

Risk Perception: A Review

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**CREATE REPORT
Under Office of Naval Research
Grant No. N00014-05-1-0630
May 22, 2007**

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HOMELAND SECURITY CENTER

**Center for Risk and Economic Analysis of Terrorism Events
University of Southern California
Los Angeles, CA**

This research was supported by the United States Department of Homeland Security through the Center for Risk and Economic Analysis of Terrorism Events (CREATE) under grant number N00014-05-1-0630. However, any opinions, findings, and conclusions or recommendations in this document are those of the authors and do not necessarily reflect views of the United States Department of Homeland Security.

Risk Perception: A Review

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Public risk perception and risk communication are very important considerations when developing policies and management strategies for dealing with terrorism. For example, the allocation of scarce resources for protecting the public against terrorists depends on public perceptions as well as on the perceptions of policy makers and experts. The consequences of terrorist acts will be also be affected by the quality and effectiveness of communicating with the public. In addition, public perceptions will affect behavior after attacks, for example due to fear of flying after an attack on commercial aircraft. The economic impacts due to public perceptions are likely to go well beyond the attack's direct consequences.

Recognizing the importance of risk perception and risk communication, all six DHS funded Research and Education Centers have ongoing activities in these areas. At least three centers (CREATE, START, and NCFDP) are conducting large surveys. Others have a strong interest in the design of materials for explaining risks as well as potential mitigating responses that would be used after a terrorist event occurs. This type of risk communication parallels research on disaster planning. As a result of this shared interest, risk perception and risk communication was identified as an important inter-center collaborative activity at the January, 2006 INC meeting of the center directors and DHS staff. CREATE was identified as the lead center for this activity.

On June 5, 2006 CREATE convened a workshop in Los Angeles with participation of nationally recognized researchers in risk perception and communication. This workshop identified existing research in this area, defined research needs and provided a number of methodological recommendations.

Literature Review and Work shop Recommendations

We begin with a brief history of risk perception research as it relates to terrorism and then describe eight national surveys and the recommendations emerging from a risk perception workshop. *We conclude with a discussion of why the next important step is to move toward a more dynamic and prescriptive view of risk perception and policy analysis and we describe how this might be accomplished.*

A. Review of Risk Perception Studies.

The events of September 11 and the anthrax attacks during the same period changed the way Americans view the threat of terrorism. Hurricane Katrina accomplished much the same with respect to natural disasters. Both types of disasters have caused the nation to pause and evaluate its state of readiness, its ability to mitigate and its capacity to respond to the risks it faces. Confidence in our institutions has been shaken as people ponder catastrophes that were a decade ago "unthinkable" (Howitt & Pangi, 2003; Clarke, 2006). Public officials, business leaders, health care providers, and most citizens now feel an increased need to prepare for the impacts a terrorist strike or natural disaster might have on their community and the country. Individuals and organizations have become aware of their vulnerability with respect to explosions, biological and chemical agents, radiological releases, and even cyber-crime. Words like dirty bomb, pandemic flu, anthrax and category-level storms are now common vernacular. Undersecretary George Foresman, at a conference in New Orleans (2006), underscored the need to develop a comprehensive strategy for the management of risk and that

individual communities and citizens should prepare themselves for disasters of the future. Echoing this theme independently, many have called for increased effort to create more disaster-resilient communities (Mileti, 2002).

Catastrophic events are costly whether they result from nature, technological accidents or terrorism and their impacts often go well beyond the direct damages of the mishap. As a consequence, over the last quarter-century, researchers have studied risk from many vantage points and we have witnessed the rapid growth of the field of risk analysis. Risk analysis consists both of the assessment (e.g., identification, quantification) and management (e.g., communication, mitigation) of risk and the field has seen many advances (Haimes, 2006). However, Slovic and Weber (2002) have pointed out that while the management of extreme events will surely look to risk assessment for guidance, the development of policy is a political enterprise involving for example choices that must recognize the distinctions between public perceptions of risk in comparison to technical risk estimates. Equally important, these judgments need to consider how people would make tradeoffs to reduce risks and consequences and the public's level of trust in the mechanisms selected to manage and respond to risk. They note that perceptions and misperceptions of risk on the part of the public and public officials appear to be behind the current examination of American preparedness for another terrorist attack [and after Katrina, a natural disaster].

