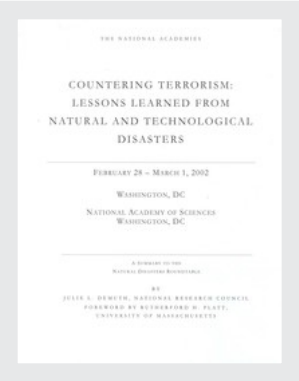

Countering Terrorism: Lessons Learned from Natural and Technological Disasters

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NATIONAL ACADEMY OF SCIENCES
WASHINGTON, DC

A SUMMARY TO THE
NATURAL DISASTERS ROUNDTABLE

BY
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FOREWORD BY RUTHERFORD H. PLATT,
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NATURAL DISASTERS ROUNDTABLE

The Natural Disasters Roundtable (NDR)[1] seeks to facilitate and enhance communication and the exchange of ideas among scientists, practitioners, and policymakers concerned with urgent and important issues related to natural disasters. Roundtable meetings are held three times a year in Washington, DC. Each meeting is an open forum focused on a specific topic or issue selected by the NDR Steering Committee.

The NDR Steering Committee is composed of 5 appointed members and sponsoring ex officio members. Appointed members are: Rutherford H. Platt, Chair, University of Massachusetts, Amherst; James P. Bruce, Global Change Strategies International, Inc., Ottawa, Canada; Wilfred D. Iwan, California Institute of Technology, Pasadena; Stephen P. Leatherman, Florida International University, Miami; and Mary Fran Myers, University of Colorado, Boulder. Ex officio members are: Lloyd S. Cluff, Pacific Gas & Electric; Frank Goodman, EPRI; Timothy Gubbels, NASA; Robert Hirsch, USGS; Margaret Lawless, FEMA; James Makris, USEPA; James Russell, Institute for Business and Home Safety; Dennis Wenger, NSF; and Helen Wood, NOAA.

For more information on the Roundtable visit our website: http://national-academies.org/naturaldisasters or contact us at the address below.

Natural Disasters Roundtable
The National Academies
2101 Constitution Avenue, NW
Washington, DC 20418
Phone: 202-334-1964
Fax: 202-334-1961.

[1] The National Research Council defines a "roundtable" as a type of convening activity of the National Academies that provides a means for representatives of government, industry, and academia to gather periodically for the identification and discussion of issues of mutual concern. In contrast to National Research Council study committees and other committees of the National Academies, roundtables are intended solely to enable dialogue and discussion among key leaders and representatives on a particular issue. They provide a valuable forum for exchanging information and for the presentation of individual views. However, because roundtables are not subject to institutional requirements concerning conflicts of interest, composition, and balance that apply to NRC committees, roundtables are prohibited by the National Academies from providing any advice or recommendation.

FOREWORD

When, where, and how will the next shoe fall? Since the cataclysmic attacks on the World Trade Center and the Pentagon on September 11, 2001 ("September 11"), the United States has held its collective breath awaiting the next acts of premeditated and wanton terrorism. While political attention has focused on international threats, acts of terrorism also originate domestically, as the bombing of the Alfred P. Murrah Federal Building in Oklahoma City attests. And the medium of choice for the next terrorist attack could be slow and insidious rather than explosive. The anonymous mailing of anthrax spores to selected human targets shortly after September 11 demonstrated the vulnerability of our most basic daily support systems to biological, chemical, or radiological disruption.

In response to the September 11 attacks and the anthrax outbreak, the National Academies (the Academies) promptly offered to assist national leaders in assessing the scientific and technical dimensions of terrorism. A meeting of the National Academy of Sciences President Bruce Alberts and other distinguished scientists on September 26, 2001 led to the formation of the Klausner-Branscomb Committee to develop a comprehensive science and technology agenda for counter-terrorism. Within the Academies, responsibility for the inventory and coordination of terrorist-related activities of various units was assigned to Dr. Douglas Bauer, Director for Counter-Terrorism Coordination.

Beyond documenting work already completed or in progress, the National Academies has sponsored a variety of ad hoc initiatives to better apply national expertise in science, engineering, and medicine to countering terrorism. Within weeks after September 11, proposals were solicited from units of the National Academies for special short-term projects relating to terrorism to be funded internally by the Academies President's Office. Dr. William Anderson, Director of the Natural Disasters Roundtable (NDR), successfully requested funds to support a two-day forum on "How Natural Disaster Research Can Inform Response to Terrorism." This program, held on February 28-March 1, 2002, was organized by Dr. Anderson and NDR Staff Associate Patricia Jones Kershaw in collaboration with the NDR Steering Committee. Together, they selected an interdisciplinary group of 24 speakers and panelists (see Appendix A for the agenda and Appendix B for speaker biographies; additionally, see Appendix C for related links and Appendix D for a list of attendees). This report summarizes the discussions of that forum.

The Natural Disasters Roundtable (NDR) was established by the National Academies in 2000 to promote communication and knowledge transfer concerning natural hazards among researchers, governmental agency staff, political decision makers, and the interested public. The NDR membership includes a steering committee of natural hazard experts from various disciplines and representatives from participating federal

agencies. Prior to its terrorism forum, the NDR had organized three public forums at the National Academies headquarters building on selected topics of immediate public interest: (1) Urban-Wildland Fires; (2) Energy Policy and Natural Disasters; and (3) Sea Level Rise and Coastal Disasters. Unlike committees and boards of the National Academies, a roundtable is intended to facilitate communication among various sectors, but not to prepare a formal report or offer recommendations. This summary therefore is simply a synopsis of the various speakers and discussion without recommendations for public policy.

The NDR Forum on Countering Terrorism was not designed to repeat truisms and conventional wisdom Instead, it was intended as a unique opportunity for researchers on natural and technological disasters to draw on and share their research in order to help us better understand how to confront and respond to terrorism. The forum also allowed responders who were on the scene in New York or Arlington, Virginia, to provide an account of their experiences, with the intent of suggesting worthwhile lines of research that may help them meet future terrorist threats and attacks. The issue of causation is crucial: deliberate causing of harm (terrorism) obviously differs from an impersonal "Act of Nature" (e.g., earthquake, flood, ice storm, drought). An airplane crash or toxic waste spill may be terrorist-induced or may result from factors unrelated to terrorism. Making the distinction is important. Terrorism is cold-blooded, calculated, and criminal. Its manifestations are largely unpredictable as to form, location, and magnitude. Secondary effects from terrorism – economic, social, and emotional – may spread more rapidly and widely than in the case of many natural or technological disasters. Moreover, the site of a terrorist act must be treated as a crime scene as well as a disaster scene.

Nevertheless, there are many commonalities between deliberate human-caused disaster and unintentional human- or natural-caused disasters. Each type of disaster may require incident command organization, information technology, warnings, communications, evacuation, special needs populations, feeding and sheltering, volunteers, emotional counseling, and stability of lifelines. The four core componets of emergency management are: (1) Preparedness, (2) Response, (3) Recovery, and (4) Mitigation. These apply equally to terrorist threats, with the possible addition of detection of threats, and prevention (or interdiction).

Clearly, there is much work to be done in relating knowledge about human response to natural and technological disasters to the threat of terrorism. The NDR Forum was a first step in what should be a long-term collaboration between natural hazards researchers and responders, and terrorism researchers and responders. I believe that each group will learn from each other, to their mutual benefit and that of the nation as a whole.

Rutherford H. Platt, Chair
Natural Disasters Roundtable

NATURAL DISASTERS ROUNDTABLE

A SUMMARY OF THE FORUM ON COUNTERING TERRORISM: LESSONS LEARNED FROM NATURAL AND TECHNOLOGICAL DISASTERS

INTRODUCTION

> *Science can play a role in helping with prevention and mitigation as well as recovery and repair. It will make its greatest contribution if we consider our vulnerability to terror attacks and to natural disasters jointly rather than separately. Because our social and economic arrangements have made us vulnerable to both, we can gain from working on them together with a program that involves the social sciences as deeply and as actively as the natural sciences (Kennedy, 2002).*

The Natural Disasters Roundtable Forum on Countering Terrorism, held at The National Academies in Washington, D. C. on February 28 – March 1, 2002, promoted a two-way process of knowledge exchange. In one direction, representatives of the hazard research community discussed lessons from past disasters that may help inform efforts to respond to and recover from acts of terrorism. In the other direction, key personnel who responded to the September 11 events, and to the anthrax bioterrorism that followed, helped to define new research needs applicable to terrorism.

