The Impact of Increased Adverse Weather Events on Freight Movement

Project Number:
19ITSUTA02

Start Date:
08/15/2019

End Date:
02/15/2021

Principal Investigator(s):
Kate Hyun
University of Texas at Arlington
kate.hyun@uta.edu
Stephen Mattingly
University of Texas at Arlington
mattingly@uta.edu

Lead Institution:
University of Texas at Arlington

Funds Requested to UTC:
$55,000

Funding Source(s):
Tran-SET
University of Texas at Arlington

Total Project Cost:
$110,000

Understanding the freight movements from the Port of Houston throughout the region and evaluating their response to adverse weather event

With significant increases in freight volumes, the impacts from severe weather events to port truck traffic may cause an economic loss in Texas and the surrounding region. Although adverse weather events significantly impact transportation infrastructure and networks, a lack of understanding on the scope and magnitude of a weather event's impact on freight movement persists. This project aims to characterize the port truck movements by identifying operational patterns by associated industry and service types and evaluate system response during adverse weather events. The research will focus on identifying (1) truck activity from the port of Houston, (2) capturing truck flow disruptions due to Hurricane Harvey, and (3) identifying flow changes and recovery process during and immediately after the adverse events. Large-sized GPS data will be used to represent individual trip characteristics such as travel time, origin-destination (OD), major route choice, and industry type. The developed framework will be applied in Houston as the major destination (or origin) of freight or the intermodal point of the shipment. Identified truck flows will be categorized by their service (trip) type (i.e., intercity, first or last mile trip, or localized service). Major trip origins and destinations will be matched with the associated industry using GIS programming. Flow disruptions and activity changes will be investigated before and after the Hurricane Harvey to understand the interactions of truck behavior to the flow disruptions due to flooding. Operational strategies before the event and behavior changes during the event such as re-routing, shifting schedules or mode changes will be classified by the truck service (trip).

Problem Statement

In 2017, a Category 4 storm, Hurricane Harvey, brought catastrophic floods to the Houston area inflicting $125 billion in damage; in the first week, the storm directly affected nearly 10% of all US trucking and other transportation throughout the Texas coastal area due to flooded roadways and damaged infrastructure. Although the adverse weather events significantly impact transportation infrastructure and networks, a lack of understanding on the scope and magnitude of a weather event's impact on freight movement persists. The knowledge of freight flows and their interaction with weather events provides a key input for developing operational strategies and identifying critical components in the port infrastructure and transportation network. Immediate responses to the event will prioritize mitigating flow disruptions. The risk of weather events may cause freight haulers to establish seasonal restrictions and freight diversion; therefore, agencies' long-term forecasts may need to consider the potential changes in freight movement resulting from climate change.

Port trucks serve different industries, facilities, and commodity types, which makes their travel pattern vary by season, dayof- week, and time-of-day. Local service traffic or drayage movement might be less impacted by severe weather events because of their short trip length and flexibility of re-routing due to a dense network. Whereas, intercity trips may more actively respond to adverse weather through shifting its delivery schedule or changing transportation modes to rail or air transport when they have rigid delivery windows. Previous studies however have mainly focused on investigating traffic volumes rather than understanding spatial activity behavior due in part to the lack of available data sources. Conventional data sources (i.e., static sensors or survey) commonly monitor port traffic over short periods based on traffic counts, which miss the spatial and temporal variations of freight movements.

Understanding port trucks' operational strategies especially during the adverse events would be of importance in designing and operating transportation infrastructure, and developing neighborhood plans for coastal communities and hurricane-prone areas. With the knowledge of quantified interaction to the weather events, it becomes also possible to prioritize resources for decision-makers in freight infrastructure investments depending on the type of weather conditions. Moreover, knowledge of port traffic

flows and behaviors by industry and service type would help developing long-term mobility, safety, and environmental plans that respond to the increasing risks of occurrence for major storm events due to climate change.

Objectives

Specific research objectives include: 1) To develop a strategy for extracting and mining port truck travel patterns from largesized GPS trajectories and transportation network of the region; 2) To develop a spatial clustering or Machine Learning model to categorize travel patterns by trip (service) types and match them to an associated industry type; 3) To quantify travel behavior changes due to adverse weather events of Hurricane Harvey.

Intended Implementation of Research

Education and Workforce Developments: The proposed research will provide advanced research experiences and technical skills to develop students as promising leaders in the transportation field. Research development using big data analytics will provide students with practical skills and research development activities will prepare the students for the skillful and practical workforce with advanced knowledge. Active interactions with HGAC and TxDOT will help the student understand the use of applied research. By employing recent advances in data mining for transportation research, technical development and knowledge transfer among students would be expected to facilitate research collaborations.

The proposed project develops support learning for one PhD student and one MS student from Civil Engineering. UTA currently has two female Ph.D. students and many qualified female masters students whom the researchers will primarily consider for support from this research. Students will gain experience using data analytic techniques including spatial analysis using a GIS programming, big data mining with database (e.g., PostgreSQL), and various statistical and hypothesis testing to understand the freight movements' operational strategies interacting to severe weather event. The project may expand the center's breadth of impact by hiring a student from computer science to assist in the analysis. Educational manuals and materials will be developed to train students to prepare them for the use of developed technologies in their studies and career. The team will prepare materials for presentation, journal articles, and professional seminar. Power point slides and word document summarized the work tasks and findings will be developed for effective delivery of seminars and workshops.

Outreach: The researchers will disseminate the findings through conference papers, peer-reviewed journal papers, and a technical workshop. Technical seminars such as an ITE meeting or ASCE conference may share research outcomes with planners and engineers. Additionally, the research team will present the findings at conferences addressing big data mining for transportation planning, e.g., Transportation Research Board and the Annual Industrial and IEEE-ITS Chapter.

Anticipated Impacts/Benefits of Implementation

The developed framework can easily be applied to capture any behavior or activity changes that result from failures, upgrades or enhancements of transportation system such as road construction, maintenance, and expansion, or an introduction of new transportation system.

Web Links

- TranSET's website (https://transet.lsu.edu/research-in-progress/)
- TRB's Research in Progress (RIP) database (https://rip.trb.org/View/1644424)

Tran-SET

Tran-SET is Region 6's University Transportation Center. It is a collaborative partnership between 11 institutions (see below) across 5 states (AR, LA, NM, OK, and TX). Tran-SET is led by Louisiana State University. It was established in late November 2016 "to address the accelerated deterioration of transportation infrastructure through the development, evaluation, and implementation of cutting-edge technologies, novel materials, and innovative construction management processes".

Learn More

For more information about Tran-SET, please visit our website, LinkedIn, Twitter, Facebook, and YouTube pages. Also, please feel free to contact Mr. Christopher Melson (Tran-SET Program Manager) directly at transet@lsu.edu.