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**HEARING ON
“PREPARING FOR CLIMATE CHANGE: ADAPTATION
PROGRAMS AND POLICIES”**

**BEFORE THE
HOUSE COMMITTEE ON ENERGY AND COMMERCE
SUBCOMMITTEE ON ENERGY AND ENVIRONMENT**

INTRODUCTION

Chairman Markey, Ranking Member Upton, and other members of the Committee, I am honored to speak with you today on climate adaptation. I am the Director of NOAA’s National Climatic Data Center, a premier service organization dedicated to providing climatological services to every sector of the United States economy and to users world-wide. I am also the Lead for developing and executing NOAA’s climate services. NOAA recognizes the importance of responding to the increasing demands for authoritative information and products to inform climate adaptation and mitigation activities. As such, we are working to improve NOAA’s climate services to the Nation. Thank you for inviting me to testify on how NOAA works across all levels of government and with other partners to help the Nation address the challenges and potential opportunities of a changing climate.

The Intergovernmental Panel on Climate Change (IPCC)’s definition of climate change refers to any change in climate over time, whether due to natural variability or as a result of human activity. Many climate-related changes are already being observed globally and within the United States, including changes in: air and water temperatures; sea level; freshwater supply; frequency and/or severity of intense hurricanes and heavy downpours, loss of sea ice; etc. These changes are likely to increase and threaten to profoundly impact the physical and biological environment, economic prosperity, human health, and national security. These changes present a substantial challenge to the Nation and the world. Climate change influences events across timescales from months to a season (e.g., floods and droughts), year-to-year variability (e.g., El Nino-Southern Oscillation events), and longer term changes over centuries (e.g., sea level rise, elevated global temperatures and attendant changes in precipitation). While we must learn to adapt across all of these timescales, this is especially challenging because we are adapting to a “moving target.”

There are two courses society can take to respond to climate-related impacts: (1) mitigation, meaning options for reducing heat-trapping emissions such as carbon dioxide, methane, nitrous oxide, and halocarbons; and (2) adaptation, meaning changes made to better respond to present

or future climatic and other environmental conditions, thereby reducing harm or taking advantage of opportunity. Most mitigation strategies concentrate on reducing greenhouse gas emissions through energy efficiency and the adoption and development of zero- or low-carbon technologies. The sooner mitigation strategies such as these are adopted, the sooner they will have an effect on long term climate change. However, while increased mitigation measures will likely reduce the need for future adaptation, the United States and the world will continue to experience changing climate conditions and resulting impacts¹. Therefore, both mitigation and adaptation are essential for a comprehensive climate change response strategy.

While mitigation is vital, my testimony will focus on adaptation and describe NOAA's role in climate adaptation activities.

NEED FOR CLIMATE ADAPTATION

We face the challenge of adapting to multiple climate induced impacts including: sea level rise, ocean acidification, increased air temperature and changes in precipitation patterns (with implications for the availability of freshwater resources), increased frequency or intensity of extreme weather events (heat waves, coastal storms, droughts and heavy downpours), changing storm patterns, coastal erosion and inundation (and corresponding water quality problems, e.g., salt water intrusion), changes in crop yields, changes in ocean productivity (fisheries), and new human health problems (changes in the climate-sensitive diseases and pests). Our efforts to adapt to changing climate will be occurring at a time of changing population dynamics, along with the continued expectations of a higher standard of living for both current and future generations. Supporting proactive climate adaptation plans and programs will enhance the resilience of the nation's communities, businesses, and natural resources in the face of changing climate conditions. Climate adaptation efforts will also help to safeguard the U.S. economy, as many industries are sensitive to weather and general climate conditions.

Adaptation can include a wide range of activities. Examples include a farmer deciding to grow a different crop variety better suited to warmer or drier climate; a company relocating key business centers away from coastal areas vulnerable to sea level rise and hurricanes; a community altering its zoning and building codes to place fewer structures in harm's way; and development or modification of buildings and infrastructure to make these structures less vulnerable to damage from floods, fires, lightning, and other extreme events. Some adaptation options are currently being pursued in various regions and sectors to deal with climate change and/or other environmental issues, but there are limits to how much adaptation can achieve (e.g., adaptation will not be able to prevent species extinction, permanent loss of land due to sea level rise, etc.).

