



USDOT Tier 1 University Transportation Center

Semi-Annual Progress Report #6

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Project Title: Maritime Transportation Research and Education Center (MarTREC)

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End Date: September 30, 2023

Reporting Period Start Date: April 1, 2021
Reporting Period End Date: September 30, 2021

Report Term or Frequency: six months

Maritime Transportation Research & Education Center (MarTREC) is a USDOT Tier 1 University Transportation Center funded through the Office of the Assistant Secretary for Research and Technology. Under the FAST Act, MarTREC is *working to preserve the Nation’s transportation system through efficient, resilient, and sustainable maritime and multimodal logistics and infrastructure*. Our vision is to be recognized as the Nation’s premier source for expertise on maritime and multimodal transportation research and education. Made up of renowned maritime transportation researchers dedicated to transferrable research and inclusive education and workforce development, the MarTREC consortium are University of Arkansas (UARK), Fayetteville, AR; Jackson State University (JSU), Jackson, MS; Louisiana State University (LSU), Baton Rouge, LA; University of New Orleans (UNO), New Orleans, LA; Texas A&M University/Texas Transportation Institute (TAMU/TTI), College Station, TX; and Vanderbilt University (VU), Nashville, TN. Maritime and related multimodal transportation research is critical to the future of our transportation system and should be a national priority. Given the link between gross domestic product and international trade, which is expected to double over the next 30 years, efficient and resilient ports are critical to the nation’s overall economy and the ability of intermodal carriers to move freight between ports of entry and inland locations. Proximity to navigable waterways makes this consortium uniquely situated to address our theme.

1. Accomplishments

1.1 Consortium-Level Accomplishments

1.1.1 Research

Goal: MarTREC will conduct research that contributes to preserve the Nation’s transportation system through efficient, resilient, and sustainable maritime and multimodal logistics and infrastructure.

Accomplishments:

Research Effectiveness Metrics	Progress
# of peer-reviewed journal articles (published, accepted, submitted)	19
# of conference presentations given	5
# of students participating in transportation research projects funded by UTC	23

1.1.2 Leadership

Goal: MarTREC will become the premier source for expertise on maritime transportation research, education, and workforce development.

Accomplishments:

Leadership Effectiveness Metrics	Progress
# of national and regional leadership positions held	35
# of invited talks given	5
# of leadership and research awards received	1

1.1.3 Education and Workforce Development

Goal: MarTREC will develop educational resources for maritime and multimodal transportation systems.

Accomplishments:

Education and Workforce Development Effectiveness Metrics	Progress
# of transportation-related courses offered	35
# of technician certification programs offered	6
# K-12 outreach programs offered	5

1.1.4 Technology Transfer

Goal: MarTREC institutions will participate in national, regional, and local education and workforce development outreach to provide knowledge to private and public transportation organizations.

Accomplishments:

Technology Transfer Effectiveness Metrics	Progress
# of project deliverables submitted	3
# of technical briefs	0
# of editorial journal positions held	17

1.1.5 Collaboration

Goal: MarTREC will continue our existing partnerships with maritime and multimodal transportation stakeholders and develop new partnerships to facilitate our planned research, leadership, education, workforce development, and technology transfer activities.

Accomplishments:

Collaboration Effectiveness Metrics	Progress
# of existing collaborative partnerships	58
# of new collaborative partnerships formed	9

1.1.6 Opportunities for Training and Professional Development

- One student presented at professional conferences
- 10 conference planning positions were held by MarTREC faculty researchers
- 35 leadership positions held by MarTREC faculty researchers
- 486 individuals completed transportation certified courses

1.1.7 Dissemination of Results (In this reporting period)

- Three final reports successfully submitted
- 14 peer-reviewed journal articles and two books were published

1.1.8 Plans to Accomplish Goals and Objectives during Next Reporting Period

The faculty researchers will continue to engage with industry experts to ensure that these projects are making transformational contributions. We will continue to emphasize educational and technology transfer activities.

1.2 Project-Level Accomplishments and Plans for Next Reporting Period

- 50 total projects (life to date)
- 25 completed projects (life to date)

1.2.1 Maritime and Multimodal Logistics Management Projects

Analysis of Blockchain's Impacts on and Applicability to Maritime Industry

Jim Kruse, MBA

Texas A&M Transportation Institute

May 2019-October 2020

Accomplishments: Currently, the most prominent blockchain projects in the maritime sector are initiatives by the shipping segment. However, the results presented in this research point toward the fact that ports and marine terminals have a pivotal role in the blockchain functionalities.

Completed Project: Final project report was submitted and distributed as per grant guidelines.

Changing Trade and Transportation Patterns: NAFTA, Cuba, and the US Gulf Coast

Bethany Stich, PhD

University of New Orleans

March 2018-December 2021

Accomplishments: Since the 1969 passage of the National Environmental Protection Act, transportation planning became a complex, interdisciplinary challenge. The need for meeting environmental legislation coupled with public participation demands have revealed innumerable problems associated with the use of outdated techniques.

Project Plans: Final review of final report for submission

Combining Truck and Vessel Tracking Data to Estimate Performance and Impacts of Inland Ports

Sarah Hernandez, PhD and Chase Rainwater, PhD

University of Arkansas

January 2019-October 2020

Accomplishments: This project developed a method to fuse truck and marine vessel tracking data to better estimate performance of multi-modal supply chains that use inland waterway ports.

Completed Project: Final project report was submitted and distributed as per grant guidelines.

Development and Application of a Methodology for Maritime-Truck Shipments Generation Analysis

Mario Monsreal, PhD and Jim Kruse, MS, MBA

Texas A&M Transportation Institute

December 2017-March 2019

Accomplishments: Truck activity is logically connected to and generated by vessel activity at a port. In turn, vessel activity is generated by truck shipments. Although one might expect a 1 to 1 relationship between the two types of shipments, that is unlikely the case. This study shed light on the relationship between multimodal flows (trucks and vessels), which will enable agencies and organizations to increase efficiency – and thus competitiveness – for industry, while minimizing negative impacts on a region.

Completed Project: Final project report was submitted and distributed as per grant guidelines.

