



# 2006 - 2009
# 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**

PI: Dr. Yolanda Jones - Email: ychemist53@aol.com - Phone: 601-877-6439

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 (Phase I)**

PI: Mr. Edward Collins - Email: edward.r.collins@jsums.edu - Phone: 601-979-1486

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 (Phase I)**

PI: Dr. Gordon Skelton - Email: gskelton@c-did.com - Phone: 610-979-5016

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**

PI: Mr. Edward Collins - Email: edward.r.collins@jsums.edu - Phone: 601-979-1486

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**

PI: Dr. Mingzhou Jin - Email: mjin@ise.msstate.edu - Phone: 662-325-3923

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 - 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**

PI: Dr. Lori Bruce - Email: bruce@ece.msstate.edu - Phone: 662-325-9848

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 - 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**

PI: Dr. David R. Shaw - Email: dshaw@gri.msstate.edu - Phone: 662-325-9575

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**

PI: Dr. Nicholas Younan - Email: younan@ece.msstate.edu - Phone: 662-325-7397

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**

PI: Dr. Rayford Vaughn - Email: vaughn@cse.msstate.edu - Phone: 662-325-7450

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**

PI: Dr. R. T. Jubin - Email: jubinrt@ornl.gov - Phone: 865-574-4934

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**

PI: Dr. S. Y. Wang - Email: wang@ncche.olemiss.edu - Phone: 662-915-7788

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 (Phase I)**

PI: Dr. Alexander H.D. Cheng - Email: acheng@ncche.olemiss.edu - Phone: 662-915-3783

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, and 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 (Phase I)**

PI: Dr. Greg Easson - Email: 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 - 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 (Phase I)**

PI: Dr. Mustafa Altinakar - Email: 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

**Real-time Detection of Chemicals and Biological Pathogens in Fluids (Phase I)**

PI: Dr. Gordon Cannon - Email: gordon.cannon@usm.edu - Phone: 601-266-4221

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.

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

PI : Dr. Lou Marciani - Email : 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 causalities 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.

# 2.0 Regional Research and Operations Support 2006 Projects

## 2.1 Oak Ridge National Laboratory

### Shelby County Sensor Fusion Center

PI: Dr. Hamilton Hunter - Email: hunterht@ornl.gov - Phone: 865-574-6297

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 - 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**

PI: Dr. Kalyan Perumalla - Email: perumallaks@ornl.gov - Phone: 865-241-1315

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 - 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 - 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 Tennessee State University

**Cyber Security Projects**

PI: Dr. Tamara Rogers - Email: 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.

## 2.3 University of Tennessee

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

PI: Dr. Hairong Qi (UT) - Email: hqi@utk.edu - Phone: 865-974-8527

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.

## 2.4 University of Kentucky (via Kentucky Transportation Cabinet)

**Integrated Threat Tracking and Information System**

PI: Mr. Brian Beaven (KTC) - Email: brian.beaven@ky.gov – Phone: 502-382-6995
PI: Dr. Joe Crabtree (UK) – Email: 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.

## 2.5 Western Carolina University

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

PI: Laura Meyers - Email: lbmyers@email.wcu.edu - Phone: 828-227-3723

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.

## 2.6 Saliant Solutions Corporation

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

PI: Joe Fitzergerald – Email: joef@saliantsolutions.com – Phone: 423-618-5296
PI: Lee Reese - Email: reesediamond@comcast.net - Phone: 240-422-9115

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
PI: Alan Liby - Email: libyal@ornl.gov - Phone: 865-5764221

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 - 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, Mult-Scale Storm Surge and Flood Forecasting for Planning and Preparedness

PI: Dr. Shahrouz Aliabadi - Email: 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 $(MSFP)^2$ 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

PI: Dr. Isaac L. Howard - Email: ilhoward@cee.msstate.edu - Phone: 662-325-7193

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 - 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**

PI: Dr. Charles A. Waggoner - Email: waggoner@icet.msstate.edu - Phone: 662-325-9848

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. T**hrust 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**

PI: Mr. Dallas Breen - Email: dallas.breen@ssrc.msstate.edu - Phone: 662-325-8115

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

PI: Dr. Alexander H.D. Cheng - Email: acheng@ncche.olemiss.edu - Phone: 662-915-3783

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

PI: Dr. Yafei Jai - Email: jia@ncche.olemiss.edu - Phone: 662-915-7783

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 Oak Ridge National Laboratory

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

PI: Mr. Warren Edwards - Email: edwardswc@srnl.doe.gov - Phone: 865-574-8277

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 Savannah River National Laboratory

### Resilient Homes

PI: Dr. John Plodinec - Email: john.plodinec@srnl.doe.gov - Phone: 803-725-1134

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

PI: Dr. John Plodinec - Emails: john.plodinec@srnl.doe.gov - Phone: 803-725-1134

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.

## 5.3 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.

## 5.4 Middle Tennessee State University

**Biosensor Research (Phase I)**

PI: Dr. Andrienne Friedli - Email: afriedli@mtsu.edu - Phone: 615-898-2071

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

PI: Dr. Yolanda Jones - Email: ychemist53@aol.com - Phone: 601-877-6439

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, *Staphyloccoccus* aureus, *Clostridium* boulinum, *Norovirus*, *Tilletia* indica, *Phakopsora* pachyrhizi, and *Synchytrium* endobioticum.

## 6.2 Jackson State University

### All Hazards Emergency Operations Management System (Phase II)

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During Phase I of the project, the researchers developed a disaster response common operating picture for use by first-responder data collection and research teams associated with fire, police, and emergency management teams; scalable, easily usable, and portable. The resultant system, called All Hazards Emergency Operations Management System (ALLHAZ), has been developed and demonstrated. The objective of Phase II is to integrate the ALLHAZ tool with an advanced tool that will provide first responders access to additional information that will enhance emergency management operations. Efforts during Phase II will result in the development of a tool similar to Virtual Alabama that will be a "Virtual Mississippi" Google Earth Enterprise system that will be integrated with ALLHAZ.

### Disaster Response Intelligent System (Phase II)

PI: Dr. Gordon Skelton - Email: gskelton@c-did.com - Phone: 610-979-5016

The objective of this project is to develop an intelligent decision-support system for use by emergency operations for search and rescue, risk assessment, evacuation planning, and resource management. The primary function is to assist first responders during emergency events to ensure quick and synchronized

efforts to help reduce the risk to property and life. The application (Disaster Response Intelligent System (DRIS)) will provide a common operating picture that will enable users to quickly comprehend enormous amounts of data. DRIS will provide key GIS layers such as topography, roads, socioeconomic data, critical infrastructure, shelters, and transportation corridors that are necessary to assist in response operations. The application will geographically fuse high-resolution imagery, GIS data layers, population and demographic parameters, sensor data, wireless handheld devices, GPS data, intelligence engines and other calculated data. The system will allow users to quickly view assets that are available and to filter those assets based on the type of catastrophe. The system may be used to: i) provide rapid analysis and reporting; ii) conduct planning and training exercises using simulated data; iii) assess risk to community and infrastructure; iv) develop route recommendations for the disaster areas; v) help evaluate the scale of a disaster; and vi) identify at-risk populations.

