U.S. Department of Homeland Security

Office of University Programs

University Network Student Day Abstract Book

March 16, 2009
Washington, DC

Homeland Security University Programs
Today's Research & Education, Tomorrow's Security

Homeland Security

This document was prepared for the U.S. Department of Homeland Security by the Oak Ridge Institute for Science and Education (ORISE) through an interagency agreement with the U.S. Department of Energy (DOE). ORISE is managed by Oak Ridge Associated Universities under DOE contract number DE-AC05-06OR23100.

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2-D Numerical Simulation of I-Wall for Retrofitting Design of Flood Protection Systems in New Orleans

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Project Scope: This study aims to provide the geotechnical solutions to enhance the performance of the hurricane and flood protection system against the future disasters. The main geotechnical design principals and retrofitting techniques that the project proposes are the improved floodwall sections to counteract the overturning; the use of bentonite plugs as the self sealing material of the gaps formed behind the flood walls during the high floods; use of composite sheet piles to increase the stiffness of the sheet pile walls; and the protection on the front side of the flood walls against erosion due to the overtopping. The numerical analysis is particularly important for the reliable analysis of the proposed counter measures.

Recent Progress: This study was performed to accurately calibrate the soil parameters by a comprehensive analysis of the floodwall system using the finite difference code equipped with plastic soil behavior and proper models of soil- structure interface. The calibration of the numerical model was done by matching the measured data like flood wall deflections and the soil displacements indicated by inclinometers during the full scale loading test performed on London Avenue Canal, New Orleans by the US Army corps of Engineers, New Orleans District. Using this full loading test data, the calibration of soil properties for individual layer was possible. Currently, it turns out that a) the overall stiffness of the field soil is to be increased by different magnitude to the predicted magnitude in existing researches and b) the marsh layer is the main layer that causes the instability of the levee. The issues like the gap formation on the rear side of the floodwalls and the reduction of the shear strength of the marsh layer during the high flood level were incorporated during the analysis as the improved analysis procedure. This study has been completed providing the information regarding the behavior of the floodwalls and the calibrated soil parameters required for the further analysis.

Future Plans: The calibrated parameters and the improved analysis procedures developed during the study will be used for further numerical analysis as the future plans of the research. These analyses include 2-D simulation of the 17th street canal failure of New Orleans area and to evaluate the factor of safety of the floodwall system with and without bentonite plugs that are used to seal the gap incurred behind the wall. Further the numerical tool will also be used to evaluate the factor of safety for different erosion and scour conditions and to evaluate the improved factor of safety by using the erosion resistant materials.

Relevance to Listed Research Areas: The results of this study will be used to improve the design and construction principles for a sustainable and robust flood wall system which will significantly contribute to the reduction of the damages from the natural disasters.

A Novel Decision Making Tool Design for Short-Notice Evacuation Planning

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Project Scope: Hurricanes are one of the costliest and most destructive events in the United States. Proper preparations can substantially reduce damages incurred by natural disasters such as a hurricane. Evacuation is one of the crucial components in disaster preparation. In this multi-institutional project, our goal is to develop a decision making tool that deals with assigning evacuation routes and schedules to evacuees in different living areas. In particular, we plan to address the strategic routing and scheduling problems faced by federal and local government that manage the evacuation operations of a large metropolitan area. We assume that decision makers have complete information on the number of evacuees in each area, the capacity and topology of transportation networks, and the path forecasts of approaching hurricanes. Based on the available information, we aim at facilitating the evacuation process by providing clear temporal and spatial schedules and routes to evacuees by utilizing network optimization techniques. The results will be integrated into Google Earth™ platform.

Recent Progress: We have developed a large-scale optimization model to tackle this problem. Since the optimization model is computationally expensive, we have developed an efficient heuristic algorithm for determining the leaving times, schedules, and recommended routes of the evacuation process. We made several revisions to this algorithm to achieve a 98% speed gain compared to our previously existing algorithm for a real world data set related to three coastal counties of the state of Mississippi. We utilize ArcGIS software and Microsoft Visual Studio 2008 for implementation.

Future Plans: Information-based rerouting has been defined as our future plan. Using our model, we can dynamically determine the evacuation routes and schedules for unpredicted situations. Also, we will integrate our optimization module into Google Earth™ platform to display a color-coded animation of our evacuation paths and congestion status in real time.

Relevance to Listed Research Areas: This project is currently funded by DHS – SERRI and is directly related to the areas "Natural Disasters and Related Geophysical Studies" and "Emergency Preparedness and Response".

Publications:

G. Lim, S. Zangeneh, R. Baharnemati, and T. Assavapokee"A simple binary search algorithm for short notice evacuation scheduling and routing", Conference Proceedings, Annual IERC Conference, Miami, May 2009.

S. Zangeneh, G. Lim, T. Assavapokee, and M.R. Baharnemati, "A Solution Framework for Hurricane Evacuation Planning and Management", INFORMS Annual Conference, Washington D.C., October 2008.

S. Zangeneh and T. Assavapokee, "Optimization Model for Efficient Hurricane Evacuation", INFORMS Semi-Annual Conference, Texas A&M University, April 2008.

Application of a Model for the Identification, Classification, and Risk Ranking of Self-Sustaining Regional or Community Containment Sites

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Project Scope: Developed by CREATE's Working Together for A Safer Tomorrow program, this project introduces and applies a three-part user friendly model designed to assist local, state, and tribal entities to work together to identify (Part I) and classify (Part II) geographic locations within a region as self-sustaining communities (SSC), community containment areas (CCA), or campus sites in the event of a natural disaster or terror attack. Once identified and classified, sites are ranked (Part III) using a standardized matrix for each disaster or terror event. This risk ranking process, which enhances the educational and scientific merit of this project, can then be utilized by resource allocators at the local, tribal, state, and national levels to support cooperative approaches that utilize shared resources to maximize response capabilities and reduce the economic impact of disaster and terror events.

Recent Progress: Proposed by students in July 2008 and officially initiated in October 2009, this project became unintentionally aligned with the January 2009 DHS's mission relevant directive (Napolitano, 2009) requiring local, state, and tribal integration. Historical data searches and review for identification, classification, and risk ranking of CAA was completed in December 2008. Results identified past and current studies but those located tended to be community specific, not CAA specific. Relatively little data was found to exist that specifically discussed state, local, and tribal integration or interoperability or that identified *and* classified civilian regions capable of self-sustainment post terror or disaster events.

Future Plans: Should finances allow, the model will be introduced to local, state, and tribal leaders via the Working Together for A Safer Tomorrow interactive website and technical symposia. Both student and faculty members of the WTST team will be available to guide clients through the identification, classification, and risk ranking process thus enhancing the project's educational merit and empowering clients to create an integrated interoperability framework designed to reduce the economic impact of disaster and terror events.

Relevance to Listed Research Areas: This project relates to the Social, Behavioral and Economic Sciences research area generally via community preparedness, response and recovery from catastrophic events, and specifically, via the introduction and application of a user friendly model that enhances the integration of regional governments. This project also relates to the Risk and Decision Sciences research area via the utilization of a risk matrix ranking system.

Publications:

Mitchell, L., Baldwin, K, and Friend, B. (2009) Uses of simplified risk matrices for community bioterror event planning: An annotated bibliography. (Submitted)

Detecting Trace Ambient Pesticides in Real Time Using Single Particle Aerosol Mass Spectrometry (SPAMS)

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Pesticides, by nature, are toxic substances, and may cause harm if improperly controlled. Given that pesticides are fairly ubiquitous, with wide use in agriculture and the household, and considering the potential for harm that pesticides pose to pets and humans in agricultural deployments and in a possible intentional malicious release, the detection of pesticides using rapid and effective means is particularly attractive.

Project Scope: Single-Particle Aerosol Mass Spectrometry (SPAMS) was previously developed at Lawrence Livermore National Laboratory for biological agent detection, but has since been adapted to a variety of other applications including the identification of drugs, high explosives, biological materials, and chemical warfare agent simulants. This study demonstrates the capability of SPAMS to identify pesticide analytical samples and to rapidly detect the presence of pesticides in a variety of sample types with little sample preparation required.

Recent Progress: Analytical standards of the pesticide compounds permethrin, malathion, dichlorvos, imidacloprid, and carbaryl were used to prepare liquid solutions through mixture with water or ethanol. The final liquid sample solutions were then aerosolized in a Collision nebulizer to create particles for analysis in the SPAMS instrument. The resultant dual-polarity time-of-flight mass spectra were then analyzed to identify the characteristic peaks of the compound in the samples. Additionally, samples of common household items containing pesticides, Raid™ Ant Killer 16 spray containing permethrin, and a canine flea collar containing carbaryl, were analyzed in their original state using SPAMS, without any further sample preparation. The characteristic peaks of the active pesticides in these samples were identified using the mass spectra obtained earlier from the pesticide analytical standards.

Future Plans: A possible advancement for SPAMS research would be a demonstration of the rapid detection and identification of pesticide compounds in natural water and food samples.

Relevance to Listed Research Areas: This study demonstrates the ability of SPAMS to detect pesticides in a variety of sample types. Thus, SPAMS could be of interest to research and applications in chemical threats and countermeasures, possibly in monitoring for a malicious release of pesticide compounds in food supplies and water sources.

Publications: A research paper explaining the details of this particular study is currently being drafted. This work was performed under the auspices of the U.S. Department of Energy by Lawrence Livermore National Laboratory under Contract W-7405-Eng-48.

Guerilla Marketing Gone Bad: A Centering Resonance Analysis of Online and Traditional Media Coverage of the 2007 "Boston Bomb Scare"

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Project Scope: Hoaxes, scares, and putative terrorist incidents command significant media attention. As diverse electronic media assume greater significance in homeland security reportage, a need exists to examine their dynamics compared to conventional media, as well as assess their influence vis-à-vis citizen and institutional awareness and response. This research project analyzes the media coverage of the incident known colloquially as the 2007 "Boston Bomb Scare." Using Centering Resonance Analysis (CRA), this study charts changing media frames across time and media for the two-week period following the scare in Boston-area blogs (BostonMetBlogs, Boing Boing, Slashdot, and Universal Hub), 21 national television news transcripts (ABC, NBC, CBS, MSNBC, Fox, and CNN), and 76 articles from national (n = 21) and local online news (n = 55). Media dynamics of the scare mirrored coverage of actual terrorism events in several ways. However, officials and citizens who turned to online newspapers and message boards may have perceived earlier and more accurately that the Boston "bomb scare" was actually "guerrilla marketing gone bad."

Recent Progress: Data collection and analysis is complete. An article-length submission to *Journalism & Mass Communication Quarterly* in February 2009 is pending.

Future Plans: A follow-up study of the media dynamics of homeland security risk reporting is underway.

Relevance to Listed Research Areas: This study explores whether and how differences in coverage across media sources—however slight—influence citizen and institutional response in actionable ways. As a result, this project contributes to risk communication research and initiatives across DHS, especially Emergency Preparedness and Response, Human Factors, and Communications and Interoperability.

Publications: Pending.

Inkjet Printed Reference Materials for Explosive Analysis

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Project Scope: As the threat of terrorism becomes more pronounced, the manner in which explosive materials are detected becomes crucially important. Currently, the simplest and most widespread method of detecting trace explosives is with the use of an Ion Mobility Spectrometer (IMS). IMS instruments are capable of rapid (~10 seconds) trace level explosive analysis and are both rugged and portable, making them ideal for use outside of the laboratory setting. Approximately 10,000 IMS analyzers are found in airports in the United States alone. A reliable, low-cost, robust reference material is therefore necessary to validate the performance of these instruments. These reference materials must be able to verify the proper operation of the instruments, establish detector response criteria, and be usable for calibration purposes.

Recent Progress: We have developed a method to create reliable and precise inkjet-printed explosive standards of RDX for IMS using piezoelectric drop-on-demand inkjet printing technology. Each standard includes the date and time of production, a validated concentration and an expected life-time of the standard. Standards were validated by gas chromatography/ mass spectrometry, IMS and gravimetry and were tested on various on- and off-site instruments. IMS instrument response to varying levels of trace explosives' standards was also evaluated. The repeatability of the printing process was determined by gravimetric techniques to be better than 2 % (relative standard deviation) for a single day of printing and less than 3% day-to-day.

Future Plans: This process has currently only been validated for RDX and so this method must be explored for other explosives such as TNT and PETN. It is also possible that this method could be expanded to involve the production of reference materials used for narcotics detection.

Relevance to Listed Research Areas: This research is directly linked to the research area of explosives detection, mitigation, and response. If successful, this method will enable more reliable explosive screening in locations such as airports, seaports, embassies, and other government facilities. Other methods of trace explosives detection exist, however they are not designed for the volume of use that would be required of them. The IMS is ideal since it operates in most conditions and is both portable and durable enough to be deployed if necessary.

Publications: A publication involving this work is pending.

Nanotechnology, Lessons and Experiments: Synthesis of Nanoparticles and Easy Form to Detect Explosives for High School and Undergraduate Students

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Project Scope: Nanotechnology has increased their attention and application in the last years in many fields of the science: physics, biology, materials science and chemistry. High school and undergraduate students sometimes ignore the development of this new science; they do not know what nanotechnology is; what nanoparticles are. To educate the students in this field in the synthesis of gold and silver nanospheres has been a top priority in the research lab for various years. Students from different high schools have visited the lab and have participated in the synthesis and characterization of nanoparticles. Also many undergraduate students work on this area where they have the opportunity acquire fundamental concepts of nanoparticles. In addition, this type of activities helps to prepare students for career opportunities in the future and also helps them decide about graduate studies. One component of the project involves the wet chemistry synthesis of gold and silver nanoparticles. The second component includes the application of these nanoparticles by introducing the concept of Surface Enhanced Raman Spectroscopy for detecting explosives such TNT in solutions.

Recent Progress: Recent activities include development and optimization of the synthesis of the nanoparticles in a short time. Also the creation of modules that include: guide students to discuss what they can see and touch and what they cannot see but are there, conversion to meter to nanometers, properties of the silver and gold nanoparticles and others. Full lab period dedicated to the synthesis of nanoparticles, concepts of Raman spectroscopy and the combination of SERS to nanotechnology in Homeland Security perspective.

Future Plans: The next steps of the project are: first, visit high schools and educate teachers in these new concepts, so they can explain students the underlying concepts in science classes; second, to plan visits of the students to the lab and so they can learn through hands-on experiences; third, in the case of undergraduate students, to create a new undergraduate course in nanoparticles and applications on detection of explosives.

Relevance to Listed Research Areas: The developments of this type of activities increase new forms to detect explosives in an easy way and at the same time we are educating high schools and undergraduate students.

Publications: We are writing a paper that will be submitted to J. Chemical Education.

Terahertz Technology for Sensing of Explosives and Related Compounds (ERCs)

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Project Scope: Sensing of explosives and energetic materials has been the focus of many investigations over the past ten years as they are closely related to safety screening and pollution monitoring. Many commonly used solid-state explosives and related compounds (ERCs), including TNT (2, 4, 6-Trinitrotoluene), HMX (Cyclotetramethylene tetranitramine), RDX (Cyclotrimethylenetrinitramine) and PETN (Pentaerythritol tetranitrate), have spectral fingerprints in the THz range. These fingerprints arise from the intramolecular and intermolecular vibrational modes or phonon modes of these explosive materials. THz Time-Domain Spectroscopy (THz-TDS) has been considered a competitive method for inspection and detection of explosives because of its unique advantages over other spectroscopic techniques. Our purpose is to develop new THz technology, which is applicable for security applications.

Recent Progress: In this project, we used THz time domain spectroscopy (THz-TDS) to investigate the spectral property of commonly used ERCs. The ample THz fingerprints of these organic and inorganic compounds form a spectral database, with which the future THz imaging system will apply innovative pattern recognition and classification methods to distinguish explosives from non-explosive objects. In addition, we investigated the absorption spectra of explosives under covering materials to demonstrate that a THz system can be used for the detection of hidden explosives.

Future Plans: The next step of this project is to develop THz system which is applicable for the sensing of explosives under condition close to real life.

Relevance to Listed Research Areas: The work we are doing is related to the research area of Explosives Detection, Mitigation and Response.

Publications:

Jian Chen, etc. “Absorption coefficients of selected explosives and related compounds in the range of 0.1-2.8 THz,” *Optics Express* 15, 12060 (2007)

Geovisual Analytics of Spatial Clusters at Multiple Scales

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Research Area: Geovisual Analytics, Geovisualization, Spatial Data Mining
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Project Scope: The research presented here focuses on developing a geovisual analytics approach (Thomas and Cook 2005) to identify and understand geographic clusters in crime, disease, and other events of relevance to homeland security. Most of traditional geospatial cluster analysis methods detect potential spatial clusters without statistically confirming the clusters. In addition, these methods do not cope with scale dependence of clusters, which is an important issue as emphasized in multiple research domains (Wilbanks and Kates 1999; Elliott and Wartenberg 2004; McMaster and Sheppard 2004).

Recent Progress: My research has developed and implemented an exploratory spatial data analysis process that integrates and interactive, map-based interface with a spatial scan statistic method, which is both descriptive (to locate spatial clusters), and deterministic (to statistically confirm the clusters). A key result is identification of scale-sensitivity issues for commonly used spatial scan statistics. Specifically, the application developed allows analysts to (1) explore results from the spatial scan statistic method, (2) effectively cope with the scale-sensitivity issues, and (3) identify more reliable clusters and enhance the understanding of the clusters produced by the spatial scan statistic method. The approach has been applied to the analysis of U.S. vehicle theft and disease patterns.

Future Plans: In addition to study what has happened and where; my future research plan aims to explain "why a spatial cluster occurred" by identifying potential or highly likely association between geographic (and other) spatial clusters and related risk factors.

Relevance to Listed Research Areas: This research focuses on Advanced Data Analysis and Visualization. The ability it supports to identify and understand geographic clusters can have important implications in a broad range of research and application domains that include but are not limited to: natural disasters, border security, and chemical and biological threats. For example, spatial cluster analysis had been applied recently to identify spatial patterns of natural hazard mortality in the United States (Borden and Cutter 2008). The methods can also facilitate identification and visualization of emerging hotspots of crime activities along the border (Chang, Zeng et al. 2005) and researchers have employed the spatial scan statistic to develop bioterrorism surveillance systems (Griffiths, Berndt et al. 2006).

Publications:

Chen, J., Roth, R., Naito, A., Lengerich, E. & MacEachren, A. (2008a) 'Geovisual analytics to enhance spatial scan statistic interpretation: an analysis of U.S. cervical cancer mortality', International Journal of Health Geographics, 7, p. 57.

Chen, J., MacEachren, A. & Lengerich, E. J. (2008b). 'Visual Analytics of Spatial Scan Statistic Results', in Geospatial Visual Analytics Workshop, GIScience Conference, Utah.

Control-Based Real-Time Metadata Matching for Information Dissemination

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Research Areas: Advanced Data Analysis and Visualization, Emergency Preparedness and Response
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Project Scope: In recent years, real-time information dissemination has become increasingly important. In many systems, data flowing from numerous sources to numerous sinks have to be channeled flexibly, efficiently and more importantly, in a real-time manner. This requirement has been generally described as Valuable Information at the Right Time (VIRT). Our work aims to explore effective algorithms based on control theory to guarantee the goal of VIRT. This is in sharp contrast to existing solutions which are mainly based on heuristic approaches that rely on extensive empirical evaluation and manual tuning. The proposed algorithms have been applied to achieve real-time metadata matching between publishers and consumers in a data sharing middleware for information dissemination (INFOD) purpose, where hundreds of millions entries need to be processed in order to route the right information to the right person at the right time.

Recent Progress: We have explored novel feedback control architecture for INFOD to adaptively control the average response time of metadata matching. Empirical results on a physical testbed demonstrate that our algorithm outperforms two heuristic-based solutions. Further, we have proposed a Multiple-Input-Multiple-Output (MIMO) control algorithm based on optimal control theory to address the response time and the system throughput in an integrated manner. Empirical results show that our algorithm not only effectively guarantee the real-time requirement but also achieve the maximal system throughput.

