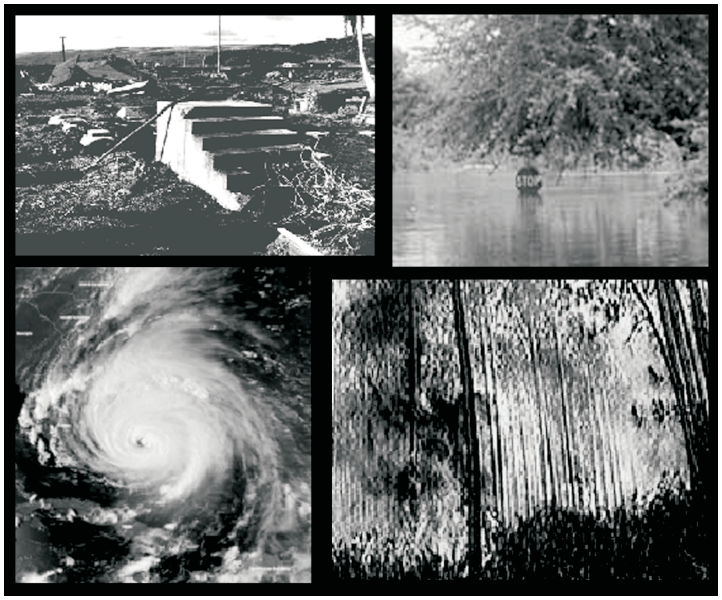
U.S. DEPARTMENT OF COMMERCE/ National Oceanic and Atmospheric Administration

OFCM

OFFICE OF THE FEDERAL COORDINATOR FOR
METEOROLOGICAL SERVICES AND SUPPORTING RESEARCH

PROCEEDINGS OF THE FORUM ON RISK MANAGEMENT AND ASSESSMENTS OF NATURAL HAZARDS



February 5-6, 2001
Hotel Washington
Washington, D.C.

Toward a Safer America: Building Natural Hazard Resistant Communities Through Risk Management and Assessments

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PROCEEDINGS

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Washington, DC
July 2001

FOREWORD

The Forum on Risk Management and Assessments of Natural Hazards was held on February 5-6, 2001 at the Hotel Washington, Washington, D.C. The theme of the Forum was "*Toward a Safer America: Building Natural Hazard Resistant Communities through Risk Management and Assessments."* An unprecedented cross-section of more than 120 weather, natural disaster and risk management professionals, and academia attended the Forum. The Forum was sponsored by the Office of the Federal Coordinator for Meteorological Services and Supporting Research (OFCM) and the National Science and Technology Council, Committee on Environment and Natural Resources (CENR), Subcommittee on Natural Disaster Reduction (SNDR).

The purpose of this Forum was to assess the state of risk assessment and management for natural hazards. To do this, Federal research, applications, services, implementations, and public outreach programs were reviewed. In addition, the attendees discussed national standards for models, data or values used in risk assessment. They continued previous studies and work by examining and identifying national vulnerabilities that could be evaluated and mitigated. The overarching objectives of the Forum were to:

- Examine risk assessment processes and approaches that evolved from legislation or agency guidance;
- Review risk assessment research and its applications to manage natural hazards;
- Identify areas of vulnerability and exposure, probability of occurrence, consequences, and mitigation opportunities;
- Highlight efforts in developing national standards and capabilities for data monitoring, data collection, and model development;
- Examine methods to quantify and publicize the social and economic impacts of natural hazards; and
- Develop a consensus leading to coordinated risk assessment and management of natural hazards.

This document summarizes the proceedings of the Forum, captures the recommendations of the breakout sessions and panels, and summarizes the overarching issues and actions that surfaced during the Forum.

In conclusion, I wish to thank the Federal Emergency Management Agency (FEMA) and the United States Forest Service (USFS) for co-hosting this important Forum. I am indebted to the membership of the Interdepartmental Committee for Meteorological Services and Supporting Research (ICMSSR) and the SNDR for their support and guidance. In addition, I wish to extend my deepest appreciation to the panelists, moderators, rapporteurs, and attendees whose lively involvement, interaction, discussion, and interest made this meeting a solid success.

Samuel P. Williamson
Federal Coordinator for Meteorological Services
and Supporting Research

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WELCOMING ADDRESS

Mr. Scott B. Gudes, Acting Under Secretary of Commerce for Oceans and Atmosphere, and Acting Administrator of the National Oceanic and Atmospheric Administration (NOAA)

Remarks. Welcome to the Forum on Risk Management and Assessments of Natural Hazards. I want to thank Sam Williamson and Margaret Lawless for giving me the opportunity to say a few words before you jump into this very important work. The theme for the Forum really hits the mark: "Toward a Safer America: Building Natural Hazard Resistant Communities Through Risk Management and Assessments." With this in mind, this group is taking on a very important task, one that will aid in mitigating losses attributed to natural hazards--I applaud all of you for your efforts. As I'm sure you are all aware, the losses due to natural hazards have been staggering over the last several years:

- From 1989 to 1993, the average annual losses from disasters were $3.3 billion.
- From 1993-1996, the annual losses rose to $13 billion!
- As a comparison, waging the Persian Gulf War cost the United States and its allies $60 billion.

In NOAA, we continue to play a significant role in the overall effort to mitigate losses caused from natural hazards. Optimal decision-making in agriculture, construction, energy, transportation, and water resource management must be based on reliable predictions of extreme weather phenomena. In March, the nation's premier severe weather experts will discuss their latest research findings and forecasting techniques during the National Severe Weather Workshop. This Workshop is being sponsored by NOAA's Storm Prediction Center, Central Oklahoma Chapter of the American Meteorological Society, the Oklahoma Chapter of the National Weather Association, and the Oklahoma Emergency Managers Association. The more these hazards are understood and prediction capabilities improve (understanding and predicting these hazards are principal NOAA responsibilities), the more effective risk assessment and mitigation strategies will become.

Each year, more and more Americans are at risk from a variety of natural hazards that affect the coastal environment. Indeed, the coastal environment is also of extreme importance to NOAA. In fact, NOAA maintains a national network of monitoring programs that detect, quantify, and forecast changes in coastal environmental quality. In the past 30 years, there has been explosive growth along the Nation's coastal margins such that today more than 50% of U.S. citizens live in the coastal zone (coastal waters and the adjacent lands of the coastal states, including islands, territories, and the Great Lakes states). Many of these citizens build their homes, businesses, schools, and hospitals in locations that are particularly vulnerable to catastrophic and chronic coastal hazards such as hurricanes, severe storms, coastal erosion, ocean flooding, riverine flooding or landslides.

Of note, NOAA's National Ocean Service recently released a report prepared by the U.S. Global Change Research Program's National Assessment of the Potential Consequences of Climate Variability and Change. The report, entitled: "The Potential Impacts of Climate Change on Coastal and Marine Resources," highlighted shoreline erosion as a key issue of climate change.

The report states, "Globally averaged, sea-level will continue to rise, and the developed nature of

many coastlines will make both human settlements and ecosystems more vulnerable to flooding and inundation."

As always, NOAA will continue to play a vital role in warning the public and emergency managers of many of the natural hazards and will partner with other agencies to aid in mitigating the losses and impacts of these hazards. I appreciate your participation and truly hope you have an informative, successful Forum.

FORUM OBJECTIVES

Mr. Samuel P. Williamson, Federal Coordinator for Meteorological Services and Supporting Research

Synopsis: Mr. Williamson provided the history, purpose, and objectives of the Forum. His presentation (see Appendix B) specifically covered types of hazards, impacts of natural hazards, definitions, statute/guidance compliance, forum objectives, and a primer on the Office of the Federal Coordinator for Meteorological Services and Supporting Research (OFCM). He described the types of hazards that encompass 1) natural hazards: weather and weather related (tornadoes, hurricanes, hailstorms, drought, coastal erosion), earthquakes, volcanoes, space environmental disturbances; and 2) technological hazards: dam failures, nuclear accidents, fires, and hazardous material events.

The impacts of natural hazards are impressive in terms of cost in lives and resources. From 1993-1996, meteorological disasters cost the U.S. about one quarter billion dollars per week. Earthquakes and hurricanes were the primary causes of the monetary losses. From 1975-1994, more than 6,000 people were killed and 50,000 injured in natural disasters. Mr. Williamson emphasized the importance of having a common set of definitions of risk related terms for use in this forum and follow-on activities. The terms defined included hazard, natural hazard, risk, risk assessment, risk management, and risk mitigation. Mr. Williamson next described the statutes and guidance compliance that covers risk assessments that are 1) not related to natural hazards and 2) related to natural hazards. For the first instance, three Acts were listed for the Environmental Protection Agency (EPA), four for the U.S. Department of Agriculture (USDA), and others for the U.S. Forest Service (USFS), Bureau of Land Management (BLM), U.S. Fish and Wildlife Service and the Department of Defense (DOD). Statutes and guidance compliance for risk assessments related to natural hazards include the Earthquake Hazards Reduction Act of 1977, the Water Resources Development Act, the National Drought Policy Act, the Coastal Zone Management Act of 1972, the Department of the Interior and Associated Agencies Appropriations Act 2001, and Executive order 13151.

Mr. Williamson next described the Forum's overarching issues and challenges that need to be addressed, including examining risk assessment processes and ways to build a consensus to proceed with a national natural hazard assessment. The intent of the Forum is to update the participants on programs and processes that have been implemented or are ready to be implemented; identify promising programs that will need on-going support to reach fruition; and illuminate gaps where neither the government agencies nor the private sector has work planned or in progress. Hopefully, a consensus can be reached leading to coordinated risk assessment and management of natural hazards through legislative proposals, policy guidance, and agency cooperation.

Finally, Mr. Williamson reminded the audience about the mission and coordinating infrastructure of the OFCM. The mission is to ensure the effective use of Federal meteorological resources by leading the systematic coordination of operational weather requirements, services, and supporting research, among the Federal agencies (currently fifteen). The coordinating infrastructure is organized into a Federal committee, an interdepartmental committee, standing committees for various specialized areas, and program councils. OFCM membership and affiliations cover a broad range of weather, atmospheric, climate and technology organizations and associations.

Ms. Margaret Lawless, Chairperson of the Subcommittee for Natural Disaster Reduction (SNDR) and Acting Executive Associate Director for Mitigation, Federal Emergency Management Agency (FEMA)

Remarks. Natural disasters are a global concern. During the 1990's, the global community has seen a paradigm shift in emergency management. While continuing to streamline and improve response and recovery operations, we have increasingly embraced the importance of mitigation as a means of reducing disaster losses.

This Forum is, in fact, a recognition that the foundation of mitigation is risk assessment. The time has come to make a national multi-hazard risk assessment. Through our discussions over the next two days, we will hear about the tools currently available, we will learn what different agencies are currently doing in this area, and we will identify specific actions for how we can come together as the Federal Government to accomplish this critical need. From FEMA, you will hear about our progress with expanding the HAZUS (Hazards U.S.) loss-estimation model to encompass the earthquake, flood, and wind hazards. Incorporating data on: infrastructure, building inventory, geology, damage estimation formulas, and critical operating center locations, HAZUS estimates structural damage and forecasts casualties. You will also hear an update on our flood map modernization efforts, but we have to be mindful that having the tools is not the ultimate goal.

Scientific research, forecasting, modeling, warning systems are only valuable when they are applied and when they are put into practice. With HAZUS, this has already begun. In the last 3-4 years since the HAZUS earthquake module was released, we have already seen widespread use in the public and private sectors. For example, Charles Schwab has used HAZUS for business continuity planning; the State of California has used it to develop its own statewide earthquake risk assessment; and users groups have formed, such as the Bay Area HAZUS Users Group, which brings together nearly 100 public and private sector organizations to focus on planning, coordinating, and disaster response protocols. Their website address is HAZUS.org. Southern California is also in the process of forming a HAZUS Users Group, and Senator Feinstein used the HAZUS earthquake risk assessment in the legislative process to identify the level of risk for particular communities and in proposing financial incentives for earthquake mitigation actions.

Following this focus on implementation, we will hear updates on FEMA's Project Impact initiative and its corollary, Disaster Resistant Universities. From the beginning, in 1997, Project Impact has emphasized the importance of risk assessment as the starting point for creating disaster resistant communities. With its advocacy of an interrelated process incorporating risk assessment, local level involvement, private sector partnerships, and a long-term investment in prevention measures, Project Impact has radically changed how communities, nationwide, approach reducing disaster losses.

Developing a national multi-hazard risk assessment is fundamental to making our Nation safer from disasters. The Congress has also recognized this. In October 2000, Congress passed the Disaster Mitigation Act to amend FEMA's authorizing legislation, the Stafford Act. In addition to authorizing a pre-disaster mitigation program and increasing funding for post-disaster mitigation contingent on pre-disaster planning, Congress has asked FEMA to pilot the generation of multi-hazard advisory maps. These are defined as "maps on which data concerning each type of natural disaster is identified simultaneously for the purpose of showing areas of overlap" in a minimum of 5 states. This is a clear endorsement of the course we have already charted. As we proceed towards a national multi-hazard risk assessment, we must come together to share our

strengths and to leverage each other's work. Congress recognizes the contributions of agencies across the Federal government and used the Disaster Mitigation Act to create an Interagency Task Force to coordinate "the implementation of pre-disaster hazard mitigation programs administered by the Federal Government."

While this particular task force may be new, our working relationships are not. The Office of the Federal Coordinator for Meteorological Services and Supporting Research has, of course, been serving to collaborate across agencies for many years. In addition, the Subcommittee on Natural Disaster Reduction (SNDR) includes membership of nearly 20 agencies, many of which are attending this Forum. Reflecting a greater emphasis on applied research and implementation, the mission of the SNDR has been modified over time to include both developing the necessary scientific information and applicable tools and to focus on applying these tools. Recent activities of the SNDR include a November 2000 report "Effective Disaster Warning Systems," on public and private sector R&D (Research and Development) capability to provide early warning of natural or technological hazards that threaten the safety of the Nation. This has been posted on the CENR and the SNDR web page (see below).

Public-Private Partnership 2000 (PPP-2000) was a series of 14 forums held from September 1997 through 1999 to identify new and innovative opportunities for government and nonprofit, private sector organizations to work together to reduce vulnerability to and losses from natural hazards in communities throughout the Nation. A final draft report has been completed and is in concurrence for publication.

As an outgrowth of PPP-2000, Congress created the Natural Hazards Caucus. Co-chaired by Senator Ted Stevens (R-AK) and Senator John Edwards (D-NC), this Caucus seeks to educate Members and staff about the costs of natural disasters to their districts and states, and the benefits their constituents will realize through greater efforts to understand, prevent, and mitigate natural disasters.

A working group on Remote Sensing Applications, co-chaired by USGS (U.S. Geological Survey) and NOAA/NESDIS (National Environmental Satellite, Data, and Information Service) was established to study how data from current and planned Earth Observation satellites can be employed more effectively to mitigate losses from disasters. This Forum is an excellent opportunity for us to come together as the Federal Government, to move from thought to action and from concept to application, and to make the national multi-hazard risk assessment a reality.

Some reference web sites are: www.HAZUS.org and www.nnic.noaa.gov/CENR/cenr.html

GUEST SPEAKERS
FEMA Success Stories Project Impact

Ms. Maria Vorel, Director, Outreach and Community Support Division, FEMA

Remarks. Project Impact brings risk assessment to a "by the people, for the people" mind-set. Project Impact communities are adding a practical application to risk assessment which in turn is putting pressure on all of us to work together, not only in policy development, but also in developing practical job aides for non-technical community based applications. We at FEMA have been funding the States for decades to conduct hazard identification, vulnerability analysis and risk assessment, but I have not seen risk assessment serve as the backbone of community planning and project prioritization, until Project Impact came along.

Let me tell you a little about what Project Impact is all about. Project Impact is a way to give communities responsibility and ownership for long-term natural hazards risk reduction activities. It allows FEMA a focused delivery mechanism to provide holistic technical assistance to an enthusiastic audience. Project Impact creates public value and demand for sound land use and growth strategies. And although it was designed and implemented to benefit communities, the benefits for FEMA, and potentially all of us, are profound. We began in 1997 with seven pilot communities. Currently we have 250 areas designated Project Impact communities, which represent about 800 jurisdictions.

As a result of FEMA's role in Project Impact, we have learned valuable lessons about risk assessment at the community level. For many of our communities, risk assessment is an elephant to be eaten one bite at a time. As such, partners are needed to help build capacity. But risk assessment plays different roles depending on the community. Generally, it is not a linear process and we do not often see a scientific, highly technical process at the onset.

Two examples I want to share with you highlight the importance of public education and consensus building for using risk assessment in the community setting. Once the community agrees on what the problem is, and where they are most vulnerable, risk assessment can be used to prioritize mitigation projects, to make decisions with respect to economic development and to decide where to leave open space.

Pascagoula, Mississippi, held a Hurricane Awareness Day. There were over 30 exhibits and other awareness activities, including the FEMA Project Impact and Hurricane Awareness displays. One of the top billings was a risk assessment hot air balloon ride over the city, which was an educational ride showing the flood plains and surge prone areas of the city. The success of this exposure was dramatic. By providing an aerial vantage point, citizens could see the interface of development and vulnerable areas and could better understand the need to protect these important, protective land barriers.

We encourage communities to convene large groups of local partners to build support for the nature of the problems to be faced by the community. If mitigation planning is new to the community, sometimes an oral history of disasters in the area is an important educational part of the gathering.

Johnson County, Kansas, held a consensus-building meeting focusing on risk assessment with 40 key local officials and FEMA staff. A representative from the National Weather Service and a local meteorologist also participated. The local FOX station interviewed Thomas Dow,

from the Kansas State Department of Commerce and a representative from FEMA Region VII for the evening news.

I don't want you to leave here thinking that Project Impact communities are all at a rudimentary level of risk assessment. Some are extremely sophisticated and are setting the standards of how to integrate risk analysis into everyday local decision-making and long-term planning. Peer mentoring is also invaluable to us in growing capacity across the board and across the country.

FEMA places a premium on the use of HAZUS and GIS (Geographic Information System) technologies as tools for risk assessment. Hazards US or HAZUS, FEMA's earthquake loss estimation methodology, has been provided to each Project Impact community along with special outreach and training opportunities designed specifically for communities.

FEMA has also created a GIS partnership with the Environmental Sciences Research Institute, Inc (ESRI) and hosts a link from FEMA's website to the ESRI "Know Your Risk" website, which provides hazards information at community level. In 1999 and 2000, ESRI provided free GIS software to every Project Impact community and began sponsoring the Project Impact ESRI Challenge Grant. Recipients are chosen based on the merit of their proposal for developing GIS applications for hazard management. Challenge grants have been awarded to 17 communities in the last 2 years, on the condition that they make templates of their GIS projects available to everyone.

We have also learned that the process of becoming disaster resistant doesn't happen overnight. Tucker and Randolph Counties, West Virginia, stretch for more than 75 miles along the northern fringe of the Allegheny Mountains in eastern West Virginia. With a combined population in 1990 of just over 35,000, the region is predominantly rural, with most settlements restricted to narrow river valleys. The primary concern in this area is flooding. Tucker and Randolph Counties have received presidential disaster declarations as a consequence of flooding five times since 1967. In 1996, several events resulted in a total of $65 million in disaster aid to the communities.

