Freight Analysis on the Multimodal Transportation System at the Regional or State Level

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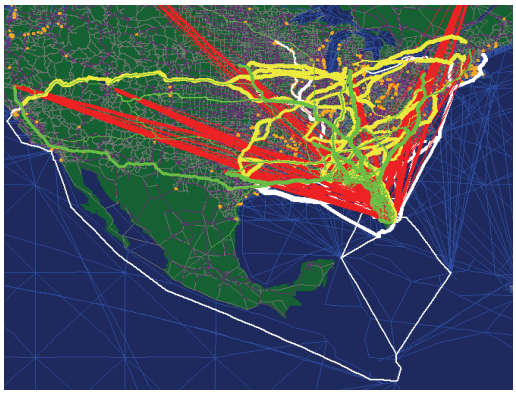
Freight transportation is multimodal in nature, which involves highways, railways, waterways, airways, terminals, and intermodal transfers. Publicly-funded transportation projects, particularly those concerning freight transportation, are no longer restricted to highways, but are focused more on freight corridors, ports and terminals, and intermodal connectors. Wise investment in the development of multimodal and intermodal infrastructures can effectively remove major bottlenecks in freight networks, expand shipping alternatives, reduce congestion and environmental impact, and improve safety and efficiency on the entire transportation system.

Through the research and development effort sponsored by U.S. Department of Transportation (USDOT) and Florida DOT (FDOT), the Oak Ridge National Laboratory (ORNL's) Center for Transportation Analysis (CTA) has developed data and analytical solutions to facilitate planning and operations decisions on the multimodal freight transportation system at the state level. These solutions focus on three types of analysis issues. (1) Estimation of Commodity Production, Consumption, and Origin-Destination (OD) Matrices; (2) Development of an integrated multimodal freight analysis network; and (3) Freight flow assignment on the multimodal freight network [1][2][3].

Estimation of Commodity Production, Consumption, and Origin-Destination (OD) Matrices

In spite of the increasing attention to freight transportation, freight data that are required to support intermodal transportation decisions are still lacking, particularly in areas of freight production, consumption, and OD patterns.



Multimodal-freight flows originated from and designated to Florida.

By working with USDOT, CTA has developed a solution strategy that starts with a set of supply and demand models that estimate freight tonnages originating from and designated-to county boundaries. This was accomplished by using the U.S. Census County Business Pattern (CBP) data. These models resolve two critical estimation issues: one involves the matching of the estimated production and

consumption patterns with the Freight Analysis Framework (FAF) OD patterns, and the second involves overcoming the incompatibility of the use of the North American Industry Classification System (NAICS) with the CBP data and the use of the Standard Classification of the Transportation Goods (SCTG) with the FAF data. The established commodity production and consumption patterns are then embedded into a spatial interaction modeling framework to derive freight OD matrices at the county level using objective functions that aim to minimize transportation cost, maximize entropy, and minimize estimation errors with regard to the known FAF OD matrices, simultaneously and independently.

Analytical Multimodal Freight Network

By working with FDOT, CTA has developed a multimodal network that combines airways, highways, railways, waterways, terminals, ports, and intermodal facilities to form an integrated, analytical freight network. To develop the multimodal network, network databases from different sources were processed and combined together. For highways, the FDOT's state wide highway network and ORNL's National Highway Network were combined to provide detailed representations of road connections and intersections within Florida and more strategic representations of highways outside of Florida. For railways, an ORNL network that was adapted from the Federal Railroad Administration's railway database was used to first construct sub-networks for individual railway companies, and then connect these sub-networks into a routable analytical rail network using inter-railway connectors. For waterways, the waterway database from the National Transportation Atlas Database (NTAD) with added global connection links was utilized. Three types of sub-networks—shallow draft, deep draft and Great Lake waterway routes--were first separated, and then merged and integrated to form the analytical waterway network. The ORNL intermodal terminals database forms the basis for the construction of intermodal transfer links and links between intermodal facilities and multimodal networks. Merging intermodal nodes and links with nodes and links of the multimodal networks results in an integrated analytical freight network that contains nodes and links for highways, railways, waterways, and intermodal facilities.

Multimodal Freight Flow Assignment

By working with FDOT, ORNL has developed analytical tools to assign freight flows onto the multimodal network, which includes highways, railways, waterways, air transportation, and intermodal facilities. For computational efficiency, five OD tables were generated separately using the Transearch batabase. These five OD tables were: (1) the intermodal OD table; (2) the highway OD table; (3) the railway OD table; (4) the waterway OD table; and (5) the airway OD table. Flow assignment with these five tables, except for the highways table, all involved intermodal routes. For the waterway OD table, for example, the flow loading process first identified routes that start with highways, then switch to waterways, and then come back to highways again. This is the same for railways and airways. While for the intermodal flow OD table, routes were identified on the entire multimodal network with preference given to railways, waterways, highways, and intermodal facilities. The resulting flow patterns with the five OD tables were then aggregated to a single network, which provides the finalized flow patterns on the Florida Multimodal Network.

Reference

[1] Xiong, D., "Estimating Commodity Consumption, Production and Origin-Destination Patterns Using Freight Analysis Framework Data," Report Prepared for USDOT, July 2007.

[2] Xiong, D., "Establishing Intermodal Commodity Flow Patterns on the Florida Multimodal Network," Report Prepared for FDOT, April 2007.

[3] Xiong, D., "Development of the Florida Multimodal Network," Report Prepared FDOT, January 2006.

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