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

PI: Dr. Marvin Watts - Email: marvin.d.watts@jsums - Phone: 601-979-3302

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 - 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

**Real-Time Identification and Monitoring of Barge-Carried Hazardous Commodities (Phase II)**

PI: Dr. Mingzhou Jin - Email: mjin@ise.msstate.edu - Phone: 662-325-3923

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 (IRVMC) of the movement of barges loaded with Certain Dangerous Cargo (CDC). The current reporting process is manual (i.e.; phone, fax, or email) 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. An information fusion system will be developed to analyze the collected real-time data and other information, detect anomalies, and identify any potential security threats. The identified anomalies and threats will be communicated to various stakeholders with a visual interface. The system will also automate the reporting process for barge companies and electronically feed data to the IRVMC. The automation will help the barge companies and the Coast Guard to reduce the workload. The proposed research is relevant to the missions of the U.S. Department of Homeland Security (DHS) and Mississippi Office of Homeland Security (MS OHS) to prevent and deter terrorist attacks and to protect against and respond to threats and hazards to the nation and the State. The system will benefit homeland security community, first responders, local law enforcement personnel and business by providing timely and accurate barge information to make quick and right decisions in disasters involving CDC movement on the inland waterway. Five major tasks were completed in the first phase of the project. Those tasks were: 1) Summarize the state-of-the-practice, requirements and restrictions for inland waterway barge commodity tracking, 2) Review CDC flows on the Mississippi River and Tennessee-Tombigbee River Systems to determine candidate locations for the field test, 3) Evaluate potential commercial off-the-shelf (COTS) solutions for identifying and tracking barge commodities, 4) Develop software for test server and web-based applications for data input, integration, analysis, and display, and 5) Acquire and initially test the prototype system, including the tags, sensors, antennas, global positioning systems, and software on one barge. The team will conduct three major tasks in the

second phase: 1) Evolve the software to an operational version, 2) Test the overall system in an operational environment, and 3) Embed port security using automatic identification system technology. The barge tracking system (BTS) web service will use secured data transmissions to provide information and analysis results to system users. Mississippi State University (MSU) and Oak Ridge National Laboratory (ORNL) will develop the proposed system in cooperation with Port Authorities, U.S. Coast Guard, Mississippi Department of Transportation (MDOT), MS Office of Homeland Security, and individual barge companies.

**Rapid Detection of Agriterrorism via Remote Sensing (Phase II)**

PI: Dr. Lori Bruce - Email: bruce@ece.msstate.edu - Phone: 662-325-9848

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. This approach would be similar to that of the Oklahoma City bombing, where commonly available agricultural products were utilized because they were easily accessible and highly effective in delivering the desired result. Depending upon the type, the ABA could impact not only the current crop, but also have long residuals that would affect crops in subsequent years. 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 automated target recognition (ATR) system for utilizing hyperspectral imaging (HSI) data to detect when an ABA has been applied to an agricultural crop. Validation will be conducted using HSI data of crops that have been exposed to various concentrations of ABAs. Emphasis will be placed on agricultural crops that are common throughout the state of Mississippi and on pesticides and other toxic industrial chemicals with high potential for use in terrorist activities. Two primary outcomes are expected from this project: i) Prototype ATR system software that can be used with a handheld HSI sensor for detecting and characterizing applications of ABAs to agricultural crops; and ii) Proof-of-concept study report, where the prototype ATR software has been used in conjunction with handheld HSI sensors to detect ABAs of interest. A key advantage of the proposed system is that it could be used to detect the application of an ABA to crops several days before crop injury is visible to the human eye, providing a critical lead time in first response. Often, there is no visible indicator that the ABA has been applied to crops. In these cases, HSI technology can provide critical intelligence that would otherwise be unavailable.

**Capturing Hurricane Katrina Data for Analysis and Lessons-Learned Research (Phase II)**

PI: Dr. David R. Shaw - Email: dshaw@gri.msstate.edu - Phone: 662-325-9575

Hurricane Katrina was the first disaster of great magnitude where the widespread use of GIS and recent advances in technology made it possible to use GIS in a variety of recovery operations for a sustained period of time. The scale of this disaster also has made it possible to look back and evaluate how GIS was used. The Phase I effort identified several gaps in geospatial data and analytical processes for hurricane disaster preparedness, response, and recovery. Three major lessons learned were: 1) Successful implementation of geospatial solutions was greatly hampered by dispersed and inaccessible data; 2) Knowledge of responder cultures is a critical element for defining standardized and customized geospatial products that aid effective disaster

management; and 3) Rapid delineation of damage severity and extent is critical for effective disaster management. Phase I survey findings of the Katrina Lessons Learned Project proved that there is a wide disparity of "readiness" for geospatial data among first responders at local, state, and federal agencies. Thus the key research objective in **Phase II** is to expand upon the Phase I understanding of geospatial information known to be required to enhance disaster response and recovery and regional resilience. To accomplish this the project team will: 1) develop a web-based Geospatial Readiness Self Assessment Tool (GRSAT) that enables communities/regions to be self-trained on the capabilities of geospatial information as well as to assess their geospatial vulnerabilities with respect to the status of the high-priority geospatial data layers identified in Phase I; 2) identify the geospatial requirements of response agencies to develop recommendations for standard geospatial products; and 3) implement a mirror data repository of the Katrina Lessons Learned Database (KLLD) including development of plan to scale the mirror site for the southeast region, and identify required inputs for geospatial analytical tools.

**Southeast Region Critical Infrastructure Protection Center Initiative (Phase II)**
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The first phase of the project focused on training that was conducted by university-based experts in a particular field of relevancy to protection and preparedness. During FY 2008, the Critical Infrastructure Protection Center Initiative (CIPC) was able to leverage an NSA grant opportunity to purchase and put in place a one-of-a-kind control system security laboratory (also known as a SCADA security laboratory). By acquiring this laboratory, the CIPC began a strong, nationally recognized research program in vulnerability identification within industrial control systems and recommendations on mitigation strategies. Phase II of the project will focus on several tasks that utilize the resources of the SCADA security laboratory. The first task is to develop an appropriate test bed from which the CIPC can conduct vulnerability analyses of commercial software used within control system environments. A second task is to investigate the development of tools to mitigate the flaws discovered by the first task. To this end, encryption strategies will be developed to assist in control system protection. A third major task is to develop tools to forensically capture evidence of malicious activity within control system environments.

**Analysis of WMD Materials in Waste and Storm Water Treatment Infrastructures in Southeastern US Cities (Phase II)**
PI: Dr. R. T. Jubin - Email: jubinrt@ornl.gov - Phone: 865-574-4934

This project responds to the need to protect critical infrastructure and offers clear and important relevance to the Department of Homeland Security (DHS) mission. 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 stormwater 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. Since the purpose of wastewater and storm water treatment and handling systems is to protect human health and the environment, this work contributes to protecting the ability of these systems to accomplish their purposes by

understanding the fate and distribution of WMD material malevolently introduced into these systems. This enhanced understanding will integrate with other efforts to predict and model the initial material release and lead to improvements in emergency planning efforts to reduce immediate and long-term risks to the ability of these important critical infrastructure elements to protect the environment and human health. In addition to providing a means to help protect and manage this vital urban infrastructure, it also supports the planning efforts to reduce immediate and long-term risks to the environment and human health through optimal monitoring and detection, development of mitigation plans, emergency response planning, and post event reconstruction. In the case of a release from a WMD dispersal device it is likely that large urban areas will be contaminated. It is also likely that a significant fraction of the dispersed materials will move into the stormwater and/or sanitary wastewater systems as a result of precipitation, initial decontamination efforts, or attempts to clear pathways for ingress or egress from affected areas. In addition to the run-off of materials, materials may be introduced into the sanitary systems from individual decontamination efforts. The work conducted in this project seeks to utilize scenarios of maliciously introduced WMD materials, local urban conditions during and after a dispersal event as well as imbedded models for uptake by the structural, biological, and other materials in the system to predict this fate and distribution. Year-1 activities culminated in the development of a suit of models (SIMFATE) that can be used to simulate and predict the fate and transport of WMD materials in urban wastewater and stormwater treatment systems. The following Year-2 activities are designed to attain a Technology Readiness Level (TRL) of 6-7 for the SIMFATE suite of tools: 1) Expand and integrate the methodologies to provide fate and transport predictions for additional radiological and biological WMD agents through a) simplification and streamlining of methodology, b) validation of software, and c) expansion of WMD capability; 2) commercialization of developed methodology; and 3) investigation of short-cut prediction methods for estimation or extrapolation of fundamental property information for use in SIMFATE.

