



USDOT Tier 1 University Transportation Center

Semi-Annual Progress Report #5

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

Federal Grant ID #: 69A3551747130

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

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Submission Date: April 27, 2021

DUNS: 1914297450000

EIN: 71-6003252

Recipient Organization: University of Arkansas

Project/Grant Period: Start Date November 30, 2016
End Date: September 30, 2023

Reporting Period Start Date: October 1, 2020
Reporting Period End Date: March 31, 2021

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. 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)	16
# of conference presentations given	15
# of students participating in transportation research projects funded by UTC	38

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	41
# of invited talks given	7
# of leadership and research awards received	3

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	29
# of technician certification programs offered	7
# K-12 outreach programs offered	0

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	5
# 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	29
# of new collaborative partnerships formed	29

1.1.6 Opportunities for Training and Professional Development

- Five students presented at professional conferences
- 12 conference planning positions were held by MarTREC faculty researchers
- 41 leadership positions held by MarTREC faculty researchers
- 871 individuals completed transportation certified courses

1.1.7 Dissemination of Results (In this reporting period)

- Five final reports successfully submitted
- Eight peer-reviewed journal articles 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

- 44 total projects (life to date)
- 22 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: It is unclear how relevant or critical the use of blockchain is for maritime business. A recent survey by Deloitte interviewed U.S.-based executives in the shipping sector and found that 39% of them have little or no knowledge about blockchain. Still 55% of them believe that failure to implement blockchain will put their company at a disadvantage; and 25% of them said that their companies viewed blockchain as a critical top 5 priority. Since it is new to an industry that is international, fragmented, and complex in nature, we explore several research questions arising from the application of blockchain to maritime supply chains and logistics.

Completed Project: Conducted by TTI, this project was completed in October 2020. 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-February 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: The purpose of this project is to develop 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: Conducted by UA, this project was completed in October 2020. 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. Terminal capacity is a determinant and a coupling link for vessel and truck flows. This study found data availability as an important constraint for a more detailed analysis. The main recommendation is to explore new data sources and evaluate data generation techniques to produce a more complete data set for a more thorough analysis.

Completed Project: Conducted by TTI, this project was completed in March 2019. 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 mentioned above 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.

Project Plans: Evaluate the effect of “special conditions” on travel time.

Inland Waterway Travel Time Prediction

Jim Kruse, MBA

Texas A&M Transportation Institute

November 2020-January 2022

New Project: 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 (ERDC). The model will be developed in steps. In the first iteration the team will 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. In every case, explanatory variables will be explored and incorporated as appropriate.

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 school, and first-year college students.

Completed Project: Conducted by UA, this project was completed in August 2020. 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: This project plans to describe stoppages that cause downtime. This information would be a valuable addition to what has previously been available in the Lock Performance Management System data. We have assembled a dataset for the Key Locks, from the Public Lock Commodity, Usage and Unavailability Reports.

Project Plans: Our focus now is on creating and understanding methods for mitigating interdependence among Public Lock Report variables while preserving the most important among them, to understand variation in usage and unavailability. We have generated some results related to effectiveness of our methods based on Cluster Variables, and we have generated some other results based on competing methods. We must devise a reasonable, systematic way to compare model recommendations. Then we must assess those recommendations according to model assumptions. Also, we want to interpret our selected model(s) of Public Lock Report data and communicate what it is we have learned from them.

Modal Comparison Update: 2001-2019

Jim Kruse, MBA

Texas A&M Transportation Institute

March 2021-September 2021

New Project: In December 2007, the Texas A&M Transportation Institute (TTI) submitted a report to the U.S. Maritime Administration (MARAD) and the National Waterways Foundation (NWF) 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. This study will cover the period 2001 to 2019. Effects will cover congestion, emissions, energy efficiency, safety, and infrastructure impacts.

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 developing 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. In addition, we are preparing a presentation for the upcoming 2021 Institute of Industrial and Systems Engineers annual conference.

