MarTREC
Maritime Transportation Research & Education Center

BIL MarTREC Tier 1 UTC Project Request Form
Completed form should not exceed 2 pages
Return to Amy Shell at shell@uark.edu

Submission Date: 03/06/2025
Lead Recipient/Grant Number: University of Arkansas / 69A3552348331
Principal Investigator Institution: Jackson State University
Center Name: Maritime Transportation Research and Education Center
USDOT Research Priority: Preserving the Existing Transportation System
Primary USDOT Strategic Goal (select drop down): System Resilience
Principal Investigator(s) with ORCID(s) and Contact Information: Rocky Talchabhadel 0000-0003-0526-7663, Department of Civil & Environmental Engineering, Jackson State University, 1400 John R. Lynch St., Jackson, MS 39217-0168, Ph: 601-979-3927
Project Partners: n/a
Project Type (select drop down): Advanced Research
Project Research Topic Type (select drop down): Disruption Response and Transportation Planning for Coastal and River Valley Communities
Transportation Modes Involved (check all that apply): ☒Waterway ☒Road ☒Rail ☐Pipeline ☐Other
Research Project Funding: Federal funding of $50,000, of which $5,000 will be spent on planned Technology Transfer activities. Faculty time as cost share $27,500. Total $77,500.
Project Start and End Dates (Format month/day/year to month/day/year): 08/01/2025 to 5/31/2026
Project Title: Improved Road Flood Predictability and Disruption Response Through the Synergistic Integration of Geospatial Databases, Process-Based Modeling, and Machine Learning
Project Abstract (Brief Description): Major flood events can have devastating impacts on communities, ecosystems, and infrastructure. Heavy rainfall in urban areas often overwhelms existing infrastructure, resulting in localized streets or section flooding. Flooded roads hinder access to essential services and pose significant challenges for emergency management. Predicting these floods in near-real-time and with high resolution is difficult due to limited data and the computational cost of detailed models. We have already developed and tested a framework (Bhattarai et al., 2024). This project will test the modeling framework around the Jackson downtown and the surrounding, MS. For instance, events like floodwater beneath the train bridge on Monument Street near Mill Street in Jackson, MS. (reported on Wednesday, Jan. 24, 2024, and similar events). The project will compile information on flooded road and railway networks from local and regional news portals and X (formerly Twitter). Using location keywords (Jackson', 'Jackson downtown', 'Jackson MS') and flood-related terms ('flood', 'flooding', 'road flood', 'urban flood', 'flash flood', 'road closure', 'rainfall'). We will identify flooding dates and affected road locations for the recent time and geolocate flooded locations using QGIS, that will serve as training-testing data for the machine learning model. Then the project will develop and test machine learning models (base learner models, such as random forest, support vector machines, and ensemble of these base learners). We will use covariates dataset from other available hydrodynamic models, satellite rainfall estimates, traffic cameras (if available), flood-control infrastructure databases, and basin characteristics to predict flood inundation at street-level resolution. We believe these machine learning-based models offer significant improvements in computational efficiency while maintaining accuracy and consistency. In a nutshell, we will identify the most susceptible road and rail networks to critical urban facilities.

USDOT Priorities: This project supports the priorities of USDOT and RD&T strategic goals by enhancing road safety, infrastructure resilience, and innovation. With the combination of geospatial databases, hydrodynamic modeling, and machine learning, this project will develop a high-resolution, near-real-time flood prediction system. The advanced machine learning surrogate models significantly reduce computational costs while maintaining high accuracy. Furthermore, disruption modeling predicts the impact of floods on transportation networks, improving emergency response. These innovations contribute to the development of next-generation flood prediction systems, strengthening urban resilience to major flood events.

Outputs (results of the work performed): This project will leverage machine learning models trained on crowd-sourced flood data sets to improve road, and rail network flood risk assessment, mapping, and predictions. First, a GIS layer of training-testing data of flooding events will be developed as a benchmark dataset for Jackson, MS. Also, this project will compile several flood conditioning factors, such as diverse geospatial characteristics, including hydrologic, infrastructure, topographic, and meteorological features, such as elevation, distance to stream, road surface roughness, rainfall, slope, distance to combined sewer outfall, and curve number. In particular, rainfall estimates will be obtained from the National Oceanic and Atmospheric Administration's Multi-Radar/Multi-Sensor System (MRMS), and satellite-derived estimates. MRMS provides near-real-time rainfall IEEE ACCESS 3 estimates by mosaicking data from multiple weather radars, satellites and observation networks on a grid with a horizontal spacing of 1 km updated every 2 min. A key outcome will be the development of machine learning models for high-resolution, near-real-time flood prediction, that can rely on weather forecast to map hotspots of road, and rail floods.

Outcomes/Impacts: The project outcomes have the potential to transform flood management into transportation systems. By enabling high-resolution, near-real-time predictions of road and railroad flooding, these outputs enhance safety through proactive measures, strengthen infrastructure resilience by identifying vulnerable areas, and optimize resource allocation for maintenance and emergency response. Moreover, the application of these findings could inform regulatory and policy frameworks, encouraging legislative support for the adoption of advanced flood prediction technologies and better urban planning practices. Overall, this project promises to significantly improve the transportation system's resilience, reliability, and cost efficiency in the face of major flood events.

Technology Transfer Activities: Research results will be disseminated through academic journals, conference presentations, workshops, and webinars, as well as by publishing technical reports, providing online access to datasets and software tools, collaborating with industry and government partners, and producing policy briefs. Around 10% of the budget is allocated to these efforts, which aim to make the findings accessible and relevant to stakeholders in academia, government, industry, and the wider community. This approach will facilitate the implementation, utilization, commercialization, and policy impact of the research.

Final Research Report: Upon completion of the project, a URL link to final report will be provided

Project Deliverables: ☒ PI agrees to submit all deliverables within 4 weeks after the project end date.

Data Management Plan (DMP): ☒ PI has reviewed and agrees to adhere to MarTREC DMP. Proposed project DMP must be attached to the submission email along with this form.

Center Director Approval Signature and Date:  04.01.25