**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.

**Assemilation 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.**

PI: Dr. Haldun Karan - Email: karan@hpc.msstate.edu - Phone: 228-688-7141

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

**Nano-Particle Reinforced Composites for Critical Infrastructure Protection (Phase II)**

PI: Dr. Alexander H.D. Cheng - Email: acheng@ncche.olemiss.edu - Phone: 662-915-3783

This project investigate the use of the recent advancement in material, structure, and building technologies for the protection of critical infrastructures, which may include governmental buildings, emergency response system (police station, fire house, hospital), oil and gas pipelines, power and communication transmission towers, etc., against terrorist threats, fire hazard, 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. The research takes the multi-pronged and integrated approach, simultaneously addressing four research areas: 1) Material Research [new materials ranging from the carbon nanotube and graphite platelets reinforced plastics to nano-clay and polymer enhanced concrete]; 2) Structural Component Research [innovative structural components and subsystems ranging from grid and foam stiffened panels and tubes to elastomer coated walls]; 3) Structural System Research [the dynamic response and damage of small and large buildings and structures exposed to blast/impact (e.g. terrorist), fire, and severe natural (e.g. tornado, hurricane, and earthquake) hazards]; and 4) Decision Support System Research [tools to generate different threat scenarios, for defining defense and protection barriers, for recommending retrofitting measures, and for evacuation planning]. The outcome of the research will reach a technology readiness level (TRL) between 5 (component and/or breadboard validation in relevant environment) and 6 (system/subsystem model or prototype demonstration in a relevant environment).

**Specification, Validation and Verification of Imagery Products for Disaster Management and Response (Phase II)**

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Geospatial information systems are a core asset for situational awareness before, during and after a natural disaster. The data and information used by geospatial information systems may be derived from both map and imagery sources. Imagery obtained via satellite and aircraft mounted sensors has the ability to provide rapid access to the information needed to assess the situation prior to, during, and after a disaster. The use of imagery and imagery-derived products is very robust for some hazard types such as fires but has not been used to its full potential for other hazards such as hurricanes, due to several factors that include the complicated nature and scope of hurricane events, the lack of standard imagery products for pre-determined response needs, and a lack of understanding of the positional and content accuracy of the information. Complicating this lack of understanding is a gap between first responders and response agencies and scientist and technologists who use technology to provide much needed products for disaster response. Disasters such as hurricanes, tornadoes, earthquakes, fires, chemical attacks, bombings, and bioterrorism, pose unique challenges to disaster response organizations. Each type of disaster requires a tailored suite of data and information to make informed timely decisions. Highly localized events, such as the World Trade Center incident, require high spatial and high temporal resolution data, while wide area events such as hurricane Katrina require a variety of resolution ranging from regional, high temporal resolution, coarse spatial resolution remote sensing data to large area coverage, high-spatial-resolution data sets. In order to address different types of events, data products designed for specific events are desired. To partially address this problem, FEMA has completed the development of a set of Essential Elements of Information (EEI) that specify functional requirements for critical information concerning a variety of hazard types. While this information describes the need in a functional manner there is no defined, integrated approach to developing this information; much of which can be derived from measurements taken by remote sensing systems. The proposed project will use a systems engineering approach to determine methods that will optimize the use of remotely sensed data to this complex integration problem. This systems engineering function includes determining user needs, selection and mission assignment of appropriate imagery source, validating and verifying the imagery, and researching and developing advanced data exploitation methods to extract information from imagery and distribute the needed product in a reliable, consistent manner achievable within the existing technology structure for incident response. The goal of the proposed project is to create a system designed to increase the utility of imagery products for disaster response. This system 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. This will be accomplished by a thorough analysis of information needs, evaluating the appropriate imagery sources against operational needs of response agencies, and developing advanced methods of information extraction and distribution to meet specific needs of incident response teams. For this project the team intends to focus on the use of high spatial resolution, digital panchromatic and multispectral remote sensing data. The project team will review the EEI and determine, in partnership with first responders, the ability of high resolution digital remote sensing imagery to address the functional requirements of the specific EEI.

**Simulation-Based Decision Support System for Water Infrastructural Security (Phase II)**

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Failure of dams and levees could not only result in disruption of the vital services provided by these critical infrastructures but also lead to highly dynamic, catastrophic floods with potential to cause loss of life, urban and agricultural property damage, environmental degradation, and cascading failures in other critical sectors. Currently about half of the 11,881 high-hazard dams, and 13,549 significant-hazard dams do not yet have an Emergency Action Plan (EAP). The 1st Phase of the DSS-WISE project was, therefore, motivated by the urgent need to develop a new generation of numerical models and decision support tools to carry out this task in time- and cost-effective manner. It also aimed at reconciling engineering practice of flood simulation and flood damage analyses with the currently available state-of-the-art numerical methods, GIS and remote sensing technologies, and information systems.

The integrated environment delivered by the 1st Phase of the DSS-WISE Project combines a two-dimensional first-order upwind numerical model, CCHE2D_FLOOD, that can accurately simulate dam/levee break floods with mixed flow regimes and wetting and drying over a complex geometry, with a collection of GIS-based decision support tools to evaluate potential loss-of-life, and urban and agricultural damage by interfacing numerical results with various geospatial socioeconomic data layers such as population distribution, building stock, agricultural exploitation data, critical infrastructures, etc. The numerical model is enhanced with cut-cell boundary method to represent linear terrain features. Cut cell boundaries can also be used to represent rivers. This gives the possibility of carrying out coupled 1D-2D simulations of levee breaching. In this 1st Phase the efforts were primarily focused on initiating active research on various elements of the decision support system the developed technology and finished deliverables can be regarded to be somewhere between TRL 4 and 5

The 2nd Phase of DSS-WISE Project has the objective of advancing DSS-WISE Project to Technology Readiness Level (TRL) of 5 or 6. The focus will be placed on bringing the system to a sufficient level of maturity for commercialization and accreditation for third party use. This will be achieved by improving and refining the numerical simulation model with the implementation of additional capabilities, as well as by custom tailoring the entire DSS-WISE environment to suit the needs and working habits of the end users. As TRL 5 or higher require demonstration of the research results and the capabilities of the entire software in a realistic environment close to operational conditions, a special emphasis will be reserved for testing the model using real-life flood analysis problems with complete data sets. The activities to be carried out under the proposed follow-on research and development are grouped under five principal tasks: 1) refining and improving the numerical model by redesigning the code and data structures, increasing computational speed and implementing wide river capability using the cut-cell method; 2) custom tailoring the GIS-based GUI (pre-processor) and decision support tools (post-processor) by working closely with users at state and federal agencies; 3) testing DSS-WISE software in a realistic environment close to operational conditions; and 4) technology transfer to the user community through short courses and seminars. Data for realistic test cases and feedback on the DSS-WISE software will be provided by supporting agencies.

**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**

PI: Dr. Richard G. Forgette - Email: rforgett@olemiss.edu - Phone: 662-915-7401

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

**Real-time Detection of Chemicals and Biological Pathogens in Fluids (Phase II)**
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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. The need is critical for reliable real-time data collection to identify the nature and extent of biological and chemical contamination at agricultural, urban, and water sites. The acquisition of such data in real time allows first responders to immediately communicate critical information to homeland security leadership, who are expected to make informed decisions rapidly about appropriate responses to the threats. Our work is expected to lead to a model detector system that constitutes proof-of-concept that it can meet those needs. The real-time detector system we propose to develop will have robust plug-in modules that are responsive to different pathogenic or chemical agents. The detector system will be the well known mass-sensitive quartz crystal microbalance (QCM). We propose to make improvements to the QCM technology that will result in increased sensor sensitivity, robustness and reliability for detection of both biological and chemical agents in the field. A crucial aspect of our proposed project is the development of a common electronic reader that accepts the different plug-in QCM sensing modules. Improvements to the sensing modules themselves will be achieved by recombinant DNA methods, which will produce antibody fragments for QCM immunosensors, and by the development of QCM mass displacement assays that are expected to dramatically increase the sensitivity to pathogens. In addition, selective polymer clathrate-based sensors will be developed for the detection of chemicals of concern. We expect to have in hand proof-of-concept modules for bacterial, viral and chemical sensor that will serve as models for the production of future plug-in sensors for different pathogens and chemicals. During Phase I of the project a novel method for polling the sensor chip was envisioned and will be implemented and tested in Phase II. Aside from greater sensitivity the

new method should facilitate development of multi-target sensors. The sensor system we propose to develop will be amenable to remote transmission of its data signals and to the future development of networked sensors around the site of concern.

