COLUMBIA/WHARTON ROUNDTABLE

# RISK MANAGEMENT STRATEGIES IN AN UNCERTAIN WORLD

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The Wharton School of Business, University of Pennsylvania, Risk Management and Decision Processes Center

# RISK ASSESSMENT AND RISK MANAGEMENT STRATEGIES IN AN UNCERTAIN WORLD

## EXECUTIVE SUMMARY

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## INTRODUCTION

The terrorist attacks on the World Trade Center (WTC) and the Pentagon have definitively changed the ways in which both the public and private sectors deal with extreme events. Prior to September 11th there was certainly concern about terrorism, but there was also the expectation that terrorism could not or would not happen here. As the attacks made painfully clear, extreme events, however unlikely they may first appear, can deliver a devastating blow when they do actually occur. As communities, government agencies and relief organizations attempted to cope with the devastation in the wake of the WTC collapse, the critical need for collaboration and the sharing of relevant data was keenly felt. In fact, the extent to which relief efforts have been, and continue to be, successful is in large part due to effective collaboration and the sharing of vital resources and information between individuals, organizations, agencies and research centers.

Recognizing these practical successes and the importance of continued collaboration, the Columbia University Center for Hazards and Risk Research and the Wharton School Risk Management and Decision Processes Center of the University of Pennsylvania hosted a Roundtable on April 12-13, 2002 to discuss the appropriate roles of the private and public sectors in mitigating the possible consequences of future catastrophes, whether malevolent or random in nature, and in providing the necessary funds for recovery.

The Roundtable attracted practitioners and decision-makers from the public and private sectors as well as researchers involved in assessing and managing extreme events. This Executive Summary identifies key issues discussed and debated during the two-day Roundtable with a particular emphasis on plans for future, more specialized Roundtables on managing risk in an uncertain world.

A key theme of this Roundtable was how risk analysis could be used to better understand the challenges associated with extreme events so that more effective planning could be undertaken in the future to reduce potential losses and better manage the impacts following a man-made, technological or natural disaster. Some of the participants prepared white papers and others wrote shorter notes that were distributed to all attendees

* We thank Danielle Bizzarro, Kristina Rodriguez Czuchlewski and Kathleen Boyer for their editorial assistance in preparing this Executive Summary. We thank Bonnie Mayer and Stacey Gander of the Seismology Division of the Lamont-Doherty Earth Observatory for their assistance in organizing the Roundtable.

in advance of the Roundtable. **Appendix A** lists the participants and their affiliations. **Appendix B** includes the Roundtable Agenda. **Appendix C** lists the titles of the white papers and the short papers prepared by participants.

While the basic principles of risk management involve a wide range of approaches and institutions, the malicious intent and the deliberate exploitation of terrorist attacks have added new dimensions to the problem demanding new types of research and understanding. The six future roundtables proposed by the participants build upon past experience in coping with natural and man-made hazards. At the same time, each is designed to identify new institutional structures and mechanisms for dealing with extreme events in an uncertain and increasingly interdependent world.

## FUTURE ROUNDTABLES

One of the principal objectives of this Roundtable was to examine how the basic concepts of risk analysis could help us better address the problems that will be faced by different sectors of the economy and the networks for processing data and communicating information in the future. Experts from six areas presented their views on the types of research issues that might be explored. Following these presentations, participants divided into small groups to design six future roundtables, which are summarized below. The specific features of these proposed roundtables are discussed in more detail at the end of the Executive Summary.

- **Roundtable 1 — Developing Financial Instruments in Developing Countries (Financial Institutions)**: Developing countries facing extreme threats often have no economic structure in place to provide support for mitigation or to establish economic reserves for remediation and response. The developed world often responds to emergencies after their occurrence with insufficient aid and devotes scant attention to developing sustainable mechanisms that would improve the economic basis for decreasing vulnerability. This Roundtable will focus on the design and implementation of appropriate financial instruments to reduce the vulnerability of developing countries to extreme threats and to provide funds for aiding the recovery process.

- **Roundtable 2 — Dynamics of Insurance and Reinsurance Markets Under Conditions of Ambiguity (Insurance)**: Following September 11$^{th}$ there has been increasing interest in the ambiguities associated with risks surrounding extreme events. Investors are now demanding higher returns on their investments when they provide funds for insuring against terrorist acts. As a result, insurers and reinsurers are charging higher premiums or are not offering coverage against this type of event at all. This Roundtable will focus on the supply and demand for insurance and reinsurance when risks are ambiguous and will consider strategies for managing these types of risks more effectively in the future.