The devastating events of September 11 stimulated researchers and practitioners familiar with natural and technological disasters to apply their expertise to the new challenge of countering terrorism. Certainly there are important differences between terrorism and other disasters, the issue of causation in particular. Terrorist acts are deliberate, willful, and criminal, while such "conventional" disasters as earthquakes, floods, and toxic spills happen due to acts of nature or negligence, but not intention. But subject to this fundamental distinction, there are nevertheless many commonalties between deliberate and nondeliberate disasters, particularly relating to response and recovery. As noted by Kenneth Bloem of The Johns Hopkins University Center for Civilian Biodefense Studies, parallels exist between many natural and human-induced calamities, e.g., wildfires vs. arson, accidental explosions vs. bombs, airplane accidents vs. aviation terrorism, floods vs. dam sabotage, chemical spills vs. chemical attacks, and epidemics vs. biological terrorism. Experience gained from decades of research on natural and technological disasters may therefore provide useful guidance to those charged with planning for and responding to the threat of terrorism. These relate particularly to issues of organization, communication, search and rescue, coordination of volunteers

and donated resources, and addressing the emotional and economic impacts on victims and the larger society.

Despite numerous similarities, there are key differences between natural, technological, and terrorist-induced disasters. Natural hazards can have natural cycles. Also, the location of natural hazards is known to a certain extent, i.e., hurricanes usually hit coastal areas, while earthquakes occur near fault lines. Similarly, technological hazards exist in known locations. However, technological disasters, usually resulting from human error, are difficult to predict. Proper planning, training, and decision making can keep natural and technological hazards from becoming disasters. Although the disasters in these cases are preventable, the hazard is not. On the other hand, with terrorism, the hazard is the terrorist and the disaster results from the attack--both of which are predictable and preventable if science and intelligence are applied effectively (Bloem, 2002[1]; Kennedy, 2002). Also, terrorists often are intelligent enemies willing to sacrifice anything for their cause, and unlike natural disasters, their attacks result in criminal investigations. (Bloem, 2002).

The acquisition and utilization of knowledge is essential for coping with perilous situations. For natural disasters, this may include such things as monitoring fault lines to determine potential danger from earthquakes, obtaining data for forecasting hurricane tracks in order to evacuate potential victims, or conducting research to better understand climate change. For technological disasters, *a priori* knowledge may include risk assessment of potential infrastructure failures or employee training to prevent accidents.

Similarly, understanding the traits and motivations of terrorists may be essential to countering their actions. According to William Waugh of Georgia State University, four key characteristics of terrorists are their 1) use or threat of extraordinary violence, 2) creation of a psychological impact beyond the victims, 3) selection of specific targets or victims for symbolic value, and 4) belief that their behavior is purposeful. Part of the psychological fear terrorists induce is due to their use of familiar agents and objects as weapons (Lindell, 2002), such as flammable materials, toxic chemicals, biological agents, and most recently, fully fuelled airplanes loaded with passengers. Moreover, it is perceived that terrorism is becoming more violent and deadly. The new age of international terrorism, often religiously and politically motivated, is worsened by access to weapons of mass destruction (Waugh, 2002; Hansen, 2002).

It is because of both the similarities and the differences between natural and human-induced disasters that a panel of experts – policymakers, emergency managers, first responders, public health workers, physicians, and researchers – assembled at the Natural Disasters Roundtable forum to

[1] All speakers presentations are referenced as '2002', based on the date of the date of the workshop, February 28-March 1, 2002, when their material was presented.

discuss what lessons can be gleaned from experience with both types of disasters. The objective was to consider how to handle future disaster emergency situations better. A summary of the major areas discussed during the forum is presented, focusing on a generalized approach to disaster management, specific lessons learned from past incidents, and challenges and opportunities for improved disaster response.

DISASTER MANAGEMENT

Whether considering natural, technological, or terrorist-induced events, many of the comments of forum participants focused on disaster management issues related to preparedness, detection, response, and recovery. It is noted that these points of discussion are not meant to be the same four core components of emergency management discussed in the Foreword. Rather, the emphasis during the forum on the need for effective detection measures inspired its inclusion here as a main discussion area, whereas mitigation is not.

Preparedness

"Preparedness equals success." - Frances Edwards-Winslow, Director of Emergency Management for the City of San José

Preparedness was expressed by Susan Cutter of the University of South Carolina in terms of the "precautionary principle", the notion of reducing vulnerability before a threat occurs. J. Kenneth Mitchell of Rutgers University asserted that vulnerability is an important but understudied topic in hazard research. He contrasted "vulnerability", the exposed, dependent state of people and physical systems, to "risk" which is an estimate of the statistical probability of loss or injury. Psychologist Paul Slovic defined "risk" as a term invented by humans to help understand and cope with dangers in life. He and Richard Little, of the National Research Council's Board on Infrastructure and the Constructed Environment, discussed how risk assessment – the process of determining what can go wrong, with what probability, and with what consequences – is essential to preparedness strategies. However, Slovic warned about the limitations, subjectivity, and contentiousness of risk assessment. He described how perceptions of risk and other social processes cause risk to be amplified (social amplification of risk) such that even small events can lead to ripple effects whose consequences exceed the direct impacts from loss of lives and immediate damages. This ripple-effect model has important implications for risk assessment and decision-making. For example, it implies that prevention of frightening events may be even more important than reduction of consequences after they occur. Slovic also discussed the key role of affect and emotion in determining risk perceptions

and pointed to some implications of this, such as strong affective response to possible events, which can overwhelm consideration of the probabilities of these events.

Risk management supplements risk assessment by addressing what options are available for preventative action, what associated trade-offs exist in terms of costs, benefits, and risks, and what impacts current decisions have on the future (Little, 2002). One essential area is risk management of critical infrastructure, the linked system of facilities and activities vital to providing services necessary to support our economy and quality of life; according to Little, the entire system is incapacitated if particular components or subsystem are not functioning. Critical infrastructure ("lifelines") include electrical power, medical and public health services, transportation, oil and gas production and storage, water supply, emergency services, government services, banking and finance, and telecommunications. Risk management includes determining the most vulnerable infrastructure systems as well as the age and condition of specific structures (Hess, 2002).

Despite rigorous protection of critical infrastructure, natural, technological, and terrorist-related disasters inevitably will handicap systems, thus it is imperative to establish redundancy. Seismologist Stuart Nishenko demonstrated the value of risk management and redundant systems in electric power transmission with the example of the 7.4 magnitude earthquake that hit Izmet, Turkey on August 17, 1999. Power failed within minutes of the earthquake due to damage at a key substation and various power plants tripping off. Power was rerouted through additional circuits that were planned as redundant backups to the power grid in the event of fire or earthquake, and the system was up and stable within four hours after the earthquake. This example illustrates the importance of planned alternatives to reduce the downtime of critical systems and expedite response and recovery.

In addition to large-scale infrastructure, like electrical power, localized infrastructure such as health care systems are equally essential. Public health speakers at the forum such as Eric Noji, Kim Shoaf, Sam Stratton, and Donald Weiss noted that two crucial preparatory functions are maximizing laboratory capacity and creating flexible health care systems. In other words, a healthy dose of disaster planning is needed, yet it is recognized that unusual or extreme situations can and will occur, and responders must be able to adapt accordingly. For practitioners, advanced health care preparation includes:

- Practice drills;
- Stockpiling pharmaceuticals;
- Adequately staffing hospitals and public health facilities;
- Creating response plans;
- Training and educating responders;

- Vaccinating against potential or current biological threats; and
- Establishing comprehensive relationships with fellow organizations and responders so that communication is facilitated and integrative databases are established.

Participants especially stressed the latter three activities as cardinal to disaster response. For researchers, health care preparation entails:

- Analyzing existing and novel pathogens;
- Studying the weaponization of chemical, biological, and nuclear agents;
- Parameterizing the transport and diffusion of agents;
- Developing new vaccines;
- Improving detection and surveillance techniques.

For preparation purposes in general, nearly every governmental and private organization has a disaster response plan dictating action in emergency situations. For instance, at the federal level, Federal Response and National Contingency plans exist; locally there are numerous city and county emergency response plans which mobilize specialty teams and support functions (Jackson, 2002), and there are incident command structures and mutual aid agreements (Harrald, 2002). Peter LaPorte, of the Washington, DC Emergency Management Agency, even suggested that response plans should be personalized, meaning every individual or family should have an advanced "game plan" in the event of various disasters.