Much has been learned by social scientists regarding peoples' perception of risk, how people are likely to respond to different types of hazards and about effective risk communication (Taylor-Gooby & Zinn, 2006). Sociologists have investigated peoples' response to a wide array of disasters across different populations using "quick-response" studies following major disasters (Tierney, 2006). Tierney notes peoples' perceptions of risk, risk-related response, and resilience to disasters differs across subpopulations and has called for greater sensitivity to this fact. A recurring finding has been that peoples' protective response is directly related to their perceptions of risk immediately prior to taking action and that emergency warnings play a pivotal role in these perceptions (Mileti, 2000).

The program of research initiated by Slovic, Lichtenstein and Fischhoff has led to a taxonomy of the attributes of activities or events that are associated with risks that cause individuals to rate them differently. Two factors were derived from the multiple dimensions that people associate with risk. The first of these, labeled as *dread*, corresponds to events that are unthinkable and catastrophic. A second attribute is associated with whether the process is known. This factor also includes consideration of whether the risk is voluntarily assumed or not, whether it is viewed as controllable, poses hazards for future generations, is easily reduced, falls on the individual or society as a whole. The second, expressed in the negative, relates to events that are classified as sources for *unknown risk* (e.g., not observable, effect delayed, new source for risk). Activities that may be new and incompletely understood by laypersons would be in this group. If the effect is delayed or is not well understood by science it is more likely to be regarded as unknown by the lay public. This paradigm has helped explain why public perception and acceptability of certain hazards differ markedly from that of experts (Fischhoff et al., 1978; Slovic, 1987). During the last decade emotion has been shown to play an important role in how people process risk information and respond to potential threats (Lowenstein et al., 2001; Slovic et al. 2002). The risk-as-feelings hypothesis for example, suggests that feelings play an important role in risky decision making and where emotional reactions differ from cognitive evaluations (probabilities and consequences) the former usually prevails.

The relationship between emotion and risk perception may affect behaviors that managers and policy makers care about. For example, Gigerenzer (2006) states that after the attacks on September 11 the public's desire to avoid airline travel not only contributed to the huge losses suffered by the industry but that such behavior resulted in an estimated 1,595 additional highway deaths (six times the deaths on the four fatal flights). Fischhoff et al. (2004) found travelers' willingness to travel to a destination

depended on their estimate of terrorism risk and their degree of worry. Shortly after September 11 a study, using national sample, (Fischhoff et al., 2003a, 2003b, 2005; Lerner et al., 2003; Small et al., 2006) found Americans' predictions of terrorist risk related to whether they experienced the events and their proximity to the World Trade Center. Likewise, they found that fear increased risk estimates and plans to take precautionary measures (even weeks later) while anger had an opposite effect. Additionally, fear was associated with a desire for less punitive measures toward foreigners than was anger, causing the authors to wonder whether an angry public might support policies different than a fearful one.

The role of emotion may have a prominent influence on how communities respond to threats of the future. For example, emotional states have been demonstrated to affect cognitive evaluations which in turn can affect emotional states (Johnson & Tversky, 1983). According to Lowenstein et al. (2001), this reciprocal and self-reinforcing relationship affords the potential for fear to greatly intensify at the individual and societal levels leading the authors to suggest that effective policy must seek to mitigate both the real risks as well as irrational fears. This latter point appears especially appropriate with respect to a number of dire threats including pandemic flu (Bruine De Bruin, in press). Burns & Slovic (2006), using hypothetical damage scenarios, found that acts of terrorism had unusually large effects on perceptions of risk relative to comparable non-terrorist events. The mechanism involved (infectious disease vs. explosions) also mattered. They incorporated their findings into a system dynamics simulation model to show how fear might rapidly diffuse in a community following a terrorist attack. While panic is rarely seen (Tierney et al., 2001), intense and prolonged fear in a community not only has implications for quality of life but may cause large ripple effects through the national economy (Kasperson et al., 1988; Burns et al., 1993; Cass, 2003; Santos & Haines, 2004).