- **Roundtable 3 — Recreating Civil Defense: Preparedness in Response to Extreme Events (Supply Chain Management)**: Civil Defense is: (1) the delivery of services "just in time" in response to a disaster, or (2) the *ex ante* "just in case" establishment of supply chains for mitigation, remediation or response purposes. A proactive perspective treats "civil defense" as a supply chain management problem, with significant uncertainties associated with the delivery of goods and services. This Roundtable will focus on preparedness and response to extreme events and the development of a unifying management framework to cope with the uncertainty surrounding these events.

- **Roundtable 4 — Risk and Performance-Based Approaches for Design and Management of the Built Environment (Construction and Engineering)**: "Performance-based engineering," promotes an integrated systems approach to the design and management of buildings and infrastructure, subject to well-defined goals and objectives. This Roundtable will address the types of performance metrics needed for extreme event risk management and will develop new type(s) of resilient design and engineering systems.

- **Roundtable 5 — Cities at Risk: Institutional Approaches to Urban Risk Management (Urban Planning and Design)**: Cities contain complex, interdependent power structures and decision-making institutions operating on different geographic scales and serving different constituencies simultaneously. Investment in risk reduction measures typically takes place on many levels and at many locations, often with little coordination. This Roundtable will address and develop appropriate strategies for urban risk management at neighborhood, municipal, regional, and state/national/international levels.

- **Roundtable 6 — Computers and Users: Managing Risk Management with Information Technology (Urban Information Management and Services)**: Risk management data have multiple temporal and spatial scales. The user community is heterogeneous and has varying data needs for a wide range of purposes. The effective management of data and use of available information in decision-making require systems that account for user needs, intrinsic data structures, and differences in data sources and analyses. This Roundtable will address and develop the organizing principles for managing risk management data in the context of rapidly changing risk environments and uncertainties.

## FRAMEWORK FOR DEALING WITH EXTREME EVENTS

Despite recent advances in science and technology there is still considerable uncertainty regarding our ability to estimate risks, particularly when they involve low probability/high consequence events. Consider the following:

- What are the chances that New York City will have an earthquake of magnitude 7.0 or greater next year, and what will be the resulting damage and indirect losses?
- What is the likelihood of a severe nuclear power accident somewhere in the United States and what would be the resulting impacts?
- What is the probability that an airplane will crash into the Sears Tower in the next year and how serious would the consequences be?
- What are the chances that there will be a terrorist-induced smallpox epidemic in the United States in the next five years, and how many people would be affected?

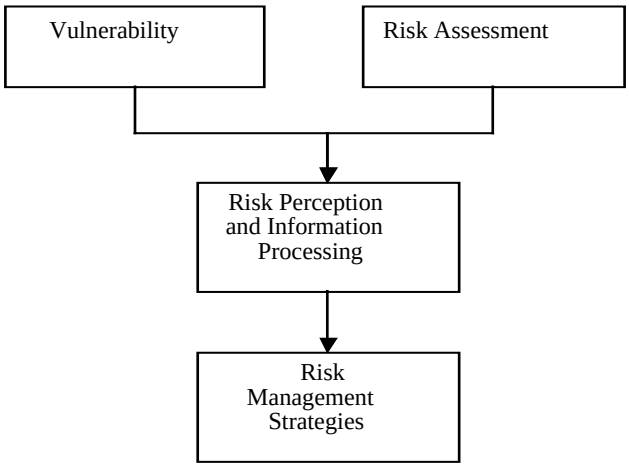
Prior to answering questions such as these, scientists first need to define the event itself. Take the question related to a significant earthquake occurring in New York City. In this case, experts might initially ask:

- What is the geographic area that defines New York City?
- What do you mean by next year (i.e. starting today or January 1, 2003)?
- What is an indirect loss?

Even with this information, there is still considerable ambiguity surrounding the likelihood of these events occurring and their possible consequences. Those concerned with the management of risk must also consider some of the following types of questions:

- What are the causes of widely varying public perceptions and acceptances of risk and what can be done to address these differences?
- Does research on risk perception have implications for ways that risk assessment processes can be improved?
- How should policy makers respond when the public's perception of risk differs from the results of scientific risk assessment?
- How should information be presented and evaluated when experts disagree with each other?
- What are the alternative ways in which information on the probabilities and consequences associated with specific events could be framed and presented to decision-makers, and what impact will these different formats have on the choices eventually made?
- What types of incentives (e.g., subsidies, fines) are appropriate to encourage certain behaviors by the stakeholders?
- What types of regulations and standards are appropriate to deal directly with specific types of problems, and how can these be well enforced?
- What types of public-private partnerships can be developed utilizing existing institutional arrangements or creating new ones?

Questions such as these can be addressed using the conceptual framework depicted below, which links the risk assessment process with risk management strategies.




Let us consider each of the elements in the framework:

- ***Vulnerability***—the potential for damage and other losses should a technological, man-made or natural disaster occur. Discussions of extreme-threat vulnerability include an assessment of the capacity to respond, either reactively in an emergency response mode, or proactively through mitigation.