The two counties were jointly named as a pilot Project Impact community in 1997. At the time, there was no clear idea of what to do to become disaster resistant. And while there was no political cohesion, citizen groups and a group of elderly widows knew they needed to change the way they were running their community. In the spring of 1998, the "Spring Break" student community activity for the area was to train college students to use GPS (Global Positioning System) and plot the elevations of homes in some highly vulnerable areas. In July 1999, Tucker-Randolph Counties Partnership hired Woolpert and Associates, LLC to prepare a Risk Assessment study for their community. Also in 1999, the ESRI donated almost $5,000 worth of GIS software and training to the partnership to assist in developing a comprehensive disaster resistant planning tool[1]. In June 2000, the joint county partnership received documentation and GIS discs from Woolpert and Associates comprising the final risk assessment. Over 1,200 structures, that were identified as "at-risk" structures, are being prioritized for mitigation. Once prioritized, the structures will be ranked and funding for the mitigation implementation will be sought. Additional funding to expand the risk assessment has been requested from the Region VII Development Council[2]. At the 2000 Project Impact Summit, Tucker-Randolph was named as one of 13 Project Impact ESRI Challenge Grant recipients. The Tucker-Randolph Steering

[1] Information provided by community as reported in Community Highlights dated July 12, 1999 and stated in the Community Overview.

[2] Information taken from Tucker-Randolph Annual Progress Report dated June 14, 2000.

Committee also decided to add activities to develop their application to the Community Rating System program. They plan to work with the individual municipalities and county commissions to reduce flood insurance premium rates.

To give you another example, the NOAA Coastal Services Center developed a computer-based Risk Assessment Tutorial, for Wilmington, North Carolina, which is now provided to all of our communities as part of our Project Impact Community Tool Kit. Additionally, many of our communities in the Pacific Northwest have been greatly assisted by USGS in their risk assessment efforts.

Finally, we have learned that to be effective Project Impact should not be perceived solely as a function of emergency management. It is more appropriately a consensus based on publicly held value of the community at large, employing a community development implementing process. In observing successful Project Impact communities, features of commonality emerge. While the format, structure and implementation reflect the culture of each community, the following are what appear to be operational components for successful Project Impact communities:

- Strong Local leadership that involves local elected officials and integrates mitigation into institutions of local government;
- A coordinating mechanism including public/private consensus decision making;
- Partnership development that includes all sectors of the community;
- Multi-hazard identification and risk assessment, including adopting a risk reduction plan;
- A public education strategy, plan, and implementation;
- Implementation of projects to reduce risk;
- Strategies for sustaining community participation in disaster resistance;
- Evaluation of goals, strategies, and implementation; and
- Mentoring and networking with other Project Impact communities.

Let me take advantage of this opportunity to ask you to consider how your agency can support our communities. If you have a grant that can be used for hazard identification, risk assessment, or GIS, consider a Project Impact community, where you will get good return on your investment. The benefits to the Federal Government are not only a sound performance outcome, but also useful feedback. Project Impact communities are great places for field-testing and for getting valuable feedback. If this has any interest to you, please get in touch and we would be happy to get the word out to our communities.

FEMA Success Stories: Disaster Resistant Universities

Mr. Brian Cowan, Director, Office of Strategic Initiatives, FEMA

Synopsis: Mr. Cowan discussed the initiative to build Disaster Resistant Universities. He covered an excellent example of a university that has advanced and enhanced its risk management activities under this program. The University of California, Berkeley, has assessed campus structural and (more importantly from a business continuity perspective) non-structural vulnerability to seismic disasters, and made substantial progress in planning for and implementing upgrades to reduce these risks. Universities, and those with vested interest in them, must be concerned about how they prepare for and recover from disasters in a manner that minimizes the effects of the disaster on their business activities. Universities, for example, have over $15 billion in annual Federal funding for research.

Website: www.CED.Berkeley

The Role of Insurance in Hazard Resistant Communities

Dr. Paul R. Kleindorfer, Co-Director, Wharton Risk Management and Decision Processes Center, University of Pennsylvania

Synopsis: Dr. Kleindorfer described the role of insurance in promoting mitigation and encouraging the development of hazard resistant communities. His presentation built on the results of a multi-year project at the Wharton School on financing and mitigation of catastrophic risks, including the key role that insurance plays in this regard. He traced the important trends that have occurred in recent years in insurance markets for catastrophic risks, including the development of better scientific tools for risk quantification and their increasing use by insurers and reinsurers in assessing the portfolios of risk they insure.

Remarks: While insurance can play an important role in signaling the cost of risk from decisions like location, mitigation and structural features of homes and businesses, there are also very important reasons for insurance to be understood as only one ingredient of the public-private partnership necessary to cope with natural hazards. These include reducing the magnitude and uncertainty in these risks through individual and community level mitigation initiatives. In particular, the problems faced by the insurance industry in insuring natural hazard risks will be exacerbated if surge, flooding and coastal erosion damages from climate change should continue or become even more pronounced in the years ahead. A fundamental driver of concern in the insurance industry in the U.S. has been the significant increase in the risks of natural disasters in recent years, straining private insurance markets and creating troublesome problems for disaster-prone areas.

The threat of mega-catastrophes resulting from intense hurricanes or earthquakes striking major population centers has dramatically altered the insurance environment. Estimates of probable maximum losses to insurers from a mega-catastrophe range from $50-$115 billion, depending on the location and intensity of the event. Under current conditions, many insurers could become insolvent or financially impaired if a mega-catastrophe occurred, with rippling effects throughout insurance markets and the economy. Increased catastrophe risk poses difficult

challenges for insurers, reinsurers, property owners, and public officials.

The fundamental dilemma concerns insurers' ability to finance low-probability, high-consequence (LPHC) events. LPHC events generate a host of interrelated issues with respect to how the risk of such events are managed, financed, and priced. Insurers have sought to raise their prices and decrease their exposure to catastrophe losses, while looking for efficient ways to diversify their exposure through reinsurance and securitization.

Research at the Wharton school focuses on the effects of these various strategies on actual coverage offered and prices charged in the Florida market. This research represents the first significant attempt to examine the nature of the natural disaster insurance market at a detailed, micro-economic level. Such an examination is made possible by the unprecedented assembly of an extensive, detailed database on residential insurance transactions affected by catastrophe risk. These data are supplemented by information on insurer financial and organizational characteristics and the demographics of residential households at a zip code level. This contributes to previous research by exploring several significant aspects of residential insurance markets in areas threatened by natural disasters.

An initial analysis identifies the key determinants of the demand for residential/catastrophe insurance and their effects on the quantity, quality, and price of insurance purchased. Among the factors are the sensitivity of demand and supply to prices, policy features, and the bundling/unbundling of perils and coverages. In particular, the insurers are sensitive in their pricing to key aspects of location and mitigation, both at the level of individual structures and at the level of the community. This has obvious and important implications for the interaction of initiatives to promote hazard resistant communities through a partnership with the insurance industry and the risk science that underlies it.

Website: www.grace.wharton.upenn.edu\risk\

INTERACTIVE TOOLS, POSTER PAPERS AND DISPLAYS SESSION

Introduction

Dr. Stuart Nishenko, Earthquake Policy Advisor, Mitigation Directorate and FEMA Forum Coordinator

The introduction of Geographic Information Systems (GIS) has ushered in a new era of emergency management. This session presents three talks that highlight some of the recent advances in disaster information technology and a number of poster papers and displays that discuss the application of these technologies to risk management and disaster reduction. (See Appendix B for a copy of their presentations.)

Global Disaster Information Network (GDIN)

Mr. Joe Szwarckop, Director, GDIN Committee Support Office

Synopsis. Mr. Szwarckop stated that the GDIN challenge is to deliver the right information in the right format to the right person at the right time to make a right decision, which leads to the need to address problems associated with accessibility to disaster information. He said that emergency managers require interactive access to situation information in a spatial context (map-based) and coordinated tracking of the changing conditions and management actions. This last one has to be a part of the information management structure and should be at multiple levels such as regional/state, county/local, and interstate levels. He stated that the GDIN vision is to have a robust, integrated virtual network for cooperative exchange of timely, relevant information during all phases of a disaster. This virtual network would include multiple sources of knowledge, integration of standards and protocols, multiple types of connectivity, and multiple participants.

Mr. Szwarckop stressed that GDIN's "value added" would be integration of information for decision making, certification of the accuracy and quality of information and standardization for compatibility of information products. He next provided background information on the Executive Order issued on April 27, 2000 that began a Federal initiative to establish an Interagency Coordination Committee (ICC) on disaster information. The ICC is to provide coordination of Federal agency efforts, provide manpower and material support for network development activities, and develop, delegate, and monitor interagency opportunities and ideas supporting the development of the network. The ICC mission is to enhance access to and use of relevant disaster information resources worldwide. An example given was the use of risk analysis and consequence analysis affecting land use decisions. He also described the use of 3-dimension models for visual representation of disaster information and noted upcoming international coordination meetings.

Open Geographic Information System (GIS) Consortium (OGC): Benefits of Spatial Interoperability

Mr. Mark Reichardt, OGC

Synopsis. Mr. Reichardt first described the vision and mission of OGC. The OGC vision is the complete integration of geospatial data and geoprocessing resources into mainstream computing. The mission is to develop the interface specifications needed to achieve the vision. Such interfaces should be based on field standards, be affordable, and provide rapid technology test-beds. The interfaces will help to translate and fuse data and provide guidance for applying data from multi-sources to facilitate decision-making. OGC encourages the fielding of standards-based Commercial off the Shelf products and services to consumers at a reasonable cost.

Mr. Reichardt next covered the approach taken by OGC to accomplish the vision and mission. OGC uses a global, non-profit, and consensus based process, which has over 200 members from industry, government, academia. They collaborate to develop interface specifications that make geospatial data and processes an integral part of the process. This specification program develops implementation level spatial technology specifications for open access and use. The interoperability program is an innovative, hands-on engineering and test environment designed to deliver proven standards for finalization through the specifications program. OGC also coordinates with the international and commercial standards organizations to focus the agenda for spatial technology interoperability. OGC's vision is to have an open web service which would provide easier access to multiple online information sources and services, use and reuse different vendor solutions, reduce deployment costs by reusing information from other communities, and provide tools to provide custom information to users.

Results from the 2000 interoperability program include accessibility to critical information and establishment of geospatial fusion services. Critical information can be obtained from an update web map server with symbolism controlled by the client. The web site has feature and coverage servers, GML and Imagery Markup Annotation Language based extensions of XML, integration of access control security, and geospatial fusion operators. Geospatial fusion services provides: OGC based applications which can be employed on intelligence problems; cooperating analysts who can discover, access, register, correlate, analyze, and store related multi-source information; and collections of information which can be captured and shared through the Location Organizer Folders (LOFs). OGC plans to improve capabilities in 2001 by initiating the third phase of web mapping, the Inter-Community Enablement Phase 1, the Geoanalysis & Decision Support Phase 1, and the open location services test bed.

In summary OGC brings to the table interfaces to support interoperable, component-based products. Mr. Reichardt recommended the participation in OGC interoperability initiatives, inclusion of international and commercial standards and specification conformance requirements in procurement, serving your data via OGC-based server products, and participation in the OGC standards development and special interest groups.

Website: www.opengis.org

Center for Integration of Natural Disaster Information (CINDI)

Ms. Susan C. Clark, Research and Communications Coordinator, Center for Integration of Natural Disaster Information (CINDI), U.S. Geological Survey (USGS)

Synopsis. Ms. Clark stated that CINDI was established to help fill the need for a single source of the broad range of information needed for natural disaster reduction and to help integrate information from diverse sources. The mission of CINDI is to serve as a research and operational facility that explores methods for collecting, integrating and communicating information about the risks posed by natural hazards and the effects of natural disasters. Through CINDI, USGS seeks to broaden, integrate, and promote collaboration of universities' and agencies' understanding of physics, geology, hydrology, biology, and cartography. The facility is the USGS focal point for data integration for hazardous events, provides real-time operational hazards coverage, provides data collection and integration software, and is developing an enhanced communication infrastructure for long-term data vital to both emergency response and analysis of hazard risks. These allow CINDI to analyze multiple themes of the data and to support applied hazards research by allowing assessment and integration of key multi-disciplinary data sets, construction of predictive models and decision support systems, and application of intuitive data visualization techniques. During 2000, CINDI's hazards research included development of flood extent and visualization models, an integrated information management system for the West Nile Virus, a hazard information seamless deliver and distributed data system for the Red River system, and web-based software to develop estimates of population density. CINDI has participated in recent outreach activities, such as the USGS Natural Hazards Workshop, the National Disaster Education Coalition, the Natural Hazards Speaker Series, and the USGS open house on April 28, 2001. On-going efforts in hazard data infrastructure development are focused on providing basic information tools; acquisition of new data, damage and risk assessment models; data integration and delivery of products and data; and capacity building. In addition, CINDI is collaborating with other agencies on the following projects:

- Coastal Hazards Risk Atlas (NOAA, FEMA, and USGS)
- Climatologic Integration (NOAA/Forecast System Lab and USGS/CINDI)
- International Imager Node (Office of Foreign Disaster Assistance and USGS/CINDI)

Website: cindi.usgs.gov

List of Poster Papers and Displays.

The following groups provided papers and displays concerning risk management in the conference room for viewing and for discussion with the authors during breaks.

Baker, Inc: Ms. Kathryn Field: *Staying Afloat--A GIS-Based Communications Floodplain Management Tool*
Ms. Jane Huzil: *Past, Present, and Future - Hazards U.S. (HAZUS), GIS-Based Loss Estimation Software*

Mr. Edward Mifflin: *A Risk Analysis of Exposure to Natural Hazards in the U.S.*

Federal Emergency Management Agency (2 displays)**:**
HAZards U.S. (HAZUS)
FEMA Flood Map Modernization Program

Centers for Disease Control and Prevention: Dr. Josephine Malilay, Team Leader for Disaster Epidemiology and Assessment, National Center for Environmental Health, *Estimating Health Risks from Natural Hazards Using Risk Assessment and Epidemiology*

National Academy of Sciences (book display)

U.S. Geological Survey: Mr. John Sutter, *Forecasting Geohazards Vulnerability in the Tri-State Region of Indiana, Kentucky, and Illinois*

University of DC: Dr. Mark Siegal, *Multihazard vulnerability assessment in the greater Evansville, IN (Tri-state) region: R&D tools for communication with non-geoscientists*

Oak Ridge National Laboratory/Department of Energy (DOE):
Dr. John Sorensen and Dr. Barbara Vogt, *Risk Assessments of Environmental Hazards*

Cooperative Institute for Research in the Atmosphere (CIRA), Colorado State University: Dr. Chris Adams, Research Scientist: *Colorado State University Flash Flood Laboratory*

LUNCHEON ADDRESSES

Summary of Previous Studies/Reports Related to Risk Management of Natural Hazards and their Recommendations.

Dr. Dennis Mileti, Director of the Natural Hazard Research and Applications Information Center, University of Colorado

Remarks. In 1991, we had just started the International Decade of Natural Disaster Reduction. Beginning in 1989, our Nation had just entered a period where some of the largest catastrophes had begun to befall us. Terms like disaster resilience, local responsibility, and disaster resistance were largely unknown. There was no mitigation director at FEMA. Federal agency cooperation and coordination focused largely on the Federal Response Plan. Many of us were playing zero sum games and bickering over who got the National Earthquake Engineering Center. Wind engineers didn't have a national program. Billions were spent in preparing to respond to broken nuclear power plants, but we were ignoring and not preparing for hazards that were giving us losses annually.

Furthermore, university-based disciplines were and still are self-referential systems, interested in furthering the limited boundaries of knowledge in one discipline at a time. The problem of disasters ten years ago was getting worse and the big disasters were getting worse. The "chaos theory" was popular and supported the idea that the future was not predictable.

In 1991, a few of our Nation's intellectual elite got an idea and provided strong national leadership. Eventually, these men and women served on the SNDR and made me come up with a new theory of the structure of American government. At the top of the pyramid are a few of the political appointees who rotate in and out. At the bottom of the pyramid is everyone who goes to work in the morning with the goal of not being noticed. In a thin layer of the pyramid are the men and women who have the owner's manual of how our government works. They ended up serving on the SNDR. One of their delegates asked me to conduct a second national assessment on natural hazards. She cited the need to link hazards mitigation, preparedness, and response to sustainable development.

Recently, three major works were completed. One is the Assessment of Natural Hazards and Disasters, another is the National Research Council's 1999 book titled, "Impacts of Natural Disasters; a Framework for Loss Estimation," and a third is the Heinz Center's book, "The Hidden Costs of Natural Hazards; Implications for Risk Assessment." These three very different documents vary greatly in detail but carry the same message.

Regarding loss data, they say that we as a nation don't know what hazards cost us. We don't count everything that should be counted nor do we count consistently. In addition, data are not available to those who should have access to it. There is no arrangement in place for the centralization and standardization of data. Regarding risk information, we don't know what risks we face. We don't know how global processes impact risks to local communities. When future losses happen, we won't know the relationship of factors that made them happen. We don't know the shape of the dependent and independent variables or the relationships between them. We view all mitigation programs as good but we don't evaluate them or know if they work.

It is time for this Nation to conduct a national risk assessment, but only if we do it in a way that is useful for local decision makers. It should be customer-oriented, understandable, interdisciplinary, and multi-planed. It should merge the natural and physical sciences, the constructed environment and engineering, and the social and economic sciences, for it is those

three systems that determine risk. We are becoming more vulnerable because of changes in who we are. An assessment should be forward looking. It should draw in resources from places and agencies that already exist, such as from NASA (National Aeronautics and Space Administration) and USGS. It should not be disciplinary or agency specific. For if it were, it would become a self-referential system. The product should be marketable and useful.

As a next step, we need, as a nation, to start counting losses appropriately. We need to begin the ongoing, never-ending process of national risk assessment that informs decision-making at the local level.

Ten years later I am happy to say that the assessment of research on natural hazards is complete; the ball is back in your court!

Media and Disasters: Why we are not the enemy.

Mr. Daniel Dubno, Producer and Technologist, CBS News Special Events

Introduction. Showing a 1 meter satellite picture of Washington, D.C. and then zooming to the White House and the meeting hotel, Mr. Dubno described the 1 meter imagery with 4 meter color overlaid on it. He also showed the India earthquake site, indicating that the image was requested on Friday and received the same day. The image showed a mostly flattened city. He said this technology was unthinkable three or four years ago, and where we are headed is quite extraordinary. Then he showed a Russian spy satellite image of Washington D.C. Earlier in the day, he took a picture of the White House. On this camera, he had a GPS device that imbedded the coordinates on the image and creates a web site which goes out and fetches maps to go with the photograph. He said that geo-referenced data has easy consumer applications and especially for disaster related work.

Remarks. At CBS News, I spend a lot of time thinking about how to cover disasters more effectively. That is because new powerful technologies allow us do this. The media's relationship with disaster managers requires some new thinking, as new technologies change our relationship. Our relationship must improve as technology does. Managers and the media have similar responses. They have to understand the crisis, they have to manage the response, they have to dedicate resources, they have to inform the public responsibly, and they have to illustrate the event and response. Even the responders hear about the disaster first from press reports. We convey your message, we help you save lives, that is not meant to be arrogant.

There have been times that managers have been at odds with the press because you need to control the situation and we need to question the situation. However, it is your job to direct the public out of danger and our job to follow your lead. It is very important for you to feel very confident about this. Liability dictates that we not misinform the public. If you manage an incident well but are arrogant and keep people in the dark, you will have a failure. If you manage an incident less well but work closely with us, you will be considered a success.

