



**2006 - 2008  
Projects Abstracts**

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## **1.0 Mississippi Research Initiative 2006 Projects (By University)**

### **1.1 Alcorn State University**

#### **Development of an Integrated Sensor System for Real-time Monitoring of Metabolites of Organophosphorus Chemical Warfare Agents, Pesticides, and E. coli in Food and Water**

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The Department of Homeland Security (DHS) has assigned high priority to the deterrence and prevention of terrorist acts, which threaten the security of American citizens and critical infrastructure. The focus of this project is to address this critical need by developing technology for a low cost, robust sensor system which will be deployed for three critical environments for monitoring against biological and chemical agents.

### **1.2 Jackson State University**

#### **All Hazards Emergency Operations Management System**

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A region must not only have the capacity to respond effectively in the short-term but must also have the ability to sustain coordination and control through the request for targeted ex-region response requirements, and to effectively transition to a joint response when ex-region and Federal response capabilities are brought to bear on plans; systems, skills and relationships must exist for local leaders to not only manage their own jurisdiction, but also to collaborate effectively regionally in incident management. This project focus on three specific areas: (1) automate All Hazards Incident Management System with GIS integration (2) applying remote sensing and geographic information systems technology to critical infrastructure protection (3) “Putting Mississippi on the map”; a homeland security community mapping.

#### **Disaster Response Intelligent System**

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Information technology decision aids and data fusion systems are revolutionizing decision making in operational scenarios. The JSU team is proposing to leverage these advances by developing innovative decision support aids useful for converting and fusing data to useable knowledge for DHS emergency response. Specifically, the JSU team will transition an existing analysis and fusion system developed from an on-going DOD program into a Disaster Response Intelligent System (DRIS). The system is designed to be interoperable with the Jackson State University proposal “All Hazards Emergency Operations Management System (ALLHAZ)” and/or any other open architecture system. The Disaster Response Intelligent System (DRIS) is designed to provide real-time analysis and decision support for the Department of Homeland Security and operational agencies in disaster response.

## **The Education, Operations and Workforce Development Initiative**

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The nation needs to improve its ability to rapidly deploy homeland security relevant science, technology, engineering and mathematics (STEM) knowledge to a wide range of stakeholders, from the leadership of national, state and local organizations to first and early responders, to the general citizenry and to the future workforce. This project will develop a hub and spoke model for Workforce Development among the colleges and universities in the DHS University Centers of Excellence (COE). COE universities would function as the 'hubs' of the homeland security related STEM (science, technology, engineering and mathematics) distribution network. This project will also produce an architecture and prototype for the rapid deployment of technology within the national K-12 thorough Post Graduate Education System infrastructure, and architecture and prototype for implementation of the enabling technology at the Homeland Security Operational Unit level.

### **1.3 Mississippi State University**

#### **Real-Time Identification and Monitoring of Barge-Carried Hazardous Commodities**

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In response to increased terrorist threats related to hazardous material movements on the U.S. inland waterway system, towing vessel operators and fleet area managers, at specified reporting points, are required to notify the U.S. Coast Guard's Inland River Vessel Movement Center of the movement of barges loaded with Certain Dangerous Cargo (CDC). The current reporting process is manual and cannot identify and monitor CDC loaded barges in real-time. The objective of this proposal is to develop and field test a prototype system that provides more accurate, uniform, and timely data on hazardous movements by barges, especially those certified as CDC, and to identify and report barges with potential security threats. The proposed system is expected to automatically track and monitor barges with CDC and communicate the real-time information to a data server.

#### **Real-Time Operations Support for Emergency Evacuations**

PI: Dr. Li Zhang - Email: [lzhang@engr.msstate.edu](mailto:lzhang@engr.msstate.edu) - Phone: 662-325-9338

Real-time traffic information gathering and management is one of the most important aspects of emergency evacuations operations, but one where scarce practical research has been conducted. This research proposes to improve the operations during a vehicular emergency evacuation by using newly developed real-time traffic information gathering technologies to assess traffic conditions and to detect incidents on the main evacuation routes. The ultimate goal is to create a system which emergency management agencies, and/or other public safety organizations, can rapidly deploy anywhere to help manage traffic operations during emergency evacuations.

### **Rapid Detection of Agriterrorism via Remote Sensing**

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Interruption of the agricultural food supply could be accomplished by widespread application of airborne bio-chemical agents (ABAs) to agricultural crops. Terrorists could utilize plant pathogens or existing, commercially available herbicides and pesticides that may be safely used in some crops but which would have catastrophic effects on others. There exists a strong need for a means to rapidly and accurately detect such an event, or the lack thereof in the case of a hoax. This project includes the design, implementation, and validation of an automated target recognition (ATR) system for utilizing hyperspectral imaging (HSI) data to detect when an ABA has been applied to an agricultural crop.

### **Assured Strategic Communications During Natural and Willful Disasters**

PI: Dr. Lori Bruce - Email: [bruce@ece.msstate.edu](mailto:bruce@ece.msstate.edu) - Phone: 662-325-9848

The objective of this proposal is to develop a strategic plan for building, operating, and maintaining a robust, national emergency communications system that will assure reliable communications during disaster management operations, improve preparedness, and ensure interoperability. The proposed strategic plan will include risk and economic viability assessments, identification of critical systems and technologies, and development of operating principles that are necessary for assured communications during future national emergencies. This proposed research program will take advantage of the Office of Interoperability and Compatibility's SAFECOM and RapidCom initiatives in devising strategies for a highly reliable communications (both public and private) infrastructure during disaster management. The technology will be developed taking into account the existing and emerging standards so as to provide ease of interoperability and upgradeability.

### **Capturing Hurricane Katrina Data for Analysis and Lessons-Learned Research**

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Hurricane Katrina represents an unparalleled opportunity for homeland security research and study. During this event of national significance, the importance of geospatial data was demonstrated during the search, rescue and recovery efforts. The Mississippi Geographic Information System community volunteered countless hours in the weeks following Katrina, generating thousands of GIS, remote sensing and map products for use by local, state and federal agency personnel. However, the lack of a **central archive** for geospatial information presents a lost opportunity for understanding how these services could be improved for future events. For most major catastrophic incidents, the acquisition, management and archive of critical data does not occur in a coordinated, organized manner. Instead, various agencies that have operational responsibilities acquire and hold data that pertain to their mission without the mandate or funding to share those data to a central archive. Data held by individual agencies is maintained for varying lengths of time and is then either discarded or written out to a permanent storage media. Without a central archive to hold the entire collection of data from all agencies the full understanding of response efforts to any incident will be very difficult.