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

New Project: COVID-19 responses by public agencies and private citizens have affected drivers and driver support systems. In this project, we consider an expanded definition of the freight network, beyond roads and warehouses, to include truck drivers and driver support systems. Driver support systems include physical infrastructure like public and private rest stops as well as operational protections like Hours of Service (HOS).

Completed Project: Conducted by UA, this project was completed in September 2020. 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.

Project Plans: A multi-stage stochastic optimization model will be 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.

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, rather than the ocean carriers.

Completed Project: Conducted by UNO, this project was completed in December 2019. Final project report was submitted and distributed as per grant guidelines.

1.2.2 Maritime and Multimodal Infrastructure Preservation Projects

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, 101th TRB, and GeoCongress 2022.

Dredging Projects Selection when the Random Shoaling Effect is Considered

Bruce Wang, PhD

Texas A&M University

October 2019-March 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: Conducted by TTI, this project was completed in August 2018. 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: Conducted by JSU, this project was completed in December 2019. 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 is to assess if the use of 3D virtual and augmented reality as a policy deliberation tool for improved coastal planning, engineering and design by deepening the understanding of sea level rise impacts among the business and tourism industries in Waikiki.

Completed Project: Conducted by LSU, this project was completed in December 2020. 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-July 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: We are now optimizing hydrogel treatment recipe based on the stress-strain curve of the hydrogel-treated samples. The focus is on the improvement of the swelling behavior of expansive soil.

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: Conducted by UA, this project was completed in February 2021. 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: Conducted by JSU, this project was completed in December 2019. 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: The team has gathered information related to levee infrastructure and has begun the health assessment activities in terms of erosion and overtopping events. The team is working with the USACE Little Rock District and ERDC groups for this information. Gathering information related to the transportation system will be the main activity.

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: Conducted by JSU, this project was completed in April 2019. 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: Conducted by UNO, this project was completed in December 2019. 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: Conducted by UNO, this project was completed in December 2019. 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: Conducted by TAMU, this project was completed in January 2019. 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: The team is working with the USACE Little Rock district and has identified at least one levee of interest for field testing. We are making arrangements and requesting all permissions needed in order for the team to be able to conduct the field testing and have access to the historical data.

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: Conducted by UA, this project was completed in December 2019. 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-May 2021

Accomplishments: Calcium Sulfoaluminate-Belite (CSA) cement is a rapid setting hydraulic cement. Due to its rapid hardening characteristics and lower shrinkage and creep compared to typical portland cement, it is an ideal candidate as a repair material. The goal of this work is to develop new mixtures utilizing CSA cement that can be applied to waterway repairs.

Project Plans: A grout mixture capable of setting up rapidly underwater and a soil-cement mixture that can rapidly stabilize slopes and waterway structures will be developed. We have found the ideal water/cement ratio for an underwater BCSA cement grout. Soil cement mixtures is being developed to test the soil cement under moving water and determine its resistance to erosion.

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-August 2021

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.

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: Conducted by Vanderbilt, this project was completed in March 2019. 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 2021

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.

Project Plans: 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.

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

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

Louisiana State University

July 2020-June 2021

New Project: 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.

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: Conducted by UA, this project was completed in September 2019. 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-May 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: Perform a case study to analyze the impact of potential disasters on multimodal transportation systems and the interdependent food and agriculture sector.

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

Janey Camp, PhD, PE, GISP, CFM

Vanderbilt University

October 2018-May 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: Progress has been made on the GIS to feed into the model that our colleagues at U of Arkansas is building. Next steps are 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.

Completed Project: Conducted by LSU, this project was completed in August 2019. 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-June 2021

New Project: 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.

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 – June 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.

Completed Project: Conducted by LSU, this project was completed in March 2021. 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: Conducted by VU, this project was completed in March 2020. 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: Conducted by LSU, this project was completed in December 2019. 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.