B. Review of Eight National Surveys Relevant to the Threat of Terrorism.

In recent years there have been a number of surveys involving perceptions of terrorism risk conducted nation-wide yielding a wide array of useful findings.

Harvard School of Public Health. Blendon (2001), together with colleagues at the Harvard School of Public Health and Robert Wood Johnson Foundation conducted a national survey immediately following the anthrax attacks in fall 2001 to look at Americans' response to the threat of biological terrorism. Four telephone surveys were completed one nationally (over 1000 respondents), and three in areas where anthrax had been reported (about 500 respondents). They found that 61% of Americans believed that another bioterrorist attack (anthrax or smallpox) was very likely in the next several months. In areas where anthrax had been reported, a sizable percentage (10-20 percent) of people indicated they, a friend, or a family member had been exposed to or tested for anthrax with some having their workplace closed. The attacks caused the public to worry about their safety and take precautionary measures. For example, 43% of those "affected" in the Washington D.C. area reported that they were worried about opening their mail and had resorted to washing their hands, wearing rubber gloves when handling the mail or even avoiding the mail entirely (about 24% nationally). While some indicated that members of their household had gotten a prescription for antibiotics they (as opposed to these not affected) were not more likely to take measures such as avoiding public events or maintaining emergency supplies. The authors remark that Americans not directly or indirectly connected to the attacks were left relatively untouched. About 60% of respondents were confident that the CDC would provide correct information to protect families. The study notes that had the disease been highly contagious, affected larger numbers, unidentifiable, low chance of survival or treatment not available public response may have been different [more dramatic]. Because results to these attacks differed across region the authors emphasize the need for both national and local surveys.

Carnegie Mellon University National Field Experiment. Lerner et al. (2003) conducted a two-part nationally representative web-based field study (using a Knowledge Network panel) directly following the attacks of September 11. The first survey (September 20th) queried nearly 1,000 respondents about the attacks and their emotional reactions (fear and anger). The second survey (November 10th) with the same respondents involved an experimental manipulation (media clip) designed to induce a certain emotion (fear, anger or sadness). In addition, respondents were asked about their perception of risks regarding terrorist attacks (as well as non-terrorist risks), their willingness to take precautionary measures and their preferences for policies in dealing with terrorism. The authors found that risk perceptions were directly related to an individual's proximity to the event and to the emotion evoked (higher for fear and lower for anger). Fear was predictive of a willingness to take precautionary actions. In the follow-up survey they found that emotion also had an impact on policy preferences. For example, experimentally induced anger activated more punitive policy preferences while fear triggered preferences for conciliatory policies and investment in widely applicable precautionary measures. They suggest that media has a strong influence on emotions, producing anger in some cases and fear in others. The authors note that in a real-world setting (e.g., a crisis, political debate) these same emotions and perceptions are likely to intensify and that citizens [and policy makers] need to understand these processes to better prepare for a sustained struggle with the risks posed by terrorism.

