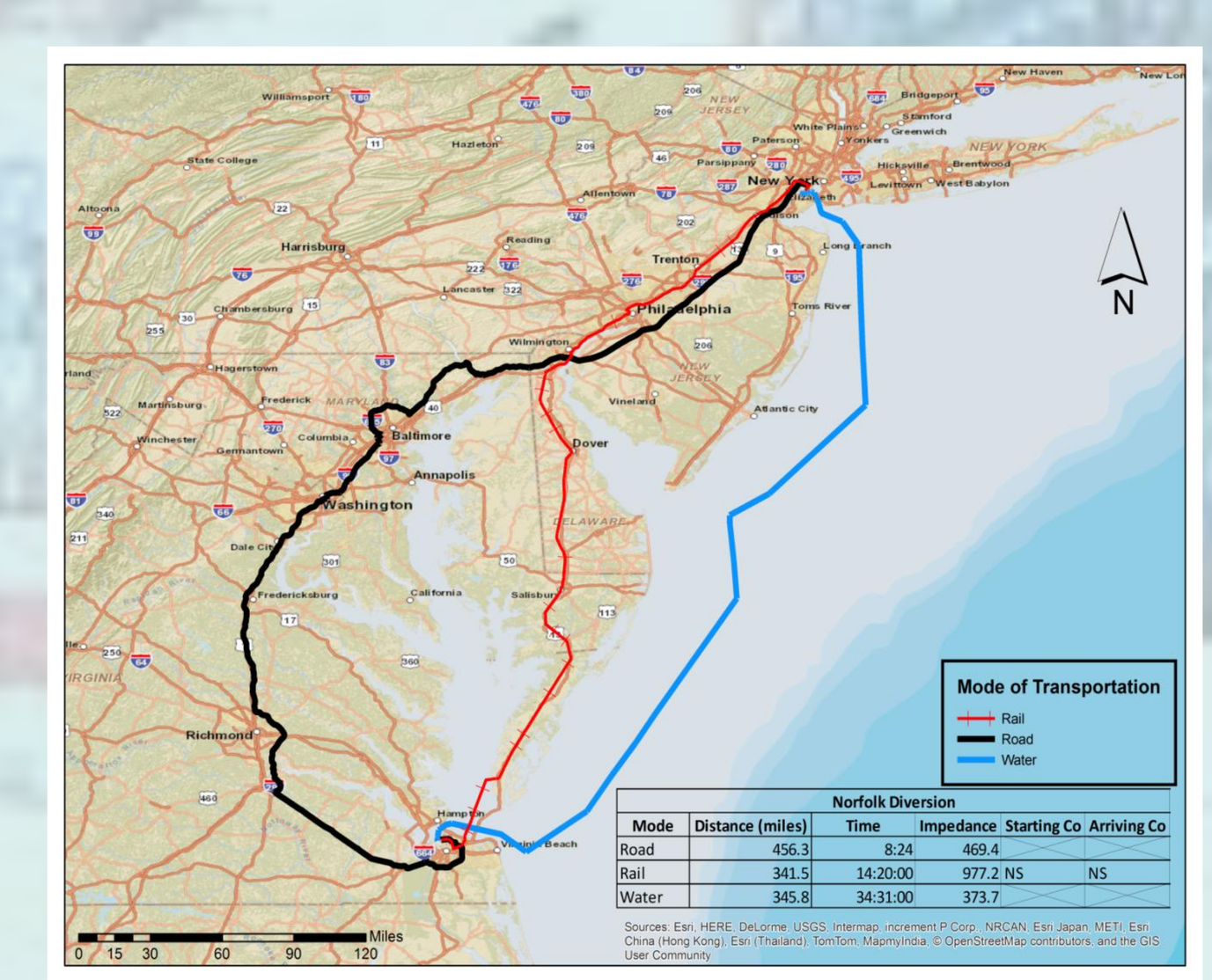
- 6 Ports (Boston, Philadelphia, Baltimore, Norfolk, Charleston, Savannah) of Origin
- Port of New York & New Jersey as Destination
- 3 Modal routes presented in each scenario (Road, Rail, Water)
- Distance traveled, transit time, and impedance measured