Development of AIS Model of Texas Gulf Intracoastal Waterway Travel Times

Jim Kruse, MBA

Texas A&M Transportation Institute

October 2019-April 2021

Accomplishments: The focus of this research project is to perform analysis on the Texas portion of the Gulf Intracoastal Waterway (GIWW). The Texas GIWW presents a level of complexity significantly greater than rivers because of the intersections with ship channels and the fact that some barges go into and exit port areas while others pass through. Established origins and destinations. Segmented the

waterway into links. Analyzed AIS data to identify vessel transits and associated transit times on the links. Developed a methodology for predicting travel times. Evaluated the effect of special conditions.
Completed Project: Final project report was submitted and distributed as per grant guidelines.

Driving Simulators as Educational Outreach for Freight Transportation

Sarah Hernandez, PhD, PE

University of Arkansas

August 2021-June 2023

New Project: The goal of this project is to enhance outreach efforts for middle and high school student groups for freight career awareness by using truck driving simulators. There is a shortage of truck drivers across the US which contributes to inefficiency in the freight system. While there are many complex factors leading to the driver shortage, lack of awareness of the trucking profession is among them. Through engaging workforce outreach programs, it may be possible to attract a new generation.

Inland Waterway Travel Time Prediction

Jim Kruse, MBA

Texas A&M Transportation Institute

November 2020-January 2022

Accomplishments: This project will build an inland waterways travel time prediction model that builds on and improves existing work at the Corps of Engineers Engineer Research and Development Center.

Project Plans: Forecast and analyze travel times in one of the simplest river segments. The resulting forecast model will then be applied to a more complex river segment involving locks and possibly bridges.

Interdisciplinary Educational Outreach with Traffic Sensor Build Kits

Sarah Hernandez, PhD, PE

University of Arkansas

May 2019-August 2020

Accomplishments: This project designed and implemented freight oriented educational outreach activities centered on traffic sensing technologies for middle, high, and first-year college students.

Completed Project: Final project report was submitted and distributed as per grant guidelines.

Learning from USACE Open Data for Locks

Justin Chimka, PhD

University of Arkansas

August 2018-May 2021

Accomplishments: In August 2017, the USACE began to enable unprecedented data access by publishing its Open Data for Navigation online. This project sought to explore the new USACE Open Data for Locks, describe its relevant datasets, and inventory their contents, identify responses or variables across relevant datasets, and diagnose efficient statistical models.

Completed Project: Final project report was submitted and distributed as per grant guidelines.

Modal Comparison Update: 2001-2019

Jim Kruse, MBA

Texas A&M Transportation Institute

March 2021-October 2021

Accomplishments: In December 2007, the Texas A&M Transportation Institute submitted a report to the U.S. Maritime Administration and the National Waterways Foundation titled "A Modal Comparison of

Domestic Freight Transportation Effects on the General Public”. Since that time, several updates to the study have been performed, with the last update covering the period 2001 to 2014. Effects will cover congestion, emissions, energy efficiency, safety, and infrastructure impacts from 2001 to 2019.

Project Plans: Working on final report

Modeling Dynamic Behavior of Navigable Inland Waterways

Heather Nachtmann, PhD and Justin Chimka, PhD

University of Arkansas

August 2018-June 2022

Accomplishments: This project is expanding prior MarTREC research. We collected current data and replicated our past scenario analyses of the McClellan-Kerr Arkansas River Navigation System (MKARNS). A literature search and review of prior research on and implementation of container-on-barge was submitted to the Maritime Economics and Logistics (MEL) journal and is currently under revision. We have developed a value-focused framework to assess the feasibility of container-on-barge in the United States. Results of this project were presented in at the Institute of Industrial and Systems Engineers annual conferences (May 2019 and November 2020) and the annual American Society for Engineering Management conference (October 2019).

Project Plans: We will complete and resubmit our literature review manuscript to MEL. We continue our work on the multi-attribute framework for evaluating the decision whether or not to implement Container-on-Barge within an inland waterway system.

Measures of Freight Network Resiliency: An expanded data capture of Truck Drivers and Support Services under Pandemic Distress

Sarah Hernandez, PhD, PE

University of Arkansas

May 2020-September 2020

Accomplishments: The purpose of this research was to collect timely data on the impacts of the Covid-19 pandemic on truckdriver and trucking operations with a specific focus on issues that affect driver health and safety. An online opt-in panel survey was developed using the Qualtrics survey platform. The survey questionnaire contained 65 questions with skip logic dependent on responses. A total of 523 responses were collected between the dates of May 19th and June 1st, 2020. The dates of the survey correspond to the period of lifted Hours of Service (HOS) restrictions.

Completed Project: Final project report was submitted and distributed as per grant guidelines.

Policy and Infrastructure Evaluation Model of Commodity Flows through Inland Waterway Ports

Sarah Hernandez, PhD, PE and Sandra Eksioglu, PhD

University of Arkansas

August 2020-December 2021

Accomplishments: The purpose of this project is to guide strategic investment into port capacity through the development of a policy and infrastructure evaluation model of inland waterway commodity flows. A multi-stage stochastic optimization model has been developed to evaluate tradeoffs in strategic, long-term port infrastructure investment with mid-term capacity expansion decisions and provision of complementary highway infrastructure made by public and private stakeholders, and shorter-term operational practices made by shippers and carriers.

Project Plans: We are exploring use and operation of the driving simulator; contacting national truck education program for curriculum sharing

Shipping Container Chassis in the US: The Legacy of Ocean Carriers

Bethany Stich, PhD

University of New Orleans

March 2018-December 2019

Accomplishments: Almost half of the chassis date from before 1997 and it is common at marine terminals to find chassis well over 20 years old. Newer chassis are safer, as they are outfitted with radial tires, antilock brakes, and LED lights. The evolution of key safety regulations related to chassis usage has placed the burden of compliance on the marine terminals and trucking companies.

Completed Project: Final project report was submitted and distributed as per grant guidelines.

The Changing Legal Landscape of Intermodalism – Part 1

Bethany Stich, PhD

University of New Orleans

July 2021-June 2022

New Project: This project investigates the ongoing legal challenges surrounding chassis. In 2020, Intermodal Motor Carriers Conference (IMCC) of American Trucking Associations and the Ocean Carriers Equipment Management Association (OCEMA) were involved in negotiations to resolve what IMCC charged were high-priced and inferior quality chassis at many of the nation's ports.