- ***Risk assessment***— a systematic approach to organizing and analyzing scientific knowledge and information for potentially hazardous activities or for substances that might pose risks under specified circumstances

- ***Risk perception*** —includes determining which factors influence an individual's judgment on how *risky* an event is and considering how people think about, and respond to, these risks;

- ***Information processing***—the types of data collected, communicated and utilized by individuals, groups and organizations in making choices between alternatives (including maintaining the status quo) following an extreme event, as well as protection of this data in the case of an extreme event;

- ***Risk management strategies***—public-private partnerships that utilize such policy tools as subsidies, fines, insurance, regulations and standards.

Physical scientists and engineers provide the relevant data on the vulnerability of a region to different types of hazards and then they assess the risks to different structures and the surrounding environment, noting the uncertainties surrounding these estimates. Social scientists complement these studies by focusing on how the risk is perceived and how information is processed during decision-making. Based on this knowledge, policy

analysts then develop a set of risk management strategies for dealing with extreme events.

Coping effectively with extreme events and their inherent uncertainty requires a diverse set of methodological tools that provide a policy framework for decision-making. These include formal approaches (e.g., decision analysis, cost-benefit analysis) and intuitive approaches (e.g., systematic heuristics and rules of thumb) for choosing between alternatives. The nature of institutional arrangements, the types of interaction between the key interested parties concerned, as well as the nature of the hazard itself need to be taken into account when applying these formal and intuitive approaches.

## RESEARCH CHALLENGES

Using the above conceptual framework Roundtable participants probed more deeply into the types of research and management challenges posed by extreme events. We have characterized some of key research areas below.

### Vulnerability

- Vulnerability metrics need to address the direct and indirect impacts of extreme events as well as the capacity of the system to respond to the needs generated by disasters of different magnitudes.

- There are significant data and analytical issues that impede vulnerability assessment. There are few guidelines for gathering *ex post* loss data across different socio-economic environments. The methodology for acquiring and assessing indirect loss data is not well established nor is it universally applied. An additional challenge is how to gather consistent loss data across multiple hazards.

- There is a need to construct economic and social indicators for measuring the survival and response capacity of the system following an extreme event.

- We need to understand the factors or underlying socio-economic structure that contribute to the disproportionate suffering of the poor from extreme events.

- In addition to research on threat probabilities, engineering and system response, there needs to be additional studies on disaster demographics, and the characteristics of political and social capital in different cultural environments. Also important is the characterization and definition of crisis states, and the characteristics of agents that may precipitate these situations.

**Risk Assessment**

- For some hazards (e.g., natural disasters) there are well-developed models specifying probabilities and consequences. Yet there is still considerable uncertainty regarding these risks. How can these uncertainties be quantified and presented to interested parties using the data?

- For other risks (e.g., terrorism) the risks are much more difficult, if not impossible, to estimate. To what extent can existing methods be applied to this type of risk? Do we need new methods (e.g., scenario analysis) for dealing with these more ambiguous and uncertain risks?

- For multiple threats, there is no universally accepted methodology for developing joint probabilistic assessments, especially where significant direct and indirect impacts must be considered. Are performance-based methodologies, as applied to significant engineering issues, an appropriate starting point?

- Is *quantification of uncertainty* a realistic goal? Are there extreme risks in which the estimation of the probability distributions is so uncertain that these risks should be classified as trans-scientific—beyond the realm of what science can deal with?

**Risk Perception**

- There are multiple conceptions of risk. The most common are:

  Risk as probability. *Example*: "What is the risk of getting AIDS from an infected needle?"

  Risk as consequence. *Example*: "What is the risk of letting your parking meter expire?" (e.g., getting a ticket)

  Risk as potential adversity or threat. *Example*: "How great is the risk of riding a motorcycle?"

  Risk as a measure of the possibility of deviation from the expected. *Example:* What are the unexpected benefits to a disaster area in terms of employment opportunities and new investments to rebuild the community?

- Each way of expressing risk embodies its own set of values. For example, "reduction in life expectancy" treats deaths of young people as more important than deaths of older people, who have lower life expectancy. How do these different values determine which risks people will pay most attention to?

- Expressions of risk and risk values must also account for potential benefits as well as potential harms from exposure. Investments by organizations have the potential not only for losses but also for reward through profit or equity value increase. In the context of a biological example, exposure to a virus creates the risk of infection leading to disease, but also has the potential to strengthen the exposed system's future resistance to infection.

- Subjectivity permeates risk assessments at every stage of the process from the initial structuring of a risk problem to deciding which endpoints or consequences to include in the analysis, to identifying and estimating exposures and their impact.

- What are the causes of widely varying public perceptions and acceptances of risk and what can be done to address these differences? Can research on risk perception improve current risk assessment processes?