Disaster managers are getting wiser, it is clear that people are providing more data, imagery and graphics, all things that are critical to help us help you. What does the media need? Raw imagery and data are increasingly important for the media to tell the story. Data should be relevant, accurate, useful, timely, free, unfettered, and interoperable. We are not interested in getting processed stuff from you as much as editorial input on how we can tell your story better. Even with your great web site, you still need the press to help tell your story better and put your info into context, which is the way the public expects to receive its information.

Powerful graphics technology is letting us explain your story more clearly to the viewers and show how an event may affect them. We need to get GOES (Geostationary Operational Environmental Satellite) and POES (Polar-orbiting Operational Environmental Satellite) data integrated with other data so we can tell your story more effectively. I want to show you a tape now showing new ways we are using technology. Examples include: India testing bombs; Iraqi conflict; and environment disasters associated with El Nino. With the successful launch of the space imagery satellite, we have 1 meter images to use with news stories (shows images of Pakistani nuclear reactor; Mt. Washington; Space Shuttle Endeavor data set, and radar topography data with 30 meter resolution, showing elevation of the earth for flood mapping). NASA and NIMA (National Imagery and Mapping Agency) are not in agreement, yet imagery will be released (shows images of Mt. Everest, Camp 4 plus animation, fictional Mt. Everest 2,

3-dimensional image of Washington D.C., and NOAA light data showing electric power outages and recovery times). Media is becoming more sophisticated in using imagery in telling your story better.

What does all this mean for news? This kind of imagery opens up denied areas when nature and governments say no. It allows before and after comparisons to inform the public. This imagery is obtained of the India earthquake and Oklahoma tornadoes, and the series of fires in Colorado. The imagery is NOAA GOES 1 minute imagery, as depicted by NASA software, of a hurricane as it moves. The government is committed to enhancing 1 meter commercial remote sensing but has also signed agreements with two companies to provide ½ meter satellites (images) in about 4 years. Many countries have said they will provide competitive commercial remote sensing. So either we do it or they will do it.

To conclude, data liberation and integration is going to happen. Only the acronyms will change. We have been introduced to HAZUS and we would like the ability to get useful SLOSH (storm surge model) models. Together, we need disaster managers to integrate the press in their planning and response. Direct data conduits to the press need to be established. Web applications to provide customized warnings to the public are inevitable, such as web-based NOAA weather radio. We need to work better to integrate imagery and GIS, and develop a wonderful global base map that can be shared with the disaster mangers and the media to tell your stories in powerful graphic ways. You have to get your data sets out to us (media).

Please visit my website for more information, and hopefully, someone will improve on it and make it obsolete. The press serves an integral role in performing our core mission of informing the public on life threatening events.

Websites: www.disasterlinks.net and www.gizmorama.com

BREAKOUT SESSIONS

Breakout Session 1. Process of Conducting Risk Assessments

Session 1A: Characterize/Quantify Exposure

Moderator: Mr. Michael Buckley, Director, Technical Services Division, Mitigation Directorate, FEMA
Rapporteur: Dr. Timothy Cohn, Theme Coordinator for Hazards, USGS National Center

Questions Considered.

1) Are there better ways to characterize the exposure to known natural hazards that will be useful for a variety of audiences (public, media, state and local government, and federal government)?
2) Are there indicators of natural disaster vulnerability similar to economic indicators that can be used for this purpose?
3) Should the presentation of the information be as risk hazard maps in GIS Spatial Representation?

Synopsis. This breakout session focused on trying to characterize or quantify exposure. There was a good mix of people from various disciplines including engineers, scientists, planners, a physician, and a philosopher, even someone with a background in English. The discussion began with defining the meaning of terms, including vulnerability, exposure, and risk, among others. Participants found that there was a lot of confusion, there was no common terminology, and single term definitions were difficult. The terms vulnerability, exposure and risk relate to space and time relationships such as a person or building that may not be vulnerable at any one time. The group went through a discussion of examples. One was on the risk of heart attacks where factors such as weight, blood pressure, and diet are important. How does one compare that to school violence where the risk at schools is not high but receives a lot of attention? When does risk become critical in the vulnerability characterization of a situation? When a machete is being swung in school, students are more vulnerable. There needs to be a clarification of terms in ordinary language, and a number of audiences must be involved such as engineers, planners, businesses, government, and medics. Are there indicators of exposure that relate to economic indicators? All of these elements point to the inconsistencies in language and vocabulary with respect to hazards, disciplines, cultural backgrounds, and socio-economic class.

Accessibility of data is another problem area. Not all data are accessible. In order to understand risk, vulnerability and exposure, one must have data. There is a need for the loss history of flood insurance claims to show where there have been repetitive losses. Data are needed on the number of variances issued by local governments for buildings that do not comply with flood plain management (people building on beaches). Some felt that FEMA is not communicating well regarding the need for detailed data to understand risk in a community. FEMA does not supply detailed inventories of data in communities—that is the responsibility of the state and local levels. As a result, the need to collect detailed data was felt to be not well communicated.

There was also a discussion of HAZUS. Is it the right tool? There was a sense of concern about HAZUS in that there is variability in results in its use, thus the results may not be reliable. Mr. Buckley also recommended that the audience review the FEMA strategic plan, a copy of which was available at the exhibit table.

Recommendations.

- Develop a consistent standard language for communicating exposures to risk with respect to:
  - Hazards (floods vs volcanoes)
  - Discipline
  - Cultural background
  - Socio-economic class

- Improve detailed data accessibility through better communication of need for the data to improve understanding of a community's risk.

- Resolve issues on financial accounting:
  - Agreement on units
  - Agreement on definition of terms
  - Across cultures and socio-economic groups

Session 1B: Predict/Forecast Probability of Occurrence

Moderator: Dr. David Cleaves, National Program Leader, Fire Systems Research, Research and Development, Vegetation Management and Protection Research, USDA Forest Service
Rapporteur: Dr. Rachelle D. Hollander, Program Director, Societal Dimensions of Engineering, Science, and Technology Program, Ethics and Values studies, Research on Science and Technology, National Science Foundation

Questions Considered.

1) Do we need to expand use of the existing models, create new models, and/or better integrate models?

2) What criteria are needed for evaluating existing models? For example:
- \+ Limitations/assumptions
- \+ Standard comparable results
- \+ Design criteria and language for standards
- \+ How to improve quality of assessment

3) Are there better ways to use the results of these models in our risk assessments?

4) How do we improve/develop the coordination loop between research and operations to ensure innovative capabilities and technology quickly transition into operational use?

Synopsis. This group discussed problems and issues for the development and operational use of predictive or probabilistic models for risk assessment. Participants focused on questions concerning the probability of phenomena that create hazards in relationship to risk assessment. They agreed that there are difficulties in assessment, prediction, and forecasting for risk assessment purposes. In considering what SNDR could do to promote multi-hazard risk assessment at the national level, they classified their recommendations into four areas: foundational issues, applications issues, technical quality, and communications. Foundational issues included responding to questions like, "Why do this and what do you tell people about?" In addition, each agency has its own risk focus or foci. Applications issues concerned the technical components and communication of probabilities. There are many different users with different needs, many of which are not documented. In the technical quality area, more research is needed to help describe how low probability/high consequence events affect the public's mitigation desires and actions. Probability is a concept and skill that most people have problems with understanding, many cannot handle statistical concepts or factor probabilities into their decisions effectively.

Recommendations.

- Foundational issues:
  - Develop an organizing framework and terms.
  - Clarify assumptions underlying the forecasting mission.

- Applications:
  - Develop a user list and model specifications for each group.
  - Develop a set of guidelines for customizing forecasts.

- Technical quality:
  - Foster research into low probability/high consequence events.
  - Characterize comparisons and interactions among hazard processes.
  - Foster research into measuring or evaluating mitigation effects on low probability/high consequence events.

- Develop methods for two-way communication/education about event uncertainties.

Session 1C: Estimating Losses

Moderator: Dr. Christopher Adams, Research Scientist, Cooperative Institute for Research in the Atmosphere (CIRA), Colorado State University
Rapporteur: Mr. Floyd Hauth, OFCM Staff (STC)

Questions Considered.

1) What new or improved tools or techniques are available to characterize or evaluate alternative risk assessments for natural hazards? What criteria should be used in such assessments?

2) Should an assessment be conducted for each hazard, each part of society, or for specific economic impacts/benefits? Or is an integrated assessment more useful? For example: Societal, built environment, economic/business, and infrastructure losses could be associated with each natural hazard or with multiple hazards for a specified location.

3) What types of economic considerations and consequences should be considered in an assessment of economic losses? For example: Potential losses (or savings) from a home or business being destroyed/severely damaged vice potential costs of repairing a home/business that is less damaged and able to be quickly rebuilt.

4) What role does community development and rebuilding policies and regulations serve in the assessment process?

5) What improvements are needed in tools to better assess the costs, benefits, effectiveness, priorities, and consequences of alternative risk assessment policies and strategies?

Synopsis. Session participants represented government agencies and non-government organizations such as insurance and academia (research). In general, the participants agreed that a full range of direct and indirect loss data is needed to serve the various organizations that are involved with responding to natural hazards/disasters. Concerns were expressed about the availability of data, the quality or completeness/comprehensiveness of data, and the sharing of data among agencies or organizations that prepare for and respond to natural hazards/disasters. Several participants emphasized the importance of building capabilities that would be useful for those who initiate responses at the local levels of government. Others noted that it is often the case that emergency response team members don't know what data may already be available or is being collected, or whether it is archived and available for sharing (depending on the proprietary nature of the information).

Loss-estimate models are often designed to serve specific needs of an agency or organization or to serve a specific function. In many cases, the output of the models is difficult to compare with other models because of the unique nature of some data and assumptions used in the design of the model. Further, research results on modeling and its applications are not readily available or well publicized leading to some duplication of effort and possibly wasted resources.

Leveraging research results might facilitate earlier solutions and more efficient/effective use of models.

Participants agreed that data collection would benefit from building on some of the current initiatives such as Project Impact. Templates could be provided to the 250 communities involved in this program for use in collecting additional or more complete data, including improved spatial coverage, if needed. There are many working groups in place that could assist with refining the data collection, archival, and distribution activities. It was also suggested that funding and other incentives may be needed to gather more or better information in some regions or areas. Proposed Federal legislation hold some promise for future improvements in both data collection and in research.

Recommendations.

- Define, standardize, collect, and make information available:
  - small steps
  - know what is currently available
  - improving the spatial component
  - leveraging current working groups;

- Address compatibility of loss-estimate models by addressing data sharing problems:
  - provide incentives for data sharing among federal, state and private sector
  - tie funding for projects to data sharing;

- Build capabilities for use by local governments;

- Leverage current programs (such as Project Impact) to gather more data (provide template for use by communities to collect more/better data);

- Review and publicize current federally-sponsored risk assessment and management research; and

- Promoting data collection as part of mitigation plans required by Stafford Act.

Breakout Session 2. Risk Management Discussions: Ramifications for Risk Assessment and Decision Making for Natural Hazards

Session 2A: How to characterize and reconcile the tradeoffs implicit in making risk management decisions?

Moderator: Dr. John Sorensen, Director, Emergency Management Program, Oak Ridge National Laboratory (DOE)
Rapporteur: Col (sel) David A. Smarsh (USAF), PhD, Deputy to NOAA for Federal and National Programs

Questions Considered.

1) What new or improved tools or techniques are available to characterize or evaluate alternative risk assessments for natural hazards? What criteria should be used in such assessments?

2) Should an assessment be conducted for each hazard, each part of society, or for specific economic impacts/benefits? Or is an integrated assessment more useful? For example: Societal, built environment, economic/business, and infrastructure losses could be associated with each natural hazard or with multiple hazards for a specified location.

3) What types of economic considerations and consequences should be considered in an assessment of economic losses? For example: Potential losses (or savings) from a home or business being destroyed/severely damaged vice potential costs of repairing a home/business that is less damaged and able to be quickly rebuilt.

4) What role does community development and rebuilding policies and regulations serve in the assessment process?

5) What improvements are needed in tools to better assess the costs, benefits, effectiveness, priorities, and consequences of alternative risk assessment policies and strategies?

Synopsis. Twelve people attended the session concerning tradeoffs in making risk management decisions. A basic question that was addressed at the beginning by the moderator was "What is a trade-off?" The classical definition is two-fold: a balancing of factors all of which are not attainable at the same time and giving up one thing in return for another. The group noted that the following issues make the explicit process of making risk management decisions somewhat difficult: identifying all relevant factors that may be relevant to a decision, characterizing all relevant factors that may be vying for attention, and comparing those factors. It was noted that a number of factors clouded these questions. First is the timeframe of the decision. One may make very different decisions about managing the risk of a hazard in a 100-year timeframe as opposed to a 4-year frame. The geographic scale is the second factor. Global change may be

managed at a regional level, whereas floods may require management at a household level. Third is the distribution of costs and benefits. Releases of hazardous materials caused by flooding may have disproportional impacts on low income or minority households. The choice of alternatives to consider in risk management is the fourth factor. Until recently many mitigation options for reducing losses were not politically feasible. Finally, uncertainties make quantifying the tradeoffs difficult. For example, historical rainfall records may not be represented by a single probability distribution. Four major themes captured most of the session's discussions: status of risk assessment models, role of formal methods and models, how to conduct a national assessment, and when to conduct a national assessment.

Status of Risk Assessment Models. A central concern of the discussion group was the ability of risk assessment models to support decision making about investing in hazard reduction. It was noted that the nature of formal models differed greatly among hazards. Some models are primarily stochastic, while others are deterministic. This makes comparisons very challenging and perhaps misleading. In addition, uncertainties will vary markedly between models, further confounding the comparison issue. A second concern was model validation. There is no standard method to validate a model. How does one validate the results of a model? A variety of methods are used in science for validation of results. It was suggested that standardization is needed in order to compare model results. A third concern raised was that the scientific community does not even know what models exist and at what stage of development they are. Furthermore, the appropriate uses of alternative models is not really clear.

Role of Formal Methods/Models. A second point concerned whether or not formal models are needed for risk management. Considerable discussion ensued that centered on HAZUS. Some felt that formal models are necessary for good risk management. Others suggested that the process is more important and risk management decisions must be negotiated, as models cannot fully incorporate values and other non-comensurables. A related theme was the usefulness of formal models to state and local government. At present, there is a very poor understanding of how any model is used in risk management decision making. Moreover, the costs of obtaining data to use in the models (such as HAZUS) may restrict the use of the models. It was also noted that institutional barriers limited the use of models. Some politicians simply refuse to believe the results of models when they are non-intuitive or challenge a political position. Finally, the ability of models to capture non-quantifiable dimensions of risk tradeoffs was discussed. It is likely that formal methods will never satisfy critics over the difficult issues of valuing human life or making explicit changes in the quality of human life.

How to Conduct a National Assessment. A major issue, on risk management decision making, concerned scale and approach. On the one hand, the group concluded this was relevant to conducting a national risk assessment of natural hazards. It was suggested that the National Climate Change Impact Assessment might provide a useful model. On the other hand, it was noted what was meaningful for the nation may not be relevant for the neighborhood or the community. This argues for a different approach to risk management that begins with assessments at the local level.

When to Conduct a National Assessment. The final issue concerned when to conduct an assessment. Some argued that the current state of modeling precluded timely assessment and that it was premature to assess risks due to both model and data limitations. It may be a decade before adequate tools and data make an assessment worth conducting. A second and less vocal position was to conduct an assessment now. This would be valuable in identifying limitations and setting priorities for data collection or model development.

Recommendations.

- Establish a subcommittee to identify and assess the potential uses of risk assessment models for hazard management which would:
  - examine the data inputs needed to use the model and the information that is produced by the model,
  - assess the usefulness to risk management, and
  - develop validation guidelines;

- Develop a mechanism for disseminating information on local experiences with hazard risk management experiences;

- Work at both scales (global and local) at the same time by conducting a national assessment while conducting a carefully chosen set of localized assessments; and

- Conduct a relative risk assessment on a hazard by hazard basis to prioritize risk management policies.

Session 2B. How do we improve and/or change policies (private or government) regarding risk management to reduce the effects of natural disasters?

Moderator: Dr. Ben Wisner, Environmental Studies Program, Vice-chair, IGU Commission on Hazards and Risks and Vice-chair, Earthquakes and Megacities Initiative, Oberlin College
Rapporteur: Dr. Paula Davidson, Science Plans Branch, Office of Science and Technology, National Weather Service, NOAA

Questions Considered.

1) What are the roles of private industry and government? How do we enlist the support of interest groups; e.g., insurance industry, business development, and humanitarian groups?

2) Are there the necessary baseline vulnerability studies that could provide a measure of our success in decreasing risk? If not, what are the procedures necessary to complete them?

3) How do we improve program and budget coordination among federal and state agencies and non-government organizations? How do we factor-in risk assessment in agency budget requests?

4) Where should the U.S. be in 10 years in the use of risk management for mitigation of natural hazards? Is a national natural hazards risk assessment(s) part of this future?

Synopsis. The group began by identifying some long term value shifts necessary to underpin and provide the political saliency necessary for policy changes. These include: mainstreaming disaster risk reduction into routine planning, elevation of the importance of comprehensive planning, and development of a consistent "culture of prevention." With notable exceptions, all three are largely missing in U.S. popular and political culture, especially at the local level.

In the spirit of a prologue, the group also acknowledged an interplay between "top down" policy changes and the demand for change that comes through the political process and marketplace from "the bottom up." Considerable time was spent identifying bottlenecks to effective planning, hence mitigation of hazard impacts, at local level. It was noted that most important land use and development decisions in this country are highly localized. At local level, the influence of groups, that benefit from even unwise land use decisions in the short run, is very strong. Much of the consideration of land use proposals is done by untrained volunteers. An example of how a political action may help promote mitigation is in the revision of the Stafford Act. It allows states to be reimbursed at a higher percentage of disaster recovery costs if the state has a comprehensive mitigation plan.

The group also discussed two more general changes necessary at the Federal level. The group felt that setting a good example by ensuring that all Federal property is disaster resistant and land use incorporates hazard mitigation and sustainability (e.g. some DOD housing is not disaster resistant) was important. One positive example mentioned was how, in the aftermath of the 1971 San Fernando Valley earthquake in California, all VA hospitals were inspected and made disaster resistant. Also necessary is to build greater appreciation of the perspective of business in matters of risk management on the part of government, and vice versa. Business and government need to understand one another's perspectives better.

Virtually all of the group's recommendations implied, in one way or another, the importance of full cost accounting of disaster losses. At the moment, not even all economic costs are accounted, let alone non-economic costs such as health effects, psychological impacts, and social consequences. Full cost accounting would be an important tool in motivating localities, businesses, and other entities and jurisdictions to invest in mitigation. It was noted that, even though some costs of disaster are not quantifiable, they are real and should be included and taken seriously (e.g. some social and psychological costs). Better assessment of the baseline situation as regards community economic development, health, and social integrity at the local level would also help assess total costs of natural hazard impacts.

Recommendations.

- Encourage government development of incentives for comprehensive planning at local level;
- Develop all-hazard insurance by government and/or private industry;
- Encourage enforcement of building codes;
- Improve data availability (especially private sector insurance data, possibly in a pooled form) for planning;
- Improve knowledge and information dissemination to the local level (for example the use of scenarios);
- Set a good example by ensuring that all Federal property is disaster resistant and land use incorporates hazard mitigation and sustainability (e.g. some DOD housing is not disaster resistant); and
- Build greater appreciation of the perspective of business in matters of risk management (business and government).

