

UNIVERSITY OF
DELAWARE

DRC

Disaster Research Center



2012 ANNUAL REPORT

DISASTER RESEARCH CENTER

OFFICE OF RESEARCH / COLLEGE OF ARTS AND SCIENCES

UNIVERSITY OF DELAWARE

2012 ANNUAL REPORT

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Table of Contents

	Page
<i>DRC Background</i>	5
<i>Director's Message</i>	7
<i>Research</i>	9
<i>Project Descriptions</i>	9
• <i>Projects Initiated in 2012</i>	10
• <i>Ongoing Projects</i>	10
• <i>Recently Completed Projects</i>	21
<i>DRC Field Studies</i>	23
<i>Education / Mentoring</i>	25
<i>Doctoral Dissertations</i>	25
<i>Master's Theses</i>	25
<i>DRC Sponsored Seminars</i>	25
<i>Graduate Student Achievements</i>	26
<i>Outreach / Dissemination</i>	27
<i>Peer Reviewed Publications</i>	27
• <i>Articles</i>	27
• <i>Book Chapters</i>	28
<i>Other Publications</i>	28
• <i>Books and Monographs</i>	28
• <i>Final Project Reports</i>	28
• <i>Miscellaneous Reports</i>	29
• <i>Working Papers</i>	29
<i>Presentations at Professional Conferences</i>	29
• <i>Paper Presentations</i>	29
• <i>Invited Presentations</i>	31
• <i>Poster Presentations</i>	32
• <i>Sessions Organized or Moderated</i>	34
<i>DRC in the News</i>	35
<i>Visitors to DRC</i>	37
<i>Other Disaster Related Activities</i>	39
<i>The E. L. Quarantelli Resource Collection—Report of Activities</i>	41

Disaster Research Center (DRC)

Established at Ohio State University in 1963 by Professors E. L. Quarantelli, Russell Dynes, and Eugene Haas, and moved to its current location at the University of Delaware (UD) in 1985, DRC was the first research center in the world devoted to the social scientific study of disasters. Historically, the Center has conducted field interviews and extended research projects on group, organizational, and community preparation for, response to, and recovery from natural and technological disasters and other community-wide crises for both academic and practical development of the field of disaster research and mitigation.

Recognizing the broader research interests in disasters across the campus and the interdisciplinary nature of the research, the Center moved from the Department of Sociology and Criminal Justice to the College of Arts and Sciences in the summer of 2006 and in June 2007 the Center moved again to come under the oversight of the UD Research Office. DRC moved back to the College of Arts and Sciences in July, 2012. While much of the research at DRC has been interdisciplinary, UD researchers from disciplines other than Sociology are now actively engaged with the Center. Research at the Center continues to build on the foundation in the social sciences while broadening activities to more explicitly embrace interdisciplinary, multidisciplinary and cross-disciplinary research.

In Fall 2010, the University of Delaware launched a new interdisciplinary graduate program in Disaster Science and Management that is administered through the School of Public Policy and Administration (formerly the School of Urban Affairs and Public Policy). DRC core and affiliated faculty are actively involved in the program as advisors and instructors, as well as in the administration of the program. The program offers Master of Science and Doctor of Philosophy degrees. Graduate researchers from DRC have gone on to careers at leading universities, prominent research centers, key disaster-oriented government agencies, and private sector organizations that deal with disaster and risk issues.

Graduate and undergraduate training has been and continues to be an integral component of DRC's mission. Faculty members from the University of Delaware's School of Public Policy and Administration, Department of Sociology and Criminal Justice and Department of Civil and Environmental Engineering oversee DRC projects. Classes are taught in the Department of Sociology and Criminal Justice's graduate concentration in Collective Behavior, Social Movements, and Disasters as well as in the undergraduate concentration in Emergency and Environmental Management. Classes on Risk Analysis, Civil Infrastructure Systems, and Modeling Systems are also taught in the graduate program in Civil and Environmental Engineering in the concentration on Infrastructure Systems, while classes on organizational behavior, fundamentals of disasters, and public administration and public policy are taught in the School of Public Policy and Administration.

Researchers at DRC have conducted nearly 700 field studies since the Center's inception, traveling to communities throughout the United States as well as internationally. DRC researchers have carried out systematic studies on a broad range of disaster types, including but not limited to hurricanes, floods, earthquakes, tornadoes, hazardous chemical incidents, plane crashes, civil disturbances, and terrorism. Past DRC studies have focused on such topics as emergency medical and mental health service delivery in disasters, community responses to acute chemical hazards, mass evacuation and sheltering, preparations for and responses to major community disasters by lifeline organizations, group and organizational improvisation, and community earthquake mitigation and emergency preparedness in the U.S. to name just a few. This report provides detailed information regarding DRC's current studies and projects.

Since its founding nearly five decades ago, DRC's activities have been supported by diverse sources, including the National Institute of Mental Health, the Federal Emergency Management Agency (FEMA) and its preceding agencies, the NOAA Sea Grant Program, and the U.S. Geological Survey. Major research funding is currently provided by grants from the National Science Foundation (NSF), FEMA, the Department of Homeland Security (DHS), the Centers for Disease Control, the National Institute of Standards and Technology (NIST), and the United States Department of Transportation through the UD University Transportation Center.

In addition to maintaining its own databases, DRC serves as a repository for materials collected by other agencies and researchers. DRC's specialized library, the E. L. Quarantelli Resource Collection, contains the world's most complete collection on the social and behavioral aspects of disasters — now numbering more than 60,000 items. It is open to both interested scholars and agencies involved in emergency management.

The Center has its own book, monograph, and report series with nearly 1,400 publications including preliminary papers and published articles. The DRC maintains ongoing contact with scholars from throughout the United States, Asia, Europe, and Mexico, some of whom have been visiting research associates at the Center for periods of up to a year. Many of these contacts have led to ongoing research collaboration.

For more information, consult DRC's home page at www.udel.edu/DRC, find us on Facebook at <https://www.facebook.com/disasterresearchcenter?sk=info> and follow us on Twitter at <https://twitter.com/UDELDRC>



Director's Message

Dear DRC Alumni, Staff, and Friends,

We are pleased to present the Annual Report for 2012, in which we provide a summary of our activities over the past year.

During this time, we continued the interdisciplinary work which has characterized the last several years, including—among others—projects focused on building evacuations, tornado warnings, hurricane evacuation and sheltering, transportation system resilience, and logistics and supply chains. We also pursued research at the intersection of public health and disaster, furthering a new research thrust at the Center, with research focusing on community resilience, radiological emergency preparedness, and emergency preparedness for nursing home and assisted living residents and people with functional and access needs. These latter two projects were funded by the State of Delaware, which gave us an opportunity to deploy our skill and expertise close to home. Apart from the attention that these projects give to specific kinds of disaster-management challenges, they pursue larger questions of importance to disaster research and probe matters that are of wider-scale interest: are our social and built systems durable under stress? How will people behave during a burgeoning crisis? What makes systems survive and even prosper?

Hurricane Sandy shone a spotlight on those questions, striking at the end of October. Delaware and DRC missed the worst of that storm, but many DRC staff had family and friends throughout the more-heavily impacted areas that were affected, some seriously, including significant damage to homes. In a very sad way, that storm proved the reliability of decades of studies conducted in the disaster research and allied scholarly communities. Very little that happened was a surprise: widespread power outages, devastating storm surge, massive coastal erosion, flooding of the subterranean infrastructure, and hospitals and other critical facilities cut off from their communities, had all been predicted for years. The effects of this storm suggest a need for reconsideration, in both research and policy realms, of systems for managing risk throughout regions and across jurisdictional scales. The tightly-woven skein of habitation, commerce, and infrastructure that comprises the Northeastern urban landscape and that, simultaneously, creates vulnerability to hazard agents and challenges will resist attempts at unraveling it. Other places globally face similar challenges. For many places, in the U.S. and elsewhere, the principal question may be how to live in conditions of perpetual exposure to hazard.

Meanwhile, we know that DRC's alums and friends are looking ahead to a noteworthy milestone—DRC's 50th Anniversary. We hope to see all of you at our upcoming workshop and celebration.

We hope that 2012 was a safe and prosperous year for you. As always, we are interested in hearing from our friends.

Best wishes,
Jim Kendra

Research

DRC has a well-established research tradition built on its foundations in the social sciences, a proven capacity for quick response field research, and a culture of collaboration between faculty, staff, and graduate and undergraduate students. A number of recent events and policy developments have created not only an increased demand for DRC's traditional expertise, but have also provided motivation to go beyond multidisciplinary work to develop a sustainable interdisciplinary program. These include the increase in focus on challenges related to disasters, the multidisciplinary funding climate, emerging collaborations between DRC and external agencies, and the many unfunded mandates related to disaster planning that have been imposed on governmental agencies. All have converged to further support and encourage DRC's efforts to establish a strong interdisciplinary research environment. In developing such an environment, DRC draws on the core research areas of current DRC faculty, all of which are prime for interdisciplinary collaboration, including:

- The identification of the social, physical and environmental factors/conditions that influence vulnerability and resilience of social and physical systems
- Individual and collective threat perception and behavior
- Organizational and inter-organizational dynamics
- Development and disasters
- Social and political dynamics that enhance the development of public policy for disaster reduction
- Analysis and management of infrastructure systems

In developing and conducting research projects, DRC acts as a catalyst for and serves as the intellectual home for interdisciplinary disaster-related research. Our integrated project teams leverage the interests and capacities of other disciplines on campus that balance quantitative and qualitative approaches to research, that demonstrate systems-level thinking, that employ the broadest possible set of methodologies and analytic techniques, and that nurture a culture which values the integration of disciplinary insights and thinking.