- How should policy makers respond when the public's perception of risk differs from the results of scientific risk assessment? How should information be presented and evaluated when experts disagree with each other?

**Information Processing**

- The impacts of catastrophic events often extend far beyond the direct damages to victims and property and may result in massive indirect impacts, such as litigation against a company, loss of sales, or increased regulation of an industry. We need to understand more fully the nature of the social amplification of risk and how to deal with it when developing risk management strategies.

- The concept of *accidents as signals* helps explain our society's strong response to terrorism. Because the risks associated with terrorism are poorly understood, catastrophic events may be seen as omens of disaster and produce responses that carry immense psychological, socioeconomic and political impacts. How can we better understand public reaction to develop more effective risk management strategies?

- There are two fundamentally different ways in which human beings process information about the world when making judgments or arriving at decisions. One system uses association and emotions, and often serves as an "early-warning" system. The other uses algorithms and rules, but is slower, and requires more conscious effort. Both systems have their own sets of advantages, as well as biases and limitations. The challenge is to figure out how to capitalize on these advantages, while minimizing the limitations when we assess risks.

**Risk Management Strategies**

- For some risks the incentive for any firm to invest in risk-reduction measures depends upon how others behave. For example an airline will be less likely to invest in baggage security system if they know other airlines are not following suit due to the possibility of having contaminated bags transferred to their planes. For the smallpox risk there is an incentive for a person to be vaccinated if others are not, since this protects you from the possibility of being contaminated. What strategies should be developed for dealing with interdependent security problems and reducing the chances of contamination for different types of risks?

- In developing strategies for providing insurance against low probability events, the two major challenges are the ambiguity of the risk and the high correlation among possible losses. A key question is how differences in perceived ambiguity by buyers and sellers affect the type of contracts that are completed? What is the role of the public sector if insurers feel that they cannot offer protection against risks that can produce catastrophic losses to them?

- What types of incentives (e.g., subsidies, fines) should be implemented to encourage certain behaviors by the stakeholders? What types of regulations and standards are appropriate for reducing losses for certain risks and how can they be well enforced? What types of public-private partnerships can be developed utilizing existing institutional arrangements, or new ones?

## FUTURE RESEARCH PROJECTS

The above research challenges identified during the first day of the Roundtable formed the basis for a series of small group discussions in which the participants formulated research projects as exemplars of the larger research questions. These are summarized below:

### 1. Reducing Community Vulnerability Through Shared Information

This project would develop a computer-based community forum to allow: 1) residents of New York City from various social and economic groups to share their values; and 2) to compare community perceived risks with those perceived by technical, scientific and insurance experts. Such a forum could serve as a pilot for future studies around the country and around the world.

### 2. Understanding The Nature of Extreme Events

This project is designed to increase our understanding of low probability, high consequence events by understanding the nature of extreme events and our responses to them, Particular attention should be given to how the events of September 11th have transformed our understanding of uncertainty.

### 3. Resource Allocation Strategies for Future Extreme Events

This research project is designed to compare extreme events, such as earthquakes, nuclear accidents, and terrorist attacks in the United States and abroad with special attention devoted to understanding feedback and learning effects. This should enable one to develop a framework for dealing with future extreme events.

### 4. Distribution of Information on Risk and Institutional Power Structures

This project is designed to analyze the interaction between experts, decision-makers, stakeholders and the grass-roots public in democratic and non-democratic societies and to identify potential roadblocks to effective and legitimate risk management.

## FUTURE ROUNDTABLES

### Roundtable 1 — Developing Financial Instruments in Developing Countries (Financial Institutions)

***Objective:*** Developing countries facing extreme threats often have no economic structure in place to provide support for mitigation or establish economic reserves for remediation and response. The developed world often responds to emergencies after their occurrence with insufficient aid. It devotes scant attention to developing sustainable mechanisms that would improve the economic basis for decreasing vulnerability. This Roundtable would address the design and implementation of appropriate financial instruments to reduce the vulnerability of developing countries to extreme threats.

***Key Questions:***

- What is the performance of existing financial mechanisms for pursuing vulnerability reduction in developing and emerging economies?
- What components of vulnerability reduction could be addressed through financial instruments? What categories of events and impacts should be covered?
- What are the design elements of financial instruments covering extreme event vulnerability? Such elements could include:
    - Post-event compensation vs. pre-event mitigation
    - Securitization and options
    - Secondary markets
- Do financial markets address other development issues in addition to vulnerability reduction? What design elements of financial markets are consistent with the social investments needed for vulnerability reduction?
- Why do financial markets take so long to penetrate developing economies? Is *vulnerability reduction* a rationale for strengthening the role of markets?