Future Plans*:* We will conduct thorough analysis of control accuracy and system stability when the system is suffering unpredictable workload variations. In addition, we will implement our algorithms in a real application of INFOD to further verify their effectiveness and superiority.

Relevance to Listed Research Areas: Our research is closely related to *Advanced Data Analysis and Visualization*. Since it addresses a universal issue of real-time, it can be applied on many other research areas that have a high requirement on timeliness, including but not limited to Emergency Preparedness and Response, Risk and Decision Sciences, and Explosives Detection, Mitigation and Response.

Publications:

M. Chen, X. Wang, R. Gunasekaran, H. Qi, M. Shankar, "Control-Based Real-Time Metadata Matching for Information Dissemination," *the 14th IEEE International Conference on Embedded and Real-Time Computing Systems and Applications (RTCSA)*, Taiwan, Aug 2008.

Mental Healthcare Professionals' Anticipated Attitudes for Providing Psychological Services to Survivors During the Aftermath of a Major Terrorist Incident

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Project Scope: The purpose of this study was to identify factors that correlate with mental healthcare providers' ability and willingness to provide psychological care to survivors of a major disaster. The theoretical foundations of this study were based on social cognitive theory as a basis for understanding motivation. It was hypothesized that anticipated perception of risk, anxiety, depression, fear, loss of confidence in government and social institutions, religious convictions, and proximal location to a disaster would be associated with participants' willingness and ability to provide care in a post disaster environment.

Recent Progress: Multiple regression analysis and multivariate analysis of covariance were among the statistical procedures utilized in this study. Anxiety and proximity to major disasters were associated with mental health clinicians' unwillingness and inability to provide critical care to traumatized survivors. Additionally, as participants' level of religious convictions increased, so did their willingness and ability to provide post disaster services. Supplemental analyses revealed that under certain circumstances 51.6% of the survey participants would be unwilling to provide post disaster services. Our nation's disaster mental healthcare preparedness may differ dramatically from our actual response capabilities. It is recommended that: (a) American universities expand their graduate psychology curriculum to include disaster mental health courses, (b) advocate mental healthcare via the internet, and (c) promote disaster mental health journalism.

Future Plans: Findings from this study will contribute to positive social change by providing our nation's leaders with research-based information that can enhance disaster training and the delivery of critical mental health services in times of national emergency.

Relevance to Listed Research Areas: This study has relevance to the Emergency Preparedness and Response research area that is highlighted in your Abstract Guidelines. There is no current publication of this study in any professional journal as of the date of this submission. The project scope, research findings, and recommendations are discussed in the body of this abstract.

Publications: I have made presentations on my research work during United States Psychology delegation visits to Vietnam (2006, November) and China (2008, November). These psychology delegations were organized by People to People International (Spokane, Washington) with Dr. Norine Johnson, Past President of the American Psychology Association, as the delegation leader. I was also invited by the Centre of Defence and National Security Studies in Chandigarh, India, to give a presentation on my research findings during an international conference on civil-military relations (2009, January). A manuscript has been submitted to *Psychological Trauma: Theory, Research, Practice, and Policy* for editorial review. A decision regarding publication is pending.

References: http://timesofindia.indiatimes.com/Cities/Chandigarh/Armymen_discuss_civilian-military_relations/articleshow/4027887.cms

http://www.puchd.ac.in/section.php?action=news&id=1052&code=show

Relation Detection Towards Textual Inference

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Project Scope: Many natural language processing applications require semantic inference which, in turn, demands a common framework for applied semantics. Recently, textual entailment has shown considerable promise for textual inference. Among several approaches developed to achieve the ultimate goal of the textual entailment task, the approach based on a model of natural logic, which utilizes entity relations to do inference, has proved to be very promising. However, this approach requires an effective way to exploit the background knowledge that provides useful and accurate information to the inference process. Most of the current approaches look at specific collections of text and extract all possible facts from these corpora. However, it is difficult for a textual inference system to get benefit from this direction because of two difficulties: (1) the extracted knowledge may not be particularly well-suited for natural language inference and (2) knowledge of specific entities may not be associated with the extracted facts due to the inherent characteristics of natural language.

In this project, we develop a novel approach that uses Wikipedia as the background knowledge to detect the relations between entities in real time. We position the problem of relation detection in the context of the textual entailment task. Our system can be considered as a black box that accepts two input entities and returns the relation between the entities along with their possible classes. Our approach can discover whether two input entities pose an equivalence relation (synonym), alternation relation (sibling), forward entailment (child), backward entailment (parent), or independence (no relation). The goal of this project is to provide an effective solution for detecting relations between pairs of given entities at run-time. Although our approach is designed to be applied directly to the textual entailment task, it can also be applied to many other problems in natural language processing, such as information extraction, question answering, and so forth.

Recent Progress: We developed a module detecting the relations between entities that automatically disambiguates input entities by using prominence-based search. An input entity is, therefore, associated with a list of prominent concepts. Two input entities are sibling if their concepts share the same class. The association strength between two input entities and all of their concepts are quantified to retrieve the most possible common class of the relation. Similarly, child and parent relations are determined if one entity dominates the other; otherwise the two input entities are not related. We evaluated model performance at detecting relations between entity positioning in textual inference.

Future Plans: We plan to evaluate our approach on the textual inference task itself. We plan to add two basic entailment relations into our solution: exhaustive exclusion and nonexclusive exhaustion.

Relevance to Listed Research Areas: This project develops powerful techniques to garner useful information from large text data sets, improving semantic inference in natural language processing applications.

Publications:

M. Chang, Q. Do, and D. Roth, "*Multilingual Dependency* Parsing: A Pipeline Approach," Recent Advances in Natural Language Processing, 2006, pp. 55-78.

M. Chang, Q. Do, and D. Roth, "*Local Search for Bottom-Up Dependency Parsing*," ACL 2006.

Integrated Economic-Epidemiologic Modeling of Avian Influenza Mitigation Options: An Application to Texas Poultry Industry

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Project Scope: Recent Avian Influenza (AI) outbreaks and their consequences have raised concerns about prevention, control and response options and their cost effectiveness. The United States has experienced several outbreaks of AI with the most recent in Gonzales, Texas in 2004. During that outbreak the index flock (6,608 broilers) and 5 live bird markets were depopulated (Pelzel et al., 2004). Costs of control strategies comprised the largest part of the overall economic costs of that outbreak. Many more and larger outbreaks have occurred internationally (Nigeria, Egypt, Benin, Togo, Canada, and United Kingdom in 2008) and some are zoonotic. We develop and apply an integrated economic-epidemiologic model of Avian Influenza (AI) that includes mitigation options. The application examines the welfare implications of the current USDA recommended and one alternative mitigation strategy (vaccination) in the context of Texas commercial poultry operations.

Recent Progress: Preliminary results indicate that the vaccination strategy dominates the currently used strategy in a first degree stochastic dominance sense. However, the government implementation costs for the vaccination strategy exceed those under the current strategy. Nevertheless, the expected welfare gains of consumers and producers more than offset the additional costs incurred by the government.

Future Plans: Future works include the estimation of the impact of AI outbreak on meat prices in the context of our model. The project is also considering an extension of the model to the entire United States poultry industry while accounting for international trade.

Relevance to Listed Research Areas: Beyond "Food and Agriculture Security" this study is directly relevant to "Social, Behavioral and Economic Sciences." The paper developed an integrated epidemiologic-economic model to evaluate different strategies of AI mitigation and response. This study is also relevant to the "Emergency Preparedness and Response" to catastrophic events and our study has made a contribution to the "Risk and Decision Sciences" by using advanced risk analysis and simulation methods to study possibilities of the disease spread in the context of our model.

Publications:

A. Egbendewe-Mondzozo, L.Elbakidze, and B.McCarl, "Integrated economic-epidemiologic modeling of avian influenza mitigation options: An application to Texas poultry industry". (*Submitted to the American Economic Association Meeting, July 2009).*

Delving Further Into State Fragility and Terrorism: The Importance of War

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Project Scope: This project explores the relationship between state fragility and terrorism from 1970-1997. Terrorism is defined by the Global Terrorism Database incident data as "the threatened or actual use of illegal force and violence to obtain a political, economic, religious or social goal through fear, coercion or intimidation" State fragility is defined by the Political Instability Task Force event data as four specific types of events: revolutionary wars, ethnic wars, adverse or disruptive regime transitions, and genocides or "complex" which is when more than one type of fragility co-occurs. In prior work, I established that terrorism was more likely to occur in fragile states during fragile years. Here, I establish that different types of co-occurring fragility have different effects on levels of terrorism. The highest likelihood of terrorism occurred in states experiencing two to three co-occurring types of fragility, particularly when one of those types included either ethnic or revolutionary war. Terrorism seemed to be highest in states experiencing ethnic war or revolutionary war in combination with only one or two other types of fragility. Those states experiencing more than three episodes of fragility contemporaneously seem to be too fragile for terrorism to take root.

Recent Progress: I have completed disaggregating these "complex" events to find a more precise way of categorizing them and have found that the relationship between terrorism and fragility varies by type and number of co-occurring fragilities.

Future Plans: Future work will include analyzing the relationship in a multivariate framework with such country-level covariates as GDP, income inequality, degree of international openness or trade among others. It is highly important to analyze the relationship while controlling for other characteristics of these countries that may render the terrorism-fragility relationship unimportant. In addition, I plan to update the analysis to include data up to 2006.

Relevance to Listed Research Areas: This research fits into the "Social, Economic and Behavioral Sciences" area, because I am exploring why terrorism occurs in which specific countries and in which specific years.

Publications:

G. LaFree, L. Dugan, and S. Fahey (2007). "Global Terrorism and Failed States." In Peace and Conflict, 2007, eds. J. Joseph Hewitt, Jonathan Wilkenfeld, Ted R. Gurr. Boulder, Colorado: Paradigm Publishers.

Standoff Gas Phase Detection of Explosives by Raman Resonance and Nano-Cars

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Project Scope: This study is focused in developing new technologies to detect high explosives the gas phase.

Recent Progress: Ultraviolet spectra of high explosives (HE) TNT, 2,4-DNT, 2,6-DNT, RDX and TATP were acquired to identify the wavelength of maximum absorbance and the electronic structure of these important HE. The molar absorptivity of each explosive was calculated in water solution for UV/VIS spectroscopy to have an idea of the light absorption capacity of these explosives. The study was carried out because the solubility of these explosives in water as solvent is very low, so an extrapolation of the results can be approximated for the gas phase of the explosives. It is important to determine the optimum wavelength of excitation line that should be used for Raman Resonance and an estimated of the amount of light that is absorbed for the explosive.

Future Plans: Work in Raman Resonance using the wavelength of maximum absorbance of each explosive and nearby regions (for pre-resonance experiments) will be completed to obtain additional information useful in nano-Coherent Anti-Stokes Raman Spectroscopy and also is possible identify traces of explosives. The nano-CARS experimental set up will be built using a Nd:YAG laser (with 1064, 532,355 and 266 nm excitation lines available) coupled to a high performance new generation dye laser with all the ranges of excitation lines that the system allows, including frequency doubling of the dye output. All of the parameters that include the optimization of the experimental set up of nano-CARS to detect explosives in gas phase are the next steps in this work.

Relevance to Listed Research Areas: Gas phase remote detection of explosives has become one of the main interests in world security.

Publications: None at this moment.

Standoff Detection of Concealed Body-Worn Explosives Using Millimeter-Wave Radar with Limited View ISAR and Fourier Based Imaging Techniques

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Project Scope: In the increasingly important problem of identifying suicide bombers, it is essential to detect suspicious individuals at a distance. Current systems employ multiple sensors to determine the presence of explosives on people, including observing and following individuals, identifying explosive residues or heat signatures on the outer surfaces of their clothing, or by characterizing explosives using penetrating X-rays or terahertz wave radar. Current radar systems require impractically large synthetic apertures to effectively distinguish people wearing concealed body-worn improvised explosive devices from innocent individuals.

Experiments with a narrow band 77 GHz Frequency Modulated Continuous Wave (FMCW) radar, indicate that simple threshold detection fails to distinguish metal pipes on skin from skin alone. Analysis indicates this is due to the extremely complex nature of scattering and interference from the electrically large contours of a human body at mm-wave frequencies.

Recent Progress: Experimental studies conducted jointly by Northeastern University's Awareness Localization of Explosive Related Threats (ALERT) center of excellence and Forschungsgesellschaft für Angewandte Naturwissenschaften (FGAN-FHR) in Germany using a monostatic 94 GHz FMCW radar system and limited view ISAR processing techniques have demonstrated up to 93% probability of successful detection of subjects wearing metal pipe explosive surrogates.

Future Plans: To overcome the scattering interference from unknown electrically large natural contours on the human bodies, it is necessary to scan a small illuminating spot across the body surface. The illuminated region must be small relative to the size of threat objects, such as metal pipes. Reduction in size of the illuminated region will isolate scattering sources and enable the detection of artificial changes in body surface contours. For this particular application, a 5 cm wide spot at a range of 50 meters would require 1000 wavelength antenna aperture. The only cost effective antenna of this size is created using an array of reflectors.

Relevance to Listed Research Areas: At present, millimeter wave radar is the only modality that can penetrate and sense beneath clothing at a distance of 10 to 50 meters without causing physical harm.

Publications:

J. Fernandes, C. Rappaport, J. Martinez, M. Hagelen. "Experimental results for standoff detection of concealed body-worn explosives using millimeter-wave radar and limited view ISAR processing" accepted for publishing in *IEEE Homeland Security Tech. Conf.*, May 2009, Boston, MA

Economic Growth Consequences of Terrorism and Conflicts

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Project Scope: The project investigates the economic consequences of terrorism and conflicts around the world by grouping countries into regions and studying the impact of violence on economies of a particular region. Such a study allows us to carefully examine a specific region and ascertain, for example, whether Asian economies respond differently than the rest of the world or Europe to terrorism.

Recent Progress: We produced two research papers from this project so far that were funded in part by DHS through CREATE. In "Growth Consequences of Terrorism in Western Europe" we estimate the effect of domestic and transnational terrorism on economic growth for 18 Western Europe countries for 1971-2004. Results show that each additional transnational terrorist incident per million persons reduces economic growth by about 0.4 percentage points, while the effect of domestic terrorism is only about half this size. We show that the pathway by which domestic and transnational terrorism influences growth differs; transnational terrorism works more through the crowding out of investments, while domestic terrorism works more through crowding in government spending.

"The Impact of Terrorism and Conflicts on Growth in Asia" quantifies the impact of terrorism and conflicts on income per capita growth in Asia using a panel of 42 Asian countries for 1970-2004. The panel estimations show that an additional transnational terrorist incident per million persons reduces GDP per capita growth by about 1.5 percent. Transnational terrorism reduces growth by crowding in government expenditures, which diverts resources from private and public investments. Unlike developing countries, developed countries are able to absorb terrorism without displaying adverse economic consequences. An internal conflict has the greatest growth concern, more than twice that of transnational terrorism. Both internal and external conflicts are associated with smaller investment shares and increased government spending.

Future Plans: Currently, I am working with Professor Sandler on collecting relevant data to perform similar growth study for Africa. After completing regional studies, we will be able to summarize and contrast them to come up with some unifying principles.

Relevance to Listed Research Areas: This project is most relevant to the area of Social, Behavioral and Economic Sciences. More specifically, the project contributes in understanding of the macroeconomic consequences of terrorism and conflicts and presents a number of important policy insights towards security resource allocation and regional and global cooperation in counterterrorism efforts.

Publications:

K. Gaibulloev and T. Sandler. **"**Since the beginning of the project in fall 2007, we produced two research papers. "Growth Consequences of Terrorism in Western Europe" is published in, *Kyklos*, 61(3), 411–424, 2008 and "The Impact of Terrorism and Conflicts on Growth in Asia" is, accepted for publication in a forthcoming 2009 issue of *Economics and Politics.* A version of the latter paper is also published as ADBI Discussion Paper 113. Tokyo: Asian Development Bank Institute.

Technical Application and Review of Remote Public Health Monitors

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Project Scope: The project is primarily to monitor the health among disaster victims in shelters or quarantine situations. The monitor is a band that can be placed on the wrist, or elsewhere on the body, and provides heart rate and body movement in real time and/or stores data for assessments. While the monitor is currently designed for rehabilitation, an advanced, multi-sensor device can measure body heat and fluids to determine different stages of infections, lifespan status and individuals' locations. Since the bands remotely monitor the infected and sick, health management can be more effective. If a specialist monitors an affected population to detect possible illness, such as less movement and/or heart rate changes, protocols can determine whether to attach the advanced band to monitor health care more effectively. The mass production of the heart rate and movement band will cost $60 and the advanced band will cost $180. Other costs include equipment such as computers with software designed to view the status of each band and also the trained staff to install and maintain the equipment.

Recent Progress: Research has progressed about the cost analysis of the monitors and about the technology transitioning of similar devices in the market.

Relevance to Listed Research Areas: This project can primarily be used for emergency response and for emergency preparedness. In the context of emergency response, the health monitors can be implemented at shelters and for quarantines to improve recognition of infections and minimize the spread of disease in confinement. In the context of preparedness, the monitors can be available for emergency services in communities and provide a way that severe infections can be successfully managed and the sick quarantined to improve the protection of the survivors and prevent a disaster.

Future Plans: If funded, a similar device on the market can be purchased and tested to remotely monitor sickness among a target population, such as a business office. If remote protocols are helpful in a test community, the design of an advanced monitor is warranted. Also, more research into risk analysis and mitigation, competition, project management, and budgeting staff expenses are needed to make this project a success.

Publications: Brief descriptions, project management and technical information can be viewed at http://68.115.186.102:84/dotproject/ with Username: "Guest" and Password: "project", and go to the forum section of the Project labeled "Remote Public Health Monitors".

Terrorist Attacks Against the Police

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Terrorist attacks against the police are more common than expected. Over 8% of terrorist attacks worldwide target police, and police have been the victims in over 10,000 terrorist attacks since 1970. *The Police Chief* magazine recently called attention to terror attacks on police; however, empirical studies of terrorist attacks on police are lacking. This project explores such terrorist attacks.

Project Scope: This project primarily involves secondary data analysis of the Global Terrorism Database (GTD), which is an incident-level compilation of systematically collected data from open-source information between 1998 and (currently) 2004. This project will limit the terrorist incidents under study to those occurring in countries in North America and Europe, whose social structures are more relevant to United States homeland security policy.

Recent Progress: Several scholars have noted that most traditional explanations for violence do not extend to violence against the police. This project explores the similarities and differences of terrorist attacks against the general population and terrorist attacks against the police, examining whether traditional criminological explanations may apply to terrorist attacks against police.

Future Plans: This project constitutes the beginning of my dissertation research. The purpose and primary goal of the dissertation research is to explore micro- and macro-level factors, drawn from criminological theory, related to terrorist attacks against the police. Specifically, the objectives of this research are to (1) identify the incident-level predictors, if any, of terrorist attacks against police; (2) identify the macro-level determinants, if any, of terrorist attacks against police; and, based on this evidence, (3) generate policy specifically for the homeland security community (i.e., emergency responders), potentially reducing the vulnerability of police and other targets of terrorists, as well as contribute to the body of knowledge on violence against/victimization of police.

Relevance to Listed Research Areas: Because this project examines factors relating to terrorist attacks, it is relevant to the Social, Behavioral and Economic Sciences research area.

Publications: To date, there have been no publications of this project.

Bovine Cathelicidins: A Frontline Defense

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Project Scope: Cathelicidins (CATHLs) are small, cationic antimicrobial peptides that establish an early innate immune defense against infections in mammals. Their wide spectrum of antimicrobial activity includes the inhibition of bacteria, fungi, and viruses, which are the causes of such high-consequence agricultural and human health threats as Foot and Mouth Disease (FMD), Bovine Tuberculosis, and Rift Valley Fever (RVF). Thus, polymorphisms present in bovine CATHLs 2, 5, 6, and 7 could potentially underlie inherited differences in innate immunity and resistance to these and other diseases. The purpose of the present study was to characterize single nucleotide polymorphisms (SNPs) and insertion–deletion (indel) polymorphisms within the bovine CATHL gene family. Comparative sequence analysis for 10 domestic cattle breeds representing both Bos taurus and Bos indicus revealed 60 SNPs, 7 of which were nonsynonymous, and 5 indel mutations. Infectious diseases of cattle result in part from an animal's inability to resist invading pathogens. Therefore, characterization of these novel polymorphisms is central to developing a firm understanding regarding the effects CATHL variation has with respect to bovine innate immunity, and may enhance our ability to defend against devastating animal disease outbreaks.