Humans have adapted to changing conditions in the past. In the future, however, adaptation will be particularly challenging because climate will be changing for the next several generations. Climate will be continually changing, moving at a relatively rapid rate, outside the range to

¹ Solomon, S.; Plattner, G.-K.; Knutti, R.; and Friedlingstein, P. *Irreversible climate change due to carbon dioxide emissions*. Proceedings of the National Academy of Sciences. Vol. 106(6): 1704-1709.

which society has adapted to in the past². The precise amounts and timing of these changes can not be known with certainty. Because of this uncertainty, adaptation plans will need to be robust, flexible, and able to evolve over time.

Supporting the development of climate change adaptation plans and strategies requires information at temporal and spatial scales relevant for decision-making, and significant coordination and collaboration with a host of other federal, state and non-governmental entities. Consequently, understanding and responding to these information needs requires close collaboration between scientists and decision makers through a program of shared learning and joint problem solving. One adaptation strategy may call for specific modifications to existing infrastructure, while another might adopt a more general risk management approach as the best way to deal with climate change. Adaptation plans will likely span time scales from months to years to decades, and spatial scales from local to state, to regional, and to national. Decisions will need to be made based upon best available data and with knowledge of uncertainty about future climate change. Adaptation plans will need to be periodically evaluated and adjusted in light of new scientific findings and changing conditions.

NOAA'S ROLE – OUR WORK

NOAA is the nation's provider of weather and climate data and information assembled from a variety of sources, notably from NOAA and other agencies like the National Aeronautics and Space Administration (NASA) and the National Science Foundation (NSF), and from other countries such as France, Japan, and the United Kingdom. NOAA's climate information services result from a long history of NOAA collaboration and coordination with NASA, the U.S. Geological Survey, the U.S. Department of Agriculture, NSF, and other U.S. government agencies on weather and climate science based upon extensive observations, data stewardship, monitoring, research, modeling, predictions, projections, and assessments. Climate information such as drought forecasts, long-term precipitation trends, fire forecasts, and frequency and intensity of coastal storms, are all examples of information provided by NOAA that can inform the development of adaptation plans and strategies by resources managers. NOAA's National Weather Service is a vital component of its weather activities through the management and operation of its observing systems and the resulting observations, development of weather information on shorter time scales, and long standing information delivery infrastructure to communicate information to the public. NOAA works with customers and stakeholders to ensure we are providing high quality information that is user-friendly, responsive, and relevant to the issues being addressed. Increasing demands for integrated climate change information for adaptation however is now straining NOAA's ability to provide adequate climate change services.

NOAA has a strong resource management mission that requires timely, reliable, and authoritative information on climate change impacts. NOAA has both direct and indirect stewardship responsibilities, which are mandated or authorized by existing laws such as the *Magnuson-Stevens Fisheries Conservation and Management Reauthorization Act*, the *Coastal*

² IPCC, 2007: *Climate Change 2007: Synthesis Report. Contribution of Working Groups I, II and III to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change* [Core Writing Team, Pachauri, R.K. and Reisinger, A. (eds.)]. IPCC, Geneva, Switzerland, 104 pp.

Zone Management Act, the Marine Mammal Protection Act, the National Marine Sanctuaries Act, the Endangered Species Act, and others. NOAA also has responsibilities associated with the maintenance of coastal economies including maritime transportation under the Coast and Geodetic Survey Act and the Hydrographic Services Improvement Act. As part of these mandates, NOAA managers need to account for the effects of climate variability and change on coastal and marine ecosystems, living marine resources and communities, and adapt their management practices accordingly. A changing climate impacts numerous physical and biological conditions and processes, including ocean temperatures and pH levels, relative water levels in coastal regions and the Great Lakes, sea and lake ice cover, ocean current patterns, freshwater supply, saltwater intrusion, ecological services, biological diversity and distributions, changing patterns of disease, and atmospheric extremes.