Regarding preparatory logistics, Frances Edwards-Winslow discussed how the city of San José's emergency preparedness team modified training exercises, forcing trainees to think thoroughly about their actions before carrying them out. This enables the trainees to 'get it right the first time' rather than correcting mistakes afterward. She also reported on San José's policy of the "dual use concept" whereby no equipment or plans are used for a specific purpose (i.e., sarin gas detectors). This concept of systematic usage promotes familiarity with the equipment, ensures regular maintenance, and builds constituency among health organizations. Finally, San José's foundation for hazard response consists of numerous plans and response units, and their recently added bioterrorism plan was created more easily due to two of these pre-existing plans: the multiple casualty incident plan and the disaster medical/health plan. Thus plans for natural and technological disasters proved applicable to the threat of terrorism.

Detection

Effective execution of the second component, detection, is extremely dependent upon the success of preparedness. As noted by both Donald Weiss of the New York City Department of Health, and Sam Stratton of the Los Angeles County Emergency Medical Services Agency,

communication among researchers, physicians, public health workers, government officials, and even veterinarians overshadows all other detection systems in importance. For instance, the West Nile Virus outbreak during Summer 1999 may have been diagnosed earlier if veterinarians and physicians had pre-existing working relationships to facilitate interaction, or if they had integrated databases to facilitate information exchange (Weiss, 2002). For more blatant terrorist attacks such as those on September 11, rapid communication among government officials, air traffic controllers, and even the victims on United Airlines Flight 93 helped avert what may have been additional casualties.

Effective communication is contingent upon sufficient surveillance systems to detect problems. For terrorist-induced disasters, surveillance systems include instrumentation to detect chemical, biological, or nuclear agents, integrated databases, and metal detectors; simple visual surveillance also is key, including being aware of unusual behavior or activities and checking for appropriate documentation. For all disaster types, Stratton stressed the use of information networks, such as ongoing field data collection systems, to show variations in health trends and promptly identify public health threats. Additionally, education, thorough medical examinations, and modern lab systems with adequate capacity are necessary for rapid diagnoses of existing and novel strains, which further facilitate effective information exchange.

Response

Even with comprehensive preparedness and detection measures in place, disasters occur and therefore response is the essential next step in disaster management.

Once agencies are notified of and mobilized for a disaster, prompt, effective response is contingent upon assessment and consequent matching of needs with resources (Stratton, 2002). According to Michael Lindell of the Hazard Reduction and Recovery Center at Texas A&M University, there are key assessment functions that should be implemented immediately after any disaster occurs. They include:

- Threat detection and emergency classification;
- Hazard and environmental monitoring;
- Population monitoring and assessment;
- Damage assessment.

Threat detection and emergency classification are used to determine how bad a situation is, who responds, and the logistics of acting. Hazard and environmental monitoring provide air quality measurements, biohazard point of distribution and dispersion, and infrastructure-related hazards (gas leaks, downed power lines, debris, etc.). Population monitoring and assessment addresses if, when, and where to evacuate and quarantine people, and includes reporting on the status of injured,

missing, or deceased victims. Finally, damage assessment entails determining structural safety to mitigate further injuries or casualties. Thorough execution of all assessment functions is crucial to effectively responding to victims and the disaster site; furthermore, it helps prepare for the final phase of recovery.

Several forum presenters provided specific examples of Lindell's emergency assessment functions. John Sorensen of Oak Ridge National Laboratory discussed warning systems relevant to emergency classification and population monitoring. He asserted that public response during terrorist attacks is similar to natural or technological disasters, and he defined the process in terms of "hearing, understanding, believing, personalizing, confirming, and finally responding". Sorensen debunked several myths about issuing warnings, such as the beliefs that (1) panic ensues, (2) people are confused if given too much information, (3) "crying wolf" leads to inaction, and (4) people automatically follow instructions. To increase warning response, he suggests giving consistent, specific, accurate descriptions of the hazard and its impacts using pre-scripted text and visual aids. Public messages should be issued frequently and by multiple sources to reach as many people as possible. Fortunately, this objective has a tendency to be accomplished more easily for terrorist-induced disasters, because mass communication is more plentiful for such events due to public interest (Quarantelli, 2002).

Other examples of population monitoring were discussed by Kathleen Tierney of the Disaster Research Center at the University of Delaware in terms of group and organizational response, including convergence, emergence, and improvisation. Social scientists long ago identified that there is a spontaneous mobilization of people, goods, and information into disaster-stricken areas. It is inevitable and, in general, the more severe an event, the greater the convergence. While convergence can lead to congestion and hinder operations, such as impact zone access control and security, it does provide an abundance of resources to meet needs including reception and care of victims. For example, Enrico Quarantelli of the Disaster Research Center at the University of Delaware noted that 94 percent of Americans took some sort of behavioral step – displaying the American flag, donating blood and money, supplying goods, attending religious services, etc. – post September 11 due to the sheer magnitude of the devastation. Emergence, the formation of new, unofficial groups to address newly defined disaster needs, is another phenomenon that occurs in response to disasters. Like convergence, it also is inevitable and directly proportional to the size of the disaster. While it does help ensure that needs are met, established groups may distrust emergent groups' knowledge, skills, and abilities regarding what needs to be done. While extensive preparedness for all disasters is of the essence, not all contingencies can be anticipated, thus the ability to improvise – apply new technologies, tools, and strategies – during response is of equal importance. In fact, Tierney asserted

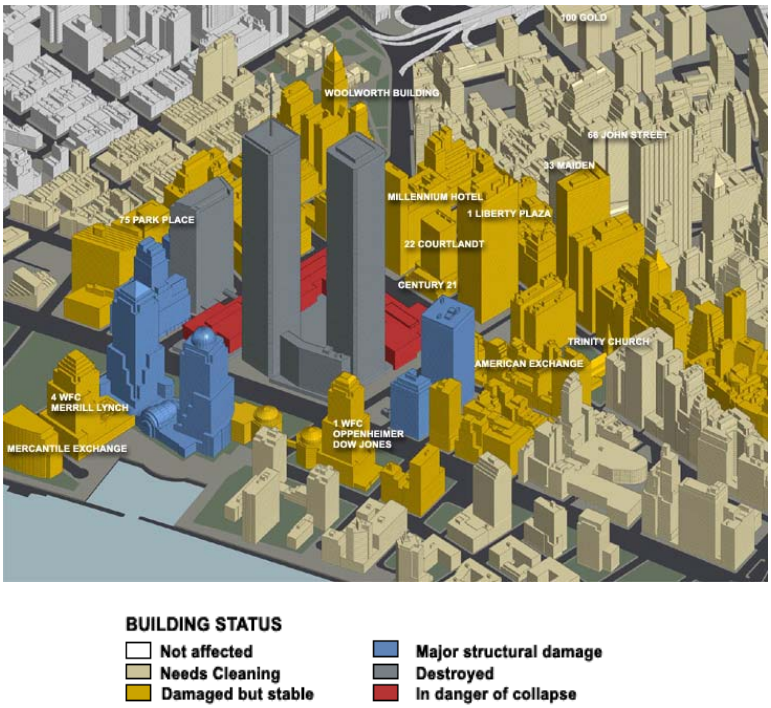

Figure 1. 3D damage report of Lower Manhattan. (Reprinted with permission from Urban Data Solutions, Inc., 2002).

that "any event that does not require improvisation is not a true disaster", and that organizations must be able to effectively improvise to manage major disasters. Since adequate preparedness at all scales is impossible, in many cases improvisation may be the key to improving response.

Another of Lindell's emergency assessment functions, damage assessment, is increasingly accomplished with new technologies. For instance, a Light Detection and Ranging (LIDAR) system was used post September 11 to give a three-dimensional topographic map of the remaining debris and buildings around the World Trade Center (Tierney, 2002) (see Figure 1). Additionally, as an example of improvisation, the Geographical Information System (GIS) technique used to determine structural soundness after earthquakes was applied to the World Trade Center area for rapid assessment of the surrounding structures (Nishenko, 2002).