Recent Progress: Literature suggests that the number of members within the bovine CATHL family is unresolved and the bovine genome assembly is in early stages of completion. Consequently, we have begun to generate sequence data from two Bacterial Artificial Chromosome (BAC) libraries to more accurately determine the correct number and order of the CATHL genes within the bovine genome.

Future Plans: Once the genomic foundation and framework of the CATHL gene family has been established, we will investigate the epigenetic regulation of these genes in various tissues. The mammalian innate immune response is less understood than the acquired immune response, and this research will provide further insight into specific CATHL functions and their role in host-pathogen interactions throughout the body.

Relevance to Listed Research Areas: Increased understanding of innate immunity will be central to the development of effective strategies to prevent or mitigate high consequence foreign animal and zoonotic diseases.

Publications:

E.N. Gillenwaters, C.M. Seabury, J.S. Elliott, J.E. Womack. Sequence Variability Analysis and Polymorphism Discovery in 4 Members of the Bovine Cathelicidin Gene Family. J. Hered. (2009) In Press. (http://jhered.oxfordjournals.org/cgi/content/full/esn112.

Ideologically-Motivated (IM) Homicide in the U.S., 1990-2007:
A Comparison of Far-Right and Bias Homicide Events

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Project Scope: In this study, data on all homicides committed by far-right extremists since 1990 are compiled from open-source documents. Comparative analyses within this type of violence are done to reveal the similarities and differences in the nature of these homicide events across motivational subtypes. Additionally, far-right bias-motivated homicides and other bias-homicides not perpetrated by far-right extremists are compared. Preliminary findings reveal far-right extremist perpetrators vary in important ways, such as their past criminal histories and group affiliations, and have been responsible for both terroristic and more traditional types of homicide. Furthermore, victims have ranged from law enforcement to social minority groups, as well as to terrorist affiliates.

Recent Progress: Detailed open-source data collection and coding for approximately 250 homicide events (over 500 victims) has been recently completed. Open-source data collection and coding for non far-right bias-motivated homicides has also been completed, thus making preliminary comparisons between far-right and non far-right bias-motivated homicides possible.

Future Plans: This research serves as my dissertation on IM homicide in the United States, which will be defended this summer (2009). Based on my dissertation, I intend to produce a number of scholarly articles for instance, a multivariate analysis of factors important for distinguishing terroristic far-right homicide events from other types of homicide. Moreover, other articles examining methodological, theoretical, and policy issues will be produced.

Relevance to Listed Research Areas: This study of IM homicide is relevant to the DHS mission, as it specifically addresses the criminal and terroristic behaviors of far-right extremists and extremist groups in the United States. To date, there have been no systematic studies on the nature of IM homicide events perpetrated by far-right extremists. Far-right extremists have claimed hundreds of lives since the early 1980s. Future terrorist attacks will likely involve not only militant Islamic extremists, but also far-right extremists (Hewitt, 2003; see also Carlson, 1995; Riley, 1995). The proposed study will benefit criminal justice agencies in identifying the characteristics of far-right extremist homicide from other forms of IM and traditional homicide incidents and perpetrators, as well as aid other criminal justice actors in preventing such acts and prosecuting and punishing actors participating in this form of domestic terrorism.

Publications:
J. Gruenewald, J. Freilich, S. Chermak, (2008). A review of the far-right extremism literature. In *R. Blazak & B. Perry (Ed.). Hate crime issues and perspectives*. Westport: Praeger.

The Youth Coping Responses Inventory: Development and Initial Validation

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Project Scope: The purpose of the current study was to develop a psychometrically sound measure of coping for use in studying children's resiliency and adjustment following a disaster. Coping is defined as the actions and cognitions used to manage stressful demands and has been conceptualized in various ways. Negative coping behaviors (e.g., blame, anger) have been found to relate to maladjustment after a major hurricane, while positive coping behaviors (e.g., routines, spirituality, family support) have been related to positive adjustment following a major hurricane. Despite the importance of children's coping, there is no accepted standard for measuring youth coping. Although numerous measures are available, many have significant limitations with regard to the development, content, and psychometric properties. For example, most measures were developed on a middle- or upper-class Caucasian sample, and omit coping strategies that may be important to underrepresented samples (e.g., the use of spirituality and family support). These limitations have been very problematic in our research examining the role of children's coping with the effects of Hurricane Katrina. Therefore, the current study sought to develop a measure of youth coping using a diverse sample and incorporating largely ignored content areas.

Recent Progress: Measure development began with initial item generation, which was based on theory, past coping measures, and item reviews. Items were piloted with a diverse sample. Data were factor analyzed, yielding a 44-item coping measure with a three-factor solution (Diversion, Destructive Coping, and Ameliorative Coping). The Youth Coping Responses Inventory (YCRI) showed strong reliability for each subscale, and adequate preliminary validity data with select subscales of the Behavioral Assessment System for Children, Second Edition (anxiety, depression, social stress, internalizing problems, and personal adjustment. Coping scores were also related to PTSD scores obtained from the sample of children affected by Hurricane Katrina.

Future Plans: Since completion of the measure's development, the YCRI has been included in a packet of materials used for longitudinal research studying diverse populations affected by Hurricane Katrina (a DHS-funded grant project). Coping data will be analyzed alongside data assessing social support, post-traumatic growth, spirituality, and adjustment. In addition, the YCRI is being used in the clinical setting to study how coping behaviors are affected by and influence various psychological disorders in youth.

Relevance to Listed Research Areas: This study has relevance to the research area of "Social, Behavioral, and Economic Sciences," due to the YCRI's focus on behaviors used in response to stress, as well as the use of social support. This new measure will aid in determining which coping mechanisms lead to better outcomes for children and which lead to more negative outcomes following daily and major stressors.

Publications: The manuscript for this study is currently in preparation to be reviewed for publication.

Deterministic Emergency Evacuation Modeling Under a Terrorist Threat for Populations with Special Needs

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Project Scope: Presently, the threats of emergencies seem to be more evident than in the past. These emergencies consist of biological threats, chemical threats, terrorist threats, and even natural disasters. With a growing population the government is obligated to invest in a larger public transportation system. Millions of people each day rely on public transportation, which could play a significant role in transporting people with special needs as well as people without cars in time of emergency. With a population growing more dependent on public transportation the planning to serve this demand must be met especially in the time of an emergency. In this study, the main control strategy is to identify the best routing approach in order to fully utilize the available capacity of a public transportation network. The case study for this project is Washington D.C., which has a large metropolitan population that enters the city for business purposes. Considering that this city is the nation's capital, an effective emergency plan needs to be in place. The District Department of Transportation does have several evacuation plans in place, but the purpose of this project is to focus on evacuating people with special needs using the public transportation systems already in place. Bearing in mind that the majority of the people in the city during business hours don't have vehicles and use public transportation to enter the city; the same system is going to have to be optimized to get them out of the city quickly and safely.

Recent Progress: In order to optimize the public and metro transportation systems of the city computer modeling is being used. A worst case scenario will be analyzed in order to ensure that the maximum number of people can be safely evacuated. This scenario would take place in the middle of a work day when business personnel and tourists would be greatest. Using satellite images city roads and highway networks were set up in the computer program. Furthermore, bus and metro lines will be set up in the program following current schedules given by the city.

Future Plans: The intent of this research is to implement more detail and calibrate the developed model to increase its validity. Development of this model seeks to focus on uncertainties of human behavior, traffic demand and the public transit system. Both mesoscopic and microscopic simulations will be used and analyzed.

Relevance to Listed Research Areas: This project falls under the research category of Emergency Preparedness and Response. It focuses on the evacuation of people with special needs in the time of multiple types of emergencies. With this proper planning of optimization of the city's transit system a situation like the one found in New Orleans after Hurricane Katrina can be avoided.

Modeling the Spread of Viral Pathogens in Feral Swine Populations

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Project Scope: Feral swine (*Sus scrofa*) populations continue to grow in the United States, and they have the potential to play a major role in the spread of infectious diseases in both domestic and wildlife populations. Simulation modeling can be used to better understand how viral pathogens can spread throughout a population of feral swine and potentially infect domestic livestock. Understanding those factors leading to disease propagation within and between domestic and wildlife populations is crucial for effective response, control and recovery from intentional and non-intentional disease incursions within the United States.

Recent Progress: Distributional data of wild pigs in California have been collected and analyzed. In addition, the California Wildlife Habitat Relationships model has been used to identify suitable habitats for feral pigs within California. A GIS layer with habitat suitability rankings was created for all land cover types. Another GIS layer representing the locations of all livestock operations was also created and incorporated into the Davis Animal Disease Simulation (DADS) epidemic model. This information was then used to develop a wildlife mobility modeling framework that interfaces with the DADS model to determine the probability of disease entering wild pig populations and factors leading to disease endemicity.

Future Plans: The wildlife modeling framework developed will be applicable to other mobile wildlife species (e.g., deer, elk, and bison) and diseases (e.g., foot and mouth disease, classical swine fever, and brucellosis). Since the model will be able to simulate disease spread in wildlife populations in various landscapes, it can be adapted to other relevant regions in the United States where wildlife are of concern, such as Texas and Yellowstone National Park.

Relevance to Listed Research Areas: Viral pathogens such as foot and mouth disease and classical swine fever are biological threats to the U.S. domestic livestock industry. If introduced, their impact would be economically devastating. Understanding and evaluating disease spread, economic consequences of, and control strategies for disease outbreaks will directly enhance the ability of DHS to prepare for, respond to, and recover from biological attacks, as well as effectively enhance the security of our food and agricultural in the United States.

Identifiability Analysis for Fate and Transport Model of Indoor Releasing *Bacillus Anthracis*

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Project Scope: A model used for modeling the fate and transport of *Bacillus anthracis* spores is developed. For a better estimation of the risk, the quantity and particle size of pathogens released is important, and the process of computing this information for sampling result is termed system identification. In this project, condition number will be employed to evaluate if environmental sampling can identify the quantity and particle sizes of a pathogen release.

Recent Progress: When four different spore sizes are required to be identified, four sampling surfaces are needed from five available sampling surfaces in one compartment model or nine in a two compartment model, respectively. But none of these models can provide a satisfactory condition number which indicates that there exists colinearity internally. If the identification target is reduced to three different spore sizes, the overall condition numbers are decreased, and three forms of two compartments models are identifiable which implies that sampling surfaces from two compartments can reduce colinearity and supply stable results.

Future Plans: In the future, we will focus on parameters' identification issue which is the other element of identifiability analysis. Model sensitivity and uncertainty analysis will be carried out.

Relevance to Listed Research Areas: This project is related to the area of Risk and Decision Sciences. By facilitating the estimation of risks, this work may assist responders in deciding how to sample contaminated environments.

Publications:
Tao Hong, P. L. Gurian and N. F. D. Ward (2009). "Setting risk-informed environmental standards for bacillus anthracis spores." (under review) Risk Analysis.

Time-Dose-Response Model

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Project Scope: The work presented in this poster is a component of a greater effort to develop human dose-response data for pathogenic organisms and present this information in the scientific literature and the general public. Dose-response data in the technical literature are generally from animal experimental studies or from epidemiological studies. Thus a significant thrust of this project is use of such data to develop estimates of microbial risk for human populations. To date, data have been collected for all category A bioterror agents, many category B agents and other agents of concern such as *Vibrio cholera* and *Mycobacterium tuberculosis*. Future work will focus on incorporation of microbial kinetics, epidemiological data and other data and techniques for developing dose response models for pathogens with limited or no experimental dose-response data.

Recent Progress: The classical exponential and beta Poisson dose-response models were modified to include exponential-power dependency of time post inoculation (TPI) or its simplified form - exponential-reciprocal dependency of TPI, to quantify the time effect on dose response. By using the maximum likelihood estimation (MLE) approach, the resulting time-dose-response models were found capable of providing statistically acceptable fits to all tested pooled animal survival dose-response data. These new models can consequently describe the development of animal infectious response over time and represent observed responses fairly accurately. This is the first showing that a time-dose-response model can be developed for describing infections initiated with various pathogens. It provides an advanced approach for future microbial risk assessment frameworks.

Future Plans: We plan to use the advanced time-dose-response model including TPI dependency for describing time to response for human infections

Relevance to Listed Research Areas: Biological Threats & Countermeasures

Publications:

Y. Huang, Y, Bartrand, TA, Haas CN and Weir MH. 2008. Incorporating Time Post Inoculation into a Dose-Response Model of *Yersinia pestis* in Mice. Journal of Applied Microbiology. Accepted for publication in 2009.

Y. Huang, and C. Haas. "Time-dose-response models for microbial risk assessment." *Risk Anal* 2009.

Y. Huang, T. Hong, T. Bartrand, P. Gurian, C. Haas, R. Liu, and S. Tamarakar. "How sensitive is safe? Risk-based targets for ambient monitoring of pathogens." *IEEE Sensors Journal*. Under review.

Simulating the Diffusion of Warnings

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Project Scope: In the event of a natural disaster, technological disaster, or hazardous event, it is very important that warnings effectively alert and motivate individuals to take appropriate actions to ensure their safety. This project involves formulating an axiomatic framework for modeling the diffusion of warnings in a social network through the concept of trust.

Recent Progress: We assess our theoretical framework by modeling the California Wildfires of 2007. One particular interest is in analyzing the Reverse 911 notification system that was used during the wildfire to notify residents to evacuate. We are generating a hypothetical social network of San Diego County with one million nodes. We postulate the social network of households using demographic data estimates from the San Diego Association of Governments. We define two groups of household nodes corresponding to a Hispanic population and a Non-Hispanic population. The edges between the households are defined using probabilities based on their geographic distance and their group. For example, assume that the probability of an edge between close pairs of Hispanic households is much higher than pairs that are farther away. We will apply our framework and calibrate the parameters to perform scenario analyses and examine questions such as, how would the observed results vary if the population's trust in the initial broadcast of warnings changed?

Future Plans: The next step in the model development is to incorporate the concept of an abort. Since false or inaccurate information can lead to mistrust, it is important to be able to quickly abort an earlier warning message, if needed to at a later time. The objective is to impede the diffusion of the inaccurate message by sending an abort message to vaccinate the false information.

Relevance to Listed Research Areas: This project contributes to the areas of command, control and interoperability, and emergency preparedness and response to extreme events. The resulting simulation can serve as a tool for emergency response teams to gain insights on how social communities and demographics may respond to various warning technologies.

Publications:

C. Hui, M. Goldberg, M. Magdon-Ismail, and W. Wallace. "Micro-Simulation of Diffusion of Warnings", In: Proceedings of the 5th International Conference on Information Systems for Crisis Response and Management ISCRAM2008 (Eds. F. Fiedrich and B. Van de Walle), 2008, pp. 424-430 (Accepted)

C. Hui, M. Magdon-Ismail, W. A. Wallace and M. Goldberg, "The Impact of Changes in Network Structure on Diffusion of Warnings", ICDM Workshop on Analysis of Dynamic Networks, 2009.

Nano-Particle Reinforced Composites for Critical Infrastructure Protection

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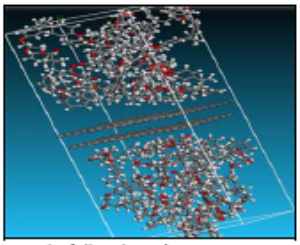
Project scope: This project investigates the use of recent advancements in material, structure, and building technologies for the protection of critical infrastructures, which include governmental buildings, emergency response systems (police stations, fire houses, hospitals), oil and gas pipelines, power and communication transmission towers, etc., against terrorist threats as well as natural disasters.

Recent Progress: A theoretical material database has been constructed for nano-particle reinforced composites and other innovative materials, based on Molecular Dynamics (MD) simulation. A procedure for computing pressure impulse (P-I) curves for has been developed based on TM 5-1300 methodology. A database of these curves has been created for reinforced concrete column sizes and reinforcement ratios representative of low-rise buildings in Mississippi satisfying 2006 IBC provisions. Also, the effect of the blast loading onto CMU infill (non-load bearing) wall panels with and without retrofit was evaluated. The BLS facilities at ERDC were used to evaluate blast response of CMU (both with and without elastomeric nano-coatings or nano films) to blast pressure waveforms. A high-fidelity model has been developed for a 3-story building representing a characteristic RC building.

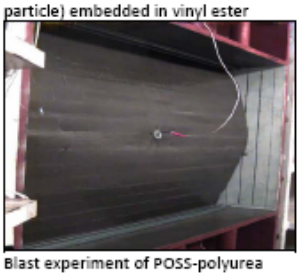
Future Plans: Phase II of the project started two months ago. The scope of the research on phase II will be extended from the present blast focus to multiple hazards, which include fire, earthquakes, and wind.

Relevance to Listed Research Areas: The new structural/building technologies developed from this research can be used to improve the survivability of structures.

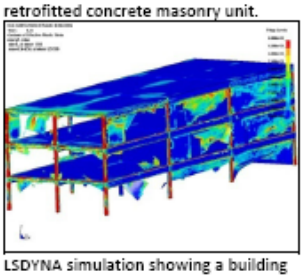
Publications: One conference paper was submitted and three journal papers are in preparation.



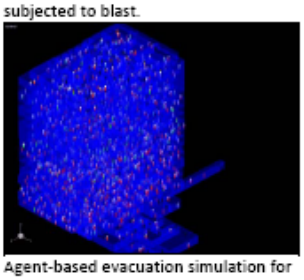
xGnP (exfoliated graphene nano particle) embedded in vinyl ester



Blast experiment of POSS-polyurea retrofitted concrete masonry unit.



LSDYNA simulation showing a building without nano-particle-reinforcement subjected to blast.



Agent-based evacuation simulation for a nano-particle-reinforcement retrofitted building.

Development of Erosion Resistant Levee Retrofitting Material

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Project Scope: Many times, earth levees and dams are not expected to be overtopped. However, the worldwide climate changes and associated severe weather conditions bring unprecedented incidents such as the heavy rain and wind. Overtopping inevitably brings out the erosion of levee materials and subsequent failure. During Hurricane Katrina, erosion was one of the major causes for the failure of New Orleans levee system (IPET, 2007). This study aimed at the development of erosion resistant materials so that levees can be retrofitted. This research includes the development and testing for erosion resistant materials and full-scale performance analysis using numerical techniques. For development and testing, erosion tests for soils with different clay contents, different degree of compactions, and different fiber contents are included. For numerical analysis, 3-D hydrodynamic simulations are included. To simulate the field overtopping condition, development of special testing apparatus that simulate the actual floodwall overtopping, UMETB (University of Mississippi Erosion Test Bed), was included.

Recent Progress: The UMETB was fabricated, calibrated and under operation. Erosion tests were performed for ASTM C-109 sand, levee soils from New Orleans with different clay contents and degree of compactions. Current results show that soils with higher percentage of fine contents showed significant higher erosion resistance. However, the different degree of compactions did not show consistent trend, meaning that the degree of compaction may not be a major factor that governs erosion resistant. With current results, it was demonstrated that increasing the clay content in the levee material is much more effective way of increasing the erosion resistance of levee than increasing the degree compaction.

Future Plans: The erodibility of soils may depend on many factors such as the degree of saturation, clay percentage, fiber content, degree of compaction, and dispersiveness of clay minerals. These factors need to be evaluated. The results of this study will provide the effective levee retrofitting method so that the nation's flood protection system would be more disaster resilient.

Relevance to Listed Research Areas: On August 29, 2005, Hurricane Katrina caused devastation along the Gulf Coast, making it the costliest and one of the deadliest hurricane disasters in history. In New Orleans, levees within flood protection system were overtopped and breached. Subsequently, the levee breaches caused over 1000 casualties and property losses. Therefore, erosion resistant levee system will significantly enhance the resiliency of the nation's infrastructure against natural disasters.