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

PI : Dr. Lou Marciani - Email : lou.marciani@usm.edu - Phone : 601-266-5675

Effective emergency security management of large-scale spectator sports events is vital nationwide because of the potential for mass causalities and detrimental economic impact. Efforts have been undertaken previously to establish security management standards and methodologies. Nonetheless, it is evident that there are gaps related to effective incident command control, emergency preparedness, and evacuation capabilities at such high consequence sports events. In order to mitigate gaps and deficiencies in preparedness for incidents that cannot be rehearsed in real life, advanced technological tools are required to assist planners to prepare for scenarios that are often dismissed as unthinkable. The objective of the first phase of this project was to develop a robust evacuation simulation system to evaluate and support emergency response, stadium evacuation operations at high consequence sports events. The proposed system is capable of simulating the evacuation of up to 70,000+ spectators. The system is based on an open design philosophy that supports portability, scalability, interoperability, feature extensibility, multi-agency collaboration, and ease of dissemination. The simulation system is based on a powerful physics engine augmented by computational intelligence algorithms and techniques to best model a realistic physical, social, environmental, and behavioral characteristics of crowd demographics and dynamics. The system is designed and built specifically for high capacity spectator events and it is distinctively optimized for sports venues. It utilizes a hybrid approach between agent based system and crowd cumulative analysis to minimize system computational demands and hence optimize system deployment on modest platforms. The second phase of the project will push for higher level of technical sophistication in the simulation. It would provide a more comprehensive verification / validation procedure for system performance. In this phase, a novel methodology of seamless integration of the new technology into the planning, briefing, training, and assessment process will be implemented through a layered approach of 3-D graphic interface. This layered approach will allow building and updating security assurance measures. It will assure that data integrity and operational constraints will be checked for user or for automated corrective actions. Moreover, it will allow efficient linking / integration of new applications. Additionally, in this phase the nucleus of the scenario library and the methodology to integrate them in Tabletop Exercises will be developed. Finally, a feasibility analysis of integration with other tools and systems will be conducted. A case study of this linking will be done by integrating a population distribution GIS for sporting events that could be used for consequence assessment of incidents such as the effects of biological attack. All of the above are essential factors for a successful technology development (TRL 5) and technology demonstration (TRL 6).

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

PI: Dr. Lou Marciani - Email : lou.marciani@usm.edu - Phone : 601-266-5675

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 Oak Ridge National Laboratory

**Sensorpedia**

PI: PI: Dr. Bryan Gorman - Email: gormanbl@ornl.gov - Phone: 865-576-4241

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 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.

## 7.3 Western Carolina University

**Regional Emergency Planning Model (REPM) for Continuous Disaster Mitigation Response (Phase II)**

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The research objective for Phase II of the REPM Project is to further refine the template developed in Phase I to make it applicable to broader regional jurisdictions. Towards this end, the project team will enhance the capabilities of the template by expanding its application to other regional jurisdictions; test and demonstrate the template's adaptability to unique regional issues; train planners on the use of the enhanced model template; create a regional planning sustainability network; and increase awareness of the model for use by other regions. The research will result in product development of an advanced REPM template that has been field tested in various regional jurisdictions, and a final report detailing the technical capabilities, operational considerations, and end-users experiences with the REPM template.

# 8.0 Mississippi Research Initiative 2009 Projects (By University)

## 8.1 Alcorn State University

**Business Continuity Planning Gap Analysis for Small Minority-Owned Businesses in MS**

PI: Dr. William Piper - Email: wpiper@alcorn.edu - Phone: 601-877-6458 (304-4348)

The key objective of this research project is to understand essential research and operational gaps for business continuity planning (BCP) and disaster recovery among small minority-owned businesses (SMOBs). Other supporting objectives of this research project are to: i) identify BCP best practices which can be customized or tailored for other small business communities; and ii) expand the awareness of BCP and its impact on community and regional resilience. To accomplish these objectives, a preliminary study of business continuity planning and disaster recovery for small minority-owned businesses (SMOBs) in the State of Mississippi will be conducted that will focus on information, programs, and SMOBs for the current decade (e.g., 2000 to present). A comparative analysis will also be conducted that compares BCP between pre-Katrina (2000 – August 2005) and post-Katrina (September 2005 – present) periods. The intent of these activities is to identify research and operational gaps for BCP for SMOBs in Mississippi that are likely representative of the southeast region and the nation. The final deliverable of this research will be a final report documenting the activities, findings, assessments, comparative analyses, lessons learned, and recommendations emerging from this research effort. Appropriate practitioners and researchers will be consulted to ensure the products of this research are reasonable and practical.

**A Thermal Face Recognition System for Security Applications – A Novel Approach for Face Pattern Words**

PI: Dr. Yufeng Zheng - Email: yzheng@alcorn.edu - Phone: 601-877-6117

Tight security-imposed applications (at airports, at customs and borders, or at highly-secured buildings) require a contactless data acquisition and a fast identification process. This makes face recognition an ideal biometric option for such homeland security applications since it offers non-intrusive identification of human subjects at a distance without their cooperation. Hence, the objective of this research project is to develop a reliable thermal face recognition system that accurately identifies a human subject under a variety of conditions. These conditions include daytime and nighttime lighting, wearing glasses, complex background, and dust/smoke-filled environment. Results of this research may include new approaches, techniques and standards which may be used to circumvent some of the challenges in facial recognition. In addition the results of this research should help improve effective application of facial recognition technology as a security surveillance capability in border security and in public places such as airports and sports stadiums.

## 8.2 Jackson State University

**Development of a Software Tool for Modeling the Impact of Explosions in Urban Environments**

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Quick calculation of the expected damage or necessary evacuation distances from an improvised explosive device (IED) in an urban environment is a difficult problem. The safety standoff distance from an IED must take into consideration both the threat from blast overpressure and the potential range of hazardous fragments. The objective of this project is to improve the blast damage predictions and calculation of evacuation distances for explosions in urban environments. The effort will involve enhancements of the Visual Interactive Site Analysis Code (VISAC) which is a Java-based graphical expert system developed by Oak Ridge National Laboratory in response to the pressing needs of the Defense Threat Reduction Agency (DTRA), Nuclear Regulatory Commission (NRC), Defense Intelligence Agency (DIA), and other government sponsors. As part of this project, VISAC will be modified to include correlations for explicitly tracking reflection and diffraction of the shock front from a blast in an urban setting. VISAC will also be extended to include an estimate of the fragmentation hazards from an IED. In addition, the target geometric modeling capabilities of VISAC will be expanded for rapid and automated construction of 3D building geometries of urban environments using either geographic information system (GIS) data files or aerial imagery, from applications such as Google Earth, as source data. These changes will create a version of VISAC optimized for responding to IED threats in densely populated urban areas.

**Disaster Response Intelligent System – Phase III**

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The DRIS Project supports the need for decision making tools that assist incident management and information sharing during natural or manmade disasters. This research project was established to leverage advances in operational decision technologies by developing and integrating specialized analytical tools to provide useful information for emergency responders. The research objectives for Phase III will focus on developing additional analytical tools, customizing for counties outside of MS, conducting field exercises, and enhancing capabilities to include a web-based release. It is expected that the research in Phase III will result in an advanced system that has been field tested to support the operations of first responders and incident managers during an emergency. A final report detailing the technical capabilities, operational considerations, and end-users experiences shall also be developed.

## 8.3 Mississippi State University

**Effective Mold and Contaminant Remediation for Flood and Water Damaged Homes**

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It became quite clear following hurricanes Katrina and Rita that information on methods of cleaning and/or remediating flooded or rain-damaged homes was unknown, inadequate, or unavailable to those who needed it. The objective of this project is to conduct scientific tests and

evaluations to identify new approaches to help reduce the costs and time associated with recovery from flooding or other water damage resulting from natural disasters such as hurricanes. The project is divided into six (6) tasks: **1)** Microbial evaluation and detection of fungi in select flood-damaged building materials; **2)** Long-term flood exposure and delayed drying testing; **3)** Contaminated materials and systems testing; **4)** Remediation strategies for contaminated materials and systems; **5)** Remediation strategies for mold and materials and systems; and **6)** Test remediation strategies on flood damaged homes. The studies involved will provide data to: (i) Assist homeowners and associated construction workers to better assess the threats from mold growth and contaminants that could impact the home in the short- and long-term; (ii) Generate information about proven techniques to increase a structure's resilience to flood and water damage; (iii) Shorten the time it takes for homeowners to re-occupy their homes by clearly identifying what areas need mitigation and what can be retained and restored; (iv) Develop measures to effectively mitigate damage from mold fungi and contaminants; (v) Improve methods of rebuilding structures to make them more flood-damage resistant; and (vi) Improve methods of communication to homeowners, local government officials, volunteer groups, etc. regarding the choices available for repairing or rebuilding structures. The project will help to assure that the correct mitigation approach is used to achieve a healthy post-flood home environment, an expeditious return to dwellings, and appropriate costs for restoration of structures.