3. Outputs

3.1 Publications

Peer Reviewed Journal Articles

1. Ahmadsreza, Mohammad, Adel Khodakaramia, Chaolun Ma (students), Kenneth N. Mitchell, Xiubin B. Wang, and Yunlong Zhang, "Waterway Maintenance Budget Allocation in a Multimodal Network," 146 1-13, (printed).
2. 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* (accepted).
3. Dundon, L. and J. Camp., "Climate Justice and Home-Buyout Programs: Renters as a Forgotten Population in Managed Retreat Actions," *Journal of Environmental Studies and Sciences*, (in review).
4. Dundon, L. and M. Abkowitz, "Climate-Induced Managed Retreat in the U.S.: A Review of the Transportation Sector," *Climate Risk Management*, (in review).
5. Duru, O., Galvao, C.B. Gharehgozli, A. H., Mileski, J.P., Robles, L.T., "Developing a Comprehensive Approach to Port Performance Assessment," *The Asian Journal of Shipping and Logistics*, Volume 36, Issue 4, Pages 169-180, <https://doi.org/10.1016/j.ajsl.2020.03.001>
6. Galvao, C.B. and Robles, L.T., "The Political Dimension of Brazilian Port Development: a content analysis of the 2013 New Port Law," *WMU Journal of Maritime Affairs*, 2021, pp. 1-23. <https://doi.org/10.1007/s13437-020-00223-x>
7. Ivoke, J. Khan, M.S., and Nobahar, M., "Unsaturated Hydraulic Conductivity Variation of Expansive Yazoo Clay with Wet-Dry Cycles," *Journal of Transportation Research Board: Transportation Research Record*, 2020 (accepted).
8. Johnson, P., C. Brady, C. Philip, H. Baroud, J. Camp, M. Abkowitz, "A Factor Analysis Approach to Unify Community Vulnerability and Resilience Indices for Natural Hazards," *Risk Analysis*. 40(9): 1795-1810.
9. Khan, M.S., Hossian, M.S., and Nobahar, M., "Stabilization of the Highway Slope Constructed on Expansive Soil Using Recycled Plastic Pins (RPPs)," *Journal of Transportation Research Board: Transportation Research Record*, 2020 (accepted).
10. Khan, M.S., Ivoke, J. and Nobahar, M., "Numerical Investigation of Slope Stabilization using Recycled Plastic Pin on Yazoo Clay," *Infrastructures* 2021, 6(3), 47; <https://doi.org/10.3390/infrastructures6030047>
11. Li, X., S. M. Mousavi , B. Dadashova, D. Lord, B. Wolshon, "Toward a Crowdsourcing Solution to Identify High-Risk Highway Segments Through Mining Driving Jerks," *Accident Analysis and Prevention*, 2021 (under review).
12. Ma, C., Y. Peng, L. Wu, X. Guo, X. Wang and X. Kong, "Application of Machine Learning Techniques to Predicting the Occurrence of Distraction-affected Crashes with Phone Use Data," *Transportation Research Record, Journal of the Transportation Research Board of National Academies*, (accepted).
13. Mileski, J.P., Clott, C, La Verne, T. Galvao, C.B., "Technical Analysis: The Psychology of the Market of Dry Bulk Freight Rate," *Journal of Shipping and Trade*, Vol 5, 26, <https://doi.org/10.1186/s41072-020-00079-7>
14. Nelson, K.S. and J. Camp, "Quantifying the Benefits of Home Buyouts, Demonstration of an Approach and Local Application to an Urban Area," *Anthropocene (special issue) - Urban Hydroclimatic Risks in the 21st Century: Integrating Engineering, Natural, Physical and Social Sciences to Build Resilience*, Vol 31:100246.

15. Xiao, Yunlong Zhang, Xiubin B. Wang, Shu Yang, and Tianyi Chen, "A Connected Automated Vehicle Hierarchical Longitudinal Control for Mixed Traffic on Consecutive Signalized Arterials Submitted to Sustainability," (submitted).
16. Zhang, Z., Liu, F., B. Wolshon, and Sheng, Y., "Virtual Traffic Signals: Safe, Rapid, and Efficient Driving Without Traffic Controls," IEEE Transactions on Intelligent Transportation Systems, 2020 doi: 10.1109/TITS.2020.2998907.