## **Semantics-Driven Knowledge Discovery System for Wide Area Monitoring of Electric Power Grid**

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A new innovation related to **critical infrastructure protection** and **cyber security** for electric power systems would be to provide a well engineered human-machine interface that allows knowledge discovery for comprehensive wide area monitoring across the State of Mississippi and the southeastern part of the United States. This would permit the integration of data and information between electric utilities before an incident - allowing for detection of terrorist threats, prevention of cascading failures through remedial actions, and innovative solutions for restoration efforts.

### **Southeast Region Critical Infrastructure Protection Center Initiative**

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This proposal seeks to expand the current operational Center for Computer Security Research (CCSR) and its Department of Justice funded Forensics Training Center (FTC) with an end result of creating a Critical Infrastructure Protection Center (CIPC) at Mississippi State University. This proposal offers to expand current facilities to create a Southeast region Critical Infrastructure Protection Center which will provide training, awareness, testing, technical advisement, and emergency response capability. The CIPC will initially focus on cyber security, digital forensics, and biological agents during the first year of operation and will expand into a more comprehensive operation during years 2 and 3 which will address all critical infrastructure priorities as identified by PDD-63 and HSPD-7.

### **Analysis of WMD Materials in Waste and Storm Water Treatment Infrastructures in Southeastern US Cities**

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This effort focuses on the development of estimation tools and the required supporting data to predict the distribution and fate of a dispersed Weapons of Mass Destruction (WMD) material (radiological, chemical, or biological agents) in wastewater and storm water treatment and handling systems of the State of Mississippi, specifically, and in general, for any Southeastern US urban environment in the 24 to 96-hour period immediately following a dispersal event.

## **1.4 University of Mississippi**

### **Computational Tools for Water Security**

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The proposed research is to transfer the technology in the area of computational simulation of water infrastructures to DHS to strengthen its technological base for preventing, being prepared for, responding to, and planning to recover from major incidents on critical water infrastructures in general. The focus in the near-term, however, is on providing useful tools to the local homeland security personnel for them to make the best possible (compromised) decisions to meet the urgent need at the initial stages of major incidents of chemical spills in critical water

infrastructures. The newly developed technologies can also be used to identify the optimal designs of new water infrastructures and/or the plans for the improvements of the existing critical water infrastructures, so that they can be less vulnerable to major hazardous incidents and better prepared for and recovered from the chemical spill incidents if they do happen.

### **Nano-Particle Reinforced Composites for Critical Infrastructure Protection**

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This project investigates the use of the recent advancement in material, structure, and building technologies for the protection of critical infrastructures, which include governmental buildings, emergency response system (police station, fire house, hospital), oil and gas pipelines, power and communication transmission towers, etc., against terrorist threats, as well as natural disasters. The new structural/building technologies developed from this research can be used to improve the survivability of these structures. The findings, recommendations, and tools derived can become a part of the decision support system for local, state, tribal and regional leaders and emergency responders for better preparedness.

### **Specification, Validation and Verification of Imagery Products for Disaster Management and Response**

PI: Dr. Greg Easson - Email: [geasson@olemiss.edu](mailto:geasson@olemiss.edu) - Phone: 662-915-6687

The goal of this proposed project is to create a reference key designed to increase the utility of imagery products for disaster response. This reference key will describe the technical specifications for remote sensing data acquisition systems that are necessary to produce data products that address the functional requirements of the first responder community and the FEMA Essential Elements of Information.

### **Mississippi Groundwater, Surface Water, and Dam Inventory and Vulnerability Assessment**

PI: Dr. Robert Holt - Email: [rmholt@olemiss.edu](mailto:rmholt@olemiss.edu) - Phone: 662-915-6687

Mississippi groundwater and surface water (GW/SW) resources, including shallow aquifers, streams, dams, and reservoirs, represent “key resources” and “key assets” as defined by the Interim National Infrastructure Protection Plan (NIPP) of February 2005. We propose three interrelated tasks to 1) inventory Mississippi GW/SW resources and dams in a GIS spatial database which can be used for vulnerability assessment and to parameterize numerical GW/SW models for additional risk assessment and modeling and 2) assess the vulnerability of these resources to various threats, and 3) provide training to state agency end users of the GIS database and vulnerability assessment tools. The GIS databases and vulnerability assessments produced in this effort will be developed in coordination with and provided to sector specific agencies, including the Mississippi Department of Public Safety Office of Homeland Security, Mississippi Emergency Management Agency, and Mississippi Department of Environmental Quality (including the Dam Safety Division). Database and model training will be provided to end users of these products.

## **Simulation-Based Decision Support System for Water Infrastructural Security**

PI: Dr. Mustafa Altinakar - Email: [Altinakar@ncche.olemiss.edu](mailto:Altinakar@ncche.olemiss.edu) - Phone: 662-915-3783

Water infrastructures such as dams, levees, water control structures, etc. are critical infrastructures whose incapacitation/destruction may have a serious negative impact on our nation's security. We propose the development of a new "systems approach" for carrying out threat-risk vulnerability analysis of water resources and water-related infrastructures based on robust, state-of-the-art, realistic two-dimensional (2D) numerical simulations. The proposed approach yield spatial variability of solved variables and various criteria computed by 2D numerical models, and thus eliminates the deficiencies of the currently used one-dimensional approach, which is neither sufficiently reliable nor provides enough information for a detailed damage analysis. The present proposal also involves development of innovative spatial risk and uncertainty analysis methods and procedures making use of the rich level of spatial information provided by two-dimensional approach.

### **1.5 University of Southern Mississippi**

#### **A Simulation Environment for Planning, Training, and Assessment of Emergency Response and Evacuation Capabilities at High Consequence Sports Events**

PI : Dr. Lou Marciani - Email : [lou.marciani@usm.edu](mailto:lou.marciani@usm.edu) - Phone : 601-266-5675

Effective emergency security management of large-scale spectator sports events is vital nation wide because of the potential for mass casualties and detrimental economic impact. The objective of this project is to develop a robust evacuation simulation system to evaluate and support emergency response, stadium evacuation operations, and the subsequent traffic flow at high consequence sports events. At the completion of this project, the new evacuation simulation system will be accessible to universities, professional and amateur sports organizations nationwide. This project has been endorsed by the NCAA and NFL.