The Changing Legal Landscape of Intermodalism – Part 2

Janey Camp, PhD, PE

Vanderbilt University

August 2021-July 2022

New Project: This project investigates the ongoing legal challenges surrounding chassis. In 2020, Intermodal Motor Carriers Conference (IMCC) of American Trucking Associations and the Ocean Carriers Equipment Management Association (OCEMA) were involved in negotiations to resolve what IMCC charged were high-priced and inferior quality chassis at many of the nation's ports.

1.2.2 Maritime and Multimodal Infrastructure Preservation Projects

A Digital Twin for Visualizing, Evaluating and Maintaining Multimodal Transportation

Haito Liao, PhD

Shengfan Zhang, PhD

Heather Nacthmann, PhD

University of Arkansas

August 2021-June 2023

New Project: This research project will develop a digital twin that enables visualizing, evaluating and maintaining multimodal transportation infrastructure. The ultimate goal is to provide an open-source software tool and machine learning-based decision-making approaches that assist the relevant stakeholders in improving their information collection and tracking capabilities, and enhancing the resilience of multimodal transportation infrastructure and beyond.

Bio-Inspired Stabilization of Levee Slope on Expansive Yazoo Clay at the Maritime and Multimodal Transportation Infrastructure in Mississippi

Sadik Kahn, PhD, PE

Jackson State University

April 2020 – June 2022

Accomplishments: The existence of Yazoo clay in Mississippi frequently causes distress in levee and highway embankment slopes, which are an integral component of maritime and multimodal transportation infrastructure. This project will investigate the effect of the vetiver grassroots to stabilize levee slopes at the maritime and multimodal transportation infrastructures at Mississippi. Study were presented in TRB AKG 90 Standing Committee on Stabilization of Geomaterials and Recycled Materials.

Project Plans: The findings thus far have been presented to the senior officials of MDOT. More dissemination is planned in 2021 MS ASCE Section meeting, 101st TRB, and GeoCongress 2022.

Continued Study of Rapidly Deployable Soil-Cement Mixtures

Cameron Murray, PhD, PE

Michelle Barry, PhD, PE

University of Arkansas

September 2021-June 2023

New Project: The maintenance and repair of maritime infrastructure is critical to maintaining important shipping channels and preventing unnecessary loss of life or economic impact from severe weather events. The fastest repair, reconstruction, and maintenance techniques may become more desirable as labor costs increase and delays become costlier. The objective of this research is to identify the properties and proportioning of Belitic Calcium Sulfoaluminate (BCSA) soil-cement mixtures most effective for use in waterway structures. BCSA cement is a rapid setting, low-shrinkage cement which can be used in a similar fashion to portland cement.

K8 MEMES: K-8 Maritime Education Modules to Engage Students

Gary Prinz, PhD, PE

University of Arkansas

September 2021-June 2023

New Project: This education development project will create entertaining, informative, and STEM promoting "plug-and-play" curriculum learning modules for K-8 educators, using maritime transportation and infrastructure related topics to teach STEM concepts. Coupling music memory, fun STEM theories, and innovative experiential demonstrations into entertaining video learning modules, the objective of this project is to open the door for student excitement in learning of science topics and to develop a new virtual learning paradigm that: 1) excites curiosity, 2) engages alternative cognitive processes, and 3) promotes future engagement in the STEM areas.

Dredging Projects Selection when the Random Shoaling Effect is Considered

Bruce Wang, PhD

Texas A&M University

October 2019-December 2021

Accomplishments: Dredging is a constant operation to maintain the waterway shipping capacity. The goal is to achieve a maximum network capacity to support the regional and national economies within a given budget. Literature review complete. Problem formulation developed.

Project Plans: Algorithms and numerical tests are in the works.

Economic Impact of the Gulf Intracoastal Waterway on the States It Serves

Brianne Glover, JD and Jim Kruse, MS, MBA

Texas A&M Transportation Institute

September 2017-August 2018

Accomplishments: This project reviewed existing literature on the economic value of the Gulf Intracoastal Waterway (GIWW), reviewed the importance of the GIWW to the energy industry, examined the overall economic impact of the GIWW to the states it serves, and estimated the increases in transportation costs resulting from an immediate closure in the GIWW.

Completed Project: Final project report was submitted and distributed as per grant guidelines.

Effect of Permeability Variation of Expansive Yazoo Clay, Maritime and Multimodal Trans Infra MS

Sadik Kahn, PhD, PE

Jackson State University

September 2018-December 2019

Accomplishments: The existence of Yazoo clay soil in Mississippi frequently causes pavement distress in multimodal transportation infrastructure. Each year, fixing the pavement requires significant maintenance budget of MS DOT.

Completed Project: Final project report was submitted and distributed as per grant guidelines.

Engaging the Business and Tourism Industry in Visualizing Sea Level Rise Impacts to Trans Infra HI

Brian Wolshon, PhD, PE, PTOE

Louisiana State University

March 2018-December 2020

Accomplishments: The goal of this research was to assess the use of 3D virtual and augmented reality as a tool for improved coastal planning for better understanding of sea level rise impacts among the business and tourism industries in Waikiki. The study found that participants were better able to understand the data about flood impacts in the future due to SLR after watching a 3D video.

Completed Project: Final project report was submitted and distributed as per grant guidelines.

Evaluation of Hydrogel–stabilized Expansive Soils in Mississippi for Sustainable Maritime Infrastructure Design

Yadong Li, PhD

Jackson State University

August 2019-December 2021

Accomplishments: Expansive soil causes a variety of maritime transportation infrastructure problems, such as cracks, damage of pipeline, and the differential settlement of foundation. Test results showed that many cracks appeared on the surface of the hydrogel-treated Yazoo clay samples when subjected to moisture, which could be caused by the swelling property of clay in water. Unconfined compressive stress test on the samples showed that the hydrogel improved the strain of the clay significantly but had little improvement on its stress.

Project Plans: Working on final report

Fatigue Crack Control in Waterway Lock Gate Pintle Locations Subjected to Multi Modal Fracture

Gary Prinz, PhD, PE

University of Arkansas

August 2018-February 2021

Accomplishments: This research project will address multi-mode fatigue cracking within critical lock gate pintle locations. The lock gate pintle is a ball-and-socket joint that is crucial for proper gate

operation but is subject to frequent fatigue cracking. Fatigue crack repair within pintle locations is particularly challenging due to the complex multi-axial loading conditions.