Project Descriptions

This section provides brief descriptions of newly initiated, active, and recently completed projects involving faculty from the Disaster Research Center at the University of Delaware. Although by no means an exhaustive list of capabilities, these projects demonstrate the Center's expertise and our current agenda.

Projects Initiated in 2012

Issues in Disaster Science and Management: A Critical Dialogue between Scientists and Emergency Managers (FEMA)

Principal Investigators: Joseph E. Trainor, Disaster Research Center, and Tony Subbio, Tetra Tech

Graduate Research Assistant: Daryl Yoder-Bontrager

Funding Agency: FEMA in Higher Education Program

This project will work to help bridge the divide between disaster science and practice. Our approach focuses the attention of academic/practitioner teams on a series of critical contemporary issues related to disasters. For each issue, academics and practitioners are working to describe what we “know.” Researchers will be asked to focus on the scientific findings and practitioners will be

asked to discuss patterns and variation in national policies/state of practice. The focus of the project will be on facilitating an exchange of ideas between these communities and developing a vision for how their important insights could be brought together to make the US emergency management system better.

Ongoing Projects

Collaborative Research Proposal on Improvisation and Sensemaking in Sudden Crisis

Principal Investigators: James Kendra and Tricia Wachtendorf

Senior Personnel: Jasmin Ruback, Ruback & Associates

Graduate Research Assistant: Brandi Lea, University of North Texas

Undergraduate Research Assistants: Alicia Badoff, Josh Kelly, and Samantha Penta

Funding Agencies: National Science Foundation, University of Delaware Research Foundation

The waterborne evacuation project focuses on the unplanned waterborne evacuation of more than 500,000 commuters from Lower Manhattan by an ad hoc flotilla of ferries, tugs, workboats, dinner cruise boats and other assorted harbor craft after the 9/11 attacks on the World Trade Center, and the subsequent improvised boat-lift of supplies and equipment into the city. The goal of this project is to examine organizational improvisation and distributed sensemaking under conditions of rapid change and urgent needs for decision making and action. The focus of this research is on geographically dispersed organizations that are able to coordinate actions and responses by “making sense” of their surroundings and environment during a crisis. The study works to ascertain:

- The cues upon which participants relied in assessing shifting environmental information;

- The existing and developing networks which were significant in coordinating action;
- The processes of gathering, assessing, and disseminating information to support distributed learning; and
- The significance of prior experience and the process by which it was employed in changing circumstances, including the emergence of new norms.

Principal analytical methods include an inductive qualitative approach, a social network analysis of pre- and post-attack relationships among participants and GIS mapping of vessel activity. The study will provide an explanatory framework for how organizations understand rapid change, communicate with others in turbulent and complex environments and develop new strategies and procedures for emergent needs under crisis conditions.

Community Resilience Index

Principal Investigator: James Kendra

Funding Agency: Centers for Disease Control, sub-award from Johns Hopkins University Bloomberg School of Public Health

This research will advance understanding of a community's survivability. In cooperation with colleagues at the Johns Hopkins School of Public Health, we will consider community resilience in light of both the cur-

rent literature on the topic as well as taking a fresh look at elements of resilience based on DRC's field research and on advanced modeling techniques.

DRU: Contending with Materiel Convergence: Optimal Control, Coordination, and Delivery of Critical Supplies to the Site of Extreme Events

Principal Investigators: Jose Holguin-Veras, Rensselaer Polytechnic Institute, Tricia Wachtendorf, Disaster Research Center, Havidán Rodríguez, Disaster Research Center, Satish V. Ukkusuri, Purdue University, and Didier M. Valdes, University of Puerto Rico-Mayagüez

Undergraduate Research Assistants: Austin Barlow, Zephi Frances, and Josh Kelly

Funding Agency: National Science Foundation

The overall goal of this project is to develop methodologies and tools to foster an accelerated convergence between the dynamic needs and supplies of critical resources (e.g., blood, water) to the site of an extreme event. Achieving the overall goal of this project requires a modeling framework that integrates concepts from the social sciences, control theory, and robust and stochastic optimization of supply chains to bridge the gap between dynamic demand and supply of critical resources (i.e., resources available on site, private donations, resources provided by emergency agencies) after an extreme event, as a system, and in consistency with social science principles. These mathematical procedures would help proactively advise the general public about donation priorities, thus reducing the probability of a repeat of previous extreme events in which a massive influx of non-priority donations hampered the flow of critical resources.

The project seeks to develop novel analytical formulations to:

- Forecast what is needed, providing robust estimates of the dynamic resource requirements following an extreme event (e.g., demand for water or food);
- Estimate what is available, i.e., critical resources available on site and in adjacent areas;

- Estimate the dynamic pattern of unmet needs, i.e., what needs to be transported to the site;
- Establish an optimal strategy of priority allocation among the donations from the general public and emergency agencies;
- Design the most effective ways to deliver, store and distribute critical supplies to the impacted area;
- Identify institutional impediments to coordinating an effective response to extreme events, and formulate mechanisms to overcome these obstacles; and,
- Identify ways in which tighter integration of the information technology systems can be achieved among the pertinent stakeholders.

The work will lead to scientific contributions in the social sciences, control theory, robust and stochastic optimization, and dynamic modeling of supply chain; and to improved national emergency response capabilities. As a part of the effort to promote learning education at all levels, the research team will engage both undergraduates and middle school students in research activities with specific emphasis on members of underrepresented groups.

Infrastructure Security and Emergency Preparedness

Principal Investigators: Sue McNeil, Tricia Wachtendorf, Earl Lee, Rachel Davidson, and Joseph Trainor

Graduate Research Assistant: Sekine Rahimian

Funding Agencies: Delaware Department of Transportation and University Transportation Center

The first part of this project (funded by Delaware Department of Transportation) considers the protection of our national infrastructure systems. Of special relevance to this project is the joint responsibility of the Department of Transportation and the Department of Homeland Security to collaborate on all matters pertaining to transportation security and transportation infrastructural protection. Given the many pressing needs for transportation resources in Delaware, assessing the vulnerability and risk of Delaware's critical transportation infrastructure, identifying possible countermeasures, and estimating the capital and operating costs of these improvements is challenging.

The objectives of this research are:

- To provide background and context for addressing risks and vulnerabilities as outlined above; and
- To explore the applicability of one tool, CAPTA, for costing asset protection.

The tool requires knowledge of the hazards faced, the events of concern, the assets of high consequence, and appropriate counter measures and preparations. Armed with this information, CAPTA iteratively assists the agency to understand when and where to commit resources. The research involves a literature review, review of CAPTA, and development of a case study.

A second part of this project (funded by the University of Delaware's University Transportation Center) recognizes that transportation infrastructure security and emergency preparedness present an enormous challenge for both the State of Delaware and for the major transportation corridors that run through the state. The objective of this part of the project is to review the current state of practice for Delaware, review external research and apply insights from state-of-the-art social science and engineering, and develop a plan for integrating research insights into practice.

Interaction between Building and Occupant Responses during Collapse (IBORC)

Principal Investigators: Benigno E. Aguirre, Disaster Research Center, and Sherif El-Tawil, University of Michigan

Graduate Research Assistants: Kimberly Gill, and Eric Best

Undergraduate Research Assistant: Shawn Reynolds

Funding Agency: National Science Foundation

The aim of this project is to interview survivors of building collapses in order to find out how they evacuated the building and how they received warnings. We anticipate that perception of danger, decision to flee, choice of evacuation route, and the urge to assist victims will strongly depend on signals (such as sounds, sights and smells) that are produced by the building during and after a collapse. Other goals of this project are to investigate the impact of the building's structure on building collapse response and occupant survival rates through computer simulation modeling.

2010 Project accomplishments:

- Obtained copy of the Oklahoma State Department of Health, Injury Prevention Service Bombing Injury Database for secondary data analysis

Following the April 19, 1995 bombing of the Alfred P. Murrah Federal Building in Oklahoma City, the Commissioner of Health of the State of Oklahoma declared injuries and other health conditions related to the bombing to be reportable conditions for special study. As a result, the Injury Prevention Service (IPS) of the Oklahoma State Department of Health (OSDH) conducted an assessment of physical injuries incurred as a direct result of the bombing.

Following this investigation, an OSDH registry

was compiled and developed into a database that included information for 1,259 injured and uninjured persons who were directly exposed to the bombing. Persons involved in search and rescue efforts were excluded. The IPS collected bombing injury data from medical records, surveys, and medical examiner reports. Additionally, in October 1996, the IPS began a follow-up study of Oklahoma City bombing survivors to collect further information about the causes of bombing injuries, long-term health problems, and medical costs associated with the bombing.