Session 2C. Risk Management and Public Perception of Vulnerabilities: How do we build the public's awareness of risks and their vulnerabilities so that mitigation efforts will provide the maximum benefits?

Moderator: Dr. Betty Hearn Morrow, Director, Lab for Social and Behavioral Research, International Hurricane Center, and Professor, Department of Sociology and Anthropology, Florida International University
Rapporteur: Ms. Kathleen Gohn, U.S. Geological Survey

Questions Considered.

1) How can mitigation and response decisions be improved?

2) What methods would best communicate risks to the public?

3) What roles do the public and private sectors have in user outreach and education regarding risk management?

4) Does user outreach and education have an impact on the effectiveness of risk management? How do we use outreach and education to change cultural values?

Synopsis. The group discussed the general problem of achieving accurate public perception of risk, and the corollary, encouraging the acceptance of responsibility by individuals. Key points from the discussion include the following: communicating about risk, understanding of

probabilities, behavior in high stress situations, and goals and information needs.

Communication about risk requires knowing the audience, which includes determining what audience you wish most to communicate with. The public is not homogeneous; people have different backgrounds, perceptions, circumstances, and priorities. Any attempt to communicate with the public must reflect this diversity. Minorities, including ethnic populations, the elderly, and poorer segments of society, are especially at risk of being overlooked. Radio is a generally underused resource for communication, and is particularly valuable for reaching minority communities. In general, public television and radio are seen as reliable sources of unbiased information.

There is a general assumption that people don't understand low probability/high consequence events. This assumption may be untrue. They may well understand the probabilities, but have more urgent concerns, such as feeding or clothing themselves or their children. Perhaps there is inadequate understanding of the consequences. Financial constraints are not the only reason for making bad decisions. Vacation homes built on the coast are a decision that may impose burdens on the community. Even if the home is adequately insured, the community must pay to replace infrastructure, such as roads, when a coastal storm strikes.

There was an extended and unresolved discussion of whether people behave rationally or irrationally in high-stress situations. Clearly, the way an issue is framed will shape the response. What an observer perceives as an irrational decision may result from a rational assessment of information that the observer fails to recognize. This discussion re-emphasized the importance of
knowing the audience's value systems and perceptions, which is critical to successful communication.

Some choices put individuals at risk; others put communities at risk. Similarly, there are two different goals of safety messages: to take personal action (such as fastening a seat belt and building a tornado safe room) and to support larger community actions (such as building codes and land use planning). Choices must be made about for whom and for what purpose one does mitigation, because resources are limited. We need better information on the effectiveness of various mitigation attempts and techniques and we need to celebrate successes.

Many cultural changes occurred in the past decades, attitudes toward seat belts, smoking, and motorcycle and bicycle helmets, for example. These changes in attitude took a long time, and many different approaches were used to reach different key audiences. A similar long-term multi-faceted effort will be needed to change public attitudes about natural disasters.

Recommendations for government and private sector roles.

- Land-use planning and other activities (helping spark awareness of hazards issues), for which benefits are long term, should continue to be the responsibility of government.

- Mitigating hazards, that may directly affect a business and educating their employees, should be the responsibility of companies. Charles Schwab, for example, has put significant effort into helping employees prepare their homes and communities for potential natural hazards.

- Partnerships between government and the private sector, like those in FEMA's Project Impact, are an excellent way to leverage resources and involve the community.

- Education of the private sector as to the value of mitigation and encouraging a more integrated approach in the private sector is needed.

- Systematic disclosure of structural vulnerability as part of real estate transactions (such as flood risk) should be instituted. This is already done in California for flood risk and proximity to fault zones.

Recommendations for encouraging people to take action.

- Consistent messages, supported by many credible sources, should include specifics on what you can do as well as general educational information about the risk.

- Two-way communication should be initiated, often through respected community leaders who must first understand the message and then facilitate the communication. However, one must be sure the leaders represent the full range of community groups. It's not enough to assume that the most vocal or those in positions of authority are the best avenue to reach a given group.

- Experimental, hands-on projects or graphic/visual demonstration will assist with understanding the problems.

- Recognition that actions can serve more than one goal should be promoted. For example, a homeowner is more likely to strengthen an interior bathroom or closet to serve as a tornado safe room than to build a separate structure. In parts of Florida, extra-strong window screens that act as hurricane shutters also provide more security against break-ins.

- Availability of models, templates, etc. that have been successfully used in one community and can be applied, with minor modifications, in other places must be promoted. For example, a property tax incentive for mitigation in Kauai has been posted on the city web site and could serve as a model for other localities.

PANEL SESSIONS

Panel 1. Risk Assessment: Methodology and Approach

Moderator: Col (sel) Mark Welshinger (USAF), Assistant Federal Coordinator for Department of Defense/Air Force and Army Affairs, OFCM
Rapporteur: Mr. Robert Dumont, OFCM Senior Staff Meteorologist

Panelists

Ms. Karen Carson, Deputy Director, Office of Plant and Dairy Foods and Beverages, Food and Drug Administration (FDA)
Mr. Clifford Oliver, Chief, Assessment Branch, Mitigation Directorate, FEMA
Dr. Michael MacCracken, Director, National Assessment Center, U.S. Global Change Research Program (USGCRP)

Introduction

Col (sel) Mark Welshinger (USAF)

The purpose of this panel was to describe, from the perspective of three different agencies, methodologies and approaches used to conduct risk assessments.

Risk Assessment: Food Safety and Public Health Hazards

Ms. Karen Carson, FDA

Synopsis. Ms. Carson stated that within the Office of Plant and Dairy Foods and Beverages, risk assessments are done to characterize the nature and magnitude of the risk to human health in order to choose the best risk management option. The options include: regulations, action levels, guidance, and recalls. Chemical risk assessments for food ingredients (principally additives) and chemical contaminants, like lead, patulin, and dioxins, have been ongoing for 40 years. The goal is to provide a 100-fold safety factor. Microbial risk assessment (for example, *salmonella entertidis* in eggs, *listeria monocytogenes*, and *vibrio parahaemolyticus*) is a new, but rapidly growing scientific discipline. The first step in the public health risk assessment process is to identify the hazard as a potential health risk, and Ms. Carson stressed the importance of the immediate involvement of risk managers. The remaining steps in the process include constructing a model of the risk, drawing conclusions and recommendations, sending the results out for public comment, and insuring comments include supporting data, finalizing the report, and developing an action plan to mitigate the risk/hazard.

Overview of the HAZards U.S. (HAZUS) Loss Estimation Modules

Mr. Clifford Oliver, FEMA

Synopsis. Mr. Oliver reported that FEMA, under a cooperative agreement with National Institute of Building Sciences, has developed a standardized, nationally applicable earthquake loss estimation methodology. This methodology is implemented through PC-based Geographic Information System (GIS) software called HAZUS. HAZUS provides an improved basis for making decisions on risk reduction and is an essential element of FEMA's Project Impact initiative, which is a national movement to create safer and more disaster resistant communities. User involvement and strong technical oversight throughout the process were key elements in the HAZUS development effort. HAZUS is being expanded into a multi-hazard methodology with new models for estimating potential losses from wind (hurricanes, thunderstorms, tornadoes, extra-tropical storms, and hail) and flood (riverine and coastal) hazards. The full flood and wind (hurricane) preview modules are scheduled for completion in December 2002. Annualized earthquake losses in the United States are $4.4 billion per year, and FEMA recognizes that mounting dollar losses cannot be adequately addressed by a fragmented approach to natural hazards. Instead, estimated losses for other hazards are needed to support FEMA's risk-based approach to mitigation and emergency preparedness and comprehensive mitigation programs by local communities. Mr. Oliver concluded by stating that FEMA is committed to developing and implementing state-of-the-art risk assessment models and technology; providing training and education, and technical support; developing partnerships (for example, FEMA is partnering with NASA on the hurricane module); and ensuring private sector involvement throughout the process.

National Assessment of the Consequences of Climate Variability and Change for the United States

Dr. Michael MacCracken, USGCRP

Synopsis. Dr. MacCracken reported that the overall goal of the National Assessment of the Consequences of Climate Variability and Change for the United States was to analyze and evaluate what is known about the potential consequences of such changes in the context of other pressures on the public, the environment, and the Nation's resources. Three types of activities underpinned the Assessment effort: regional analyses and assessments; sectoral analyses which included agriculture, forests, human health, water, and coastal areas and marine resources; and a National overview. The results are summarized as follows:

- The magnitude of climate change impacts depends on time period and geographic scale. Short-term impacts differ from long-term impacts. Regional and local level impacts are much more pronounced than those at the national level.

- For the Nation as a whole, direct economic impacts are likely to be modest, while in some places, economic losses or gains are likely to be large. For example, while crop yields are likely to increase at the national scale over the next few decades, large increases or decreases in yields of specific crops in particular places are likely.

- Through time, climate change will possibly affect the same resource in opposite ways. For example, forest productivity is likely to increase in the short term, while over the longer term, changes in processes such as fire, insects, drought, and disease will possibly decrease forest productivity.

In addition, the vulnerability in the United States is linked to the fates of other nations. Dr. MacCracken stated we cannot evaluate national consequences due to climate variability and change without considering the consequences elsewhere in the world. The U.S. is linked to other nations in many ways, and both our vulnerabilities and our potential responses will likely depend in part on impacts and responses in other nations. Results from these research efforts will assist future assessments in continuing the process of building our understanding of humanity's impacts on climate and climate's impacts on us.

Additional information is available at: http://www.nacc.usgcrp.gov

Panel 2. National Perspectives on Risk Assessment and Decision Making for Natural Hazards

Moderator: Dr. Susan Cutter, President, Association of American Geographers and Director, Hazards Research Laboratory, University of South Carolina
Rapporteur: Dr. Nathalie Valette-Silver, National Centers for Coastal Ocean Science, National Ocean Service, NOAA and SNDR Executive Secretary

Panelists

Dr. Ronald McPherson, Executive Director, American Meteorological Society
Dr. Robert Hamilton, Deputy Executive Director, Division on Earth and Life Studies, National Research Council (NRC)
Dr. Margaret Davidson, Acting Assistant Administrator for Ocean Services and Coastal Zone Management, National Oceanic and Atmospheric Administration
Dr. Robert Hirsch, Associate Director for Water, U.S. Geological Survey
Mr. Robert F. Shea, Director, Program Support Division, Mitigation Directorate, Federal Emergency Management Agency

Questions considered.

1) What are the political, economic and societal benefits for instituting a national risk assessment program for all natural hazards?
- Things to consider are personnel injuries/deaths, transportation infrastructure and built environment, crops and livestock, fisheries, direct and indirect economic impacts caused by natural disasters.

2) What are some of the mechanisms for efficiently and effectively coordinating legislative efforts to support a risk assessment methodology for all natural hazards?
- Examples to date that have created effective programs are the National Flood Insurance Program and the Earthquake Hazards Reduction Act.

3) What are the organizational roles (Federal/State agencies, private sector, professional, scientific, and technological organizations) in developing and implementing a risk assessment methodology for all natural hazards?

4) What is the best method for encouraging appropriate research activities and ensuring technology transfer into operations?

Dr. Susan Cutter

Synopsis. As an introduction to this panel session, Dr. Cutter stated that risk assessment is not a new concept. She reviewed the questions provided to the panel members and then noted that the National Research Council developed in 1983 a framework for the government that includes four steps:

- Risk Identification,
- Dose Response,
- Exposure Assessment, and
- Risk Characterization.

More recently this general concept was modified for hazard assessment. This framework can be found in Mileti, 1999 and Cutter et. al., 2001 and includes three steps:

- Identification of the hazard (risk estimation models for specific hazards, mapping hazard zones, etc.),
- Assessment of the risks (pattern of human occupancy, differential impacts on people and places, etc.), and
- Management/mitigation of the impacts (differential adjustment and adaptation to the risk, variability in preparedness, response and mitigation capabilities, etc.).

Dr. Ronald McPherson

Synopsis. Dr. McPherson described the value of risk assessment as a way to keep score which helps to focus on our progress and on our deficiencies. In addition, risk assessment suggests where to do the right investments. He stated that assessments should be complete and consistent from hazard to hazard and should go beyond fatalities and property damage and include business disruption. Dr. McPherson gave the example of a plant flooded that was out of business for over 6 months. The costs associated with this interruption were larger than the repair costs.

Dr. McPherson next described one risk assessment coordination mechanism. This mechanism is the Congressional National Hazard Caucus, which is co-chaired by Senators Stevens and Edwards. The Caucus is led by the American Geophysical Union and the American Meteorological Society, among other professional organizations. A Natural Hazards transition document was prepared by the Caucus for the new administration.

Dr. McPherson discussed a recent National Research Council report which suggested that, in the Federal Government, the Department of Commerce (DOC) should take the lead for risk assessment, to encourage uniformity and consistency of the results. DOC would have to work with FEMA, USGS, USACE and other Federal agencies. Another consideration was the private sector which was currently doing risk assessment, but it was not generally doing it on a national scale. This is an ideal topic where public/private organizations could partner very well.

Recommendations. Dr. McPherson closed with two recommendations. A National Risk Assessment should be done, but it has to be complete and well done. There is a need to encourage risk assessment research, technology development, and their transfer to operational use.

Dr. Robert Hamilton

Remarks. In regard to the first question, I would say that we should undertake a National Risk Assessment. One of the problems is to know which natural hazards are included in it. We need to include hazard assessment for severe weather, flood, earthquake, volcanic activity, landslide, tsunami, wildfire, climatic variation (e.g., drought, rain, El Niño/La Niña). Many different agencies are working on these topics and have a clear role to play . The main difficulty is to coordinate activities among the various players. The main roles and responsibilities (not exhaustive) of various agencies are:

- Severe Weather: NOAA;
- Floods: FEMA/NFIP, NWS, USGS;
- Earthquakes and Volcanoes: USGS, NASA;
- Landslides: State and local gov., and many players;
- Tsunamis: NOAA, USGS;
- Wildfires: USFS, BLM, NPS;
- Climatic variability: NOAA, Agriculture; and
- Space weather: NASA, DOD, NSF, USGS, NOAA, FCC.

The value of a risk assessment derives from facilitating comparison among risks, guiding the identification of the gaps, and allocation of research. It will indicate common issues, opportunities for collaboration, and help suppress redundancies. This would also promote public awareness and political commitment and guide national policy. However, we need to look at compounded risk. For example, Charleston is located in an area subjected to hurricanes, earthquakes and floods, so we need to look at wind and seismic risk together. Where do we stand for the various hazards?

- For the earthquake, we are fairly OK since we have HAZUS;
- For volcanoes, we do not have too much, but there are 24 active volcanoes close to population centers;
- For wind and floods, it is a more difficult problem and HAZUS is in the process of developing a module for those hazards; and
- For climate changes, we do not have too much, but it is coming too.

Recommendations. In conclusion, we are facing some challenges. Yes, we need to develop a National Risk Assessment and all the agencies need to coordinate their activities. This will help in priority setting, advancing methodology, and creating a data base. To move ahead, we need to gradually improve with time what we have and go step by step. Most of all, we need somebody or some entity to take the responsibility for moving ahead.

Dr. Margaret Davidson

Remarks. Regardless of the killer storms and inconveniences caused by hurricanes and other weather-related disasters, growth along the coast is increasing. It is pretty stupid to live very close to the coast since it is the place that has seen up to 70% repeated losses. I am living along the coast in Charleston, and after the devastation of Hurricane Hugo, we were expecting housing to slow down but there was no fire sale after Hugo. In fact, the resale value of my house has increased 400% in the past 15 years.

Risk assessment data quality is very variable. Large and small companies presently have better data than government and academia, because they need the data to do business. Having good data is the first step in creating effective hazard mitigation measures, and it is important, that the data collected and used, are FGDC (Federal Geographic Data Committee) approved format and have well documented metadata. New data collected with new technologies are increasing. For example, LIDAR data are airborne lasers that are being used to make beach surveying quicker and more accurate. These data are very important for states since they are used to predict erosion rates, set construction setback lines and create oceanfront policies. LIDAR is also used after a storm to assess beach damages.

Coastal resources managers have rated near shore bathymetry as being the most needed data set. NOAA is presently focusing some of its resources to increase knowledge about offshore contours that will, in turn, improve the accuracy of models. Topographic seamless maps are also very important and small scale projects are presently underway (Tampa, FL and Louisiana).

Speaking of models, NOAA is committed to improving the predictive models themselves, as well as access to this important information. Two new examples are the Risk Atlas and the Coastal Storm Initiative. The Risk Atlas is being developed by NOS (National Ocean Service) in partnership with many other entities such as the USGS and the National Climatic Data Center (NCDC). The Risk Atlas will provide a geographically referenced tool containing the information needed to determine vulnerability. Data sets include weather trend information, erosion rates, demographics, economic information, reports on the location and capacity of the infrastructure, and other pertinent data and information.

Recommendations. In conclusion, the difficult step is how to graphically and accurately communicate the danger to the general public. We need to have something tied to the pocket book, if not via taxes or lost property value. It is very important that the land-planning and zoning decision be done at the local level in the right way. Technology transfer is an essential part of this needed education and must be available to the local planner. On the legislative front, we can use the recently created Natural Hazards Caucus as a vehicle.

Dr. Robert Hirsch

Remarks. **The role of science and technology in risk assessment.** Hazards do not know the political boundaries of states. Science and technology is important at two time scales: 1) to understand the risk and make long-term decisions and 2) to anticipate and prepare for an event and make short term decisions. The role of the USGS is to document the events (before, during, and after) to try to understand the processes underlying earthquake, floods and volcanic eruptions and prepare risk maps for each hazard. Presently, flood frequency analysis looks at the relationship between topography, bathymetry and river flow. The instruments deployed by the agency are used to enhance understanding of these processes and give real-time information.

It seems that presently, we have both the knowledge and the technology at hand to prepare better for disasters. However, it is not obvious that we have the political will to use this knowledge. For example, stream gages are essential to predict flooding, since the data are an essential component of NOAA's flood modeling. Unfortunately, the program is not funded in a coherent way, and in a recent case, the removal of a stream gage (that was out of order) resulted in NWS's inability to provide an adequate forecast, and lives were lost. In some other cases, property is lost because of the lack of warning due to the inadequacy of the observing system.

The same is true for earthquakes. For example, in the case of the Loma Prieta earthquake, all 911 lines were down, and the officials were unable to send emergency response.

Recommendations. We need to have a reliable observation system and have the will power to use the available technology. The technology is available to provide rational, quick decisions. We need to develop instruments that will continue to function and communicate during the event. We also need to improve risk maps.

Dr. Robert Shea

Remarks. I will cover the following topics regarding the various questions that were posed from an operational view point.

National Risk Assessment. We are trying to do an impossible task. To be successful we need to:

- Formulate a common goal with many different people involved, including Federal agencies;
- Address terrorist activity; and
- Partner and develop a common agenda for risk assessment.

We need to admit where we are and the fact there are the people living in harms way. Disasters need not to be so disruptive. The present paradigm is not right. Good and reliable risk assessment is one of the major ways to achieve this goal. We have the tools and could do it now.

