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Table of Contents

Archibong, Edikan
Florida A&M University, NCFPD.....1
Extraction, Concentration and Decontamination of PCB's and Dioxins in Food using Small Peptides on Polyaniline Matrix.....2

Baharnemati, MohammadReza
University of Houston, SERRI 3
A Novel Decision Support Tool for Short-Notice Evacuation Planning.....4

Bakhtiyarov, Akshin
New Mexico Institute of Mining and Technology, HS-STEM.....5
Thermally Activated Self-Healing Phenomenon in Metal/Metal/Ceramic High Temperature Coating Systems 6

Behlendorf, Brandon
University of Maryland, START 7
Striking the Nearby: Spatial and Temporal Factors in Terrorist Targeting Strategies 8

Brothers, Michael
University of Illinois at Urbana-Champaign, DHS Research Fellow.....9
Structural and Biophysical Characterization of the Binding/Translocation Domain of *Pasteurella multocida* Toxin and Related Toxins 10

Busch, Catherine
Texas A&M University, FAZD 11
Understanding a Genetic Mechanism for Natural Resistance to Rift Valley Fever 12

Fernandes, Justin
Northeastern University, ALERT 13
Simulation Results for Standoff Detection of Suicide Bombers at Millimeter-Wave Frequencies using a Full Wave Numerical Analysis 14

Friend, Brittany
Elizabeth City State University, CREATE 15
Achieving State, Local, and Tribal Integration using a Risk Matrix and Real Time Reporting in an Effort to Reduce the Economic Impacts of Disaster and Terror Events.....16

Gillenwaters, Erin
Texas A&M University, FAZD 17
A Bovine Defense Strategy: Cathelicidins 18

Gordon, Arlene
Louisiana State University, NDCIEM 19
Assessing Social Support in Youth: Development and Validation of the Social Support Questionnaire for Children.....20

Hecht, Ariel
University of Michigan, DHS Research Fellow 21
The Rotating Magnetic Sandwich Assay: A Novel Biosensor Based on Magnetic Torque....22

Herring, Bryan
Jackson State University, NDCIEM 23
An Efficient Storm Surge Forecasting Tool for Coastal Mississippi using Data Mining 24

Hui, Cindy
Rensselaer Polytechnic Institute, C2I 25
Simulating the Diffusion of Warnings in Large Dynamic Networks 26

Krusemark, Kathryn
Kansas State University, NCFPD 27
Decision-Making Applications in Food Safety and Food Defense 28

Medal, Hugh
University of Arkansas, NTSCOE.....29
Designing Resilient Supply Chain Networks 30

Meir, Talmor
Stevens Institute of Technology, MIREES.....31
Coastal Urban Prediction for NYC.....32

Naghawi, Hana
Louisiana State University, NDCIEM 33
Transit-Based Emergency Evacuation Modeling with Microscopic Simulation.....34

Namvar, Azadeh
University of Guelph, NCFPD.....35
Antibody Modified Conducting Electrospun Nano-fibers for the Extraction and
Detection of Select Agents.....36

Newkirk, Ryan
University of Minnesota, Twin Cities Campus NCFPD & CREATE.....37
Using Multiple Techniques to Assess Terrorism Risk to Food Systems.....38

Taylor, Katherine
University of Texas Medical Branch, FAZD.....39
A Novel Model to Study Lethal vs. Non-lethal Viral Encephalitis.....40

Centers of Excellence 42

COE Directors Contact List.....44

BIOS

AND

ABSTRACTS

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My name is Edikan Edem Archibong; I was born in Nigeria, West Africa. Growing up as a kid, I suffered from chronic asthma that almost took my life at a tender age, but thankfully I was under the care of experienced doctors who recommended that I travel out the country and see if it will be any better as we were experiencing major environmental changes due to pollution. This was the beginning of my stay in the United States.

In 2001 I was accepted into Florida A&M University where I studied and earned my Bachelor's of Science degree in chemistry. After graduation, I joined the Master's in Chemistry program at the same university. It was an honor and privilege for me to go for a research project this past summer under the provision of the United States Department of Homeland Security. Traveling to Canada and Minnesota in a quest to research and build a device so crucial to the national security is an accomplishment that I will always appreciate.

My career objective therefore, falls in line with my pursuit for higher knowledge and expansion of research skills in the areas of biohazard diagnostics. Therefore, I plan to pursue a PhD program in the Fall of 2010, and continue using my chemistry background and expand in the field of innovative research in a way that can also be in compliance with the Homeland Security Mission Statement, and meets with the state-of-the-art technology that will deal with tomorrow's problems.

Research Topic: Chemical Threats and Countermeasures

Extraction, Concentration and Decontamination of PCB's and Dioxins in Food Using Small Peptides on Polyaniline Matrix

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Project Scope: Dioxins and PCB's are highly stable thereby persist in the environment, in addition to accumulating in the bodies of animals and humans. Extraction and determination of PCBs and dioxins in complex matrixes requires multiple step and time consuming procedures. This project utilizes the binding ability of selected small peptides and amino acids incorporated into a polyaniline matrix thus creating a valuable tool for toxin binding in food and water.

Recent Progress: Emeraldine base and emeraldine hydrochloride was synthesized both at room temperature and 0 ^{o}C and glutaraldehyde was chemically bound to the polymer. Glutamine as well as several small peptides were incorporated in the so-prepared matrix. The material was tested for dioxin binding using GC/MS. From another side, fluorescently labeled amino acids and peptides were tested for toxin binding in water solution following the absorption and emission changes during the complexation process.

Relevance to Chemical Threats and Countermeasures and Food and Agriculture Security: PCBs and dioxins are chemical agents of opportunity easily available through industrial waste sources and listed in the CDC list as possible terrorist weapons disseminated through food and water. In case of a terrorist attack fast detection and identification of the toxic substances is crucial for the overall response time. Our research aim is to develop simple, rapid, inexpensive and effective method for toxin detection in contaminated substances. It will be a valuable tool in the hands of the emergency response teams.

Conclusions/Findings: Polyaniline matrix as well as binding peptides were successfully obtained in our laboratory. Their structure and composition was confirmed by ^{1}H-NMR, IR and elemental analysis. Fluorescence changes indicate interaction between the toxins and selected amino acids and peptides.

Future Plans: Future plans include synthesis of pentapeptides, their incorporation in the polyaniline matrix and utilizing them for PCBs binding using GC/MS. Casting polymer films is the next step toward developing an analytical tool for PCBs and dioxin determination.

Publications: This work has not been published yet.

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MohammadReza Baharnemati is a PhD candidate in the Industrial Engineering Department at the University of Houston. Since May 2007 he has worked on evacuation planning systems under the supervision of Dr. Lim.

Research Topic: Emergency Preparedness and Response

A Novel Decision Support Tool for Short-Notice Evacuation Planning

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Project Scope: Preparation is a key component in evacuation planning for natural disasters. Hurricane is a frequent natural disaster that has led to devastating and expensive aftermaths in the United States. A proper preparation with well designed decision-making tools can help reduce damages caused by hurricanes. Such decision support tools can play a vital role for helping Federal and local governments that manage the evacuation procedure of large metropolitan areas with strategic routing and scheduling problems. The goal is to evacuate as many people as possible from the evacuation zones to safe destinations before a hurricane makes its landfall.

Recent Progress: We developed a large-scale optimization model for finding the evacuation paths and corresponding schedules. However, it was computationally expensive due to extremely large network size. Therefore, we have developed an efficient heuristic algorithm to prepare an effective evacuation plan that reduces the computation time from 30 days to 1 minute. Our algorithm determines evacuation schedule for the path of each evacuation zone with a fixed flow rate. In case of any incident during the evacuation period, our information-based rerouting algorithm dynamically determines the evacuation routes and schedules for unpredicted situations. The algorithms are implemented in a C++ environment on a 64 bit Linux platform and the results are integrated into Google Earth™.