We obtained permission to receive a copy of this database, with identifying information removed. The data is provided through a Memorandum of Agreement established between approved qualified research investigators and the OSDH. The data may be used only for research, characterizing health conditions, and developing prevention strategies. All of the forms that were used for data collection can be found on the OSDH website at: http://www.ok.gov/health/Disease_Prevention_Preparedness/Injury_Prevention_Service/Injury_Surveillance_Toolbox/index.html

We are now using this data set to study people who were trapped by the explosion, and intend to use the dataset to expand the ongoing effort to build a computer based Agent Based Model of building evacuation that would apply to multi-floor buildings like the Murrah Building in OKC.

- Obtained copy of interviews conducted by The Oklahoma Historical Society Oral History Program for secondary data analysis

The OHS conducted interviews with survivors,

first responders and experts following the 1995 terrorist bombing of the Alfred P. Murrah building. We worked with the Historical Society to determine which of their interviews would be relevant to the goals of our project and we obtained copies of 12 CDs and 5 DVDs that contain interviews with survivors, FEMA task force teams and other first responders, terrorism and bomb experts, and documentation of damage to the buildings.

A sample of the interviews that are available through the Oklahoma Historical Society's Oral History Program can be found on their website at: <http://www.okhistory.org/research/collections/oh/bombing.html>

- Disaster Research Center Interviews with Oklahoma City Bombing Survivors

Continued use of IRB approved in-person/telephone interview guide and web-based questionnaire for use in conducting interviews with survivors of the 1995 Oklahoma City bombing or with survivors of other building collapses. Web-based questionnaire is available at: https://delaware.qualtrics.com/SE/?SID=SV_0ICxLeiLCIAFrEw&SVID=Prod

Nine telephone interviews have been conducted with survivors and six web-based surveys have been completed.

Our recruitment notice was circulated to survivors by the Executive Director of the Oklahoma City National Memorial and Museum through their newsletter. Recruitment efforts also included a direct mailing to approximately 300 survivors of the bombing for whom addresses could be determined.

Investment Planning for Regional Natural Disaster Mitigation

Principal Investigator: Rachel Davidson

Co-PI: Linda Nozick, Cornell University

Graduate Research Assistants: Meredith Legg, Cornell University, and Pantea Vaziri, Cornell University

Funding Agency: National Science Foundation

In this project, we are developing a set of mathematical models to help guide an optimal expenditure of regional natural disaster mitigation funds, and provide insight into the many factors that interact to determine the best

mix of mitigation strategies. Focusing on earthquakes and hurricanes, the regional natural disaster mitigation analysis models will help an at-risk region with a limited budget decide how much to spend on pre-event mitiga-

tion that aims to reduce future losses versus post-event recovery, and which of the many possible pre-event mitigation activities to fund so as to meet the region's objectives. The proposed set of models will advance knowledge about natural disaster risk management and the simultaneous planning for multiple hazards. While it is widely thought that pre-disaster mitigation is desirable, and a lot has been done to develop structural and other

techniques for disaster mitigation, the circumstances in which it is desirable to implement different mitigation measures are not well understood. This project will merge optimization and loss estimation modeling to provide new insights into resource allocation decisions for mitigation. The findings may be generalizable to other hazards and to risk managers in other contexts.

Lessons Learned from Traffic Data Collected Before, During and After a Hurricane

Principal Investigator: Sue McNeil

Graduate Research Assistant: Erik Archibald

Funding Agency: University of Delaware University Transportation Center with funding from U.S. Department of Transportation

Access to real-time collection and analysis of traffic data that can be used to inform the evacuation planning process and enhance the efficiency of operations before and after a disaster presents an interesting opportunity. The objective of this work is to identify ways to use traffic data to better understand evacuation behavior and to explore ways to integrate traffic data into evacuation planning and response. Analysis of these data is performed and the usefulness of these type of data is then discussed. Hurricane Irene provides a rich source of data

on actual behavior during a mandatory evacuation that has important implications for future events including developing strategies for improving situational awareness and post incident review and planning. These issues are important as the perceived increases in frequency and intensity of weather related events mean that there are increasing pressures to address evacuation issues. The use of traffic data will ultimately allow government to better plan and execute evacuations and help make the corridors used for evacuation more resilient.

Modeling Natural Disaster Risk Management: A Stakeholder Perspective

Principal Investigator: Rachel Davidson

Co-PIs: Linda Nozick, Cornell University, Jamie Kruse, East Carolina University, and Thomas D. O'Rourke, Jr., Cornell University

Graduate Research Assistant: Jiazhen Peng

Funding Agency: National Institute of Standards and Technology (NIST)

Natural disasters are a significant and growing national challenge. This project involves developing risk and game theoretic optimization models to support design of a regional natural disaster risk management system that is effective, efficient, sustainable, equitable, and that is appealing to each of the key stakeholders so that it will be implementable. The modeling will be novel in: (1) using sophisticated large-scale game theory optimization to model regional natural disaster risk management; (2) incorporating realistic representations of regional risk and mitigation options; (3) explicitly considering the differing objectives, constraints, and alternatives of each of the key stakeholders (e.g., build-

ing owners, insurers, government); (4) recognizing the biases people and organizations have in making disaster risk decisions; (5) allowing decisions and investments to be made over time; and (6) representing the large uncertainty in disaster losses. The new models will be demonstrated through case studies focusing on earthquake risk in Los Angeles and hurricane risk in North Carolina. Successful completion of the project will provide tools to help address the increasingly severe problem of natural disaster risk, a topic of major national concern.

Modeling Post-earthquake Fire Spread

Principal Investigator: Rachel Davidson

Graduate Research Assistant: Sizheng Li

Funding Agency: Multidisciplinary Center for Earthquake Engineering Research (MCEER)

In the aftermath of an earthquake, many fires may ignite simultaneously and at the same time that a region's suppression capabilities are severely diminished due to damaged water supplies, transportation, and communication systems, and increased demands on fire service personnel. The result can be conflagrations that cause losses exceeding those caused by ground shaking. In this project, we are developing a new simulation model of post-earthquake fire spread and applying it to a case study area in Los Angeles. The model is designed to have several desirable features: (1) to be physics-based, representing the various modes of fire spread separately (e.g. radiation, branding); (2) to be computationally tractable so that it can be applied to an entire urban area;

(3) to provide many types of detailed results including for example, total area burned, spatial description of spread, and relative importance of different modes of spread so that it can provide insight into the relative importance of different contributors to fire spread; (4) to quantify uncertainty in the results; and (5) to be flexible to allow for easy modification. The new post-earthquake fire spread model is designed to be used to (1) improve estimation of fire damage for a specified earthquake scenario, (2) provide new insight into the relative importance of factors that contribute to post-earthquake fire spread, and (3) help future evaluation of potential long- and short-term post-earthquake fire risk reduction strategies.

Modeling the Interactions between Development and Regional Disaster Risk

Principal Investigator: Rachel Davidson

Graduate Research Assistant: Susan Brink

Funding Agency: National Science Foundation (NSF) Graduate Research Fellowship

In order to understand the root causes of risk and the full implications of mitigation and recovery decisions on a city's development trajectory, a broad decision frame is needed that considers disasters in a long time framework and fully captures the many interactions between normal development processes and the ongoing cycle of mitigation, preparedness, response and

recovery. This research aims to understand the interactions between a city's disaster risk and its development trajectory by (1) developing a system dynamics model capable of describing vulnerability and development, (2) applying the model to Port-au-Prince, Haiti and Padang, Indonesia, and (3) using the model to answer questions about development and disaster risk.

Multi-Organizational Collaborative Leadership and Interaction

Principal Investigators: Tricia Wachtendorf, Disaster Research Center, and William Waugh, Georgia State University

Funding Agency: Department of Homeland Security: Center of Excellence for the Study of Natural Disasters, Coastal Infrastructure, and Emergency Management

The goal of this project is to help officials do a better job of coordinating incidents that are multiorganizational and/or multi-jurisdictional. Consideration is given to traditional formal responders as well as other community-based involvement and the integration of public and private sector efforts, social and human factor elements, and political and cultural facilitators/barriers to

response participation. This project will (1) assess the effectiveness of current organizational structures and incident management systems in building and maintaining collaboration among stakeholders involved in managing hazards and disasters; (2) identify best practices, major issues, and the skill-set (individual and organizational) necessary to build and maintain collaborative

relationships; (3) identify skills, cultural features, and social relationships that can foster effective improvised action when a multi-organizational response is necessary; and (4) design and test a training program in col-

laborative management and leadership for community and state officials involved in managing hazards and disasters. Research methodology includes focus groups, in-depth interviews, and test-bed application.

New Methods for Measuring, Monitoring, and Evaluating Post-disaster Recovery

Principal Investigator: Ronald Eguchi, Imagecat, Inc.

Co-PIs: Rachel Davidson, Disaster Research Center, Stephanie Chang, University of British Columbia, Arleen Hill, University of Memphis, and Beverley Adams, Imagecat, Inc.