Organizational models. We should stay away from various organizational models such as NEHRP (National Earthquake Hazard Reduction Program), which gives the model of destructive behavior, and NFIP (National Flood Insurance Program) which is an antiquity created 30 years ago. We should create a paradigm that has a united goal based on community needs.

Principal criteria. Science is crucial to be able to implement good ideas, but we can't ignore business interests. We can't be a closed society in terms of risk assessments and we need to reach out to others. Academia needs to be at the table, but the results need to be integrated. We do not need a perfect science to start to communicate in clear terms. We need to deliver the message in an understandable way, so that middle America will have the common sense to take the appropriate measures.

Recommendations.

New opportunities. A new administration is coming and we need to educate them on this topic. Under the Disaster Mitigation Act of 2000, there is $50M/year for planned risk assessment. We need to be involved in pre-disaster studies. We also need post-disaster studies. Maybe we should have a Federal interagency task force on risk assessment, including members from all pertinent parts of DOD.

RESEARCH REVIEW PRESENTATIONS: CONTRIBUTIONS TO NATURAL DISASTER REDUCTION AND RISK ASSESSMENTS

Subcommittee for Natural Disaster Reduction (SNDR) Strategic Plan

Dr. Stuart Nishenko, Earthquake Policy Advisor, Mitigation Directorate, FEMA

Remarks. In 1984, Dr. Frank Press, President of the National Academy of Sciences, proposed an International Decade for Natural Disaster Reduction. In 1989, the United Nations General Assembly declared 1990 through 2000 A. D. as the International Decade for Natural Disaster Reduction (IDNDR), a period of concentrated international action to reduce loss of life and property and to reduce social and economic disruption caused by natural disasters, especially in developing countries. Each member nation was urged to develop a national program for the IDNDR that, together with others, would constitute the core of the IDNDR effort.

The U.S. Congress passed resolutions calling for U. S. participation in the IDNDR (H. Con. Res. 290, Sept. 22, 1988). The Subcommittee on Natural Disaster Reduction (SNDR) was formed to ensure coordination in the Federal government's research agenda related to natural hazards and to develop the U.S. strategy under the auspices of the Committee on Earth and Environmental Sciences, of the Federal Coordinating Council on Science, Engineering, and Technology (FCCSET) under the direction of the President's Science Advisor. When the Clinton Administration reformulated the FCCSET into the National Science and Technology Council (NSTC), the SNDR retained both its name and general purview.

Throughout its history, the SNDR has not only increased understanding of the science of natural disasters but has also fostered a growing awareness of natural disaster reduction strategies at the state and community level. While the SNDR maintains a role of coordinating Federal hazards research, the work of the SNDR has evolved to include a broader range of related activities, including policy coordination and assessment, information dissemination, and coordinating Federal programs to better serve state and local governments, not-for-profit organizations, the private sector, and the public at large. SNDR agencies played a major role in funding the five-year study culminating in the publication of "*Disasters by Design*". In addition, the SNDR has focused on how best to apply knowledge generated from research to reduce loss of life and property. To further these ends, the SNDR reached out to private enterprise from 1997 to 1998 through its Public Private Partnership 2000.

Future actions of the SNDR focus on continued research on understanding natural hazards, modeling disasters and understanding the expected impact on the built environment, promoting tools for risk assessment, supporting new developments in building sciences and building code adoption and enforcement, and a continued commitment to disseminating disaster reduction information and tools throughout the country. To further these goals, the SNDR Strategy recommends a number of national policy shifts in natural hazards reduction and research:

- Anticipate and assess risks;
- Accurately identify and measure disaster losses and long-term impacts;
- Focus on comprehensive mitigation, including educating the public and building resilience at the earliest planning stages;

- Recognize the responsibility of local communities for developing, evaluating, and implementing natural disaster reduction strategies; and
- Exercise leadership in reducing natural disasters worldwide.

Of specific relevance to today's Forum, the SNDR recommends that the United States refine capabilities for a comprehensive national risk assessment with respect to:

- More precise characterization of the physical/biological risk of specific natural hazards, including microzonation and the cumulative risk associated with multiple hazards;
- Improved knowledge of interaction between natural hazards and natural/manmade environments and technological systems;
- Impact assessments and characterization of risk in terms of:
  - Lives,
  - Property,
  - Economy,
  - Ecology;
- Extension of analysis capabilities beyond structural integrity of individual buildings to comprehensive assessments of the functional viability of communities (especially large urban areas) and regions;
- Improved ability to analyze the cost-benefit tradeoffs of various policy options;
- Improved introduction of best-available risk assessment into operational practice; and
- Expanded capabilities to aid other nations in their efforts to carry out national assessments of risks from other natural hazards.

The SDNR further recommends that the United States begin to exercise these new analytical capabilities in an integrated national risk assessment, which would contain the following elements:

- A summary of recent disasters and extreme events;
- A comparison of the past loss of life and economic loss during the previous reporting period with the predictions of previous risk assessments;
- Assessment of risk in future years, over time frames ranging from the next year to the next quarter century;
- Identification of special risks by theme (e.g., hazard type, or engineering vulnerability, or ecological and environmental concerns) and by urban area or geographical region; and
- Highlights of advances in risk assessment methodology and national capabilities for risk assessment.

This morning's session presents summaries by the Federal agencies that participate in the SNDR on their activities in natural disaster reduction and risk assessment.

Federal Agency Presentations

U.S. Department of Agriculture (USDA), U.S. Forest Service (USFS)

Dr. David Cleaves, National Program Leader, Fire Systems Research, Research and Development, Vegetation Management and Protection Research

Synopsis: Risk Assessment Approaches.

The USDA Forest Service uses risk assessment approaches to deal with such issues as: impacts of land management options on threatened and endangered species habitat, forest insect and disease threats, hazards from landslides and avalanches, and the introduction of invasive species through international and domestic trade. The most common use of risk assessment occurs in the field of wildland fire management. In planning and budgeting fire programs, each national forest manager analyzes the likelihood of fire events, control successes, and large fire consequences under different funding scenarios in the simulation-based process called the National Fire Management Analysis System (NFMAS). These analyses estimate the most efficient funding level (MEL) for each forest, which guides each year's request for fire fighting preparedness funding.

On ongoing wildfires, incident commanders estimate the probability of success for ranges of suppression options in a structured risk assessment process called the Wildland Fire Situation Analysis (WFSA). The WFSA guides the incident commander's choices about the level of aggressiveness to employ and the number of resources to order to implement the chosen strategy.

On a nationwide basis, staffing and mobilization for firefighters and equipment are guided by the National Fire Danger Rating System (NFDRS), which rates and updates each day for its potential for extreme fire behavior. Other indices and measures of vegetation and soil moisture are also used to guide regional and national resource allocation decisions.

For fuels treatment and prescribed burning, fire managers evaluate the likelihoods of achieving fuels treatment and other objectives and of contingencies such as prescribed fire escapes and smoke intrusions in nearby communities. A more recent use of risk assessment has been in comparing the relative riskiness of different fuels/urban interface settings in an attempt to prioritize investments in treatment and other forms of mitigation. This has led to the development of national maps of vegetation, fire potential, and housing conditions, which are now being integrated into a more formal overall approach for communication and prioritization.

Risk Assessment and Research.

The agency has developed a number of perspectives on risk assessment, including the need to link closely to the research and development efforts in fire management and ecology. The Forest Service has proposed program research and technology development in three major areas.

Quantifying the tradeoffs of fire and fuels management options. This includes evaluating the ecological, environmental, and economic consequences of alternatives for treating fuels; characterizing how fire interacts with other disturbance processes, such as windstorms, invasive plants, insects, and disease; and developing guidelines for incorporating these tradeoffs into planning processes for land and fire management.

Developing and delivering more effective prediction. This includes improving risk assessment, expert judgment, and decision processes for prescribed fire planning and fire suppression; validating and improving fire weather and fire behavior prediction models; and improving the ability to predict and monitor smoke emissions from prescribed and wildfires.

Quantifying fire effects and interactions. This includes developing tools for monitoring and predicting fuels, fire hazards, and vegetation recovery; developing remote sensing tools to estimate fire severity, area burned, and smoke emissions; and evaluating factors that affect the vulnerability of wildland interface communities to fire impacts.

USDA, Agricultural Research Service (ARS)

Dr. Steven R. Shafer, National Program Leader, National Program Staff, Natural Resources and Sustainable Agricultural Systems

Remarks: Overview. Risk assessments and risk management activities are conducted in a number of agencies throughout the U.S. Department of Agriculture (USDA). Some agencies in which these analyses and actions are undertaken include the Animal and Plant Health Inspection Service (APHIS), the Forest Service, the Natural Resources Conservation Service (NRCS), the Food Safety Inspection Service (FSIS), the Risk Management Agency, and the Office of Risk Assessment and Cost-Benefit Analysis (ORACBA). The Agricultural Research Service (ARS) is the main in-house research arm of the USDA, and it does not have responsibilities for risk assessment or risk management beyond those associated with conducting research. However, risk assessments can help identify high-priority research within ARS, and ARS' research provides important information to risk assessors and risk managers in other agencies and throughout the Nation.

Approximately 2,000 scientists conduct ARS research at just over 100 locations. These research activities are organized into 22 National Programs having titles such as Arthropod Pests of Animals and Humans, Food Safety, Water Quality and Management, Global Change, Crop Protection and Quarantine, and others. As the names of these research programs suggest, much of the research can be viewed as risk-related, i.e., focused on identifying hazards and quantifying the likelihood and consequences of adverse events.

Watershed Flood Control. Research on watershed flood control is a good example of ARS research on natural disaster reduction and risk assessment. USDA has been involved in flood control since the early 20th century. There are several programs and legislative authorities that keep USDA involved in flood control; most of these programs are delivered to the public by NRCS. One is the Watershed Protection and Flood Prevention Act of 1954, which authorized watershed management projects throughout the country. As of late 2000, funds authorized by this Act have been spent on over 6,000 dams, managing flood risks on over 100 million acres in all 50 states. Across all USDA programs since the 1940s, some $14 billion has been delivered to local communities to build about 10,000 flood control structures, yielding an estimated $1 billion in benefits annually. The design criteria and construction of many of these structures were developed by ARS engineers in cooperation with NRCS personnel.

However, some of these dams are now over 50 years old and are beginning to have structural problems or are not considered to be consistent with modern performance or safety criteria. Thus, ARS engineers continue to conduct research in cooperation with NRCS personnel in areas such as: technology for predicting performance during extreme events; design criteria for upgrading structures to meet modern safety and performance standards; proven procedures for estimating sediment loading that affects performance; improved procedures for evaluating the impact of structure installation, modification, or decommissioning; and evaluation of hydraulic performance and site-specific problems.

There have been some significant accomplishments over the years, for example, in the design of structures to dissipate energy of rapidly-flowing water, or sediment management. These can affect the life span and performance of many of the aging dams. Innovative designs and modifications such as drop structures and streambank stabilization are products of ARS research. In other activities, ARS researchers and their cooperators in NRCS and at universities have spent decades in research focused on understanding erosion and sediment deposition. The Universal Soil Loss Equation and its more recent successors, the Revised Universal Soil Loss Equation (RUSLE), are interacting sets of equations and models using data describing soil, topography, land use, climate and weather, plant cover, and management activities to quantify soil loss and deposition for many different purposes around the world. In addition, ARS researchers have made major advances in the use and management of vegetation to control water flow and erosion associated with streams and rivers in croplands. All these accomplishments have greatly reduced the risk of flooding and excess erosion and sedimentation in watersheds of various sizes.

Global Change National Program. Another ARS National Program focused on understanding and managing risks in the environment is the Global Change National Program. Agriculture has existed in an ever-changing environment throughout its entire 10,000-year history. Scientists still debate whether the earth's climate is changing unusually quickly, whether increasing concentrations of "greenhouse gases" are to blame, or whether human activities have anything to do with greenhouse gases and putative climate change. Nonetheless, no one disputes that agriculture is constantly affected by changes in land use; weather and climate variability; increasing atmospheric carbon dioxide concentrations; pests, pathogens, and weeds; and changes in soil carbon. The Global Change National Program investigates the impacts of these factors and evaluates various options to reduce the risks to food and fiber production.

One example of risk assessment and management research in the ARS Global Change National Program includes work on ways to apply three-month climate projections developed by the National Oceanic and Atmospheric Administration (NOAA) to reduce risks in crop and grazing land management. In the near future, farmers and range managers will have tools that will allow them to make decisions related to crop selection or animal stocking rates according to risk-based decision support tools that will help anticipate unusual temperature or moisture conditions. In other research, scientists are investigating how CO_2 concentration - crop yield response models are modified by other environmental conditions, such as tropospheric ozone that is toxic to plants. Dose-response models are critical inputs to ecological risk assessments that will be necessary to estimate risks and benefits to crop production associated with rising CO_2 and other environmental changes. Other risk-related global change research in ARS includes such topics as ways to manage cattle to reduce production of methane, another greenhouse gas; how

changing weather and climate may alter interactions of crops with their pests and pathogens; and how changing climate could alter water supplies available for food production.

Although the USDA-ARS does not have a specific mandate to conduct risk assessments or risk management activities, research conducted throughout the agency forms an important base for many risk assessments and risk management actions conducted by others. This research has a major role in minimizing risks to the most plentiful, safe, and highly nutritious supply of food in the world.

Department of Commerce (DOC), National Institute of Standards and Technology (NIST)

Dr. David D. Evans, P.E., Fire Research Division, Building and Fire Research Laboratory

Remarks: Fire, Wind, and Earthquake Disaster Reduction Research.

The National Institute of Standards and Technology (NIST) is a non-regulatory Federal agency that works with industry to develop and apply technology, measurements and standards. The Building and Fire Research Laboratory (BFRL) is the NIST laboratory that leads studies in disaster mitigation. Two words that characterize the technical work of BFRL are measurement and prediction.

BFRL develops measurement, evaluation, and performance prediction technologies enabling cost effective improvements in practice to increase the disaster-resistance of new and existing construction. The development and adoption of performance-based standards for new construction and the retrofit of existing construction are one means to enable fire, wind, and earthquake disaster mitigation. Disaster response and recovery can be improved through the dissemination of nondestructive evaluation methods for condition assessment and quality control.

Fire Spread and Plume Dispersion. NIST is performing research to simulate the major effects of urban-wildland fire spread through the use of computer simulations. These studies examine the interactions of wind-blown-fires on buildings. The site-specific simulations currently model features of structures and vegetation with a resolution of one meter. The burning of ignited buildings is fundamentally different in character from the burning of vegetation. Urban-wildland fire models that hope to quantify the value of disaster mitigation efforts and strategies for fire protection and fire fighting with limited water supplies, need to simulate the burning of structures as well as vegetation to be successful.

NIST has provided a tool for the analysis of large fire plume dispersed contaminates, such as smoke particulates. The software ALOFT, available at (www.fire.nist.gov), was initially developed to assist the Department of the Interior, Minerals Management Service and oil spill responders to determine conditions under which in-situ burning of oil spills would be acceptable. It has been used to establish state guidelines for approval of burning as a primary response to an oil spill.

Wind. NIST in collaboration with universities and industry performs studies to enable the development and use of next generation wind load standards by U.S. industry to achieve safer, more cost effective, and efficient design of structures. The technical challenge in this area is to develop advanced computational models based on state-of-the-art aerodynamic

measurements and extreme value statistics to predict time and direction dependent wind effects including structural collapse.

Earthquakes. As part of the National Earthquake Hazard Reduction Program (NEHRP), NIST, along with its industry and academic partners, has established a new practice for the use of precast concrete moment frame construction for tall buildings in earthquake regions. Its use represents a savings of $50-$100 per square meter in construction costs over conventional steel and cast-in-place concrete structures. This method, based on use of an innovative beam-to-column connection developed by NIST and its partners, was chosen for construction of a 39-story (128 m) apartment building in San Francisco -- the tallest concrete frame ever built in the highest-risk seismic zone of the United States. This revolutionary system is rapidly gaining worldwide acceptance as evidenced by its use in five other projects where construction is complete or nearly complete. It is also under active consideration for several new buildings that are planned for construction. The American Concrete Institute has issued two provisional standards for this method of construction.

Summary.

The BFRL hazard loss reduction research program focuses on the study of structural fire endurance, ignition resistance, wind loads and wind resistance, earthquake loads and resistance, innovative connections and fasteners, alternative materials, and alternative structural systems. BFRL seeks to enable construction cost reduction and increased disaster resistance of housing systems by U.S. industry through design and innovation. The research effort produces measurement and predictive methods for the performance of typical housing systems and the development of higher performance systems.

DOC, NOAA, National Weather Service (NWS)

Mr. Donald Wernly, Chief, Performance and Awareness Division, Office of Climate, Water, and Weather Services

Remarks. The National Weather Service (NWS) provides weather, water, and climate forecasts and warnings for the protection of life and property and the enhancement of the national economy. The data the NWS uses for its warning and forecasts is available to others to determine vulnerable areas, establish building codes, and assist in land use planning. As such, just about everything the NWS does is designed to keep natural hazards from becoming disasters.

NWS forecasts now span from the storm scale to interannual, decadel, and centennial climate change. This seamless suite of forecast services is designed to enable weather sensitive groups to plan for future eventualities and then execute their response actions as the event draws near. In the hurricane and flood programs, forecast uncertainties are quantified and made available to local officials and the public to help them make better preparedness and response decisions.

Warnings and forecasts are not sufficient to reduce the impacts of natural hazards. People and organizations must have preparedness plans and know how to respond when they receive a warning or are confronted with a hazard. The NWS has begun a community recognition program for jurisdictions willing to prepare for extreme events. Communities are designated as

StormReady when they have: a 24 hour emergency operating center, more than one way to receive severe weather warnings, methods to alert the public, and a formal hazardous weather plan. To date, 64 communities in 18 states are recognized as StormReady. Recognition comes from their emergency manager peers in concert with the local NWS office.

Following extreme events, the NWS deploys field personnel to assess the magnitude of the event as well as the impacts of the event. When a catastrophic event occurs, the NWS works with the Office of the Federal Coordinator for Meteorological Services and Supporting Research to deploy teams to the stricken area to compliment the data collecting function. Once the data is available, the information becomes the definitive source for the type of event as well as its magnitude. This is especially critical in the severe local storm arena where decisions must be made as to whether the event was a severe thunderstorm, downburst, or tornado. This information then can be used to define future vulnerabilities as well as future mitigation and response actions.

Department of Interior (DOI), U.S. Geological Survey (USGS)

Dr. Timothy Cohn, Science Advisor for Hazards, USGS National Center

Remarks. The mission of the U.S. Geological Survey (USGS) is to serve the Nation by providing reliable scientific information: to describe and understand the Earth; to minimize loss of life and property from natural disasters; to manage water, biological, energy, and mineral resources; and to enhance and protect our quality of life.

To carry out its mission related to natural disasters, the USGS works with partners, including state, local and federal agencies, the private sector, and non-governmental organizations, to provide the scientific information on which to base effective mitigation, response and recovery. The USGS conducts basic research on geologic and geophysical hazards (earthquakes, volcanic activity, sea-level rise, tsunamis, landslides, ground subsidence, coastal erosion, and geomagnetic storms), hydrologic hazards (floods and droughts), and biological hazards (including land cover characteristics for fire-fuel assessments and disease in natural populations). The USGS also performs hazard and risk assessments on national, international, regional, urban, and local scales. It develops and deploys monitoring networks and geographic information systems. It transfers the technology needed to enhance professional skills and to expand the technical capacity for mitigation, preparedness, emergency response, and recovery. It organizes and conducts post-disaster investigations.

