



USDOT Tier 1 University Transportation Center

Semi-Annual Progress Report #9

Federal Agency: Office of the Assistant Secretary for Research and Technology

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

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Reporting Period Start Date: October 1, 2022
Reporting Period End Date: March 31, 2023

Report Term or Frequency: six months

Signature: 

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.

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)	11
# of conference presentations given	9
# of students participating in transportation research projects funded by UTC	50

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	36
# of invited talks given	0
# of leadership and research awards received	7

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	23
# of technician certification programs offered	8
# K-12 outreach programs offered	6

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	1
# of technical briefs	0
# of editorial journal positions held	14

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	67
# of new collaborative partnerships formed	25

1.1.6 Opportunities for Training and Professional Development

- Two students presented at professional conferences
- Eight conference planning positions were held by MarTREC faculty researchers
- 36 leadership positions held by MarTREC faculty researchers
- 507 individuals completed transportation certified courses

1.1.7 Dissemination of Results (In this reporting period)

- One final report
- 11 peer-reviewed journal articles

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

- 63 total projects (life to date)
- 33 completed projects (life to date)

1.2.1 Maritime and Multimodal Logistics Management Projects

A Supply Chain-oriented Methodology to Analyze Performance of Port-related Multimodal Freight Infrastructure

Jim Kruse, MBA

Texas A&M Transportation Institute

August 2022-June 2023

Accomplishments: This project will build on these past studies to develop a supply chain-oriented methodology to analyze performance of the port-related multimodal freight infrastructure. Specifically, the project team will identify and match up the key freight corridors with ship activity to analyze what happens on relevant supply chain corridors at times of ship arrivals and departures.

Project Plans: Statistical analysis

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-August 2023

Accomplishments: Since the 1969 passage of the National Environmental Protection Act, transportation planning became a complex, interdisciplinary challenge. The need for meeting environmental legislation and public participation demands have revealed innumerable problems 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 which will enable agencies and organizations to increase efficiency

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

Accomplishments: 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. Analyzing findings of presentation to six undergraduate students. Submitted paper on work to ASEE conference.

Project Plans: Working on final report.

Evaluating the resilience of port operations to local and regional transportation infrastructure

Jim Kruse, MBA

Texas A&M Transportation Institute

December 2021-April 2023

Accomplishments: This project will develop a quantitative model of the local and regional road and rail network that serve a port, and the flow of goods to and from the port. The goal is to develop a reusable quantitative framework to assess questions relating to the port road transportation system. Completed algorithms to estimate flooding from storm surge. Using fixed wing LIDAR data to develop models of road and rail elevation relative to the surrounding land. Models will be used to estimate effect of storm surge flooding. We have analyzed cargo flows and defined traffic origins and destinations.

Project Plans: Completing analysis of storm surge flooding in and around freeport and its effect on travel metrics to and from port. Finalizing report.

Inland Waterway Travel Time Prediction

Jim Kruse, MBA

Texas A&M Transportation Institute

November 2020-April 2022

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

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

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.

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

Modeling Dynamic Behavior of Navigable Inland Waterways

Heather Nachtmann, PhD and Justin Chimka, PhD

University of Arkansas

August 2018-August 2023

Accomplishments: This project is expanding prior MarTREC research. A literature search and review of prior research on and implementation of container-on-barge was published in the Maritime Economics and Logistics journal (August 2021).

Project Plans: We are submitting a journal article manuscript on the value-focused framework to assess the feasibility of container-on-barge in the United States to the Engineering Management Journal in April 2023. We are collecting and analyzing data for a machine learning study to perform container volume forecasting for COB transportation within the United States.

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.

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-September 2022

Accomplishments: The purpose of this project was to guide strategic investment into port capacity through the development of a policy and infrastructure evaluation model of inland waterway commodity flows.

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

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-August 2023

Accomplishments: 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.

Project Plans: Determine the status of the United States International Trade Commission and the US Chamber of Commerce investigations about Chassis and Subassemblies from China, determine the current domestic situation for chassis production as well as other international providers, determine if and to what extent China is dumping chassis in the US to put domestic production out of business.

The Changing Legal Landscape of Intermodalism – Part 2

Janey Camp, PhD, PE

Vanderbilt University

August 2021-August 2023

Accomplishments: 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.

Project Plans: Determine the status of the United States International Trade Commission and the US Chamber of Commerce investigations about Chassis and Subassemblies from China, determine the current domestic situation for chassis production as well as other international providers, determine if and to what extent China is dumping chassis in the US to put domestic production out of business.

Novel Big Data and Artificial Intelligence Analytics Methods for Tracking and Monitoring Maritime Traf.