The New York Academy of Medicine Redefining Readiness Survey. This study sought to explore how the American public might react to protective instructions in two very different terrorist attacks: smallpox and a dirty bomb with the intent of providing planners with guidance as to how to best deal with situations like these (Lasker, 2004). The study specifically addressed three questions: How are community residents likely to react to these situations? What issues are they most concerned with? What factors determine whether they will do what they are told? Over 2500 U.S. residents were surveyed via the telephone with over-sampling of African Americans and people in the two cities in which the 9/11 attacks took place. The study used smallpox and dirty bomb scenarios that put people in a time and place that they would be likely to hear of such news. Interviewers then explored how willing respondents were to follow specific safety instructions under each scenario. They also asked people about their perceptions of their community's terrorism planning activities. They discovered that far fewer people than needed would comply with instructions during a terrorist attack: Only forty percent would get vaccinated in the event of a smallpox outbreak and sixty percent would shelter in place if a dirty bomb exploded. Concerns about the safety of the vaccine and being in close proximity to those who may be contagious reduced compliance for instructions regarding smallpox. Conflicting obligations (dependents housed elsewhere) were a major problem for the dirty bomb scenario. In both scenarios, trust in government officials' information and behavior was critical, especially for minority groups. Respondents indicated a strong need for decision support, not just facts. They also wanted to talk with someone they could trust beforehand, not just during the attacks. This research suggests that current plans to deal with smallpox and dirty bomb attacks (or other types of terrorist attacks) may be far less effective than what planners want or the public needs. It also concludes that by addressing public concerns and involving them in community planning, officials can develop behaviorally realistic approaches to these crises.

National Security and Nuclear Futures Project. During their most recent study, Herron & Jenkins-Smith (2006) used both telephone and internet surveys to poll Americans' views on a wide range of issues pertaining to nuclear security and terrorism. Also included are results from a panel study conducted shortly after the London suicide bombings that examined the potential impact of these attacks on US views (it turns out the attacks had little impact). This study builds on 15 previous studies dating from 1993 to 2003. This stream of research arguably represents one of the most extensive looks at trends in the public's view of issues related to nuclear security and terrorism. One of the primary objectives in this present study was to examine trends in public concern about the threat of terrorism, public assessment of U.S. policy toward terrorism, and the war on terrorism. The findings

were extensive and only a few highlights will be mentioned here. The study found that Americans consider terrorism to pose the greatest threat to the US today, especially the potential for terrorists to obtain weapons of mass destruction or to engage in suicide bombings. Confidence in eventually winning the war on terrorism was guarded. There exists moderate confidence in the US government to assess the threat of terrorism in the US but less so for terrorism abroad. Additionally, when government assessments are wrong the public believes they tend to overestimate the risks. In terms of preventing terrorism, respondents indicate less agreement than in the past with assertions that terrorism can only be stopped by unacceptable intrusions into people's privacy as well as little current support for collecting behavioral information (e.g. shopping patterns). They have moderate confidence that the US can prevent a large-scale attack over the next ten years but less confidence that large scale attacks abroad or small scale attacks in the US can be prevented. In terms of response, support for a forceful response to terrorist attacks increases as the number of deaths increases. Confidence in the ability to respond to attacks is higher for the federal government (DOD and DHS) than it is for state and local governments. As mentioned, there is strong concern about suicide bombings in the US and a willingness to support even intrusive measures to prevent it. Using causal modeling the authors demonstrate that understanding core and domain specific belief structures can predict public policy preferences with regards to terrorism.

National Center for Food Protection and Defense Survey. Stinson, Kinsey, and Ghosh (2006) conducted a national survey of over 4200 US residents over the age of 16 during August of 2005 as part of a study for the National Center for Food Protection and Defense (NCFPD). The study was conducted over the Internet and responses were weighted to reflect national demographic characteristics such as age, race, ethnicity, sex, region and income. Respondents were asked how likely and how serious certain types of attacks appeared to be (e.g. another airline hijacking, attack on some other form of public transportation, destruction of a national monument, deliberate contamination of the food supply, disruption of the power grid and release of a chemical or biological agent in a public area). They were also asked how much they would be willing to pay to defend against terrorism and how they believed anti-terrorism spending should be allocated. The authors found that Americans have substantial concerns about future terrorist attacks and that they would be willing to support policies that commit considerable resources to prevent future attacks. While respondents felt preventing another 9/11 style attack is important they were even more concerned about protecting the nation's food supply and preventing the release of a toxic chemical or biological agent in a public area (e.g., indicated allocation on average was about 12-13% higher for protecting the food supply and preventing release of toxic agents than for preventing another airline hijacking).