Recovery

According to Stratton, the final, and most important component of disaster management is recovery of the disaster site and the people affected directly and indirectly. For all types of disasters, this involves short and long-term efforts. Marianne Jackson of FEMA spoke of many temporary financial projects to assist victims immediately following disasters, including for home repair, mortgage, and rental assistance programs; individual and family grant programs; low interest disaster loans for home or business; and disaster unemployment. She noted additional aid provided by disaster assistance service centers, including crisis counseling, child care service, interpreters, and health care. Jackson also discussed long-term recovery task forces, which (1) promote the flow of information between federal agencies at the recovery area and the national level, (2) provide federal

agencies an open forum to exchange information related to recovery issues, and (3) streamline delivery of federal aid. Furthermore, congressional and intergovernmental liaisons provide congressional delegations with continual information and intelligence on developing trends.

In relation to financial recovery, there is often a surge of donations and financial assistance immediately following natural, technological, or terrorist-induced disasters. However, the monetary flow may not be maintained through to the crucial recovery phase when rebuilding and future mitigation plans are developed. In contrast to this pattern, Michael Byrne of the White House Office of Homeland Security discussed the National Security Strategy, established shortly after September 11. The strategy is required to be long-term and supported by a multi-year, crosscutting budget plan so that recovery and preparedness for future disasters will continue over the longterm. Similarly, LaPorte discussed his ongoing efforts to ensure that the Washington, DC Emergency Management Agency receives the funding it needs to prepare for, detect, respond to, and recover effectively from all types of disasters.

LESSONS LEARNED

Two primary lessons learned from past disasters crosscut each of the disaster management components: the need for effective organization and communication. Several forum participants noted the insularity among all disaster personnel, including policymakers, emergency managers, first responders, public health workers, physicians, and researchers. Distrust, territoriality, and reluctance or inability to share information hinders disaster management and perpetuates insularity. For instance, public health researcher Kim Shoaf noted that the public health sector – a field responsible for protecting the health and well-being of the community as a whole – is not yet readily accepted in the medical and emergency response fields. She asserted that group segregation promotes varying cultures, terminology, and a feeling of righteousness and distrust; this is problematic when different groups are forced to work together in stressful, emergency situations. Mark Penn, Arlington County Director of Emergency Management, proposed that in addition to establishing ongoing relationships, an incident command structure is needed at all levels of government and private sector organizations. Therefore, during states of emergency, a hierarchy will exist to manage agency notification and mobilization, internal direction and control, external coordination, public information distribution, administrative and logistical support, and documentation (Lindell, 2002).

Communication and organization also are needed for successful disaster response when unusual challenges are presented, particularly at the local levels (Noji, 2002). For example, Charles Hess noted that on the morning of September 11 many emergency management directors were attending

the National Emergency Management Association annual conference in Big Sky, Montana. Since air traffic was halted, the directors were unable to return to their jurisdictions to manage the disaster. However, effective communication and well-trained, capable emergency management staffs averted what could have been an additional, massive problem.

Forum participants mentioned many other lessons learned related to one or more of the disaster management components. Little observed that the relationships among terrorist threats, vulnerability, and targets are not well understood, suggesting that preparedness may be challenging. He encouraged research and education in these areas as well as implementation of blast-resistant construction and scenario building as necessary pre-emptive measures. Penn credited Arlington County's timely response to the September 11 terrorist attack on the Pentagon to their preparation for Y2K. Their planned redundancy of portable cellular communication literally was set up within minutes so that first responders could communicate. Thus a key lesson learned was that preparation for previous situations unrelated to terrorist events is nonetheless applicable. Another lesson learned which produced a needed change in preparedness strategy occurred at the Centers for Disease Control and Prevention (CDC) following the recent anthrax outbreak. Eric Noji of the CDC and White House Office of Homeland Security noted that the CDC mandated bioterrorism training to improve response time and competence should a future biological emergency occur.

Regarding detection, forum participants discussed the lessons learned from previous viral outbreaks of pandemic influenza, smallpox, and West Nile Virus. In general, the need for surveillance, rapid diagnoses, and integrated data systems were not met in these cases. For instance, the West Nile Virus was difficult to detect because only one CDC laboratory in Fort Collins, Colorado was equipped to test for it (Weiss, 2002). Noji discussed the anthrax outbreak and compared the difference of working with previous viral outbreaks to the classified information constraints of anthrax as "working half blind-folded". The logistics of criminal investigations and having to work within such restrictions complicate the recovery from terrorist attacks. Weiss described several other anthrax detection problems to be remedied such as false "powder" incidents, and problems related to point of distribution logistics, sample tracking, laboratory testing, and multi-agency coordination.

The unprecedented response of spontaneous, volunteer convergent and emergent groups after the September 11 attacks sometimes were as problematic as they were beneficial. According to Hess, it was daunting to combine highly trained responders with volunteers having little or no experience and whose mental and physical abilities were unknown. Thus, a method of surveying volunteer workers is necessary for emergency response officials to determine their abilities and limitations; this ensures that the organizational response is expeditious and that safety is not compromised. The

convergence of materials and supplies, especially those not requested, after the attacks also caused difficulties for response and recovery. This highlighted the need for an improved donation management and distribution system for future disasters (Tierney, 2002; Jackson, 2002).

For evacuation as well as search and rescue operations, more comprehensive population statistics are needed. Estimates of daytime, nighttime, and weekend populations in commercial, industrial, and tourist areas may help determine the methods and feasibility of evacuation procedures versus sheltering in place (Cutter, 2002).

Regarding sheltering in place or the possible need to quarantine, Richard Rotanz of the New York City Office of Emergency Management pointed out the services—food, water, clothing, and financial assistance—that would need to be provided to large numbers of people in scattered locations.

Edwards-Winslow described how non-governmental organizations (NGOs) can be particularly valuable in providing shelter for disaster victims. NGOs have multi-lingual workers to communicate with ethnically diverse groups, they provide basic medical care to sick people who may be screened out of other shelters, and they can assist special need victims. Communication with and utilization of such groups may alleviate some of the burden of response and recovery.

Finally, Rotanz described celebrity visits to Ground Zero that occurred after the attack on the World Trade Center buildings as a worker morale booster. This type of activity proved to be a valuable part of raising spirits during recovery efforts, but Rotanz stressed the importance of properly coordinating such appearances.

After every disaster, challenging experiences result in new knowledge. They also highlight previous lessons learned but not fully integrated into emergency management plans. Lessons, old and new, must be taken into account in order to improve the management of future disasters. Obtaining a firm commitment from various leaders to interact with one another on a regular basis, and encouraging the shedding of distrust and territoriality furthers improved organization and communication. Joint training exercises, seminars, and conferences could be beneficial in this regard. Other lessons learned, such as the value of tabulating census data for commercial, industrial, and tourist areas, may require new mandates from Congress. Still other lessons, such as managing convergence and emergence, may require new ways of thinking and new approaches to disaster management.

CHALLENGES AND OPPORTUNITIES

Many forum participants noted that a window of opportunity exists in the wake of disasters, the length of which may be proportional to the magnitude of devastation. Thus, a time exists to seize opportunities and address new challenges. The following summarizes discussion by forum participants on the links between lessons learned and implementation strategies.

Lindell observed that what may prove to be the most difficult challenge of predicting and mitigating future terrorist attacks is that terrorists are intelligent adversaries. They do their research, they know how to elude or infiltrate the system, and they can exploit the media to their advantage by striking when public preventative or evacuation measures are being undertaken or during a time of low risk as declared by the government. For instance, with the advent of the Internet, a colossal amount of information is available to anyone with a computer or simply access to a local public library. Prior to the attacks of September 11, data about public facilities were available on the Internet for many commercial and industrial sites. The threat of future terrorist attacks prompted the removal of such information from public availability.

The medical and public health sectors bear much of the responsibility for preparedness, detection, response, and recovery. For instance, the post September 11 anthrax outbreak underscored the threat of chemical, biological, and nuclear agents. Detection is complicated for biological outbreaks, preventing rapid treatment or casualty estimates (Noji, 2002). Contagious diseases also are more difficult to contain, and the possibility of needing to quarantine raises legal and ethical challenges (Bloem, 2002). Furthermore, if an extremely large attack or outbreak occurs, limitations of medication and vaccines are an issue. Accordingly, research on biohazard contamination is needed as well as new biohazard-specific emergency response procedures and training (Lindell, 2002). Another challenge is in contrast to the convergence of workers and volunteers that occurred after September 11; the possibility exists that some critical personnel may refuse to work or volunteer if a biological disaster occurs, although this could be alleviated if proper education and preventative measures are in place (Noji, 2002).