***Project Components:***

- Develop financial instruments that could provide compensation after a disaster
- Investigate possibility of using securities/derivatives indexed on magnitude, scale, and location of natural disasters to provide reinsurance cover
- Determine who would pay for coverage (local government/communities, international aid agencies, individuals in form of charity)
- Identify events to be covered: conceptual/financial level (World Bank, UN)
- Develop case studies (real life situations) for the following purposes: to develop infrastructure to account for damage; to provide mechanisms for audits before and after such events; to examine the political, legal safeguards and effectiveness of disaster assistance/ insurance coverage.
- Develop performance metrics for vulnerability reduction.

***Participants:*** International financial agencies such as the World Bank, regional development banks, country representatives, reinsurance companies, investment banks, national aid agencies, private aid agencies

**Roundtable 2 — Dynamics of Insurance and Reinsurance Markets Under Conditions of Ambiguity (Insurance)**

***Objective:*** Determine the supply and demand for insurance and reinsurance when there is considerable ambiguity in the risk (e.g., terrorism insurance, environmental hazards).

***Key Questions:***

Investigate the demand side

- What factors affect consumers' perception of risk: and their attitudes towards ambiguity?
- What factors affect institutional investors perception of risk: and their attitudes towards ambiguity? (e.g., How do we make CAT bonds more attractive to investors?)
- Why do so few individuals purchase insurance in developing nations?

Investigate the supply side

- Why are insurers reluctant to underwrite risks following catastrophes?
- Are there problems in lining up the correct incentives for agents to push coverage?
- What are the legal constraints keeping insurers from covering certain risks?
- How can insurance companies more effectively hedge risk?
- What is the appropriate role of government in fostering novel ways of hedging risk?

Investigate market behavior

- Why does the market price of insurance typically rise following an extreme event and then fall off?
- In what ways can we accelerate learning in markets to reach equilibrium more rapidly?
- Is there potential for learning across crises? (e.g. Do insurance cycles get shorter, the way they do in some financial markets?)

***Project Components:***

- Understand culturally appropriate insurance structure.
- Relation of insurance to international investment
- Insurance and law
- Pilot insurance markets, design of market stabilizing mechanisms
- Definition of equilibrium in markets exposed to multiple extreme threats.

***Participants:*** Insurers, reinsurers, financial institutions, FEMA, National Association of Insurance Commissioners

**Roundtable 3 — Recreating Civil Defense: Preparedness in Response to Extreme Events (Supply Chain Management)**

***Objective:*** Civil Defense is: (1) the delivery of services "just in time" in response to a disaster, or (2) *ex ante* "just in case" establishment of supply chains for mitigation remediation, or response. A proactive perspective treats "civil defense" as a supply chain management problem, with significant uncertainties associated with the delivery of goods and services. This Roundtable will focus on preparedness and response to extreme events and the development of a unifying management framework to cope with the uncertainty associated with these events.

***Key Questions:***

- How can the activities of multiple communities and agencies best be coordinated *ex ante*?
- What infrastructure from the private as well as public sectors could be used in case of emergency? How can this be identified? What legal and economic structures need to be in place to compensate or provide for the use of infrastructure in emergencies?
- What is the role of inventory (material, capacity) in *just in case* scenarios?
- What is the disruption to existing supply chains as a consequence of extreme events? And what is the impact of this disruption on the emergency response? Will the adoption of *just in case* infrastructure promote economic growth in developing countries?

***Project Components:***

Case studies in three sectors:

- Public health environment: natural and inflicted epidemics (environmental factors and bio-warfare)
- Built environment: property damage from extreme events
- Information environment: information networks and cyber-events

***Participants:*** Specialists in management, organizations, and institutions, legal experts, public health specialists, structural engineers, operations researchers, computer scientists, insurance industry, pharmaceutical industry, construction and infrastructure companies.

**Roundtable 4 — Risk- and Performance-Based Approaches for Design and Management of the Built Environment (Construction and Engineering)**

***Objective:*** *Performance-based engineering* promotes an integrated systems approach to the design and management of buildings and infrastructure, subject to well-defined goals and objectives. This Roundtable will address the types of performance metrics needed for extreme event risk management and will develop new type(s) of resilient design and engineering systems.

***Key Questions:***

- What is the best method to aggregate risks from multiple extreme threats?
- What factors should control the aggregation of multiple-threat remediation and retrofitting solutions?
- What is the role of indirect impacts in performance-based engineering?
- How are direct and indirect impacts aggregated?
- How are other elements of engineered systems, such as insurance and finance, legal and liability, integrated? What is the capacity of the integrated system to manage risks, and how is that capacity defined?
- How can we be sure that the specified performance metrics actually capture the most important aspects of performance? If not, what are the risks if facilities are designed to achieve the stated performance metrics?
- What regulatory system needs to be put in place to ensure that the assumptions for which a facility was designed (e.g., amount of flammable material present, intended occupancy, etc.) remain valid?