Yale National Risk and Culture Survey. Kahan, Slovic, Braman and Gastil (2006) conducted a national survey to investigate the existence of cultural cognition on a national scale and for a wide range of risks. The authors were not only interested in cultural cognition but were primarily interested in whether cultural world views could predict perceptions of risk and the implications for policy with regards to risk management. Over 1800 persons were randomly selected to participate in a 30 minute telephone interview. Respondents' worldviews were measured on scales based on a typology first suggested by Douglas and Wildavsky (1982) that categorizes cultural ways of life along two dimensions: "group" and "grid". In a high group or "solidarity" social orientation individuals interact frequently and depend on each other in contrast to a low group or "individualistic" orientation in which individuals are expected to fend for themselves and therefore are competitive. In a high grid or "hierarchical" orientation individuals expect resources to be distributed on the basis of explicit public social classification (e.g. sex, color, public office) in contrast to low grid or "egalitarian" orientation believe no one should be excluded from any social role on the basis of gender, age and so forth. The authors found that that these two dimensions did a better job predicting perceptions of risk than did other individual characteristics such as race, income, education, personality type and political affiliation. For example, individuals who are egalitarian and solidaristic worry more about the risk of

gun accidents and crime and are likely to support policy regulating gun ownership. Likewise, persons who are hierarchical and individualistic are more concerned with not being able to defend themselves and therefore resist efforts to control gun ownership. The authors conclude that individuals appear to take a posture toward risk that expresses their cultural worldview. They note that even when people of diverse cultural worldviews agree that policy decisions should be made on the basis of some consequentialist standard these same worldviews prevent them from agreeing on what policies have the best consequences. The key is to find policy solutions that find common ground which affirms rather than threatens these worldviews.

CREATE/RTI/ASU Survey. V. Kerry Smith and Carol Mansfield (2006) conducted an internet based survey, using Knowledge Networks, of over 2000 households. The survey was designed to collect information on their willingness to make tradeoffs to reduce risks to the commercial aircraft sector from shoulder mounted missiles. In addition the interview collected information on individual perceived risks that the US would experience a major bio-terrorism attack in the next five years; Questions evaluating perceptions of the risks of domestic and international travel as well as confidence in the current security systems were included. The survey also included questions to evaluate conventional economic measures of the respondents' aversion to risk. Analysis of the stated preference questions concerning policies to protect commercial aircraft from Manpads indicate that it is possible to present these types of policies to individuals and that they are willing to pay to protect commercial aircraft. The responses suggest willingness to pay is not limited to air travelers and that estimates vary consistently with income and frequency of air travel.

START CENTER-Group 3a Project. The most recent survey effort involves the START CENTER's current plan to conduct a survey of U.S. households (Linda Bourque-PI and Dennis Mileti (START researcher). They will sample over 3000 people with an over-sampling of Los Angeles, New York and Washington D.C. and will collect data via telephone interviews. This is a carefully designed and ambitious survey that will cover a broad range of issues such as psychological vulnerability, definition of terrorism, normative information network, trust in organizations, perceived risk, information seeking, actions taken and intended to be taken (preparedness, mitigation, avoidance) and perceived ability to recover to name but a few. These researchers indicate that risk perception will play a central role in a theoretical model to be tested, with perceptions of risk predicting and being predicted by other key variables. The researchers plan to extend a comprehensive body of research regarding natural hazards to the domain of terrorism.