Future Plans: We plan to extend our model to consider uncertainties that can arise in the evacuation network.

Relevance to DHS Research Areas: Natural disasters such as hurricanes often disrupt the Gulf Coast regions in the U.S. Well crafted decision support tools emergency preparedness and response can enhance ability for handling the evacuation procedure with a much lower risk. Hence it can save many lives as well as economic losses in the affected area.

Publications:

- G. Lim, M.R. Baharnemati, S. Zangeneh, and H. Parsaei, "A network flow based optimization approach for hurricane evacuation planning", Conference Proceedings, ICOVACS Conference, October 2009.
- M.R. Baharnemati, G. Lim, and S. Zangeneh, "An Optimization Approach for Hurricane Evacuation Using a Fixed Flow Rate", INFORMS Annual Conference, San Diego, October 2009.
- S. Zangeneh, G. Lim, and M.R. Baharnemati, "A Novel Decision Making Approach for Large-scale Short-notice Evacuation Planning Problems", INFORMS Annual Conference, San Diego, October 2009.
- G. Lim, S. Zangeneh, M.R. Baharnemati, and T. Assavapokee, "A simple binary search algorithm for short notice evacuation scheduling and routing", Proceedings of the IIE Annual Conference, IERC 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.

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Research Topic: Explosives Detection, Mitigation and Response

Thermally Activated Self-Healing Phenomenon in Metal/Metal/Ceramic High Temperature Coating Systems

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Project Scope: The recent studies demonstrated that the addition of Cr element to Fe-Al alloys results in a remarkable synergistic effect of a great technological importance. This phenomenon has allowed designing of more ductile alloys and coating composites. The following three primary regions of oxidation can be identified: (I) Fe_2O_3/Fe_3O_4 external scales + Cr_2O_3/Al_2O_3 internal scales, (II) $Cr_2O_3/Fe(Cr, Al)_2O_4$ external scale + Al_2O_3 internal scales and (III) external scale of only Al_2O_3. The role of the high chromium content in producing TGO Al_2O_3 scales at such lower aluminum content and then in binary Fe-Al alloys can be described by considering the transient oxidation phenomena for a Fe-45%Cr-4%Al-0.3%La at $1200^{O}C$.

Recent Progress: Our recent studies have been focused on the self healing mechanisms of heterogeneous architectured metal/ceramic high temperature sandwich thermal barrier coating systems on the surfaces refractory metals. The compositions were obtained on monocrystals (e.g., Nb and/or Mo) and low alloyed Cr samples coated with Fe-45%Cr-4%Al-1%Ni-0.3%RE (La, Y) alloy using EB-PVD technique. SEM, WDS, AES and LM investigations were conducted.

Future Plans: In near future we plan to develop similar coating material for extreme high temperature applications (> 2,000 ^{0}C).

Relevance to listed research areas: The developed self-healing material will be used in crucial areas of the structures (aerospace, civil, military) to mitigate the explosives attack .

Publications:

1. Proceedings of the **Second International Conference on Self-Healing Materials 2009**, June 28-July 1, 2009
2. Proceedings of the **NACE Corrosion 2009 Conference**, March 22-26, 2009.
3. Proceedings of **the 20th Annual Rio Grande Symposium on Advanced Materials**, University of New Mexico, Albuquerque, NM, September 24, 2008, p. 13.

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Brandon Behlendorf is currently a third year Ph.D. student at the University of Maryland, where he serves as the geocoding coordinator for the Global Terrorism Database at the National Consortium for the Study of Terrorism and Responses to Terrorism. He is currently working on several projects, including an examination of the effects of foreclosures on neighborhood levels of crime, assessing the help-seeking behavior of victims of intimate partner violence in a cross-national sample, and understanding the situational determinants of maritime piracy and armed robbery at sea. Prior to coming to the University of Maryland, he was a researcher with the Ohio State Highway Patrol, where he conducted a multi-agency evaluation of a commercial vehicle diversion program and assisted in the creation of risk management programs and assessments for the Ohio Department of Public Safety. From 2006-2008, he served on the Traffic Law Enforcement Committee for the Transportation Research Board of the National Academy of Sciences. He has an M.A. in education administration from Ohio State, and a B.A. in history and religious studies from the University of California at San Diego.

Research Topic: Social, Behavioral and Economic Sciences

Striking the Nearby: Spatial and Temporal Factors in Terrorist Targeting Strategies

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Recent research on both crime and Improvised Explosive Devices has demonstrated that the occurrence of a single incident elevates the risk of similar incidents occurring nearby within a short timeframe. However, prior analyses have not addressed the temporal dependency of these events; that some events may inherently spur or induce others to follow. To address this relationship, I use a combination of spatial and non-linear modeling to identify situational factors that differentiate between events which amplify risk of future nearby attacks and events that suppress this risk. I then examine results at the group-level to determine differences in attack recency and nearness between various terrorist entities.

Project Scope: I use data from the Global Terrorism Database to evaluate spatial patterns of activity among terrorist groups operating in Spain between 1970 and 2007. Incidents were coded to the latitude and longitude of the centroid for the city/village/town where the incident occurred through a combination of automated and manual processes utilizing open source geospatial intelligence. Ninety-four percent of all incidents in Spain received a coordinate.

Recent Progress: Using this data, I conducted Knox analyses using multiple spatial and temporal bandwidths to calculate the spatio-temporal dependency of incidents. In addition, I created dyads measuring the distance in both space and time between an event and a subsequent event in time to identify all possible spatio-temporal relationships. These dyads were used to classify incidents as originating, near-repeats, or non-patterned events for the multinomial logistic regression modeling.

Future Plans: Ultimately, I plan to incorporate other exogenous factors, like specific counterterrorism operations, to determine whether the elevation of risk is sensitive to governmental interventions. In addition, inclusion of terrorist group activities (such as splits or achievement of specific political aims) would assist in understanding how group dynamics shifts timing and location of terrorist events.

Relevance to Social, Behavioral, and Economic Sciences: Each occurrence of a terrorist attack prompts policy makers to consider the potential risk of additional attacks to follow. For example, a highly-lethal terrorist attack could attract attention by those interested in perpetrating more violence and elevate the short-term risk of subsequent attacks, or draw increased surveillance of terrorist groups by authorities and suppress the risk of subsequent attacks. Understanding the factors of a terrorist incident which differentiate between these responses would be beneficial for the formation of effect counterterrorism interventions.

Publications: This research has not yet been published.

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Michael Brothers is a 2nd year graduate student in the Department of Chemistry at the University of Illinois-Urbana Champaign. He is a joint student under Dr. Chad Rienstra and Dr. Brenda Wilson, studying the biophysical characteristics of toxins, primarily using Solid State Nuclear Magnetic Resonance (SSNMR). His focus currently is on *Pasteurella multocida* toxin and the related dermonecrotic toxins, which has implications for humans and for livestock. He is also developing methods to accelerate structure generation using SSNMR data to score prospective models generated using homology-modeling programs.

Michael received his Bachelor of Science degrees in chemistry and biology in 2004 from the University of Cincinnati, graduating summa cum laude and receiving the McKibben award as the "Most Outstanding Male Graduate from the McMicken College of Arts and Sciences."

Previously, Michael has worked for Sandia National Laboratories under Dr. Ken Sale modeling molecular springs, for Dr. Suri Iyer at the University of Cincinnati synthesizing sugars that bind to Shiga toxin, and for Pittsburgh Plate Glass synthesizing polymers to be used to replace commercially used polymers such as bisphenol A and polyvinyl dichloride. He also continues to work with Valley Forge Composite Technologies on development and production of the next generation of airport screeners and helped design LOKI, a long-range nuclear explosion detection system.