Tor A. Kwembe, PhD

Jackson State University

November 2021-August 2023

Accomplishments: This project will utilize Automatic Identification System (AIS) datasets to design scalable Maritime Traffic Monitoring and Analysis (MTMA) applications and tools. Critical applications such as the detection of anomalies, offshore and onshore attacks and data intrusions, require fast

mechanisms for Artificial Intelligence (AI) analysis of thousands of events per second, as well as efficient techniques for the analysis of massive historical AIS data. An automated generation of the AutoML end-to-end pipeline model is complete. Data has been acquired from SPIRE for testing. We are at the testing stage with this version of the project. Module lecture series have been developed to teach the mathematics and statistical principles for AutoML models and model selections.

Project Plans: More Model development and literature review in progress.

Network Science-based Analysis of the US Marine Highway Network and a Random Graph Model for the Intermodal Port Network

Natarajan Meghanathan, PhD

Jackson State University

November 2021-August 2023

Accomplishments: Marine highways in the US correspond to navigable waterways that run closer to major interstate roads in the country. Unlike the US Interstate road network and the airport network, the US marine highway network (MHN) and the US marine intermodal port network (MIPN) have not been analyzed and no results have been so far reported in the literature. We propose to analyze the MHN using algorithms for community detection, cluster analysis and centrality assessment to identify the critical marine highways and their intersection points that could potentially be a bottleneck.

Collecting the distances and routes (on the marine highways) between any two intermodal ports. We have identified close to 75 major intermodal ports within the US and 16 marine highways connecting them.

Project Plans: We are currently working on finding the closest core ports for about 70 stub ports (intermodal ports that are located on only one marine highway) and integrating these stub ports to the MIPN. We will run all pairs with shortest path algorithm on the comprehensive MIPN and find the shortest paths between any two ports (there will be about 90 intermodal ports in the comprehensive MIPN).

Mississippi Multimodal Freight Analysis Model

Tzusheng Pei, PhD

Jackson State University

November 2021-August 2023

Accomplishments: Enable policy makers, transportation planners and logistic analysts in various federal, state, and local agencies for assessing the demand for transportation facilities and services, energy use, and safety risk and environmental concerns. Completed algorithm and development data.

Project Plan: Working on final report

Assessing Maritime Infrastructure along the Mississippi: Chokepoints and Implications for Food Security

Bernece S. Herbert, PhD

Jackson State University

November 2021-August 2023

Accomplishments: Supply chains are inherently complex due to their interdependency with critical infrastructure systems including maritime and multimodal transportation with the largest risk to agricultural trade resulting from age and inadequate or inappropriate infrastructure. It is imperative to close the infrastructure gap. We have assessed hazards to maritime infrastructure and resulting delays in agricultural trade. The second phase of the JSU-UC Berkeley program was conducted in MS supported by a total of 12 students, faculty and researchers. We focused on the transportation issues along the Mississippi River in Vicksburg with the students making recommendations. We also focused on flooding issues along the Pearl River in Jackson.

Project Plans: Excel databases are being developed that specify the names, county/parish location, authority, design and size. GIS maps will be created from the database. An assessment will be made

about the vulnerabilities of these infrastructures and how they can impact agricultural trade and food security. The project will also result in the development of a proposal for a transportation concentration or tract for our graduate programs.

1.2.2 Maritime and Multimodal Infrastructure Preservation Projects

A Digital Twin for Visualizing, Evaluating and Maintaining Multimodal Transportation

Haitao Liao, PhD, Shengfan Zhang, PhD, and Heather Nachtmann, PhD

University of Arkansas

August 2021-August 2023

Accomplishments: This research project will develop a digital twin that enables visualizing, evaluating and maintaining multimodal transportation infrastructure. The ultimate goal is to provide an opensource software tool and machine learning-based decision-making approaches that assist the relevant stakeholders in improving their information collection and tracking capabilities, as well as enhancing the resilience of multimodal transportation infrastructure and beyond. We have created a complete dataset for the boats and land transportation.

Project Plans: Changing simulation by focusing on barges instead of tows. We can carry an arbitrary variety of commodities on each tow. One commodity per barge. Create barges as agents in the simulation. Commodities are defined according to a user's requirements before runtime. The distribution of each commodity type can be specified by the user before runtime. Towboats contain an arbitrary number of barges and the distribution of barges per towboat can be specified by the user before runtime. Truck allocation to sink destination is customizable before runtime. Simulation ends when all added towboats arrive to their destinations or a pre-specified duration is reached.

Multimodal Transportation Infrastructure in Mississippi

Sadik Kahn, PhD, PE

Jackson State University

April 2020 – August 2023

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 AG 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.