Graduate Research Assistant: Dana Rathfon

Funding Agency: National Science Foundation

Post-disaster recovery—one of the phases of the disaster management cycle—is a complex physical, social, economic, environmental, and political process. It lasts years, requires enormous financial and other resources, and can define the character of the affected communities for years to come. The literature includes theoretical frameworks of recovery and empirical case studies of historic events. The empirical studies have often focused on a single dimension of recovery, such as housing, and have typically relied on interviews, focus groups, and one-time surveys for data gathering. This literature offers rich cross-sectional insights into recovery at a point in time, but limited systematic, quantitative empirical descriptions of regional recovery over time. Using newly available high-resolution satellite imagery, previously underutilized statistical data, and advanced field survey techniques that capture a detailed geographically-referenced record of recovery through photographs, video, and observations, this study will develop innovative methods for systematically and quantitatively mea-

suring and monitoring post-disaster recovery. Using a single recent hurricane as a case study, in this project we are (1) developing methods to process and interpret remote-sensing data to describe the physical and socioeconomic manifestations of post-disaster recovery; (2) obtaining and compiling quantitative and qualitative recovery data from remote-sensing, field reconnaissance surveys, secondary statistical sources, interviews, and surveys; (3) developing methods to analyze and synthesize the recovery data to comprehensively measure and monitor recovery; and (4) demonstrating application of the new methods within the case study area. Improved tracking of recovery will serve as a critical first step for future efforts to better explain and evaluate recovery by addressing questions such as (1) For a disaster that has just occurred, over what timeframes and in what ways is recovery likely to unfold?; (2) Why is recovery proceeding in a particular way?; and (3) How are recovery speed and character correlated with various pre- and post-disaster decisions and actions?

Post-earthquake Water Supply Restoration

Principal Investigator: Rachel Davidson

Graduate Research Assistant: Susan Brink

In this project, we are developing a discrete event simulation model of post-earthquake restoration for the Los Angeles Department of Water and Power water supply system, and using it to provide insight into the factors that govern restoration efficiency and ways to improve the process. The model mimics the real-life process in detail, simulating the movement of different types of crews as they inspect, reroute around, isolate, and repair system damage. For any given earthquake, it pro-

vides restoration curves with uncertainty bounds, maps showing the spatial distribution of outages over time, and crew and repair material usage information. Results for the 1994 Northridge earthquake suggest the model is capable of accurately estimating the time and spatial sequence of the restoration. This is the first application of discrete event simulation to post-disaster water supply restoration, and one of the first for any infrastructure system.

RAPID: Post-earthquake Fires in the March 2011 Japan Earthquake and Tsunami

Principal Investigator: Rachel Davidson

Graduate Research Assistant: Sizheng Li

Funding Agency: National Science Foundation RAPID Program

The Tohoku earthquake and tsunami caused approximately 300 fires—more recorded fires than any other earthquake in history. By comparison, there were about 110 recorded in Kobe (1995), 110 in Northridge (1994), 128 in San Fernando (1971), and 36 in Loma Prieta (1989). In this RAPID project we are studying the fire-related aspects of the March 2011 Japan earthquake with the aims to improve understanding of where, when, and how fires ignite, how fires spread through a neighborhood, and how they ignite and are suppressed in industrial facilities. The project involves

three main steps: (1) collecting data on the fire-related aspects of the event through site visits, interviews with key informants, and secondary data sources; (2) compiling the data into easily usable, comprehensive databases that include all data on each fire and relevant auxiliary data in a consistent format; and (3) analyzing the data through descriptive statistics, fitting generalized linear statistical models to the ignition data, and comparing observations of spread to that estimated by a new physics-based urban fire spread model.

Resilience of Transportation Corridors during Disaster

Principal Investigator: Tricia Wachtendorf

Senior Personnel: Joseph Trainor

Graduate Research Assistant: Ben Johnson

Undergraduate Research Assistants: Austin Barlow, Joshua Kelly, and Samantha Penta

Funding Agency: University Transportation Center, University of Delaware

Transportation corridors are vital in allowing for public and commercial mobility. When these corridors are compromised during a disaster, the way in which emergency response networks function is critical to ensuring continuity or resumption of the transportation flow. Inter-organizational coordination is central to an effective disaster response and may require interaction across jurisdiction, timely exchange of information, and provision of personnel or material resources. This study examines how multi-organizational actors/agencies expect and are expected to interact during a transportation corridor disaster. Using social network analysis, researchers will examine the codified and actor-anticipated interaction in maintaining the continuity of transportation

flows along the I-95 corridor in Delaware.

The study works to:

- Provide information to facilitate planning and management of response in Delaware and the surrounding states
- Increase our understanding of social response networks in place during corridor disasters, which may have applicability in other geographic areas
- Generate results useful in the development of socio-technical systems to improve communication and coordination during corridor disasters.

RAPID: The Tohoku Catastrophe: Volunteers and Non-profit Organizations in Post-Kobe Japan

Principal Investigator: James Kendra

Co-PI: Joanne Nigg

Funding Agency: National Science Foundation

On March 11, 2011, the nation of Japan experienced a catastrophe—a great earthquake of M9.0, a near-shore

tsunami 10 meters high that reached the coast in less than 30 minutes and traveled inland four miles in some

locations, and a nuclear emergency in six reactors on one site that released significant amounts of radiation into the air, land, and water. These events resulted in difficult and delayed search and rescue efforts, extremely short warning periods, evacuation and sheltering of over 500,000 people, heroic efforts to stop the melting of cores and spent fuel rods at nuclear power plant reactors, and confusion in risk communication to the pub-

lic. Given the enormity of the Tohoku destruction and the evident inventiveness that was required at all stages of response, an entirely new framework is needed in responding to catastrophic events. This project focuses on volunteers, how they coordinate (or do not coordinate) with officials and with each other, and considers the needs for distributed and independent actions in all-encompassing events.

Technology, Weather Forecasts, and Warnings: Integrating the End-user Community

Principal Investigator: Joseph Trainor

Graduate Research Assistants: Danielle Nagele, Brittany Scott, and Lucia Velotti

Undergraduate Research Assistants: Andrea Fendt, Caitlin Gruber, and Precious Morris

Funding Agencies: National Science Foundation Engineering Research Center for the Collaborative Adaptive Sensing of the Atmosphere (ERC-CASA)

Through research, scientists at the Disaster Research Center are contributing to the end user integration efforts of the Center for Collaborative Adaptive Sensing of the Atmosphere (CASA) by exploring the social and human dimensions of severe weather forecasts and warnings. CASA is an Engineering Research Center (ERC) within NSF's Directorate for Engineering that focuses on the development of revolutionary sensing technology that will enable earlier and more accurate forecasts of severe weather events. The aim of CASA is to design the necessary infrastructure to sense, analyze, and predict lower atmospheric events and to respond to potentially hazardous phenomena in order to significantly reduce their impact on society. More accurate and reliable weather forecasts and warning systems (based on the technology proposed by CASA researchers) may lead to improved disaster mitigation, preparedness, and response initiatives. Social scientists in the CASA project are focusing their research efforts on examining how improved forecasting can reduce the exposure and vulnerability of individuals and property to everyday and extreme weather events. Specifically, through the use of survey methodology, focus groups, face-to-face

in-depth interviews, and phone interviews using DRC's CATI (Computer Assisted Telephone Interviewing) system we are examining how the end-user community members access, utilize, and respond to weather forecasts. We also seek to explore their knowledge and interests concerning weather forecasting issues, attitudes towards climatological information, and their needs and interests in relation to the use of meteorological information. We aim to answer a variety of questions, including: What are the primary sources of weather information used by emergency management agencies?; How much confidence do these end-users have in this type of information?; According to the end-users, how reliable are weather forecasts and warnings?; How does climatological information affect the decision-making processes of this community of end-users?; and finally, How does the public respond to and interpret warnings? To collect data on the public, we launched a CATI survey in June 2008 and continued collecting data during the 2009 and 2010 tornado seasons. During 2012 we focused on cleaning and analyzing that data as well as contributing to new programs evolving in CASA including the Dallas-Fort Worth Test Bed.

Understanding Post-event Transportation Network Performance

Principal Investigator: Sue McNeil

Graduate Research Assistant: Sekine Rahimian

Understanding and modeling both the supply of and demand for transportation services after an event is

vitaly important for emergency managers and government agencies to mitigate, prepare for, respond to, and

recover from potential impacts effectively. The changes in the supply side of transportation networks include failure of and capacity reduction for bridges and roadways, as discussed in several studies while the demand side, capturing changes in travel patterns, has drawn less attention.

Models to estimate travel demand after an event are necessary to estimate the performance of the whole system.

This research focuses on modeling trips after an earthquake recognizing that the purposes of these trips are completely different from the normal situation. The demand models are being developed and then assigned to the disrupted network with reduced capacity so performance measures can be computed. Moreover, to be able to use this study for mitigation planning, probabilistic performance measures based on earthquake scenarios will be developed.