Research Topic: Biological Threats and Countermeasures

Structural and Biophysical Characterization of the Binding/Translocation Domain of *Pasteurella multocida* Toxin and Related Toxins

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Relevance to listed research areas: *Pasteurella multocida* is a zoonotic bacterium that causes significant economic damage each year. *Pasteurella multocida* Toxin (PMT) is its primary virulence factor and is the most potent known mitogen of the biological toxins characterized. PMT is a biosecurity threat to pets, livestock, and humans. Currently there are no anti-toxins available for PMT or related toxins. We are studying PMT to understand the structure and function of the binding and translocation domains of PMT (N-PMT) and related toxins that are potential bioterrorism agents. These studies will allow us to generate novel therapeutics for PMT, including using N-PMT as a delivery vesicle for anti-toxins.

Project Scope: We wish to characterize N-PMT's binding partners on the cell surface, how it initiates cellular uptake, and how it releases the catalytic domain into the cytosol. We are using surface plasmon resonance, circular dichroism, confocal microscopy, and other methods to determine N-PMT's biophysical characteristics and to guide the selection of appropriate sample conditions for solid-state NMR (SSNMR) spectroscopy. Acquisition of atomic-resolution structural details will then allow us to develop novel therapeutics.

Recent Progress: Perturbations in the secondary structure of N-PMT as a function of pH have been collected and analyzed. Data characterizing perturbations of secondary structure in the presence of lipid micelles at physiologically relevant pHs have also been collected and analyzed. Binding data to synthetic vesicles of various lipid compositions and to natural membranes have been collected and analyzed. The data collected supports that detergent resistant rafts play a vital role in cell-mediated endocytosis of the toxin. It also supports that acidification of the endosome causes N-PMT to embed itself within the lipid bilayer, preserving its secondary structure. This would support the belief that N-PMT forms a pore through which the catalytic domain is released into the cytosol. Preparation of isotopically labeled samples has been optimized. Acquisition and analysis of this high-resolution 2D data proves that we can use SSNMR to interrogate the structure using 3D experiments.

Future Plans: We are determining whether co-localization of N-PMT to the endosome occurs in tissue culture upon depletion of membrane components. We are acquiring spectra and making new samples in order to make assignments for N-PMT. We will capture N-PMT in lipid vesicles and acquire SSNMR data to determine the structure of the translocation domain at low pH. We will apply the methods developed and use homology modeling to study related dermonecrotic toxins from Bordetella (DNT) and *Escherichia coli* (CNF).

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After having graduated magna cum laude (GPR 3.8) with a B.S. in biomedical science from Texas A&M University (TAMU), I am now in my fourth year of graduate study earning a Ph.D. in genetics at TAMU. Having completed my required coursework for the program, I am currently maintaining my 4.0 GPR while continuing my research. I have presented my research at the Texas Genetics Society Annual Meeting 2009, the Genetics Graduate Student Association (GGSA) Spring Symposium 2009, the FAZD Center Annual Meeting 2009, and at a seminar at the University of Texas Medical Branch in Galveston, Texas, in 2009. I am a recipient of the Cary N. Smith '34 Memorial Academic Excellence Award (2007-2008), the GGSA Travel Award (2009), the TAMU College of Veterinary Medicine and Biomedical Sciences (CVM-BS) Graduate Fellowship (2009), the CVM Graduate Student Association Travel Award (2009), and the TAMU CVM-BS Graduate Student Scholarship Award (2009-2010). I also received an award for Exceptional Performance as a Genetics Teaching Assistant for my work teaching undergraduate genetics labs in 2006-2007. Additionally, I have served as the GGSA Representative to the Graduate Student Council (2008-2009) and as the GGSA Recruiting Chair (2009-2010). My research interests include the investigation of the genetic sources of natural resistance to diseases, particularly those which present potential bioterrorism threats, and the development of applications of those methods and mechanisms that can transcend species barriers.

Research Topic: Biological Threats and Countermeasures

Understanding a Genetic Mechanism for Natural Resistance to Rift Valley Fever

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Research Topic: Biological Threats and Countermeasures
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Project Scope: Rift Valley Fever (RVF) virus causes disease in both humans and livestock. Inbred rat strains show similar characteristic responses to the disease as humans and livestock, making them a suitable model species. Previous studies have shown that Lewis (LEW) rats are resistant to RVF hepatic disease as compared to the highly susceptible Wistar-Furth (WF) strain, and that this resistance trait follows the pattern of a single dominant gene inherited in Mendelian fashion. We are employing the techniques of backcrossing, genotyping, and subsequent challenges of various rat litters with RVF virus to narrow down the prospective genomic region containing this gene and facilitate its identification.

Recent Progress: We have performed genome scans of the WF and LEW strains and have produced various successful genetic crosses, including one rat containing recombination in our prospective genomic region, which have subsequently been genotyped and challenged with RVF virus.

Relevance to Biological Threats and Countermeasures: Infection with RVF virus causes high mortality and nearly 100% abortion rates in domestic ruminants, especially those of European origin. Thus, RVF is a disease of great economic and agricultural importance and is potentially a frighteningly effective weapon of bioterrorism, particularly due to its ability to infect humans as well as livestock. This threat has been recognized by the CDC and the USDA, both of which have classified the virus as a select agent. It is also one of the three primary animal diseases being focused on by DHS's FAZD Center and has been identified as one of four high-priority threats by the Foreign Animal Disease Threats Subcommittee. Understanding the mechanism by which these resistant rats survive infection will provide a basis for developing protection against the disease for both livestock and humans.

Conclusions/Findings: We have thus far narrowed the genomic region containing the gene conferring resistance to a ~1MB region, containing 37 annotated genes, on the distal end of rat chromosome 3.

Future Plans: Through further techniques of expression microarray studies, sequencing and polymorphism scans, development of transgenic and knockout rats, and studies of regions of homology, our final goals are to identify a candidate gene, to elucidate the method by which these rats are able to resist RVF disease, and to determine how that resistance can be translated to or reproduced in other species, including livestock and humans.

Publications: This research has not yet been published.

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Justin L. Fernandes was born in Denver, Colorado, in 1985. He received his Bachelor of Science degree in electrical and computer engineering (magna cum laude) in 2008 from Northeastern University in Boston, Massachusetts. He is currently pursuing a Master of Science in electromagnetics at Northeastern University, where he received a research assistant fellowship. His interests include computational electromagnetics, synthetic aperture radar, and time-frequency signal analysis.

Research Topic: Explosives Detection, Mitigation and Response

Simulation results for standoff detection of suicide bombers at millimeter-wave frequencies using a full wave numerical analysis

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Project Scope: The deaths of innocent civilians due to suicide bombers wearing concealed body-worn explosives is an ever increasingly important issue of national and international security. Multiple modalities are currently being researched to determine the presence of explosives on people, including observing and following individuals, identifying explosive residues or heat signatures on the outer surface of their clothing, or characterizing explosives using penetrating X-rays or terahertz wave radar. However, the most important detection situation is to detect suspicious individuals at a standoff distance (10 to 50 meters). At present, millimeter-wave (MMW) radar is the only modality that can penetrate and sense beneath clothing at a standoff distance without causing physical harm. Recent advances in digitally controlled FMCW radar frequency sources are making ultra-wideband (UWB) imaging at MMW frequencies a more realizable and cost efficient solution for remote sensing applications.

Recent Progress: Using a two dimensional transverse magnetic (TM) finite difference frequency domain (FDFD) full wave analysis, various MMW FMCW radar systems have been simulated on a standard desktop personal computer. It has been found that at conventional standoff distances, using basic Fourier based imaging yields poor reconstruction because it fails to account for the radar being in the near-field of scattering from a human body. A manual focusing technique using the Raleigh-Sommerfeld formula has been developed to make high resolution images with scattered field data from the FDFD analysis. It has also been found that a wide-aperture multistatic system is necessary to obtain adequate cross-range resolution to distinguish explosives concealed on human bodies.