Climate Financing for Marine Transport: Analyzing the Impact of Climate Adaptation Investments in Inland Waterways

Hiba Baroud, PhD and Craig Philip, PhD

Vanderbilt University

October 2022-June 2023

New Project: The project proposes to develop a state-of-the-art, data-driven approach to evaluate climate financing strategies for inland waterways based on future costs of inland waterway supply chain disruptions due to climate change.

Continued Study of Rapidly Deployable Soil-Cement Mixtures

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

University of Arkansas

September 2021-August 2023

Accomplishments: 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.

Project Plans: Working on final report

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

Gary Prinz, PhD, PE

University of Arkansas

September 2021-August 2023

Accomplishments: 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. Three of the learning modules have been outlined, the educational songs have been written and recorded. The educational songs have been written, recorded, and music videos have been completed.

Project Plans: It is anticipated that the three modules will be recorded this semester and ready to be implemented into the elementary class curriculum.

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.

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

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. Results showed that cracks appeared on the surface of the hydrogel-treated Yazoo clay samples when subjected to moisture.

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

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-August 2023

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: The team is 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 several different approaches for weighting the criteria. The team has determined relevant criteria and is 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 detailed and developed. A survey is also being developed to send out to levee stakeholders to determine a subjective measured of weighting for the criteria which can be compared to the more objective results determined using AHP or other methods. The team is working with USACE personnel to develop the survey and create the contact list for distributing the survey.

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-August 2023

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. Wind-surge FE models are all completed, along with validation experiments.

Project Plans: Working on final report.

Rapid Assessment of Internal Erosion Damage and Erodibility in Levees

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

University of Arkansas

July 2020-August 2023

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. Development of the Hole Erosion Test (HET) apparatus has been completed including the addition and calibration of an internal waterproof camera. This novel adaptation will allow for more accurate measurements and more efficient testing to be conducted, as well as potentially lead to an entirely new method for analyzing HET data. The team has identified and tested 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 also collected field samples from the Crawford County levee and conducted HET and laboratory resistivity testing.

Project Plans: Similar testing will be conducted on samples retrieved from the Wood River Levee.

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

Analysis of the Impacts of the COVID-19 Pandemic on Vessel and Cargo Movements in the U.S.

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

Louisiana State University

August 2022-August 2023

Accomplishments: This research seeks to understand changes in national and international shipping trends. We will investigate shifts in cargo movements, by commodity for both import and export operations for several ports across the US. We will also examine changes origin/destination patterns.

Project Plans: Data collection is completed and currently we are working on data interpretation.

Assessment of Evacuation Network Performance under Different Evacuation Scenarios

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

Louisiana State University

July 2019-August 2023

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.

Project Plans: Data collection is completed and currently we are working on data interpretation.

Development and Implementation of Sustainable Transportation Resilience Indicators

Mark Abkowitz, PhD

Vanderbilt University

June 2017-March 2019

Accomplishments: This project established a protocol and method for evaluating a community’s level of sustainable transportation resilience. If deficiencies exist, attention can be focused on mitigating those concerns. The project was 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-August 2023

Accomplishments: Natural disasters like hurricanes and floods leave coastal areas being most vulnerable. 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.

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

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

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

Louisiana State University

July 2020-August 2023

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: Data collection is completed and currently we are working on data interpretation.

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.

Impacts of COVID Restrictions on Freight Transportation in Coastal and Intermodal Port Regions

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

Louisiana State University

February 2022-August 2023

Accomplishments: The global COVID pandemic of 2020, effected travel patterns across the world. This research is to identify and quantitatively assess the impact of COVID-related restrictions on travel activities, with a particular focus on freight and economic activity. The study will examine vehicle classification volume in both the United States and China to compare volume trends of specific types of traffic in both countries. Specific attention will be focused in areas where freight movement is related to intermodal port exchange.

Project Plans: Data collection is completed and currently we are working on data interpretation.

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 successfully created a mathematical model to characterize multi-modal transportation flow while incorporating interdependencies between agriculture and 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 - Phase II VU

Janey Camp, PhD, PE, GISP, CFM

Vanderbilt University

October 2018-August 2023

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 built upon prior knowledge and expanded 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.

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

International Port Dependencies and Resilience to Supply Chain Disruptions

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

Louisiana State University

August 2022-August 2023

Accomplishments: This research will further identify the most central ports in the network and determine groups of highly interconnected ports.

Project Plans: Data collection is completed and currently we are working on data interpretation.