Conference Papers

1. Asborno, M. and Hernandez, S., "Commodity-based Vessel Trip Characterization on an Inland Waterway Network," Annual Meeting of the Transportation Research Board, January 2021.
2. Galvao, C. "Maritime Clusters: Trends and Challenges in the U.S. Context," Sixth Biennial Marine Transportation System, under the call of "Innovative Science and Technology Conference: Advancing the Marine Transportation System through Automation and Autonomous Technologies: Trends, Applications and Challenges," Technical Breakout Session: Automation Drivers & Challenges, March 2021.
3. Gludemans, D. (student), N. Gludemans (student), M. Abkowitz, W. Barbour, D. Work, "Quantifying Social Distancing Compliance and the Effects of Behavioral Interventions Using Computer Vision," January 2021.
4. Villa, Juan Carlos and Joan P. Mileski, "Analysis of Blockchain's Impacts on and Applicability to the Maritime Industry," Transportation Research Board Annual Meeting. Event: 1161 - Current Research Related to Ports and Channels. Presentation Number: TRBAM-21-02966, January 2021.

Books/Other One-Time Publications

1. Abkowitz, M., "Climate Adaptation is a Necessity and No Longer an Option," The Hill, October 2020.
2. Alix, Yann, Michèle Montantin, and José M. Sánchez, "Dinámicas portuarias en el Caribe y América Latina: Ports in transition to face global challenges," EMS Management & Society, Paris (2021), ISBN : 978-2-37687-428-7.
3. Vasconcellos, Flavia Nico, Cassia Bomer Galvao, and Léo Tadeu Robles, "Brazilian Port Development Policy: Contemporary challenges towards sustainability and port-city relationships," Chapter 11.

Editorial Journal Positions – Tech transfer

1. Area Editor, Health Systems
2. Associate Editor, ASCE Journal of Structural Engineering
3. Associate Editor, IISE 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

1. Evaluating Uncertain and Dynamic Interdependencies of Critical Infrastructure Systems. Department of Civil, Architectural & Environmental Engineering, University of Colorado, Boulder. Virtual Participation, December 2020.
2. Evaluating Uncertain and Dynamic Interdependencies Across Critical Infrastructure Systems and Communities. The Department of Industrial Engineering, University of Arkansas. Virtual Participation, November 2020.
3. Evaluating Uncertain and Dynamic Interdependencies Across Critical Infrastructure Systems and Communities. Stanford Urban Resilience Initiative, Stanford University. Virtual Participation, November 2020.
4. Transportation policy and administration on a city, regional, and national level. Specifics included multimodal transportation, transit, trucking, Sharon Leader, Laura Bryan, Randy Guillot and Jeff Roesel, March 2021.
5. Applied Techniques for Transportation Professionals on traffic analysis, safety, and performance evaluation Derek Chisholm and Robert Stickney, February 2021.

Leadership and Research Awards

1. Hiba Baroud, awarded National Science Foundation Early CAREER Award
2. Sadik Kahn, awarded National Science Foundation Early CAREER Award
3. Sarah Hernandez, awarded National Science Foundation Early CAREER Award

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

4.3 Increases in body of knowledge

Conference Presentations

1. Abkowitz, M. "Resiliency in Transportation", The Sustainable Transportation Forum, Nashville, November; Allen, M. (student), "Flood Risk and Resilience: Enhancing Rural Communities' Ability to Prepare for and Respond to Flood Events," American Geophysical Union (AGU) Annual Meeting, December 2020.
2. Asborno, M., (student) and Hernandez, S., "Towards Multimodal Freight Network Modeling: Geospatial Map-matching of AIS Data and Integration with Truck Movements," Sixth Biennial Marine Transportation System Innovative Science and Technology Conference, Washington, D.C., March 2021.