Completed Project: Final project report was submitted and distributed as per grant guidelines.

Green Technology Approach for Capturing Pollution Washed from Transportation Infrastructures

Danuta Leszczynska, PhD

Jackson State University

March 2018-December 2019

Accomplishments: This study produced and investigated a carbon-based substance, namely biochar, as a new material for the in-situ adsorption of pollutants carried by the storm water runoff from the roads.

Completed Project: Final project report was submitted and distributed as per grant guidelines.

Identifying Critical Waterway Infrastructure and Managing Risk Associated with Natural Disasters

Michelle Barry, PhD, PE and Shengfan Zhang, PhD

University of Arkansas

July 2020-June 2022

Accomplishments: The transportation system in the U.S. is extremely vulnerable to disruptions and delays from natural disasters. The overall goal of this research is to develop a risk assessment framework that can be used to aid decision making and mitigation strategies for maritime infrastructure deemed critical to the U.S. transportation system and economy.

Project Plans: Currently reviewing and developing models using several different methods for the risk framework and analysis. These include: a multi-criteria decision analysis (MCDA) approach and a failure modes and effects analysis (FMEA) approach. We have determined relevant criteria and are working to determine the proper weighting and ensure that the necessary data is available to the group. A preliminary MCDA model has returned promising results and is currently being further developed.

Large Scale Evaluation of Erosion Resistance of Biocementation against Bridge Scour and Roadway Shoulder Erosion

Lin Li, PhD., P.E.

Jackson State University

March 2018-April 2019

Accomplishments: This project examined the feasibility of using biocementation through MICP as an erosion countermeasure. The results of this study bring an important conclusion that MICP-treated soil was weak to resist long-term erosion of exposing to outdoor environment.

Completed Project: Final project report was submitted and distributed as per grant guidelines.

Liquefied Natural Gas Phase II: The Future of LNG for the US and Gulf Coast Economies

Bethany Stich, PhD

University of New Orleans

November 2017-December 2019

Accomplishments: The continued growth of Liquefied Natural Gas (LNG) production and long-distance trade has traditionally been taken as a given by global energy analysts, who have premised their positive estimates on gas being both relatively scarce and demand for it virtually unquenchable. Despite Louisiana experiencing a new cargo export potential with LNG and the subsequent construction and pending permitting of LNG Export Terminals in diverse locations along Louisiana's shorelines, the primary finding of this report, based on the state of the current energy market, precludes the utility of a focus on LNG as an export commodity.

Completed Project: Final project report was submitted and distributed as per grant guidelines.

Liquefied Natural Gas III: Export Competition in a Well Supplied, Flow-Shifting Global Economy

Bethany Stich, PhD

University of New Orleans

March 2018-December 2019

Accomplishments: With trillions of cubic feet of shale reserves, the United States' (US) abundance of natural gas has prompted an increase in production of Liquefied Natural Gas (LNG) as an export commodity. UNOTI continues to urge that U.S. natural gas energy policy best practice is not to focus on export and export alone, but rather adopt a diversified and climate responsible energy policy that focuses on the Ports of South Louisiana, the Gulf Coast, and the U.S. remaining globally competitive by investing in necessary LNG fueling infrastructure, as well as continued investment in the existing petrochemical sector of Coastal Louisiana and the Gulf Coast.

Completed Project: Final project report was submitted and distributed as per grant guidelines.

Multimodal Network Approach to the Inland and Coastal Waterway System

Bruce Wang, PhD

Texas A&M University

July 2017-January 2019

Accomplishments: This project has developed a multimodal freight network model that includes both waterway landside components in order to analyze the impact of waterway operations. Tests show that the solutions are not sensitive to these parameters. The model illustrates changing the total amount of available budget into five different scenarios, each having an amount allocated to the locks and dams.

Completed Project: Final project report was submitted and distributed as per grant guidelines.

Port Infrastructure Resilience through Combined Wind-Surge Demand Characterization

Gary Prinz, PhD, PE

University of Arkansas

July 2020-June 2022

Accomplishments: This project aims to understand the interactive effects of severe wind and storm surge demands on port infrastructure and to develop hazard demand models to aid improvements to infrastructure design.

Project Plans: An integrated analytical and experimental research approach, combining information from detailed fluid-structure-interaction simulations and scaled wind-wave experiments.

Rapid Assessment of Internal Erosion Damage and Erodibility in Levees

Michelle Barry, PhD, PE and Clint Wood, PhD, PE

University of Arkansas

July 2020-June 2022

Accomplishments: Recent flooding events have tested our nation's levee systems and highlighted the vulnerability of our transportation system to disruptions and delays caused by natural disasters. Traditional drilling and sampling techniques only provide discrete data points. This project seeks to make a correlation between geophysical properties and vital engineering properties such as erodibility.

Project Plans: Development of the Hole Erosion Test (HET) apparatus has been completed including the addition of an internal waterproof camera. This novel adaptation will allow for more accurate measurements and more efficient testing to be conducted. The team has identified a number of benchmark samples that will provide a wide range of soil property and erosion behavior data that can be used to develop correlations capable of predicting erosion potential for a given soil. The team has also collected field samples from the Crawford County levee and will conduct HET and laboratory resistivity testing to catalogue the soil in relationship to the benchmark samples.

Trade-Off Analytics for Infrastructure Preservation

Greg Parnell, PhD and Ed Pohl, PhD

University of Arkansas

August 2018-December 2019

Accomplishments: The objective of this project was to develop a course that can be taught to civil engineers, industrial engineers, and the maritime and multimodal infrastructure community on the use of trade-off analytics as a tool to assist them in their infrastructure preservation efforts. This course was packaged into a webinar that can be delivered on-line for practicing professionals.

Completed Project: Final project report was submitted and distributed as per grant guidelines.