#### **Real-time Detection of Chemicals and Biological Pathogens in Fluids**

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Our goal is to produce a simple-to-use, portable detector system that is able to sense in real time various pathogens and toxic chemicals that pose potential threats to both Mississippi and the nation as a result of acts of terrorism, accidental events, or acts of nature.

## **2.0 Regional Research and Operations Support 2006 Projects**

### **2.1 Projects Lead by Oak Ridge National Laboratory**

#### **Shelby County Sensor Fusion Center**

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The Shelby County Fusion Center (SCFC) will be deployed in a test prototype setting at the Shelby County Sheriffs Office in downtown Memphis, TN. The proposed research will offer the following innovative features of the SCFC: 1) A live sensor data sharing platform with integration of local area sensors, weather, and video. 2) Decision support from Hazard Prediction Assessment Capability (HPAC) plume modeling pre-configured and user-initiated will provide area responders with valuable advance knowledge before deployment. 3) A display platform based on area maps and topology will provide a common view of area resources, sensors, alerts, and plume computational results. Data from a mobile sensor platform deployed in the Shelby County and surrounding area will be brought into the system as well as the fixed chemical sensors at the Port of Memphis that provides additional detection capabilities without additional costs for near real time environmental condition within the surveillance area. On the other hand, the mobile platform will serve as a dynamically data feeding unit to evaluate the real-time response capability of the middleware in incorporating dynamically changing data items.

#### **Kentucky Intelligence Fusion Center (KIFC)**

PI: Dr. Cyrus Smith - Email: [smithcm2@ornl.gov](mailto:smithcm2@ornl.gov) - Phone: 865-574-5570

This project examines the requirements of the Kentucky Information Fusion Center (KIFC) in regard to the total homeland security threat profile from natural disasters to terrorist activities and what information and analysis is required to interdict, plan, and perform consequence management. The overall information architecture of this project will examine requirements, information flows and fusion, and will demonstrate an interoperable, standards-based implementation which will provide a seamless transfer of data between federal and state organizations, orderly transition from interdiction actions to consequence management actions, and common on-scene awareness throughout the responding communities. In particular, this project address six critical aspects of the homeland security threat profile; (1) weigh station information collection and analysis, (2) traffic camera observation and correlation, (3) HAZMAT shipment information analysis and correlation, (4) critical infrastructure information correlation, (5) Kentucky State Police (KSP) officer tracking and real-time streaming video capability, and (6) State-to-State and State-to-National information exchange. Information from each of these critical aspects will be collected at the KIFC and analysis, correlation, and exchange will be performed in order to demonstrate the feasibility and benefit of this information in interdiction, planning, and consequence management.

## **REALSIM: Data-Driven Simulation System for Training, Decision Support and Policy Evaluations**

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Local, state and regional officials need a capability to track material assets and key personnel; to evaluate the effectiveness of proposed and existing local, state and federal policies relating to preparedness and response to disasters; to improve training of personnel that must plan and respond to disasters; to improve investment strategies for dealing with planning and response; and to enhance response ability on real-time decisions by real-time situational awareness. This project will develop a system that will consist of a core modeling and simulation capability that will be able to determine the dynamic movement and tracking of material assets and people based on real-time data feeds to the system, simulate the dynamic movement and tracking of material assets and people based on simulated real-time data feeds to the system for the purposes of training, event planning, and policy evaluations, scale from local to state to regional to national needs, serve as dynamic information repository and as an archive of information, and provide a flexible range of user interfaces based on open standards to provide interoperability to existing and future applications and data systems.

## **Rule Set Automation in Support of Critical Infrastructure Protection (CIPRSA)**

PI: Dr. Richard Hale - Email: [halere1@ornl.gov](mailto:halere1@ornl.gov) - Phone: 865-574-8537

Responses to attacks or damage to critical infrastructure are frequently suboptimal because the responders do not have critical information, do not understand the environment, are not aware of important plans and lack the tools to guide their initial decisions thereby relegating their responses to reacting to events rather than guiding and directing events along a logical and responsive pathway. Current progress in automated decision making processes and systems provide substantial promise to solve this problem. Working closely with ORNL, Enterra Solutions LLC (Enterra) will provide the design and deployment of a repeatable solution for Critical Infrastructure Protection associated with the management of radiological releases at Oak Ridge National Laboratory. Specifically, Enterra will make use of radiological field measurement data from the HFIR sensor suite, along with the emergency operations rules and requirements embedded within the Laboratory's SBMS procedures for response to radiological emergencies.

## **High Performance Agent Based Topic Monitoring**

PI: Mr. Jim Treadwell - Email: [treadwelljn@ornl.gov](mailto:treadwelljn@ornl.gov) - Phone: 865-574-5530

The ability of policy makers to make effective decisions and take action in near real-time during a rapidly evolving disaster would be significantly enhanced if they could effectively monitor and correlate patterns and trends in communications across many media types and sources (TV, Internet News, Web logs, Messages, Call Center activity etc.). This remains a challenging problem because of the integration and processing requirements. ORNL, supported under contract by Psydex Incorporated, will develop and deploy a prototype system that demonstrates how multiple news data sources can be monitored, fused, correlated and analyzed in near real time for known and emerging threats to national security. Decision makers will be able to visualize threats with charts and geospatial views to identify patterns and trends in the subject

matter contained in various unstructured information sources. The system will be developed and deployed to a High Performance Agent Based cluster at ORNL.

## **2.2 Projects Lead by Regional Universities**

### **2.2.1 Tennessee State University**

#### **Cyber Security Projects**

PI: Dr. Tamara Rogers - Email: [trogers3@tnstate.edu](mailto:trogers3@tnstate.edu) - Phone: 615-963-1520

Cyber security remains a critical national vulnerability. At the local, state and regional level, products developed for the national security environment or the national homeland security environments are not necessarily adaptable, usable or affordable.

#### **Localization and Tracking System (LTS) of a Client Process for an Internal Wireless Network**

The objective of this research is to develop a secure wireless sensor network by designing and implementing a network security capability that is able to localize and track a network client in a static wireless network. This is achieved through the deployment of an array of directional antennae along the perimeter of a given wireless network.