Future Plans: Based upon simulation and previous experimental results, a far superior radar configuration is being developed by our international partners at the Fraunhofer Institute for High Frequency Physics and Radar Techniques in Wachtberg, Germany. The new system is multistatic, which will deliver better cross range resolution, and has a digitally controlled frequency source, virtually eliminating phase noise which corrupted previous experimental data. A new measurement campaign will be conducted to validate simulation results and test new signal/image processing algorithms.

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. The ability to simulate multiple system configurations with a full wave analysis is vital to developing an optimal solution with time and cost efficiency.

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My name is Brittany Friend. I'm currently a sophomore at Elizabeth City State University and am also a part of the ROTC program. The abstract I have submitted is a project I have been traveling and doing research on through Applied Research in Environmental Science (ARIES)

Research Topic: Emergency Preparedness and Response

Achieving state, local, and tribal integration using a risk matrix and real time reporting in an effort to reduce the economic impacts of disaster and terror events

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Project Scope: Designed and implemented by a student team from the CREATE sponsored Working Together for A Safer Tomorrow (WTST) program, this project applies a two-step model to determine the ability of multi-jurisdictional, demographically diverse areas to integrate resources with the goal of operating cooperatively as self-sustaining communities or campus sites in the event of natural disaster or terror attacks. First, a risk matrix is used to determine a risk ranking of regional disaster and terror events. Second, an area in the study region is chosen and a real time tri-level status report is conducted by area stakeholders. An integrated operability score, or IOS, is then calculated to determine integrative and cooperative regional response capabilities. As the model is incorporated for each area, a cumulative regional integrated operability score, or CRIOS, becomes apparent. The broader impact of this study ranges, for example, from a.) The creation of a risk ranked database that can be used for the establishment of resource allocation priorities based upon the CRIOS, to b.) The development of qualitatively derived statistical indicators related to stakeholder perceived abilities to function as self-sustaining communities or campus sites in the event of a natural disaster or terror attacks, to c.) The reduction of economic impact of disaster and terror events, which is in alignment with CREATE's mission.

Recent Progress: In October 2008, this project became directly aligned with the January 2009 Homeland Security's mission relevant directive requiring local, state, and tribal integration. A pilot model was field tested in the Pacific Northwest, results have been submitted to the WTST student faculty mentor.

Future Plans: The model is to be introduced for state, local, and tribal leaders during symposia sponsored by WTST. Once the model is employed, strategies incorporating the integration and shared utilization of regionally available human and material resources can be coordinated that enhance response capabilities.

Relevance to research areas: This project is related to the Social and Behavioral Sciences research area via the introduction and application of a user friendly model designed to promote diverse entities to work together to identify areas within to operate as self-sustaining communities/campus sites in catastrophic events.

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I received my Bachelor of Science degree in biomedical science at Texas A&M University in 2005 and entered the genetics doctoral program in the fall of 2006. The purpose of my research has been to characterize a gene family of the innate immune system of cattle called cathelicidins. I presented my research at two genetics conferences in 2008, one of which was the Plant and Animal Genome XVII Conference in San Diego, CA. It was at this conference that I was awarded the Neal A. Jorgensen Genome Travel Grant. Also in 2008, I was awarded a graduate fellowship in animal biotechnology and genomics from the United States Department of Agriculture (USDA) as part of the USDA Food and Agriculture Science National Needs Graduate and Post-Doctoral Fellowship Grants Program.

After graduation, I expect to continue conducting research in genetics, with emphasis on uncovering genetic foundations for mammalian diseases. I believe characterization of the genetic background of both human and animal diseases is paramount for medical diagnoses and will facilitate novel treatment regimens.

Aside from my research, I am also a volunteer and an active member of Search Dog Network, a canine search and rescue team that serves the Brazos Valley in TX. I serve as a canine handler and am training a Human Remains Detection canine. As a canine team, we are both deployable and certified to work missions in the state of Texas.

Research Topic: Food and Agriculture Security

A Bovine Defense Strategy: Cathelicidins

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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, segmental variation in the bovine CATHL gene family could potentially underlie inherited differences in innate immunity and resistance to these and other diseases. The purpose of the present study was to characterize copy number variations (CNVs) within the bovine CATHL4 locus. Quantitative real-time PCR (qRT-PCR) of genomic DNA for 100 animals representing 29 diverse *Bos taurus* and *Bos indicus* breeds revealed vast differences in the number of CATHL4 copies. Similar variations were revealed in the mRNA from neutrophils, suggesting that transcriptional products quantitatively correlate to genomic CNVs. Infectious diseases of cattle result in part from an animal's inability to resist invading pathogens. Therefore, developing a firm understanding regarding the effect CNVs have on bovine innate immunity may enhance our ability to defend against devastating animal disease outbreaks.

Recent Progress: CATHLs are expressed in circulating neutrophils, therefore a bactericidal assay is underway to determine the killing capacity of neutrophils with high and low copy numbers of CATHL4. This research will provide further insight into specific CATHL functions and their role in host-pathogen interactions throughout the body.

Future Plans: As a case study, animals from a typical animal feeding operation, such as a feedlot, will be genotyped for CATHL4 CNVs, and their medical records reflecting the duration of their time in the feedlot will be scrutinized for association between respiratory sickness and CNVs. If coupled with a simple qPCR genotyping test for CNVs, the results of this phase of the project will directly influence how U.S. cattlemen implement novel treatment regimens for sick cattle.

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: Gillenwaters EN, Seabury CM, Elliott JS, Womack JE. Sequence Variability and Polymorphism Discovery in 4 Members of the Bovine Cathelicidin Gene Family. J Hered. 2009 Mar-Apr;100(2):241-5.

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Arlene Tayag Gordon, M.A., Department of Psychology, Louisiana State University. Ms. Gordon is a clinical psychology doctoral student whose research interests center around child coping and adjustment pertaining to general and health related trauma. Ms. Gordon has worked with families of youth who sustained pediatric traumatic brain injury to examine various outcomes post-trauma. Her current work investigates risk and protective factors associated with child adjustment after experiencing a natural disaster.

Research Topic: Emergency Preparedness and Response, Social, Behavioral and Economic Sciences

Assessing Social Support in Youth: Development and Validation of the Social Support Questionnaire for Children

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Project Scope: Social support is one of the strongest predictors of psychological resiliency and recovery in children and adults following a disaster. Greater perceived social support has been related to positive outcomes in children. Understanding the impact social support has on coping with inopportune events, such as natural disasters, is limited by the lack of psychometrically sound measures. Existing measures limit sources of support assessed to parents, teachers, and peers and exclude potentially invaluable sources such as relatives and siblings. Literature examining social support in ethnic minority populations emphasizes the contribution of extended family and community members as sources of support. This study addresses this limitation.

Recent Progress: The development of the Social Support Questionnaire for Children (SSQC) began with the generation of 108 items obtained from existing measures, the literature, and parent and child input. The SSQC examines five sources of child social support: parent, relative, non-relative adult, sibling, and peer. 421 youth rated each item in terms of frequency. Items were eliminated based on results of Exploratory Factor Analysis, high and low inter-item correlations, an increase in alpha resulting from item deletion, content redundancy, and theoretical logic; 58 items were eliminated. The final measure, consisting of 50 items, was shown to have high internal consistency.

Relevant to Listed Research Areas: With social support delineated as one of the strongest predictors of psychological adjustment post-disaster, the availability of a sound measure of child social support is vital as it will allow the identification of children at greater risk for maladjustment following disaster exposure and lead to more effective interventions.