Workshop on Deploying Post-disaster Quick-response Reconnaissance Teams: Methods, Strategies, and Needs

Principal Investigator: James Kendra

Funding Agency: National Science Foundation

This project consists of both a workshop and an analysis of comments and suggestions made by the researchers and officials in attendance. Scholars in a number of disciplines have long recognized the importance of deploying research teams to the site of a disaster as soon as possible in order to gather perishable or ephemeral data, i.e., data that might be available for only a short period of time. Initial data gathering, scoping out the likely scientific content, proposal development, assembling a team (including collaboration with colleagues in the affected area), and reaching the field quickly are among the challenges in this research. While findings from RAPID studies have enriched knowledge across the phases of disaster, techniques for conducting quick-response research are less shared across the research community. The workshop provided a forum for information exchange and development of best practices, including new and innovative ones, for this demanding

research genre. Workshop attendees included RAPID grant recipients, as well as representatives of the principal research centers, agencies, and societies whose work involves disaster-related research. The workshop explored burgeoning methods for developing initial situation awareness after disaster strikes (such as through growing social media), transforming initial situation awareness into researchable questions for transformative potential, team-building and best practices for deploying researchers (including the prospect of novel approaches), and recommendations to NSF and the hazards community on how to best organize and support RAPIDs following a major disaster for maximum efficiency, alacrity in reaching research sites, and scientific benefits. Analysis of the workshop content is now underway to lead to formal recommendations to funders and to the research community.

Recently Completed Projects

Emergency Planning for Skilled Long Term Care Facilities in Delaware

Principal Investigator: James Kendra

Co-PI: Bethany Hall-Long, School of Nursing, University of Delaware

Funding Agency: Delaware Department of Health and Social Services

This project, in cooperation with the College of Health Sciences at the University of Delaware, focused on disaster preparedness of nursing homes and other congregate care facilities in Delaware. Through focus groups, interviews, and a set of planning sessions with

facility administrators, project staff analyzed emergency preparedness challenges and, working closely with state officials, helped facilities bolster their emergency planning capacities.

International Research Network

Principal Investigators: Joseph Trainor, Disaster Research Center, Erna Danielsson, Mid Sweden University, Anna Olofsson, Mid Sweden University, Kurt Petersen, Lund University, Ann Enander, Karlstad University, and Tricia Wachtendorf, Disaster Research Center
Graduate Research Assistants: Rochelle Brittingham and Susan Brink
Funding Agency: Swedish Central Bank Tricentenary Fund

The goal of this project was the development of a national and international “knowledge network” with the requisite skills necessary to support the growing interest in risk, crisis, and disaster research. New technologies and new approaches to research have made it possible to create 21st century solutions to coordinating and integrating researchers. These activities created synergy among participants, aided in the production of innovative approaches, and produced ideas, solutions, and techniques that would not have come into being

without this grant’s assistance. The level of sustained research interaction this funding provided helped us to overcome the barriers that distance and disciplinary training had created. By continuing to work together, our interactions facilitated the creation of permanent relationships that can serve as the basis for future projects which will expand our proposed work in directions that other groups will simply not be equipped to handle. In particular we focused on empowering graduate students and providing them with collaboration opportunities.

NEES-SG. NEESWood: Development of a Performance-based Seismic Design Philosophy for Mid-rise Woodframe Construction

Principal Investigator: John van de Lindt, Colorado State University
Co-PIs: Rachel Davidson, Disaster Research Center, Andre Filiatrault, University of Buffalo, David Rosowsky, Texas A&M University, Michael Symans, Rensselaer Polytechnic Institute
Graduate Research Assistant: Greg Black
Funding Agency: National Science Foundation, Network for Earthquake Engineering Simulation (NEES) Program

The objective of this project was to develop and experimentally validate a performance-based seismic design (PBSD) procedure that would make construction of mid-rise wood-frame construction possible in regions of moderate to high seismicity in the U.S. While wood-frame structures have historically performed well in earthquakes with regard to life safety, they have sustained significant structural and non-structural damage in recent events. Further, the height of wood-frame construction has been limited to approximately four stories, and current building code requirements for engineered wood construction are not based on a global

seismic design philosophy but rather wood elements are designed independently of each other. In this project, we sought to provide the necessary mechanisms to take advantage of the engineering characteristics that make wood-frame construction perform well with regard to life safety, while safely increasing the height of wood-frame structures in seismically active areas and mitigating damage to low-rise wood-frame structures. The UD portion of the project was to develop a regional earthquake loss model for wood frame buildings to help guide the specification of appropriate performance objectives.

Netherlands US Water Crisis Research Network (NUWCRen)

Principal Investigators: Joseph Trainor, Disaster Research Center, Sue McNeil, Disaster Research Center, Karen Engle, COT, Jack Harald, Virginia Tech, Liesel Ritchie, Natural Hazards Center, University of Colorado, Boulder, Harold Bousche, TNO, and Georg Frerks, Wageningen University

Graduate Research Assistant: Lucia Velotti

Funding Agency: The Ministry of Public Works, Transport, and Water Management, The Netherlands

The purpose of NUWCRen was to develop a sustainable network of Dutch and U.S. knowledge institutes that could facilitate the advancement of the Netherlands' preparedness with respect to possible floods. In addition to distributing existing knowledge, we also

developed scientific knowledge and assessed operational practices for flood disaster management. The ultimate goal was to institutionalize a collaborative international network that can generate approaches to policy in the Netherlands and/or the United States.

RAPID/Collaborative Research: The Forgotten Aspects of Evacuation: Mass Evacuee Processing and Care by Host Communities Following the Haiti Earthquake

Principal Investigator: Sudha Arlikatti, University of North Texas

Co-PIs: Joanne Nigg, Disaster Research Center, and James Kendra, Disaster Research Center

Graduate Research Assistant: Manuel Torres

Funding Agency: National Science Foundation

This project researched the hosting of evacuees in the Miami area from the January, 2010 earthquake in Haiti. The field team interviewed public and non-profit decision makers and analyzed agency reports and news media accounts. In May of 2010 James Kendra and Sudha Arlikatti (University of North Texas) and Manuel Torres (University of Delaware) traveled to the Miami area for interviews and site visits.

Principal research questions included:

- What procedures were used to identify airlift passengers from Haiti or the Dominican Republic bound for the US?
- What organizations/agencies provided processing and services in the cities receiving an influx of displaced Haitian earthquake victims? What specific services were needed?
- Were these organizations and agencies adopting new roles or expanding their normal activities in the processes of receiving and providing services for evacuees?
- What were the key issues surrounding inter-organizational or inter-governmental coordination in the processes of evacuation and invacuation?

- Had improvisation occurred among these agencies/organizations when solving expected and/or emerging needs?

Preliminary findings include:

- Organizations reported the importance of prior experience and (for the most part) familiarity with each other.
- Organizations reported the utility of the Incident Command System.
- Organizations reported that the lack of a federal lead agency introduced ambiguity. Our document search suggested there were multiple "leads."
- Congruence of Florida and FEMA ESF structures likely assisted in multiorganizational coordination.
- Local NGOs reported local challenges in assisting non-citizen evacuees.
- Economic conditions in Florida negatively affected the ability of families to assist evacuees and to send money to Haiti.

RAPID: San Bruno, California Sept. 9, 2010 Gas Pipeline Explosion and Fire

Principal Investigator: Rachel Davidson

Co-PIs: James Kendra, Disaster Research Center and David McEntire, University of North Texas

Graduate Research Assistant: Sizheng Li

Funding Agency: National Science Foundation RAPID Program

On September 9, 2010, in San Bruno, California, a suburb of San Francisco, a 30-inch steel natural gas pipeline exploded in flames, igniting a fire that ultimately killed seven residents and damaged or destroyed dozens of houses. In this RAPID project, we studied the San Bruno explosion and fire with the aims of (a) improving understanding of how urban fires spread and are suppressed, (b) supporting development and validation of next-

generation urban fire simulation models, and (c) advancing theories of resilience. An interdisciplinary field team gathered data that provided a holistic account of the event across the engineering and social sciences. In particular, the team examined the composition and distribution of structures, rate and means of fire spread, local topography and weather conditions, and elements of multi-organizational coordination and decision making.

DRC Field Studies

In addition to our regular projects, researchers at DRC have conducted over 695 field studies since the Center's inception, traveling to communities throughout the United States and internationally in the immediate aftermath of disasters. Our work has encompassed a broad range of disaster types. Recent field studies have focused on a number of topics including organization, multi-organizational coordination, behavioral response to disasters, warning and evacuation, and vulnerability.

This section offers a brief list of the field research conducted by DRC faculty and graduate students during the past calendar year.

Location:	Tohoku, Japan
Dates:	January 21–29, 2012
Researchers:	Rochelle Brittingham, Alex Greer, Joanne Nigg
Funding Agency:	National Science Foundation
Project Title:	Learning How Volunteer Organizations Function Following Catastrophes
Purpose:	This project examined the response of various volunteer organizations to the Tohoku, Japan, earthquake, tsunami, and nuclear power plant failure. It looked specifically at how organizations cooperated with one another and how they integrated new members who came forward during the response. A special emphasis was given to those organizations addressing the special needs of persons with disabilities.

Location: Minxian, Gansu Province, China
Dates: May 21–31, 2012
Researcher: Ziqiang Han
Funding Agency: Natural Hazards Center, University of Colorado at Boulder
Project Title: Interagency Coordination during Crisis: Experience from Extreme Weather Disaster Response in Northwest China
Purpose: This Quick Response project looked at the coordination among various agencies regarding their response efforts to the May, 2012, earthquake that struck northwest China.