Geotubes Behavior in Galveston During Hurricane Ike

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Project Scope: Geotubes (geotextile material hydraulically filled with soil to form specified dimensions) are used in practice as a means of shoreline protection. There is, however, a focus in literature on the internal stability aspects of geotubes performance where design pressure are specified such that rupture does not occur during filling. Few studies have investigated aspects related to external stability, and effect of wave impact on geotubes' protection function. After Hurricane Ike, which struck Texas in September 2008, most of damage to geotubes was observed to be due to differential lateral displacement and failure in a bearing capacity mode due to scour of the underlying foundation soil. Based on condition assessment of the geotubes after Ike, it was clear that external stability due to storm loading (variable storm surge and wave impact) should be carefully considered in design. The behavior of geotubes installed at Galveston is studied in this paper using loading representative of Hurricane Ike considering the effects of wave loading with the rising water level due to storm surge.

Figure 1. Failed geotube due to scour of foundation soil

Recent Progress: Information on geotubes geometry at Galveston and data on wave loading during Ike were collected for the purpose of this study. Calculations were made considering the effect of wave equivalent forces, and safety factors were assessed for sliding, overtopping and bearing capacity failure modes. Results showed that wave impact led to the instability of geotubes during the storm as evidenced by induced differential sliding and failure in bearing capacity mode. Critical factors leading to instability include wave period and significant wave height, with the most critical cases occurring due to impact with wave breaking at the geotubes, and with occurrence of plunging-type wave for scour.

Future Plans: Compared to other coastal protective structures, geotubes are less expensive, easier to build, and can be widely used not only for shore protection, but also as temporary flood protection measures and as liquid containers during and after storms. Future work to provide cost-effective design includes deterministic and probabilistic analyses of geotubes to establish a baseline design approach in literature. Deterministic analysis will include numerical modeling to assess factors contributing to coupled stability and deformations under loading time history with the progression of a storm loading. Results from the current study has indicated that the most critical loading does not necessarily correspond to the maximum wave height, but rather to wave breaking in relation to the location of the geotubes. Probabilistic analyses will consider past storm history effect on properties of supporting foundation, joint probability of failure in combined modes, and the probabilistic nature of the wave loading.

Geospatial and Temporal Analysis of Barrier Island Systems from Time Series Analysis of Lidar Data: A Case Study of the North Carolina Outer Banks – Hatteras Island

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Project Scope: Beaches, dunes, and barrier island systems are a vital component of coastal and flood defenses in many parts of the world. Understanding how the system responds to long- and short-term forcing functions at various geospatial and temporal scales is critical to safe and responsible coastal planning and management. In order to accurately predict the coastal response to large storms, quantification and characterization of the impact of these storms on barrier islands is required. Previous studies have demonstrated advantages of Airborne Light Detection and Ranging (LIDAR) surveys for evaluating beach changes and assessment of shoreline erosion as well as the quantification of beach and dunes volume change. The high density of lidar data points and almost-annual frequency of mapping offer the possibility of extracting additional information about spatial patterns of coastal dynamics over an eleven year period using raster-based techniques (Mitasova *et al.*, 2009). The purpose of this research is to advance the use of airborne LIDAR as a valuable coastal data source for geomorphologic studies focusing on the geospatial and temporal variability and evolution.

Recent Progress: Recent work consists of deriving maps representing multilayer trends in spatial patterns of elevation change, quantifying dynamics at each cell using standard deviation maps, extracting core surface data and the maximum elevation surface for an elevation envelope and seeing the effect of Hurricane Isabel on the Hatteras barrier island. The specific location of the study area includes inlet (or breach) that occurred during the storm and that was filled in the post-storm period. The listed purpose items are completed. The core volume, that is the undisturbed volume of the barrier of the sampling period reveals stable portion of the subsurface and informs more precisely the vulnerability of the system.

Future Plans: The future plans for the research is to couple the raster based analysis with process based models for a better understanding of the response to time and extreme events. Further, the results will be used to evaluate restorative post-storm design practices.

Relevance to Listed Research Areas: The outcomes of this research will lead to understanding location effects and will provide insights to protect critical coastal infrastructure through the use of advanced visualization and analysis of multilayer trends of spatial features of the coast.

Publications:

H**.** Mitasova, M. Overton, J.J. Recalde, D.J. Bernstein, and C.W. Freeman, "Raster-based analysis of coastal terrain dynamics from multitemporal lidar data" is in press in the (Journal of Coastal Research spring 2009). Kurum, M.; Mitasova, H.; Overton, M., and Hardin, E., "Geospatial and temporal analysis of vulnerable beach-fore dune systems from decadal time series of lidar data" will be submitted to the Journal of Coastal Preservation Planning and Management in late spring, 2009.

Hyperspectral Imaging for Detecting the Application of Biochemical Agents to Food Crops

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Project Scope: Based on information discovered in Afghanistan, the FBI issued a September 2004 warning that terrorists might attempt to contaminate the nation's food or water supply. An act of agriterrorism, either real or perceived, could cause irreparable economic damage to the U.S., where one in eight jobs depends on food production. If deterrence is not possible, then early detection of an act of agriterrorism is critical. Remote sensing technologies, such as hyperspectral imagers (HSI) hold great potential for being an early detection tool. At Mississippi State University, we are designing, implementing, and validating the use of an HSI-based automated target recognition system for detecting when airborne bio-chemical agents (ABA) have been applied to agricultural crops. Likewise, the system could be used to detect false alarms, such as hoaxes aimed at causing disruptions in our nation's food supply.

Recent Progress: We have developed a pattern classification paradigm based on wavelet transforms, multi-classifiers and decision fusion. The algorithm is capable of detecting chemical and biological stress in food crops using very little training (ground-truth) data. This algorithm was tested on handheld data collected in 2008 from corn and wheat crops at a Mississippi State University experiment station. We also collected airborne hyperspectral imagery of our research area.

Future Plans: We plan to test our algorithm on the hyperspectral airborne imagery we have collected, and we will also be developing a user interface for our software.

Relevance to Listed Research Areas: The primary focus of this project is to improve food and agriculture security by providing a way to quickly detect chemical and biological threats to our crops. Every farm in the United States cannot be protected because the costs are prohibitive. Our strategy is to use hyperspectral remote sensing technology to quickly detect an attack once it starts. Once an attack is detected, high intensity, emergency steps can be taken to discover the source of the attack and limit the damage.

Publications: This work has resulted in eight peer reviewed conference publications, presented at 2007 and 2008 IEEE Geoscience and Remote Sensing Symposium and 2007 SPIE Defense and Security Symposium.

US-VISIT: Evaluating the Costs and Benefits of Biometric Exit Monitoring at Land Ports of Entry

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Project Scope: Through the 170 transnational Ports of Entry (POES) more than 300 million travelers cross into the US. Around one percent of these travelers are non-immigrants who travel to the U.S. for a short stay. During their stay, some decide to never leave the U.S. and thus overstay their visa. This problem, along with other security concerns, has become a challenge for the U.S. Customs and Border Protection and Immigration and Customs Enforcement service (ICE). The Biometrics Entry-Exit Monitoring System, which is a part of the US-VISIT program, has been proposed as a solution for tracking the arrival and departure of U.S. visa holders. The proposed value of collecting fingerprints lies in being able to (1) verify the identity of a visa holder, (2) detect individuals using fraudulent documents, and (3) track criminals and terrorists crossing the border. Today, the entry portion of the US-VISIT program is currently in place; however, the exit program has yet to be implemented.

Recent Progress: The goal of this research project is to provide individuals developing and evaluating the US-VISIT exit monitoring systems an assessment of the costs and benefits of current aspects of the US-VISIT exit-monitoring program. The paper reviews "informed compliance" for collecting biographic and biometric information at land Points of Entry (POEs) as a method for meeting the exit-monitoring objectives of the US-VISIT program. In assessing the impact of "informed compliance", the paper outlines the various stakeholders that will be affected by the system and highlights the type of ports for which the program is best suited. To assess the benefits, the paper estimates the coverage and accuracy of the biometric technology in being able to verify the true identity of an individual as well as the rate at which the technology can be expected to falsely identify a person.

Future Plans: The assessment results will provide insights into the larger implications of biometric technology systems at land exits. I will discuss the effectiveness of the biometric technology through quantitative analysis. I will also use qualitative analysis to review the costs and benefits of this US-VISIT Exit Monitoring System.

Relevance to Listed Research Areas: The objectives of the US-VISIT Program are to ensure border security and the integrity of the immigration system. This system protects the private identity of individuals visiting the United States, and enhances security at the border. The US-VISIT Program works in conjunction with other federal law enforcement databases. The entry system has been put in place but the exit monitoring system must still be implemented to accomplish the goals outlined by DHS. This research project will assist the policy makers in determining if the Biometrics Exit System may be successful in meeting the objectives of the US-VISIT Program.

Publications: None at present.

Mitigation Strategy Analysis of Foot-and-Mouth Disease in the Texas High Plains

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Project Scope: A Foot and Mouth Disease (FMD) outbreak would have a significant impact on the US. agricultural industry and the welfare of producers and consumers. The optimal combination of best strategies has been shown to be disease-, location-, context-, and time-specific. While definite answers cannot be provided on the optimal set of mitigation strategies across the total disease spectrum, strategies can be evaluated relative to each other using a disease-, location- and context-specific combined modeling framework like the Forestry and Agricultural Sector Optimization Model (FASOM)/AusSpread model. By examining the possible impact of an FMD disease outbreak in the Texas High Plains, we can examine animal disease management strategies and decision rules to reduce the potential losses in such an unusual event.

Recent Progress: Epidemic simulations from the AusSpread epidemic model were run as perfectly correlated random trials in the FASOM economic model, resulting in a range of welfare results for each of the original 64 scenarios. These random trials were then examined using stochastic dominance with respect to a function in order to rank certain mitigation strategies. We have found that different mitigation strategies have very different impacts on the four types of livestock production operations in the Texas High Plains that were examined. In some cases, the ranking of strategies changes from one type of operation to the next.

Future Plans: The project is now proceeding toward looking at each individual simulation point. In the previous findings, the results we have found are from the simulated average values. Furthermore, we want to investigate the mitigation strategies by using economic tools such as stochastic dominance and probability distribution changes to know how to build a solid disease management skill.

Relevance to Listed Research Areas: This project has direct relevance to the “Social, Behavioral and Economic Sciences” area since more economic analysis is used in this study. Because FMD has an unknown probability but the potential for catastrophic losses combined with a general unpreparedness this project also has relevance to the “Emergency Preparedness and Response" research area.

Publications:

L. Elbakidze, A. Hagerman, L. Highfield, H. Lin, S. Loneragan, M. Ward, B. McCarl, B. Norby, J. Jacobs, R. Srinivasan. "The High Plains Project Report: Version II." FAZD Report, 2008.

Omni-Directional Standoff Terahertz Detection for Explosives

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Research Area: THz-Wave Remote Sensing, Broadband THz Spectroscopy
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Project Scope: In past years, terahertz (THz) technology has been proven very powerful in detecting explosives related compound (ERC) in real time. However, standoff distance detection of ERC remains a big challenge in the field of explosives detection, mitigation and response as well as transportation security. All current THz detection techniques are limited to short detection distance due to the ambient moisture absorption. Here, we aim to develop an innovative technique of THz standoff detection of explosives, hidden weapon or drugs using terahertz-field- enhanced-fluorescence in laser induced air plasma. This technique provides ultra-high, long range sensitivity and unlimited choice of sensor/operator location. It can also work in forward, sideways, or backward detection mode. Furthermore, this technique can be applied to remote sensing in microwave, infrared, and X-ray ranges.

Recent Progress: In this project, we demonstrate a new approach to coherent terahertz detection by measuring terahertz field enhanced fluorescence emission from ultrashort laser pulse induced plasma in ambient air. After the terahertz wave interacts with the plasma, the increase in electron temperature leads to significant enhancement of fluorescence emission from nitrogen molecules/ions. The magnitude of terahertz enhanced fluorescence is quadratically dependent on terahertz field. The THz intensity waveform can be timely resolved. A detailed physical model for this phenomenon is proposed. Unlike any other THz detection methods, this approach allows omnidirectional coherent terahertz detection as well as standoff detection without suffering ambient moisture absorption due to the high transparency to Ultra-Violet fluorescence in air.

Future Plans: (1) Broaden the application of this method to microwave, infrared, and X-ray ranges. (2) Improve system sensitivity/working range. (3) Demonstrate the THz standoff detection of explosives, drugs, or hidden weapons (>30m). (4) Complete fundamental physics study of plasma and EM wave interaction within ps scale.

Relevance to Listed Research Areas: Omni-directional standoff terahertz detection for explosives is related to multiple research fields which include Explosives Detection, Mitigation and Response, Transportation Security; Border Security; and Biological/Chemical Threats and Countermeasures.

Publications: A paper on this new THz standoff detection's principle and application is in preparation. A patent disclosure on this new THz standoff detection technique is being filed.

Using Risk Analysis to Support Law Enforcement Intelligence Targeting

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Project Scope: While intelligence has often been used to inform risk analysis in the allocation of resources, intelligence collection is itself a constrained asset that can benefit from applied risk analysis. Intelligence collection is constrained by limited personnel, limited technical assets, and limited legal authorities. These assets can be applied to examining many threats (terrorism, drug trade, organized crime, etc.), gathering many types of intelligence (financial reports, wiretaps, etc.) for many purposes (disrupting activities, accumulating evidence for a conviction, understanding modus operandi, etc.). This study is developing and evaluating a process to improve the allocation of intelligence collection assets.

Recent Progress: Using an approach based upon probabilistic risk analysis and integer programming, we have developed an initial decision framework to quantify the value of assigning a specific asset to a specific crime.

Future Plans: The next steps involve validating this decision framework with law enforcement practitioners to ensure that the decision realistically reflects law enforcement processes. From here, we can define a maximization problem which can theoretically be maximized to select the optimal asset allocation under the specific constraints. This will allow us to demonstrate proof of concept for this approach, both for consideration of homeland security concerns within law enforcement priorities, and to be extendable to a wider range of intelligence allocation contexts.

An Enhanced 2D Numerical Model for Simulating Dam/Levee Break Floods

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Project Scope: This project develops a GIS-based decision support system to carry out risk and vulnerability studies of water infrastructures based on two-dimensional (2D) numerical flood simulations. My work covers the development of a state-of-the-art 2D numerical model for flood simulation.

Recent Progress: A 2D numerical model called CCHE2D-FLOOD was developed using a first-order shock-capturing finite-volume scheme to simulate dambreak type flows with mixed regimes over a complex topography defined by a digital elevation model (DEM). Important linear features may not be adequately captured by a DEM with large cell sizes. Two-sided cut-cell boundaries based on the immersed-boundary method are used to model linear features in the computation without reducing the cell size. Cut-cell boundaries can be overtopped by the flow. A special version of cut-cell boundary is implemented to represent a one-dimensional (1D) river flow which may exchange discharges with the 2D model. This second option can be used to carry out coupled 1D-2D simulations of levee breaching floods. The enhanced model can be used to carry out detailed studies on a relatively coarse mesh without compromising ease of use and speed.

Future Plans: New types of boundary conditions, faster computations using GPU parallel computing, and improving the cut-cell method will be addressed as development continues.

Relevance to Listed Research Areas: Dams and levees are critical infrastructures whose destruction may have a serious negative impact on our nation's security. About half of the high- and significant-hazard dams in the United States do not have an Emergency Action Plan. Considering that dam failure floods can cause loss of life, damage the environment and man-made infrastructure, and lead to cascading failures in other critical sectors, this project is relevant to food and agricultural security, transportation security, infrastructure protection, emergency preparedness and response, natural and man-made disasters, and risk and decision sciences.

Publications:

Altinakar, McGrath, Fijolek, and Miglio. "Risk and Vulnerability Studies for Water Infrastructures Using a GIS-Based Decision Support System with 2D Numerical Flood Modeling" Proceedings of Int. Conf. on Hydroscience and Engineering, ICHE-2008.

Altinakar, McGrath, Ozeren, and Miglio. "Representation of Linear Terrain Features in a 2D Flood Model with Regular Cartesian Mesh" Submitted to ASCE/EWRI-2009 Conference.

Altinakar, McGrath, Ozeren, and Miglio. "Two-Sided Cut-Cell Boundary Method for Simulating Linear Terrain Features and 1D Stream Flows on a 2D Rectangular Mesh" Submitted to 33rd Biannual Conf. of Int. Assoc. of Hydraulic Engrg. and Res. IAHR-2009.

Examining Vulnerabilities in SCADA/HMI Products

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Project Scope: This project is being undertaken in order to help improve the security of automated systems and processes, especially those that are critical to our national infrastructure. Human-Machine Interface (HMI) software products are used in Supervisory Control And Data Acquisition (SCADA) installations as a means for monitoring and controlling these automated systems. By discovering, studying, and comparing the vulnerabilities in a wide range of HMI software, we hope to improve the overall security of the national critical infrastructure.

Recent Progress: Vulnerabilities have been found and reported in a widely used HMI product. The vulnerabilities found represent architectural and design decisions that reduce the product's ability to adequately defend itself against modern threats.

Future Plans: Other HMI products are being examined for similar vulnerabilities and a set of recommendations and best-practices will be developed that will help remediate these issues. The intent is to help both the vendors in developing more secure HMI products, and to help the end-users of the software layer defenses around existing HMI products that have vulnerabilities.

Relevance to Listed Research Areas: With HMI systems being in-use in many areas of our national critical infrastructure, such as water treatment and power generation, it is very important that these systems adequately implement the security features that they are expected to have. By testing the security of these products in a laboratory environment, vulnerabilities can be remediated before they are used in high-profile or highly damaging attacks.

Publications:

R. McGrew. "Discovering Vulnerabilities in Control System Human-Machine Interface Software" The Journal of Systems & Software (awaiting publication).

Patterns of Decline among Terrorist Organizations

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In an effort to develop an understanding of desistance from violence by terrorist organizations, I conduct macro-level analyses of patterns of decline in terrorist group activity. This research fills a gap in the literature on terrorist group activity with respect to two dimensions. First, research often focuses on the inception of groups while failing to evaluate their decline. Second, prior research has focused on case studies of individual organizations while ignoring patterns of behavior among terrorist groups more generally.

Project Scope: I use data from the Global Terrorism Database to evaluate patterns of activity among all terrorist groups worldwide that have been active for at least one year between 1970 and 1997 (n=420). Currently, I use the number of terrorist attacks per year as the primary metric of terrorist group activity.

Recent Progress: Thus far I have used group-based trajectory modeling to establish baseline trajectories of activity among the 420 terrorist organizations in question. I have conducted preliminary analyses of several covariates, including group ideology, geographic location, tactics, and the time period in which the group was active. I have isolated the patterns of decline among terrorist groups, independent of the absolute magnitude of activity. Finally, I have estimated dual trajectory models to investigate the relationship between patterns of onset and patterns of decline.

Future Plans: Ultimately, I plan to include additional measures of activity (e.g., casualties), extend the analysis beyond 1997 as data become available, collect additional data on group-level covariates that may predict desistance, and account for complex relationships among groups that share a cause by exploring patterns of decline among broader ideological movements.

Relevance to Listed Research Areas: Though until recently research on the decline of terrorist organizations has been somewhat rare, a number of terrorism scholars have hypothesized about likely causes and mechanisms of desistance. Several have noted that the relevant factors and strategies that effectively precipitate desistance are likely to vary by context. However, at this time there have been no systematic evaluations of patterns of decline among terrorist groups or of the hypothesized reasons for decline. This research fosters a better understanding of the behavior of terrorist organizations and reasons for decline in terrorist activity that policymakers can exploit to inform counterterrorism policy.

Publications: This research has not yet been published.

Prognostics and Health Monitoring of Bridge Structures

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Project Scope: The ability to predict the future performance of civil engineering infrastructure enhances the resilience of the built and natural environment. This phase of the project focuses on bridge structures as a key component of the critical civil infrastructure network. The overall objective is to develop a prognostic scheme (i.e., predict and prevent), which is a fundamental shift from current inspection schemes (i.e., fail and fix).