***Project Components:***

- Identify disconnects and linkages among decisions by insurance, finance, legal, and engineering systems.
- Identify and evaluate the ways in which institutional capacity is defined and limited by these disconnects and linkages.
- Develop performance metrics for risk management of structures and infrastructure.
- Develop institutional models with risk-management capacity.
- Develop pilot regulatory systems governing whole systems.
- Case studies and pilot programs.

***Participants:*** Insurance, finance, legal, development, engineering, design, planning, and construction sectors. Public-private partnerships.

**Roundtable 5 — Cities at Risk: Institutional Approaches to Urban Risk Management (Urban Planning and Design)**

***Objective:*** Cities contain complex, interdependent power structures and decision-making institutions working at different geographic scales and with different constituencies. Investment in risk reduction takes place at all scales, often with little coordination. How can integrated risk management be incorporated into urban planning and design at the neighborhood, municipal, regional, and state/national/international levels?

***Key Questions:***

- What are the organizational structures of modern cities in the developed and developing world, and how do these relate to safety?
- What are the roles of different geographic scales of decision-making with respect to risk management?
- What is the importance of participatory processes in risk management? What are the roles of regulation and markets? Do markets meet civic interests?
- What is the importance of communication and information management?
- What is the relationship between the geographies of risk and jurisdiction?
- Which urban decision-making models or institutional approaches provide the best opportunities for identifying and managing risk?

***Project Components:***

- Evaluate decision-making: how are decisions **now** made? What are the relevant decision processes involved (who, what, where, when)?
- Evaluate the range of scales of organization structures in large metropolitan areas, medium cities, small localities;
- Determine how city governments communicate with people, the private sector, NGOs etc. with respect to questions of risk
- Examine regional cooperative arrangements (e.g., Metro Council of Governments)
- Examine decision process at the municipal level where regulatory responsibility resides
- Examine spatial distribution of risks: geography of mitigation and response activities and jurisdictional involvement (limits of political boundaries)
- Examine the balance between public interest and market mechanisms: civic rights vs. market interests

***Participants*:** International City and County Managers Assoc., PRIMA (risk managers), Earthquake Megacities Initiative, National Assoc. of Flood Planning Managers, Metropolis, International Emergency Managers Assoc., League of Cities

**Roundtable 6 — Computers and Users: Managing Risk Management with Information Technology (Urban Information Management and Services)**

***Objective:*** Cities contain complex, interdependent power structures and decision-making institutions operating on different geographic scales and serving different constituencies simultaneously. Mitigation of risk and investment in risk reduction typically take place on many levels and at many locations, often with little coordination. This Roundtable will address and develop appropriate strategies for urban information management and services at neighborhood, municipal, regional, and state/national/international levels.

***Key Questions:***

- What are the linkages between social networks and information networks?
- How do information networks contribute to risk perception? To risk management decisions?
- What kind of information technology standardization is needed to promote cooperation among different users and communities? What does *interoperability* mean in the context of decision support and social networks?
- What institutional challenges prevent (or encourage) the adoption of modern technological solutions to risk management problems?

***Project Components:***

- Database (e.g., tools for data analysis and visualization to serve research assessment and management of response)
- Interfaces and communication of risk to various audiences and public
- Data interoperability (compatibility of hard and software): combining of data from various sources; metadata compatibility; architecture of database (distributed vs. centralized vs. virtual; integrated and routed repository
- Communication of risk: requires adaptive and user-friendly mechanisms (public; business community; insurance industry; political and government agencies)
- Risk management data: physical destruction; breakdowns of connectivity; ripple effects of impairment (local, global) (e.g., telephone system overload)