Some recent accomplishments of the USGS in helping to reduce natural disaster losses include development of:

- Earthquake shake maps, which identify those areas subjected to extreme shaking within minutes of an earthquake;
- El Niño induced landslide hazard maps;
- Real-time stream gage data;
- Volcanic ash maps for aircraft safety;
- Real-time seismic monitoring; and
- Wildlife monitoring for West Nile virus.

Department of Defense (DOD), U.S. Army Corps of Engineers (USACE)

Mr. Ronald R. Connors, Emergency Management Branch, USACE

Remarks. Participation in recent strategic planning sessions in the USACE has resulted in direction to better integrate the before-event activities with the post-event activities. The presentation today focuses on past and future efforts to accomplish this integration while keeping the tools in mind.

The Corps plans, constructs and manages water resource and coastal storm projects. Planning includes problem identification, alternative development, economic evaluation, and assessment of Federal interest. In recent years, local sponsors contributed 50% of feasibility study funds and varying percentages of the actual construction funds. The Corps is also responsible for the Public Works and Infrastructure portion of the Federal Response Plan. Post-event missions include ice water and emergency power provision and debris removal. Therefore, the Corps is involved pre-event with assessment and mitigation and post-event in recovery.

The Corps regards risk management as the overall process with risk based analysis as a tool in the process. The steps in risk management are to identify options, evaluate tradeoffs, and select the appropriate risk-level. Risk-based analysis is an approach to evaluation and decision making that explicitly, and to the extent practical, analytically incorporates considerations of risk and uncertainty. In a flood control example, the Corps integrated a process that developed probability distributions for each variable, sampled those distributions randomly, and by running multiple interruptions, can now come up with an expected number that reflects the uncertainty of variables. Emergency Management (EM) models are used for mission scoping for debris, ice and water responsibilities based on historic information. Planning models look at the spectrum of natural events, EM models look at single events. The key is that effects or damages drive both models.

The Corps has an extensive research program. Their eight research facilities support both civil and military projects. Research work ranges form the quality of concrete to the passing of fish through dams. Other research helps the Corps produce tools in both emergency management and civil works areas. The Corps also has programs for the Corps water management system, to help assess coastal storms, and to assist with collecting flood damage data. In summary, the Corps believes that an integrated program of risk management will bring together Federal and state programs to address the mitigation, the response, and recovery from riverine and coastal flooding.

Environmental Protection Agency (EPA)

Mr. James Makris, Director, Center for Emergency Preparedness and Prevention Office (CEPPO)

Synopsis. In the 16 years since the Bhopal, India, disaster, the EPA has adopted an alternative to previous risk analysis and management processes. The idea is to provide information to the public in a way that the risk taker can communicate directly with the risk-maker. This decision allows risk assessment to be done at the local level and opens the door to more effective communication. The Clean Air Act of 1990 opened risk assessment and management plans to

the public. The EPA continues to evaluate its activities and the stimulus for the reduction of incidents. Risk management required a lot of data/information. They are working with international organizations on definitions of risk. The American Chemistry Council has a program called "responsible care" in which every company is obligated to do all it can to avoid accidents. One of the most important current activities is a round table run by Texas A&M University, where a group is examining fundamental metrics that might be involved in funding measurements of chemical accidents. In theory, it doesn't matter whether it is a regulatory, legislative or private sector program or if better training or manufacturing practices contribute to fewer accidents. The idea is to give credit rather than take credit and to promote the sharing of credit with stakeholders.

Housing and Urban Development (HUD)

Mr. William E. Freeborne, Division of Affordable Housing Research and Technology

Synopsis. Mr. Freeborne's Division works primarily on single family and manufactured housing. New construction amounts to about 1.5 million units per year. Existing Construction consists of about 115,000,000 housing units, of which 80,000,000 units are single family and 8,500,000 units are manufactured housing. The following are some of HUD's projects.

Partnership for Advanced Technology in Housing (PATH). Goals, by the Year 2010, are to develop technologies and methods to reduce the monthly cost of housing by 20 percent; cut the environmental impact and energy use of housing by 50 percent; improve durability and reduce maintenance costs by 50 percent, and reduce by 10 percent the risk of loss of life, injury and property destruction from natural hazards (excludes fire); and reduce by 20 percent residential construction work illness and injuries. PATH is a cooperative effort involving other federal agencies and the private sector.

Program for Research and Optimum Value Engineering (PROVE). This is a cooperative effort with the National Association of Home Builders (NAHB) to find least cost ways of resisting natural hazards primarily with wood stick built housing. Initial effort has been primarily on wind events looking at both the load (e.g.- wind speeds) and resistance (e.g.- nailing schedule). The NAHB Research Center has provided the technical support for this effort plus alternative materials such as steel and concrete.

Minimum Property Standards (MPS). The MPS are used for insuring homes (approximately 70,000 homes are insured each year) and constructing homes. MPS includes a statement that cites ASCE 7-88 (American Society of Civil Engineers) as the specific mandatory standards for protecting against seismic hazards. Standards for other hazards are not specific and default to local or state codes.

HUD Code. Manufactured Home Construction and Safety Standards (approximately 250,000 homes are constructed each year) has wind standards for hurricane events which were upgraded in 1994. New law, American Homeowner and Economic Opportunity Act of 2000, will result in new installation standards to secure the homes in natural hazard events.

Guides. There are two guides that apply to single family and manufactured homes. The REHAB GUIDE is a nine volume series with suggestions for upgrading homes. The REHAB INSPECTION GUIDE is used for inspecting a home for resistance to hazards, amongst other considerations. This guide was recently reissued.

MF Risk Assessment. An ongoing project with USGS, it provides a method to assess the seismic risk for HUD Assisted Multi-Family (MF) housing.

ICSSC (Interagency Committee on Seismic Safety in Construction). A multi-agency effort, ICSSC is to be used to estimate seismic rehabilitation costs. HUD does not specifically own housing, but has many programs that provide assistance thus increasing potential financial exposure when there are seismic events.

Web sites: www.Pathnet.org
www.HUDUser.org
www.hud.gov

DOC, NOAA, Office of Oceanic and Atmospheric Research (OAR)

Dr. John Gaynor, Director, U.S. Weather research Program (USWRP) Interagency Program Office

Remarks. OAR's role in natural hazards. OAR provides the science and research which supports the NOAA offices who provide services. In addition, OAR provides environmental knowledge and information to the public. In the area of natural hazards, OAR provides research to improve forecasts of hazardous weather events such as hurricanes, tornados, and heavy precipitation which may lead to flooding. Much of this research is organized under the US Weather Research Program (USWRP) which includes, in addition to OAR, two other NOAA Line Offices (the National Weather Service and the National Environmental Satellite, Data, and Information Service) and three other agencies (the National Science Foundation, NASA, and the Department of Defense). The initial research priorities of the USWRP are directed toward the improvement of hurricane landfall track, intensity, and coastal rain forecasts as well as precipitation forecasts as the storm moves inland. Over the last decade, most of the deaths and damages from hurricanes have been caused by flooding after the storms move inland. The National Sea Grant College Program housed in OAR provides research and assessment concerning the effects of coastal storm surges and high winds.

OAR's Air Resources Laboratory provides the operational modeling and underlying research for the forecasting of volcanic and wildfire smoke plumes on an international scale, which are hazards for aircraft operations and human health.

In the climate area, some OAR research laboratories, in cooperation with the National Weather Service, are working on improving seasonal to interannual forecasts with emphasis on the seasonal probabilities of extreme events. This effort has met some success with the regional impact forecasts of the 1997-98 El Niño event. OAR's Office of Global Programs is providing regional assessments of climate impacts.

Finally, OAR's Space Environment Center (SEC) provides forecasts of geomagnetic storms, often referred to as space weather. Geomagnetic storms caused by solar flares can and have created significant disruptions in electrical supply, particularly in the northern latitudes, communications, and aircraft and ship navigation. SEC also contains a significant research component directed toward improving the accuracy and lead time of these forecasts through improved modeling and improved use of satellite observations.

Specific OAR contributions to risk management and assessment of natural hazards.

OAR's main contributions are focused on research applied to NOAA's environmental forecasting and understanding mission. Therefore, much of its contribution is one step removed from risk management and assessment. However, there are several areas in OAR in which such activity is a natural off-shoot of OAR's applied research and expertise. The following bullets highlight some of this activity:

- Public education and outreach from the National Severe Storms Laboratory (NSSL) on tornado, lightning and severe storm safety;
- Participation of NSSL tornado experts in storm damage assessments;
- Close cooperation with and information to California emergency managers, water managers, Weather Service Forecast Offices, and fishing interests concerning severe winter coastal storm and coastal flooding potential during recent and planned west coast storm field campaigns;
- Provision of short-term forecasts of hurricane surface winds at landfall and surface wind field analysis soon after hurricane passage for emergency managers, insurance industry, and the general public;
- Informal campaign of public education and awareness of hurricane threat from OAR's Hurricane Research Division personnel, particularly in Florida;
- Research by Sea Grant on optimum beach and building design/construction to minimize storm surge or tide beach erosion and building damage and working closely with local building code authorities on this project;
- Instrumentation of a home on the North Carolina coast to study the effects of winds on structures and provision of information by Sea Grant to state and local building authorities as part of this project;
- Advising western water managers on seasonal precipitation outlooks; and
- Providing geomagnetic storm forecasts and forecast interpretation to vulnerable utility and communications companies.

National Science Foundation (NSF)

Dr. Ann Bostrom, Program Director, Decision, Risk, and Management Sciences Program

Remarks. Overview. The National Science Foundation's (NSF) vision is to enable the Nation's future through discovery, learning and innovation. The NSF mission is set out in the NSF Act of 1950 (Public Law 810507). The Foundation is to promote the progress of science and engineering; to advance the National health, prosperity, and welfare; to secure the National defense; and to support worthy other purposes. The Act authorizes and directs NSF to initiate and support:

- Basic scientific research and research fundamental to the engineering process;
- Programs to strengthen scientific and engineering research potential;
- Science and engineering education programs at all levels and in all fields of science and engineering; and
- An information base on science and engineering appropriate for development of national and international policy.

Over time, the following additional responsibilities have been added to the agency's mission: foster the interchange of scientific and engineering information nationally and internationally; support the development of computer and other methodologies; maintain facilities in the Antarctic and promote the U.S. presence through research conducted there; and address issues of equal opportunity in science and engineering.

As an independent agency of the Federal Government, NSF sponsors and funds scientific and engineering research and education projects and supports cooperative research between the U.S. and other countries. The NSF does not itself conduct research; but by itself and in cooperation with other Federal agencies, it funds research related to natural hazards that develops new and fundamental knowledge needed to better understand, manage, and mitigate natural disasters.

NSF supported over $60 million in natural disaster-related research and education in Fiscal Year (FY) 2000. This does not include a full accounting of investments in climate change research, research through NSF's interdisciplinary Biocomplexity in the Environment initiative, nor in digital government research that will aid natural disaster mitigation efforts. It does include NSF investments in the National Space Weather Program, the U.S. Weather Research Program (USWRP), the National Earthquake Hazard Reduction Program (NEHRP), and a wide range of individual research projects in engineering and across the social, behavioral, economic, geophysical, mathematical, biological, and computer sciences, as well as in educational and international research collaborations and workshops.

Space Program. NSF participation in the National Space Weather Program (NSWP) supports research aimed at understanding and predicting the effects of solar storms on the Earth's nearby space environment and the effect of these storms on space-borne and ground-based technological systems. NSF plans to provide additional support for focused space weather research and modeling in fiscal years 2001-2002. The National Space Weather Program coordinates the Foundation's efforts in this area with other agencies, principally NASA, DOD,

and NOAA (through the OFCM Space Weather Program Council). The NSF contact is Richard Behnke in the GeoSciences Directorate.

USWRP. NSF participation in the USWRP includes support for the National Center for Atmospheric Research (NCAR) and NSF awards in joint NSF/NOAA/NASA/USN weather research projects. The large majority of incremental NSF support in fiscal years 2000-2004 will go for research and infrastructure projects that will improve forecasting capabilities in extreme weather events, such as hurricanes, heavy precipitation, and flooding. Scientific and technical challenges include performing process studies to improve fundamental understanding; developing new observational capabilities and strategies to eliminate persistent observational blind spots; and developing advanced numerical techniques for simulating and forecasting complex weather phenomena, in addition to accelerating transfer of research and development projects into operations. The NSF contact is Steve Nelson in the GeoSciences Directorate.

Earthquakes. NSF is a NEHRP agency and develops joint strategic plans with FEMA, USGS, and NIST in that context. It supports investigator-initiated research, as well as three Earthquake Engineering Research Centers, the Southern California Earthquake Center and research on aspects of natural and constructed environments under extreme conditions. For instance, NSF supports projects that are aimed at enhanced engineering analysis, design and construction to improve the response and to reduce the impact of natural and technological hazards. Laboratory and field experiments and monitoring (advanced sensors) projects improve prediction and assessment of infrastructure integrity during and following major disasters. Research efforts use high-speed computers to develop models and improve simulation of natural disaster events and community response and recovery. NSF supports post-disaster reconnaissance inspections and data acquisition to develop databases for local, national and international use. The Network for Earthquake Engineering Simulation (NEES) is a new NSF project authorized by the National Science Board for fiscal years 2000-2004. The goal is to provide a networked national resource of geographically distributed shared-use research equipment installations. The NEES network will be a catalyst to transform the civil engineering profession by revolutionizing the environment for earthquake engineering research, focusing on collaborative and integrated physical testing, theory, computation, databases, and model-based simulation to improve seismic design and performance of U.S. civil and mechanical infrastructure systems. The NSF contact is Priscilla Nelson in NSF's Engineering Directorate.

Social and Behavioral Sciences. Natural disasters and natural disaster losses occur at the intersection of human beings with natural and built environments. Understanding how humans contribute to amplifying or ameliorating disasters is critical to preventing or mitigating them. Therefore, NSF supports basic research on the social and behavioral factors that influence these outcomes. For instance, NSF has supported the research of speakers and participants at this workshop, including that of Paul Kleindorfer. NSF cooperated with FEMA, EPA, USFS, and USGS to support Dennis Mileti's work on *Disasters by Design: A Reassessment of Natural Hazards in the United States* (Dennis S. Mileti, Joseph Henry Press, Washington DC 1999). Recent results from NSF support also include ethical guidance for hazard mitigation officials, extensive characterization of the perception of risk, and guidelines for improving the policy relevance of predictions. Investments in individual natural disaster-related research projects through the Directorate for Social, Behavioral and Economic Sciences have increased somewhat

over the last decade. As NSF's representative on the Subcommittee for Natural Disaster Reduction, Rachelle Hollander is the contact person for these efforts.

Education. Building a climate in which people are responsive to risk messages - an underlying ethos - is critical for the effectiveness of Natural Disaster Reduction efforts. NSF also supports education, as well as outreach efforts to build public understanding of hazard-related science, as illustrated by the Faultline webpage and webcasts from the Exploratorium. NSF also supports the Incorporated Research Institutions for Seismology (IRIS), a university consortium. IRIS projects include, among others, the IRIS Education and Outreach (E&O) program, to enhance seismology and earth science education in informal and formal (K-12 through university and adult education) settings. NSF also supports several information centers and the Earthquake Information Providers Group (EqIP), a consortium of 20 organizations and Federal agencies. In the last decade, NSF has supported hazard-related collaborative research and workshops all over the world. In FY2000, NSF supported earthquake-related research collaborations with colleagues in Japan, Turkey, and Taiwan.

Summary. As these titles of individual research awards illustrate, NSF supports hazard research in forms ranging from centers and collaboratories to individual workshops and dissertations, on topics as diverse as stress to children and brains for buildings. This illustrates NSF's investment in
natural hazard research through its Biocomplexity in the Environment initiative, which is a foundation-wide interdisciplinary initiative.

Dr. Margaret Leinen, a paleoceanographer and paleoclimatologist from the University of Rhode Island joined NSF last year to head our GeoSciences Directorate and coordinate environmental science and engineering programs within NSF, including the Biocomplexity in the Environment initiative. Dr. Leinen is also responsible for environmental cooperation and collaborations between NSF and other Federal agencies, and has indicated that this will be one of her priorities this year.

Within NSF, we will continue to advance a coordinated extreme events research agenda. We are hosting a small workshop on strategic directions for extreme events decision making research at the end of April. NSF will continue to invest in research infrastructure, interdisciplinary centers, and basic research on natural hazards and disaster reduction across the sciences. NSF will increase such investments through current and upcoming foundation-wide interdisciplinary research initiatives in: Biocomplexity in the Environment, Mathematics, Social, Behavioral and Economic Sciences, and Information Technology Research. I'd like to close with an illustration of the potential benefits from the pursuing these last two.

Improvements in information technology provide new opportunities for social and behavioral scientists to assess, inform and improve risk decisions and tradeoffs. Integrated assessments such as those undertaken by climate change researchers, can inform strategic policy choices. Analysis of risk tradeoffs can also reveal where decisions have socially desirable outcomes that might not come to light in analyses of individual risks. Some mitigation investments may not treat subpopulations equitably. Research on such ethical dimensions can improve the fairness of mitigation programs.

As illustrated so well by Dr. Kleindorfer's and Dr. Mileti's talks yesterday, we also need more research on how best to inform and motivate action. A historic problem in successful implementation of risk reduction efforts has been the lack of understanding of factors that

motivate action. Research on communications and incentives for individual, organizational and collective action to reduce risks, overcome institutional obstacles, and institute effective responses would improve practice. SNDR agencies should work together to identify specific topics where further research is needed. To find out more about what NSF is supporting, see NSF's webpage, http://www.nsf.gov/, and search Fastlane award abstracts.

DOC, Bureau of Economic Analysis (BEA)

Dr. Barbara Fraumeni, Chief Economist

Bureau of Economic Analysis Disaster Damage Estimates.

The disaster damage estimates produced by the Bureau of Economic Analysis (BEA) are frequently quoted. One example of this is the table in the 1999 Economic Report of the President (ERP), which is reproduced for the 90's in the presentation table.[3] As the table shows, when comparing BEA disaster damage across time in constant dollars (which allows for such comparisons), Hurricane Andrew and the Northridge earthquake stand out. When considering these estimates, it is important to understand their scope. BEA estimates disaster damage only to fixed tangible capital, e.g., structures and equipment, and does so only if these estimates meet or exceed a trigger value.

In a manner that is consistent with the definition of and methodologies underlying the Gross Domestic Product (GDP) estimates in the national accounts and the mission of BEA, certain types of damage are excluded from the estimates, and no attempt is made to isolate the impact of disasters beyond that needed to produce BEA products. The exclusions include damage to life, limb, nature, business inventories, consumer durables such as cars, appliances, household furnishings, and repairable damage. No attempt is made to isolate the impact of disasters on sales and income. However the impact of disasters is reflected in the source data used to compile GDP and regional information such as Gross State Product (GSP), therefore reflected in BEA estimates. BEA estimates disaster damage to fixed tangible capital only when the current dollar value of the damages is at least .25% of total Consumption of Fixed Capital (CFC), e.g., for disaster damage of at least $2.6 billion in 2000.[4] The specific BEA procedures for estimating disaster damage fall in to two general categories, which use similar methodologies. These are:

- most of the damage is covered by insurance, in which case the primary sources are the American Insurance Services Group (AISG) estimates and
- most of the damage is not covered by insurance, in which case the primary sources are usually the State Disaster Offices and/or the Red Cross.