As both a producer and user of weather and climate information, NOAA is well positioned to meet its mandates by integrating all climate, coastal, and marine ecosystem observations and predictions, improving delivery of integrated regionally-focused climate information to ocean and coastal decision-makers, and providing tools to effectively use this information to assess risks and implement effective management strategies. Existing NOAA programs provide a critical backbone for effective adaptation:

- NOAA provides operational, sustained weather, climate, and ocean observing networks and monitoring for the state of the ocean, coasts, and atmosphere;
- NOAA is the steward of climate-related data and information;
- NOAA provides critical weather and climate predictions, projections, and key climate model simulations for national and international climate assessment programs such as the IPCC and to those within other federal agencies for their use in development of revised management plans and adaptation strategies;
- NOAA provides predictions and projections of the future state of the climate;
- NOAA develops and delivers products, services, and technical assistance that respond to the needs of decision makers, resource managers, scientists, and the general public;
- NOAA participates in and leads many state of knowledge assessments for specific user-focused issues (e.g., water resource management, marine and coastal resources, disaster management); and
- NOAA has a growing number of collaborative efforts with other federal agencies to produce more effective decision support tools.

The following sections provide some illustrative highlights of climate information, products, services, technical assistance, and training that NOAA provides to the Nation as we address the challenges of a changing climate:

Scientific assessments of climate change impacts and science:

- NOAA is one of several agencies providing authors and review editors, observations, data, model simulations, and analysis, to develop IPCC Assessment Reports.
- NOAA is one of 13 federal agencies involved the U.S. Climate Change Science Program and led the development of nine of the CCSP's Synthesis and Assessment Products. NOAA is currently involved in the development of the CCSP's *USP for Global Climate*

Change Impacts in the USA. The *USP*, when finalized, will be a compilation of the Synthesis and Assessment Products, a series of assessments integrating the current science and information on key climate issues of concern for decision makers (e.g., Synthesis and Assessment Product 3.3 provides a comprehensive analysis of observed and projected changes in weather and climate extremes in North America and U.S. territories).

- NOAA and many federal agencies contributed to the development of the Arctic Climate Impact Assessment (2004), which synthesized the available information on climate variability and change in the Arctic region and analyzed potential climate-related impacts.
- NOAA provides global, North American, and U.S. assessments of the current state of the climate including analysis of temperature, precipitation, drought, significant events, extremes and hazards. Reports such as the intergovernmental and interagency U.S. and North American Drought Monitor and the National Climatic Data Center's State of the Climate Reports place the current state of the climate into the context of the historical climate and climate events.
- NOAA's National Climatic Data Center, with the University of North Carolina, Asheville, supported the production of *Adaptation Planning Handbook: Planning for a New Energy and Climate Future*, which was developed for the Professional Planner. This resource will be used in workshops across the country by State Climatologists and decision makers, to help cities and counties make informed decisions and adapt to climate change. (Anticipated to be published by the American Planning Association in 2009.)
- NOAA maintains key observing systems for monitoring climate change and climate impacts (e.g., ocean buoy and drifter systems, satellites, tide and water level gauges, and coastal land elevation monitoring systems for sea level rise, and the Climate Reference Network) to help decision makers design mitigation and adaptation strategies.
- NOAA develops regional and coastal climatologies such as the Pacific Region Integrated Climatologies Program, which focus on providing information on the patterns and impacts of storminess (high seas, strong winds, and heavy rain) that contribute to coastal inundation hazards.

Partnerships and Applied Information Services in Support of Adaptation:

- The Regional Integrated Sciences and Assessments (RISA) program supports research to address complex climate-sensitive issues of concern for decision-makers and policy planners at a regional level. The RISAs are primarily based at universities, though some members are based at government research facilities, non-profit organizations, or private sector entities. Research topics include agriculture, ecosystem restoration, fisheries, health, water, and wildfire.
 - The Climate Impacts Group RISA at the University of Washington (in partnership with several other entities) released a report exploring what climate change means for Washington State. The Washington Climate Change Impacts Assessment evaluates the impacts of climate change across eight sectors and considers options for adapting to climate change within each. This RISA was also involved with the development of a guidebook, *Preparing for Climate Change: A Guidebook for Local, Regional, and State Governments*. This guidebook is the product of a

collaborative effort between the RISA, King County, WA, and ICLEI – Local Governments for Sustainability, and provides information for regional, state, and local governments on adapting to climate change and its impacts.