Using CSA Cement for Novel Waterway Repair Materials

Cameron Murray, PhD and Michelle Bernhardt-Barry, PhD, PE

University of Arkansas

August 2018-August 2021

Accomplishments: The goal of this study was to proportion a mortar mixture using BCSA cement suitable for underwater use. The mixture developed is expected to be suitable as a repair material. The mixture was intended to achieve a compressive strength of 4000 psi (27.6 MPa) within 3 hours when placed underwater while being self-consolidating. Mortar flow was measured as well as compressive strength for “dry-cast” and “wet-cast” specimens. A follow up project has been approved.

Completed Project: Final project report was submitted and distributed as per grant guidelines.

1.2.3 Disaster Response and Transportation Planning for Coastal and River Valley Communities Projects

Assessment of Evacuation Network Performance under Different Evacuation Scenarios

Brian Wolshon, PhD., P.E., PTOE

Louisiana State University

July 2019-April 2022

Accomplishments: Several major disasters have occurred in the United States and impacted coastal and river valley communities. The economic and societal impact of such disasters have demonstrated a need for better emergency planning, response, recovery, and adaptation. This study will utilize data from Hurricane Irma (2017).

Project Plans: Focusing on the evacuation process of the coastal communities in the Florida Keys and preparing final report.

Development and Implementation of Sustainable Transportation Resilience Indicators

Mark Abkowitz, PhD

Vanderbilt University

June 2017-March 2019

Accomplishments: This project worked to establish a protocol and method for evaluating a community's level of sustainable transportation resilience, such that if deficiencies exist, attention can be focused on mitigating those concerns. The protocol and method were applied to a river valley community to demonstrate proof-of-concept.

Completed Project: Final project report was submitted and distributed as per grant guidelines.

Development of Freeway Corridor Capacity Measure to Improve Transportation Resilience

Brian Wolshon, PhD., P.E., PTOE

Louisiana State University

July 2019-April 2022

Accomplishments: Natural disasters like hurricanes and floods occur throughout the world. However, coastal areas tend to be the most vulnerable to these disasters. Capacity is one of the most important characteristics of a freeway facility which quantifies its traffic carrying capability and is a critical component to the resilience of transportation systems. A case study has been conducted in this research to estimate the capacity of a freeway corridor consisting of multiple bottleneck sections using traffic data from a coastal area. The results have been analyzed. A journal article has been published.

Project Plans: Preparing final report

Evacuation Behavior and its Mobility Impacts in Coastal Communities from Across the Nation

Brian Wolshon, PhD., P.E., PTOE

Louisiana State University

July 2020-April 2022

Accomplishments: Coastal communities are at risk from a multitude of potentially disruptive events. Severe weather, climate change, and sea-level rise all pose serious and long-term societal challenges. This research seeks to develop a better understanding of the travel flow principles that govern the evacuation process and its impact on the mobility of a community, for different hazard types.

Project Plans: Collecting Hurricane evacuation and wildfire evacuation data and next stage is spatial and temporal analysis for each event.

Exposure to STEM: Diversity in Maritime Transportation

Rick Coffman, PhD, PE

University of Arkansas

August 2018-September 2019

Accomplishments: The goal of this education and workforce development project was to develop an educational/mentoring/advising model to open doors to all students, regardless of socio-economic background, who want to pursue careers in fields related to maritime and multimodal transportation.

Completed Project: Final project report was submitted and distributed as per grant guidelines.

Informing Post Disaster Restoration through Modeling Interdependent Agriculture and Transportation Networks

Sarah Nurre, PhD, Kelly Sullivan, PhD, and Ben Runkle, PhD

University of Arkansas

August 2018-December 2021

Accomplishments: Agriculture supply chains are important for the function of society. Agriculture supply chains are inherently complex due to their interdependency with critical infrastructure systems including energy, water, and maritime and multimodal transportation. We aim is to develop the necessary methodology to describe ag-sector and transportation-sector interdependence. We successfully created a mathematical model to characterize multi-modal transportation flow while incorporating interdependencies between agriculture and transportation.

Project Plans: Working on final report and publication in peer reviewed journal.

Informing Post-Disaster Restoration through Modeling Interdependent Agriculture and Transportation Networks - Phase II VU

Janey Camp, PhD, PE, GISP, CFM

Vanderbilt University

October 2018-December 2021

Accomplishments: While disruptions due to weather, etc. can affect any sector, agriculture is unique in its time sensitivity for planting, harvesting, etc. Agriculture is interdependent on other sectors, particularly transportation to get seed and fertilizers to fields at appropriate times and in getting products that may spoil to market efficiently. This project will develop models that determine how to use transportation and coordinate restoration efforts to make ag supply chains more resilient.

Project Plans: Resolving issues with coordinate systems and the transportation networks across the three modes, as well as identifying potential disruption scenarios.

Interdependency of Port Clusters during Regional Disasters

Brian Wolshon, PhD, PE, PTOE

Louisiana State University

January 2018-August 2019

Accomplishments: The research seeks to build upon the prior knowledge and expand the scientific understanding of regional disruptions to port clusters, areas of the country with multiple ports servicing the same region. The results showed that regionally, ports are more resilient to disruptive events than the individual ports that make up the region.

Completed Project: Final project report was submitted and distributed as per grant guidelines.

Modifying Ramp Management Strategies to Enhance Resiliency of Freeway Facilities

Brian Wolshon, PhD., P.E., PTOE

Louisiana State University

July 2020-April 2022

Accomplishments: Increased traffic demand of coastal areas during emergency evacuations have been shown to affect transportation systems negatively. Application of the ramp management algorithms modified by this method becomes increasingly important during emergency evacuation.

Project Plans: Data collection complete. Currently developing the simulation model.

Planning for Managed Retreat: Decision Making in the Face of Climate Uncertainty

Leah A. Dundon, JD, PhD and Mark Abkowitz, PhD

Vanderbilt University

December 2019-May 2022

Accomplishments: Sea level rise, increased frequency and intensity of flooding, and other extreme weather events have sparked a growing recognition that managed retreat must be among the solutions considered. This project will examine the need for managed retreat, case studies, and the significant challenges to implementing managed retreat as an adaptation strategy with a particular focus on transportation and its interdependencies with other critical infrastructure systems.

Project Plans: Looking at shifting away from specific crops in certain areas, changes to the types of vessels or scheduling used in inland waterway freight shipping, changes to the flood insurance program to stop rewarding building in high-risk areas or shifts in regulations governing water management.