[3] BEA estimates for Hurricane Floyd (3rd quarter of 1999) were added to the ERP table.

[4] CFC is a charge for the using up of private and government fixed capital in the United States. This is defined as the decline in the value of the stock of assets due to wear and tear, obsolescence, accidental damage, and aging.

Disaster Damage: National Income and Product Accounts
Estimates of Value of Structures and Equipment Destroyed

Disaster	Area Affected	Impact on NIPAs	
		Period	Value destroyed (billions of 1992 dollars at annual rates)[5]
Fire	**Oakland (CA)**	**1991: IV**	**6.1**
Hurricane Andrew	**Florida & Louisiana**	**1992: III**	**63.9**
Hurricane Iniki	**Hawaii**	**1992: III**	**7.9**
Winter Storm	**24 Eastern States**	**1993: I**	**7.9**
Floods	**9 Midwestern States**	**1993: III**	**8.2**
Earthquake	**Northridge (CA)**	**1994: I**	**74.8**
Hurricane Opal	**Florida & 9 Southern States**	**1995: IV**	**8.6**
Hurricane Floyd	**North Carolina & 4 other States**	**1999: III**	**3.4**

Source: BEA estimates, prior to 1999 as shown in the February 1999 ERP, Table 2.2.

In my example, I will discuss category 1 (most of the damage covered by insurance). Whether the procedures fall into category 1 or 2, defaults are used in the absence of other information. These are indicated in parentheses and give a general sense of how large the adjustments are on average. The following five steps are undertaken:

(1) raise AISG estimates to allow for general underestimating, (Default, raise estimate by 20% in general, more for large disasters);
(2) split damage between damage to housing and damage to business property, (Defaults are a 75-25% split);
(3) reduce losses to eliminate non-capitalized losses, (Default is a 25% and a 5% reduction);
(4) raise estimates to account for losses not in the AISG estimates, e.g., uninsured losses, deductibles, and damage to public utility property, (Defaults are a 35% and 30% increase); and
(5) distribute the estimates by industry and affected counties.

[5]BEA estimates for Hurricane Floyd(3rd quarter of 1999) were added to the ERP table.

BEA disaster estimates are available in the new National Income and Product Account (NIPA) Table 5.16 (billions of dollars), under "Other changes in volume of assets," and in Table 2.2 (billions of 1992 dollars), ERP February, 1999. A useful discussion of BEA disaster adjustments for Hurricanes Andrew and Iniki appears in the Survey of Current Business, September 1992, box on p. 2, and October 1992, pp. 2-4. Other BEA data useful for disaster analysis include:

- selected NIPA data now interactively accessible on the web, with all other NIPA data available on the web, go to www.bea.doc.gov;
- regional accounts data almost all interactively accessible on the web, e.g., annual GSP, annual and quarterly State Personal Income, and annual Local Area Personal Income, go to www.bea.doc.gov/bea/regional/data.htm; and

- input-output (I-O) and industry data available on the web including annual I-O data and recently released Gross Product Originating (GPO) data, go to www.bea.doc.gov/bea/dn2/ied01-01.htm for a complete listing and web links to the data.

Federal Emergency Management Agency (FEMA)

Ms. Donna Dannels, Director, Policy and Assessment Division, Mitigation Directorate

Remarks. The FEMA Mitigation Division was created in 1993. Since then, risk assessment (RA) and risk management (RM) have played a valuable role in agency activities. The objective of FEMA's activities in RA and RM is to change the public's behavior in preparing for and responding to disasters. This is best exemplified by Project Impact (PI), a nationwide initiative that started with seven communities and has grown to 250 as more communities began to see the value in disaster planning and mitigation. PI incorporates the full spectrum of mitigation practices requiring local participation and leadership that results in an overall change in the effectiveness of preparation and recovery activities. FEMA supports communities through tool kits, mentoring, partnerships, training, celebrating success, and highlighting achievements. By linking newly involved communities with those having success, we have been able to expand the enthusiasm and energy for the program. FEMA also helps communities find local and national partners. An annual summit brings together partners and parties and showcases disaster reduction actions.

HAZUS was covered in another presentation but it is FEMA's premier effort in RA. Indeed, we have accelerated the original schedule, and expect to complete the multi-hazard loss-estimation model by 2002. FEMA is also working on map modernization, with the goal of improving and converting maps to a digital format. On-line ordering of flood maps and other materials is another part of the modernization program. The philosophy is that only when tools are useful and accessible will they be used.

Over the past 12 months, construction guidance has been issued in the form of a Coastal Construction Manual, guidance on the International family of codes (I-codes) (including the International Building Code, the International Residential Codes, etc.), the National Flood Insurance Program (NFIP), building performance assessment team reports, and technical publications. Hazard specific efforts of FEMA include the National Earthquake Hazard

Reduction Program, NFIP, and the Flood Mitigation Assistance program. The Cooperating Technical Partnership is a new approach to mapping and is intended to foster community ownership and participation. There are currently 62 partnerships and 400 communities involved. The Repetitive Loss Strategy addresses the problem of about 11,000 buildings that require mitigation action. Post-mitigation activities include the Hazard Mitigation Grant Program (HMGP) and technical assistance with planning. The Disaster Mitigation Act of 2000 provides increased funding for the HMGP, as well as stricter planning criteria requirements and authorization for pre-disaster mitigation.

U.S. Nuclear Regulatory Commission (NRC)

Dr. Andrew J. Murphy, Senior Technical Advisor, Division of Engineering Technology.

Synopsis. Dr. Murphy presented a historical perspective on deterministic regulations and guidance, discussed the uncertainties in maximum credible earthquake values, and discussed the development in the seismic safety margins program. The NRC was responsible for monitoring seismic activity until 1985, and then cooperated with the USGS to develop a national seismic network for the United States. NRC focused on models to be used for earthquakes, because of the size of the threat. Designing for earthquakes can add 5-10% to the engineering of nuclear power plants. Probability analysis is one of the methods to use for mitigation work. NRC started by using the maximum credible values for earthquakes and storms, evaluators kept asking about uncertainties in these estimates. Should a larger or smaller estimate be used? If a different uncertainty value were used, what would the consequences be on NRC planning actions? In the mid-1970s, NRC started the Seismic Safety Margins Program as a result of these questions. Through this program, an individual tool for rudimentary probabilistic seismic hazard assessment was developed. Comments were received from the public, and through a National Research Council evaluation, it was determined improvements were needed in the tool. In the 1980s and 90s, initiatives focused on gaining knowledge of seismic hazards. These included:

- A study by Lawrence Livermore National Laboratory (LLNL) provided an assessment of two improvements to tools.
- Electric Power Research Institute took the above tools and developed a process for handling seismic hazards.
- The National Research Council Committee on Seismology checked whether the above ideas made sense and provided advice on probabilistic analysis.
- The NRC took the National Research Council advice, wrote siting guidance, and selected 10 to the –5 median occurrence of earthquakes as the safe shutdown threshold.
- The NRC was satisfied with the 2 methodologies but they found when applying them there could be an order of magnitude difference in the results. LLNL and the Senior Seismic Hazard analysis Committee reviewed the methodologies, input data, and results and developed guidance on a better way to use the tools. NRC is working to apply the NRC guidance.

Bottom line is that decision-makers want probabilistic information. It provides a way to express confidence in uncertainty values for seismic events.

DOC, NOAA, National Environmental Satellite, Data, and Information Service (NESDIS)

Ms. Francis C. Holt, Chief, Atmospheric Research and Applications Division

Synopsis. Research and Products in Support of Natural Hazard Monitoring.

Ms. Holt focused on the operational satellite products and guidance tools that are currently available or under development by National Environmental Satellite, Data, and Information Service (NESDIS). The products that were highlighted began with hurricane intensity and track products that have been available for more than 20 years. Although landfall and strong winds are the main concern of most of our population, statistics now show that there are more fatalities from these systems inland than along the coast. These fatalities are primarily the result of flooding caused by the heavy rains associated with tropical systems. Several products were shown that estimate the rainfall potential of storms before landfall, plus the operational 15 minute interval precipitation estimation products and outlooks. She stated that these can be accessed via the Internet and viewed down to the county level. Also playing a role in the potential of flooding is the condition of the soil. An experimental soil wetness/moisture product from microwave sensors on the polar orbiting satellites was shown. Thunderstorms, hail, strong winds, and tornadoes were also discussed. Hourly stability and moisture products from the GOES satellite along with decision tools to assess rapidly changing conditions were illustrated.

The focus of the presentation then moved to land and environmental issues. These included vegetation health that are not only agricultural and economic concerns, but assist in the assessment of fire fuels. A real-time demonstration of fire and smoke monitoring from GOES and polar satellites will be underway during the summer of 2001 as part of NESDIS' Global Data and Information Network (GDIN) program. The use of multiple satellites and sensors to create products is an emerging activity. As an example, the use of the Defense Meteorological Satellite Program data to assess the power outages after hurricane Fran helped utility companies assess resources needed to respond to this disaster.

Finally, an example of the capability to monitor volcanic eruptions was illustrated. Advisories of eruptions and the ensuing smoke and ash plumes are based on both polar and geostationary data, depending on the location of the activity. These are provided primarily to the aviation community. Attendees were invited to view these and other products at three websites (see Appendix B).

DOC, NOAA, National Ocean Service (NOS)

Dr. Nathalie Valette-Silver, National Centers for Coastal Ocean Science (NCCOS) and SNDR Executive Secretary

Remarks. Introduction. The NOS is dedicated to supporting and providing the science (including basic and applied research), information, management, and leadership necessary to balance the environmental and economic well being of the Nation's coastal resources and communities. Our goals include:

- Preserve and restore the U.S. coastal and ocean environments;
- Reduce the costs and risks to people, the economy, and natural resources associated with both natural and man-induced hazards;
- Expand and improve navigation products and services in response to changing technology and needs of our customers and increase the safety of vessel movements on the Nation's waterways, especially in major ports; and
- Increase coastal communities ability to adapt to changing conditions and to mitigate the impacts of all natural and man-induced hazards, including climate change.

Many NOS projects and programs are supporting these goals and in this short presentation I would like to just touch on four of these programs.

Physical Oceanographic Real-Time System (PORTS). PORTS is a program that supports safe and cost effective navigation by providing ship masters and pilots with accurate real-time information required to avoid groundings and collisions. This technological innovation has the potential to save the maritime insurance industry from multi-million dollar claims resulting from shipping accidents. PORTS is in place or being developed for: San Francisco Bay, New York/New Jersey Harbor, Houston/Galveston, Tampa Bay, Narragansett Bay, Chesapeake Bay, and Soo Locks. PORTS includes centralized data acquisition and dissemination systems that provide real-time water levels, currents, and other oceanographic and meteorological data from bays and harbors to the maritime user community in a variety of user friendly formats. Also, by using numerical circulation models, PORTS provides nowcasts and predictions of these parameters. Telephone voice access to accurate real-time water level information allows U.S. port authorities and maritime shippers to make sound decisions regarding loading of tonnage (based on available bottom clearance), maximizing loads, and limiting passage times, without compromising safety. PORTS is critical to environmental protection, since marine accidents can lead to hazardous material spills that can destroy a bay's ecosystem, tourism, fishing, and other industries that depend on it. The human, environmental, and economic consequences of marine accidents can be staggering, as demonstrated by the 35 deaths caused by the May 1980 ramming of the Sunshine Skyway Bridge in Tampa Bay (which led to the first PORTS installation), and the estimated $3 billion cost of the EXXON Valdez accident in 1990. For more information visit this NOS web site: http://co-ops.nos.noaa.gov/d_ports.html.

Response and Restoration. Each year, millions of gallons of oil and hazardous chemicals spill into U.S. waters, often because of accidental releases from marine vessels and transportation pipelines. These discharges and releases can alter habitat, kill or injure important fish and bird populations, and reduce food supplies for aquatic life and for humans. Ecological effects can persist for long periods of time and over geographic areas large and small. Within NOS, scientists in the Office of Response and Restoration (ORR) respond to dozens of oil spills and other hazardous materials each year; help emergency planners prepare for potential accidents; create software, databases, and other tools to help people respond to hazardous material accidents; work to find remedies for the environmental damage caused by hazardous waste sites in coastal areas; assess injury to coastal resources from releases of oil and hazardous materials; and pursue restoration from those responsible for the harm. The Hazardous Materials

Response Division (HazMat) consists of an interdisciplinary scientific team that responds to oil and chemical spills in U.S. waters. This team provides and coordinates critical advice on science and natural resource issues to the Unified Command. The team forecasts the movement and behavior of spilled oil or chemicals, evaluates the risk to resources, and recommends protection priorities and appropriate cleanup actions. The Coastal Protection and Restoration Division implements the Secretary of Commerce's natural resource trusteeship by protecting and restoring coastal habitats and resources affected by hazardous materials releases. This team works with the U.S. Environmental Protection Agency, other lead waste cleanup agencies and responsible parties through the CERCLA (Comprehensive Environmental Response, Compensation and Liability Act) remedial process to insure that selected remedies are protective and that appropriate measures are implemented to restore our trust resources. The Damage Assessment Center also implements DOC trustee responsibilities by carrying out natural resource damage assessments for releases of oil and hazardous substances. This team is also activated in case of ship groundings or other navigation incidents. The Center has primary responsibility for maintaining the natural resource damage assessment regulations under OPA (Oil Pollution Act of 1990) and for providing guidance to pursuing damage assessments under these regulations. The Center's scientists and economists provide the technical foundation for these assessments and work with other trustees and responsible parties to restore injured resources.

For more information go to: http://www.nos.noaa.gov/Programs/ORR.html

NOS Disaster Response Team. A few years ago, NOS created a Disaster Response Team to provide assistance to states or other Federal agencies in case of natural or man-made disaster. This team also covers plane crashes and other dramatic incidents. The response team is composed of representatives from all the NOS program, but at times can also involve personnel from other line offices such as the National Weather Service, and will provide many different types of assistance. For example, in the case of a hurricane landfall, our group will assist the state that is declared a disaster area and FEMA by rapidly providing well geo-referenced areal photographs (photogrammetry) and coastal area images of various kinds (e.g, remote sensing, hyperspectral, etc). Comparison of images taken before and after an event speed up the damage assessment and the emergency response and assist in the recovery phase of the response, too. Immediately following a hurricane, this group assists the state in evaluating the status of its harbors and assess the risk of bathymetric changes to the maritime industry; thus insuring the quick re-opening of harbors that are vital for our coastal economies

In the case of a plane crash (such as the TWA or the Alaska Airline crashes), NOAA has assisted the U.S. Coast Guard and Navy in the search and rescue phase as well as in the recovery phase of the operations. To do so, NOAA provides not only vessels, planes, and field personnel, but also hydrodynamic measurements, back trajectories modeling, and weather information and forecasts.

The NOS Disaster Response Team has produced a Response Plan that explains the functioning of the NOAA team. This plan includes a special section that deals exclusively with ecological disasters such as red tides or anoxic events.

For more information go to: http://www.nos.noaa.gov/Programs/

Ecological Forecasting. This represents a new NOS effort which is lead by the National Center for Coastal Ocean Science (NCCOS). This group was created two and a half years ago to provide NOS and NOAA with the scientific and research support needed to protect our coastal

environment. All our activities are centered around "Integrated Assessments" which represent a formal bridge between science and management. The integrated assessment includes four steps:

- Document the status and trends,
- Describe the causes and consequences of the trends,
- Predict future outcomes under various action scenarios, and
- Provide guidance for potential actions.

These four steps can be applied to assess the causes and the consequences of any type of disaster, including ecological disasters such as red tides or anoxic episodes.

In the last few months, NOS has been successful in identifying and tracking harmful algae blooms (HAB) and in forecasting their landfall in the Gulf of Mexico. As the result of this forecast, our group was able to send warnings to coastal managers in Florida that alerted them of the incoming HAB event. This allowed them to respond better to the event by closing beaches to safeguard public health (respiratory problems and others) and by targeting their sampling strategy, thus saving money to the taxpayer.

NOS is presently working closely with coastal zone managers around the country, as well as with marine sanctuaries and estuarine research reserves managers and science coordinators, to assess and understand what kind of forecasts they need. This constant communication and feedback is needed to guide NOS in its work. In the near future, this concept will also be presented to the international academic community in order to gather the support needed to fill out the gaps still present in our knowledge.

For more information, please visit: http://www.nccos.noaa.gov/

Conclusion. These are the four areas that I wanted to present to you in the short time allocated for this presentation, but this is a very small sample of all the activities that are taking place in NOAA/NOS. I would recommend that you visit our web site: http://www.nos.noaa.gov/. Thank you for your attention.

OVERARCHING ISSUES AND NEXT STEPS

Mr. Samuel P. Williamson, Federal Coordinator for Meteorological Services and Supporting Research and **Ms. Margaret Lawless**, Chairperson of SNDR and Acting Executive Associate Director for Mitigation, FEMA

Synopsis. Throughout the Forum, it was emphasized that natural hazards cause a significant impact on the United States. Natural hazards have to be prepared for so the Nation can avoid them as much as possible. Hurricanes, tornadoes, drought, earthquakes, and flooding are just a few of the hazards the Nation faces. Although not extensively discussed, manmade hazards can be equally as devastating, and therefore, the country needs to plan for these, as well. Basic processes, methodologies or approaches were developed to evaluate what was needed for both risk assessment and risk management and were used by the breakout sessions' and panel sessions' discussions to cover the Forum's overarching objectives. The success of these approaches was possible because of the various sectors that were brought together: the Federal Government, academia, and the private sector. These Forum objectives were to:

- Examine risk assessment processes and approaches that evolved from legislation or agency guidance;
- Review risk assessment research and its applications to manage/reduce natural hazards;
- Identify/characterize areas of vulnerability and exposure, probability of occurrence, consequences, and mitigation opportunities;
- Highlight efforts in developing national standards and capabilities for data monitoring, data collection, and model development;
- Examine methods to quantify and publicize the social and economic impacts of natural hazards; and
- Develop a consensus leading to coordinated risk assessment and management of natural hazards through:
    - Legislative proposals
    - Policy guidance
    - Agency cooperation.