C. Summary of Risk Perception Workshop

As mentioned above, during June 2006 nationally recognized risk perception and communication researchers were invited to participate in a workshop at CREATE to develop a research agenda for the study of risk perception and its implication for policy regarding terrorism. Prior to attending participants were sent a questionnaire asking them to articulate what they thought were the most important research questions as well as to recommend best methodological practices to achieve these research objectives. What follows is a brief summary of questionnaire and workshop recommendations.

Research Recommendations. Participants felt that more attention needs to be paid to how and why individuals may differ in their risk perception and response. Differences may be due to membership in a cultural subgroup, hazard knowledge, prior experience with a hazard or particular worldview. Characteristics of the threat itself were also deemed important. Researchers have long observed that the public appears to respond very differently to natural disasters than to technological disasters. Terrorism may represent an even more pronounced difference and has been described by some as "a

new species of trouble". Even within terrorist events it was thought important to distinguish between bomb blasts and biological releases for example. Preliminary simulation modeling suggests that the diffusion of fear in a community may well vary depending on the type of event and how the community responds. The impact of mitigation efforts on perceptions of risk for example is not well understood but could be very important. The question was posed: Do efforts to improve community preparedness affect residents' perceptions of risk and response during a crisis? It was also emphasized that careful work was needed to understand those conditions that contribute to sustained support for policies related to the threat of terrorism. A better understanding of how the media shapes risk perceptions and response was also called for.

Methodological Recommendations. Research design and analytical approaches naturally must fit the questions being addressed but based on the participants' considerable experience there were a number of general recommendations. For a national survey, there was wide agreement that some combination of repeated cross-sectional and panel design (to capture changes in response to an event) was recommended. There was considerable support for "field experimentation" like the kind previously described as a useful way of manipulating a factor of interest (e.g. communication or event type) and then surveying respondents' reactions (e.g. compliance with request to evacuate). Lab experiments could also be used to manipulate key factors (e.g., communications) but under even more controlled conditions. The use of hypothetical scenarios, both in the lab and field surveys to simulate crisis situations, was also thought to possess a great deal of potential. There was general agreement that subpopulations were likely to differ in their response to threats and needed to be sampled and surveyed carefully. Because of the cognitively demanding nature of this research, there was wide support for a web-based survey if a representative sample could be achieved. Lastly, it was clear that a range of analytical models would be necessary to properly address the research questions above (e.g. time series, causal modeling, hierarchical linear modeling, system dynamics modeling, and GIS mapping).

D. Summary Review

Important Research Issues. These studies and workshop recommendations indicate that there is a need to provide policy makers and risk managers with input to make behaviorally sound decisions with the idea of not only responding to crises but developing disaster resilient communities (Fischhoff, 2006, Lasker, 2004). Numerous studies point to the central role perceptions of risk play in people's level of concern and likely behavior during and following a disaster. The indirect impact emerging from these perceptions and behaviors may well dwarf the direct costs resulting from loss of life and property. This possibility has led many researchers to suggest that as a long term strategy we need to investigate and place more emphasis on loss mitigation both from natural disasters as well as terrorist acts. But effective mitigation requires sustained support for such policies over a long period of time. *How much do we really know about the conditions that contribute to or erode public support?* Preferences for policy in the short term appear to be influenced by the type of emotion the situation evokes (e.g. anger versus fear) and to some extent the credibility of information sources during an emergency. Both are themselves impacted by media portrayal. However, sustained policy support may be tied to belief structure, trust in public officials, and perhaps active participation in community disaster planning. These latter three factors also seem to vary across cultural subgroups. Type of event (natural disaster, anthrax release, suicide bombing) may also determine the nature of public response and the policies people are willing to support to ensure their safety. It seems reasonable to suspect that the dynamics of community response (e.g. mitigation efforts prior to and after an attack) may be a product of and contribute to sustained support for disaster policy.