Modifying Ramp Management Strategies to Enhance Resiliency of Freeway Facilities

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

Louisiana State University

July 2020-August 2023

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 is completed and currently we are working on data interpretation.

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-August 2023

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: Working on final report.

Prediction of Port Recovery Time after a Severe Storm Project

Bruce Wang, PhD

Texas A&M University

September 2022-August 2023

Accomplishments: This study will explore the relationship of potential influencing factors on port recovery under adverse storm events. Using multi-source data and applying machine learning

algorithms, a model will be developed to predict the port recovery after adverse storm events. The study will benefit transportation agencies and ports by enhancing the resilience, safety, and efficiency.
Project Plans: Working on final report.

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 – March 2023

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 utilized 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 examined the extent to which community size and ruralness contribute to phenomenon.

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

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.

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.

Vehicle to Infrastructure (V2I) and Vehicle to Vehicle (V2V) passenger and freight vehicle applications to enhance safety and efficiency in coastal evacuations

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

Louisiana State University

August 2022-August 2023

Accomplishments: this study seeks to address this limitation by using a driving simulator to assess and understanding how drivers interact with V2V and V2I advisories during emergency evacuation scenarios.

Project Plans: Data collection is completed and currently we are working on data interpretation.

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

Travis Black, MARAD; Bruce Lambert, MARAD; Katie Lientz, MARAD; Matthew Chambers, BTS; Wade Morefield, MARAD; Thaddaeus Babb, Oklahoma Department of Transportation; Cassandra Caldwell, Arkansas Waterways Commission; Megan Gray, moment.ai; Dr. Michelle Harper, The MITRE Corporation, building collaboration on advanced mobility; Jordan Bearden, Runway Group, collaborator on NSF Regional Innovation Engines proposal; Jeannette Collins, NWA Council, collaborator on NSF Regional Innovation Engines proposal; Justin Kits, Tulsa Innovation Labs, collaborator on NSF Regional Innovation Engines proposal; Candler McCollum, Roadway Management Technologies. Collaboration with Port Freeport, TX on port resiliency. Collaborating with Port of Beaumont on supply chain methodology project. Emily Erickson (Univ. of Warwick, England); Chloe Dotson (City of Jackson MS); Dominika Parry (Climate NGO); Jürgen Hackl (Princeton University); Stephen Barnes (University of Louisiana); Jae-Young Ko (JSU); and Rebecca A. Efroymsen (Oak Ridge National Laboratory). Partnerships involve research projects and new grant applications with Drs Hackl, Barnes and Ko. Matt Kondolf (UC Berkley). Brandi Christian, Laura Mellem: Port of New Orleans; research, outreach, board service. Kristi App: International Freight Forwarders & Customs Brokers Assn. of New Orleans; Christine Titus: GNO Port Safety Council; RADM Joel Whitehead: Propeller Club of New Orleans. Dawn Lopez, David Fennelly: Turn Services, outreach. Jeff Roesel: N.O. Regional Planning Commission, board service, adjunct teacher. Paul Matthews: Port of South LA, research, outreach, board service. Randy Guillot, President, Triple G. Express, Inc.: research, outreach, board service. And 67 more.

3. Outputs

3.1 Publications - Peer Reviewed Journal Articles

1. Bu, F., J. Liu, H. Liao, and H. Nachtmann, (2023). "An Alternative Solution to Congestion Relief of U.S. Seaports by Container-on-barge: A Simulation Study," *Simulation Modelling Practice and Theory*, Under Review.
2. Cole, G., B. Wolshon, and J. Shmidt, (2023). "Route Decisions in Congestion: A Comparison of Choice Influencers in Urban and Non-Urban Networks," *ASCE*, Accepted.
3. Cole, G., B. Wolshon, and J. Shmidt, (2023). "Travel Diversion During Disruption and Uncertainty Motivators and Influencers of Driver Choice," *Traffic Psych and Behavior*, Accepted.
4. Dundon, L., M. Abkowitz and J. Camp, (2023). "Governing Transition: Case Studies in Transformative Adaptation, *Case Studies in the Environment*" 7 (1): 1816908.
5. Fuller, J., M. Shapouri, B. Wolshon, and J. Shmidt, (2023). "Motivations and Influencers of Driver Route Diversion: Driver Behavior and Decision-Making During Commute Disruptions," *Transportation Research Part F: Traffic Psychology and Behavior*, Accepted.
6. Johnson, P. M., H. Baroud, C. Philip, and M. Abkowitz, (2022). "An Integrated Approach to Evaluating Inland Waterway Disruptions Using Economic Interdependence, Agent-based, and Bayesian models," *The Engineering Economist*, 1-18.