#### **Wireless Authentication, Localization and Tracking System (WALTS) Using Radio Frequency Identification (RFID)**

Securing network hardware and/or software alone is insufficient to avoid exploiting the flaws in wireless networks. With this in mind, there exists a need to physically locate, track and authenticate users to identify offenders. The purpose of this research is to improve wireless network security by exploring the utilization of Radio Frequency Identifications (RFIDs) in the authentication scheme.

### **2.2.2 University of Tennessee**

#### **Data-Sharing Middleware for Information Dissemination among Heterogeneous Sources**

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A key growing need is to provide derived knowledge for empirical real-time situational awareness systems that span wide-area deployments (such as E911 systems in a metro area). Sharing of information to various agencies to and from emergency response teams requires delivery and display of accurate, time-sensitive data for rapid coordination and efficient operations. This project will develop a data sharing “middleware” that is able to handle multiple distributed data sources and dynamically changing data items, to assist in real-time information dissemination across multiple agencies for homeland security purposes. This will be used as a mechanism that is able to “translate” data from different sources into a repository maintained

with common templates so that data can be moved from originators to requestors in a generic manner.

### **2.2.3 University of Kentucky (via Kentucky Transportation Cabinet)**

#### **Integrated Threat Tracking and Information System**

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PI: Dr. Joe Crabtree (UK) – Email: [crabtree@engr.uky.edu](mailto:crabtree@engr.uky.edu) - Phone: 859-257-4508

The efforts outlined in this proposal provide an examination and assessment of the total homeland security threat profile for the Commonwealth of Kentucky and what information is required to interdict, plan, and perform consequence management. In addition, this project will develop a baseline system for the Commonwealth for tracking hazardous materials shipments on a real-time basis. This will enhance Kentucky's ability to monitor and track the shipment of high-value, high-risk freight on Kentucky's roadways.

### **2.2.4 Western Carolina University**

#### **Regional Emergency Planning Model for Continuous Disaster Mitigation Response**

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Deficiencies in interagency communication remain a key obstacle to successfully developing and implementing emergency plans during times of disaster. The Institute for the Economy and the Future at Western Carolina University, under contract to SERRI, will develop a Regional Emergency Planning Model (REPM) that will enhance interagency communication by designing a framework for effective disaster response; devise an effective methodology for considering human behavior in emergency situations that can be adopted and implemented throughout our nation; identify important policy considerations and best practices that must be examined for effective disaster responses; and disseminate the information to relevant practitioners.

## **2.3 Projects Lead By Regional Private Industrial Partners**

### **2.3.1 Saliant Solutions Corporation**

#### **Law Enforcement Regional Technology Assessment and Gap Analysis**

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The NPG's approach to enhancing homeland security focuses efforts on identifying and developing critical capabilities from the Target Capabilities List (TCL). A significant amount of effort and resources have been devoted over the course of the past few years to achieving targeted capabilities. While much has been accomplished, there remain a number of potential gaps in specialized law enforcement capabilities to achieve the objectives outlined in the NPG. This effort will survey the conformity of selected Law Enforcement agencies throughout the Southeastern region of the United States with the technology aspects of the Department of Homeland Security Target Capabilities List, utilizing a nationally-recognized law enforcement

professional, with the requisite law enforcement seniority and homeland security technology experience, to survey continuing law enforcement technology needs throughout the law enforcement community in the Southeastern United States.

### **3.0 Mississippi Operations Support Initiative 2006 Projects**

#### **Southeast Region Technology Transfer Network - Oak Ridge National Laboratory**

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There is not currently a comprehensive, region-wide mechanism in place to ensure that non-commercial investments in homeland security-related research and development are expeditiously transitioned into the private sector when positive prospects for viable commercial marketing exist. This project will establish a network of research universities, homeland security-related businesses and economic development organizations to support SERRI's objective of developing and implementing technology-based tools to improve public safety, readiness and disaster response. The near-term objective is to create the SERRI-sponsored network in a small group of contiguous states (Mississippi, Alabama, Tennessee, South Carolina and Kentucky), that already share common interests in infrastructure, homeland security and technology-based economic development, taking advantage of established relationships and initiatives where possible.

#### **Mississippi Technology Alliance and Outreach Program - Oak Ridge National Laboratory**

PI: Alan Liby - Email: [libyal@ornl.gov](mailto:libyal@ornl.gov) - Phone: 865-5764221

A principal SERRI objective is to develop and implement technology transition strategies that will convert research results into useable products and put them into the hands of the Homeland Security community. The Mississippi Technology Alliance (MTA) is uniquely positioned to fulfill this objective. It is a non-profit organization whose mission is to champion innovation and technology-based economic development for the state of Mississippi. With SERRI support, MTA will use staff and consultants to perform assessment steps and then call upon its well-established relationships with Mississippi universities and businesses to manage and complete the Technology Transition process.

## **4.0 Mississippi Research Initiative 2007 Projects (By University)**

### **4.1 Jackson State University**

#### **Multi-Purpose, Multi-Scale Storm Surge and Flood Forecasting for Planning and Preparedness**

PI: Dr. Shahrouz Aliabadi - Email: [saliabadi@jsums.edu](mailto:saliabadi@jsums.edu) - Phone: 601-979-1821

We propose the development of a fully integrated framework for the modeling and simulation of storm surge and flood events, with applicability at macro-, meso-, and micro-scale levels. This project is comprised of three components: (1) High-Resolution Storm Surge and Flood Modeling (2) Infrastructure Assessment and Resiliency, and (3) Disaster Preparedness and Response. The proposed (MSFP)<sup>2</sup> project employs existing flood, assessment and management (FAM) models and new FAM models developed by project partners, with intended application to the forecast of hurricanes in the Gulf Coast, flood inundation in associated coastal regions, infrastructure assessment, and disaster preparedness and response in an integrated framework.

### **4.2 Mississippi State University**

#### **Increasing Community Disaster Resilience through Targeted Strengthening of Critical Infrastructure**

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The resilience of communities against the force of natural disasters is a complex function of the community's socio-political and physical features. This proposal focuses on technical and engineering aspects of two of the most significant components of a community's physical resilience -- protection against threats posed by moving water, and the reconstitution of critical infrastructure to permit community recovery. In contrast to historical "case hardening" approaches, this research focuses on targeted solutions for key infrastructure components, as identified by the community or its designees. The research further considers only those solutions which may be rapidly deployed to achieve maximum benefit to the community, typically through the use of on-site materials, pre-engineered components, and innovative construction materials and techniques. Finally, the proposed research is limited to components that may be damaged by water currents or waves, though portions of the work may be easily extensible to disasters initiated by high winds or by strong ground motions.