The Unintended Consequences of Flood Mitigation along Inland Waterways – A Look at Resilience and Social Vulnerabilities

Janey Camp, PhD, PE, GISP, CFM

Vanderbilt University

July 2020 – December 2021

Accomplishments: The objective of this project is to evaluate different flood mitigation efforts in terms of the community costs such as residential buyouts or elevation of structures. We will utilize agent-based models and empirical data from select communities where significant buyouts have taken place to simulate and estimate the extent to which buyouts may negatively affect community resilience. We will also examine the extent to which community size and ruralness contribute to phenomenon.

Project Plans: Near complete data collection on the project to inform development of the social fabric scores for communities. The remaining tasks are to finish developing the “model”, which may not be an agent-based model now that we better understand the data and issues at play and then writing the report. The graduate student on the project is working on developing a journal manuscript about the social fabric score at present.

Towards Integrating Resilience into Everyday Transportation Practices of Coastal and River Valley Communities

Brian Wolshon, PhD, PE, PTOE and Nelida Herrera

Louisiana State University

August 2018-March 2021

Accomplishments: Coastal and river valley communities have become increasingly vulnerable to sea level rise, hurricanes, and other natural disasters. In many cases, these events force the communities to evacuate in a relatively unpredictable way. The results showed that the resilience metrics and methods implemented in this study seemed to have captured the resilience of the freeway using simulation. The results of the analysis also showed that active ramp metering improved the resilience of the freeway based on all of the methods and metrics considered in this study.

Completed Project: Final project report was submitted and distributed as per grant guidelines.

Utilizing Graceful Failure as an Opportunity for Flood Mitigation Downstream to Protect Communities and Infrastructure

Janey Camp, PhD, PE, GISP, CFM

Vanderbilt University

May 2018-March 2020

Accomplishments: In 2011, we observed how “graceful failure” through planned damages to the Birds Point Levee by the US Army Corps of Engineers was enacted to alleviate extreme flooding on the Mississippi River. This action, while flooding croplands as planned in the past, actually reduced flooding and damage to waterway infrastructure and communities downstream.

Completed Project: Final project report was submitted and distributed as per grant guidelines.

Visualizing Sea Level Rise Impacts in Transportation Planning

Brian Wolshon, PhD, PE, PTOE

Louisiana State University

January 2018-December 2019

Accomplishments: The goal of this research was to test and compare new technologies in community-meetings in South Florida to assess the effectiveness of 3D visualization technology, improving residents’ understanding of the impacts of sea level rise on their communities and infrastructure.

Completed Project: Final project report was submitted and distributed as per grant guidelines.

2. Participants & Collaborating Organizations

Amir, Gharehgozli, California State University Northridge; Okan Duru, Nanyang Technological University, Singapore; Jean-Paul Rodrigue, Hofstra University; Chris Clott, Maritime College State University of New York; Leo Tadeu Robles, Federal University of Maranhao State, Brazil; Ana Casaca, World of Shipping Portugal; Port of New Orleans, International Freight Forwarders & Customs Brokers Association; World Trade Center Transportation Committee; Ports Association of Louisiana; Greater New Orleans Port Safety Council; New Orleans Regional Planning Commission; MS Valley Trade & Transport; Port of South LA; Port of Plaquemines; Coastal Cargo; Jefferson Transit; Regional Innovation Alliance; TN Dept. of Transportation; TN Dept. of Economic and Community Development; American Bureau of Shipping; Don Loftis, Olin Corporation; Brian Rafferty, Ingram Barge Company; Chris Barkin, University of Illinois; Diane Husic, Moravian College; Gillian Bowser, Colorado State; Deidre Smith, Deputy Director, Inland Rivers, Ports and Terminals, Inc.; Dr. Jingjing Tong, Assistant Professor, Southeast Missouri State University, Cape Girardeau, MO; Dr. Kenneth Ned Mitchell, Research Civil Engineer, US Army Engineer Research and Development Center Coastal and Hydraulics Laboratory, Vicksburg, MS; Chad Johnston, United States Department of Homeland Security, Office of Infrastructure Protection, Protective Security Advisor – Arkansas District; Glenn Moore, United States Department of Homeland Security, Office of Infrastructure Protection, Protective Security Advisor – Oklahoma District; Dr. Furkan Oztanriseven, Assistant Professor of Data Science, LeMoyne College; Travis Black, Office of Ports & Waterways Planning, Port Infrastructure Development Program Team Lead, US Dept. of Transportation Maritime Administration; Matthew Chambers, Bureau of Transportation Statistics, USDOT; Raquel Wright, Federal Railway Administration, USDOT; Kirk Claussen, Loan Specialist, Maritime Administration, USDOT; Wade Morefield, Office of Ports & Waterways Planning, US Dept. of Transportation, Maritime Administration; Bruce Lambert, MARAD, USDOT; Bill Eisele, Head of the Mobility Division, Texas A&M University Texas Transportation Institute; Marin Kress, Research Scientist, CHL, ERDC, USACE; Chase Long, Staff Lead, Maritime Data Integrated Action Team (IAT); Action Coordinator, Infrastructure Investment IAT, Committee on the Marine Transportation System, USDOT; Forrest Vanderbilt, Headquarters, USACE; Ed Strocko, Director, Office of Spatial Analysis and Visualization, BTS, USDOT; Brian Tetreault, Navigation Systems Specialist, CHL, ERDC, USACE; Reese M. Brewer, Transportation Director, Frontier Metropolitan Planning Organization; Cody Schindler, MPO Transportation Planner Western Arkansas Planning and Development District; Mat Pitsch, Western Arkansas intermodal Authority and AR State Senator; Katie Lientz, Economist, MARAD, USDOT; Doug McDonald, Director, Office of Policy and Plans, MARAD, USDOT; Jack Cothren, Center for Advanced Spatial Technology, University of Arkansas; Chris Angel, Center for Advanced Spatial Technology, University of Arkansas; Dr. Donald T. Resio, University of North Florida; Dr. John van de Lindt, Colorado State University; Dr. Dan Cox, Oregon State University; Dr. Phil Berke, University of North Carolina; Dr. Phil Bedient and Dr. Jamie Padgett, Rice University; Dr. Casey Dietrich, Dr. Billy Edge, and Dr. Gavin Smith, North Carolina State University; Dr. Issac Ginis and Dr. Jim Prochaska, University of Rhode Island; Dr. Scott Hagen, Dr. Carola Kaiser, Dr. Robert Twilley, Louisiana State University. Dr. Mizunur Rahman, University of Alabama, Dr. Karl Kim, University of Hawaii, Dr. Jasim Imran, University of South Carolina, Chris Price, Chief Geotechnical Engineering and Geosciences Branch, US Army Corps of Engineers ERDC, Jamie Lopez Soto, US Army Corps of Engineers ERDC, Elmo Webb, Seth Martin, and Jonathan Palmer US Army Corps of Engineers, Leslie Montgomery Crawford County Levee