As new legislation is formulated and policy guidance is generated by any particular agency that will have an impact on another, interagency coordination and cooperation must be promoted and maintained. OFCM and SNDR are both well situated and willing to accomplish this on the Federal level. In addition, development of good partnerships between the users and the developers, as well as with the all important local users, is key to the overall success of any risk management program. Many of the Forum breakout sessions emphasized the great work that takes place at the local level and how important it is to take their concerns into consideration. At the conclusion of the Forum, it was clear that there was an affirmation of the Forum's generic risk assessment and management approach and an overall consensus to focus efforts on the following identified overarching issues and needed next steps:

- Consensus to proceed with National Natural Hazard Assessment
  - Attack in “bite-size chunks
  - Develop an action plan to proceed
  - Define roles/responsibilities of public and private entities

- Integrate efforts with the Congressional Natural Hazards Caucus
  - Coordinate on steps the Federal, state and local governments can take to lessen the severity of natural disasters

- Develop improved partnerships between users and developers
  - Publicize ongoing and planned research among all entities

- Standardize within risk assessment and management
  - Terminology and language
  - Risk assessment methodology and approach for all natural hazards

- Compile available risk assessment tools/models
  - Designate a clearing house for consistency of information
  - Leverage existing programs and entities/agencies

- Improve public outreach, education, and training
  - Include all sectors of society

APPENDIX A

FORUM
AGENDA

Forum on
Risk Management and Assessments of
Natural Hazards

Toward a Safer America: Building Natural Hazard Resistant Communities Through Risk Management and Assessments

AGENDA

Monday, February 5, 2001

7:00 AM — Registration, Continental Breakfast, and Poster and Display Set-up (Ballroom)

8:00 AM — *Opening/Administrative Remarks* (Ballroom)
- **Ms. Cynthia Nelson**, OFCM Senior Staff Meteorologist and Forum Coordinator

8:10 AM — *Introduction*
- **Mr. Samuel P. Williamson**, Federal Coordinator for Meteorology

8:15 AM — *Welcoming Remarks*
- **Mr. Scott B. Gudes**, Acting Under Secretary of Commerce for Oceans and Atmosphere and Acting Administrator of the National Oceanic and Atmospheric Administration (NOAA)

8:30 AM — *Forum Objectives*
- **Mr. Samuel P. Williamson**, Federal Coordinator for Meteorological Services and Supporing Research
- **Ms. Margaret Lawless,** Chairperson of the Subcommittee for Natural Disaster Reduction (SNDR) and Acting Executive Associate Director for Mitigation, Federal Emergency Management Agency (FEMA)

9:15 AM — *FEMA Success Stories: Project Impact and Disaster Resistant Universities*
- **Ms. Maria Vorel**, Director, Outreach and Community Support, FEMA
- **Mr. Brian Cowan**, Director, Office of Strategic Initiatives, FEMA

9:45 AM — *The Role of Insurance in Hazard Resistant Communities*
- **Dr. Paul R. Kleindorfer**, Co-Director, Wharton Risk Management and Decision Processes Center, University of Pennsylvania

10:15 AM Refreshment Break (Ballroom)

10:30 AM *Introduction to Session on Interactive Tools, Poster Papers, and Displays* (Ballroom)

- **Dr. Stuart Nishenko**, Earthquake Policy Advisor, Mitigation Directorate and FEMA Forum Coordinator

10:40 AM *Interactive Tools*

- **Mr. Joseph Szwarckop**, Director, GDIN Committee Support Office: *The Global Disaster Information Network (GDIN)*
- **Mr. Mark Reichardt**: *Open Geographic Information System (GIS) Consortium*
- **Ms. Susan C. Clark**, Research and Communications Coordinator, Center for Integration of Natural Disaster Information (CINDI), U.S.Geological Survey (USGS): *CINDI Project*

11:15 AM *Poster and Display Session* (Ballroom)

- Baker, Inc: Ms. Kathryn Field: *Staying Afloat--A GIS-Based Communications Floodplain Management Tool*
  Ms. Jane Huzil: *Past, Present, and Future - Hazards U.S. (HAZUS), GIS-Based Loss Estimation Software*
  Mr. Edward Mifflin: *A Risk Analysis of Exposure to Natural Hazards in the U.S.*
- Federal Emergency Management Agency (2 displays)
- Centers for Disease Control and Prevention: Dr. Josephine Malilay, Team Leader for Disaster Epidemiology and Assessment, National Center for Environmental Health, *Estimating Health Risks from Natural Hazards Using Risk Assessment and Epidemiology*
- National Academy of Sciences (book display)
- Multihazard Mitigation Council of the National Institute of Building Sciences: Ms. Claret Heider (display)
- U.S. Geological Survey: Mr. John Sutter, *Forecasting Geohazards Vulnerability in the Tri-State Region of Indiana, Kentucky, and Illinois*
- University of DC: Dr. Mark Siegal, *Multihazard vulnerability assessment in the greater Evansville, IN (Tri-state) region: R&D tools for communication with non-geoscientists*
- Oak Ridge National Laboratory/Department of Energy (DOE): Dr. John Sorensen and Dr. Barbara Vogt, *Risk Assessments of Environmental Hazards*
- Cooperative Institute for Research in the Atmosphere (CIRA), Colorado State University: Dr. Chris Adams, Research Scientist: *Colorado State University Flash Flood Laboratory*

11:45 AM Working Lunch (Ballroom)

12:15 PM Luncheon Address

- Introduction: **Mr. Samuel P. Williamson**, Federal Coordinator

- *Summary of Previous Studies/Reports Related to Risk Management of Natural Hazards and their Recommendations*
  Dr. Dennis Mileti, Director of the Natural Hazard Research and Applications Information Center, University of Colorado

1:15 PM Reconvene General Session: **Mr. James Harrison**, Deputy Federal Coordinator (Ballroom)

Panel: *Risk Assessment: Methodology and Approach* (Ballroom)
Moderator: **Col (sel) Mark Welshinger** (USAF), Assistant Federal Coordinator for Department of Defense/Air Force and Army Affairs, OFCM
Rapporteur: **Mr. Robert Dumont**, OFCM Senior Staff Meteorologist

Panelists:

- **Ms. Karen Carson**, Deputy Director, Office of Plant and Dairy Foods and Beverages, Food and Drug Administration: *Methods used for Risk Assessment of Food Hazards*
- **Mr. Clifford Oliver**, Chief, Assessment Branch, Mitigation Directorate, FEMA: *Hazards U.S. (HAZUS)*
- **Dr. Michael MacCracken**, Director, National Assessment Center, U.S. Global Change Research Program (USGCRP), NOAA: *National Assessment of Global Change*

Discussion/Wrap-up

2:15 PM Breakout Sessions: *Process of Conducting Risk Assessments*
Instructions: Ms. Cynthia Nelson, OFCM Forum Coordinator

- Session 1A: *Characterize/Quantify Exposure* (Council Room, MZ)
  Moderator: **Mr. Michael Buckley**, Director, Technical Services Division, Mitigation Directorate, FEMA
  Rapporteur: **Dr. Timothy Cohn**, Theme Coordinator for Hazards, USGS National Center

- Session 1B: *Predict/Forecast Probability of Occurrence* (Ballroom)
  Moderator: **Dr. David Cleaves**, National Program Leader, Fire Systems Research, Research and Development, Vegetation Management and Protection Research, USDA Forest Service
  Rapporteur: **Dr. Rachelle D. Hollander**, Program Director, Societal Dimensions of Engineering, Science, and Technology Program, Ethics and Values Studies, Research on Science and Technology, National Science Foundation

Session 1C: *Estimating Losses* (Caucus Room, MZ)
Moderator: **Dr. Christopher Adams**, Research Scientist, Cooperative Institute for Research in the Atmosphere (CIRA), Colorado State University
Rapporteur: **Mr. Floyd Hauth**, OFCM Staff (STC)

3:15 PM Refreshment Break (Ballroom)

3:35 PM Reconvene Breakout sessions (assigned rooms)

4:35 PM Breakout sessions conclude

4:35 PM Moderators and rapporteurs compile session results (Ballroom)

General Session: Poster Session Continued (Ballroom)

5:00 PM Moderators, rapporteurs, Federal Coordinator, OFCM Staff discuss day's results and session summaries.

General Session Adjourn for the Day

Tuesday, February 6, 2001

7:15 AM Continental Breakfast (Ballroom)

7:55 AM Reconvene General Session: **Mr. James Harrison**, Deputy Federal Coordinator (Ballroom)

Recap of Day 1 Panel and Breakout Sessions by Moderators:

- Day 1 Panel: **Col (sel) Mark Welshinger** (USAF), Assistant Federal Coordinator
- 1A: **Mr. Michael Buckley**, FEMA
- 1B: **Dr. David Cleaves**, USFS
- 1C: **Dr. Christopher Adams**, CIRA, Colorado State University

8:45 AM *Research Review Presentations: Contributions to Natural Disaster Reduction and Risk Assessments* (Ballroom)

Moderator: **Dr. Stuart Nishenko**, Earthquake Policy Advisor, Mitigation Directorate and FEMA Forum Coordinator

Rapporteur: **Mr. Michael Neyland**, OFCM Staff (STC)

- *Subcommittee for Natural Disaster Reduction (SNDR) Strategic Plan*
  Dr. Stuart Nishenko, FEMA

Federal Agency	Presenter
• U.S. Forest Service	**Dr. David Cleaves**, National Program Leader, Fire Systems Research, Research and Development, Vegetation Management and Protection Research
• U.S. Department of Agriculture, Agricultural Research Service	**Dr. Steven Shafer**, National Program Agricultural research Service Leader, Global Change
• National Institute of Standards and Technology	**Dr. Dave Evans**, P.E., Fire Research Division, Building and Fire Research Laboratory
• National Weather Service	**Mr. Donald Wernly,** Chief, Performance and Awareness Division, Office of Climate, Water, and Weather Services
• U.S. Geological Survey	**Dr. Timothy Cohn,** Theme Coordinator for Hazards, USGS National Center
• U.S. Army Corps of Engineers	**Mr. Ronald R. Conners**

10:00 AM Refreshment Break (Ballroom)

10:15 AM Reconvene General Session: **Dr. Stuart Nishenko**, FEMA Forum Coordinator (Ballroom)
Contributions Presentations Continue

Federal Agency	Presenter
• Environmental Protection Agency	**Mr. James Makris**, Director, Center for Emergency Preparedness and Prevention Office (CEPPO)
• Housing and Urban Development	**Mr. William E. Freeborne**
• Office of Oceanic and Atmospheric Research (NOAA)	**Dr. John Gaynor**, Director, U.S. Weather Research Program (USWRP) Interagency Program Office
• National Science Foundation	**Dr. Ann Bostrom**, Program Director, Decision, Risk, and Management Sciences Program
• Bureau of Economic Analysis	**Dr. Barbara Fraumeni**, Chief Economist
• Federal Emergency Management Agency	**Ms. Donna Dannels**, Director, Policy and Assessment Division, Mitigation Directorate
• US Nuclear Regulatory Commission	**Dr. Andrew J. Murphy**, Senior Technical Advisor, Division of Engineering Technology
• National Environmental Satellite Data and Information Service (NOAA)	**Ms. Frances C. Holt**, Chief, Atmospheric Research and Applications Division
• National Ocean Service	**Dr. Nathalie Valette-Silver**, National Centers for Coastal Ocean Science (NCCOS) and SNDR Executive Secretary

11:45 AM Working Lunch (Ballroom)

12:15 PM Luncheon Address

- Introduction: **Ms. Margaret Lawless**, Acting SNDR Chairperson and Acting Executive Associate Director for Mitigation, FEMA

- *Media and Disasters: Why we are not the enemy.*
  Mr. Daniel Dubno, Producer and Technologist, CBS News Special Events

1:10 PM Reconvene General Session: **Ms. Cynthia Nelson**, OFCM Forum Coordinator (Ballroom)

1:15PM Breakout Sessions: *Risk Management Discussions--Ramifications of Risk Assessment and Decision Making for Natural Hazards*
Instructions: **Ms. Cynthia Nelson**, OFCM Forum Coordinator

- Session 2A: *How to characterize and reconcile the tradeoffs implicit in making risk management decisions?* (Council Room, MZ)
  Moderator: **Dr. John Sorensen**, Director, Emergency Management Program, Oak Ridge National Laboratory (DOE)
  Rapporteur: **Col (sel) David A. Smarsh** (USAF), PhD, Deputy to NOAA for Federal and National Programs

- Session 2B: *How do we improve and/or change policies (private and government) using risk management that will assist in natural disaster reduction?* (Ballroom)
  Moderator: **Dr. Ben Wisner**, Environmental Studies Program, Vice-chair, IGU Commission on Hazards and Risks and Vice-chair, Earthquakes and Megacities Initiative, Oberlin College
  Rapporteur: **Dr. Paula Davidson**, Sciences Plans Branch, Office of Science and Technology, National Weather Service, NOAA

- Session 2C: *Risk Management and Public Perception of Vulnerabilities - How do we build the public's awareness of risks and their vulnerabilities so that mitigation efforts will provide the maximum benefits?* (Caucus Room, MZ)
  Moderator: **Dr. Betty Hearn Morrow**, Director, Lab for Social and Behavioral Research, International Hurricane Center, and Professor, Department of Sociology and Anthropology, Florida International University
  Rapporteur: **Ms. Kathleen Gohn**, U.S. Geological Survey

2:15 PM Refreshment Break, and View Displays and Posters (Ballroom)

Moderators and rapporteurs compile breakout session results and discuss with Federal Coordinator and SNDR Chairperson

3:00 PM Reconvene General Session: **Ms. Cynthia Nelson**, OFCM Forum Coordinator (Ballroom)

Recap of Breakout Sessions by Session Moderators
- 2A: **Dr. John Sorensen**, Oak Ridge National Laboratory, DOE
- 2B: **Dr. Ben Wisner**, Oberlin College
- 2C: **Dr. Betty Hearn Morrow**, Florida International University

3:30 PM Panel: *National Perspectives on Risk Assessment and Decision Making for Natural Hazards* (Ballroom)

Moderator: **Dr. Susan Cutter**, President, Association of American Geographers and Director, Hazards Research Laboratory, University of South Carolina
Rapporteur: **Dr. Nathalie Valette-Silver**, National Centers for Coastal Ocean Science, National Ocean Service, NOAA

Panelists:

- **Dr. Ronald McPherson,** Executive Director, American Meteorological Society
- **Dr. Robert Hamilton,** Deputy Executive Director, Division on Earth and Life Studies, National Research Council
- **Dr. Margaret Davidson,** Acting Assistant Administrator for Ocean Services and Coastal Zone Management, National Oceanic and Atmospheric Administration
- **Dr. Robert Hirsch,** Associate Director for Water, U.S. Geological Survey
- **Mr. Robert F. Shea,** Director, Program Support Division, Mitigation Directorate, Federal Emergency Management Agency

- Discussion/Wrap-up

5:00 PM *Next Steps/Action Plan* (Ballroom)

- **Mr. Samuel P. Williamson**, Federal Coordinator for Meteorological Services Supporting Research
- **Ms. Margaret Lawless**, Chairperson of SNDR and Acting Executive Associate Director for Mitigation, FEMA

5:30 PM Adjourn

Posters and Displays disassembled and removed.

APPENDIX B

FORUM PRESENTATIONS

Full color and animated presentations can be viewed on the OFCM web site. The URL is http://www.ofcm.gov/. Click on “Special Projects” and navigate to Risk Management/ Assessment section.

APPENDIX C

FORUM ATTENDEES

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APPENDIX D

ACRONYMS

-A-

AISG	American Insurance Services Group
ALOFT	tool for the analysis of large fire plume dispersed contaminates
APHIS	Animal and Plant Health Inspection Service
ARS	Agricultural Research Service
ASCE	American Society of Civil Engineers

-B-

BEA	Bureau of Economic Analysis
BFRL	Building and Fire Research Laboratory
BLM	Bureau of Land Management

-C-

CENR	Committee on Environment and Natural Resources
CEPPO	Center for Emergency Preparedness and Prevention Office
CERCLA	Comprehensive Environmental Response, Compensation and Liability Act
CFC	Consumption of Fixed Capital
CINDI	Center for Integration of Natural Disaster Information
CIRA	Cooperative Institute for Research in the Atmosphere
CIRES	Cooperative Institute for Research in Environmental Sciences (NOAA)

-D-

DOC	Department of Commerce
DOD	Department of Defense
DOE	Department of Energy
DOI	Department of Interior

-E-

EM	Emergency Management
E&O	Education and Outreach
EPA	Environmental Protection Agency
EqIP	Earthquake Information Providers Group
ERP	Economic Report of the President
ESRI	Environmental Sciences Research Institute, Inc.

-F-

FCC	Federal Communications Commission
FCCSET	Federal Coordinating Council on Science, Engineering, and Technology
FDA	Food and Drug Administration
FEMA	Federal Emergency Management Agency
FGDC	Federal Geographic Data Committee
FSIS	Food Safety Inspection Service

-G-

GDIN	Global Disaster Information Network
GDP	Gross Domestic Product
GIS	Geographic Information System
GOES	Geostationary Operational Environmental Satellite
GPO	Gross Product Originating data
GPS	Global Positioning System
GSP	Gross State Product

-H-

HAB	Harmful Algae Blooms
HazMat	Hazardous Materials Response Division
HAZUS	HAZards U.S.
HMGP	Hazard Mitigation Grant Program
HUD	Housing and Urban Development

-I-

ICMSSR	Interdepartmental Committee for Meteorological Services and Supporting Research
ICC	Interagency Coordination Committee on disaster information
I-codes	International family of codes
ICSSC	Interagency Committee on Seismic Safety in Construction
IDNDR	International Decade for Natural Disaster Reduction
IGU	International Geophysical Union
I-O	Input-Output
IRIS	Incorporated Research Institutions for Seismology

-L-

LLNL	Lawrence Livermore National Laboratory (DOE)
LOFs	Location Organizer Folders
LPHC	Low-Probability, High-Consequence

-M-

MEL	Most Efficient funding Level
MF	Multi-Family
MPS	Minimum Property Standards

-N-

NAHB	National Association of Home Builders
NASA	National Aeronautics and Space Administration
NCAR	National Center for Atmospheric Research
NCCOS	National Centers for Coastal Ocean Science
NCDC	National Climatic Data Center (NOAA/NESDIS)
NEES	Network for Earthquake Engineering Simulation
NEHRP	National Earthquake Hazard Reduction Program
NESDIS	National Environmental Satellite, Data, and Information Service (NOAA)
NFIP	National Flood Insurance Program
NFDRS	National Fire Danger Rating System
NFMAS	National Fire Management Analysis System
NIMA	National Imagery and Mapping Agency
NIPA	National Income and Product Account
NIST	National Institute of Standards and Technology
NOAA	National Oceanic and Atmospheric Administration
NOS	National Ocean Service
NPOESS	National Polar-orbiting Operational Environmental Satellite System
NPS	National Park Service
NRC	National Research Council
NRC	U.S. Nuclear Regulatory Commission
NRCS	Natural Resources Conservation Service
NSF	National Science Foundation
NSSL	National Severe Storms Laboratory
NSTC	National Science and Technology Council
NSWP	National Space Weather Program
NWS	National Weather Service

-O-

OAR	Office of Oceanic and Atmospheric Research
OFCM	Office of the Federal Coordinator for Meteorological Services and Supporting Research
OGC	Open GIS Consortium
OGP	Office of Global Programs
OPA	Oil Pollution Act of 1990
ORACBA	Office of Risk Assessment and Cost-Benefit Analysis
ORR	Office of Response and Restoration
OSTP	Office of Science and Technology Policy

-P-

PATH	Partnership for Advanced Technology in Housing
PI	Project Impact
POES	Polar-orbiting Operational Environmental Satellite
PORTS	Physical Oceanographic Real-Time System
PPP-2000	Public-Private Partnership 2000
PROVE	Program for Research and Optimum Value Engineering

-R-

RA	Risk Assessment
R&D	Research and Development
RM	Risk Management
RUSLE	Revised Universal Soil Loss Equation

-S-

SEC	Space Environmental Center
SLOSH	storm surge model
SNDR	Subcommittee on Natural Disaster Reduction

-U-

USA	U.S. Army
USACE	U.S. Army Corps of Engineers
USAF	U.S. Air Force

USDA	U.S. Department of Agriculture
USFS	U.S. Forest Service
USGCRP	U.S. Global Change Research Program
USGS	U.S. Geological Survey
USN	U.S. Navy
USWRP	U.S. Weather Research Program

-W-

WFSA	Wildland Fire Situation Analysis