#### **Secure Border Initiative Unattended Ground Sensor Networks**

PI: Dr. Patrick Donohoe - Email: [donohoe@ece.msstate.edu](mailto:donohoe@ece.msstate.edu) - Phone: 662-325-2180

The proposed research program is focused on enhancing the technologies utilized in UGS to improve the performance, endurance, covertness, maintainability and integration of these devices in the context of the overall SBInet security system. The objectives of the proposed research program include: (1) defining UGS technical requirements that are consistent with DHS SBInet needs; (2) conducting a detailed system engineering effort to enable the development of a

fieldable SBIUGS prototype system and (3) developing a SBI-UGS prototype that demonstrates new advancements in sensing performance consistent with DHS border security requirements.

### **Tools for Enhanced Mapping and Managing Post-Disaster Debris**

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The overall objective of this research effort is to enhance recovery from and resilience to large scale disasters by providing Mississippi state agency personnel, as well as Mississippi local governments with tools to enhance their ability to manage disaster related debris. The research outlined in this proposal will be carried out in four general thrust areas. **Thrust Area 1** – Use of Remote Sensing Data to Enhance Effectiveness of Debris Management. This activity will involve developing software and procedures for rapidly producing post-disaster maps containing information necessary to optimize management of debris piles. **Thrust Area 2** – Evaluation of an Alternative Treatment Technology for Selected Waste Streams. Land filling debris in unlined trenches is currently a major disposal mechanism. Numerous waste streams are prospects for segregation and alternative treatment. Certain problem waste streams (such as Copper Chromated Arsenic (CCA) treated wood) will be evaluated for disposal by low temperature pyrolysis. **Thrust Area 3** – Development of a Preliminary Debris Disposal Cost Projection Model. This model will be a first step toward providing MEMA and FEMA with an effective tool that will greatly simplify the process of providing relief funding to counties and municipalities. **Thrust Area 4** – Filling in Technical Data Gaps for Debris Management. This effort will receive extensive input from the Advisory Council to identify gaps in technical information with respect to the behavior of various components of debris piles to treatment. Data will also be collected to reduce uncertainties associated with the composition of large debris piles. Information needed to enhance the accuracy of the Preliminary Debris Disposal Model will be generated by this effort.

### **Utilization of Emergency Alert Systems: An Analysis of Oktibbeha County and MSU Systems**

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The purpose of this research is to understand the technical, operational and social aspects of emergency warning systems. The research objective is to perform comparative analysis of currently available emergency warning (or alerting) systems in Oktibbeha County, Mississippi. This analysis will highlight performance and capabilities of each system and help emergency management decision makers gauge the relative advantages and/or disadvantages of implement particular emergency warning systems. It will also serve as a primer in understanding the future implications for improving alert systems in the event of future emergencies impacting not only a region but public entities (such as universities). The research will aim to determine the overall effectiveness, usefulness, and cohesion with other emergency alert activities currently utilized by emergency response personnel in the field. The research will result in a report detailing the technical capabilities, operational considerations, and social implications of each system.

### 4.3 University of Mississippi

#### **Structural, Material, and Geotechnical Solutions to Levee and Floodwall Construction and Retrofitting**

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The extensive investigation and research of the *Interagency Performance Evaluation Taskforce* (IPET), as well as other teams organized by the NSF and ASCE, presented comprehensive insights for the failure mechanism of the levees and floodwalls in New Orleans areas during Hurricane Katrina. However, despite the authoritative nature of these reports, very little work was done to address the enhancement of integrity and resiliency of the nation's hurricane and flood protection system against future disasters. This research proposal addresses the application of a number of creative ideas that can provide new design principles and retrofitting techniques to enhance the integrity and resiliency of these infrastructures. We propose four interrelated technical avenues to address the vulnerability of the hurricane protection system and to improve the overall integrity and endurance of a reconstructed system. The tasks are divided into four tasks: 1) Geotechnical solutions for a resilient levee and floodwall system that includes improved floodwall section design to prevent overturning; piling and anchoring to increase the resistance to sliding; clay and bentonite apron to reduce the seepage; and levee back side protection to prevent erosion caused by overtopping; 2) Structural solutions to increase the lateral stiffness of the sheet pile system for load transfer to geotechnically reinforced stations, and to increase the bending stiffness of the buried sheet piles by cross-sectional design to prevent the formation of gap in front of the floodwall; 3) Material solutions that use a new generation of lighter, stronger, and non-corrosive materials, such as polymer composite sheet pile, polymer concrete, nano particle enhanced spray-on polymer coating, to improve the performance of the system in terms of strength, durability, and resistance against sabotage; and 4) Testing and validation of the tools, technologies, and systems developed in this research.

#### **Development of an Integrated Simulation Tool for Predicting Disastrous Flooding, Water Contamination, Sediment Transport and their Impacts on the Environment**

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In this proposal, developing an integrated computational tool and supporting databases is proposed for studying disasters caused by extreme flooding including 1) flood wave propagation under catastrophic conditions (dam/levee breach due to storm surge, high approaching flow, and terror attack); 2) water contamination due to industrial chemical spills, sewage/waste material, and debris resulted from flooding and hurricane impact; 3) dam/levee breaching, its associated sediment transport processes and breaching closure practices; and 4) flooding and contamination resulted environmental and ecological problems during and after the flooding. To make it possible for responders to study the overall situations as well as local details of the flooding effectively and quickly, all of the computational capabilities will be integrated into a Graphic User Interface to carry out numerical simulations, visualize the results and guide response and recovery efforts. Databases will be developed to archive the data collected to support the numerical simulations. Due to the nature of the computation tool, the data should cover a wide spectrum of information ranging from water infrastructure, hydrology, topography of potential flooding zones, contamination sources of industrial chemicals, sewage and waste treatment,

inventories of high risk dam and levee structures, etc. The developed technologies can also be used for evaluating losses in vulnerable flooding zones and making plans for improvements of the high risk water infrastructures, industrial chemicals, sewage/waste plants, etc., and enhancement of emergency response and recovery plans, so that the flooding zones will be less vulnerable to major hazardous and terror attack incidents and therefore have better resilience to natural and manmade disasters. It is anticipated that the computational tool can be applied by DHS personnel and responders to make well-informed and/or science-based decisions by studying the outcomes of flooding and mitigation measure scenarios in order to minimize the potential losses of lives and property as well as the short and long-term environmental impacts. The capabilities developed in one of the current SERRI project “Computational Tools for Water Security (CTW)” will be used in this research project.

