

Consequence Assessment for Food Transportation Systems

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Export Grain Chain: Vulnerable?

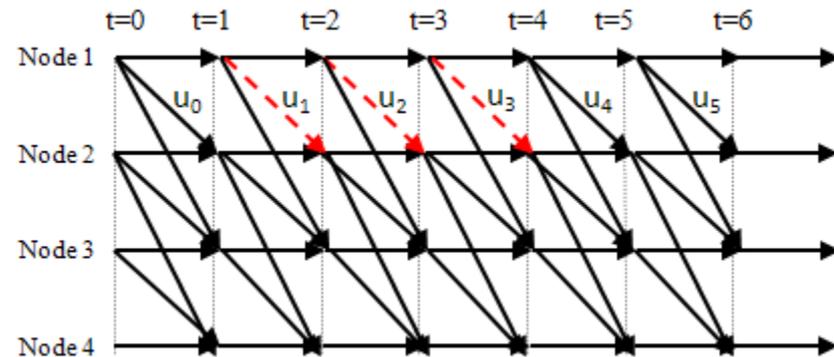
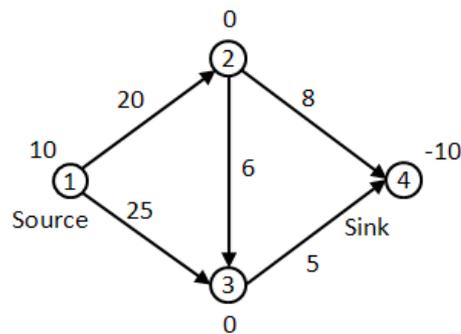
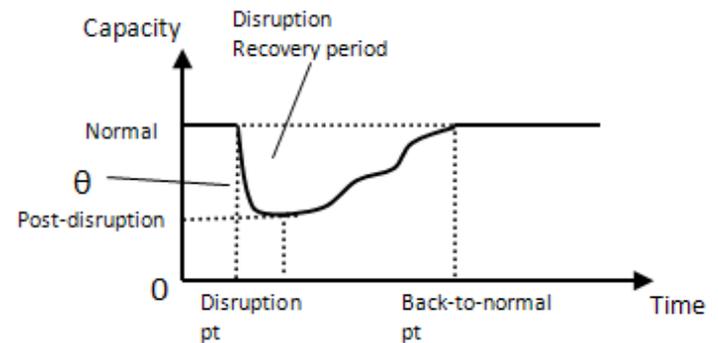
- Corn, wheat, soybeans
- Large export flows
 - Annual tonnage: 425 mmt; value: ~\$55 billion (2007)
- Transport capacity limited by bottlenecks
 - Inland barge: locks, ports
 - Rail: bridges
- Suppose Lock 27 (Mississippi) closes **unexpectedly** for one week:
 - What happens to 500k tons of throughput flow?

Vulnerability Assessment Methodology

- Method overview
 - Assess impacts to system *given* disruption
 - Incorporate rerouting, holding, backordering
- Impacts
 - Increased supply chain costs
- Disruptions
 - Natural hazards, terrorist attacks

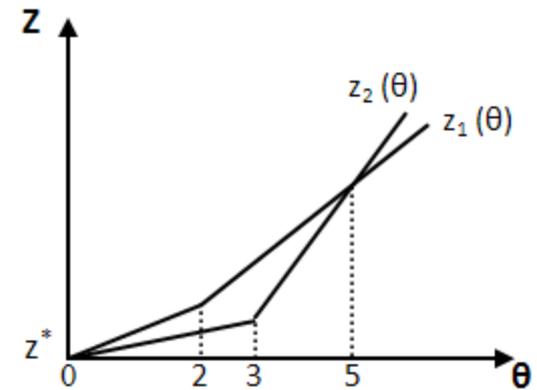
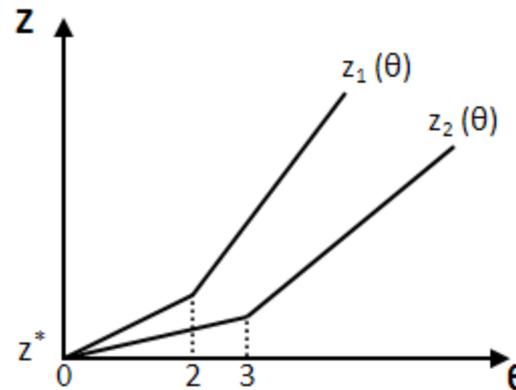
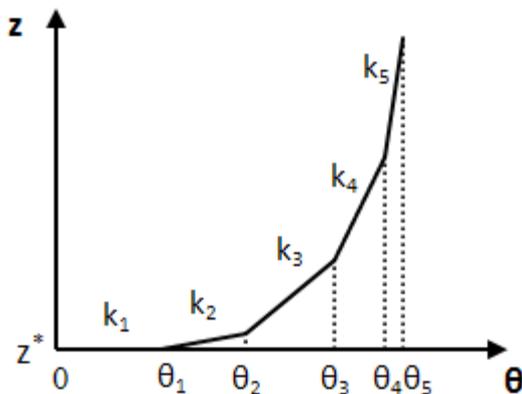
Vulnerability Assessment Methodology