3. Outputs

3.1 Publications

Peer Reviewed Journal Articles

1. Alkhaleel, B., H. Liao, and K. Sullivan, "Risk and Resilience-Based Optimal Post-Disruption Restoration for Critical Infrastructures under Uncertainty," *European Journal of Operational Research*, 296(1): 174-202, published
2. Asborno, M. and S. Hernandez, "Assigning a Commodity Dimension to AIS Data: Disaggregated Freight Flow on an Inland Waterway Network," *Research in Transportation Business and Management*, June 2021, Vol. 100683, published
3. Azucena, Jose Basem Alkhaleel, Haitao Liao, and Heather Nachtmann, "Hybrid Simulation to Support Interdependence Modeling of a Multimodal Transportation Network," *Journal: Simulation Modelling Practice and Theory*, published
4. Dundon, L. A., and M. Abkowitz, "Climate-Induced Managed Retreat in the US: A Review of Current Research," *Climate Risk Management*, 100337, published
5. Dundon, L.A. and J.S. Camp, "Climate Justice and Home-Buyout Programs: Renters as a Forgotten Population in Managed Retreat Actions," *Journal of Environmental Studies and Sciences*, May:1-14, DOI: 10.1007/s13412-021-00691-4, published
6. Folkman, D., A. Gharehgozli, J. Mileski, and C. Galvao, "Port Resiliency and the Effects of Hurricanes on Port Operations," *International Journal of Advanced Operations Management*, under review
7. Galvao, Cassia, James Kruse, Villa, Juan Carlos, and Joan Mileski, "Blockchain's Impacts on and Applicability: The Case of Houston Maritime Cluster," *Maritime Transport Research Journal*, under review
8. Gharehgozli, A. H., C. Galvao, J. Mileski, and R. Swaney, "The role of Sea Ports in the International Supply Chain of Wind Energy," *International Journal of Shipping and Transport Logistics -IJSTL*, under review
9. Hemes KS, B. Runkle, K. Novick, D. Baldocchi, and C. Field, "An Ecosystem-Scale Flux Measurement Strategy to Assess Natural Climate Solutions," *Environmental Science and Technology*, <https://doi.org/10.1021/acs.est.0c06421>, published
10. Huang, X, M. Reba, A. Coffin, B. Runkle, Y. Huang, B. Chapman, B. Ziniti, S. Skakun, S. Kraatz, P. Siqueira, and N. Torbick, "Cropland Mapping with L-band UAVSAR and Development of NISAR Products, Remote Sensing of the Environment," 253:112180, published <https://www.sciencedirect.com/science/article/pii/S0034425720305538>.
11. Ivoke J., M. Khan, and M. Nobahar, "Unsaturated Hydraulic Conductivity Variation of Expansive Yazoo Clay with Wet-Dry Cycles," *Transportation Research Record*, published, 03611981211011994
12. Khan M.S., M. Nobahar, M. Stroud, S. Ferguson, and J. Ivoke, "Performance Evaluation of a Highway Slope on Expansive Soil in Mississippi," *International Journal of Geomechanics*, published
13. Khan, M.S., M. Hossain, and M. Nobahar, "Stabilization of the Highway Slope using Recycled Plastic Pins" *Transportation Research Record*, 03611981211007143, published
14. Moreno-García, B., E. Coronel, C. Reavis, K. Suvočarev, and B. Runkle, "Environmental Sustainability Assessment of Rice Management Practices using Decision Support Tools, *Journal of Cleaner Production*, 128135, <https://doi.org/10.1016/j.jclepro.2021.128135>, published

15. Parr, S., B. Wolshon, P. Murray-Tuite, and T. Lomax, "Multi-State Assessment of Roadway Travel, Social Separation, and COVID-19 Cases," *Journal of Transportation Engineering, Part A: Systems*, Vol. 147, No. 5, published
16. Parr, S., L. Acevedo, P. Murray-Tuite, and B. Wolshon, "Methodology to Quantify Statewide Evacuations," *Journal of the Transportation Research Board*, accepted
17. Reavis CW, K. Suvočarev, M. Reba, and B. Runkle, "Impacts of Alternate Wetting and Drying and Delayed Flood Rice Irrigation on Growing Season Evapotranspiration," *Journal of Hydrology*, 126080, published <https://www.sciencedirect.com/science/article/pii/S002216942100127X>
18. Reilly, A., H. Baroud, R. Flage, and M. Gerst, "Sources of Uncertainty in Interdependent Infrastructure and their Implications," *Reliability Engineering and System Safety* 213, 107756, published
19. Thompson, Peter, Faisal B. Mallum, and Gloria O. Chigbu, "Nigeria: A Narrative of Competing Needs Between Shifting Global Trend, Sustainable Transportation, and Economic Growth," *Journal of Contemporary African Studies*, accepted

Books/Other One-Time Publications

1. Baroud, H. Risk Analysis Methods in Resilience Modeling: An Overview of Critical Infrastructure Applications. *Applied Risk Analysis for Guiding Homeland Security Policy*, 357-379
2. Matherly, D., J. Mobley, P. Bye, J. McDonald, W. Ankner, K. Kim, E. Yamashita, P. Murray-Tuite, A. Pande, J. Renne, and B. Wolshon, *Resilience Primer for Transportation Executives*, Report 976 Transportation Research Board, National Research Council, Washington DC, 2021

