Data Sources and Performance Measures for the Marine Transportation System

Ned Mitchell, PhD
Research Civil Engineer
Coastal and Hydraulics Lab

TRB 5th International Transportation Systems Performance Measurement and Data Conference

Denver, CO
June 2, 2015

US Army Corps of Engineers
ERDC
Engineer Research and Development Center
Background

- Corps is resource-constrained but must maintain an aging water resources infrastructure portfolio that is critical to national well-being.
- Navigation projects at coastal ports and along inland waterways facilitate marine transportation and help support complex, dynamic, global freight supply chains.
- Challenge going forward is how to optimally support these existing and emerging freight corridors using available resources.
Intermodal Freight Systems

- Waterborne freight corridors cannot truly be separated from landside (road, rail, pipeline) systems.

- Federal policy discussions and sponsored research increasingly center on intermodal systems and the need to evaluate supply chains across modes.

- USACE Leadership has been stressing systems-based approaches to Civil Works mission execution.
Marine Transportation Data Spectrum

Inland barge data

Tradeoffs...

LPMS data

U.S. Customs

AIS

Continuously observed in transit

Reported (but not observed)

continuous system monitoring
Some Public Data Sources

http://www.navigationdatacenter.us/data/data1.htm

http://www.navigationdatacenter.us/lpms/lpms.htm
Dredging Information System (DIS)

http://www.navigationdatacenter.us/data/datadrgsel.htm

- Thousands of dredging events (O&M and new deepenings) over last 25 years.

- Location, quantities of material moved, cost, start/end dates.
Entrances and Clearances

- Reconstructed trip chains for container vessels calling at multiple U.S. ports
- Vessel draft provides a way to infer net cargo on/offloaded
- Could be coupled with separate port-level counts of TEUs, tonnage, etc.

http://www.navigationdatacenter.us/data/dataclen.htm
National Waterway Network

http://www.navigationdatacenter.us/data/datanwn.htm

- Transiting tonnage totals by commodity group for 3000+ waterway segments around the U.S.
- Spatial network for GIS application development
- Segment-level flows and transfers to/from road/rail/pipeline can be inferred.
Waterway Freight Corridor Examples

Chemicals
Tons per voyage analysis: National Summary

Dry Bulk Imports

\[ y = 6243.3x - 180841 \]

\[ R^2 = 0.9883 \]
Tons per voyage analysis: National Summary

Tanker Exports

\[ y = 2579.1x - 73849 \]
\[ R^2 = 0.9476 \]
Vessel Draft Sensitivities

Avg. Tons/vessel/ft for Selected Ports, Vessel types, Movements

Avg. Tons/vessel/ft

- 10,000
- 8,000
- 6,000
- 4,000
- 2,000

HSC, Dry Bulk Imports
Delaware River below Philly Imports
HSC, Tanker, Imports
SNWW, Tanker Imports
Mobile, Dry Bulk Imports
Texas City, Tanker Imports
Delaware River below Philly Imports
LMSR, Tanker Imports
Mobile, Dry Bulk Imports
HSC, Dry Bulk Imports
Tampa, Dry Bulk Imports
LMSR, Dry Bulk Imports
SNWW, Dry Bulk Imports
LMSR, Dry Bulk Imports
LAJB, Dry Bulk Imports
Columbia River, Dry Bulk Imports
Delaware River below Philly Imports
LAJB, Container, Exports

Innovative solutions for a safer, better world
Automatic Identification System (AIS)

- Coast Guard mandate for nearly all commercial vessels operating in U.S. waters.
- VHF messages broadcast from the vessels to network of shore-based towers at intervals between 2 seconds and 5 minutes depending on operating state.
- Envisioned for maritime domain awareness, i.e. collision avoidance and port security, but shows great potential for many other applications to the national Marine Transportation System (MTS).
Navigation Systems Performance Monitoring via AIS
Performance Monitoring via AIS

- Automatic Identification System Analysis Package (AISAP)
  - traffic densities
  - O-D travel times, dwell times
  - fleet characteristics, movements and seasonal variations
  - traffic response to disruptions or waterway improvements
  - Tidal dependence
  - incident investigations

- Analyses are scalable across time and space, so single channels can be monitored for a few hours, or entire coasts can be monitored for years.
Bayport Ship Channel, Texas

AIS Vessel Transit Data
Vessel Speeds Approaching Bayport Flare

10-day Average Vessel Speeds, HSC below Bayport, 2013
AIS for Collision Risk Analysis:

- Use archival AIS data to establish baseline collision risk levels within ports and waterways.
- Compare segments of waterway based on proximity of transiting vessels to one another, with consideration of respective headings, courses over ground, and speeds.
- Several methodologies in the literature, usually with very localized application → NAIS provides basis for national assessments.
Innovative solutions for a safer, better world

Port/Anchorage Dwell Times, Travel Times
West Coast Port Slowdown: Oakland
West Coast Port Slowdown: Oakland
Inland Waterways Example

- Cumulative delay provides an objective baseline, combining congestion metric (avg. delay) with traffic volume.

- Performance can be tracked through time, comparisons made between locks, and correlations with nearby segments tracked ~> system disruptions.
Towards Freight Fluidity Analysis

• Ultimately we seek a means of evaluating the performance of entire intermodal freight supply chains.

• Data from across the spectrum help inform this process.

• Opportunity to merge AIS and GPS probe datasets with traditional reported data to provide a more complete picture of intermodal freight fluidity.
Data Sources and Performance Measures for the Marine Transportation System

Questions?

Ned Mitchell
Kenneth.n.mitchell@usace.army.mil
601-634-2022