Recent Progress: The research to date has developed an approach for health assessment and the identification of damage location for steel bridge super-structures based on their vibration response. The acceleration response of a structure can provide information on possible changes in mass or stiffness; however, it is practically impossible to recognize these changes in the structure simply by direct comparison of the acceleration data. In this research, two features have been derived to detect the existence and the location of damage in an idealized bridge structure. Acceleration data are obtained from different damage conditions of the structure using finite element simulations. The first feature is derived based on the frequency energy of the vibration response, while the second feature is developed by fitting an autoregressive model to the acceleration response. Both impact and ambient vibrations are considered as load sources. The results demonstrate the ability of these features to detect the existence and the location of damage within a structure.

Future Plans: In the near future, an experimental program is planned to evaluate the suitability of these features in detecting the existence and the location of damage using a laboratory-scale structure. The ability of these features to distinguish damage in the presence of variations due to environmental conditions, such as changes in temperature, will be also determined.

Relevance to Listed Research Areas: The outcomes of this research will enhance the ability to predict the future performance of critical infrastructure (prognostics) beyond what current monitoring schemes and inspections are currently capable of. It will enable inspection, maintenance, and repair schedules that ensure a minimum performance standard.

Publications:

A. Mosavi Khandan, E. Sumner, R. Seracino, and S. Rizkalla. "Effect of Temperature on Modal Characteristics of Steel-Concrete Composite Bridge Structures: Field Testing" *4th International Conference on Structural Health Monitoring on Intelligent Infrastructure*, July 2009, Zurich, Switzerland. (Paper submitted for review).

Economic Analysis of Avian Influenza Information Effects on U.S. Meat Demand Markets

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Project Scope: Avian Influenza (AI) is a potentially devastating animal disease that has gained international attention. Consequently, economic and welfare impacts of outbreaks of AI warrant examination. The question of interest in this study is how and to what magnitude does AI information affect U.S. meat demand in the market? This project will estimate the demand changes in different states for meats (poultry, beef and pork) in a time neighborhood of recent Avian Influenza (AI) outbreaks. Our hypothesis is that demand drops significantly for poultry products over a very short horizon and increases for other meat products. The estimation uses national panel data and the generalized almost ideal demand (AIDS) model.

Recent Progress: Consumers' willingness to pay (WTP) for traceability of poultry products in Beijing, China has been estimated by using survey data based on different treatments of payment card methods including normal payment card, payment card with cheap talk and stochastic payment card. Estimated results are that consumers in Beijing on average had stated a significant WTP for traceability of poultry products which was approximately 9–10% of the base price.

Future Plans: The project is now proceeding toward evaluating food safety information, including positive and negative effects on both demand and supply sides for countries other than the U.S. and comparing welfare changes on an international scope.

Relevance to Listed Research Areas: The project has direct relevance to the "Social, Behavioral and Economic Sciences" area since the study is focused on the economic implications of a major bio-security event in on a national scale and the effects on the meat demand market through changes of consumers' behavioral patterns. The work also addresses "Food and Agricultural Security" by capturing food safety issue effects on demand and supply of meat markets. In addition, the project addresses "Emergency Preparedness and Response" both through its response option focus and also through the development of tools to evaluate or simulate strategy effectiveness.

Publications:

J. Yanhong and M. Jianhong. "Consumer Willingness to Pay for Traceability of Poultry Products: Evidence from Beijing" Submitted abstract for AAEA meeting, 2009.

J. Yanhong and M. Jianhong. "Elicitation Effects of Using Payment Cards on Consumer Willingness to Pay" Working paper.

Resetting Semi-Passive Stiffness Damper

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Project Scope: The Resetting Semi-Active Stiffness Damper (RSASD) has been implemented in buildings in many occasions to mitigate the effects of applied loads on civil structures. While the RSASD has proved to mitigate effects from such loads and overall increase the health of a structure, some drawbacks seem inevitable. Since the device utilizes a computer to analyze the inputs (load intensities), then feeds the information back to the mechanism in order for it to react, a time delay is accumulated, which can bring severe damage to structure. The time delay can bring the mechanism to believe that it has mitigated the effect, but in turn is increasing the severity of the load because of reacting at a time that is Δt past the original computer reading. To account for this issue, a semi-passive mechanism is used. This mechanism eliminates the need for electrical inputs and a computer, and at the same time incorporates a mechanical device which reacts instantaneously to the movement of a building. During blast load activity, a structure may fail due to the improper response of its control device. With this mechanism the Resetting Semi-Passive Stiffness Damper (RSPSD), the effects of blast loads can be mitigated immediately with an accurate level of intensity.

Recent Progress: Since the initial proposal of the RSPSD, the design has been created and analyzed. The mechanism proved to undergo proper functionality while programmed in Mat Lab/ Simulink as a lump mass model and the velocity and displacement of the device under very strict and simple circumstances have been recorded and proved to follow a pattern. The RSPSD undergoes the correct movements to indicate its potential in the task it has been assigned to. The time interval has been shown to have no time delay under ideal conditions and a 7-story model has been designed in Mat Lab to be used in the implementation of the device.

Future Plans: Currently, a force analysis and dynamic analysis is being performed to assign the right dimensions for each member of the RSPSD under extreme blast load conditions. Once this analysis is complete, a model of the RSPSD (including its dimensions) will be simulated, using data of historical blast loads/potential blast loads, and analyzed. Once the simulation process is complete, different structures, as well as different blast inputs will be tested to find the versatility of the device and its potential. The final time delay issue will also be analyzed during the simulation scenarios to compare the data from the previous RSASD.

This mechanism promises to overcome an issue present in the current RSASD and can potentially reduce the amount of damage a building would undergo during explosive circumstances. The device can be used in a variety of structures to mitigate effects of blast loads, which can destroy a building and consequently jeopardize the safety of inhabitants.

Detection of Patulin Mycotoxin using Molecular Imprinted Polypyrrole Modified Electrodes

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Project Scope: Patulin is a polyketide lactone mycotoxin that is produced by *Aspergillus*, amongst other fungi, which is commonly associated with apple juice derived from contaminated fruit. The mycotoxin is very stable and can accumulate within the body causing acute or chronic illness when ingested. Due to the stability of patulin there is a strong reliance on screening products so that contaminated batches can be removed from the food chain. On-site assays based on ELISA are available but are costly and require significant user input. The following reports on the fabrication of a patulin sensor based on molecular imprinted polypyrrole. Molecular imprinted (MI) films are artificial antibodies which are produced by forming a polymer around the analyte (or analog) template. Upon completion of the polymerization the template is removed leaving voids which exhibit high affinity towards the analyte. Unlike biological agents such as antibodies, MI's are robust, stable, cheap and conducive to mass manufacturing. Polypyrrole is a semi-conductor that can switch between conducting and insulating states under the influence of external stimuli. The main advantage of using polypyrrole for MI fabrication is that the binding of target analyte and be instantly transduced into an electrical signal thereby enabling reagentless sensing.

Recent Progress: Imprinted films were prepared by electropolymerization of pyrrole onto a glassy carbon electrode in the presence of patulin. AC impedance spectroscopy was used to monitor changes in the polypyrrole layer during interaction with patulin. From the impedance spectra it was observed that the change in Y" (susceptance) correlated to patulin concentration with a lower detection limit of 20ppb. In comparison, non-imprinted films showed negligible responses to patulin. Equivalent circuit analysis illustrated that the interaction of patulin resulted in a decrease in polymer resistance (Rp) and increase in capacitance (CPE-P). Evidence obtained using a combination of ATR-FTIR and NMR studies have suggested that patulin undertakes a nucleophilic attack on the polaron/bipolanron present on the polypryrrole adduct that results in loss of chain conjugation, hence conductivity.

Future Plans: Further optimization of the patulin sensor will be undertaken to further probe the chemistry between patulin and polypyrrole. In addition, sensor performance will be verified using apple juice spiked with patulin and assess potential interference derived from endogenous anti-oxidants such as ascorbic acid.

Relevance to Listed Research Areas: The work has demonstrated proof-of-principle of fabricating reagentless sensors for detection of toxins in the field. The patulin sequestering property of polypyrrole could find utility in developing smart materials for detection and bioremediation applications.

Publications:

K. Warriner, E. Lai, A. Namvar, D. Hawkins, and S. Reddy. "Molecular Imprinted Polymers for Biorecognition of Bioagents." In: M. Zourob, A. Turner, editors. *Handbook of Bacterial d*etection: Biosensors, recognition *receptors and microsystems*.Ed:. Mohammed Zourob and Antony Turner. Springer Scientific (In Press).

A Dose-Response Model for Equine Encephalitis Viruses, with Age Susceptibility Quantification

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Project Scope: Equine encephalitis viruses (EEV) have been listed as Class B bioterrorism agents and thus, microbial risk assessments for this group of viruses are necessary. Dose-response (D-R) data for Venezuelan (VEE), Western (WEE), and Eastern equine encephalitis viruses (EEE) were obtained from peer-reviewed literature and fit with three D-R models. While the viruses differ genetically, they produce similar host symptoms and are mosquito-borne. Attempts were made to pool data from the different EEVs and from different exposure routes to provide a general D-R model for all EEVs.

Recent Progress: Animal (albino Swiss mice) D-R data for three exposure routes were found in the open literature with age delineation, allowing for the incorporation of an age dependency parameter into the D-R models. Maximum likelihood estimations quantified the goodness of fit for each model. All EEVs were successfully pooled by the intracranial route and quantitatively described using the age dependent modification in a beta Poisson model (α_o : 1.14; α_1 : 8.56×10^{-6}; N_{50o} : 14.71; N_{501} : 0.01). Additionally, at the lowest host age, the subcutaneous and intracranial routes were pooled for WEE using an exponential model (k = 0.05). Only the VEE intraperitoneal route could be described by a beta Poisson model (α: 1.04; N_{50} : 33.72).

Future Plans: The age-dependent D-R models will be expanded to evaluate a group of mosquito-borne Flaviviruses: Japanese Encephalitis Virus, Saint Louis Encephalitis Virus, and West Nile Virus.

Relevance to Listed Research Areas: To our knowledge, this is a first attempt at pooling similar virus types by route and with an age-dependency parameter. Information from this D-R analysis will help inform future risk assessments associated with all EEVs.

Publications: A manuscript describing the full results of this analysis is in preparation.

Spectroscopic Discrimination of Bacterial Species by FTIR, Raman and Computational Methods

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Project Scope: Use of vibrational spectroscopy techniques for characterization of spectroscopic signatures of biological and chemical warfare agents has recently gained considerable attention because these techniques require minimum sample, allow for fast identification of agents, and can be easily adapted to a variety of detection schemes including point detection and remote sensing. The techniques also show high sensitivity and selectivity. The focus of this project is to study the potential use of vibrational spectroscopy for combating bioterrorism.

Recent Progress: Fourier Transform Infrared (FTIR), Raman spectroscopy and Surface Enhanced Raman Scattering (SERS) signatures of several bacterial species are reported. The evaluated microorganisms included *Staphylococcus* spp., *Pseudomonas* spp., *Bacillus* spp., *Enterobacteriaceae* spp. and others. Spectroscopic similarities and marked differences have been found for FTIR and Spontaneous or Normal Raman spectra, and SERS spectra usingsilver nanoparticles assisted spectroscopy. The use of principal component analysis (PCA), discriminant factor analysis (DFA) and hierarchical cluster analysis (HCA) were used to evaluate the efficiency of identifying potential threat bacterial from their spectra collected on single bacteria.

Future Plans: The path forward is to use the same discriminant analysis approach for data acquired by standoff techniques. Finally we want to detect and characterize these microorganisms in air (bioaerosols).

Relevance to Listed Research Areas: The development of spectral libraries and discrimination methods for microorganisms with potential as BWAs will promote the use of spectroscopic based techniques as a quick, cost effective and selective tool for detection and monitoring of biological hazards.

Publications: To be submitted.

Continuous and Pulse Laser Raman for Standoff Detection and Their Detection Limit

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Project Scope: A Standoff Raman Spectroscopy based detection system has been designed built and tested in detection of threat chemicals of importance in Defense and Security applications. Research on Raman standoff detection was realized using continuous and pulsed lasers. The experiments mentioned next were done for continuous laser and are being conducted for Pulse Laser. The prototype system consists of an Andor spectrograph, equipped with a charge-coupled device (CCD) detector (continuo and pulse camera) and laser radiation to block Rayleigh scattered light (notch and edge filters); a telescope; a fiber optic assembly; a continuous single line/frequency laser system operating at 514/488nm (argon ion), 532 nm (frequency doubled Nd:YAG solid state diode laser) and 633 nm (He-Ne ions); and a Nd:YAG laser (with 1064, 532, 355 and 266 nm excitation available) assisted with a dye laser with all the ranges of excitation lines that it allows. The telescope used (MEADE ETX-125, Maksutov-Cassegrain design, 125 mm clear aperture, 1900 mm focal length, f/15) was coupled to the Raman with an optical fiber (non-imaging, 600 μm diameter, model AL 1217, Ocean Optics, Inc). Three lenses collimate the light from the telescope output, which is directed into the fiber optic. Three sets of experiments were done to test the performance of the Standoff Raman Spectroscopy.

Recent Progress: The first experiment consisted in determining the detection limits for each of the high explosives for different laser excitation wavelengths at a fixed standoff distance and frequency of pulse in the case of pulsed lasers. In the second experiment, traces of explosives near the instrumental detection limits were done simultaneously and progressively with the three laser excitation lines and the data at the different excitation lines was used for generate a model for detection using Chemometrics analysis. In the third experiment different gratings were used explore the effect of different resolution vs. throughput and were then used to improve the models used for data analysis.

Future Plans: Begin work on a pulsed laser Raman Telescope. Couple high performance 10 in. RC telescope to high throughput Raman Explorer™ (Headwall Photonics) spectrograph.

Relevance to Listed Research Areas: This work is relevant to Remote/Standoff detection of high explosives and other threat chemicals.

Publications: To be submitted to J. Analytical and Biochemical Chemistry.

Study of Risk Factors Regarding the Application of Remote Public Health Monitors

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Project Scope: The goal of this project is to assess the use of health monitors designed for disaster victims in shelters or quarantine situations. A multi-sensor band on the wrist can remotely monitor heart rates, movement, body heat, and fluids to determine different stages of infections. The bands can assist in monitoring an affected population to measure how quickly and if a disease is spreading. A supply of bands could be *p*reemptively provided to target populations such as military bases, factories, airlines, hotels, reservations, or high risk civic areas. The band could be available to rescue personnel during emergency procedures. In the event of a natural disaster and/or terrorist attack, the band will assist in providing means to monitor a confined population to minimize the spread of disease. However, success of the band depends on the public's choice to utilize the monitor.
For this study, 1), a matrix of risk factors will be developed to assess decisions about health monitors being used during community emergencies. It is proposed that altruism, resistance and civil liberties are risk factors that can influence decisions about health monitors being used during community emergencies. 2) A quantitative survey can assess if these risk factors are relevant. Through a quantitative survey of target populations, the risk matrix about decision making can be verified. 3) After the risk matrix is verified, it can assist in protocols and strategies for implementing the health monitors for community protection in shelters or quarantine situations.

Recent Progress: Research about the risk factors of altruism, resistance, and civil liberties is progressing. Ranked questions are being developed that target these categories of risk factors. Potential sample populations are being considered.

Future Plans: To assess the application of the health monitor for community emergencies, a quantitative survey will target a non-random sample of populations, such as selected businesses, reservations and emergency response services. The assessment survey will be available on the Working Together website for a random sample and for the target populations to access. The assessment will survey decisions based on altruism, civil liberties, and resistance as they relate to cost-benefits of the health monitor. On the basis of the quantified results in relation to the risk matrix, strategies to improve cost benefits during community emergencies will be proposed. Strategies may include marketing and education to engage the community as the beneficiaries.

Relevance to Listed Research Areas: This study focuses on the social, behavior and economic sciences of decision making for community protection. Rather than terrorist decisions it emphasizes community strategies of working together for emergency preparedness and response with transitioning technology about health monitors for shelter and quarantine situations.

Integrated Systems Modeling of Civil Infrastructure and the Environment

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Project Scope: This project aims to create a modeling framework for making engineering decisions to assist in designing and constructing critical civil infrastructure components for enhanced protection against natural disasters in coastal regions. The modeling framework for system-wide performance analysis being developed in collaboration with other engineering projects within this center will compare engineering decisions and identify infrastructure design and mitigation/retrofit choices that improve preparedness for natural disasters.

Recent Progress: A class of mathematical models is being developed to abstract the interactions between failure of a levee and its implications on the transportation network. This includes a representation scheme for (1) failure probabilities, considering multiple failure modes of discrete segments of the levee as a function of levee characteristics and the possible effects of mitigation actions; (2) expected impact on downstream road segments due to potential levee failure; and (3) system-wide performance metrics associated with transportation services, where different metrics can be defined to satisfy different criteria. The models can be extended to incorporate potential damage to bridges and roads consequent to a levee failure, and the time-varying impact on essential transportation services.

Future Plans: The current modeling approach will be extended to create more sets of models with increasing complexities when additional infrastructure system components and the necessary associated interdependencies are considered. We are working to create realistic examples, based on real systems, to test and analyze the models. These models will meaningfully quantify the resilience that engineering design and mitigation/retrofit decisions confer on an integrated civil infrastructure system in coastal regions.

Relevance to Listed Research Areas: The decision framework will aid in analyzing engineering options by deriving useful information about the effects of such options. Planning for enhancing the protection of critical infrastructure system components and the services they provide can be assisted by these more informed decisions. With these tools, coastal regions can be developed to be more resilient when subjected to natural disasters.

Publications: None as of yet.

Dealing with Human Uncertainties in Stackelberg Games

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Project Scope: In security domains, such as border and maritime security, dealing with human uncertainties is important. For example, the ARMOR system deployed at Los Angeles International Airport utilizes game theory for randomization of police patrols in order to avoid deterministic scheduling. Security decisions often have to be made in advance and adversaries are able to act with knowledge of those decisions. Stackelberg games are natural models for such applications in security domains that involve human interaction. In Stackelberg games, one player, the leader (security force), commits to a strategy and the follower (adversary) makes their decision with knowledge of the leader's commitment. Existing algorithms for Stackelberg games efficiently find optimal solutions, but they critically assume that the follower plays optimally. Unfortunately, in real-world applications, security forces face human adversaries who, because of their bounded rationality and limited observation of the leader strategy, may deviate from their expected optimal response. Not taking into account these likely deviations can cause an unacceptable degradation in the leader's reward. To that end we introduce three new mixed-integer linear programs (MILPs) for Stackelberg games to consider human adversaries incorporating (i) novel anchoring theories on human perception of probability distributions and (ii) robustness approaches for MILPs to address human imprecision.

Recent Progress: Given the three new MILPs, we have considered multiple settings based on real, deployed security systems, and compared six different approaches in four different observability conditions, involving 178 human subjects playing 2560 games in total. The final conclusion was that a model which incorporates both the ideas of robustness and anchoring achieves statistically significant better rewards compared to existing approaches.

Future Plans: We plan to create an online platform which will allow for large scale testing of our new methods for a variety of security domains against traditional approaches. We also intend to investigate the effects of lower versus higher-stakes games.

Relevance to Listed Research Areas: Our research utilizes a game theoretic model, namely Stackelberg games, to address security domains where security personnel must make decisions before their human adversaries act with information regarding those decisions. We address the following important concerns within our approach: (i) humans are not perfectly rational and (ii) observation is typically limited and uncertain.

Publications:

"Deployed ARMOR Protection: The Application of a Game Theoretic Model for Security at the Los Angeles International Airport." Proceedings of the Industry Track of the 7th International Joint Conference on Autonomous Agents and Multi-agent Systems, 2008.

"Effective Solutions for Real-World Stackelberg Games: When Agents Must Deal with Human Uncertainties." Proceedings of the 7th International Joint Conference on Autonomous Agents and Multi-agent Systems, 2009.