3. Camp, J., K. Nelson, C. Philip, M. Moravec, D. Scheffler, P. Johnson, "Utilizing Agent-based Modeling to Evaluate Operational Impacts of an Incident and Possible Alternatives on U.S. Waterways," TRB Annual Meeting, Washington, D.C., January 2020.
4. Chimka: Sun, Xiaotong (student), "Dividing datasets into subsets that address interaction among regressors," INFORMS Annual Meeting, November 2020.
5. Crews, M. (student) and Hernandez, S., "Student Outreach in Transportation Using Build Kits," Arkansas Institute of Transportation Engineers, October 2020.
6. Dundon, L., "Climate Change law and litigation Seminar Title and date: Guest Lecturer at Colorado State University," March 2021.
7. Dundon, L., "The Paris Agreement and U.S. Climate Policy Seminar Title and date: Guest Lecturer at Colorado State University," February 2021.
8. Galvao, C. "Maritime Clusters: Trends and Challenges in the U.S. Context," Sixth Biennial Marine Transportation System, Innovative Science and Technology Conference: Advancing the Marine Transportation System through Automation and Autonomous Technologies: Trends, Applications and Challenges, Breakout Session: Automation Drivers & Challenges, March 2021.
9. John Ivoke, (student) "Unsaturated Hydraulic Conductivity Variation of Expansive Yazoo Clay with Wet-Dry Cycles," poster presentation, 100th Transportation research board meeting, Washington D.C., January 2021.
10. Monsreal, M., "Chesscon, "Online Chesscon User Event," February 2021.
<https://www.chesscon.com/online-chesscon-user-event-2021.html>
11. Nachtmann, Heather, "Graduate Advising and Building an Effective Research Team," IISE Doctoral Colloquium, Virtual, October 2020.
12. Nachtmann, Heather, Jack Cothren, Chris Angel, Justin Chimka, Jim Kruse and Chase Rainwater, "Transportation and Maritime Analytics Partnerships (TransMap)," Sixth Biennial Marine Transportation System Innovative Science and Technology Conference, March 2021.
13. Salunke, Rakesh, (student) "Evaluation of Effective Stress-Beta Method's Design Coefficients Using Machine Learning," poster presentation, 100th Transportation research board meeting, Washington D.C., January 2021.
14. Tolford, Tara, "Partnership for a Big Jump for Bicycling," APA Virtual Cross-Chapter Collaborative Conference, October 2020.
15. Zeringue, K., Stich, B., & Tian, G., "Suitability of Fusing Vehicle Probe Data and Vessel Data to Contextualize the Multimodal Interaction Impacts on Corridor Mobility – a New Orleans Case Study," Transportation Research Board 100th Annual Meeting, Washington D.C., January 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)

- 9 webinars and 32 in person classes
- 7 programs, 41 sessions, 871 students
- Programs: Aggregates, Asphalt mix, Asphalt paving, Concrete, Pavement, Soils, 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. Analysis of Blockchain's Impacts on and Applicability to Maritime Industry
2. Visualizing Sea Level Rise Impacts in Transportation Planning
3. Engaging the Business and Tourism Industry in Visualizing Sea Level Rise Impacts to Transportation Infrastructure in Waikiki, Hawaii
4. Fatigue Crack Control in Waterway Lock Gate Pintle Locations Subjected to Multi-Modal Fracture
5. Combining Truck and Vessel Tracking Data to Estimate Performance and Impacts of Inland Ports

Research Impacts

1. Project, Interdisciplinary Educational Outreach with Traffic Sensor Build Kits, educational modules are to be used for outreach and workforce development at the K-12 levels
2. 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

- Five final reports successfully submitted
- Eight peer-reviewed journal articles were published

5.4 Transfer of Results to Government/Industry Entities – Nothing to report

5.5 Commercialization of Technology/Process or Adoption of New Practices - Nothing to report

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

- Interdisciplinary Educational Outreach with Traffic Sensor Build Kits

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

7. Special Reporting Requirements – Nothing to report