The NTSCOE Communicator is a quarterly newsletter of the National Transportation Security Center of Excellence. This third edition focuses on inland waterway security. Inland waterways are an important component of the nation’s marine transportation system, and are vulnerable to both natural and manmade hazards. Ongoing research projects at the Mack-Blackwell Rural Transportation Center at the University of Arkansas and at the Center of Transportation Safety, Security and Risk at Rutgers University investigate the resilience of the inland waterway system and the role inland waterways can play in emergency response.

Enhancing Transportation Resilience with Inland Waterways

Supporting Secure and Resilient Inland Waterways

More than 25,000 miles of the nation’s inland waterways are transporting millions of tons of cargo every day. The U.S. Army Corps of Engineers is responsible for nearly 12,000 miles of the most commercially important waterways – the Mississippi/Ohio River System, the Gulf Intracoastal Waterway, the Intracoastal Waterway along the Atlantic Coast, and the Columbia-Snake River System in the Pacific Northwest. The inland waterway transportation system is used to transport approximately 20% of the nation’s coal, 22% of U.S. petroleum, and more than 60% of the nation’s farm exports.

Disruption to the inland waterway transportation system can result in significant economic loss. In a CBS News article published in May, the Port of New Orleans’ CEO estimated that closing the Mississippi River for just one day would result in an economic loss of $300M. Because much of the cargo shipped by barge is used as raw materials for other industries, disruptions in barge transportation results in production disruptions and economic losses throughout the country. Lynn Muench of the American Waterways Operators recently stated that the river closures and restrictions due to the May 2011 flooding “situation is akin to tearing down all the bridges across the Mississippi River to the trucking industry.” A typical tow is made up of fifteen barges, each capable of carrying approximately 60 truckloads. Rerouting disrupted cargo without overwhelming an already congested highway system presents a significant challenge.
Researchers at the Mack-Blackwell Rural Transportation Center are investigating the transportation infrastructure along the Mississippi River, including locks, dams, bridges and rail, and its reliability in allowing for the movement of goods for domestic consumption and export. The primary goal of this work is to identify a long-term allocation of limited government resources towards the improvement of vulnerable infrastructure components needed to maintain the fundamental operation of our nation’s inland waterway supply chain. Interestingly, many of the commodities (e.g. grains) transported along the waterway have a limited window of time in which they can be can sold and consumed. Therefore, disruptions of any kind often call for an expedited movement of these goods to their final destination. In order to account for this, the decision models explicitly allow for the movement of goods amongst multiple modes of transportation (e.g. barge and rail).

In addition to the challenges posed from perishability considerations, the team is interested in modeling the fact that the objectives of a human adversary may change over the span considered in a strategic plan. For example, an enemy with the original intent to destroy the most symbolically important element of the transportation network (e.g. major bridge or dam) may modify their objective in response to actions taken by government to reduce that specific element’s vulnerability. As a result, the researchers are working on capturing a so-called adaptive adversary in their mathematical models to understand how a more sophisticated enemy impacts the way to protect against the disruption of goods along our waterways.

MBTC Researchers: Edward A. Pohl, Ashlea R. Bennett, Chase Rainwater, Scott J. Mason

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Research teams at the Mack-Blackwell Rural Transportation Center (MBTC) at the University of Arkansas and the Center for Transportation Safety, Security & Risk (CTSSR) at Rutgers University are working to mitigate economic and societal losses by providing guidance on how disrupted cargo should be prioritized and moved off the rivers. They are developing a prototype decision support system that integrates geographic information system (GIS) technology and computer-based freight movement models to provide timely knowledge and awareness of what cargoes should be prioritized for offloading during emergency response and what infrastructure exhibits low resiliency in terms of modal capacity to potential attacks or natural disasters against inland waterway transportation systems. If a catastrophic disaster causes a shutdown on an inland waterway transportation system, the prototype system will address (i) how waterborne cargoes should be prioritized for offloading based on primary and secondary economic impacts and societal requirements and (ii) how prioritized freight should be offloaded and transported via rail and truck based on freight capacities.