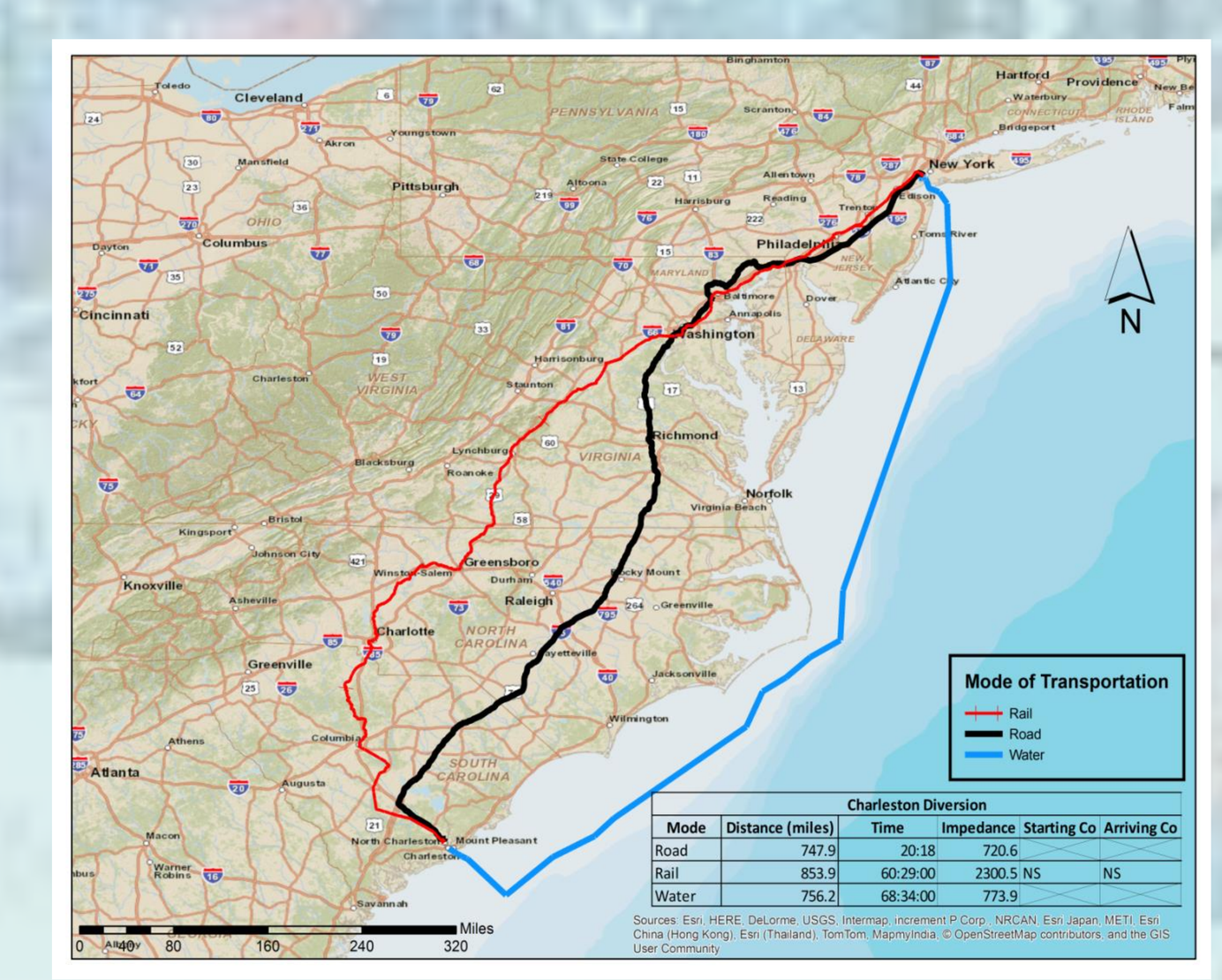
Boston

Philadelphia

Baltimore



Norfolk



Charleston

Savannah

Discussion

- Road usually had the shortest transit time or shortest distance
- Water routes illustrate opportunity for Short Sea Shipping as a strategy for handling diverted cargo
- Current output only illustrates route, does not show capacity on generated route nor congestion of increased cargo throughput
- Sensitivity analysis as to affect of rail ownership on route generation and affect on route measures

Conclusion

- Use of WebTRAGIS and GIS technology can help illustrate various options with respect to transportation rerouting, especially under scenarios where transportation infrastructure is inoperable as a result of damage
- Provide analysis technique for laws and policies relating to transportation and critical infrastructure protection

References

[1] Transportation Systems Sector-Specific Plan: An Annex to the National Infrastructure Protection Plan. Department of Homeland Security. 2010.

[2] D. Lombardi. Small Sea Changes: Big Coastal Impacts-Port of NY & NJ Sandy 2012. The Port Authority of New York New Jersey. 2014.

[3] L. Sturgis; T. Smythe; A. Tucci, Port Recovery in the Aftermath of Hurricane Sandy, *Center for a New American Security*, 2014.

[4] P. Johnson & R. Michelhaugh, Transportation Routing Analysis Geographic Information System User's Manual, ORNL/NTRC-006, 2003.

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