Findings: Preliminary analysis of the SSQC was conducted; results revealed a five factor solution consistent with the five proposed sources of support and better overall psychometric properties. In addition, the SSQC has been shown to better predict positive adjustment in children who experienced Hurricane Katrina in comparison to the Social Support Scale for Children (SSSC; Harter, 1985), one of the most widely used measures of child social support. All five subscales as well as the SSQC total score were shown to be predictive of positive adjustment, as assessed by the personal adjustment subscale of the Behavior Assessment Scale for Children, Second Edition (BASC-2). None of the SSSC subscales or total score were predictive of positive adjustment utilizing like statistical procedures. Results suggest that the SSQC is a promising assessment tool measuring children's social support.

Publications: This research has not yet been published.
Future Plans: Additional analysis of the SSQC will be conducted to further assess the measure's psychometric properties and utility when used with diverse populations.

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Ariel Hecht, in the second of three years of DHS graduate fellowship support, is currently a second year graduate student in biomedical engineering at the University of Michigan, working under the guidance of Professor Raoul Kopelman. His research involves using magnetic microparticles to design novel biosensors. Ariel completed his undergraduate work in bioengineering at the University of California, Los Angeles, in June 2008. This past summer, Ariel completed his DHS internship at Sandia National Laboratories in Livermore, CA, under the mentorship of Greg Sommer and Anson Hatch, working on using aptamers as affinity reagents in on-chip electrophoretic immunoassays.

Research Topic: Biological Threats and Countermeasures

The rotating magnetic sandwich assay: a novel biosensor based on magnetic torque

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Project Scope: Rapid, sensitive, inexpensive and portable diagnostic devices are a valuable tool in defending against biological threats. We are developing a novel biosensor, called the rotating magnetic sandwich assay, to be such a device. In the first step of this assay, the analyte binds to a 6.7 μm nonmagnetic polystyrene sphere. In the second step, a 1 μm paramagnetic bead binds to the analyte, creating a sphere-analyte-bead sandwich. The number of beads that attach to the sphere is proportional to the concentration of analyte present. The rotational frequency of the sphere in a rotating magnetic field is proportional to the number of beads that attach to the sphere. The rotational frequency of the sphere is observed either with a microscope or automatically with a laser and photodiode similar to those found in compact disc players. This type of assay has never before been published.

Recent Progress: Proof-of-concept experiments of the assay have been successfully carried out using the proteins biotin and streptavidin, which together form a strong noncovalent bond, as a model system. The spheres and beads were coated with streptavidin. The analyte was a 40 nm particle coated with biotin. The assay forms a streptavidin sphere – biotin particle – streptavidin bead sandwich complex. In a rotating magnetic field, the sandwich complex rotates at a frequency proportional to both the concentration of biotin particles in solution and the number of attached paramagnetic beads. The assay exhibited a dynamic range of two decades, with a lower limit of detection of 478 fM of biotin particles, which is in the range of physiologically relevant concentrations.

Future Plans: Now that initial proof-of-concept experiments have concluded, we are working to reproduce these results with a more physiologically relevant antigen-antibody system. The ultimate goal of the project is to design a hand-held device that can perform rapid diagnostic tests on a variety of pathogens. The assay could be modified to detect any antigen found in biological fluid for which there is a matched antibody pair, including anthrax and botulism.

Relevance to Biological Threats and Countermeasures: The need for rapid, sensitive, inexpensive and portable diagnostic devices is great. Potential applications of such devices include treating soldiers on the battlefield or triaging civilians outside of a laboratory environment after possible exposure to a biological threat. While still in its early stages, we hope that the assay can develop into a useful tool that can help save lives.

Publications: This research is currently being prepared for submission to *Analytical Chemistry*.

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I am a senior undergraduate student in coast engineering at Jackson State University in Jackson, MS. I plan to further my education through employment or graduate studies. I currently have a 4.0 GPA and will graduate in May of 2010. During my career at Jackson State, I have worked in two research fields. I have worked under the field of materials science as part of a research grant with Northrop Grumman to test materials used in ship production. I am recently working as a research assistant for Dr. Himangshu Das and Dr. Robert Whalin as part of the Center of Excellence for Natural Disasters, Coastal Infrastructure and Emergency Management. Our research pertains to Emergency Preparedness and Response in relation to storm surge from hurricanes.

Research Topic: Emergency Preparedness and Response

An Efficient Storm Surge Forecasting Tool for Coastal Mississippi Using Data Mining

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Project Scope: The simulation and prediction of storm surge are intrinsically complex due to the non-linear interaction of wind, waves and fluid motions. Multi-scale and coupled storm surge simulations with fine resolutions have become a reality due to the rapid development of computer power and advancement in the integrations of the simulation models. However, the real-time application of such robust simulations is often constrained by the availability of time and computational resources. In this study, we used an alternative, efficient and robust data mining technique to forecast storm surge in Coastal Mississippi.

Recent Progress: During 2007-08, Federal Emergency Management Agency, Region Six (FEMA-R6) and the United States Army Corps of Engineers (USACE) conducted two separate studies to identify flood frequencies for Eastern Louisiana and three coastal counties of Mississippi. Approximately, 273 hypothetical storms represented by a unique combination of track, intensity, forward speed, storm size and radial wind profile decay were simulated using **AD**vanced **CIRC**ulation Model (ADCIRC). We archived the results in a central database and developed a software tool where the central pressure, radius to maximum winds, and landing location of an approaching hurricane were used to search for the characteristics of hurricanes within the central database. For validation, we compared model results with observed High Water Marks (HWM) from historical hurricanes including hurricanes Katrina, Camille, Betsy and Gustav. Model results in simulating responses from historical hurricanes were promising. We then expanded the tool to develop a surge forecasting model applicable to coastal Mississippi. The model uses meteorological forecasts of an approaching hurricane from NOAA and then establishes a relationship between the hurricane parameters and the parameters of the synthetic storms within the underlying database. The model then identifies a group of storms that closely match with the hurricane and extracts ADCIRC simulated results associated with the identified storms in the database.

Relevance to Emergency Preparedness and Response: Using this tool as a decision aide, the emergency personnel can quickly evaluate the impact of an approaching hurricane, such as, the extent and magnitude of the surface wind and storm surge along the Mississippi coast. This will allow them to make quantitative and objective decisions and evaluate "what-if-scenarios starting one to two days ahead of the landfall.

Publications: This research has not been published yet.

Future Plans: Our plan is to enhance the database so that the tool can be applicable to the entire United States Gulf Coast region extending from the Florida Panhandle to the Texas coast.

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Cindy Hui is a graduate student in the Decision Sciences and Engineering Systems Department. Her research interests include social networks, simulation modeling, and data analysis.

Research Topic: Emergency Preparedness and Response

Simulating the Diffusion of Warnings in Large Dynamic Networks

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Project Scope: Warning systems play an important role in informing the at-risk population of potential dangers during hazardous events. These systems are also used to provide information on protective measures to promote safety in the community. In addition to a technological reliable system, it is important to understand and make use of the social communication network in communities to spread the warnings to a larger audience and to help ensure that the people at risk will act on the information they receive. This project involves formulating an axiomatic framework for modeling the diffusion of warnings in dynamic social networks through the concept of trust. The network is dynamic where individuals may leave the network and disrupt the flow of information as warnings are being diffused.

Recent Progress: We assessed the framework by modeling the 2007 San Diego Firestorms, in particular the diffusion of the Reverse911 evacuation warnings sent during the event. We generate a hypothetical social network of San Diego County with one million household nodes. We configure the parameters and map the process using multiple data sources relevant to the event. We use the model to examine how social group structure, distribution of trust, and existence of weak ties affect the spread of evacuation warnings.

Relevance to listed research areas: This project contributes to the area of emergency preparedness and response. 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.

Conclusions/Findings: Results show that the network structure and trust among social groups have a significant effect on the diffusion process. In addition to having strong ties within social groups, the existence of weak ties, between different social groups, play an important role in the spread of warnings and in the proportion of households taking action.

Future Plans: We are currently incorporating the concept of abort into the framework. The idea is to stop the spread of an inaccurate message by sending abort messages to immunize the faulty information.