**Disruptions to Rail – Impacts Analysis and Decision**

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The objective of this project is to explore the positive effects of combining homeland security issues with regional transportation infrastructure decision-making and economic development potential within the State of Mississippi and southeast region. This combined approach provides a geographically specific solution which integrates currently disparate geospatial and transportation analysis and modeling systems with policy and decision-making. This new generation of modeling capabilities can significantly improve regional transportation system resiliency. The research team will utilize freight flow-modeling and Railroad Routing Visualization and Analysis (RRVA) software (developed at Oak Ridge National Laboratory), REMI and EMSI economic modeling software, and GIS and Remote Sensing applications to develop visualizations and imagery illustrating the impact a man-made and/or natural disaster would have on the region's transportation network. The study will be comprised of two parts. First, the project will construct a general overview of how man-made and/or natural disasters will affect transportation networks and regional economies regarding current infrastructures, and display these effects through mapping and visualization tools. Second, the project seeks to determine the effects of these disasters regarding planned transportation infrastructures, comprehensive plans, long-range transportation plans, and regional and local economic development efforts. The information derived will be used to prioritize projects and ensure the most efficient usage of public resources possible.

**Flood-Proof Commercial and Fortified Residential Construction for Neighborhood-Scale, Mixed Used Buildings**

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Commercial buildings in Gulf Coast Communities were affected two ways by Hurricane Katrina. First, many buildings were lost and second many historical commercial streets are now in flood zones following the revised FEMA maps. Unlike residential construction, which can only meet the flood requirements by elevating the structure, commercial construction can be built below the base flood elevation if it is flood-proof. The requirements for flood-proof construction are demanding and unfamiliar to the community. The objective of the proposed research is to bring together the performance requirements, the technical requirements and the regulatory requirements of flood-proof construction for ground floor commercial space and fortified construction for residential space on upper levels. The proposed research project uses the design of a typical mixed-use building with ground floor flood-proof commercial space with residential space above as a case study to investigate advanced materials to construct flood-proof commercial construction. A key part of the project is the construction of a full-scale mock-up assembly that will be tested for water-tight hydrostatic and hydrodynamic performance as well as long term mold resistance. The knowledge gained from the design, research, and construction of the mock-up assembly will be compiled into web-based and printed formats for dissemination to other communities.

**Screening of Levees by Synthetic Aperture Radar**

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The United States has over 100,000 miles of levees protecting cities, towns and property from damaging flood water. These levees are owned by federal, state and local agencies and are of varied design and construction. Many of these levees are aging and are in need of repair or replacement. The objective of this research project is to develop pre-emptive screening techniques to identify levee sections that exhibit geotechnical or geologic characteristics that make the reach vulnerable to failure under flood loading. Once vulnerable reaches have been identified, further actions such as more detailed examination or repairs can be focused on these higher-priority sections. This research will facilitate levee screening by exploring the use of space-based synthetic aperture radar as an input in the classification of levee condition. It will examine the applicability of both current and future satellite-based systems, and will also demonstrate a new and very efficient approach for taking *in situ* soil measurements for ground truth validation, verification, and calibration of the screening methods. The satellite-based systems to be used include the Canadian RADARSAT-2 and the German TerraSAR-X. In addition, specifications of the planned future NASA mission DESDynI will be examined for its potential applicability to the levee assessment problem. The new method of *in situ* soil sampling to be demonstrated will use the Soil Information System (SIS) from Soil and Topography Information LLC. This system uses a GPS-guided vehicle equipped with electromagnetic sensors and ground-penetrating radar plus a soil penetrometer probe to collect samples, and Smart Sampling software to minimize the number of physical samples needed to achieve given quality goals.

**Minimal Trustworthy Computing Base (TCB) for SCADA Security**

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Cyberterrorism is a growing threat to critical infrastructure protection and the nation's economy. There are reports of systems that can infiltrate and compromise water, transportation, and power infrastructures. Intelligence reports show there are terrorist computer systems with details about SCADA systems in America. These systems control critical infrastructure, including electrical grids, nuclear plants, fiber-optic cables, oil and gas pipelines, dams, railroads and water storage and distribution facilities. Strategies that effectively address attacks on SCADA systems, especially systems controlling critical infrastructure like power grids, chemical plants, refineries, water supply systems and mass transportation systems, are vital to homeland security and to the protection of critical infrastructure. Therefore, the objectives of this research and development project are to examine substantially different approaches to securing SCADA systems, and to use those results to architect a practical low-cost solution for protecting the integrity of SCADA systems that control critical infrastructures.

**Multi-Fidelity Tools for Blast Analysis in Urban Environments**

PI: Dr. David Thompson - Email: dst@cavs.msstate.edu - Phone: 662-325-2068

Blasts in urban environments, whether intentional or accidental in origin, typically result in serious injury and loss of life as well as extensive property damage. A contributing factor is the urban environment itself, which through the proximity of multiple nearby structures, has a significant effect on the resulting blast loading on a building. Due to blast reflections and interactions, it is possible to markedly increase the loading on an affected structure that is in close proximity to other structures relative to the loading on the same structure in isolation. The objective of this project is to provide a situation-appropriate, multi-fidelity suite of blast analysis tools. There are four products that will be delivered at the conclusion of this effort: UrbanFX – an interactive, PC-based engineering tool to predict blast loadings on buildings in urban environments, Loci/BLAST – a high-fidelity simulation tool to be used in a high performance computing (HPC) environment to predict blast loadings on buildings, BlastScape – an interactive, PC-based tool that is used to define the urban geometry to be imported into Loci/BLAST, and MeshScape – an automated HPC-based tool for generating component meshes for geometries imported from BlastScape. The expected impact of the project is enhanced capabilities for analyzing the effects of blasts in urban environments.

**Tools for Enhanced Mapping and Managing Post-Disaster Debris (Phase II)**

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Dealing with debris from large scale disasters requires the combined and coordinated efforts of local, state, and federal agencies; private consultants and contractors; and research institutions. A variety of models have been developed for predicting or estimating debris volume that are useful for planning purposes. However these models do not provide for the granularity of prediction at the census block-level as requested by the project advisory group. Existing models are not easily modified to enable integration of locally-accurate baseline data including soil properties, digital elevation model data, land cover information and water budget information with actual storm data to increase accuracy. Toolsets are needed for debris mapping,

determining alternative waste streams, forecasting debris volume and for predicting the economic impact of debris removal and disposal. This project represents the second phase of a research effort to develop and demonstrate a suite of tools to support the prediction and management of debris after a major coastal disaster such as Hurricane Katrina. During Phase I, the research team developed an extensive database of meteorological data, debris volume, type, and origin data from Hurricane Katrina along with numerous other data sets specific to the state of Mississippi. The effectiveness of the predictive tools developed in Phase I have been demonstrated and endorsed by Mississippi agencies that would employ them. These agencies include Mississippi Emergency Management Agency (MEMA), Mississippi Department of Environmental Quality (MDEQ), and Mississippi Forestry Commission (MFC). During Phase II, the research team will convert the previous effort into a set of stand-alone tools with outputs tailored for each agency, will develop simulation algorithms designed to characterize potential impacts of hurricanes for planning purposes, and will also enhance the tool's capability by incorporating additional debris data from areas of the state where the U. S. Army Corps of Engineers coordinated cleanup.

## 8.4 University of Mississippi

**Nano-Coated Smart Sensors for Explosives Diagnostics and Monitoring**

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There remains a vital need to achieve higher sensitivity and greater reliability in the detection of trace explosives at the molecular level in a cost effective manner. This research addresses the application of a number of creative ideas that can provide new design principles for nano-particle coating of sensors to enhance the detection of trace explosives at the molecular level. The project is divided into four major tasks: 1) prepare and optimize coating patterns of combined mixtures of nano-particles on piezo substrates; 2) investigate the stability of coated surface for tribological life against wear and tear; 3) conduct experiments to address the level of sensitivity and capability to detect trace particles at the molecular level; and 4) test and evaluate the micro-structural properties of the coatings and the adsorption capabilities of the coated surfaces.