## **5.0 Regional Research and Operations Support 2007 Projects**

### **5.1 Projects Lead by Oak Ridge National Laboratory**

#### **Community and Regional Resilience Initiative (CARRI)**

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CARRI is a regional program with national implications for how communities and regions prepare for, respond to and recover from catastrophic events. CARRI will develop the processes and tools with which communities and regions can better prepare to withstand the effects of natural and man-made disasters. In its first year, CARRI will create a standard for community resilience that is accurate, defensible, welcomed, and applicable to communities across the region and the nation.

A resilient community anticipates problems, opportunities and the potential for surprise. It reduces vulnerabilities to development paths, socio-economic conditions and identified threats. It responds effectively, fairly and legitimately. It recovers rapidly, safely and fairly. In addition to the key disaster management services that local governments provide, a resilient community recognizes that private sector and non-governmental organizations are critical components of the fabric of a community and play significant roles in community and regional disaster resilience. CARRI processes will integrate the full resource base of a community into planning, response, and recovery so that the community can get back on its feet as quickly as possible.

CARRI is presently working with two partner communities in the southeast: Gulfport, Mississippi and Memphis, Tennessee. A third community partnership will be launched on the southeastern seaboard in fall 2007. These “laboratory” communities will help CARRI define community resilience and test its emerging resilience framework. Using input from the laboratory communities, lessons learned from around the nation, and the guidance of ORNL-convened researchers who are experts in the diverse disciplines that comprise resilience, CARRI will develop a community resilience framework that delineates a process that communities can work through to become more resilient, and be so recognized. These objective metrics will help communities differentiate themselves from less-resilient communities and regions resulting in positive economic benefits. As part of developing the community resilience framework, CARRI will collect and make available practical tools to help communities assess their resiliency status and systematically take steps towards enhancement.

Once the southeast community programs are completed and the lessons and key attributes are integrated from these communities and others, CARRI will be available as a national resource for communities and regions that seek to improve their ability to withstand and recover from a catastrophic event.

## **5.2 Projects Lead by Regional Partners**

### **5.2.1 Savannah River National Laboratory**

#### **Resilient Homes**

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The resilience of a community – its ability to rapidly recover from a disruptive event, e.g., a hurricane, an earthquake, a flood – is critically dependent on the ability of individual homeowners to regain full use of their dwelling quickly. If they are not able to do so, the continued viability of the community is in doubt. In the case of New Orleans after Hurricane Katrina, the slow pace of rebuilding has severely hampered the overall recovery of the city. After Hurricane Camille, scores of communities in Mississippi and Louisiana never recovered and were abandoned. There is evidence that the same is occurring in the wakes of Hurricanes Katrina and Rita. The purpose of this project is to make community recovery more certain by dramatically speeding the return of the homeowner to the home.

#### **Resilient Forests and Forest Products Industries Summit**

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The forests and forest products industries are important parts of the life of the southeastern US. The forests make up a majority of the land mass in the region. Over half of the land in the southeastern US is timberland (and more than that is forested); two-thirds in Georgia and South Carolina. The forests and forest products industries are mainstays of the economy of the region annually contributing several billion dollars to the economies of each of the southeastern states. Approximately one in ten workers across the region earn their living through the forests, either directly or indirectly. The forests play an essential role in maintaining the healthy natural environment that the region enjoys, and so much of its tourism depends on. Thus, the resiliency of the forests and forest product industries – their ability to quickly recover from disruptive events – is an important component of the resiliency of the south itself. The purpose of this project is to convene a Summit is to develop and implement an Action Plan for the forests and forest industries. Throughout the presentations and breakout sessions, the Summit will focus on two key questions: 1) What should be done (e.g., preventive measures, immediate responses, and long-term recovery actions) to help forest owners and the forest products industries recover from disruptive events? and 2) How can forest owners and the forest products industries aid in the overall recovery of areas affected by a disruptive event? Participants will represent the full range of interests – the forest owners; the forest products industries; federal, state and local governments; interested non-governmental organizations; the environment; and other interested groups. At the conclusion of the Summit, the Steering Committee will finalize the Action Plan based on comments received and the results of the Summit itself. A follow-on Summit is planned for 2010 to evaluate implementation progress.

## 5.2.2 Y-12 National Security Complex

### **Fusion Center Interoperability Policy and Requirements**

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The Department of Homeland Security continues to focus on the development of fusion centers. As these centers are brought on-line and additional data resource management interfaces are incorporated into their operation, questions and concerns arise related to information policy and requirements. A policy and requirements review is necessary to identify issues related to current and future practices so they can be adequately addressed in operational plans and procedures.

Y-12 will engage in defining the policy and requirements portion of fusion center interoperability efforts pursued by the Southeast Region Research Initiative (SERRI). This includes reviewing the interoperability from the initial acquiring of information at the field level by the first responder through the information flow to the federal level. The breadth of the study will include the interfaces between the law enforcement and emergency services organizations such as the local, state, and federal Emergency Operations Centers (EOCs). The current SERRI projects developing new interfaces for the fusion centers in Kentucky and Tennessee will be used as test cases for preliminary information collection. Information should also be gathered by participating in state working groups related to the fusion centers in the southeastern states and EOC interoperability initiatives. This will serve to expand the depth of understanding of the issues.

Y-12 will establish a baseline in the area of information sharing/exchange and compare this to current policies/requirements. Consideration will also be given to future policies/requirements if time permits. The review will include the current fusion center data collection interfaces as well as the interface between other fusion centers and EOCs (interstate/intrastate/federal). A final report will be generated with the results as well as written monthly status reports and quarterly status briefings.

## 5.2.3 Middle Tennessee State University

### **Biosensor Research**

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Many sensors that detect biologically-relevant molecules, including DNA and viruses, are limited to the detection of a single target at a time, and most techniques require extensive sample preparation. An interdisciplinary team at MTSU has discovered an advanced optical sensor that can selectively detect picogram quantities of specific biomolecules (e.g. proteins) simultaneously, potentially sensing up to 10,000 different substances in a single scan. The scope of this research is to investigate and develop a biosensor for rapid detection of infectious agents and other environmental contaminants as a key component of community resilience following a natural disaster. The device can be applied to water quality, food safety, medical diagnostics, and biological threat detection. The project will enable device development to selectively detect

infectious agents in the micrometer size range. The initial research focus of the project will be on detection of water-borne bacteria and viruses, especially the Norwalk-like viruses (NLV or norovirus), which spread rapidly to epidemic levels in areas affected by hurricane Katrina.