The resulting decision support tool will enhance emergency planning capability for both government and maritime industry groups. According to Commander Carlos Torres, U.S. Coast Guard Domestic Ports Division, “Having available a decision support system that can support waterborne cargo offload prioritization and facilitate multimodal distribution of cargo would be very helpful.” Jeff Lillycrop, Technical Director for Navigation at the U.S. Army Corps of Engineer’s Engineering Research and Development Center (ERDC), commented on the wide range of potential applications for such a tool, and suggested that “the data framework and decision support tool developed by this project should be useful for other applications related to optimizing movement of freight through an intermodal system, thus optimizing waterway use.”


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Modeling Perishable Commodities and Adaptive Adversaries

In the wake of natural disasters, such as those seen recently in Haiti and Japan, it is imperative to understand the implications of potential disruptions on our nation’s transportation infrastructure. Moreover, with ongoing threats from enemies around the world, the ability of our network to be resilient in light of a targeted attack remains an active goal of our government.

MBTC Researchers: Edward A. Pohl, Ashlea R. Bennett, Chase Rainwater, Scott J. Mason

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**Sustaining Resilient Inland Waterways via Renewable Energy**

Inland water transportation can play an important role in the Nation’s sustainability effort. Water transportation has environmental and economic benefits, existing capacity, and low energy consumption. Inland and intracoastal waterways directly serve thirty-eight states and carry approximately 16% of the total domestic intercity freight as measured by tonnage shipped. Inland waterways are recognized as energy-friendly. The nearly two hundred active locks maintained by the U.S. Army Corps of Engineers to facilitate commercial shipping are operated primarily by gravity. Hydroelectric power, generated mostly from dams, provides nearly 20% of the world’s electricity and over 63% of its renewable energy.

The Department of Homeland Security’s Borders and Maritime Security Division (BMD) of the Science and Technology Directorate recognizes that renewable energy sources and power management can help achieve system efficiency, effectiveness, and resiliency. Inline with BMD’s interest in this area, a current NTSCOE project explores how renewable energy sources can be used to support inland waterway security and operations. In this project, the Mack-Blackwell Rural Transportation Center, partnered with the National Renewable Energy Laboratory, is exploring the feasibility of renewable energy usage within the nation’s inland waterway system.

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**Emergency Response via Inland Waterways**

Emergency operations plans generally assume that all standard means of transportation will be available and functional when an emergency occurs. However, the event that initiates the plan may disable emergency vehicles or destroy the roads and bridges that are vital to providing emergency response. As transportation security professionals prepare contingency plans for emergency response, it is important to recognize the resource offered by the nation’s inland waterways. For many communities, inland waterways can provide access to equipment and services when other means of transportation are unavailable. Inland waterways may be especially useful for rural emergency planners as they take an all-hazards approach to emergency planning across a large geographical area and with limited resources.

The goal of this Mack-Blackwell Rural Transportation Center project is to improve community emergency preparedness and disaster relief efforts by providing emergency planners with a method for evaluating the feasibility of incorporating emergency response via inland waterways into their contingency planning. The team has developed a Waterway Emergency Service (WES) index to measure the potential of individual counties to benefit from inland waterway emergency response. The WES index consists of seven factors, including: Accessibility to Navigable Waterways, Population Demand, Social Vulnerability, Risk of Disaster, Limited Access to Medical Services, Limited Access to Resources, and Limited Access to Transportation Modes.

Throughout history, barges have been used to provide emergency response services. During World War I, British troop casualties were evacuated via floating hospital barges. A floating power plant in one of the discarded hulls of World War I supplemented power generation for communities across the nation. More recently, in the wake of the January 2010 Haiti earthquake, tugs and barges participated in the vast international relief operation, carrying food, supplies and aid. The research team developed the WES index values for four states along the lower Mississippi River: Arkansas, Louisiana, Mississippi, and Tennessee. The map graphically depicts the WES index results in the four-state region by indicating with a color-coding scheme each county’s potential to benefit from inland waterway emergency response. The results showed that, among the 145 counties in this region that have access to the Mississippi River, more than 73% have at least medium level of potential to benefit from emergency response via this river.

The research to date has contributed a systematic planning strategy for utilizing the inland waterway transportation system to provide emergency response, and the first known measurable index to allow emergency planners to evaluate the feasibility of using inland waterways for emergency response in their community. Ongoing research is developing an optimization-based methodology to determine the number of barges required, and the best starting locations for them, in order to provide the best possible inland waterway-based emergency support.

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