Nanotechnology and Surface Enhanced Raman Spectroscopy (SERS): Powerful Forms to Detect Explosives

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Project Scope: Nanotechnology has been emerged as an important field in the last years. It has begun impact on everyday life, having many applications in many various fields, including electronics, chemical and biological detection and also in medicine. Nowadays, its impact in detection has growth rapidly and it will high in the future years. By combining nanotechnology to vibrational spectroscopy, it has been possible to detect small amounts of explosives in solutions. Activities in vibrational Spectroscopy, particularly in Surface Raman Enhanced Raman Spectroscopy (SERS), have been done for several years as a powerful detection technique for trace level detection of explosive substances in solutions in our Research Group. The most commonly tested surfaces have been gold, silver or copper nanoparticles. Due the advantages that present the synthesis of nanoparticles via wet chemical method over electron beam lithography (EBL), and nanosphere lithography (NSL) it has converted in our method for metal nanoparticle fabrication. Gold, silver and gold/silver nanospheres have been prepared since the begging of the project. Experimental conditions such as stirring rate, rate of addition of reducing agents and temperature control for were varied in order to have the optimum nanoparticle sizes that gave the best Surface Enhancement Factor (SEF).

Recent Progress: Recent progress on the project has been the synthesis of new nanospheres using copper and also gold nanorods as an alternative shape. Nanorods present large local electromagnetic field enhancements at the ends that make them attractive as good substrates for SERS applications. The focus currently is centered on the optimization of the synthesis of the nanorods. However, they have been aggregated as a film in the cyclohexane/water interface using ethanol as an inducer.

Future Plans: Formation of the controlled growth of silver nanoparticles by laser induction and synthesis of silver nanoparticles by polyol process are currently investigated and the experiments will be optimized. In the laser experiments, by varying the amount of the seed solution and laser wavelength, triangles have been obtained. Due problems on making the SERS experiments in solution, the future studies are focused on the formation of aggregated silver, gold and copper nanospheres and nanorods on glass for transitioning from aqueous media to solid state detection using SERS substrates with high reproducibility.

Relevance to Listed Research Areas: With gold and silver nanospheres and SERS we have detect 10^{-15} g of TNT and DNT via alkaline hydrolysis in solution. Also, preliminary results with nanorods reveal that the films are very homogenous and it was possible to detect 22.7 pg of TNT. We have contributed with our research with a method for detecting of 2,4,6-TNT and DNT in aqueous solution using SERS with very high SEF.

Publications:

O. Primera-Pedrozo, J. Jerez-Rozo, E. De La Cruz-Montoya, et al. “Nanotechnology-Based Detection of Explosives and Biological Agents Simulants, 2008, IEEE Sensors J., 8(6): 963-973.

J. Jerez-Rozo, O. Primera-Pedrozo, M. Barreto-Caban, and S. Hernandez-Rivera. “Enhanced Raman Scattering of 2, 4, 6-TNT Using Metallic Colloids, 2008, *IEEE Sensors J* 2008;8(6):974–982.

Implementation of Sensor Evaluation Activity for Explosive Detection Course

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Project Scope: The objective is to implement the probabilistic evaluation of sensors on a laboratory course for education in explosive detection concepts. Sensibility (positive true), specificity (negative true), false alarm (positive false), missed detection (negative false), the Receiver Operating Characteristics (ROC) figures, have been introduced and estimated for different type of sensors. Discriminate Analysis (DA), Partial Least Square (PLS) and DA-PLS statistical techniques and binary response distributions (alarm vs. pass) have been used for the detection study. The detection methods used for implementation of these methodology are IMS, Fiber Optic coupled (FOC) Raman and Grazing angle FTIR.

Recent Progress: The Course of detection and analysis of explosives and its laboratory (Quim5175 university of Puerto Rico Mayaguez Campus) has been offered in the past four years and this methodology is implemented in the present. The description of the course is: general aspects, chemical and physical properties, and analytical techniques for the detection and analysis of explosives. This implementation is focused to improve this course and will be evaluated with survey by students.

Future Plans: We plan to work in outreach mode to target two year colleges with science and engineering transfer programs to UPRM. We also plan to create modules for high school teachers and students.

Relevance to Listed Research Areas: The understanding of how sensors work supports the area of Explosives Alertness and Response. First educates the community in concepts of explosives detection and hazard evaluation and also promotes the development of detection criteria and proper decision making during sensors development.

Publications: To be submitted to J. Chemical Education.

An Assessment of Formal and Informal Networks across Public Health Response Networks: A Look at Florida's 2004 Hurricane Season

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Project Scope: By most standards, the 2004 hurricane season was the most devastating in Florida's history. Four hurricanes crossed the state in five weeks, causing 47 deaths and costing nearly $50 billion in damage. Most parts of the state were affected by at least one of the storms; many places were hit by two or three. Nearly 1.7 million people were forced to evacuate their homes and response was difficult due to the ongoing nature of the natural disaster. Three years later, many are still dealing with economic and physical repercussions. Although different in size and scope from Hurricane Katrina in 2005, there are many parallels to the difficulties faced by those involved in recovery efforts. Both disasters saw the emergence of new and/or expanded roles for both formal and informal public health response, particularly at the local level, and the integration of these networks as part of standard mitigation efforts. This study emphasizes the successes and challenges to emergency response as identified through interviews with formal and informal networks active during the 2004–2005 seasons. Outcomes will be used to better prepare formal responders for the involvement of informal efforts and to maximize the power and efficiency of those in volunteer and informal response networks among various subpopulations.

Recent Progress: The study focuses on the experiences of those involved in relief efforts following Florida's 2004 hurricane season. Data continue to be collected through in-depth, semi-structured interviews with volunteers, paid staff, and leadership from government agencies, formal voluntary organizations and informal voluntary organizations. Using content analysis, researchers are coding interviews into segments of data by emerging topics. Results are yielding many accounts of victims initiating their own self-rescue and taking part in recovery efforts, asserting their agency and rejecting their "helplessness" in the aftermath of a disaster. Through our research and case studies of disaster relief models, we argue that the role of victims as volunteers should be taken into account when initiating recovery efforts. This is particularly true among underserved and neglected populations such as migrant farm workers, those with questionable legal status, and those of advanced age.

Future Plans: Data suggests that citizens affected by disasters are an effective force for response and recovery with minimal time, training and financial investment. Therefore, this study will further examine the role of victims as volunteers during disaster relief activities, especially in neglected populations. Following a hurricane or other natural disaster, the time it takes for outside assistance to arrive necessitates the involvement of victims in their own rescue, effectively making them "first responders." Victims are in a position to identify areas of concern in the disaster zone and the location of resources. During the rebuilding phase, the input of victims will contribute to community based construction plans, which will address the needs of residents. In addition, the participation of victims in these relief efforts will better prepare them for future disasters.
We continue to focus on neglected populations such as those with unknown legal status, migrant farm workers, non-English-speaking communities, those with medical concerns, of advanced age, and in group care.

Relevance to Listed Research Areas: Study outcomes are guiding the development of several tools, training programs, and workshops to prepare both formal and informal networks for disaster response and recovery.

Publications: Three papers are underway and will be submitted to peer-reviewed journals for publication. Our project team will be presenting results and lessons learned at the Florida Annual Governor's Hurricane Conference. We will also be presenting a practical workshop and training at this conference. Our PI will also serve on two hurricane-preparedness panels in May 2009.

Synthesis of Copper Particle Substrates for SERS Studies on Explosives and Chemical Threats Agents

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Project Scope: The purpose of this project is to develop novel nanomaterials of electrical and optical properties for the future establishment of an electrochemically based sensor to detect explosives and other threat agents. Cu colloidal suspensions were prepared by wet chemistry methods involving chemical reduction using trisodium citrate and hydrazine. Morphology and sizes of the copper particles were characterized using High Resolution Transmission Electron Microscopy. Steadiness varied under conditions such as stirring speed, rate of addition of reducing agent and temperature control. Sizes of nanoparticles prepared ranged from 2 to 20 nm for the synthesized copper seed particles.

Recent Progress: Another novel synthetic procedure to yield copper particles involved varying temperatures and concentrations. At low reactant concentration (0.15 mM), yielded copper cubes, and at high reactant concentrations (0.63 mM) yielded copper spheres. As reactant concentration and temperature is raised, reaction rate of particle aggregation increases, thus affecting surface charge linearity. Average particle size for copper spheres were around ~120 nm, and for cubes side size were around 140 nm. SERS (Surface Enhanced Raman Spectroscopy) studies were done on o- and p-dinitrobenzene, to study the effect of the enhancement of the signal as synthesis temperature was raised. Also to study the effect on the signal of the molecular probes as surface charge varies when particle aggregation reaction rate is increased.

Future Plans: In future experiments our group will study the surface hydrolysis 2,4,6-trinitrotoluene (TNT) in the presence of a strong base such as sodium hydroxide (NaOH) using the copper particles as SERS substrate. We will prepare TNT solutions at different pH values and use it as molecular probe for SERS studies on the cubic and spherical copper particles.

Relevance to Listed Research Areas: Development of sensors for high explosives.

Publications: Submitted

O. Rivera, O. Primera, L. Pacheco, and S. Hernandez-Rivera. “SERS and Density Functional Theory Study of o-Dinitrobenzene on Cu Nanoparticles”, *IEEE Sensors J.*

A Near Real-Time Visualization for Understanding Spatio-Temporal Patterns of Violent Crime in the District of Columbia

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Project Scope: The District of Columbia publishes violent crime incidents to their web-accessible data catalog site (http://data.octo.dc.gov/) in near real-time (one business day delay for processing). This dataset is of particular significance because of its fine precision both spatially (i.e., geocoded to within one-half of a city block) and temporally (i.e., coded to an eight hour work shift). We have developed a robust suite of web-based, space-time geovisual analytics tools to extend the value of the data served from the existing web site. Using our application, analysts can uncover detailed spatio-temporal patterns of DC crime previously unidentified due to data aggregation, as well as generate hypotheses about the etiology of crime clusters to support policy decisions for the prevention of such crimes.

Recent Progress: At run-time, the application loads the violent crime incidences from the DC data catalog site and plots the incidences on a basemap provided by the Google Maps API for Adobe Flash. Selection of an individual point on the map activates an information window with details about the crime. The user can then filter the visualization by space (e.g., police districts, census tracts), time (e.g., calendar date, day of the week, or work shift), and attribute (e.g., type of crime, method of attack). The application also provides linear animation across a user-defined temporal range and cyclical animation across a composite year, week, or day. Finally, the user is able to view crime incidents in context with other relevant information, such as police districts, police/fire stations, transportation depots, and socioeconomic variables reported by census tracts.

Future Plans: We plan on implementing added functionality (e.g., complex textual queries, point aggregation into meaningful enumeration units, and coordinated scatterplot, histogram, and PCP views of the dataset) to support reasoning about the causes of the spatio-temporal crime patterns seen. We also plan to test the utility and usability of the tool with domain experts to evaluate its success in supporting the geovisual analytics of crime data.

Relevance to Listed Research Areas: The project is directly relevant to the Communications and Interoperability Directorate and the Advanced Data Analysis and Visualization research area by implementing established and novel geovisual analytic tools in an easy-to-use web interface. It is also tangentially related to the Social, Behavioral, and Economic Sciences through its case study domain of spatial criminology and incorporation of socioeconomic context variables.

Publications: This is a new project; thus, there are no publications yet.

VALET: Visual Analytics Law Enforcement Technology

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Project Scope: Police records of daily criminal behaviors can be analyzed to provide meaningful information on community needs. As such, we have developed a prototype visual analytics toolkit to aid law enforcement agencies in their analysis of daily criminal reports. Our system uses daily crime report data from any available source [e.g., internal crime records, publicly available crime statistics provided by the SpotCrime web service (http://www.spotcrime.com/in/indianapolis)] and the West Lafayette Indiana Police Department. Our current work focuses on both spatial and temporal modeling of criminal activities as well as the early detection of unusual criminal occurrences. In the temporal domain, we have implemented a time series cumulative summation model to detect unusual occurrences within the data. In the spatial domain, we have implemented a kernel density estimation method, allowing analysts to quickly find and identify areas with unusually large criminal activity reports. Both the temporal and spatial domains are doubly linked so that alerts occurring in one domain may be interactively selected to pull up data in the other domain. Demographic and keyword filtering tools are also available for further drill-down analysis.

Recent Progress: VALET technology provides law enforcement agencies with a suite of visual analytic tools for spatio-temporal exploration of police report record sets and statistics in linked statistical and spatial-temporal views. These tools provide advanced analysis capabilities, allowing analysts to develop and test hypotheses about criminal activities within various areas of their community.

Future Plans: Future plans include a transition from data exploration through visual analytics to predictive analytics in which analysts can view future trends. By viewing the future trends, analysts can do resource management and planning.

Relevance to Listed Research Areas: This work directly relates to the advanced data analysis and visualization field, as we are creating a suite of visual analytics tools dedicated to enhancing law enforcement data exploration for discovery of trends.

Publications:

R. Maciejewski, S. Rudolph, R. Hafen, W. Cleveland, S. Grannis, D. Ebert. “A Visual Analytics Approach to Understanding Spaitotemporal Hotspots” *IEEE Transactions on Visualization and Computer Graphics* (under review).

Detection of Chemical Warfare Agent Simulants and Degradation Products Using Raman Spectroscopy

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Project Scope: Since the September 11th terrorist attack, the world has focused attention on the possibility of use of chemical agents by terrorist organizations directed as threats against troops and/or civilians. In addition to the expected use of chemical agents released to the air, terrorists may also poison water supplies. Several techniques have been employed to detect and identify chemical agents. These include HPLC/MS, GC/MS, IMS, Infrared Spectroscopy, Raman Spectroscopy (RS), among others. Vibrational spectroscopy has the advantage that provides chemical information and has potential for remote sensing. The goal of this work is to develop capability to detect and discriminate chemical warfare agents (CWAs) and degradation products using Raman Telescope technology.

Recent Progress: The first phase of this work was focused in the measurement of spectroscopic signatures of Chemical Warfare Agent Simulants (CWAs) and degradation products of chemical agents using vibrational spectroscopy for the generation of spectroscopic libraries. The chemical studied were DMMP, DIMP, 2-CEES, 2-BAET, 1, 4-thioxane, thiodiglycol sulfoxide, dihexylamine, cyclohexylamine, among others. Raman microscopy experiments were performed at different excitation wavelengths spanned from NIR at 785 nm to the VIS at 532, 514.5 and 488 nm and deep UV region at 244 nm. For the compounds studied, the optimum excitation lines were 488 nm and 532 nm with a laser power of 25 mW. The most prominent bands were at these incident wavelengths were located at 652 and 1444 cm^{-1}. Second phase of the work is the transition from lab based experiments to remote detection experiments using Raman spectrometer coupled to telescope. Spectroscopic signatures of some CWAS as a function of laser power were acquired at approximately 10 m.

Future Plans: Chemometrics combined with Raman telescope data in discrimination studies of chemical agents in field simulated experiments will be explored in the next phase of our work.

Relevance to Listed Research Areas: Anticipation of future attacks requires a wide array of detection capabilities and potential deployment scenarios. RS has the capability for remote sensing, and coupling this technology with chemometrics has the potential to discriminate between chemical agents and interferences.

Publications: Several to be submitted soon.

Source Localization and Boundary Tracking and Prediction of Chemical Plumes

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Project Scope: Accidental gas releases from industrial sites and biological terrorist attacks result in dangerous chemical plumes. To mitigate the effect of these plumes, it is necessary to not only locate but also track their evolution, with the latter problem being more challenging. We have proposed effective solutions to both problems using a group of fixed and mobile sensors, which measure the plume concentration at different locations.

Recent Progress: For a grid of fixed sensors, the plume source is located using two methods based on Nonlinear Gauss-Newton least squares and Stochastic Approximation (SA) algorithms. It is shown that stochastic approximation methods give more accurate results than Least Square methods when dealing with noise corrupted data. An iterative algorithm which uses mobile sensors to estimate the plume source is developed. It is shown that the sensors converge to the plume source after only a few iterations. The latter algorithm uses a smaller number of sensors than the first two methods to achieve the same accuracy. Boundary tracking and prediction is accomplished using mobile sensors. A novel state space plume model is used in the estimating and prediction of the plume evolution. The predicted states of the plume progression are used as reference signals to deploy the sensors using optimal controllers. New measurements obtained from the sensors are then used to update the plume state estimates recursively at every time step. The estimates are further used in estimating the plume boundary thanks to spline interpolation. The process is repeated until the sensors converge to the plume boundary.

Future Plans: Currently the sensors are controlled independently. We plan to develop autonomous consensus and rendezvous distributed coordination motion algorithms to achieve collaborative tracking. A testbed has been set up in the lab environment. A nonpoisoning chemical, e.g., water vapor, will be used to demonstrate the proposed methods.

Relevance to Listed Research Areas: This work is related to the Chemical Threats and Countermeasures research area. An accidental explosion in a chemical factory or a terrorist attack may result in spreading a chemical plume that has to be localized, tracked, and predicted to assess and mitigate its damage.

Publications:

S. Sahyoun, S. Djouadi, and H. Qi. “Source Localization using Stochastic Approximation and Least Squares Methods.” *2nd Mediterranean Conference on Intelligent Systems and Automation* (CISA'09).

S. Sahyoun, S. Djouadi, and H. Qi. “Plume Estimation and Tracking using Mobile Sensors. To be submitted to *IEEE Conference on Decision and Control* 2009.

Competition in the Political Market for Terrorist Violence

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Project Scope: This research project introduces economic and business strategy analysis techniques to the study of competition between terrorist groups in order to explain why they form or turn to terrorism, how they behave, and why some groups discontinue the use of terrorism. This model assumes that there is a demand for political violence, creating a marketplace where terrorists win political and/or material support in exchange for their production of violence. The size of this support revenue stream, production costs, and level of competition within the market all work together to determine the violent behavior of each terror group. Following promising results from a preliminary large-N statistical analysis, I am testing this model on an in-depth case study of Northern Ireland over 30 years to provide a better understanding of how the market forces interact to drive terrorists' strategic behavior.

Recent Progress: I spent nearly five months in the United Kingdom in 2007/2008 gathering data on competition between violent Republican groups from 1968 to 1998. I am currently comparing this data with patterns of violence observed in the Global Terrorism Database. The current presentation will focus on the policy implications of this research.

Future Plans: The research presented here is the basis of my doctoral dissertation (expected completion in 2009). I am presenting an updated version of the Northern Irish "Spiral of Peace" paper at the International Studies Association Annual Conference in New York on February 18, 2009. I will then prepare the paper for publication in a major academic journal.

Relevance to Listed Research Areas: This research is highly relevant to the Social, Behavioral and Economic Sciences because it formalizes a major factor of terrorist behavior that has thus far been dealt with in an ad hoc manner. Recent scholarship has begun to highlight the importance of competition, especially in explaining when groups turn to suicide terrorism, but the issue has not yet been systematically addressed. Moreover, this project challenges the conventional policy wisdom of promoting terrorist discord by demonstrating the potential for monopolist groups to be comparatively more peaceful.

Publications: I have presented this research in a number of venues over the past year. I presented papers and posters on "When Terrorists Compete: The Marketplace for Violence" at the Second DHS University Summit (March 2008), the 49th International Studies Association Annual Conference (March 2008), a START Research Roundtable (April 2008), and the Annual START Conference (September 2008). I also presented a paper on "A Spiral of Peace: Competition, Monopoly and Diversification in the Market for Political Violence in Northern Ireland" at the Mitchell Conference at Queen's University-Belfast, Northern Ireland. This paper was subsequently published in the Quest Journal (Autumn 2008).