***Participants:*** Risk scientists, computer scientists, practitioners, and planners

## APPENDIX A: ROUNDTABLE PARTICIPANTS

| | |
|---|---|
| Bier, Vicki | University of Wisconsin |
| Bookstaber, Richard | Moore Capital Group |
| Boyer, Kathleen | Columbia University |
| Chen, Robert | CIESIN |
| Coglianese, Cary | Harvard University |
| Cohn, Timothy | USGS - Reston |
| Deodatis, George | Columbia University |
| DiJohn, Jonathan | London School of Economics |
| Doherty, Neil | University of Pennsylvania |
| Durbin, David | Swiss Reinsurance Company |
| Federgruen, Awi | Columbia University |
| Flesher, Kevin | Lockheed Martin |
| Fox, Craig | Duke University |
| Freeman, Paul | University of Denver |
| Garvin, Michael | Columbia University |
| Gersen , Jacob | University of Chicago |
| Goldberg, Victor | Columbia University |
| Goldin, Ian | World Bank |
| Grava, Sig | Columbia University |
| Heal, Geoffrey | Columbia University |
| Hedde, Carl | American Re-Insurance Company |
| Heller, Miriam | National Science Foundation |
| Holguin-Veras, Jose | City University of New York |
| Hurwitz, Roger | Massachusetts Institute of Technology |
| Ilic, Marija | Massachusetts Institute of Technology |
| Jacob, Klaus | Columbia University |
| Kane, Sally | National Oceanic and Atmospheric Administration |
| Katzen, Sally | Private Consultant/Professor |
| Kleindorfer, Paul | University of Pennsylvania |
| Kloman, Felix | Risk Management Reports |
| Krantz, David | Columbia University |
| Krimgold, Frederick | Virginia Tech |
| Kunreuther, Howard | University of Pennsylvania |
| Lall, Upmanu | Columbia University |
| Lamm Tenant, Joan | General Cologne Reinsurance Company |
| Lerner-Lam, Arthur | Columbia University |
| Linnerooth-Bayer, Joanne | IIASA |
| May, Peter | University of Washington |
| McDaniels, Timothy | University of British Columbia |
| Meyer, Robert | Wharton/University of Pennsylvania |
| Miller, Roberta | Columbia University |
| Morris, Bonnie | West Virginia University |
| Muermann, Alexander | University of Pennsylvania |
| Mutter, John | Columbia University |
| Nelson, Priscilla | National Science Foundation |

| | |
|---|---|
| North, D. Warner | NorthWorks, Inc. |
| Orszag, Peter | Brookings Institute |
| Parson, Edward | Harvard University |
| Pauly, Mark | Wharton/University of Pennsylvania |
| Petak, William | SCEC |
| Pfaff, Alex | Columbia University |
| Pielke, Roger | University of Colorado at Boulder |
| Reichardt, Mark | Open GIS Consortium |
| Sarewitz, Dan | Columbia University |
| Schmittlein, David | University of Pennsylvania |
| Seeber, Leonardo | Columbia University |
| Shafir, Eldar | Princeton University |
| Shapira, Zur | New York University |
| Slovic, Paul | Decision Research |
| Smetters, Kent | US Treasury |
| Staking, Kim | Inter-American Development Bank |
| Swiren, Bruce | FEMA |
| Verkuil, Paul | University of Pennsylvania |
| Warner, Koko | IIASA |
| Weber, Elke | Columbia University |
| Zimmerman, Rae | New York University |
| Zivin, Joshua | Columbia University |

## APPENDIX B: ROUNDTABLE AGENDA

***April 11th, 2002***

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|---|---|
| 7:00 p.m. | Informal Welcome Dinner / Steering Committee Briefing |

***Day One – April 12th, 2002***

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| 7:30 - 8:30 a.m. | Sign In (Outside Meeting Room) |
| 8:30 - 9:30 a.m. | Introduction to the Roundtable—Howard Kunreuther, Art Lerner-Lam<br>• Welcoming remarks—John Mutter, David Schmittlein, Awi Federgruen<br>• Objectives of the Roundtable—Howard Kunreuther, Art Lerner-Lam<br>• Introduction of Participants |
| *Moderator:* | ***Howard Kunreuther*** |
| 9:30 - 10:30 | Vulnerability White Paper—"Vulnerability and Risk: Some Thoughts From a Political and Policy Perspective"<br>*Roger Pielke and Dan Sarewitz*<br>***Discussants: Tim Cohn, Fred Krimgold*** |
| 10:30 - 11:00 | ***Break*** |
| 11:00 – 12:00 | Risk Assessment White Paper—"Risk Assessment of Extreme Events" *Vicki Bier and Rae Zimmerman*<br>***Discussants: Kevin Flesher, D. Warner North*** |
| 12:00 - 1:00 | ***Lunch*** |
| *Moderator:* | ***Art Lerner-Lam*** |
| 1:00 - 2:00 | Risk Perception White Paper—"Perception of Risks Posed by Extreme Events" *Paul Slovic and Elke Weber*<br>***Discussants: Tim McDaniel, Kim Staking*** |
| 2:00 - 3:00 | Public Private Partnerships White Paper—"You Can Only Die Once" *Geoff Heal and Howard Kunreuther*<br>***Discussants: Joan Lamm Tenant, Peter Orszag*** |
| 3:00 - 3:30 | ***Break*** |
| 3:30 - 4:30 | Risk Management White Paper—"Market and Contract Design for Catastrophic Losses" *Neil Doherty and Paul Kleindorfer*<br>***Discussants: Paul Freeman, David Durban*** |
| 4:30 - 5:00 | Open Discussion of the Day |
| 6:00 – 7:00 | ***Dinner*** |
| 7:00 | ***Small Group Breakout Meetings Begin*** |