**Nano-Enhanced and Bio-Inspired Composite Materials for Mitigation and Protection of TIH Railcars and Stationary Tanks against High Power Impact**

PI: Dr. Ahmed Al-Ostaz - Email: alostaz@olemiss.edu - Phone: 662-915-5364

The chemical industry transports large amounts of toxic inhalant hazards (TIH) materials in railroad tank cars and stores them in stationary tanks. Under the Hazardous Materials Regulations (49 CFR 171- 180), TIH materials are defined as gases or liquids that are known or presumed on the basis of tests to be toxic to humans and to pose a hazard to health in the event of release during transportation. There is a need to develop technologies and methodologies that will reduce or eliminate the release of TIH materials from railcar tanks and stationary tanks after being subjected to natural or man-made forces, especially those produced by a 0.5 caliber armor piercing ammunition or by small improvised explosive devise (IED). The objective of this research project is to exploit the special properties of nano materials to create new, multifunctional nanocomposites to help design the next generation of railroad tank cars used for transporting TIH. The project will study how well nano enhanced composites and other

innovative materials will provide ballistic resistance against high power rifle bullet impact and mitigate any fire hazard resulting from puncture or derailment. This research intends to evaluate the success of using nano-enhanced, bio-inspired, and self- healing materials to design more resilient railcars and tanks to transport or store TIH materials.

This research will use iterative "*learn and enhance approach*" by first studying the means of designing high-speed impact-resistant materials. Systems made of selected combination of materials will, then, be fabricated for testing. The effectiveness of using four innovative ideas will be evaluated: 1) steel plates coated with polyhedral oligomeric silsequioxanes enhanced polyurea; 2) aligned graphite nanoplatelet composites for hypervelocity particle interception; 3) quasi three dimensional hybrid (glass/Kevlar) woven fabric in a polyhedral oligomeric silsequioxanes enhanced polymer; and 4) bucky–ball paper. The purpose of this research is to go beyond the current state of art using existing, high-tech materials in railcar design, and to use the technology and knowledge gained in the last decade on nano materials, bio inspired materials and self-healing materials to **design and create new materials** that are more resistant to high impact power rifle bullets and exploding fragments of shrapnel.

**Geophysical Signatures of Compromised Zones within Earthen Embankments and Levees**

PI: Dr. Craig Hickey - Email: chickey@olemiss.edu - Phone: 662-915-5963

Rapid assessment of the potential hazards from levee and earthen dam failures requires advanced screening tools to delineate, classify, and prioritize compromised levee locations. Geophysical techniques can provide indicators of the presence of internal compromised zones, such as zones of piping, preferential flow, and undercompacted zones, within the dam or its foundation that are not easily detected during a visual inspection. The objective of this research project is to further develop ground-based geophysical tools and technologies to assess the integrity and monitor earthen dams and levees. To accomplish this objective, this research shall include a field component, a laboratory component, and a numerical modeling component.

The research shall focus on three ground-based geophysical techniques which will be optimized for rapid dam and levee assessment. These techniques include: i) seismic refraction tomography; ii) electrical resistivity tomography; and iii) passive seismic monitoring. The seismic and electrical methods are considered as advanced screening tools capable of delineating and classifying the degree of mechanical integrity of a levee and/or its foundation. The passive seismic monitoring technology would be deployed on compromised dams and sections of levees, which require immediate remediation or are classified as high hazard.
Field experiments on scaled earthen embankments subject to environmental conditions as well breaching by internal erosion will establish protocols for the optimal use of the seismic and electrical geophysical techniques. Laboratory measurements on representative embankment materials will provide the relationships between geophysical attributes, erodibility, and the standard geotechnical Proctor test used in the construction of earthen embankments. These relationships between geophysical properties and standard geotechnical tests are necessary for practitioners to confidently incorporate geophysical data into their site evaluations. Furthermore, these relationships are required in the computational schemes for calculating the seismic and electrical signatures of levee and levee foundations that have zones of excessive seepage and piping, interpreting experiments, and performing sensitivity studies.

The results of this study will provide the knowledge for practitioners to fully utilize the information provided by seismic and electrical maps. Another future application based on the results of this study is the incorporation of geophysical data for quality control during the actual construction of dams and levees.

## 8.5 University of Southern Mississippi

**Real-time Detection of Chemicals and Biological Pathogens in Fluids (Phase III)**

PI: Dr. Gordon Cannon - Email: gordon.cannon@usm.edu - Phone: 601-266-4221

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.

**Modeling Micro-Economic Resilience and Restoration after a Large Scale Catastrophe: An Analysis of the Gulf Coast after Hurricane Katrina**

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This project will create a model of micro-economic vitality and resilience following a large scale disaster event (e.g., Hurricane Katrina). The researchers will estimate how communities and specific populations within those communities responded to this disaster, providing critical knowledge about potential efficacy of timely and targeted assistance to ensure rapid and effectively rebuilding of local economies. The project will be undertaken in five stages. The first two will include an analysis of existing data sets to create measures for categorizing and understanding (1) the impact of and (2) the speed of recovery from large scale disasters. Stage (3) will collect extensive data through field research on community-level factors that influenced the speed of recovery. Stage (4) will build social-economic models of resilience and recovery in order to better understand local variance in recovery outcomes. Stage (5) will produce an interactive economic model and immersed animation mapping that can be used in local and regional training efforts. The innovative aspect of this research project is in the modeling of local community economic systems. To date, no researchers have modeled the local micro-economies found in communities. This fact makes the project innovative and unique both as a tool for community leaders as well as adding to the academic literature. The end product of the proposed research is a model that helps explain the dynamics of a local economy in a community following a local disaster event. The research may also be used to improve planning for the distribution of resources following a local disaster.

**Integrated Visual Application of the Rapid Levee Condition Assessment Model: A Tool for Water Resource Infrastructure Protection**

PI: Dr. David Patrick - Email: david.patrick@usm.edu - Phone: 601-520-8960

One very important aspect often overlooked when levees are constructed along rivers is that levees are constructed without complete knowledge of the subsurface geological environment. Current levee assessment relies on visual inspection and widely-spaced soil borings are used to

classify levee materials and to determine engineering properties. Unfortunately, weaknesses along levees are not always easily identified from visual inspection or widely-spaced borings as subsurface conditions can rapidly vary due to geology and land use changes. The U.S. Army Engineer Research and Development Center (ERDC) is actively developing a levee assessment tool, Levee Condition Assessment Technology (LevCAT), to model the subsurface environment and target zones of weakness within the levee structure and also within the underlying soil matrix. Currently, LevCAT is the only such tool to rapidly model areas sensitive to levee stability. However, further calibration and validation of the tool is needed along with development of a platform for global access. A critical part of levee assessment involves the management and organization of data required for the analysis, especially as it relates to the understanding of the study area geology, soils data, and associated geophysical signatures. To meet these requirements, the refinement of LevCAT must include an interactive web-based platform and detailed conditions and specifications of levees through geophysical techniques. Furthermore, it must incorporate lessons from other classification methods and include evaluation of additional data sets of levee systems. Therefore, the objectives of this research and development project are to develop an interactive platform for LevCAT and to refine and modify LevCAT for use in global levee assessment. The focus of this research project is to addresses levee condition factors essential in the assessment of levee stability and, hence, public safety. In addition to the geologic environment, specifically the fluvial and flood regime, the project will examine other factors such as levee foundation materials and levee construction methods which impact the levee failures. The proposal addresses levee condition factors essential in the assessment of levee stability and, hence, public safety. In addition to the geologic environment, specifically the fluvial and flood regime, other factors are described in terms of levee foundation materials and levee construction methods. The focus of the proposed research is to refine LevCAT and integrate the assessment and classification tool with an interactive visual application for global access. The proposed research will integrate a visual interface with existing assessment and classification procedures.