The possibility also exists that hospitals may be the target of a chemical, biological, or nuclear attack. Accordingly, Bloem highlighted several challenges pertinent to such disasters, including the need for:

- Communication networks among public health agencies, hospitals, and community physicians;
- International surveillance and detection systems;
- Enhanced laboratory diagnostic capabilities;

- Mechanisms and manpower to distribute mass antibiotics and vaccines;
- Adequate stockpiles;
- Adequate hospital capacity to handle mass casualties, especially for contagious diseases;
- Redundant and backup facilities;
- A classification system for hospitals based on experience and resources.

Since September 11 some hospitals are conducting preparedness self-assessments to determine deficient areas. They also are encouraging active awareness measures including more meetings, web sites, and technical assistance. Increased training and community-based disaster drills are also being coordinated, as well as coalitions, so that responders are comfortable with emergency processes and each other. Perhaps most importantly, more legislative attention is being paid to meet capacity needs, staff shortages, and funding requirements so that necessary funding prospects are increasing exponentially (Bloem, 2002).

Health practitioners are not the only professionals that are challenged to make changes to better prepare for, detect, respond to, and recover from natural, technological and terrorist-induced disasters. Mitchell highlighted seven understudied disaster topics that apply to the threat of terrorism:

- Vulnerability;
- Values;
- Victimization & visibility;
- Symbolism;
- Landscapes of hazard;
- Metropolitan contexts; and
- Gaps in existing terrorism research.

He asserted that disasters vulnerability is partly driven by poverty, reliance on new technologies, and additional factors that researchers and policymakers poorly understand. He noted that the effectiveness of terrorism is based on the degree to which it engages human fears and values. Thus, a better understanding of both our values and those of the terrorists may help anticipate terrorist acts so that we can reduce our vulnerability. Research also is needed to understand who are the victims of terrorism and how their reactions to being targeted differ from one another. Symbolism is deeply connected to terrorism such that symbolic people and places often are targeted, again to instill fear and threaten values; but past terrorist targets also become a symbol of survival. Similarly, landscapes of hazards include representative symbols of past terrorist events as well as vulnerability to potential future threats. There is also a need to study large cities, their evolution with technology and global

interaction, their multitude of authority and the consequent vulnerability, and their diverse environments. Finally, Mitchell suggested that past research on terrorism either was too general or too specific to one event, creating gaps in our knowledge; thus, he encourages research of all scales of terrorism.

Another challenge faced from all types of disasters is the need to strengthen infrastructure. Little suggested several research opportunities. To combat progressive collapse, generic design approaches are needed for economical concrete and steel-frame buildings that resist disproportionate collapse. Additionally, first responders need real-time assessment tools to make informed decisions on entering damaged structures. Since human error plays a role in many technological disasters, a better understanding of how systems can be designed to take human factors into account is needed. Finally, there is a general need to develop a better understanding of interdependent systems so that appropriate safeguards can be developed and deployed.

Overall, because the challenges are multiple, Jack Harrald of the Institute for Crisis, Disaster and Risk Management at the George Washington University noted the most important opportunity of all – the need for political and science organizations to conduct interdisciplinary research and applications. Without the knowledge gained from this research and its implementation, preparedness, detection, response, and recovery are much more difficult processes when dealing with natural, technological, and terrorist-induced disasters.

CONCLUDING REMARKS

Natural, technological, and terrorist-induced disasters are analogous in many important ways before, during, and after impact. Thus, lessons can be drawn and applied among all three. Policymakers, emergency managers, first responders, public health workers, physicians, and researchers came together at the Natural Disasters Roundtable forum. They shared experiences and concerns, and discussed ways to integrate efforts to improve emergency management in all types of disaster situations. The following recurring issues emerged during the forum.

- A common approach to disaster management can be conceived for natural, technological, and terrorist-related disasters involving preparedness, detection, response, and recovery.
- In all types of disasters, communication is needed among policymakers, first responders, public health workers, public service officials, practitioners, and researchers so all groups can work together efficiently and successfully during emergency situations.
- An incident command structure is needed to effectively manage disaster situations.

- Extensive planning and preventive measures are needed for all disasters, but equally important is the ability to improvise solutions for unforeseen problems that inevitably develop.
- Efficient local response is essential for natural, technological, and terrorist-induced disasters.

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* Jon Hansen was slated to present at the Natural Disasters Roundtable forum on the first day in Session III – Practitioner Panel on Cross-Disaster Experience: Meeting the Challenge of Different Types of Disasters. Unfortunately, he was unable to attend, but we are drawing upon his knowledge in this report.

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APPENDIX A – AGENDA

February 28 – March 1, 2002
National Academy of Sciences
2100 C Street, NW
Washington, DC
Lecture Room

Thursday, February 28, 2002

9:00 am **Welcoming Remarks and Introduction to Forum**
Rutherford Platt, Chair, Natural Disasters Roundtable, University of Massachusetts

9:05 am **The National Academies Counter Terrorism Activities**
Douglas Bauer, Director of Counter Terrorism

9:20 am **Introduction of Keynote Speaker**
Stephen Leatherman, Florida International University

9:25 am **Role of the Office of Homeland Security**
Michael Byrne, Office of Homeland Security

10:00 am Coffee break

10:15 am **Session I – Panel on Lessons Learned from Research on Risk Perception and Communication**
Moderator: Mary Fran Myers, University of Colorado

10:20 am **Risk Perception**
Paul Slovic, University of Oregon

10:40 am **Risk Communication and Disaster Warning**
John Sorensen, Oak Ridge National Laboratory

11:00 am **Role of the Media**
Henry Quarantelli, University of Delaware

11:20 am **Open Discussion**

11:45 am Lunch break

1:15 pm **Session II – Panel on Lessons Learned from Emergency Preparedness and Response**
Moderator: William Anderson, NRC

1:20 pm **Preparedness**
Michael Lindell, Texas A&M University

1:40 pm **Group and Organizational Response**
Kathleen Tierney, University of Delaware

2:00 pm **Evacuation**

Susan Cutter, University of South Carolina

2:20 pm **Open Discussion**

2:45 pm Coffee break

3:00 pm **Session III – Practitioner Panel on Cross-Disaster Experience: Meeting the Challenge of Different Types of Disasters**
Moderator: Richard Little, NRC

Charles Hess, FEMA

Marianne Jackson, FEMA

Richard Rotanz, City of New York

4:30 pm **Open Discussion**

5:00 pm Adjourn for the day

Friday, March 1, 2002

9:00 am **Welcome and Introduction of Keynote Speaker**
James Bruce, Global Change Strategies International, Inc, Ottawa

9:05 am **Keynote Address: The Role of the Centers for Disease Control and Prevention in Combating Natural and Human-Induced Disasters**
Eric Noji, Centers for Disease Control and Prevention and Office of Homeland Security

9:40 am Coffee Break

9:55 am **Session I – Panel on Public Health Systems Lessons**
Moderator: Wilfred Iwan, California Institute of Technology

10:00 am **Hospital Preparedness**
Ken Bloem, Johns Hopkins University

10:20 am **Implications of the Impacts of Past Natural Disaster Events on Public Health Systems**
Kim Shoaf, UCLA Center for Public Health and Disasters

10:40 am **Insights Derived from Cross-Disaster Public Health Experience**
Don Weiss, New York City Department of Health

11:00 am **Open Discussion**

11:30 am Lunch break

12:45 pm **Session II – Panel on Capacity Building: Meeting the Need for New Skills and Resources for Combating Terrorism by Building on Natural and Technological Disaster Experience and Resources**
Moderator: Richard Sylves, University of Delaware

12:50 pm **View of Practitioners**
Peter LaPorte, Washington, DC Office of Emergency Management

Mark Penn, Arlington County Fire Department

Frances Edwards-Winslow, San Jose Office of Emergency Services

Stuart Nishenko, Pacific Gas & Electric

2:10 pm Break

2:25 pm **View of Researchers**
William Waugh, Jr., Georgia State University
Sam Stratton, Los Angeles County EMS, UCLA
Jack Harrald, George Washington University
Ken Mitchell, Rutgers University

3:45 pm **Open Discussion**

4:30 pm **Concluding Remarks**
Rutherford Platt, Chair, Natural Disasters Roundtable

4:40 pm **Adjourn**

APPENDIX B – SPEAKER AND MODERATOR BIOGRAPHIES

Anderson, William – Dr. Anderson is Director of the Natural Disasters Roundtable and Associate Executive Director of the Division on Earth and Life Studies of the National Research Council. He was previously a Professor of Sociology at Arizona State University, head of the hazards mitigation program in the Directorate for Engineering at the National Science Foundation, and Senior Advisor in the Disaster Management Facility at the World Bank. He has co-authored two books, and authored and co-authored numerous research monographs and professional journal articles.