Publications: C. Hui, M. Goldberg, M. Magdon-Ismail and W. A. Wallace, "Micro-Simulation of Diffusion of Warnings", Proc. of the Int. Conf. on Information Systems for Crisis Response and Management (ISCRAM), 2008, pp. 424-430.
C. Hui, M. Magdon-Ismail, W. A. Wallace and M. Goldberg, "The Impact of Changes in Network Structure on Diffusion of Warnings", Workshop on Analysis of Dynamic Networks (SIAM Int. Conf. on Data Mining), Sparks, NV, May 2009.

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Kathryn Krusemark is an HS-STEM Career Development Fellow. She received a B.S. degree in food science and a minor in leadership studies from Kansas State University. She recently finished her M.S. degree in food science focusing on the HS-STEM research area of food and agriculture security at K- State. Her research project considered task and setting factors relevant to decision-making in food safety and food defense. Additionally, she is actively involved with the Frontier program. The program is a joint collaboration between K-State and New Mexico State University. The Frontier program approaches border security, food security, and trade policy in an interdisciplinary manner to help paint truer pictures of problems currently faced. Beyond food safety and defense, Kathryn has a broad interest in the global food supply chain and worked on several food product development projects.

Research Topic: Food and Agriculture Security

Decision-Making Applications in Food Safety and Food Defense

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Project scope: When food safety or food defense issues arise, those in the Agriculture and Food Sector must quickly make decisions to ensure the safety of consumers. Decision-making is an essential element in critical infrastructure protection and response. Naturalistic decision-making (NDM), a theoretical framework, explores how people make decisions in real-world settings. Eight NDM factors characterize the tasks and settings faced by real-world decision-makers: ill-structured problems; uncertain, dynamic environments; shifting, ill-defined, or competing goals; action/feedback loops; time constraints; outcomes with high stakes; multiple players; and organizational goals and norms. This project explored whether or not food safety and food defense educational programs incorporate methods that help professionals make good decisions.

Recent progress: Four cases involving food safety and food defense revealed the presence of all eight NDM factors. As these factors complicate the decision-making process, we evaluated whether or not prevailing educational programs and tools aimed at preparing for food safety and food defense issues (i.e., HACCP and CARVER plus Shock) directly address the eight factors characterizing NDM tasks and settings.

Conclusions/findings: Cases involving food safety and food defense revealed the presence of all eight NDM factors. The analysis indicated that the eight factors characterizing NDM settings were addressed, albeit to varying degrees, by HACCP and CARVER plus Shock. To adequately train professionals in food safety and food defense, more emphasis on responding to and recovering from incidents is needed. One way to better emphasize response and recovery is to fully incorporate the eight NDM factors into education and training. Experiential educational programs and tools, such as simulations, offer a means by which to incorporate all eight NDM factors.

Future plans: We plan to evaluate other food safety and food defense training programs for the inclusion of the eight NDM factors. Additionally, project findings will be incorporated into a new textbook entitled: *Food and Agriculture Security: An Historical, Multidisciplinary Approach* (publisher: ABC-CLIO).

Relevance to research area: This research highlights the need for new educational initiatives. Food safety and food defense incidents have significant economic and public health impacts; by heeding the results of this study, educators can help professionals make better decisions that reduce those impacts.

Publications since the beginning of the project: This research has been published in a thesis available at: http://hdl.handle.net/2097/2294.

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Hugh Medal is a doctoral candidate in the Department of Industrial Engineering at the University of Arkansas. He received a B.S. degree in industrial engineering and management from North Dakota State University in 2006 and an M.S. degree in industrial engineering from the University of Arkansas in 2008. He expects to complete his doctoral degree in the spring of 2011. Hugh's research interests include applied optimization and supply chain management. He is particularly interested in the management of supply chains in the humanitarian and nonprofit sectors. During his graduate studies he has worked on projects relating to chemical/biological attack response, vehicle routing, and demand forecasting. He is currently working on a project for the Department of Homeland Security titled "Designing Resilient and Sustainable Supply Chain Networks." He has published two conference proceedings articles and has given six presentations at international conferences. He has received several scholarships and fellowships to fund his graduate studies and was named the Mack-Blackwell Rural Transportation Center Outstanding Student of the Year in 2008. Hugh's goal is to continue as researcher and educator upon graduation.

Research Topic: Infrastructure Protection

Designing Resilient Supply Chain Networks

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Project Scope: Supply chains are complex, geographically dispersed networks that link suppliers and customers via transportation infrastructure. Due to the complexity of these networks, many interdependencies exist between transportation infrastructure elements. To improve preparedness for infrastructure disruptions it is important to be able to quantify these interdependencies. Our study explicitly considers multiple modes of transportation. In addition, we use formal risk assessment techniques in our analysis.

Relevance to Infrastructure Protection: This project aims to develop tools for improving preparedness against threats to critical transportation infrastructures in the form of man-made and natural disasters. These tools will help the DHS 1) quantify the interdependencies between transportation infrastructures, 2) assess the risk of supply chain networks, and 3) optimally allocate protection resources to transportation infrastructures to increase resilience.

Recent Progress: Thus far, we have classified the academic literature relating to risk in supply chain networks and identified work that we plan to leverage for this project. We have also identified areas of research that have not yet been studied. Due to the ambiguity of terms in the literature, we have defined several key terms relating to supply chain risk. Additionally, we have developed a multi-modal supply chain network model of the Southeastern United States and used it to demonstrate the use of existing models and risk measures.

Conclusions/Findings: From our literature search we have identified a lack of tractable models for allocating protection resources to transportation infrastructure within a supply chain. In addition, we have not found any research that incorporates the use of formal risk assessment techniques within the context of a supply chain network.

Publications: This research has not yet been published.

Future Plans: The next step in our project is to develop a mathematical model to quantify the interdependencies and risks of multi-modal supply chain networks. We also plan to integrate our mathematical model with formal risk assessment techniques. To analyze realistic sized networks it is likely that we will need to develop sophisticated solution techniques for our model. Finally, we will test our model on our example network as well as on data obtained from DHS.

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Talmor Meir is a graduate student in ocean engineering at Stevens Institute of Technology. She earned her B.Sc. in geophysics from Tel-Aviv University of Israel. At Tel-Aviv University she worked as a research assistant for the Department of Remote Sensing. Prior to entering the doctoral program at Stevens, Talmor worked as a New York City educator, teaching physics to inner city teenagers. Her interests include forecast modeling of urban surroundings and the communication and visual interchange of imperative data. Within this context she is currently working on the Navy's Coupled Ocean Atmospheric Mesoscale Prediction System (COAMPS), generating 24h weather forecasts on a ~1 km resolution grid covering the metropolitan New York City region.

Research Topic: Maritime and Port Security

Coastal Urban Prediction for NYC

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Project scope: The Navy's Coupled Ocean Atmosphere Mesoscale Prediction System (COAMPS) generates three-dimensional 24 hr weather forecasts on a ~ 1 km resolution grid covering the metropolitan New York City region. The accuracy of the forecasts is evaluated using in-situ observations, including boundary layer profilers located on skyscrapers, and regional sensor networks from coastal moored buoys. Forecasts are also compared with the National Weather Service's ~12 km resolution North American Model (NAM). Through routine data monitoring and comparison of observed temperatures and winds, coastal and urban characteristics of NYC are verified on small scales.

Relevance: Our high resolution weather forecasts, forwards the state of the atmosphere for a future time and a given location within complex coastal urban surroundings. There is a variety of events for which such forecast models can provide an emergency team with vital information. Any release of chemical, biological or radiological (CBR) agents in the NYC metropolitan region can be of devastating consequences. Advanced data analysis and visualization being offered by COAMPS is a tool to make more precise dispersion predictions, both vertically and horizontally on a local-scale all within the first hours after a release.