**Assessing the Potential of Photocatalytic Building Materials for Protecting Infrastructure and Developing Resiliency to Natural and Manmade Disasters**

PI: Dr. Janice Phillips - Email: janice.phillips@usm.edu - Phone: 601-266-4083

In recent years the photocatalytic form of titanium dioxide ($TiO_2$) has been used to create many self-cleaning structures, particularly in Europe, China and Japan. $TiO_2$ can accelerate the decomposition of many compounds and/or create highly washable surfaces. The performance of photocatalytic $TiO_2$, however, varies widely and depends on illumination conditions, contaminant species, concentration and material type as well as temperature and humidity. The objective of the initial phase of this project is to design and build a new type of photoreactor that can be used to characterize the effectiveness of existing commercial $TiO_2$ photocatalytic materials to break down certain biological and chemical agent simulants. The experiments conducted with the new photoreactor will help establish a photocatalytic materials performance database. Subsequent phases of the project will utilize laboratory results contained in the performance database as well as information from other references to develop tools that can be used to predict the performance of photocatalytic materials in response to chemical and biological terrorisms as well as support the remediation and clean up after natural disasters such as a flooding caused by hurricanes. A systematic phased approach shall be used to evaluate the

performance of these materials under a variety of controlled environmental conditions to better understand which materials are capable of protecting against which threats under given environmental conditions.

# 9.0 Regional Research and Operations Support 2009 Projects

## 9.1 Oak Ridge National Laboratory

**Multi-State Sharing Initiative -- Fusion Center Information Sharing Framework & Development**

PI: Dr. Frank DeNap - Email: denapfa@ornl.gov - Phone: 865-576-8183

The objective of this project is to establish a coherent regional architecture that will allow interstate discovery of critical infrastructure information, critical event information and law enforcement-sensitive data. The project will ensure adherence to state and federal information sharing policies, and will perform analysis to assist in preventing terrorist attacks. This effort is being coordinated through the Southern Shield Consortium (coordinating group of the Southeast Region Fusion Centers) and is being tracked by the DHS I&A Southeast Regional Director. The project's goal is to develop the policy, information sharing and analysis architecture, develop core enabling technologies, and to demonstrate the capabilities in a multi-state initiative (Alabama, Kentucky, South Carolina, Mississippi, and Tennessee). The Information Sharing Framework (ISF) is an open-source (no license fee) platform used for efficient exchange of information that encompasses all well-known communication and information exchange protocols in use today. It enables state fusion centers to securely and efficiently exchange information via gateways with all relevant sources or consumers of law enforcement and/or homeland security-related information. Information gateways are used to connect fusion centers to other sources or consumers of the information in a "plug and play" fashion. The Privacy Policy Enforcement Layer is a technical, executable implementation of the privacy policies and rules that apply to the information exchange. Initial capabilities will be demonstrated by exchanging Suspicious Activity Reports (SARs); however, the system will allow other data to be exchanged between fusion centers as well as linking fusion centers to both state Emergency Management Agencies (EMAs) and FEMA. The ISF will be based on a Service Oriented Architecture (SOA) which will allow fusion centers to perform interstate queries to support analysis and display capabilities. The overall architecture has gained Southern Shield technical working group approval and will be demonstrated to DHS I&A for possible adoption.

**Multi-State Sharing Initiative – Mobile Computing and Application Development Initiative**

PI: Dr. Edmon Begoli - Email: begolie@ornl.gov - Phone: 865-574-5570

The objective of this project is to develop the capacity for mobile-to-fusion center information exchange and situational awareness in a secure, accessible, intuitive and reliable fashion. The project will effectively integrate the operatives in the field with fusion centers via commonly available mobile devices. The project is part of the Lightweight Information Sharing Architecture (LISA) initiative at ORNL.

**Multi-State Sharing Initiative – Prototype Disaster Mitigation and Recovery Kit (DMARK)**

PI: Dr. Hamilton Hunter - Email: hunterht@ornl.gov - Phone: 865-574-6297

In many communities, when a disaster strikes, post-disaster data collection is often accomplished by assessment teams from a variety of community agencies. It is not uncommon for the teams to have little or no training and to collect data in hardcopy format. Because training is not the same for all groups, assessments of damage can often be incomplete and inconsistent. Additional issues can arise with inefficiencies with team distribution and collection areas. All of these issues lead to delays for requests of funding and aid. The objective of the research is to develop an automated tool kit to provide accurate damage assessments post-disaster. These tools would assist first responders in collecting and managing data for more rapid analysis and reporting. The Disaster Mitigation and Recovery Kit (DMARK) will contain tools to aid in the standardized collection of required data allowing communities to apply for various forms of aid after a natural or man-made disaster in a quicker and more comprehensive manner.

**Multi-State Sharing Initiative – Transportation Corridor**

PI: Dr. Cyrus Smith - Email: smithcm2@ornl.gov - Phone: 865-574-5570

The Transportation Corridor is a research project to develop anti-terrorist capability for states with respect to commercial vehicles. Previously, SERRI funded research was conducted with the Kentucky Intelligence Fusion Center (KIFC) to integrate information from multiple commercial vehicle inspection stations within a state to yield insight into possible terrorist usage of vehicles. This project continues advancement of these technologies within the Commonwealth of Kentucky as well as transplants the technologies previously developed in Kentucky to the states of Mississippi and South Carolina. Additionally, these capabilities are facilitated by the exchange of information between the participating states using Web 2.0 methodologies.

**Multi-State Sharing Initiative – Regional Data Analysis**

PI: Dr. Brian Klump - Email: klumpba@ornl.gov - Phone: 865-574-6297

The Regional Data Analysis project will work with analysts in the Tennessee Fusion Center to attempt to more clearly identify areas where current algorithms exist or can be minimally modified to address their requirements for regional analytical support that are not covered by available tools. More specifically, the project aims to fine-tune machine learning algorithms and interfaces for coarse grain data analysis in a manner that is guided by a group of analysts responsible for identifying region-specific threats that typically deal with region-specific information types. The project will also work with the analysts in order to find ways of effectively providing global data that can be fused with more region specific analysis and open up the view to identify threats and vulnerabilities without resulting in data overload.

**Multi-State Sharing Initiative – Sensorpedia (Phase II)**

PI: Mr. Bryan Gorman - Email: gormanbl@ornl.gov - Phone: 865-576-4241

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.

**Virtual Alabama – Ready Rail**

PI: Dr. Pat Hu - Email: hups@ornl.gov - Phone: 865-946-1349

The objective of this project is to integrate data layers and risk assessment capability from the RailReady system into the Virtual Alabama system. The project has three tasks. Task 1 will build the 14 data layers (as included in the RailReady system) for the entire State of Alabama. A 5-mile buffer around the state boundary will be used for all data layers. Task 2 will integrate the new layers with the Virtual Alabama system and will be converted to KML/KMZ format suitable for Google Earth. A URL to the CTA server will be provided to Virtual Alabama team for integration of these data layers into Virtual Alabama. Task 3 will modify RailReady risk assessment functionalities to cover the entire region of Alabama. Necessary analytical links between CTA server and the Virtual Alabama system will be developed and jointly field tested by ORNL and State of Alabama.

## 9.2 Y-12 National Security Complex

**Multi-State Sharing Initiative – Information Sharing Policy Review (Phase II)**

PI: Ms. Mary Regan - Email: reganme@y12.doe.gov - Phone: 865-241-6922

The Department of Homeland Security (DHS) continues to focus on the development and interoperability of fusion centers. State and major urban fusion centers have been developed to collect, protect, evaluate, and disseminate information state-to-state, state-to-federal, and local-to-state. As these evolve and additional interfaces are incorporated into their operation, fusion centers are faced with issues related to the exchangeability of information (for privacy and other legal reasons), development of interoperable systems to support the information exchange, establishment of guidance on development of Interstate Information Exchange Memoranda of Understanding (MOUs), broadening the intrastate exchange of information to include emergency responders, having an up-to-date searchable resource of available homeland security resources and products, and overall coordination of the various efforts surrounding the use of Homeland Security Information Network (HSIN). This project will deliver four (4) products to address these issues: 1) Exchangeable Information Quick Reference Matrix (will identify what information a state can and cannot exchange and any corresponding constraints); 2) Model Interstate Information Exchange MOU and Development Support (will establish a process utilizing the Quick Reference Matrix to craft an MOU formalizing the exchange between state fusion centers); 3) Searchable Database of Homeland Security Resources and Products (will provide a centralized catalog of resources and products that have been developed in support of

homeland security issues and efforts); and 4) Fusion Center Integration with Emergency Services (will extend interoperability beyond the initial efforts which were focused on law enforcement to include emergency services beginning with identifying the scope of what might be useful information to exchange between these two entities).