Editorial Journal Positions – Tech transfer

1. Area Editor, *Health Systems*
2. Associate Editor, *ASCE Journal of Structural Engineering*
3. Associate Editor, *IIE Transactions on Healthcare Systems Engineering*
4. Associate Editor, *INFORMS Journal on Computing*
5. Associate Editor, *Journal of Infrastructure Systems*
6. Associate Editor, *Operations Research Letters*
7. Editor in Chief, *The Engineering Economist*
8. Editorial Advisory Board, *Transportation Research, Interdisciplinary Perspectives*
9. Guest Associate Editor, *Climate Risk Management*
10. Guest Editor, *Geomaterials for Transportation Infrastructures*
11. Guest Editor, *Natural Hazards Review*
12. Member, Editorial Board, *ASCE Journal of Infrastructure Systems*
13. Member, Editorial Board, *Environment Systems and Decisions*
14. Member, Editorial Board, *Quality Engineering*
15. Member, Editorial Board, *Stochastics and Quality Control*
16. Member, Editorial Board, *Transportation Research Part D: Transport and Environment*
17. Member, Editorial Board, *Transportation Research Part E*

3.2 Website: martrec.uark.edu

3.3 New Methodologies, technologies, or techniques - Nothing to report

3.4 Inventions, patents, and/or licenses - Nothing to report

3.5 Other products - Nothing to report

4. Outcomes

4.1 Increased understanding and awareness of transportation issues

Distinguished Lectures

- John “Zach” Albritton, Transportation Safety in Louisiana, Django S Szilagi, Bicycle & Pedestrian Safety in New Orleans, Mike Smith, Urban Public Transit Safety, September 2021

Media Coverage

- Craig Phillip and Janey Camp, VECTOR study showing Tennessee cities served by barged petroleum fared better during the recent Colonial Pipeline shutdown, [Waterways Journal](#)
- Hiba Baroud, How climate change will continue to cause extreme weather events, [The New York Times](#)
- Hiba Baroud, The importance of building sustainable cities, [Connected World](#)
- Hiba Baroud, Updating early-warning systems and evacuation plans, [The Washington Post](#)
- Janey Camp, How devastating floods will become more common, [National Public Radio](#)

Leadership and Research Awards

- Mohammad Kahn, 2021 AASHTO Sweet 16 project Award, AASHTO Research Advisory Committee, “State Study 286: Performance Evaluation of highway slopes on Yazoo clay”

4.2 Passage of new policies, regulation, rulemaking, or legislation - Nothing to report

4.3 Increases in body of knowledge

Conference Presentations (Invited)

1. Asborno, M., and Hernandez, S., “Crowdsourcing tools to train and evaluate machine learning classifiers: freight data management application”, 2020 National Travel Monitoring Exposition and Conference (NaTMEC), June 2021
2. Asborno, M., and Hernandez, S., “Single Beam Lidar Detection for Truck-Body Type Classification”, National Travel Monitoring Exposition and Conference (NaTMEC), June 2021
3. Galvao, C. “Sustentabilidade e as Relacoes Porto-cidade,” Sustainability and Port-city relations, IV Port Management International Symposium (Simpósio Internacional de Gestão Portuária), Labports at UFMA, Federal University of Maranhao, Brazil, August 2021
4. Galvao, C. and Brown, A (student). “Port Development in the context of the Arctic Shipping Routes,” CCAPPTIA Conference: Adaptation and Resilience of Transportation and Logistics in the Post-Pandemic World, Climate Change and Adaptation Planning for Ports, Transport Infrastructures, and the Arctic, University of Manitoba, Canada, June 2021
5. Whalin, R. "Coastal Engineering and Computational Engineering, Coastal Resilience Center of Excellence, Virtual Annual Meeting, April 2021

4.4 Improved processes, technologies, techniques, and skills - Nothing to report

4.5 Enlargement of the pool of trained transportation professions

Certification Courses (Center for Training Transportation Professionals)

- 486 students through 7 webinars and 26 in person sessions
- 6 programs: Aggregates, Asphalt, Concrete, Pavement, Soils and Stormwater

4.6 Adoption of new technologies, techniques or practices – Nothing to report

5. Impacts (through project deliverables and diversity)

5.1 Effectiveness of the Transportation System – Nothing to report

5.2 Technology Transfer (Project Deliverables)

Final Reports during this period

1. Development of AIS Model of Texas Gulf Intracoastal Waterway Travel Times
2. Learning from USACE Open Data for Locks
3. Using CSA Cement for Novel Waterway Repair Materials

Research Impacts

- Project, *Development and Implementation of Sustainable Transportation Resilience Indicators*, created a methodology to determine the value of investing in port development as a resilience adaptation strategy
- Project, *Using CSA Cement for Novel Waterway Repair Materials*, research has investigated making flowable, underwater mortars with the cement used in this project. No other work has used this cement for soil-cement applications. This will have wide applications in industry.

5.3 Increase in the Body of Scientific Knowledge

- Three final reports successfully submitted
- 14 peer-reviewed journal articles and two books were published

5.4 Transfer of Results to Government/Industry Entities

- Project, *Rapid Assessment of Internal Erosion Damage and Erodibility in Levees*, Communications with USACE indicate that this work will likely have a valuable contribution to their efforts in this area and they are interested in continuing relationships and testing beyond this project.

5.5 Commercialization of Technology/Process or Adoption of New Practices

- Project, *Rapid Assessment of Internal Erosion Damage and Erodibility in Levees*, compiling a database of Hole Erosion Test (HET) data and other soil erosion existing data.
- Project, *Identifying Critical Waterway Infrastructure and Managing Risk Associated with Natural Disasters*, compiling a GIS database of US infrastructure including highway systems and bridges, locks and dams, ports and harbors, and levee data. The database contains information about location of this infrastructure, but more importantly, it will contain information related to maintenance costs/requests, repairs, damages from events, and inspection details to provide an overall health assessment and the economic impacts of performance and required costs.

5.6 Improved Performance, Skills, or Aptitudes of Underrepresented Groups

- 36% of our research projects are led by female researchers
- 40% of our student research participation is from underrepresented populations

5.7 Development and Dissemination of New Educational Materials – Nothing to report

6. Changes/Problems – Our MarTREC institutions continue to be impacted by COVID-19.

7. Special Reporting Requirements – Nothing to report