Bauer, Douglas – Dr. Bauer is the Director for Counter-Terrorism Coordination for the National Academies. In this role, he solicits information and ideas from the various divisions of the National Academies, keeps track of current and proposed activities, follows the efforts of federal agencies and other organizations, and acts as a resource to help the National Academies shape their responses to assist the nation in combating terrorism.

Bloem, Ken – Mr. Bloem is a Senior Fellow at the Johns Hopkins Center for Civilian Biodefense Studies, and he is the former CEO of the Georgetown University Medical Center. He has a health care background that spans thirty years and includes senior management leadership at three renowned academic health centers, experience as an international health administrator/epidemiologist, and appointments to a number of national, university and corporate boards.

Bruce, James – Mr. Bruce is the Senior Associate for Global Change Strategies International, Inc. in Ottawa, Canada. In his early professional life, he was a weather forecaster, established the flood warning system for the province of Ontario, and undertook research and teaching in hydrometeorology. Since then, he has held many positions, including being the Acting Deputy Secretary-General of the World Meteorological Organization, Geneva during which he assisted the Secretary-General in overseeing the establishment of the Intergovernmental Panel on Climate Change and the Global Atmosphere Watch for assessment of chemical changes in the Earth's atmosphere. Mr. Bruce has written several books, papers and articles, especially on climate change, environmental management, water resources, and disaster mitigation.

Byrne, Michael – Mr. Byrne is the Senior Director of Response and Recovery for the Office of Homeland Security. He is a 20-year veteran of the New York City Fire Department and a high-ranking official of the New York City region (Region II) of FEMA.

Cutter, Susan – Dr. Cutter is a Carolina Distinguished Professor in the Department of Geography at the University of South Carolina and Director of its Hazards Research Lab. She is the former President of the Association of American Geographers and a Fellow of the American Association for the Advancement of Science (AAAS). Dr. Cutter's research interests include hazard vulnerability, risk assessment, and GIS; human dimensions of global environmental change; and environmental policy and justice. Her most recent books include *American Hazardscapes: The Regionalization of Risks and Hazards*, *Living with Risk*, and *Environmental Risks and Hazards*. She was part of team that examined the use of geographical technologies (GIS, remote sensing, etc.) in the rescue and immediate relief phases of the World Trade Center collapse.

Edwards-Winslow, Frances – Dr. Edwards-Winslow is the Director of Emergency Preparedness for the City of San José. She has served as OES Director in San José for ten years, including one year as acting assistant chief in the San José Fire Department. Dr. Edwards-Winslow is also the

Director of San José's Metropolitan Medical Task Force, a terrorism response unit that includes police, fire, emergency services, and medical personnel. She is a certified trainer in five of the DoD "Weapons of Mass Destruction/Nuclear, Biological, Chemical" courses, and co-creator of the "Terrorism Awareness for Public Employees" course. She has written two chapters and co-authored a third in the "Terrorism" section of the *Handbook of Crisis and Disaster Management*. She participated in the Hoover Institution's Biological Terrorism Conference, and has contributed a chapter to their conference proceedings, *The New Terror*. Her article on "Dealing with the Media in the Midst of Terrorism" is on the Harvard/Kennedy School of Government website.

Hansen, Jon – Mr. Hansen was the Assistant Fire Chief of the Oklahoma City Fire Department at the time of the Alfred P. Murrah Building bombing in Oklahoma City, OK. He had Incident Commander responsibilities in addition to his role as spokesperson. He was also heavily involved when the F5 tornado with the fastest ever recorded wind speeds (in excess of 300 mph) devastated central Oklahoma in May 1999. Currently, Mr. Hansen is general manager of ATC – American LaFrance for a multi-state area and a consultant for FEMA, reporting to Director Joe Allbaugh, where he works on such special projects as assisting the FDNY at Ground Zero soon after 9-11-01.

Harrald, Jack – Dr. Harrald is the Director of the Institute for Crisis, Disaster and Risk Management (ICDRM) and a Professor of Engineering Management at George Washington University. His research interests include risk assessment, risk management, crisis management, maritime safety, aviadon safety and emergency response systems. He is a co-author of *Implementing an Effective Response Management System*.

Hess, Charles – Mr. Hess has been detailed to FEMA as Director of the Response Division, Response & Recovery Directorate. In this position he establishes doctrine, procedures, systems, and organization structure to respond effectively to natural disasters and terrorist events using the Federal Response Plan as the template for consequence management of all hazards. Prior to February of this year he was assigned as Chief of the Operations Division in the Civil Works Directorate at the Headquarters of the U.S. Army Corps of Engineers since 1997. In this position Mr. Hess oversaw the national program for Operations and Maintenance of Navigation, Hydropower, Natural Resources and Recreation infrastructure, as well as, the Civil Emergency Management and Regulatory missions of the Corps. His career with the Corps spans 30 plus years, beginning in the New York District in 1969.

Iwan, Wilfred – Dr. Iwan is a Professor of Applied Mechanics and Director of the Earthquake Engineering Laboratory at the California Institute of Technology. A noted earthquake engineer, he chaired the Board on Natural Disasters (BOND), and BOND's Committee on Hazards Mitigation Engineering (CHME). He also has served or chaired various other NRC committees, including the Committee on Natural Disasters and the Committee on Earthquake Engineering.

Jackson, Marianne – Ms. Jackson is a member of FEMA's 25-person national leadership team. Assigned to the FEMA Region II office in New York City, she is deployed to head disaster operations in New York, New Jersey, Puerto Rico and the U.S. Virgin Islands, as well as in other parts of the nation. As Federal Coordinating Officer, Ms. Jackson works in partnership with the affected state and local government to deliver disaster assistance in accordance with the Robert T. Stafford Disaster Relief and Assistance Act. Since joining FEMA in 1981, Ms. Jackson has served on more than 50 federally declared disasters. On the World Trade Center disaster, Ms. Jackson served as the Chief of Staff to the Federal Coordinating Officer for three months and is currently the Deputy Federal Coordinating Officer.

LaPorte, Peter – Mr. LaPorte was appointed in August 1999 to serve as Director of the Emergency Management Agency for the city of Washington, DC. He administers the city's comprehensive emergency response plan, which includes coordinating emergency services, training emergency

personnel, and informing the public of impending emergencies. From April to August 1999, Mr. LaPorte served as Chief of Staff with the city's Metropolitan Police Department. Previously, he was the Executive Director of the Massachusetts Emergency Management Agency, where he coordinated disaster preparedness, mitigation, and response and recovery for the state. During his tenure he managed several presidential declared disasters including the largest flood and the second largest snowfall in Massachusetts's history. Prior to entering the emergency management profession, Mr. LaPorte was a senior police official in Boston and New York City.

Leatherman, Stephen – Dr. Leatherman is the Director and a Professor of the International Hurricane Center at Florida International University where he specializes in oceanography and stratigraphy-sedimentation. His research interests include storm impacts on beaches, storm surge mapping, beach erosion, and sea-level rise impacts. He recently was Director of the Laboratory of Coastal Research at the University of Maryland. Dr. Leatherman is the foremost authority on beach quality and coastal erosion studies, and recently he chaired a FEMA-funded study conducted by the Heinz Center on coastal erosion. He has written over 100 journal articles and has authored 13 books.

Lindell, Michael – Dr. Lindell is the Director of the Hazard Reduction & Recovery Center (HRRC) at Texas A&M University. He has conducted research on emergency preparedness and response for a wide range of natural and technological hazards, and he has provided technical assistance on radiological emergency preparedness for the International Atomic Energy Agency, the US Nuclear Regulatory Commission, the Department of Energy, and nuclear utilities. In addition, he has worked on hazardous materials emergency preparedness with State Emergency Response Commissions, Local Emergency Planning Committees, and chemical companies. Professor Lindell recently served as a Visiting Scientist for the Defense Threat Reduction Agency, and currently he directs HRRC staff performing hurricane hazard analysis and evacuation planning for the Texas Gulf coast. He has made over 120 presentations before scientific societies and short courses for emergency planners, as well as being an invited participant in workshops on risk communication and emergency management in this country and abroad. He has written extensively on emergency management and is the author of over 60 technical reports, 60 journal articles and book chapters, and 5 books/monographs.