***Day Two – April 13th, 2002***

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| *Moderator:* | ***Art Lerner-Lam*** |
| 8:30 - 9:30 a.m. | Summary of Small Group Breakout Discussions |
| 9:30 – 10:45 | Risk Management Strategies: Applications to Problem Areas<br>Construction and engineering–Mike Garvin<br>Insurance–Carl Hedde<br>Financial Institutions–Richard Bookstaber<br>Supply Chain Management–Bonnie Morris<br>Urban planning and design–Sigurd Grava<br>Urban information management and services–Bob Chen and Mark Reichardt |
| 10:45-11:15 | ***Break*** |
| 11:15-noon | **Open Discussion on Problem Areas** |
| Noon – 2:00 pm | ***Lunch and Small Group Meetings—<br>Planning Future Roundtables*** |
| 2:00 - 3:00 | Summary of Small Group Luncheon Discussions–Group leaders |
| 3:00 - 4:00 | "Where Do We Go From Here?"—Howard Kunreuther and Art Lerner-Lam |
| 4:00 pm | Adjourn |

## APPENDIX C: LIST OF WHITE PAPERS AND PARTICIPANT NOTES

### White Papers

Vicki Bier and Rae Zimmerman. "Risk Assessment of Extreme Events."

Neil Doherty and Paul Kleindorfer. "Market and Contract Design for Catastrophic Losses."

Geoffrey Heal and Howard Kunreuther. "You Can Only Die Once: Public-Private Partnerships for Managing the Risks of Extreme Events."

Roger Pielke and Dan Sarewitz. "Vulnerability and Risk: Some Thoughts From A Political and Policy Perspective."

Slovic Paul and Weber, Elke. "Perception of Risks Posed by Extreme Events."

### Participant Notes

Roberta Balstad Miller. "Information Resources for Disaster Recovery in the US: Local vs. Federal Government Roles."

Robert E. Chapman and Harold E. Marshall. "Effectiveness Tool for Evaluating the Management of Terrorist Risk."

Robert Chen. "Data and Information Needs in Dealing with Multiple Threats."

Cary Coglianese. "Reducing Risk with Management-Based Regulation."

Tim Cohn. "Risk Management in an Uncertain World: A Perspective."

Craig R. Fox. "The Impact of Extreme Events in Decisions Under Uncertainty: A Cognitive Perspective."

Paul K. Freeman. "Risk Management in an Uncertain World."

Jacob Gersen. "A View From Behavioral Political Economy on Risk Management Strategies in an Uncertain World."

Victor Goldberg. "Aversion to Risk Aversion."

Sigurd Grava. "The Stigma of Disaster Probability."

Miriam Heller. "Mixing Markets and Government in Risk Sharing."

Roger Hurwitz. "The Administration of Anxiety."

Sally Kane and Nancy Beller-Simms. "Climate Information and Forecasts: New Tools for Risk Management."

Sally Katzen. "The Management Challenge of Extreme Events."

H. Felix Kloman. "Risk Management Issues for 2002."

H. Felix Kloman. "Does Risk Matter?"

David Krantz. "Individual/Cooperative Planning Under Uncertainty."

Howard Kunreuther. "The Role of Insurance in Managing Extreme Events: Implications for Terrorism Coverage."

Joan Lamm-Tennant. "Implications of Extreme Events and Market Shocks: Capacity, Price Volatility and the Value of Transparency."

Joanne Linnerooth-Bayer. "Equity and Extreme Events."

Peter J. May. "Policy Design and Implementation Perspectives."

Tim McDaniels. "Risk Management for Extreme Events: A Role for Adaptive Learning?"

Bonnie W. Morris. "Identifying Risks and Building Trust in Global Supply Chains."

John Mulvey. "Optimal Decision Making Under Extreme Event Risks."

Mark Pauly. "Personal and Social Extreme Events: The Case of Health Insurance."

William Petak and Tom Jordon (SCEC). "Managing Risk in a Complex Environment with Competing Worldviews."

D. Warner North. "Reflections on Planning and Analysis for Extreme Events."

Peter R. Orszag. "Overview of Protecting the American Homeland."

Eldar Shafir. "Psychological/Behavioral Considerations in the Management and Analysis of Extreme Events."

Zur Shapira. "Cost of Errors of Omission and Errors of Commission in Risk Management."

Geoff Shaw and Kevin Flesher. "Extreme Event (Terrorism) Risk Management and Reduced Ambiguity of Risk: What's it Worth?"

Jerry R. Skees. "Life-Cycle Infrastructure Risk Management: R&D Needs."

Kent Smetters. "Is there a Role for Government Provision of Terrorism Reinsurance.
Bruce J. Swiren and Joseph Picciano. "FEMA Region II Perspectives."

Gordon Woo. "Benefit-Cost Analyses for Malevolent Human Actions."