Mitigating Dynamic Risk in Multi-Modal Perishable Commodity Supply Chain Networks

MBTC DHS-1109

Dr. Edward A. Pohl, Dr. Ashlea R. Bennett,
Dr. Chase E. Rainwater, Dr. Scott J. Mason
Jessica Spicer, Dia St. John

03/30/2011

MACK-BLACKWELL
Rural Transportation Center

UNIVERSITY OF ARKANSAS

General Motivation

- Economic consequence of supply chain disruptions
  - Natural hazards
  - Adversaries
- Reducing risk through fortification of infrastructure components requires expensive investments
- Investment decisions should mitigate present and future risk

http://www.washingtonpost.com/wp-dyn/content/linkset/2006/03/30/LI2006033000769.html
http://www.rightpundits.com/?p=5020

Project Specific Motivation

- Prioritizing fortification investment alternatives requires knowledge of:
  - Likelihood and magnitude of potential disruptions
  - Resiliency resulting from alternate strategies
- Imprecise understanding of adversary compounds difficulty of decision making
  - Unknown objective
  - Adaptive objective
- Consideration of multi-modal response plans increases number of investment alternatives
- Perishability aspect of transported commodities introduces new component into economic consequence function

Research Focus

- Develop decision support models to maximize present and future resiliency of perishable commodity supply chain networks when allocating scarce fortification resources for multi-modal transportation infrastructure components

- Assess supply chain risk via all-hazards perspective:
  - Natural hazards
  - Adversaries with unknown and adaptive objectives

Unique Contributions

- Integrated fortification and multi-modal risk mitigation strategies
- Post-fortification fallibility
- Unknown and adaptive adversarial objective
- Perishability concerns

http://www.lifeinthefreshlane.com/

Motivating Problem

Bulk transportation of corn along upper Mississippi River via barge

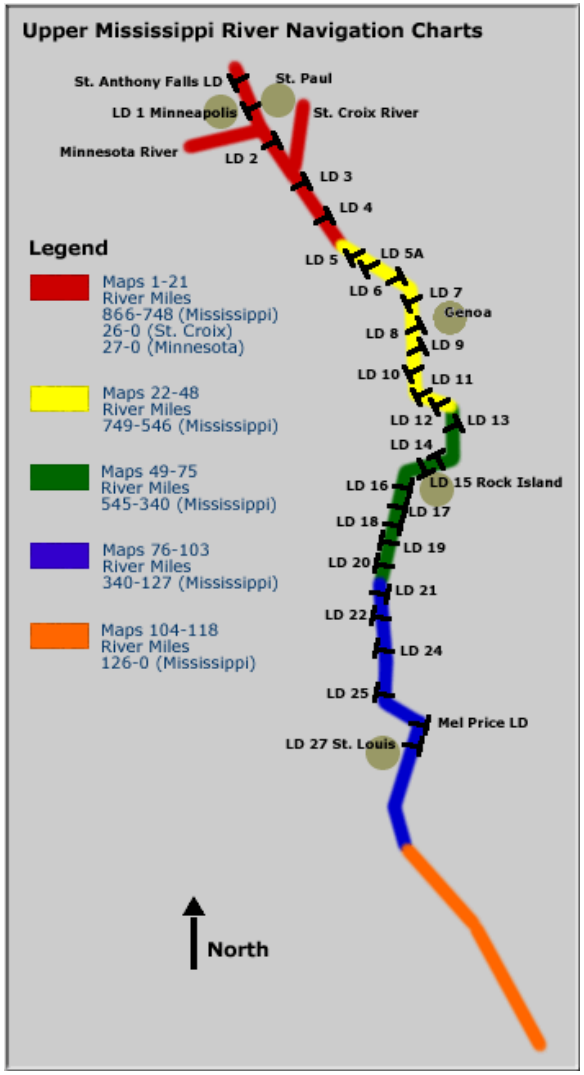
- 90% of U.S. corn destined for export travels on Mississippi*
- ½ of total freight tonnage carried on Upper Mississippi is corn*
- Economic consequence of disruption includes spoilage and delays

*Frittelli, J.F. 2005. CRS Report for Congress. Grain Transport: Modal Trends and Infrastructure Implications. January 5, 2005
http://commons.wikimedia.org/wiki/File:Cargill_grain_elevator_and_terminal.jpg

Motivating Problem

Inland waterway supply chain components at risk:

- Locks and dams
- Bridges
- Ports



http://www2.mvr.usace.army.mil/NIC2/mrcharts_omni.cfm
http://en.wikipedia.org/wiki/Lock_and_Dam_No._24

Progress to Date

- Gathered instance data for case study
  - Focus on Upper Mississippi River
  - 31 locks and dams
  - 85 bridge crossings
  - Natural disaster risk assessment
- Developed mathematical model
  - Fallible post-fortification infrastructure components
  - Budgetary concerns
  - Rolling time horizon

Next Steps

- Obtain relevant data for disruptive and fortification actions
  - Cost of fortification actions
    - E.g., bridge/lock fortification cost
  - Economic consequence of corn supply chain disruption
  - Complete likelihood of occurrence assessment
- Extend model
  - Network flow
  - Perishability
- Experimentation

Contact Information: Ed Pohl (epohl@uark.edu)