Location: Brooklyn and the Rockaways, New York
Date: November 10, 2012
Researchers: Sam Penta, Ashley Farmer, Rochelle Brittingham, Erik Archibald
Funding Agency: Disaster Research Center
Project Title: Preliminary Field Research for Superstorm Sandy
Purpose: Team members looked at how Occupy Sandy and other emergent groups organized relief efforts after Sandy.

Location: Staten Island, New York
Date: November 16, 2012
Researchers: Sam Penta, Jennifer Lazo, Jim Goetschius, Erik Archibald
Funding Agency: Disaster Research Center
Project Title: Preliminary Field Research for Superstorm Sandy
Purpose: Preliminary research into the impact of Superstorm Sandy on Staten Island, focused on the effect of the storm on hospitals.

Education/Mentoring

Students, staff, and faculty affiliated with DRC all play an important role in graduate and undergraduate education at the University. Faculty offer related classes, advise students (as academic advisors and advisors for independent studies and research), and serve on comprehensive exam and dissertation committees; faculty and staff offer professional training sessions for graduate and undergraduate students; and graduate students mentor undergraduates and serve as teaching assistants. The Disaster Research Center has a history of engaging graduate and undergraduate students in research. Although DRC does not admit students, offer classes, or award degrees, faculty teach classes as part of their responsibilities in their home departments, serve in the governance of academic programs, and also provide instruction through the interdisciplinary M.S. and Ph.D. program in Disaster Science and Management.

This section highlights DRC's vision of education and mentoring.

Doctoral Dissertations

Kimberly B. Gill

“The Role of Community Engagement in Local and State Public Health Department Emergency Preparedness.” Department of Sociology and Criminal Justice and Disaster Research Center, University of Delaware, Newark, Delaware.

Master's Theses

Alex Greer

“Oil Spill Events: Prominent Frames and Policy Implications.” Department of Sociology and Criminal Justice and Disaster Research Center, University of Delaware, Newark, Delaware.

DRC Sponsored Seminars

“Emergency Management and Recovery Efforts in New South Wales, Australia, Following the 2009 Bushfires and the 2011 Floods.” Presented by Wendy Graham, Director of Resilience and Planning, Ministry of Police and Emergency Services, Australia, April 25, 2012.

“The National Transportation Safety Board and Its Disaster Assistance Program: Responding to Air, Marine, Rail and Coach Accidents.” Presented by Sharon Bryson, Deputy Director, NTSB, November 5, 2012.

Graduate Student Achievements

DRC graduate students are typically among the more outstanding graduate students at the University of Delaware and frequently excel within their major discipline. The following graduate students were recognized by the University for their academic achievements with the awards cited or participated in the noted disaster related extra-curricular activities.

Eric Best was named a Hazards and Disasters Student Paper Competition Graduate Winner for his paper titled “Collective Models of Disaster: Making a Case for Using Collective Mobile Phone Location Data in Disaster Science” by the Natural Hazards Center, University of Colorado at Boulder.

Laura Black attended the United Nations University Institute for Environment and Human Security (UNU-EHS) and Munich Re Foundation’s Summer Academy, “From Social Vulnerability to Resilience: Measuring Progress Towards Disaster Risk Reduction.” She was one of 20 PhD researchers coming from 14 countries chosen to join international experts to address methodological challenges in measuring social vulnerability and resilience.

Ray Chang was awarded the Mary Fran Myers Scholarship to attend the 2012 Natural Hazards Research and Applications Workshop in Broomfield, Colorado. Ray was also elected president of the Taiwanese Student Association at the University of Delaware for the 2012-2013 term.

Alex Greer was named a University of Delaware Graduate Fellow for the 2011–2012 academic year.

Ziqiang Han received an IAEM scholarship sponsored by EIIP to continue his education in disaster science and management.

Jennifer Lazo was awarded third place in the Student Poster Competition at the International Association of Emergency Managers (IAEM) Conference on October 30, 2012, in Orlando, Florida.

Eva Wilson accepted a position as Internal Policy Analyst II for the Recovery Branch of Kentucky’s Division of Emergency Management.

Outreach/Dissemination

DRC is well known in the academic community of disaster researchers for the development of research methods and theory within the field. This section illustrates our activities aimed at applying or distributing the information and knowledge gained from DRC research projects and institutional history.

Peer Reviewed Publications

The following are publications authored or co-authored by DRC faculty, students and staff that are related to disasters and which have undergone the peer review process. The list is divided according to publication type.

Articles

Benigno E. Aguirre

2012. "Better Disaster Statistics: The Lisbon Earthquake." *Journal of Interdisciplinary History*, 43(1): 27–42.

Simon A. Andrew and James M. Kendra

2012. "An Adaptive Governance Approach to Disaster-related Behavioral Health Services." *Disasters*, 36(3): 514–532.

Erik Archibald and Sue McNeil

2012. "Learning from Traffic Data Collected Before, During and After a Hurricane." *LATSS Research*, 36(1): 1–10.

Alex Greer

2012. "Earthquake Preparedness and Response: Comparison of the United States and Japan." *Leadership and Management in Engineering*, 12(3): 111–125.

Danielle E. Nagele and Joseph E. Trainor

2012. "Geographic Specificity, Tornadoes, and Protective Action." *Weather, Climate, and Society*, 4(2): 145–155.

Tricia Wachtendorf and James M. Kendra

2012. "Reproductive Improvisation and the Virtues of Sameness: The Art of Reestablishing New York City's Emergency Operations Center." *International Journal of Mass Emergencies and Disasters*, 30(3): 249–274.

Book Chapters

Tricia Wachtendorf and James M. Kendra

2012. "The Making of a Mega-crisis: 9/11 as a Case for the Concept." *Mega-crises: Understanding the Prospects, Nature, Characteristics and the Effects of Cataclysmic Events* edited by Ira Helsloot, Arjen Boin, Brian Jacobs, and Louise K. Comfort. Springfield, IL: Charles C. Thomas.

Other Publications

The following are lists of publications authored by DRC faculty, students, and staff generated by DRC-conducted research projects or which represent writings within the recognized area of expertise for the author or authors.

Books and Monographs

Committee on Prepositioning Medical Countermeasures for the Public, Board on Health Sciences Policy

2012. *Prepositioning Antibiotics for Anthrax*. Washington, D.C.: The National Academies Press. Book and Monograph No. 36 (Joanne Nigg was a member of the committee).

Final Project Reports

Rachel A. Davidson, James Kendra, Sizheng Li, Laurie C. Long, David A. McEntire, Charles Scawthorn, and Joshua Kelly

2012. "San Bruno California, September 9, 2010 Gas Pipeline Explosion and Fire." Final Project Report No. 56.

Joanne M. Nigg, Kimberly Gill, Alex Greer, Matt Manierre, and Andrea Fendt

2012. "Public Health Emergency Planning for Radiological Events: Preliminary Guidance for the Delaware Department of Public Health." Final Project Report No. 58.

Yvonne Rademacher

2012. "Community Disaster Management Resources: A Case Study of the Farm Community in Sussex County, Delaware." Final Project Report No. 57.

Miscellaneous Reports

Ziqiang Han

2012. “Interagency Coordination during Crisis: Experience from Flood and Landslide Response in Northwest China.” Miscellaneous Report No. 75. (Natural Hazards Center Quick Response Report No. 232)

Netherlands US Water Crisis Research Network (NUWCRen)

2012. “Flood Preparedness in The Netherlands: A US Perspective,” edited by Bas Kolen, Saskia Hommes, and Eric Huijskes. Miscellaneous Report No. 74. (Joseph Trainor and Lucia Velotti were members of NUWCRen and coauthors of the report.)

Working Papers

Eric Best

2012. “Collective Models of Disaster: Making a Case for Using Collective Mobile Phone Location Data in Disaster Science.” Working Paper No. 93.

Presentations at Professional Conferences

DRC personnel regularly participate in conferences and professional meetings that contribute to the field. Below are lists of these activities.

Paper Presentations

Benigno Aguirre and Eric Best

“How Not to Learn: Resilience in the Study of Disaster.” Presented at the International Research Committee on Disasters (IRCD) Hazards Researchers Meeting, July 18, 2012, Broomfield, Colorado.

Rochelle Brittingham

“Challenges Facing People with Disabilities Following the Tohoku Earthquake and Tsunami.” Presented at the Advisory Council Meeting on the Collaboration for Inclusive Emergency Preparedness and Response, February, 2012, Dover, Delaware.

Rochelle Brittingham and Tricia Wachtendorf

“Hidden in the Numbers: Anticipated Disaster Shelter Use for People with Health and Access Concerns.” Presented at the International Research Committee on Disasters (IRCD) Hazards Researchers Meeting, July 18, 2012, Broomfield, Colorado.

Ray Chang and Samantha Penta

“What Do I Do When the Storm Comes In?: Information Seeking in Hurricane Evacuation and Sheltering.” Presented at the 82nd Annual Eastern Sociological Society Meeting, February 23–26, 2012, New York, New York.

