Impacts of Legal Restrictions on Freight Transportation Routing During Extreme Weather Events

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Motivation for Studying Freight Transportation

“Transportation Science isn’t rocket science...it’s harder” (Ducruet, 2010)
Freight Transportation By the Numbers

• 2012: 19,000,000,000 tons of freight moved

• Characteristics of Freight Transportation System

  – Multimodal
    • 4 million miles of highway
    • 140,000 miles of railway
    • 25,000 miles of waterway

  – Multijurisdictional (A Lawyer’s Playground)
    • DOT: FHWA, FRA, MARAD, FMCSA, FAA, STB, PHMSA
    • USACE, EPA, CBP, USCG, FEMA, TSA, DHS, DOE
    • States and Municipalities

  – Multiple Stakeholders
    • Public Sector
    • Private Sector
Hurricane Sandy: October 2012

• Category 3 Storm
  – 233 Fatalities
  – $65 Billion Recovery

• Transportation Sector
  – Port of NY/NJ closed
    • 57 vessels diverted
    • 25,000 Containers Diverted
    • 9,000 Automobile Imports Diverted
  – Rail Infrastructure incapacitated
  – Chassis’ and drayage vehicles immobilized or damaged
Impacts of Hurricane Sandy on Freight Movement

- Intermodal Coordination lacking
  - Smythe (2013): maritime division was able to restart operations at Port NY/NJ but road and rail were not able to stand up their operations

- The Merchant Marine Act of 1920, 46 U.S.C § 883 (The Jones Act)
  - Short sea shipping between U.S. “coast-wise points” is only permitted by under certain restrictions based on vessel construction and crewing requirements

- Critical Infrastructure Resilience and Security literature has viewed the law and regulatory landscape as environmental factors that the infrastructure must contend with, but is this truly the case?
My Research Question-Broadly

• How do planners and decision-makers make informed decisions for protecting and ensuring resilience in critical infrastructure if they are uncertain as to the role and effects of such laws on the infrastructure they govern?
Two Challenges in Freight Transportation Planning and Policy

• Physical (Network) Complexity
  – Modeling/representation Challenge
  – Data acquisition/availability

• Institutional Complexity: “Disjointed Multi-modalism”
  – No Integrated Freight Planning Framework
  – Agency Balkanization
    • Modal Domain Awareness
  – MAP-21
    • FHWA led approach (mixed results)
Physical Complexity

• Multiple Networks with various flows

• Methodologies
  - Optimization
    • Several existing algorithms
    • Better for planning analysis
  - Graph Theory
    • Can capacitate the network to demonstrate flow
    • Problem of scaling (highly dense graphs lose stability and can break down, e.g. Chicago)
    • Encoding behavior on the various links and nodes can be tedious
  - GIS
    • Good for visualization and network analysis
    • Large networks can slow down programs (ArcGIS)
    • Capacity is possible though requires data and computational power
Physical Complexity Continued

- **WebTRAGIS (ORNL)**
  - Genesis
    - Web-based application
    - HIGHWAY and INTERLINE legacy programs
    - Original and current purpose is to support DOE in routing Spent Nuclear Fuel (SNF)
  - Elements of Platform
    - Multimodal
      - Highway
      - Rail
      - Waterway
    - Data from variety of sources
      - Army Corp of Engineers
      - FRA
      - FMCSA
      - TIGER Shapefiles
    - Un-capacitated network
Problem Formulation/Parameters

• Question:
  – What effect does the relaxation of the Jones Act and the restriction on Short Sea Shipping have on freight capacity and movement of freight through a system experiencing disruption

• WebTRAGIS Inputs
  – Six Ports receiving diverted traffic as origin
  – Port of New York/New Jersey as destination (assumption)
  – For scenarios, 3 modal routes presented
    • Road
    • Rail (assuming the start and end rail company are the same)
    • Water (hypothetically available if Jones Act was suspended)
  – Compared Impedance Values between modal routes within the port to port O-D pairing
Observations & Limitations

• Observations
  – In scenarios presented the road trip had the lowest impedance value
  – In two of the four scenarios, the rail trip had the highest impedance value

• Limitations
  – New York as a “destination” exaggerates natural flow of freight
    • Resolved by further data from Carload Waybill Sample, Commodity Flow Survey, and/or Freight Analysis Framework
  – The results only show route, not capacity on the route
    • Current work on adding capacity values to rail and highway network to reflect congestion concerns
  – With respect to rail, the routes are assumed to start and end with the same company, changing the company ownership may alter the route
Conclusions & Areas of Future Research

• Physical Complexity
  – Potentiality of making WebTRAGIS a capacitated network
  – Illustrates utility of GIS in studying the effect of law on transportation infrastructure and other networked infrastructures under disruptive scenarios

• A re-evaluation of the Jones Act under disruptive conditions
  – Economic demand still unknown
  – Port development and improvements
  – Port regionalization/coordination
  – Administrative Law remedies (binding v. non-binding rulemaking or statutory reform)

• Institutional Complexity
  – Development of Integrated Freight Planning frameworks at regional level using GIS as a platform for coordination
  – Review of an archaic law that is past its use
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