Recent Progress: A more comprehensive survey of the COAMPS capabilities and limitations has been evaluated in real time as of January 2009. The model has recently been enhanced to include a more sophisticated atmospheric radiation scheme. The predicted weather profiles are now in the process of joining a local-fixed observation network, emphasizing the study of more vulnerable areas such as midtown and NYC coastlines.

Findings: As expected, NYC interior locations have a wide diurnal temperature range while more moderate temperature range is observed over the ocean body and waterways. The influence of the coastline on the wind is now evident due to the ~1 km resolution capability that is not seen using the NAM ~12 km resolution model currently available to the public.

Future plans: Efforts will be made to utilize the COAMPS model for different applications (including CBR emergency response scenarios) within the NYC metropolitan area to further understand the behavior of local wind flows. A major goal of this study is the linkage of the COAMPS fields to the high-resolution (<500 m) ocean forecast system, NYHOPS (currently using NAM), to create a local coupled ocean-atmospheric model for the NYC area.

Publications: This research has not yet been published. A poster presentation is scheduled for Ocean Sciences 2010 meeting.

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I'm a PhD candidate in the Department of Civil and Environmental Engineering at Louisiana State University. I got my MSc degree in highway and traffic engineering from the University of Jordan in 1997 and my BS in civil engineering from the same university in 1994. I worked in the field of highway design and traffic engineering at the Municipality of Greater Amman for seven years. I also worked as an instructor at Al Isra University in Jordan before deciding to pursue my PhD degree. My research covers issues related to the planning and management of traffic during mass evacuations, concentrating on transit-based evacuation for the carless population (tourists, elderly and disadvantaged).

Research Topic: Emergency Preparedness and Response

Transit-Based Emergency Evacuation Modeling with Microscopic Simulation

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Several recent mass evacuations, including those in advance of Hurricane Katrina in New Orleans and Hurricane Rita in Houston, demonstrated the impact of not undertaking evacuation planning for carless populations. This lack of planning meant that a portion of mobility-limited population in both these cities were unable to flee in advance of the storms.

Project Scope: This project describes one of the first efforts to ever model and simulate transit-based evacuation strategies. In it the development of and the results gained from, an application of the TRANSIMS microscopic simulation system to model scenarios based on the New Orleans 2007 City Assisted Evacuation Plan (CAEP) and The Jefferson Parish Publicly Assisted Evacuation plan are described.

Recent Progress: Two transit routing scenarios and four network loading scenarios were developed and tested then integrated with the auto-based evacuation model resulting in eight multimodal evacuation scenarios. Average travel time and total evacuation time were used to compare the results of each scenario. Average travel speed and average queue length were used to evaluate the impact of transit evacuation on the network operation.

Findings: Among the general findings was that the most effective scenarios of transit-based evacuation were those that were carried out during time periods during which the auto-base evacuation was in its off-peak periods. These conditions significantly reduced the overall travel time by up to 57 % and total evacuation time by up to 56 % when compared to peak evacuation conditions. Also it was found that carrying evacuation on arterial evacuation routes would significantly reduce the overall travel time by up to 69 % and the total evacuation time by up to 22 % compared to evacuation on the interstate. It was also found that there is no effect of adding transit on the average evacuation speed but it affects the average queue length when conducting the transit evacuation over short periods of time.

Relevance to listed research areas: The microscale simulation modeling of existing plans for car-less populations present an innovative approach that should be of interest to many of the largest regions across the United States, particularly in New York, Washington, D.C., Baltimore, Philadelphia, Boston, Chicago, and San Francisco, which all have higher percentages of car-less households than New Orleans.

Publications: Naghawi H. and Wolshon B., "Transit-Based Emergency Evacuation Modeling with Microscopic Simulation", Journal of Transportation Safety & Security, (forthcoming).

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Azadeh Namvar obtained her BSc (Hons) degree in agriculture engineering from the University of Azad. She subsequently obtained her MSc within the Department of Food Science University of Guelph. Her research thesis was focused on evaluating the dissemination of enteric contamination within pork processing facilities using DNA typing techniques. The results of the research have been used by the Ontario Ministry of Agriculture, Food and Rural Affairs (OMAFRA) to develop HACCP plans for the pork industry to enhance food safety. Mrs. Namvar is currently undertaking her PhD within the same department of the University of Guelph. Her research focus is to develop and identify the underlying recognition of imprinted polymers for the detection of biohazards. This has encompassed developing *Bacillus* endospore imprinted films and reagentless sensor for patulin analysis, in addition to developing electrospun fibers for ricin extraction/detection.

Mrs. Namvar has seven peer reviewed publications in international journals, one review article and a book chapter. She has presented results at two Biosensor World Congress meetings, in addition to seven symposiums. She was awarded the "Brightest and the Best" award by the DHS in 2007 and presented her research at the Student Summit held in Washington, DC. She is a current recipient of a prestigious Ontario Graduate Scholarship and performed consultancy for Guelph Food Technology Centre. Mrs. Namvar will be completing her PhD thesis in winter 2010 and is looking forward to pursuing a career in diagnostic research.

Research Topic: Biological Threats and Countermeasures

Antibody Modified Conducting Electrospun Nano-Fibers for the Extraction and Detection of Select Agents

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Project Scope: The following reports on developing a generic sensor strategy based on bioaffinity agent (e.g. antibodies) modified electrospun conducting polymer nano-fibres. The conducting fibres are formed into an absorbent pad that is suspended into the sample homogenate to both extract and concentrate the target analyte. Detection of bound analyte is then detected through determining the impedance changes induced in the conducting polymer fibers upon interaction of target with bioaffinity agent.

Recent Progress: Conductive electrospun fibers were formed by using polylactide polymer melt solutions containing pyrrole monomer. The optimized electrospun fibers formed a homogeous pad with an average fiber diameter of 2μm. Pyrrole, impregnated within the fiber, was polymerized by submersion in $FeCl_2$ solution. Anti-*Salmonella* antibodies were covalently immobilized onto the surface of the conducting polymer fibers and baseline conductivity determined using impedance spectroscopy. The pads were then transferred to a suspension of *Salmonella* for 5 min and returned to the electrochemical cell a with changes in fiber impedance recorded. The lower detection limit of the sensor was 4 log cfu/ml *Salmonella* with an analysis time of 5 min.

Future plans: The work perform to date has illustrated a proof-of-concept of fabricating a reagentless sensor based on conducting polymer electrospun fibers. Further optimization of the sensor approach will be in terms of selecting different conducting polymer types and derivatives to enhance the sensor response, in addition to facilitating immobilization of affinity agents. Current studies are evaluating if the same sensing approach can be applied for detecting low molecular weight select agents (e.g. ricin) using immobilized artificial antibodies (aptamers).

Relevance to listed research areas: The rapid detection of biohazard agents is essential to contain outbreaks and implement corrective agents. Although there are a diverse range of diagnostic platforms available very few can be applied outside the laboratory environment. The sensors being developed in the current project are low cost and rovust. Importantly, the sensors are reagnetless meaning that there is no restriction on sample volumes and are easy to use within the field by non-technical personnel. The sensor can be adapted to measure a diverse range of biohazards thereby providing a powerful tool in Homeland defense.

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Ryan Newkirk is an epidemiology PhD student at the University of Minnesota School of Public Health. As a graduate assistant for the National Center for Food Protection and Defense, Ryan conducts research related to terrorism preparedness, public health, and food. Ryan is also a Fellow at the University of Minnesota: Simulations and Exercises for Educational Effectiveness Center. In this position, Ryan continues his research and is involved with preparedness simulations and exercises at the state and local government levels.

Research Topic: Food and Agriculture Security

Using Multiple Techniques to Assess Terrorism Risk to Food Systems

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Research Area: Food and Agriculture Security
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Project Scope: The Department of Homeland Security (DHS) identified food protection and defense as top priorities in 2004. The continuing threat of intentional food contamination in conjunction with recent, high-profile foodborne disease outbreaks underscores the Department's prioritization and the vulnerability of the complicated food system. Risk and vulnerability assessments have proven difficult on such dynamic and highly integrated systems. Novel applications of existing risk assessment techniques are required to adequately estimate risk/vulnerability of these systems.