“Managing Personnel and Resource in Disaster Scenes.” Presented at the 2nd Annual Graduate Student Conference, University of Delaware, May 4, 2012, Newark, Delaware.

Lauren Clay and James Goetschius

“Effect of Mental Health on Disaster Preparedness.” Presented at the 140th Annual Meeting of the American Public Health Association, October 29, 2012, San Francisco, California.

Karen Engel, Georg Frerks, Lucia Velotti, Jeroen Warner, and Bart Weijs

“Disaster Cultures in Southern Netherlands: The Cases of the Villages of Borgharen and IJtteren.” Presented at the International Research Committee on Disasters (IRCD) Hazards Researchers Meeting, July 18, 2012, Broomfield, Colorado.

Alex Greer and Eric Best

“Framing and GDP: Investigating the Relationship between State Reliance on Oil and Policy Resulting Following Spills.” Presented at the International Research Committee on Disasters (IRCD) Hazards Researchers Meeting, July 18, 2012, Broomfield, Colorado.

Ziqiang Han

“The Determinants of Business Preparedness for Disasters-evidence from Hurricane Andrew in 1992.” Presented at the 2012 Governor’s Hurricane Conference, May 17, 2012, Fort Lauderdale, Florida.

“The Evolving Emergency Management System and Research Institutes in China: Towards an ‘All-Hazards’ Model?” Presented at the 15th Annual Emergency Management Higher Education Conference, June 6, 2012, Emmitsburg, Maryland.

Joseph E. Trainor

“Severe Weather Warnings and Public Response.” Presented at the Åre Risk Event, March 15, 2012, Åre, Sweden.

Lucia Velotti, Andrea Fendt, and Joseph E. Trainor

“Understanding Tornado Warning and Watch.” Presented at the International Research Committee on Disasters (IRCD) Hazards Researchers Meeting, July 18, 2012. Broomfield, Colorado.

Lucia Velotti and Joseph E. Trainor

“The Administration of Safety.” Presented at the International Research Committee on Disasters (IRCD) Hazards Researchers Meeting, July 18, 2012. Broomfield, Colorado.

Lee Zelewicz

“When There is Fear of the Shelter from the Storm: Gender, Fear of Crime, and Hurricane Shelter Decision Making.” Presented at the International Research Committee on Disasters (IRCD) Hazards Researchers Meeting, July 17, 2012, Broomfield, Colorado.

Invited Presentations

Rochelle Brittingham and Tricia Wachtendorf

“The United States and Japan: How Framing Functional and Developmental Impairments Impacts Public Shelter Operations.” Presented at the National Evacuation Conference, February 8–9, 2012, New Orleans, Louisiana.

“Where Will They Stay?: Implications for Public Shelter Provision Based on Anticipated and Known Evacuation Locations.” Presented at the Åre Risk Event, March 13–15, 2012, Åre, Sweden.

“How Disabilities are Framed in the United States: Implications for Providing Public Shelters during Times of Disaster.” Presented at the 75th Annual Meeting of the Southern Sociological Society, March 21–24, 2012, New Orleans, Louisiana.

Ray Chang

“The Current Taiwanese Disaster Management System and the Future Trends.” Presented at the Taiwanese Student and Scholar Forum of the Greater DC Metropolitan Area, September 29, 2012, Gaithersburg, Maryland.

Rachel Davidson

“Statistical Modeling of Post-earthquake Ignitions.” Presented at the Workshop for Fire-Structure Interaction and Urban and Wildland-Urban Interface (WUI) *Fires Operation Tomodachi: Fire Research*, July 2, 2012, Tsukuba, Japan.

Ziqiang Han

“Introduction to Disaster Research in the United States.” Presented at the Beijing Academy of Science and Technology, June 1, 2012, Beijing, China.

Joseph E. Trainor

“Communicating the Severe Weather Threats: Insights from Social Science.” Presented at the Dallas-Fort Worth Area Integrated Warning Team meeting, February 29, 2012, Fort Worth, Texas.

“Myths and Misconceptions of the Human Behavioral Response to Disasters.” Presented at the FEMA Brown Bag Lunch Talk, October 18, 2012, Washington, D.C.

“Myths and Misconceptions of Human Behavior and Response to Disasters.” Presented at the Investment Company Institute Meeting, November 9, 2012, King of Prussia, Pennsylvania.

Tricia Wachtendorf

“Coordination among Organizations in Disasters.” Presented at the American Red Cross Day at the White House, September 14, 2012, Washington, D.C.

Poster Presentations

Erik Archibald

“Learning about Hurricane Evacuation through Traffic Data.” Presented at the 37th Annual Natural Hazards Research and Applications Workshop, July 14–16, 2012, Broomfield, Colorado.

Eric Best, Etornam Banini, Michael Lopez, Adam Orescan, Shawn Reynolds, B.E. Aguirre, and Sherif El-Tawil

“Introducing SocEvac: Open-source Building Evacuation Software with Advanced Group and Crowd Behavior Elements.” Presented at the 37th Annual Natural Hazards Research and Applications Workshop, July 14–16, 2012, Broomfield, Colorado.

Lauren Clay, James Goetschius, James Kendra, and Mia Pappas

“Poor Mental Health as an Influence on Disaster Preparedness.” Presented at the 37th Annual Natural Hazards Research and Applications Workshop, July 14–16, 2012, Broomfield, Colorado.

Rachel Davidson, Charles Scawthorn, and Sizheng Li

“Post-earthquake Fires in the March 2011 Japan Earthquake and Tsunami.” Presented at the Japan and New Zealand RAPIDS and Research Needs Workshop, February 9–10, 2012, Arlington, Virginia.

Alex Greer

“National Science Foundation Funded Research: RAPID Grants for Quick-Response Research.” Presented at the Japan and New Zealand RAPIDS and Research Needs Workshop, February 9–10, 2012, Arlington, Virginia.

“National Science Foundation Funded Research: RAPID Grants for Quick-Response Research.” Presented at the 37th Annual Natural Hazards Research and Applications Workshop, July 14–16, 2012, Broomfield, Colorado.

Ziqiang Han

“Disaster Protective Activities in Business Organizations: The Patterns and Determinants.” Presented at the 3rd Conference of the International Society for Integrated Disaster Risk Management, September 8, 2012, Beijing, China.

“Property Acquisition and Reimbursement in Disaster and Emergency Management: Practices and Lessons from the United States.” Presented at the National Emergency Management Conference of China, October 24, 2012, Beijing, China.

James Kendra, Joanne Nigg, Debra Auger, Tomhide Atsumi, Takumi Miyamoto, Rochelle Brittingham, Alex Greer, and Yvonne Rademacher

“RAPID: The Tohoku Catastrophe: Volunteers and Non-Profit Organizations in Post-Kobe Japan.” Presented at the Natural Hazards Research and Applications Workshop, July 14–16, 2012, Broomfield, Colorado.

Jennifer Lazo

“Earthquake Preparation in Japan, New Zealand, and the United States.” Presented at the International Association of Emergency Managers (IAEM) Conference, October 30, 2012, Orlando, Florida.

Danielle Nagele

“Geographic Specificity, Tornadoes, and Protective Action.” Presented at the National Severe Weather Workshop, March 1–3, 2012, Norman, Oklahoma.

“Geographic Specificity, Tornadoes, and Protective Action.” Presented at the 37th Annual Natural Hazards Research and Applications Workshop, July 14–16, 2012, Broomfield, Colorado.

Sessions Organized or Moderated

Lauren Clay

“Breakout Session – Long-term Care Facilities.” Disaster Preparedness for Long-Term Care Facilities Conference, May 16, 2012, Newark, Delaware.

Jennifer Lazo and Samantha Penta

“Breakout Session – Assisted Living Facilities.” Disaster Preparedness for Long-Term Care Facilities Conference, May 16, 2012, Newark, Delaware.

Joseph E. Trainor and William Lovekamp

International Research Committee on Disasters (IRCD) Hazards Researchers Meetings, July 17-18, 2012, Broomfield, Colorado.

Lee Zelewicz

“Policy and Framing Session” International Research Committee on Disasters (IRCD) Hazards Researchers Meeting, July 17, 2012, Broomfield, Colorado.

DRC in the News

DRC events and activities were publicized regularly throughout the calendar year by the University's electronic newsletter, *UDaily* as well as other University of Delaware publications. The following are the news stories for 2012 along with their Web URLs:

"Averting Disaster"

This article discusses a conference that addressed disaster preparedness for long-term care facilities that was held at the University of Delaware. The conference was convened as part of a statewide research project conducted by Principal Investigators Bethany Hall-Long, professor in the University of Delaware School of Nursing and James Kendra, DRC Director.

Available online at <http://www.udel.edu/udaily/2012/may/disaster-preparedness-051712.html>

"Learning From a Mega-disaster"

This article appeared in *UD Research* and highlights DRC Associate Director Tricia Wachtendorf's field research in Japan following the devastating tsunami in 2011. Doctoral student Rochelle Brittingham was also a part of the field team.