Little, Richard – Mr. Little is Director of the Board on Infrastructure and the Constructed Environment (BICE) of the National Research Council (NRC) where he develops and directs a program of studies in building and infrastructure research and maintains outreach and liaison with federal agencies, the legislative branch, and affiliated organizations. He currently is managing the activities of an expert committee charged with the review and assessment of physical approaches, research needs, and technology transfer strategies to improve the performance of buildings and facilities from the effects of terrorist bombings and other hostile activities. He has directed NRC study activities, participated in workshops and panels, written several papers dealing with blast-effects mitigation and critical infrastructure protection, and co-edited *The Use of Underground Facilities for the Protection of Critical Infrastructure*. Mr. Little has over thirty years experience in planning, management, and policy development relating to public facilities.

Mitchell, Ken – Dr. Mitchell was born in Northern Ireland and received his Ph.D. in Geography from the University of Chicago. Since joining the Rutgers University faculty in 1970 he has specialized in hazards research and is author of more than 100 professional publications including Crucibles of Hazard: Megacities and Disasters in Transition (United Nations University Press, 1999) and The Long Road to Recovery: Community Responses to Industrial Disaster (United Nations University Press, 1996). He has served on hazard-related committees of the National Research Council and chaired the Councilís ad hoc committee on the International Decade for Natural Hazard Reduction as well as the U.S. Scientific Committee on

the Outer Continental Shelf. He founded the Hazards Specialty Group of the Association of American Geographers, the International Geographical Unionís Study Group on the Disaster Vulnerability of Megacities and the international journals Global Environmental Change and Environmental Hazards.

Myers, Mary Fran – Ms. Myers is the co-director of the Natural Hazards Research and Applications and Information Center at the University of Colorado - Boulder where she has also been a project manager since 1988. The center serves as a national clearinghouse for research data and information dealing with the social, political, economic, and behavioral aspects of natural disasters and programs to reduce damage from them. Prior to working at the center, Myers worked in the state water resource agencies of both Illinois and North Dakota, and she helped coordinate the National Flood Insurance Program in those states. She was appointed by Governor Romer to serve on the Colorado Natural Hazards Mitigation Council's Executive Committee in 1991.

Nishenko, Stuart – Dr. Nishenko is the Senior Seismologist in the Geosciences Department of the Pacific Gas and Electric Company in San Francisco and the current American Society of Civil Engineers (ASCE) / American Lifeline Alliance (ALA) FEMA Fellow. From 1996 to 2001, he was the Resident Seismologist in the Mitigation Directorate of FEMA in Washington DC where he managed national and international projects, including the ALA, the FEMA *366-HAZUS99 Estimated Annualized Earthquake Losses for the United States* study, the US-Japan High Level Forum on Earthquake Policy, and the Forum on Risk Management and Assessments of Natural Disasters. Additionally, Dr Nishenko was a contributing author to *Disasters by Design, A Reassessment of Natural Hazards in the United States*. As a research scientist with the US Geological Survey National Earthquake Information Center in Golden, Colorado, from 1985 to 1995, he developed probabilistic earthquake hazard assessments throughout the United States and the circum-Pacific region.

Noji, Eric – Dr. Noji is the Senior Medical Officer and liaison to the Centers for Disease Control (CDC) and Prevention for the White House Office of Homeland Security. Additionally, he is the Associate Director of the Office of Bioterrorism Preparedness and Response for the CDC in Atlanta. Dr. Noji has published widely about the medical and health response to natural, biological, and technological disasters including humanitarian emergencies and terrorism.

Penn, Mark – Mr. Penn is the Director of Emergency Management for the county of Arlington, Virginia.

Platt, Rutherford – Dr. Platt is a Professor of Geography and Planning Law at the University of Massachusetts at Amherst, and Chair of the Natural Disasters Roundtable. He has served on other NRC committees including the Committee on Flood Insurance Studies, the Committee on Water Resources Research Review, the Committee on a Levee Policy for the National Flood Insurance Program, the Committee on Managing Coastal Erosion, and the Committee to Review the New York City Watershed Management Plan. He also has chaired the NRC Committees on Options to Preserve the Cape Hatteras Lighthouse and Flood Control Alternatives in the American River Basin, and he is a current member of the Water Science and Technology Board. Dr. Platt recently authored, *Disasters and Democracy: The Politics of Extreme Natural Events.*

Quarantelli, Henry – Dr. Quarantelli is a Research Professor and the Founding Director of the Disaster Research Center, the world's oldest center devoted to the social scientific study of disasters, their causes, and their impacts, at the University of Delaware. His current research foci include future social trends in disasters and catastrophes; the computer revolution and its effects on disaster planning and disaster research; anti-social behavior in crises; theoretical problems of conceptualizing disasters; historical evolution of civil protection, emergency management and disaster planning organizations; and methodological problems in field research. His research

interests are collective behavior, social movements and social change, mass communication, field research methodology, complex organizations, and sociology of science. Dr. Quarantelli is the author or editor of 27 books and monographs, as well as author of 92 chapters in books, 105 articles and 106 other publications on disaster topics.

Rotanz, Richard – Captain Richard (Richie) Rotanz of the New York City Fire Department is presently assigned to the New York City Office of Emergency Management (OEM) as Deputy Director of Planning and Research. He is currently directing NYC's planning initiatives in areas such as the NYC Emergency Operations Plan that incorporates chem/bio-terrorism preparedness, which has established capabilities such as the Syndromic Surveillance and Point of Dispensing, Business & Government Continuity, and Coastal Storm preparedness. Moreover, after New York City's Emergency Operation Center (EOC) in the World Trade Center was destroyed on September 11th, Rotanz played a principal role in re-establishing and running it. During his 30 years in the fire service, of which 23 years he's been a member of the New York City Fire Department, Rotanz has faced down all manner of disasters, experience that served him well as a co-designer of the developing Masters Degree Program for Emergency Management at John Jay College.

Shoaf, Kim – Dr. Shoaf is the Research Director of the UCLA Center for Public Health and Disasters and an Adjunct Assistant Professor in the Department of Community Health Sciences at the UCLA School of Public Health. Her research interests include disaster impacts on physical injuries, agency utilization in disasters, international health, public health impact of disasters, program planning and evaluation, and health in the Latino community.

Slovic, Paul – Dr. Slovic, a Founder and President of Decision Research in Eugene, Oregon and Professor of Psychology at the University of Oregon, studies human judgment, decision making, and risk analysis. He and his colleagues worldwide have developed methods to describe risk perceptions and measure their impacts on individuals, industry, and society. He publishes extensively and serves as a consultant to companies and government agencies. Dr. Slovic is a past President of the Society for Risk Analysis.

Sorensen, John – Dr. Sorensen is a senior research staff member at Oak Ridge National Laboratory and Director of the Emergency Management Center. His research has focused on emergency planning and the impacts of hazard and risk on human systems. He is lead author of *The Impacts of Hazardous Technology: The Psycho-Social Effects of Restarting TMI-1*. Additionally, he has written extensively on public response to emergency warnings, protective action planning, and individual and organizational behavior in disasters. He has led many projects related to emergency and crisis management for the DOD, FEMA, EPA, NRC, and DOE.

Stratton, Sam – Dr. Stratton is currently an Associate Professor of Medicine at UCLA. Additionally, he serves as the Vice-Chairman of the Department of Emergency Medicine at Harbor-UCLA Medical Center, and he is the Medical Director for the Los Angeles County Emergency Medical Services Agency. Dr. Stratton also lectures on disaster and bioterrorism topics at the UCLA School of Public Health. His research interests include disaster medical response, emergency medical systems, and qualitative study methods.

Sylves, Richard – Dr. Sylves is a Professor of Political Science and International Relations at the University of Delaware. He teaches graduate and undergraduate courses in environmental, energy, and disaster policy, public policy, and public budgeting. His research interests include disaster, environmental, and energy policy. He has authored and co-authored many publications including the two books, *Disaster Management in the United States and Canada: Politics, Policy, Administration, Study and Instruction of Emergency Management* and *Cities and Disaster: North American Studies in Emergency Management*.