## 9.3 Engineering Research and Development Center (ERDC)

**Rapid Repair of Levee Breach (Phase II)**

PI: Dr. Donald T. Resio - Email: Donald.T.Resio@usace.army.mil - Phone: 601-634-2018

The first part of this research generated a novel device and approach that had 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. This part of the research will endeavor to confirm the applicability of the PLUG and other concepts to full-scale problems and will develop appropriate deployment methods which will allow helicopters or barges to transport and deploy all system elements required for typical applications. 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.

## 9.4 Middle Tennessee State University

**Biosensor Research (Phase II)**

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The scope of this research is to investigate and develop a biosensor device for rapid detection of infectious agents and other environmental contaminants in the micrometer size range. The sensor design developed in Phase I focused on new nanoimprinted materials to recognize DNT (a model for explosive TNT), and the investigation of three *Bacillus* spp. endospores as anthrax models. During Phase II, research will focus on testing the sensitivity and reproducibility of the sensor device to the target contaminants and materials identified in Phase I. The objective is to sense biological and chemical threats through detection of: 1) binding of low levels of endospores to surface-bound antibodies; 2) entrapment of gases in nanoimprinted and polymeric materials. A final report detailing the technical capabilities, operational considerations, and end-user experiences shall also be developed.

**Aerobic Decomposition as an Alternative Method for Managing Large Scale Animal Fatalities**

PI: Dr. Hugh Berryman - Email: berryman@mtsu.edu - Phone: 615-494-7896

The objective of this research is the creation of a publicly acceptable end product that provides a scientifically proven method for the appropriate disposal of deceased animals in high-magnitude

mass fatalities. Aerobic decomposition through composting has been used in the last decade for disposal of poultry and swine, but no recommendations are in place for the composting of large animals. The equine industry, along with other large animal industries, needs research to develop alternatives of disposal not only for the normal end of life occurrences but also for mass disasters where large numbers of animals die or have to be put to death. Aerobic decomposition is a method that could be developed on a small or large scale to accommodate disposal of animals in mass disaster situations or on small farms or commercial operations. Factors involving the best, aerobic media for decomposition, the proper temperatures, rate of decomposition, and effects on pathogens need to be studied. Results of this research on mass fatalities of animals may also be used to improve the handling of high-magnitude human loss. The proposed research is slated to be performed in three phases. Phase 1 will allow construction of the basic infrastructure needed for the initial experiments in seclusion and security, and will provide a baseline test of decomposition in the three main media—sand, sawdust and soil. Each medium will provide its own advantages and disadvantages. Initial experiments will be conducted to establish baselines on decomposition rates, microorganism and chemical runoff, and odor that can be used for the large animal study in Phase 2 in which horses may serve as the large animal models. Phase 3 is the concluding phase designed to answer questions identified in Phases 1 and 2, so that a high-magnitude, large-size animal fatality protocol can be formulated.

## 9.5 Small Planet Works

**Pilot Study for Business Continuity Planning (BCP) Best Practices for Small Business**

PI: Ms. Janice Banks - Email: jabanks@smallplanetworks.com - Phone: 901-521-1120

Business continuity planning (BCP) is an important aspect of community and regional resilience. It is necessary to develop a better understanding of the critical success factors necessary for small disadvantaged, minority-owned, and women-owned business enterprises (SDM/WBEs) to become more resilient in the aftermath of an emergency or disaster. Research is needed to compare, validate, and expand the findings in the research literature with practical experiences of SDM/WBEs. Therefore, the key objective of this research project is to develop mitigation strategies or best practices for business continuity planning which are appropriate and effective for SDM/WBEs. Other supporting objectives of this research project are to: i) study BCP from an academic research perspective and from a practical perspective; ii) develop a pilot set of BCP best practices which can be customized or tailored for other communities; and iii) expand the awareness of BCP and its impact on community and regional resilience. In collaborations with LeMoyne Owens College and Tennessee State University, this research effort includes a pilot study of SDM/WBEs in Memphis, TN and Nashville, TN. The research will investigate the impact of business disruption on SDM/WBEs and their ability to deliver goods and services to their prime vendor client base. The findings of this investigation will be used to develop a set of mitigation strategies or best practices for business continuity planning for SDM/WBEs.

## 9.6 Federal Alliance for Safe Homes (FLASH)

**Tornado Safe Rooms**

PI: Mr. Eric Vaughn - Email: eric@flash.org - Phone: 850-385-SAFE (Ext. 108) or 728-6787

Following laboratory research conducted at Texas Tech University, the Federal Emergency Management Agency (FEMA) developed state of the art design and construction guidance for Extreme Wind (Tornado/Hurricane) Safe Rooms. The design guidance in turn led to the development of the International Code Council (ICC) 500 consensus Safe Room/Storm Shelter standard. There is now a need to transfer these guidance and standards to homeowners, home builders and stakeholders in a clear and compelling way. The objective of this research project is to facilitate the development of tornado safe room education, awareness, and outreach through integrated collaborations among the following stakeholders: FEMA; the Federal Alliance for Safe Homes, Inc. (FLASH); the ICC and the ICC Foundation (ICCF); and the Resilient Home Program (RHP). Integrating collaborations among these stakeholders is necessary to promoting the newly revised FEMA 320 Publication and ICC/NSSA 500 Safe Room standard, and to examining core reasons why homeowners either adapt or fail to adapt safe rooms in their homes. The product of this project is to tailor an outreach campaign focused on increasing: i) public education on safe rooms for homes and small businesses; ii) public awareness that safe rooms are economically feasible; iii) builder awareness of safe room technologies and practices; iv) the number of builders likely to recommend safe rooms to their customers; and v) consumer requests for safe room information through builder-referrals and the web.

## 9.7 University of Florida

**Residential Roof Covering Investigation of Wind Resistance of Asphalt Shingles**

PI: Dr. Forrest Masters - Email: masters@ce.ufl.edu - Phone: 352-392-9537 Ext. 1505

This research focuses on wind hazard mitigation and the process of turning such advancements into regulations for developers, builders, and property owners to help reduce the damage caused by extreme wind events. Each year, severe winds from hurricanes, tornadoes, and thunderstorms damage or destroy thousands of homes and businesses, causing harm to vital infrastructure and interrupting the lives of people living in affected areas. Roof coverings represent the single most critical line of defense against damage to dwellings from high winds and rain. The overarching objective of this research project is to investigate the performance of asphalt roof shingles exposed to windstorm conditions to improve building codes and standards for coastal residential structures. The research will compare the wind resistance of new and aged asphalt shingles, calibrate current wind uplift test requirements for asphalt shingles with expected performance in actual hurricanes, and evaluate the influence of edge attachments and fastener schedules on the wind resistance of shingles. A phased development effort will be implemented. Phase 1 of the research will establish the framework for this investigation that will include formation of an advisory board, the initial design and development of a dynamic wind load simulation apparatus, the collection and construction of test structures of existing and new roof systems, and establishment of a public information resource on shingle roof systems. Phase 2 will complete the construction of a full-scale dynamic wind loading apparatus, initiate testing of shingle performance with this system (to refine the understanding of failure mechanisms), extend the

harvesting of aged shingle roof systems, and gather field data. Phase 3 will complete the testing of old and new shingle roof systems to synthesize experimental laboratory results with the knowledge base. The outcomes of the research will provide a quantification of the performance of new and aged shingle roof systems, refine the specific causes of the inadequate performance observed in field studies, and create a roadmap to mitigate damage associated with shingle loss in high wind events. The results of this research should enhance the design and construction of more resilient and sustainable residential infrastructure. The research represents a priority area for DHS operational support to the Federal Emergency Management Agency (FEMA) which is part of the National Windstorm Impact Reduction Program (NWIRP). This Program includes the National Science Foundation (NSF), the National Oceanic and Atmospheric Administration (NOAA) and the National Institute of Standards and Technology (NIST). NWIRP aims to decrease the loss of life and property due to windstorms through R&D on weather phenomena and mitigation techniques. Ultimately, this research will help improve the safety of Americans by increasing protection from wind hazards.