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.