Recent Progress: We utilized a combination of food system risk assessment methodologies, which can be conceptualized in the following phases: (1) Characterize the system by identifying system inputs, processes, outputs and the variabilities/uncertainties of these parameters, (2) Perform a risk assessment on the characterized system using a combination of deterministic and probabilistic risk assessment methodologies, and (3) attack scenario development. The relatively simple fluid milk system was chosen as a proof of concept food system, and the attack scenario includes botulinum toxin as the contaminant.

Conclusion/Findings: Model results include point and distribution estimates of morbidity, mortality, and economic consequences. Results vary dramatically according to contaminant amount, fluid milk system site of contamination, duration of scenario, and milk processing plant capacity. Informed worst case scenario results include mortality estimates of >250,000 people and economic estimates of >$147,000,000 in direct costs.

Future Plans: Given specific scenario conditions, these results underscore the significant public health and economic consequences of a botulinum toxin attack on the fluid milk system. Future work will include: (1) the incorporation of model results to inform food system risk mitigation strategies by providing insight into system nodes/processes that contribute most to the overall system risk, and (2) adaptation of this model to other liquid foods, such as liquid eggs.

Relevance to Research Area: Protecting the nation's food system from terrorism is of utmost importance. Assessing terrorism risk for food on a systemic scale is essential to adequately and accurately understanding food terrorism risks. The results of this research will allow DHS to: (1) gain a systemic understanding of food terrorism risk, and (2) potentially reduce that risk by identifying and mitigating primary, secondary, and tertiary risks/vulnerabilities. Risk reduction potentially translates into lives saved.

Publications since the beginning of the project: None to date

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I am interested in utilizing immune mechanisms providing protection from central nervous system invading viruses to develop drug therapeutics and vaccines.

Research Topic: Biological Threats and Countermeasures

A novel model to study lethal *vs.* non-lethal viral encephalitis

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Considered a significant bioterrorism threat due to ease of aerosolization and stability as an aerosol, Venezuelan equine encephalitis virus (VEEV) generally causes a febrile illness; however, a subset of patients develops lethal encephalitis. Categorized as an NIAID Class B priority pathogen, no licensed anti-viral agents or vaccines exist for treatment. Understanding immune mechanisms regulating pathogen clearance and host survival is critical to the development of vaccines and drug therapies against central nervous system invading viruses. Little is known about the correlates of protective immunity for VEEV infection. Published data from our laboratory demonstrate that vaccinated animals tolerate high-level of infection in the brain without developing encephalitic disease. Adoptive transfer of CD4+ T-cells generated in wild-type vaccinated mice ameliorates the disease in mice lacking α/β T cells (TCR KO) demonstrating the importance of the host response in disease development. Wild-type virus requires high level biocontainment (BSL3) limiting the repertoire of research tools available. A model of VEEV-like encephalitis that can be utilized at BSL2 is needed to further study the mechanisms of immunoprotection.

We hypothesized that intranasal inoculation of TC83, an attenuated strain of VEEV, administered intranasally in C657/BL mice would mimic VEEV encephalitis. Following inoculation with TC83, wild type C657/BL and TCR KO developed signs of illness including significant weight loss, lethargy, ruffled fur, and mild ataxia as compared to controls inoculated with chimeric vaccine candidate or PBS. However, all mice fully recovered from infection. Viral titers at the peak of illness reached surprisingly high levels in the brain (log 9- log 10). Following recovery, these levels were reduced (log 3- log 5). Mice maintained similar levels of virus to that found at time of initial recovery indicating the ability of TC83 to persist in the brain. Visceral organs had low level of infectious virus present during acute infection only. The reduction of viral infection occurred in the absence of T cells and/or detectable neutralizing antibody levels in TCR KO.

Infection-induced transcriptomes in the brain of the murine host as well as cytokine protein levels demonstrated elevated levels of IL-12 (p40), INF-β, MCP-1, MIP-1α, MIP-1β, and RANTES in surviving animals. TGF-β was below the limit of detection for all animals at all time points. IL-12 (p40) levels are not accounted for by subsequent rise in IL-12 (p70) or downstream IL-17. Elevated levels of IL12 (p40) in the brain are associated with survival following CD4+ T cell transfer in TCR KO mice challenged with VEEV. The increase in p40 in TCR-KO protected by CD4+ T cell-transfer is not commensurate with an increase in IL-23 (p19), IL-12 (p70), or downstream IL-17 indicating a role for the bioactive IL-12(p40) homodimer or monomer in protection. Thus, this model represents a unique situation to study acute viral response and chronic viral persistence in the CNS, antibody independent viral clearance in the periphery, and the protective response in the murine brain to develop new strategies for the treatment of this disease.

Homeland Security Centers of Excellence

The **Center for Risk and Economic Analysis of Terrorism Events (CREATE)**, led by the University of Southern California, develops advanced tools to evaluate the risks, costs and consequences of terrorism, and guides economically viable investments in countermeasures that will make our nation safer and more secure.

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.

The **National Center for Food Protection and Defense (NCFPD)**, led by the University of Minnesota, defends the safety and security of the food system from pre-farm inputs through consumption by establishing best practices, developing new tools and attracting new researchers to prevent, manage and respond to food contamination events.

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.

The **Center for Advancing Microbial Risk Assessment (CAMRA)**, led by Michigan State University, Drexel University, and established jointly with the U.S. Environmental Protection Agency, fills critical gaps in risk assessments for decontaminating microbiological threats — such as plague and anthrax — answering the question, "How clean is safe?"

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.

The **Center of Excellence for Awareness & Location of Explosives-Related Threats (ALERT)**, led by Northeastern University in Boston, MA, and the University of Rhode Island in Kingston will develop new means and methods to protect the nation from explosives-related threats, focusing on detecting leave-behind improvised explosive devices, enhancing aviation cargo security, providing next-generation baggage screening, detecting liquid explosives, and enhancing suspicious passenger identification.

The **National Center for Border Security and Immigration (NCBSI),** led by the University of Arizona in Tucson (research co-lead) and the University of Texas at El Paso (education co-lead), are developing 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.

The **Center for Maritime, Island and Remote and Extreme Security (MIREES)**, led by the University of Hawaii in Honolulu for maritime and island security and Stevens Institute of Technology in Hoboken, NJ, for port security, will strengthen maritime domain awareness and safeguard populations and properties unique to U.S. islands, ports, and remote and extreme environments.

The **Center for 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 as it relates to the consequences of catastrophic natural disasters.

The **National Transportation Security Center of Excellence (NTSCOE)**, was established in accordance with HR1, Implementing the Recommendations of the 9/11 Commission Act of 2007, in August 2007. NTSCOE is made up of seven institutions: Connecticut Transportation Institute at the University of Connecticut, Tougaloo College, Texas Southern University, National Transit Institute at Rutgers - The State University of New Jersey, Homeland Security Management Institute at Long Island University, Mack Blackwell National Rural Transportation Study Center at the University of Arkansas and the Mineta Transportation Institute at San José State University. The NTSCOE will develop new technologies, tools and advanced methods to defend, protect and increase the resilience of the nation's multi-modal transportation infrastructure and education and training base lines for transportation security geared towards transit employees and professionals.

New! The Center of Excellence in **Command, Control and Interoperability (C2I)** led by Purdue University (visualization sciences co-lead) and Rutgers University (data sciences co-lead) will create the scientific basis and enduring technologies needed to analyze massive amounts of information from multiple sources to more reliably detect threats to the security of the nation and its infrastructures, and to the health and welfare of its populace. These new technologies will also improve the dissemination of both information and related technologies.

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