## 6.0 Mississippi Research Initiative 2008 Projects (By University)

### 6.1 Alcorn State University

#### Lab on a Chip for Rapid Detection of Multiple High Consequence Human and Plant Pathogens

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The objective of the research project is the development a new technique for sample sorting, separation and sensing for simultaneous detection of DNA of eight (8) of the high priority pathogens. Current advances in micromechanical systems, nanotechnology, and microfluidics open many new possibilities for producing fast, sensitive, and inexpensive sensing systems for field applications. The synergy among these technological components is expected to improve response time, limit of detection, and sensitivity, and drastically reduce false positive and false negative responses. The proposed work is expected to advance the state of the art in pathogen detection by delivering an ultrasensitive, portable, and cost effective system for rapid detection of multiple high priority pathogens simultaneously. Potential pathogens (bacterial, viral, and fungi) to be investigated include: *Escherichia coli*, *Salmonella typhimurium*, *Salmonella enteritidis*, *Yersina enterocolitica*, *Yersina pestis*, *Listeria monocytogenes*, *Clostridium perfringens*, *Clostridium parvum*, *Ricin*, *Bacillus anthracis*, *Staphylococcus aureus*, *Clostridium boulinum*, *Norovirus*, *Tilletia indica*, *Phakopsora pachyrhizi*, and *Synchytrium endobioticum*.

### 6.2 Jackson State University

#### Development of an Ensemble Modeling System for the Simulation of Realistic Levee Overtopping Flows from Hurricanes

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The objective of this research project is to determine how storm surge interacts with levees. The research involves the development of a fully integrated ensemble modeling suite of linked numerical weather prediction, storm surge, and flood inundation models designed for simulating realistic unsteady surge overflow and wave overtopping. Namely, wind field, wind stress, hurricane track, central pressure, and maximum sustained winds shall be modeled using the model **WRF** (Weather Research and Forecast; sea surface elevation, wind forcing and coastal currents shall be modeled using the fully nonlinear, two-dimensional, barotropic hydrodynamic model **ADCIRC** (ADvanced CIRCulation Model); and the open-source, third-generation spectral wave prediction model **SWAN** (Simulation of WAVes in Near-shore area). The predicted wave profile shall be imported into a computational fluid dynamics (CFD) solver, **CaMEL**, which uses a hybrid finite volume and finite element method for solving incompressible free-surface flows. This system should close the existing gaps in the modeling of storm surge and flood events. This linking mandates the development of novel interface technology to facilitate data transfer between models and information cataloging techniques to store and access solution data. It is anticipated that this new integrate toolset will yield realistic water levels, wave heights, and erosive forces acting on the levee structure at various times,

which will facilitate more accurate research and testing related to the protection of earthen levee soils using software packages such as **PLAXIS** or **HAZUS-MH**. A subsequent advantage of this new toolset will be the capability of obtaining the necessary velocity vector and force data for analysis of other common levee failure mechanisms caused by hydraulic forces. The proposed toolset should result in a useful product for emergency management personnel and first responders.

### **Innovative Levee Strengthening and Testing under Full-Scale Overtopping Conditions**

PI: Dr. Farshad Amini - Email: [famine@jsums.edu](mailto:famine@jsums.edu) - Phone: 610-979-3913

This research project addresses innovative and cost effective methods to strengthen the crest and landside slope from erosive forces of overtopping flows. The research involves the design and development of a full-scale overtopping test-bed that has the capability to simulate both wave-only overtopping and combined wave and storm surge overtopping against each proposed method. The test-bed should be designed to allow for different levee surfaces to be installed and tested for erosion resistance and stability. The research requires that the test-bed be designed and developed to study the equivalence between steady overflow and unsteady overtopping. In addition, the research effort will develop and validate numerical computational models that can be used to support the optimal design of levee strengthening under realistic overtopping flow conditions. The activities of this research project should enhance the engineering community's understanding of alternative methods for strengthening of earthen levees. The research should result in improved ways to design and test innovative levee systems under full-scale overtopping conditions, which should have a very positive impact on the geotechnical and geophysical engineering community.

## **6.3 Mississippi State University**

### **Levee Assessment via Remote Sensing**

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The research objective of this project is to develop a suite of assessment tools and procedures and systems integration products that will assist levee owners and operators in finding potential levee problem areas. The proposed research will develop advanced methods, tools and techniques to rapidly assess the surface and sub-surface conditions of levees to identify the vulnerable zones in advance of a crisis. The research will also develop tools that can be used to classify levee segments according to their vulnerability against slope stability, under seepage, through seepage and flood overtopping mechanisms. Improved knowledge of the status of levees would significantly improve the allocation of resources to inspect, test, and repair the ones in most need. The proposed research and development effort will result in new methods and tools for improving that knowledge, and will give levee managers new tools to prioritize their tasks.

## **Assimilation of NEXRAD Radial Winds in a Regional Mesoscale Model and the Use of a Lagrangian Model to Estimate the Transport and Dispersion of Gases/Particles Over the Southern U. S.**

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The objective of this research project is to design, implement, evaluate, and make available to emergency managers or first responders a technique which will predict more accurate concentration amounts of released gases and particulates and their expected trajectories within a 30-60 min time period. The proposed technique represents a unique way of using local information acquired from NEXRAD Doppler Radars to better anticipate the characteristics of the spread of the release gasses/materials in time. Assimilating NEXRAD data to better represent the initial state of the atmosphere has been a topic of recent research studies. Since the trajectories, and therefore the transport and dispersion of released particles, are most influenced by the direction of the low level wind and boundary layer turbulence, it is hypothesized that a more accurate representation of the boundary layer winds can be achieved by assimilating local NEXRAD radial winds in mesoscale model predictions, which consequently will result in more accurate calculations of trajectories and concentration amounts by Lagrangian dispersion models such as HYSPLIT (Hybrid Single-Particle Lagrangian Integrated Trajectory). The results of this research are expected to improve emergency response activities relative to detecting the transport and dispersion of hazardous gases, toxic, chemical or biological materials released in the atmosphere. The proposed project should result in a useful product for emergency response teams, for National Weather Service (NWS), and for coordinating agencies such as Interagency Modeling & Atmospheric Assessment Center, National Atmospheric Release Advisory Center, and National Centers for Environmental Protection Agencies.