Tierney, Kathleen – Dr. Tierney is a Professor in the Department of Sociology and Criminal Justice and co-director of the Disaster Research Center, the world's oldest center devoted to the social scientific study of disasters, their causes, and their impacts, at the University of Delaware. Her research focuses on the sociological aspects of hazards and disasters and on collective behavior and social movements. Her most recent projects have concentrated mainly on the ways in which disasters affect private sector organizations and on the political economy of risk. Her recent publications include *Disasters, Collective Behavior, and Social Organization* (co-edited with Russell Dynes), a book chapter describing how businesses were affected by the 1993 Midwest Floods in Disaster Management in the US and Canada, and an analysis of collective behavior during the 1992 Los Angeles riots in *The Los Angeles Riots: Lessons for the Urban Future*. She recently co-authored a book entitled *Facing the Unexpected: Disaster Preparedness and Response in the United States*.

Waugh, Jr., William – Dr. Waugh is Professor of Public Administration, Urban Studies, and Political Science in the Andrew Young School of Policy Studies at Georgia State University. His research focuses on the design of disaster policies and hazard reduction programs and on the coordination of multi-organizational, intergovernmental operations. He is the author of *Living with Hazards, Dealing with Disasters* (2000), *Terrorism and Emergency Management* (1990), and *International Terrorism* (1982); coauthor of *State and Local Tax Policies* (1995); and coeditor of *Disaster Management in the US and Canada* (1996), *Cities and Disaster* (1990), and *Handbook of Emergency Management* (1990). Additionally, Dr. Waugh is the author of over 100 articles, chapters, and reports, and he is the coeditor of the *Review of Policy Research*. He has been a consultant to public, nonprofit, and private organizations ranging from FEMA to the City of Atlanta to Solidarity trade union. He serves on the board of directors of the Family Assistance Foundation, a nonprofit organization that helps airlines deal with aviation disasters, and as academic advisor to Regional Science Institute, an international environmental analysis firm based in Japan.

Weiss, Don – Dr. Weiss is a Medical Epidemiologist with the Communicable Disease Program of the New York City Department of Health. He received his medical degree from the University of Medicine and Dentistry of New Jersey, completed a residency in pediatrics at the Albert Einstein College of Medicine/Montefiore Medical Center and a masters of public health in epidemiology from St. Louis University. Before joining the New York City Department of Health in June of 2000 he was with the St. Louis City Department of Health and taught epidemiology at St. Louis University School of Public Health.

APPENDIX C – RELATED LINKS

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APPENDIX D – LIST OF ATTENDEES

Anderson, William – National Research Council
Angelheart, Ann – University of Florida
Applegate, David – American Geological Institute
Aron, Joan – Science Communication Studies
Ayers, Stephen – Capitol Hill Disaster Assistance Group
Bagchi, Goutam – Nuclear Regulatory Commission
Bauer, Douglas – National Research Council
Birnbaum, Marvin – University of Wisconsin
Blanchard, B. Wayne – Federal Emergency Management Agency
Blanchette, Glenn – US Southern Command
Blair, Alice – American Red Cross
Bloem, Kenneth – Johns Hopkins University
Bolton, Patricia – Battelle Seattle Research Center
Bourget, Paul – US Army Corps of Engineers
Brill, Terry – FEMA
Brown, Christy - FEMA
Bruce, James – Global Change Strategies International, Inc.
Bullock, Jane
Byrne, Michael – Office of Homeland Security
Chaker, Amar – American Society of Civil Engineers
Cluff, Janet – Word Engineering
Cluff, Lloyd – Pacific Gas and Electric
Cohn, Timothy – US Geological Survey
Comfort, Louise – University of Pittsburg
Cook, Bernard – HAZMED, Inc.
Cutter, Susan – University of South Carolina
D'Aguanno, Jane – NOAA/NESDIS
Dalrymple, Helen – Capitol Hill Disaster Assistance Group
Davenport, Alan – University of Western Ontario
Demuth, Julie – National Research Council
Descheneaux, Ronald – Parsons Brinckerhoff
Detwiler, Steve – International Association of Emergency Managers
Drobot, Sheldon – University of Colorado / National Ice Center
Ekstein, Cynthia – National Science Foundation
Fenn, Shawn - FEMA
Folger, Pete – American Geophysical Union
Friedland, Ian – Applied Technology Council
Garton, Janet – National Research Council
Gasteyer, Stephen - GCI
Geis, Don – Geis Design Research Associates
Glass-Royal, Darci – GRS Solutions, Inc.
Gohn, Kathleen – US Geological Survey
Gross, Ed – StormCenter.com, Inc.
Gubbels, Timothy - NASA
Guy-Obiakor, Levis
Hamilton, Robert – National Research Council
Harrald, John (Jack) – George Washington University
Harman, Phillip – Lewis-Burke Associates
Hatch, Marilyn - FEMA
Hattis, David – Building Technologies Inc.
Hays, Walter – Global Institute for Energy and Environmental Systems
Hellenberg, Timo – Timo Hellenberg and Associates
Henderson, Kate – US Department of Justice
Henrikson, Laurie – Aerospace Corporation
Herman, Steve – Capitol Hill Disaster Assistance Group
Hess, Charles – FEMA
Hirsch, Robert – US Geological Survey
Hooke, William – American Meteorological Society
Iwan, Wilfred – California Institute of Technology
Jackson, Marianne – FEMA
John, Kathleen – US Geological Survey
Jones, David – StormCenter.com, Inc.
Jones Kershaw, Patricia – National Research Council
Kaminosono, Takashi – National Institute for Land and Infrastructure Management
Kendra, James – University of Delaware
Kiremidjian, Anne – Stanford University
Koob, F. Kevin - FEMA
Kramer, Elaine – SRA International, Inc.
Kronenberg, Philip – Virginia Tech University

Kyle, Kevin – National Research Council
LaPorte, Peter – Washington DC Office of Emergency Management
Larson, Marci – US Department of Justice
Leatherman, Stephen – Florida International University
Levine, Robert – Montgomery College
Lindell, Michael – Texas A&M University
Little, Richard – National Research Council
Llewellyn, Craig – Uniformed Services Industry
McCreight, Robert – US Department of State
McMillion – State of Maryland
Mitchell, J. Kenneth – Rutgers University
Moodie, Linda – National Oceanic and Atmospheric Administration
Morelli, Ugo - FEMA
Morrow, Betty – International Hurricane Center
Moya, Susan – Florida International University
Myers, Mary Fran – Natural Hazards Research and Applications Information Center
Newton, Mary – NOAA/NWS
Nishenko, Stuart – Pacific Gas & Electric
Noji, Eric – Center for Disease Control and Office of Homeland Security
Penn, Mark – Arlington County Fire Department
Perez, Luis – Pan American Health Organization
Platt, Rutherford – University of Massachusetts at Amherst
Quarantelli, Henry – University of Delaware
Reed Brown, Linda – Church World Service
Rostosky, Ceil – American Red Cross
Rotanz, Richard – New York City Office of Emergency Management
Rubin, Claire – Marasco Newton
Russell, James – Institute for Business and Home Safety
Salon, Peter
Schaeffler, William – United Way Retirees Association
Schiff, Lauren – George Washington University / SRA International
Schomber, Tamara – United Way of America
Sharpe, Todd - FEMA
Shaw, Gregory – George Washington University
Shoaf, Kimberley – UCLA
Sibley, Jane – American Red Cross
Simmons, Ray – GRS Solutions, Inc.
Skillington, Jim – Disaster News Network
Slovic, Paul – University of Oregon
Sorensen, John – Oak Ridge National Laboratory
Speidel, David – Queens College, CUNY
Stahl, Charles
Stephens, Hugh – University of Houston
Stratton, Sam – Los Angeles County EMS, UCLA
Stratton, Woodrow – Capitol Hill Disaster Assistance Group
Stokols, Paul – NOAA/NWS
Swisher, Ralph – FEMA
Sylves, Richard – University of Delaware
Thirumalai, K. – US Department of Transportation
Thompson, Bob – US Environmental Protection Agency
Tierney, Kathleen – University of Delaware
Unnewehr, David – American Insurance Association
Vogt Sorensen, Barbara – Oak Ridge National Laboratory
Washington, Linda – Capitol Hill Disaster Assistance Group
Waugh Jr., William – Georgia State University
Weiss, Don – New York City Department of Health
Wenger, Dennis – National Science Foundation
Wesbrock, Terry – Church World Service
White, Patrice – DC Emergency Management Agency
Edwards-Winslow, Frances – San Jose Office of Emergency Services