A Risk Analysis of *Brucella* Transmission Among Bison, Elk, and Cattle in the Northern Greater Yellowstone Area

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Project Scope: Wild, free-ranging, bison and elk in the greater Yellowstone area (GYA) persist as the last reservoir of brucellosis (*Brucella abortus*) in the United States. There is much debate about "who infects whom" with brucellosis, which complicates disease management. The purpose of this study was to develop a conceptual model to approximate the bison and elk intra- and interspecies contact rates required to maintain current prevalence estimates in elk in the northern greater Yellowstone area. This research focuses on northern GYA wildlife as ecologically and epidemiologically distinct subpopulations of elk and bison. We will use historic and current demographic, seroprevalence, culture prevalence, and spatio-temporal distribution data to parameterize the model. We will estimate contact rates within and between populations of elk and bison by extrapolating prevalence estimates from recent surveys and combining this information with population distribution layers. Home range kernel overlap will be used as a proxy for interspecies contact probability. Expert opinion will also be used to smooth our parameter estimates. Through this process we will determine spatial and temporal transmission pathways and corridors, and differentiate locations and wildlife populations with higher transmission potential. Model development will be built upon an already existing individual-based vaccination model (IBVM) developed by the National Park Service. Stochasticity will be introduced by replacing deterministic parameters with statistical distributions as appropriate. The IBVM incorporates known population demographic data and will be expanded with available spatial distribution information as well as updated information on prevalence of brucellosis. This model will lead to a greater understanding of the potential interspecies transmission dynamics that maintain brucellosis in these two alternative hosts, which is crucial for developing meaningful strategies for the eventual elimination of brucellosis from the GYA. In addition, it may serve as a template for models of other diseases and populations.

Recent Progress: The data collection has concluded. The data analysis is in the final stages and will be completed prior to poster presentation.

Future Plans: This project fits into the National Brucellosis Elimination Zone concept of regionalization of the GYA put forward by USDA-APHIS. It will be expanded to include the entire GYA in an effort to inform policy makers of appropriate boundaries for regionalization.

Relevance to Listed Research Areas: This project is relevant to both the Risk and Decision Sciences and Advanced Data Analysis and Visualization research areas of DHS.

Publications: Two manuscripts are expected from this work and will be submitted during the 2010 calendar year.

Social Attention Theory: A New Look at Knowledge Formation in Groups

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Project Scope: The project represents the culmination of a 2-year research project on the psychological underpinnings of norm formation in groups. Evidence from three experimental studies shows that norm formation in groups does not only depend on the communication among group members, but also involves a transformation in group members' attentional experiences.

Recent Progress: All planned project studies have been completed, data analyzed and made ready for presentation. The primary researcher's dissertation that is based upon this project will be defended on February 13th, 2009.

Future Plans: Future plans involve a study of how group size influences the effect of social attention on knowledge formation in groups. Also of interest is the investigation of the social attention mechanism in existing social groups (vs. experimentally induced).

Relevance to Listed Research Areas: The notion that people's strongest attitudes and beliefs are shaped by their group memberships is a cornerstone of social psychological theory (Asch, 1952; Festinger, 1950; Latané, 1996; Sherif, 1936; Turner, 1991). Particularly influential are the social verification and self-categorization perspectives on knowledge formation, which posit that individuals seek social validation via opinions that are widely shared in or are prototypical to their group (Festinger, 1950; Turner, 1991). Both emerging and diverging from these perspectives, Social Attention Theory (SAT) examines how even when group judgment is unknown, groups can influence norm formation by transforming individuals' attentional experiences. The theory posits that attentional states can vary in their level of experienced sociality. A state of social attention is conceptualized as a result of self-definition in a group at the moment of attention. Importantly, the theory proposes that an experience of social attention on any stimulus heightens the cognitive accessibility of that stimulus. This hypothesis is tested across three studies that prime social attention on such stimuli as achievement vs. vigilance goals (study 1), high vs. low time pressure (studies 2), and simple words (studies 1 & 3). The evidence suggests that even when group opinions are unknown, stimuli under social attention are more cognitively accessible. Implications for scholarship on belief emergence and norm formation are discussed.

Publications: To date there are no publications based on this project.

Surrogate Identification from Functional Relatedness of Genomes of Bacteria Genera with Select Pathogenic Species

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Comparative analysis of the gene complement of pathogenic species within a genus can help infer the variation in the pathogen phenotype. Furthermore, comparison between pathogenic and nonpathogenic species could reveal the basis for the ability of the pathogen to cause disease. There is a continuous need to identify surrogate strains of select pathogens in order to understand various aspects of the pathogen's biology. The growing collection of completely sequenced genomes and in some cases multiple strains of the same species provides an opportunity to test the hypothesis that the differences observed in genome size and gene complement can be used to infer differences in phenotype, ability to cause disease or habitat.

Project Scope: (1) Construct a dataset of finished and unfinished genome sequencing projects of the genus of interest. The dataset will contain size of the genome, the number of genes predicted and the number of genes with functional annotation. (2) Determine how finished genomes are related based on the protein functions encoded by the genes. Methods: Tools on the Integrated Microbial Genomes Database (http://img.jgi.doe.gov/) were used to collect information on finished and unfinished genomes of a genus of interest. Genomes were clustered according to functional profiles such as Clusters of Orthologous Groups (COG) of proteins and Enzyme. Clustering methods used were hierarchical and correlation matrix. The first method provides a spatial relationship of the functional relatedness of the genomes, while the correlation matrix provides correlation coefficients indicating the strength of the relatedness.

Recent Progress: We have generated and analyzed genome clustering trees and correlation matrices for 15 genera that have species categorized as select pathogens including *Bacillus, Brucella, Burkholderia, Campylobacter, Clostridium, Coxiella, Escherichia, Francisella, Listeria, Mycobacterium, Pseudomonas, Rickettsia, Salmonella, Shigella* and *Vibrio*.

Future Plans: We plan to develop a database on functional relatedness of genomes that will permit rapid identification of surrogates that could be useful in studying a select pathogen.

Publications: Students have presented posters at the 5th International Symposium on Recent Advances in Environmental Health Research. Abstracts for presentation have been accepted for presentation at the 6th Annual Meeting of the MidSouth Computational Biology and Bioinformatics Society. A manuscript titled "Functional Relatedness of Genomes of Bacteria Genera with Select Pathogenic Species" is being prepared for publication.

Detection and Association of Infrasound Events in Utah

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Project Scope: How can we remotely obtain information on human activities in a foreign region? Send spies, satellites, use seismology. These are all useful, however, they all have their downfalls. For example; satellites aren't useful during cloud cover and sometimes are hard to decipher. This is where seismo-acoustics can be useful, because we can record signals from interesting events like explosions, aircraft, mines, etc. using networks of infrasound arrays. Infrasound is sound with a frequency too low to be heard by the human ear. The reason it's useful in detection is because it covers long distances and gets around obstacles with little dissipation. The DHS related field of the project was Explosives Detection, Mitigation and Response; and also Advanced Data Analysis and Visualization. The main objective of the project was to use infrasound networks in Utah for a month and have the networks detect noise that could possibly be events. Our goal was to figure out what the events were.

Recent Progress: We used satellite pictures via Google Earth for an initial idea of what the events might be plugging in placemarks where the events happened, and then plugging in known mine explosions, known airports, and earthquakes. We then used the InfraMonitor toolbox, which was recently developed at Los Alamos National Laboratory and Southern Methodist University. The toolbox uses an event location algorithm for event identification. Events were assigned Excellent, Good, and Poor based on the results of the Ground-Truth survey using Google Earth and the event identification analysis using InfraMonitor. A database and query was created to keep track of all events for further analysis. Moreover, the database serves the purpose of being the precedent from which other events in the future can be compared, to see if they match any events in the database.

Future Plans: Future plans for research using infrasound include developing a real-time environment in which data flows into an application and can be processed and looked at right away for quality and for government use.

Relevance to Listed Research Areas: The DHS-related field of the project was Explosives Detection, Mitigation and Response, and also Advanced Data Analysis and Visualization. This research deals with any aspect of the government or any international organizations such as the Comprehensive Test Ban Treaty Organization which try to monitor human activities worldwide. The world is ever evolving and more dangerous. If nuclear weapons are set off in remote regions with cloud cover and with background noise, the government needs to know where they were set off, what time they were set off, and how powerful the explosion was.

Publications: The research that we did in this field was published in the "2008 Monitoring Research Review: Ground-Based Nuclear Explosion Monitoring Technologies."

Trusted-Input for Anomaly Detection of Botnets

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Several studies have estimated the size of numerous botnets to be on the order of a few million infected machines participating in large-scale inappropriate network activities, posing a threat to both financial and national security. These illegal activities include denial of service attacks, sending spam (estimated at 100 billion messages per day), and identity theft.

Current botnet detection methods focus on identifying patterns in bot behavior and thus need to be constantly updated with the highly adaptive (detection-prevention) malware designs. Thus detection methods require a major paradigm shift from reactive to proactive defense, identifying bot behavior as an anomaly to computer-usage patterns and thus leading to more robust and less bot-specific solutions.

Project Scope: We believe that there are intrinsic and fundamental differences between how humans and bots interact with a computer, and these differences can be leveraged by detection software. Specifically, we explore the use of keystroke dynamics (a user's typing pattern) as a cheap, nonintrusive, and reliable biometric approach to botnet detection.

Recent Progress: We designed and implemented a remote authentication framework called TUBA that collects a computer owner's keystroke patters, extracts features, analyzes, and classifies the unique patterns to determine whether the computer has been compromised or is in use by the owner. As part of TUBA, an interoperable and robust trusted-input architecture was designed as a Linux kernel module using the Trusted Platform Module and CryptoAPI to attest the keystrokes, even when super-user access is gained by the bot (or criminal). A series of experiments testing the performance of the framework to human impersonations and statistically simulated bot attacks were conducted, from which the average false positive rates of 4.2% (human) and 1.5% (bot) were found, highlighting the robust detection.

Future Plans: In addition to further optimizing our botnet detection solution, we plan to design and implement a tool using the trusted-input architecture to detect cross-site request forgeries (XSRFs)—the unauthorized forgery of commands from a trusted, though infected, computer to web applications.

Relevance to Listed Research Areas: The input architecture can easily be integrated with existing infrastructure, including virtual private networking tools, Internet banking services, and online chat applications to provide secure, interactive authentication and trusted-input to prevent theft and other losses. Additionally, because of the ubiquitous use of the Internet for communication and commerce, TUBA contributes to the development of a more robust and secure computing infrastructure that will ultimately yield far-reaching societal and economic benefits.

Publications: These results will be submitted to the ACM Conference on Computer and Communications Security 2009.

Data Sharing Middleware for Information Dissemination (INFOD)
Among Heterogeneous Sources

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Project Scope: The objective of this project is to develop a data sharing middleware that is able to handle multiple distributed data sources and dynamically changing items, and to assist in real-time information dissemination across multiple agencies for homeland security purposes. The increasing volume, diversity, and complexity of resources and data continue to raise challenges in sharing and retrieval of information. Getting the right information to the right person at the right time becomes the ultimate goal of the project. Although publish-subscribe systems have enabled communities to exchange information, we argue that these systems have been either restrictive or simplistic, relying on predefined channels for data sharing. The INFOD model introduces a flexible and dynamic framework for brokering information among entities, including publishers who provide the information, consumers who are in need of information, and subscribers who are groups of consumers with common interests. These entities are characterized in terms of vocabularies (such as NIEM, CAP) and their interests as XQuery constraints within the INFOD registry. The registry matches publishers and consumers/subscribers dynamically on the basis of their interests such that information can be routed from the publisher directly to the consumer. The matching mechanism is more effective in handling dynamic events, and consumers would receive essential information even though they did not actively request it. We demonstrate and evaluate the INFOD approach in a First Responder use case scenario which requires information dissemination based on changing event dynamics and varying requirements.

Recent Progress: A prototype of the INFOD model has been built. A simple first responder emergency alert use case with interactive web interfaces has been demonstrated in our recent SERRI review meeting. We are in discussion with emergency responders at UT and ORNL to understand their specific requirements and current state of the art systems being used.

Future Plans: Demonstrate information exchange in an emergency situation at a university/school using the INFOD system. Collaborate with other SERRI projects working on information exchange, and emergency preparedness and response operations.

Relevance to Listed Research Areas: In applications involving emergency responders or inter-agency data sharing across fusion centers, it is critical that information be communicated to the right entity. With a number of policies/constraints to be enforced while sharing such critical information, the INFOD system provides the capability to efficiently communicate the right information to the right person at the right time.

Publications:

Y. Sun, H. Qi. “Dynamic target classification in wireless sensor networks.” ICPR, Tampa, December 2008.

R. Gunasekaran, et al. “INFOD Use Case Scenario & Demo.” Open Grid Forum. Boston, February 2008.

RankClus: Integrating Clustering with Ranking for Heterogeneous Information Network Analysis

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Project Scope: In many applications, there exist a large number of individual agents or components interacting with a specific set of components, and together they form large, interconnected, and sophisticated networks. We refer to such interconnected networks as *information networks*, with examples including the Internet, terrorist cells, research collaboration networks, public health systems, social networks, and so on. Clearly, information networks are ubiquitous and form a critical component of modern information infrastructure. Among them, the heterogeneous network is a special type of network that contains objects of multiple types.

Both ranking and clustering can provide overall views on information network data, and both have been topics of considerable research. However, ranking objects globally without considering which clusters they belong to often leads to meaningless results, e.g., ranking database and computer architecture conferences together may not make much sense. Similarly, clustering a huge number of objects (e.g., thousands of authors) in one huge cluster without distinction is dull as well.

Recent Progress: We addressed the problem of generating clusters for specified types of objects, as well as ranking information for all types of objects based on these clusters in a multi-typed (i.e., heterogeneous) information network. A novel clustering framework called RankClus has been developed that directly generates clusters integrated with ranking. Based on initial K clusters, ranking is applied separately, which serves as a good measure for each cluster. Then we use a mixture model to decompose each object into a K-dimensional vector, where each dimension is a component coefficient with respect to a cluster, which is measured by rank distribution. Objects then are reassigned to the nearest cluster under the new measure-space to improve clustering. As a result, the qualities of clustering and ranking are mutually enhanced. Such a progressive refinement process iterates until little change can be made. Our experimental results demonstrate that RankClus can generate more accurate clusters and in a more efficient way than the state-of-the-art link-based clustering methods. Moreover, the clustering results with their associated ranks can provide more informative views of data, as compared with traditional clustering.

Future Plans: We have been working on scalable analysis of more sophisticated heterogeneous information networks using a star network schema model. The research paper has been submitted to a conference and is currently under evaluation. We will report more technical details on this progress if the abstract is selected for poster in the coming DHS conference.

Relevance to Listed Research Areas: RankClus can be extended for use in many very large-scale, multi-typed networks. For example, for an e-mail network composed of user and text, groups of people with special interests can be discovered, and navigation in the cluster is facilitated by the importance-ranking the model assigns for each user and word in each cluster.

Publications: Y. Sun, J Han, P Zhao, Z Yin, H Cheng, and T Wu "*RankClus: Integrating Clustering with Ranking for Heterogeneous Information Network Analysis*" Proceedings of the 2009 International Conference on Extending Data Base Technology (EDBT' 2009), Saint-Petersburg, Russia, March, 2009.

B and C Class CpG Protect against Intranasal Challenge by *B. pseudomallei* in a Mouse Model

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Project Scope: Different CpG oligodinucleotides (CpG ODN) motifs are known to both influence the adaptive immune response in specific ways and enhance resistance to infection in many animal models. Inhibiting effective development of vaccines and therapies, the correlates for protection mediated by the adaptive immune response during *Burkholderia pseudomallei* infection remain poorly characterized. Thus, studies of different CpG ODN motifs in a mouse model of *B. pseudomallei* infection offer a unique opportunity to both evaluate the effectiveness of different CpG motifs for use as a future adjuvant in vaccine development and elucidate correlates of adaptive protection.

Recent Progress: In this study, BALB/c mice were primed with CpG B-class or C-class ODN prior to intranasal challenge with a lethal dose of *B. pseudomallei*. The treatment resulted in a significant increase in survival compared to untreated controls. Additionally, a comparison of B-class CpG ODN and C-class CpG ODN demonstrated differential protection of BALB/c mice following intranasal challenge. B-class CpG ODN are known to strongly induce B-cell prolifieration and plasmytocite dendritic cell development, whereas C-class CpG ODN exert the same effects as B-class CpG ODN to a lesser extent, as well as inducing IFN-α production.

Future Plans: Future research plans include analysis of the cytokine milieu associated with CpG protection, as well as further characterization of the precise role B-cell mediated immunity plays in protecting against intranasal *B. pseudomallei* infection.

Relevance to Listed Research Areas: With no licensed vaccine available, *Burkholderia pseudomallei*, the etiologic agent for melioidosis, presents a significant threat as a potential agent for bioterrorism because of its high rate of infectivity via aerosols combined with resistance to many commonly used antibiotics. In addition, melioidosis is an emerging zoonotic disease of humans and animals in both Southeast Asia and tropical Australia.

IRIS - A Tool for Strategic Security Allocation in Transportation Networks

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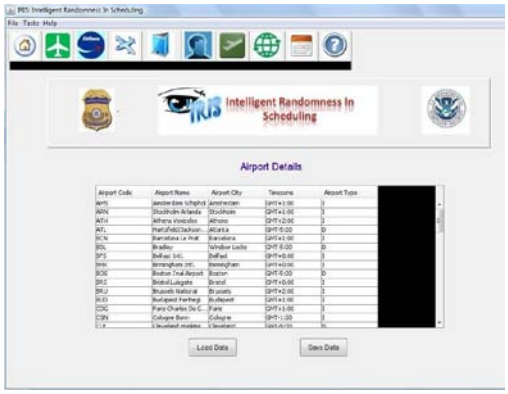
Project Scope: Intelligent Randomization In Scheduling (IRIS) is a software scheduling assistant created for the United States Federal Air Marshal Service (FAMS), which is charged with providing law enforcement aboard U.S. commercial flights. IRIS uses a game-theoretic approach to analyze the risks and costs of the flight safety problem, developing randomized coverage strategies to assist the FAMS. We model the problem as a Stackelberg game, with FAMS as leaders that commit to a flight coverage strategy and terrorists as followers that attempt to attack a flight with full knowledge of the coverage strategy. The project includes algorithmic advances in game theory, as well as implementation innovations that are necessary to create a viable scheduling assistant.

Recent Progress: We have developed new techniques that provide exponential speedups to previous algorithms. For example, previous methods were only able to solve problems with under ~100 targets, but our algorithms can handle over 2,000. We have extended these algorithms to handle the scheduling constraints inherent to any transportation network security problem. An initial version of IRIS has been delivered to the FAMS and is undergoing review for possible incorporation into their scheduling practices.

Future Plans: We continue to iterate with the FAMS to adjust the interface and are aiming for a summer 2009 deployment. Also, while our algorithms are vast improvements over past techniques, there is still room for runtime improvement as we look to expand the size of the problem to 10 times what we currently handle. We are also exploring observational uncertainty and bounded rationality of the terrorists and how to incorporate these behaviors into our model.



Relevance to Listed Research Areas: IRIS has been developed for the FAMS to aid them in their protection of U.S. commercial flights, and the methods used can be transferred to any other transportation network as well.

Publications:

J. Tsai, C. Kiekintveld, S. Rathi, F. Ordonez, and M. Tambe. “IRIS – A Tool for Strategic Security Allocation in Transportation Networks. In: *AAMAS-09 (Industry Track)*, 2009.

C. Kiekintveld, M. Jain, J. Tsai, J. Pita, M. Tambe, and F. Ordonez. “Computing Optimal Randomized Resource Allocations for Massive Security Games.” In: *AAMAS-09*, 2009.

Police Disaster and Crisis Training

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Project Scope: Members of the New Orleans Police Department (NOPD) who worked at the time of the Hurricane Katrina disaster (N = 57) were surveyed and interviewed to determine what training they had participated in prior to the storm was most helpful, which skills learned were most useful, and what types of training could help to prepare officers for similar events in the future. During interviews, subjects were asked if any of the trainings they participated in prior to the storm helped prepare them for dealing with the disaster. Approximately half of those interviewed (51%) responded negatively, expressing that no prior training was helpful; some even indicated that there was nothing that could have prepared them for the storm and the events thereafter. Conversely, those who felt their police training was advantageous cited various beneficial kinds and suggested types of trainings that could assist officers in handling a crisis situation in the future.