- Disruption: capacity reduction for a set of network links
- Time-space network

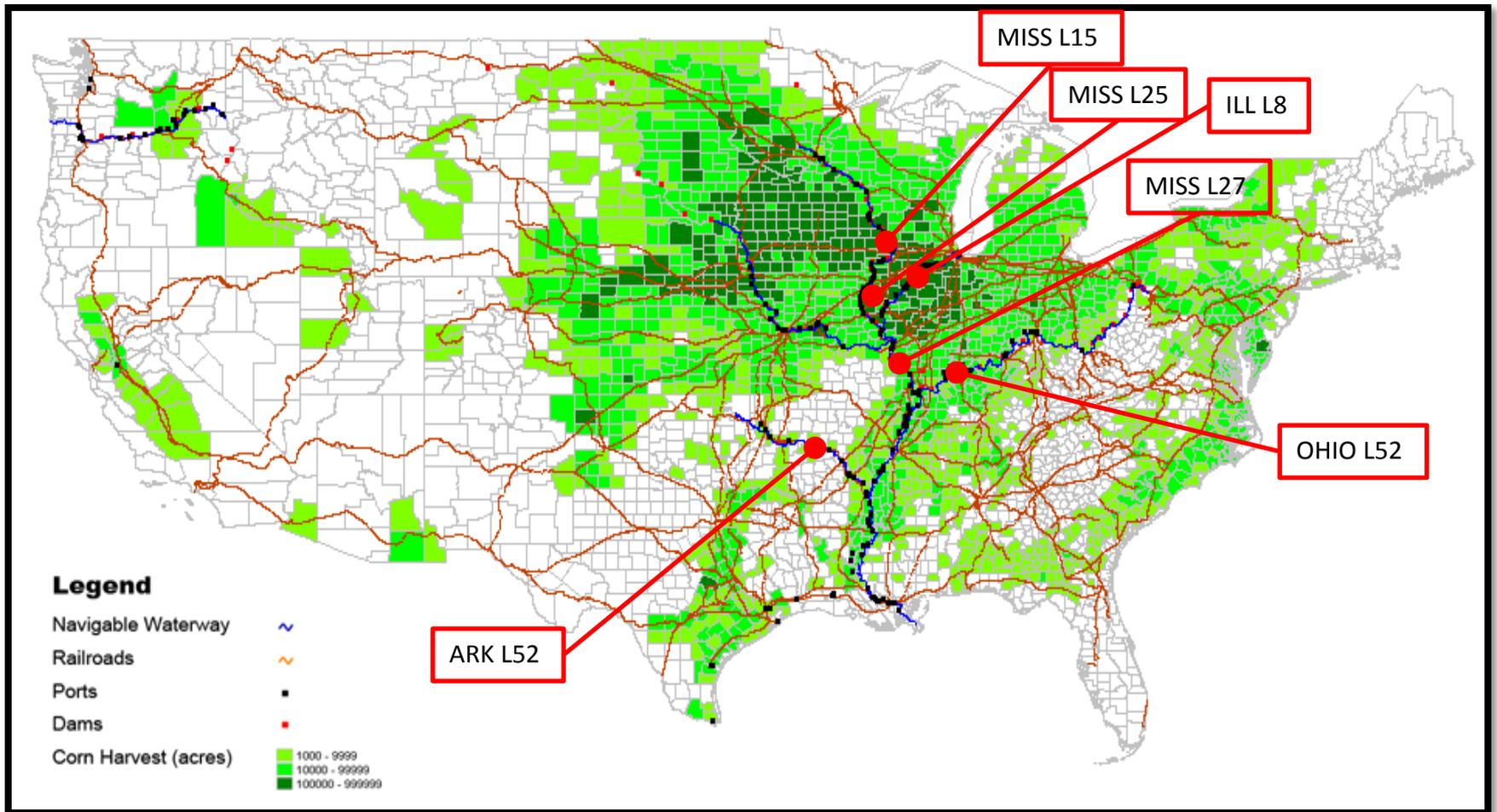


Vulnerability Assessment Methodology

- Dual network simplex based algorithm
 - **Fast** re-optimization given a link disruption scenario
- Supply chain cost impact of link disruption
 - Piecewise-linear, convex, non-decreasing in magnitude
 - Comparison by link: dominated or not?