7. Johnson, P. M., H. Baroud, C.E. Brady, and M. Abkowitz, (2023). "Who Contributes to Disaster Preparedness," Risk Analysis, Under Review.
8. Mahmoudzadeh, A., N. Mitchell, and X. Wang, (2023). "Analysis of Shoaling Rates Distributions for Varying Locations," Transportation Research Procedia, Accepted.
9. Ortega-Gonzalez, A.J., M.L. Barry, and C.D. Murray, (2022). "Development of Underwater Mortar Using Belitic Calcium Sulfoaluminate Cement," Advances in Civil Engineering Materials, 11, no. 1. <https://www.astm.org/acem20210165.html>
10. Yan, Y., D.L. Baines, Y. Yang, C. Chen, and T.A. Kwembe, (2022). "Study on the Sensitivity of the Streamwise Location of MVG on SWBLI in MVG-Based Supersonic Flow Control," Fluids, 7, 285, <https://doi.org/10.3390/fluids709028>.
11. Yang, Y., Y Yan, C. Chen, Q. Wu, T.A. Kwembe, and R. Wu, (2022). "Modal Analysis on MVG Controlled Supersonic Flow at Different Mach Numbers," Processes, 10, 1456, <https://doi.org/10.3390/pr10081456>.

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

- Database of transportation infrastructure (roads and rail) with elevation data. Useful in evaluating effects of storm surges and flooding (TTI).
- Databases on MS river crossings (bridges, ports & railroads) and port performance stats (JSU).

4. Outcomes

4.1 Increased understanding and awareness of transportation issues

- Seven leadership awards

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

4.3 Increases in body of knowledge - *Conference Presentations*

1. Herbert, B., Council of Educators in Landscape Architecture, Human & Rivers: Challenges to Public Access & Equitable Flood Risk Management Sacramento, San Antonio, TX, March 2023.
2. Kruse, Jim, Bent, But Not Broken: How global supply chains demonstrate post-pandemic resilience, TTI's Thinking Transportation podcasts, January 31, 2023.
3. Mahmoudzadeh, A., A.Khodadadi, M. Absorno, M. Hartman, N. Mitchell, X. Wang, Statistical Analysis of Shoaling Rates in the Ohio River, Port Performance Subcommittee, TRB 2023.
4. Mahmoudzadeh, A., Y. Li., X. Wang, Integrated Optimization Models for Airline Seat Pricing and Upgrading: Maximizing Profitability with Combined Cabin Capacities, TRB, 2023
5. Mohammad Shapouri, James Fuller, Brian Wolshon, Nelida Herrera, Disruptions in Mega-Regional Network Evacuations: Identifying and Assessing Critical Links, TRB 2023.
6. Taylor, Jason, Alex Hainen, Scott Parr, Brian Wolshon, Traffic Signal Management, TRB 2023.
7. Williams, Opeoluwa and Otto Ikome, Centrality and Cluster Analysis of the US Marine Highway Network, JSU Research Engagement Week, October 25, 2022.
8. Wolshon, Brian, Grace Cole, Jeffrey Schmidt, Incident Diversionary Routing, TRB 2023.
9. Wolshon, Brian, Resilience: Definitions and Summary, Presentation No P23-20096, TRB 2023.

- 4.4 Improved processes, technologies, techniques, and skills**
 - Urban Water Crisis in the City of Jackson, MS; B. Herbert; 2023 Planning Colloquium
- 4.5 Enlargement of the pool of trained transportation professions**
 - Nine students graduated with a BS, MS, or PhD
- 4.6 Adoption of new technologies, techniques or practices – Nothing to report**
- 5. Impacts**
 - 5.1 Effectiveness of the Transportation System – Nothing to report**
 - 5.2 Technology Transfer - Final Report**
 - *The Unintended Consequences of Flood Mitigation along Inland Waterways*
 - 5.3 Increase in the Body of Scientific Knowledge**
 - 14 Editorial positions
 - 5.4 Transfer of Results**
 - Stochastic shoaling data analysis adopted by USACE
 - 5.5 Commercialization of Technology**
 - Developed a new device with digital image capture analysis
 - 5.6 Underrepresented Groups -**
 - Jackson State University, a Minority Serving Institution, MarTREC partner since 2012
 - 5.7 Development and Dissemination of New Educational Materials**
 - Workshop “Use of Design of Experiments for Reliability Evaluation and Improvement”
- 6. Changes/Problems**
 - Our institutions continued to work through the impacts of the pandemic. Our spending was somewhat delayed as a result of limited K-12 outreach and experimental research, but we have a plan to complete our grant as planned.
- 7. Special Reporting Requirements – Nothing to report**