### **6.4 University of Mississippi**

#### **War Games for Flood Emergency Managers (WGFEM)**

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The objective of this research project is to develop a prototype system that can be used by flood emergency managers of state and federal agencies for operational real-time simulation, visualization and decision making. The research aims to achieve flood simulation and visualization at unprecedented frame rates by exploiting General Purpose Graphics Processing Unit (GPGPU) technologies. The developed tool will use readily available digital elevation maps (DEMs) directly as a regular Cartesian computational mesh. The user will be given the capability to review real-time simulation results in real-time both in two dimensions, as a map, and in three dimensions with texture rendering of the terrain and the water surface. To facilitate the decision making process, the user will be given the ability to probe into simulation results, change the viewing position and angle, zoom in and out, and make changes in the environment to represent the actions taken, such as modifying the topography to represent a line of sandbags. This research should result in the development of a prototype system that can be used in a cost-effective way for desktop exercises and personal training purposes. The products of this research are expected to improve training and planning for emergency response activities relative to flood related disasters. The proposed system can thus be used directly by emergency managers and

flood plain managers for operational studies before or during flood emergencies to study available options, to carry out desktop exercises with realistic simulation and visualization of the chosen scenario to train personnel.

### **Investigation of a Surge and Wave Reduction by Vegetation**

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The main objective of this research project is to investigate the effectiveness of wetland vegetation in mitigating hurricane and storm surges. The project will examine interactions among surge, wave and vegetation through laboratory experiments, field observations and computational simulations, and will develop and validate methods to quantify the reduction of surge and waves by various vegetation species under different storm conditions. The research will also address several high-priority research needs to support refinement of existing models and development of new models for frictional resistance and wave dissipation by vegetation. The research will also generate valuable datasets for use by coastal restoration and disaster mitigation organizations and authorities, such as US Army Corps of Engineers, Federal Emergency Management Agency, National Oceanic and Atmospheric Administration, US Environmental Protection Agency, US Department of Agriculture, and Mississippi and Louisiana Departments of Natural Resources, as well as academic communities.

### **Socio-Economic Resilience and Dynamic Micro-Economic Analysis for Large Scale Catastrophe**

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Little is known about how restoration of local economies should or could be targeted to enhance restoration of civic life and economic vitality within a region after a large-scale catastrophe. This scope of this project is to conduct economic analysis of what could be termed “micro-economies” that exist at the levels of neighborhoods, wards, communities, or within specific populations or social groups. The goal would be to provide guidance and understanding to local leaders, to identify centers or nodes within the economic fabric of a community, and to enhance planning for the economic restoration of communities after large-scale disasters. The key objective of the proposed research is to develop a methodology that can assist local governments and agencies to identify and understand the relationships among the people, businesses, industries and social organizations and networks that sustain a community’s socio-economic vitality. The significance of the study is that it would be the first to integrate survey-level, social network theory into an analysis of local socio-economic resilience after a large-scale catastrophe. The research will systematically assess the dynamics of micro-economic networks across an affected population in order to understand how, which, and why disaster communities recover. This capability will also allow planners to assess different post-catastrophe recovery and resilience scenarios through a dynamic simulation analysis. The methodologies and tools developed through this research project should allow local practitioners to assess their community vulnerabilities and to anticipate economic challenges for recovery from a large-scale catastrophe.

## 6.5 University of Southern Mississippi

### **Enhancing the Effectiveness of Local and Regional Communities in Planning and Training for Improvised Explosive Device Threats and Attacks on Sport Venues**

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The objective of the research project underlining this SOW is to address the needs for the development of affordable and advanced technological tools and methodologies to assist local and regional planners in preparing and responding to IED threats and attacks, especially on sports venues. The goal of this project is to set the foundation to enhance and integrate complementing but individual technologies and methodologies that have been successfully developed at University of Southern Mississippi (USM), Oak Ridge National Laboratory (ORNL), and Engineering Research and Development Center (ERDC) in order to establish an environment of rapid and efficient local and regional preparedness through planning and training to respond to IED threats and incidents in sports venues. The activities of this research project should increase the readiness of local and regional level planners and first responders in preparing for and responding to IED threats and attacks, especially those at sports venues.

## **7.0 Regional Research and Operations Support 2008 Projects**

### **7.1 Projects Lead by Oak Ridge National Laboratory**

#### **Sensorpedia**

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Sensorpedia is a concept for adapting Web 2.0 technologies (e.g., wikis, blogs, social networks, mashups, RSS alerts, streaming media) to achieve sensor information sharing across incompatible or autonomous systems. Based on the same underlying technologies that power popular web sites such as Wikipedia, Twitter, Google Maps, and FaceBook, Sensorpedia provides a “write-able” web site for communities of users who have sensor information to share. However, instead of networking users based on mutual personal interests, SensorPedia networks users and sensors based on mutual information interests. The SensorPedia user interface is designed using Web 2.0 best practices and allows extension by third-party developers using a flexible modular framework. The Sensorpedia web services API is designed to accept and publish data using popular standards such as streaming media, Google Earth KML, and GeorSS. The API permits third party “gadgets” to connect sensors and applications to Sensorpedia.

### **7.2 Projects Lead by Engineering Research and Development Center (ERDC)**

#### **Rapid Repair of Levee Breach**

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This research will generate a novel device and approach that has never been attempted for rapid levee repair. The device is a specialized fabric tube that can be moved to a breach site by helicopter or barge and then inflated with water and air. Referred to as PLUGs (Portable Universal Lightweight Gaskets), the tube should greatly reduce the required logistics footprint for levee repair. Provided the concepts are proven out with further testing on a full-scale level, the new technologies under development to refine deployment methods should allow helicopters or barges to transport and deploy all of the system elements. The full-scale system should be capable of “sealing” a man-made or natural breach in a matter of hours. Given the many miles of levees along the Mississippi River and in the rest of the US, technologies being developed on this project could be very important to the nation as a whole; and in areas with historic record floods from levee breaches, such as in Mississippi, Louisiana, and Iowa, such a technology could help meet critical needs for faster, more resilient response to flooding situations.