Utility of Survey Research. From the eight surveys described above it is apparent that much can be learned from surveys that is relevant to policy makers. Blendon et al. (2003), reflecting on what was

learned during his survey following the anthrax attacks, stresses that rapid response short-duration surveys can provide critical information to guide public officials in their response and communication. He indicates that to communicate with the public effectively during times of emergency officials need to learn, in real time, what citizens know and believe, whom they trust, and what actions they are taking to protect themselves. Lerner and her colleagues were able to demonstrate the ability and value of nation-wide field experiments following a terrorist attack to inform public policy. For example, their findings suggest that understanding people's emotional response to events may be a strong predictor of the kind of policy the public is likely to support for better or worse. These results were actually presented to NATO officials interested in examining the residual effects of terrorism. Experimentation of this kind may lead to insight into how best to communicate with the public during times of crisis. Lasker and her colleagues have shown that skillful use of hypothetical scenarios (e.g. smallpox and dirty bomb) in surveys can inform planners about critical public concerns and situational characteristics likely to foster or impede compliance with policy recommendations (e.g. vaccination and sheltering in place). Herron & Jenkins-Smith have demonstrated the value of not only tracking issues (e.g. national security) over an extended period of time but also of using a panel to assess the impact of current events (e.g. London Bombings). Through the use of causal modeling they were able to demonstrate the important role and magnitude of core and domain specific beliefs on policy preferences regarding terrorism. Because they collected data using both the Internet as well as randomly selected telephone interviews we are able to obtain a sense of how Internet surveys are likely to differ from the former. Stinson, Kinsey, and Ghosh have shown that surveys can be used to capture public preferences for the allocation of spending on security measures. Kahan, Slovic, Braman and Gastil have recently developed scales of cultural worldviews that may prove very important in predicting and understanding not only perceptions of risk, but preferences and sustained support for certain policies pertaining to terrorism. Finally, Smith and Mansfield have shown that it is possible to present respondents with different policy options and to examine peoples' willingness to make tradeoffs to reduce risks to commercial airlines. The authors suggest this same approach can be extended to other types of threats as well.

E. New Directions: Investigating Risk Perception, Policy Preference and Mitigation from a Dynamic Perspective.

The studies described thus far represent a careful but largely descriptive portrayal of peoples' world beliefs, perceptions of risk, trust in government and policy preferences with regards to a wide assortment of threats. Based on this pivotal research, a number of variables have been identified that are likely to play instrumental roles in how and to what extent the public might react in the event of a crisis. Likewise, there is also a relatively good understanding of how these factors may relate to one another at any point in time. *But snapshots, regardless of their resolution, cannot provide sufficient understanding into the processes that underlie how communities and the nation are likely to prepare for and respond to disasters of the future.* Consequently, we still are unable to reliably estimate to their full extent the ripple effects (social, political, or economic) that might follow from such events, nor can we be sure of which policies to recommend that might mitigate such impacts.

A New Generation of Research. What is needed now is a new generation of research focused on a dynamic rather than a static portrayal of risk perception, risk-related behavior and policy preference. For example, consider what is likely to occur following a terrorist strike in an urban area. Emergency response systems, information and communication channels, and social support organizations are likely to interact with the particular characteristics of a terrorist event in a nonlinear fashion to produce a wide range of physical, social, and economic impacts (Kasperson et al., 1988; Maani & Cavana, 2000). Public reaction may indeed be influenced by initial perceptions of risk but these perceptions will in turn be affected by how a community has prepared for and is currently responding to such a crisis. Local and national media may amplify these effects causing economic ripples across the nation.

To understand these interactions will require data collection and modeling approaches that address important feedback mechanisms and delays that give rise to such a system wide response.

Building on the pioneering efforts of past research there are three needed shifts of emphasis in the study of risk perception and relevant policy: the experimental manipulation of critical variables driving important systems feedback mechanisms and delays; the tracking of perceptions and risk-related behaviors over time; and the modeling of these findings in a way that captures the dynamic complexity likely to characterize community and national disaster response (e.g., system dynamics simulation, hierarchical linear modeling and time series analysis).

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