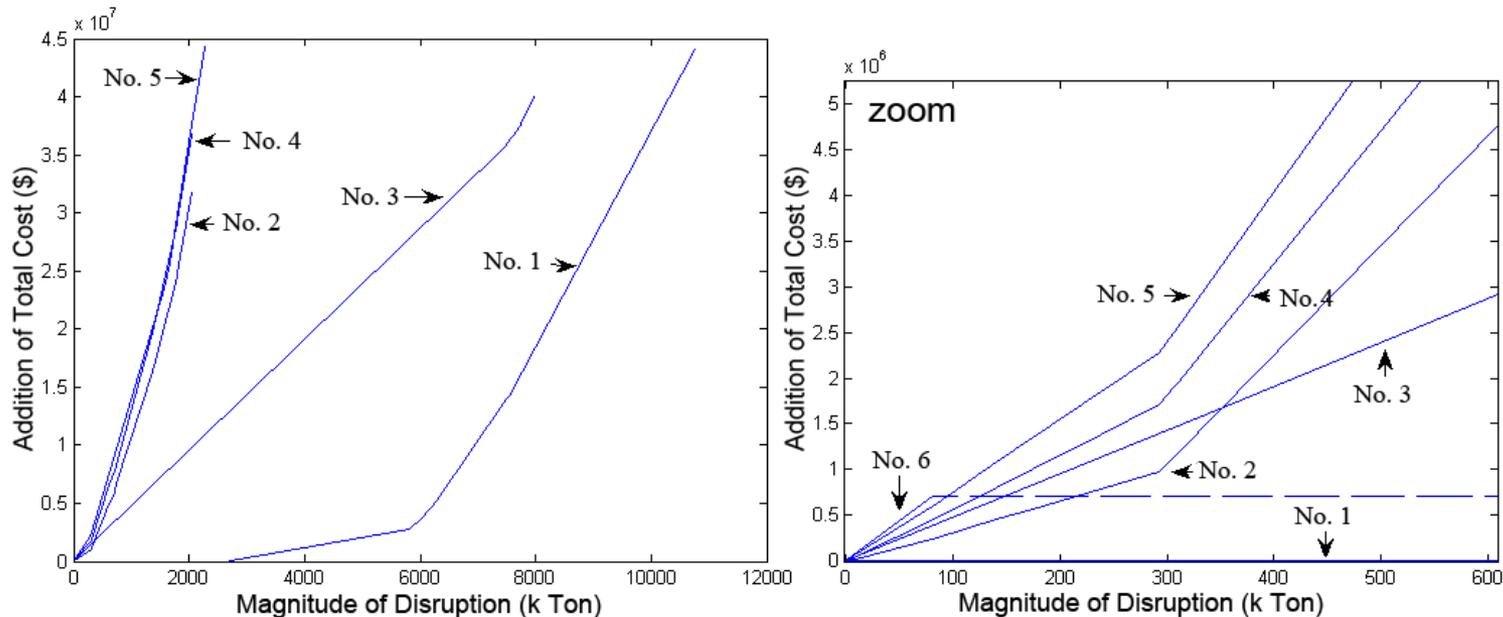
Case Study: US Corn Export



Data Collection: US Corn Export

- GIS data
 - National Transportation Atlas Database (BTS)
 - Navigable waterway; Railroads; Ports
- Grain Transportation Reports (GTR)
 - Grain export and transportation data
- Agriculture Marketing Service (AMS-USDA)
- Railroad Waybill from BTS

Vulnerability Assessment



- Most vulnerable: No. 4 and No. 5
Large disruption \rightarrow \$40M annual loss
- Less vulnerable: No. 3
- Not very vulnerable: No. 1 and No. 6

Conclusions

- Disruptions to U.S. grain export system can lead to large economic losses and political problems in U.S. and world
- Our method can assess cost consequences of disruption to each network component
- Vulnerable targets can be identified, and prioritized for protection

Future Research

- Robust transportation planning
 - Given potential disruptions (uncertainty set), what freight flows are nearly best-cost but less vulnerable to disruption?
- Game-theoretic supply chain risk assessment
 - How the decisions of attacker and defender affect each other?