Available online at http://www.udel.edu/researchmagazine/issue/vol3_no2/news_briefs.html

"Study to Keep Roads, Railways Up to Speed"

A collaborative project connecting DRC Core Faculty member Sue McNeil with researchers at Rutgers University aims to improve transportation systems with regard to maintenance, upgrade and design. The article discussing this project appeared in the *University of Delaware Messenger*.

Available online at <http://www.udel.edu/udmessenger/vol20no3/stories/research-briefs.html>

"Sustainable Transportation: Helping Delaware Stay Ahead of the Curve"

The work of DRC Core Faculty member, former DRC director, and current director of the University of Delaware's University Transportation Center Sue McNeil is featured in this article which appeared in *UD Research*.

Available online at http://www.udel.edu/researchmagazine/issue/vol4_no1/slr_sustainable_transportation.html

In addition to regular inclusion in *UDaily*, DRC staff members were also contacted for expert opinions that appeared in outside public media sources. The following are examples of these DRC appearances.

"Disaster Research Center." *International Innovation*.

Dr. James M. Kendra, director of the Disaster Research Center, discusses the role of the organization in enhancing disaster research and policies, as well as providing essential training opportunities.

“Hurricane Sandy’s Lessons Learned Reminiscent of Isaac, Experts Say.” *NOLA.com*

This article discusses the problems of risk awareness and the public’s response to messages regarding risk associated with disaster events such as Hurricane Isaac and Superstorm Sandy. Both DRC Director James Kendra and DRC Core Faculty member Joanne Nigg are quoted. Available online at http://www.nola.com/hurricane/index.ssf/2012/10/hurricane_sandys_lessons_learn.html

“Officials and Experts Praising FEMA for Its Response to Hurricane Sandy.” Steve Vogel, *The Washington Post*.

DRC Core Faculty member Joseph E. Trainor reflects on the changes within FEMA that brought it to a different level of response as evidenced in the aftermath of Superstorm Sandy. Available online at http://articles.washingtonpost.com/2012-11-01/politics/35505866_1_natural-disasters-fema-federal-disaster-response

“Reflections on the Golden Anniversary of the Disaster Research Center.” William A. Anderson, *HazNet*.

DRC alumnus William Anderson reflects on the role of the DRC within the broader field of disaster research as the center approaches the 50th anniversary of its founding in 1963. Available online at http://207.23.111.231/sites/default/files/library/HazNet_2012-09_v4n1.pdf

“Il Sociologo dei Disastri che Sfida le Emergenze.” Lucilla Niccolini, *Corriere Adriatico*.

This article discusses the current state of disaster research as reflected upon by DRC Director Dr. James Kendra. The text of the article is in Italian.

“The *Titanic* That Really Won’t Sink.” Kirk Johnson, *The New York Times*.

The *Titanic* has become a cultural meme according to Dr. James Kendra, Director of the Disaster Research Center, as quoted in this article describing public and cultural fascination with the sinking of the legendary ship even after so many years.

Article available online at http://www.nytimes.com/2012/02/26/us/the-titanic-that-really-wont-sink.html?_r=0

Visitors to DRC

DRC hosts numerous national and international visitors throughout the year, many of whom come to work with DRC personnel and to utilize the E. L. Quarantelli Resource Collection. In addition, DRC also sponsors a speaker series intended to initiate novel and provocative discussion of disaster related topics.

The following is a list of the visitors to DRC during the past year along with their institutional affiliation.

April

Wendy Graham, 2011 Churchill Fellow, New South Wales Ministry for Police and Emergency Services, New South Wales, Australia

Jun Zhuang, Multidisciplinary Center for Earthquake Engineering Research (MCEER), University of Buffalo, Buffalo, New York, USA

June

Paolo Cavalieri, Professional Emergency Manager, Foligno, Italy

September

Nuno Martins, Centro de Estudos Sociais, Azores University, Azores, Portugal

October

Victoria Cornell, School of Nursing and Midwifery, Flinders University, Adelaide, Australia

Victoria Johnson, Massey University Joint Centre for Disaster Research, Wellington, New Zealand

December

Liu Jiayang, School of Finance and Economics, Guangxi University, Nanning, China



DRC graduate students Samantha Penta and Erik Archibald talk with an Occupy Sandy volunteer from a local motorcycle club helping out at a donations and feeding site on Staten Island.
(photo by DRC graduate student Jennifer Lazo)



DRC graduate student Jennifer Lazo surveys damage from Hurricane Sandy during her field visit to Staten Island.
(photo by DRC graduate student Samantha Penta)

Other Disaster-Related Activities

In addition to the activities listed previously, DRC faculty, students and staff also participate in a range of activities pertaining to disasters including affiliations with various Boards, serving as reviewers for disaster related journals, etc.

Below is a brief list of affiliations currently held by DRC personnel.

Erik Archibald

- Volunteered with his church's Mormon Helping Hands group to help homeowners in Northern New Jersey remove debris and trees from their properties following Hurricane Sandy
- Founding Officer, International Association of Emergency Managers (IAEM) at the University of Delaware

Erik Archibald and Ziqiang Han

- Contributed to the Hurricane Sandy Volunteer effort by spending a day helping organize donated supplies and cleaning up a flooded home in Atlantic City, New Jersey

Rochelle Brittingham

- Reviewer, *Journal of Homeland Security and Emergency Management*
- Attended "Increasing Preparedness to Build Community Resilience," at the FEMA National Preparedness Symposium, Crystal City, Virginia, August 7–9, 2012

Lauren Clay

- Founding Officer, International Association of Emergency Managers (IAEM) at the University of Delaware
- Member, City of Philadelphia Medical Reserve Corps Advisory Committee

James Goetschius

- Founding Officer, International Association of Emergency Managers (IAEM) at the University of Delaware

Alex Greer

- Member, International Association of Emergency Managers (IAEM), both local and national chapters

Jennifer Lazo

- Founding Officer, International Association of Emergency Managers (IAEM) at the University of Delaware

Danielle Nagele

- Named to the Board on Societal Impacts within the American Meteorological Society as a student member

Joseph E. Trainor

- Guest Editor, *Natural Hazards Review*
- Member, FEMA Committee to Establish Research Standards for Emergency Management Research
- Member, American Meteorological Society Drafting Committee for Statement on Social Science in Meteorology
- Presenter, National Weather Service Weather Ready Nation Initiative
- Organizing Committee Member, National Weather Service Weather Ready Nation Initiative

Pat Young

- Chair, Emergency Response Working Group (ERWG), University of Delaware
- Chair, Delaware Disaster Assistance Team (DDAT)

The E. L. Quarantelli Resource Collection



Pat Young, Resource Collection Coordinator, is seated in the collection space of the E. L. Quarantelli Resource Collection.

(photo by Erna Danielsson, DRC visiting researcher from Mid Sweden University)

Report of Activities

2012 was another year of growth and development for the E. L. Quarantelli Resource Collection. The Resource Collection and its components continue to serve a key role in the DRC's core focus areas of Research, Education/Mentoring, and Outreach/Dissemination.

Collection Growth and Development

During 2012, 1,028 new items were added to the Resource Collection. Sources included selective purchases, both internal and external donations, methodical compilation of open access Web resources, and utilizing opportunities such as the Surplus Books Program offered by the Library of Congress. DRC continues to practice a careful collection development policy that both supports ongoing research efforts and also enhances the existing collection, now numbering approximately 60,000 items. The Collection continues to be utilized by disaster researchers and other interested scholars and practitioners worldwide.

Those utilizing the Collection throughout the year included 36 students from the University of Delaware and across the United States along with our seven visiting researchers from Australia, Italy, Portugal, New Zealand, China, and the U.S. In addition, staff responded to numerous collection-related inquiries from around the world via email.

All Resource Collection personnel also completed both Responsible Conduct of Research training and Human Subjects training provided by the University of Delaware to become better versed on the research issues pertaining to disaster related studies. This knowledge helped us to better serve the researchers who use the collection both in terms of historical research records as well as resources on more current events.

Additionally, collection personnel continued to provide training to researchers on the nuances of the E. L. Quarantelli Resource Collection and its companion catalog database, DISCAT. Finally, collection staff joined other DRC personnel in participating in fire safety training to be better prepared should a fire occur at DRC's location.

Activities of the Resource Collection Staff

Resource Collection Coordinator Pat Young continued her active involvement in both the Delaware Disaster Assistance Team (DDAT) and in UD's Emergency Response Working Group (ERWG). In 2012 she assumed the position of Chair for both organizations. Both DDAT and ERWG address the broad spectrum of emergency- and disaster-related topics that pertain to collections. Additional information on both groups can be found on their respective web sites (DDAT – <https://sites.google.com/site/ddatdelaware/>; ERWG – www.udel.edu/ERWG). One of the training opportunities sponsored by DDAT in which Pat participated was the recovery of wet paper-based materials such as books, articles, papers, maps, and other documents. This training illustrated hands-on techniques for minimizing the impact of a water-based event that might affect the collection spaces.

One of the most pressing challenges for the Resource Collection is the increasing need for additional space. This will be an important matter to resolve moving forward. We will also continue working diligently to identify new and innovative ways to collect, capture, preserve and provide access to the vital information that has become so integral to the disaster research field and process.

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