Recent Progress: Self-administered surveys which included the same questions were also distributed to and completed by New Orleans Police Department officers (N=575) and are currently being analyzed. While a review of related literature has been completed, more supplemental materials are being sought to answer additional questions that arose in the study.

Future Plans: The Howard University PACER research team has already begun to expand its study of police response during Hurricane Katrina to include a police department in Biloxi, Mississippi. Additionally, aide is being sought to expand the study to also include Fire and Emergency Medical Service personnel in both New Orleans, Louisiana and Biloxi, Mississippi. The additional data from the other agencies will generate a more comprehensive review of disaster training, while allowing for a comparative analysis between agencies and cities.

Relevance to Listed Research Areas: This project is relevant to the research areas of Emergency Preparedness and Response and Social, Behavioral and Economic Sciences as it closely follows the goals of preparedness studies; it aims to determine how to best prepare first responders involved in a crisis for future crisis situations. Furthermore, it seeks to discover the most effective and useful types of training for police and other first responders.

Publications: There have been no publications on this topic since the beginning of the project.

Positive Adjustment in Youth Post-Katrina: The Impact of Child and Maternal Social Support and Coping

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Project Scope: The profound effect of Hurricane Katrina penetrated family structure and dynamics, yet many youth thrived despite this chaos. This project evaluated whether select individual and environmental variables promoted adjustment in Katrina-exposed youth approximately two years after the storm. Specifically, this longitudinal study examined the roles of youths' parent-provided social support, support provided to parents, coping strategies employed by youth, and coping strategies employed by parents, to self-reported and parent-reported positive outcomes in youth (e.g., interpersonal skills, self-reliance, and self-esteem).

Recent Progress: Results indicated that hurricane-related life-threatening experiences during Hurricane Katrina were positively related to personal adjustment, indicating that youth who experienced a greater degree of life threat during the storm also evidenced better adjustment 25–28 months post-hurricane. Further, parent-provided social support was the strongest predictor of child-reported personal adjustment. Coping through diversion, which includes strategies such as distraction and returning to family routines, significantly predicted positive outcome in youth. In contrast, destructive coping strategies, such as property destruction and aggression, were inversely related with positive outcomes post-Katrina.

Future Plans: There are several other ways to conceptualize positive adjustment post-trauma, including the constructs of posttraumatic growth (PTG) and resilience. Predictors of positive outcomes, such as PTG and spirituality, will be examined in Katrina-affected youth and families in a DHS-funded extension of this current project.

Relevance to Listed Research Areas: The current study points to the very important role of parent-provided support to children's positive outcomes (i.e., good interpersonal skills, self-reliance, and self-esteem) post-disaster. This finding supports research emphasizing the importance of familial support in promoting children's adjustment in the aftermath of trauma. Moreover, it is fitting that coping through diversion was nearly as strong a predictor of child-reported positive outcomes as parent-provided support, given that this coping style relies heavily on returning to family routines and eliciting social support. These findings suggest that parents are of paramount importance in the long-term development of positive attributes in youth following large-scale disaster exposure. Assisting parents in recognizing the importance of their role in their children's adjustment post-disaster will help promote the development of positive personal attributes among youth in the face of adversity or traumatic experiences.

Publications:

J. Vigna, B. Hernandez, V. Paasch, A. Gordon, and M. Kelley. "Predicting adjustment post-disaster: The roles of child and maternal coping and social support." In K. Cherry, editor. *Lifespan Perspectives on Natural Disasters: Coping with Katrina, Rita, and other Storms*. (In press.)

Impact of Intelligence on Target-Hardening Decisions

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Project scope: We propose a game-theoretic model to explore how intelligence about terrorist preferences can affect optimal resource allocations for infrastructure protection. We consider a dynamic game with incomplete information in which an attacker chooses which target to attack according to a multi-attribute utility function, and the defender chooses how to allocate her defensive resources. In the second period, the defender also has an opportunity to update her knowledge in a Bayesian manner from actual (or attempted) attacks observed in the first period. Our model allows for both defender uncertainty about the attacker weights on the various attributes in the attacker utility function, and also defender ignorance about unobserved attributes that may be important to the attacker, but have not been identified by the defender. Using this model, we can explore how much the defender should be willing to pay for perfect intelligence that resolves all of her uncertainty, as well as the value of imperfect intelligence about attacker preferences gained from previous attacks. We can then characterize the optimal tradeoff between intelligence gathering and target hardening.

Recent Progress: Preliminary results indicate that the more confident the defender is about her prior estimates of attacker attribute weights, the less she can expect to lose at optimality, and the less she should be willing to pay for intelligence. For the attributes, targets, and prior distributions considered in our case study, we estimate the value of imperfect intelligence obtained from observing a previous actual or attempted attack as roughly 15% of the value of perfect intelligence (with imperfect intelligence becoming less valuable at lower levels of defender uncertainty). In addition, the impact of imperfect intelligence from previous attacks with regard to unknown attacker attributes is more significant for targets that have roughly comparable attractiveness. Moreover, as the importance of unknown attributes grows, the defender's optimal resource allocation begins to depend more heavily on defender target valuations and less on attacker valuations.

Future Plans: We plan to develop computational techniques to extend the model to handle arbitrary numbers of attributes and arbitrary numbers of targets. We also plan to coordinate efforts with other researchers to obtain more realistic multi-attribute utility functions for terrorist preferences.

Relevance to Listed Research Areas: This work relates to Social, Behavioral and Economic Sciences (social and behavioral analyses of terrorist threats), Risk and Decision Sciences, and Infrastructure Protection.

Publications:

V. Bier, S. Oliveros, and L. Samuelson. “Choosing What to Protect: Strategic Defensive Allocation against an Unknown Attacker.” *Journal of Public Economic Theory* 2007;9:563–587.

V. Bier. “Choosing What to Protect.” *Risk Analysis* 2007;27:607–620.

V. Bier, N. Haphuriwat, J. Menoyo, R. Zimmerman, and A. Culpen. “Optimal Resource Allocation for Defense of Targets based on Differing Measures of Attractiveness." *Risk Analysis* 2008;28:763–770.

Dose-Response Model for SARS Coronavirus Via Intranasal Inoculation

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Project Scope: In the spring of 2003, a large outbreak of severe acute respiratory syndrome (SARS) occurred in Hong Kong and rapidly spread throughout the world. Its rapid transmission and high mortality rate made SARS a global threat for which no efficacious therapy was available and empirical strategies had to be used to treat the patients. Since the SARS pandemic, mathematical models expressing the SARS propagation from person to person have been developed to guide discussions about countermeasures against such a disease transmission from community to global scales. However, these models did not incorporate primary exposures or transmission via environmental reservoirs and therefore would incompletely predict the future outbreak because model parameters would not be consistent and highly influenced by numerous factors in environment and human behavior. We aim to develop a dose-response model for SARS coronavirus (SARS-CoV) based on two datasets for intranasal infection of transgenic mice susceptible to SARS-CoV and intranasal infection of mice with murine hepatitis virus strain 1 (MHV-1) which may be a clinically relevant model of SARS. This model focusing on the interaction between human and virus would be robust and applicable to any cases of SARS outbreak.

Recent Progress: The exponential model with $k = 4.1 \times 10^2$ could describe the dose-response relationship of the pooled datasets. The beta-Poisson model did not provide a statistically significant improvement in fit. The 10 and 50% infectious doses of SARS-CoV were estimated at 43 PFU (95% C.I. = 20 to 81 PFU) and 290 PFU (95% C.I. = 130 to 530 PFU), respectively. The estimated infectivity of SARS-CoV was comparable to that of HCoV-229E, known as an agent of the human common cold, and was also similar to those of some animal coronaviruses belonging to the same genetic group. By applying the developed model to the analysis of the epidemiological data of a SARS outbreak that occurred at an apartment complex in Hong Kong in 2003, the dose to apartment residents of SARS-CoV was estimated between 16 and 160 PFU per person, depending on the floor, during the outbreak. The model developed here is the sole dose-response model for SARS-CoV at the present and would enable us to understand the possibility for reemergence of SARS in the future.

Future Plans: The effect of inoculation route (intranasal inoculation vs. aerosol inhalation) on susceptibility will be considered in the developed dose-response model.

Relevance to Listed Research Areas: Risk and Decision Sciences

Publications:
T. Watanabe, et al. “Development of a dose-response model for SARS coronavirus.” *Risk Analysis.* (Under review.)

Non-Commercial Livestock and Poultry Owner Perceptions of CASHN

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Project Scope: Underserved communities of non-commercial livestock and poultry owners (NLPO) have been identified by the veterinary community and FAZD Defense Center as a vital but difficult audience to reach for the protection of our agricultural infrastructure. Feed retailers were identified in a 2006 FAZD Defense Center study as the most common communication channel for distributing animal health and nutrition topics with NLPO communities. In response to these findings, the County Animal Security and Health Network (CASHN) concept was developed, linking state veterinarians to feed retailers through existing Cooperative Extension Systems in each state. In 2008, led by minority serving land-grant institution (MSI) (1890 and 1994) Cooperative Extension Programs in 6 states (AR, KY, MT, NC, TN, and TX), the FAZD Center pilot tested CASHN with 43 counties and 108 feed retailers. Twenty-three CASHN Community Seminars conducted by Extension educators as part of CASHN reached 277 livestock and poultry owners educating participants on CASHN, animal biosecurity, and importance of early detection/rapid response to disease events.

Recent Progress: Seventy-eight percent of participants were interested in receiving information through CASHN, and 85% indicated CASHN would increase their confidence in the animal disease-related information they received because more information from a reliable source would be available. Participants indicated the top 4 sources they got animal disease-related information were (1) veterinarian, (2) county Extension educator, (3) Internet, and (4) radio, but only 4% visited a veterinarian two to three times per month opposed to 51% who visited a feed store two to three times per month. Top four species participants purchased feed for were Beef Cattle (72%), Equine (31%), Poultry (25%), and Goats (11%), and 51% indicated they shared animal disease-related information they received with other NLPO. Animal disease-related information requested by participants was: species specific; publications, radio programs, and websites; disease origins, locations, symptoms, and what to do; and problems with other countries of possible or suspected illnesses.

Future Plans: NLPO perceptions and informational needs will help guide the creation of the CASHN resource kit for use nationwide by state veterinarians and Extension in adoption of the CASHN concept and NLPO educational programming.

Relevance to Listed Research Areas: Understanding of NLPO perceptions of a network such as CASHN and types of information needed will enhance the ability to reach and educate NLPO in a timely manner, reducing the threat of catastrophic foreign animal and zoonotic disease to the U.S. agricultural infrastructure.

Publications:

T. Vestal and S. Degenhart. “A county animal security and health network (CASHN) for early detection/rapid response to foreign and zoonotic animal diseases.” 2008.
http://fazd.tamu.edu/publications/CASHN/CASHN%20White%20Paper.pdf

Integrated GIS-Based Low- and High-Fidelity Flood Simulations

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Project Scope: This study focuses on a few aspects of an on-going project at Jackson State University regarding homeland security in the state of Mississippi. The project proposes an integrated tool for multi-scale storm surge and overland flow (flood) forecast, as well as evaluation of the flood damage on coastal infrastructure including transportation systems in the Mississippi coast. The results from the models are fed into Geographical Information Systems (GIS) for visualization, analysis and decision-making. Floods initiated from the rain, river overflow, and dam-break is another component of the project. By generating information like inundated areas, water depths, flow direction, etc., this study can help the decision making agencies in implementing non-structural solutions such as controlling development in flood-prone areas, planning new dams and managing appropriate land use practices that minimize possible flood damages.

Recent Progress: We have sequentially integrated the open source codes WRF and ADCIRC with in-house overland code. The outputs of the codes include the prediction of hurricane wind velocity and pressure; surge water elevation and velocity; and overland water diffusion, respectively. The other flood simulation has been developed using HEC RAS (U.S Army corps1-D Model) for the three coastal counties of MS.

Future Plans: The hurricane and overland component will be fully automated for the end user, such as state and federal weather and emergency planners. The study plans to disseminate the information to the decision making authorities and public through internet utilizing web based GIS technologies (Arc Internet Mapping Service- Arc IMS).

Relevance to Listed Research Areas: This study is relevant to the following areas of research: Transportation Security; Infrastructure Protection; Natural Disasters and Related Geophysical Studies; and Emergency Preparedness and Response.

Publications:

T. Wan and S. Aliabadi. “Parallel Platform for Multi-Scale CFD Storm Flood Forecast Using Geographical Information System Applications” Abstract of Parallel Computational Fluid Dynamics 2008 Conference, Lyon, France, May 19–22, 2008.

S. Aliabadi, T. Wan, R. Patel, and M. Akbar. “Simulation of Storm Surge and Overland Flows Using Geographical Information System Applications” Abstract of International Conference on Physical Coastal Processes, Management and Engineering, Malta, September 14–16, 2009.

M. Akbar, S. Aliabadi, T. Wan, and R. Patel. “Finite Element Modeling of Overland Flow in Mississippi Coastal Region Including Precipitation, River Flow, and Building Structures” Abstract of USACM's 10th US National Congress for Computational Mechanics, Columbus, Ohio, July 16–19.

In-Situ Scour Evaluation Probe (ISEP)

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Project Scope: Scour is one of the main factors contributing to failure of natural and built environments including bridges, natural dunes, and coastal protective structures. For example, the Department of Transportation estimated that 25,000 bridges are "scour critical" implying the immediate need for remediation measures. Scour occurs when flow velocity is high enough such that induced shear stresses mobilize soil particles. The scour process occurs gradually with time, and scour assessment is considered one of the most critical asset management tools for maintenance and assessment of coastal infrastructures. One technique to assess the scour rate is the Erosion Function Apparatus (EFA) developed by Dr. J. L. Briaud, et al. from Texas A&M University. The EFA approach necessitates the retrieval of specimens from the field, which can be challenging in certain type of soils. In addition, the performance of the laboratory test requires specialized equipment capable of current velocity generation to determine the relationship between scour rate and induced shear stresses. In this proposed study, an in situ approach for assessing scour rate and depth is proposed. The approach is based on performing scour assessment in situ using a specially designed probe with jetting nozzles. The proposed research will proceed in four phases: (i) development of prototype probe and basic premise of operational principles, (ii) correlation of physics on sheet flow to flow in the vertical direction with the induced jet flow, (iii) performance of laboratory proof of concept, and (iv) field testing and verification.

Recent Progress: The proposed approach for assessing scour rate and depth is based on in situ assessment using a specially designed probe with jetting nozzle. The design of the probe nozzle is completed with a pattern of openings through which the water is jetted out with various velocity-time profiles to simulate flow conditions. The general hypothesis of the proposed technique is to correlate the scour rate from vertical jet flow to that obtained from horizontal sheet flow. The probe advances through the soil only if an equivalent volume equal to the probe volume is scoured out. Based on the probe advancement rate, it is hypothesized that a scour rate with depth can be estimated. Given a known stream flow condition with time history for a given storm (i.e., Q vs. t), a simulation of the flow volume can be induced through the probe with any combination of velocity, area, and time. Accordingly, it is possible to simulate long term flow conditions over relatively short periods of testing time.

Future Plans: Currently, a prototype of the proposed device is being manufactured in the NCSU precision shop. The short term plan is to test the probe in laboratory controlled conditions (20 ft deep, 9 ft diameter test pit) and study the basic premise of operational principles. Once performance of laboratory proof of concept is completed, field testing and verification is proposed with possible comparison with results from existing EFA device.

Centers of Excellence

U.S. Department of Homeland Security

The Center for Risk & Economic Analysis of Terrorism Events (CREATE), led by the University of Southern California, evaluates the risks, costs, and consequences of terrorism, and guides economically viable investments in countermeasures that will make our Nation safer and more secure. www.usc.edu/create

CREATE
HOMELAND SECURITY CENTER

National Center for Food Protection & Defense (NCFPD), led by the University of Minnesota, defends the safety of the post-harvest food system by establishing best practices, developing new tools, and attracting new researchers to manage and respond to food contamination events. www.ncfpd.umn.edu

NATIONAL CENTER FOR
FOOD PROTECTION AND DEFENSE
A HOMELAND SECURITY CENTER OF EXCELLENCE

Discrete Science Centers are led by Rutgers University (Lead Center), the University of Southern California, the University of Illinois at Urbana-Champaign, and the University of Pittsburgh. They collaborate with the Institute for Discrete Sciences (IDS), based at Lawrence Livermore National Laboratory, to conduct research on advanced methods for information analysis and the development of computational technologies to protect the Nation. www.dydan.rutgers.edu

DyDAn

MIAS
MULTIMODAL INFORMATION ACCESS AND SYNTHESIS

The National Center for Foreign Animal and Zoonotic Disease Defense (FAZD), led by Texas A&M University, protects against the introduction of high-consequence foreign animal and zoonotic diseases into the United States, with an emphasis on prevention, surveillance, intervention, and recovery. http://fazd.tamu.edu

FAZD CENTER

Center for Advancing Microbial Risk Assessment (CAMRA), led by Michigan State University and established jointly with the U.S. Environment Protection Agency, fills gaps in risk assessments for decontaminating microbiological threats, such as the plague and anthrax—answering the question, "How Clean is Safe?" www.camra.msu.edu

CAMRA
Center for Advancing Microbial Risk Assessment

Natural Disasters, Coastal Infrastructure and Emergency Management (NDCIEM), led by the University of North Carolina at Chapel Hill and Jackson State University in Jackson, MS, will enhance the Nation's ability to safeguard populations, properties, and economies against the consequences of catastrophic natural hazards of coastal regions.

The Center for Border Security and Immigration, led by the University of Arizona and the University of Texas at El Paso, will develop technologies, tools, and advanced methods to balance immigration and

commerce with effective border security, as well as assess threats and vulnerabilities, improve surveillance and screening, analyze immigration trends, and enhance policy and law enforcement efforts.

Regional Visualization and Analytics Centers (RVACs) are led by Penn State University, Purdue University, Stanford University, the University of North Carolina at Charlotte, and the University of Washington. They collaborate with the National Visualization and Analytics Center, based at Pacific Northwest National Laboratory, to conduct research on visually based analytic techniques that help people gain insight from complex conflicting and changing information. http://nvac.pnl.gov/centers.stm

The Center for Island, Maritime and Extreme Environment Security (CIMES), led by the University of Hawaii in Honolulu for maritime and island security, and **the Center for Port Security**, led by Stevens Institute of Technology will develop technologies and tools that will strengthen maritime domain awareness and safeguard populations and properties unique to U.S. islands, ports, and remote and extreme environments.

Center for Explosives Detection, Mitigation, and Response (COE), led by Northeastern University and the University of Rhode Island, conduct research and develop technologies, tools, and advanced methods for the detection, interdiction, and mitigation of the effect of explosives used by terrorists. www.neu.edu/alert

The National Consortium for the Study of Terrorism and Responses to Terrorism (START), led by the University of Maryland, informs decisions on how to disrupt terrorists and terrorist groups while strengthening the resilience of U.S. citizens to terrorist attacks. www.start.umd.edu

National Transportation Security Center of Excellence (NTSCOE) has 3 major components: Research, Education & Training, and Petro-Chemical Transportation. The NTSCOE for Research is led by the University of Connecticut and includes the Mack-Blackwell Rural Transportation Center at the University of Arkansas and the Mineta Transportation Institute (MTI) at San Jose State University. The NTSCOE for Education & Training is led by Tougaloo College in Tougaloo, MS and includes the National Transit Institute at Rutgers University and the Homeland Security Management Institute at Long Island University. The NTSCOE- for Petro Chemical is led by Texas Southern University in Houston, TX. All 7 institutions for the NTSCOE will develop new technologies, tools, and advanced methods to defend, protect, and increase the resilience of the Nation's multimodal transportation infrastructure.

The National Center for the Study of Preparedness and Catastrophic Event Response (PACER), led by Johns Hopkins University, optimizes our Nation's preparedness in the event of a high-consequence natural or man-made disaster, as well as develops guidelines to best alleviate the effects of such an event. www.pacercenter.org

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