- The Carolinas Integrated Sciences and Assessments RISA recently established a formal relationship with the regional Sea Grant programs, as a means to leverage the work of other programs into the RISA. The major objectives of this RISA are to develop, evaluate, and provide key information on how climatic conditions in the Coastal Carolinas may be changing at present and what may be expected to happen in the future. This information is being made available to the public, stakeholders, government agencies and educational programs. Differentiating regional climatic variability and changes from global changes will be a significant part of this undertaking.
- Regional Climate Centers have helped deliver much needed climate information to many of the stakeholders in their respective regions. For example, the Western Regional Climate Center worked with the major federal land management agencies within the Department of the Interior to develop climate-related decision-support tools. Land managers use these tools to support strategies to adapt to the impacts of climate and climate change on fire-vegetation. The Southern Regional Climate Center assisted the Louisiana Governor's Office of Homeland Security and Emergency Preparedness by interpreting climate scenarios of tropical storms. The Southern Regional Climate Center has helped to produce synthetic storm scenarios for emergency planning and exercises such as Hurricane Delaney and, more recently, Hurricane Pam (a study that illustrated the impact of a theoretical storm hitting metropolitan New Orleans and the Louisiana coast, prior to the appearance of Hurricane Katrina).

Partnerships and Applied Information Services in Support of Adaptation – Applications to Living Marine Resources and Habitats

Climate change information is being incorporated into coastal and ocean living marine resource and coastal ecosystem management decisions within NOAA through an increasing emphasis on an ecosystem approach to management and other efforts. NOAA works with federal agencies, state and local governments, nonprofit organizations, and the private sector to help coastal communities acquire, protect, conserve, and restore coastal habitats, not only for the aesthetic and natural habitat benefits, but also because they provide important services to reduce the impacts of storms, flooding, and other coastal hazards. NOAA's efforts include large-scale and regional efforts involving multiple projects, as well as individual and local projects designed to protect or restore coastal wetlands, rivers, and other habitats. NOAA recognizes it is imperative to work with other federal agencies, states, and community partners to develop ecosystem approaches to respond to the effects of changing climate conditions. A strong planning element, matched by determined local involvement leads to proactive adaptation.

- NOAA's Coastal and Estuarine Land Conservation Program provides a tool for states to address climate change and coastal hazards through cost-sharing land acquisition. In the spring of 2008, NOAA held two internal workshops, the *NOAA Climate and Living Marine Resources Workshop* and the *NOAA Workshop on Strengthening Capacity to*

Address the Impacts of Climate Change on Coastal Communities and Ecosystems. The goal of these two workshops was to bring together scientists, program managers, advisors, and staff from labs, offices, and centers across NOAA to discuss and outline strategies to better incorporate climate change information to “(1) fulfill NOAA’s resource management responsibilities for living marine resources; and (2) strengthen NOAA and its partners’ capacity to address climate impacts on coastal communities and ecosystems.” A Technical Memorandum (NMFS-F/SPO-95) outlining the outcomes, possible near-term opportunities, and next steps were developed to capture many of the suggestions and recommendations presented by the participants in the workshops.

- NOAA’s Coral Reef Watch satellite program produces near-real-time, web-accessible sea surface temperature products, which monitor for conditions conducive to coral bleaching around the globe. The data provide current reef conditions to quickly identify areas at risk, as well as archived information and retrospective analysis to be used for reef management, scientific research, and monitoring our changing climate.
- NOAA has worked with the Bureau of Reclamation and other agency projects on the impacts of long-term precipitation patterns on management of endangered salmon stocks on the West Coast.

Applied Partnerships and Information Services in Support of Adaptation – Applications to Coastal Communities

NOAA, through a federal-state partnership under its Coastal Zone Management Program, provides national leadership, technical assistance and funding to state and territory coastal management programs to plan for and adapt to climate change. Climate change related projects include creating sea level rise inundation models, developing plans for adapting to climate change, understanding changing ecosystem function and services, changes in ecosystem health and marine animal disease under existing and predicted climate change impacts, and establishing new guidelines for dealing with sea level rise.

- NOAA is engaged a collaborative effort with the U.S. Geological Survey to help the nation prepare coastal adaptation strategies by conducting workshops and fostering partnerships within and between states, regional governance structures, and federal agencies to facilitate adaptation to increased coastal inundation and sea level rise. These agencies are cooperating on joint coastal mapping efforts pursuant to the funding provided by the *American Recovery and Reinvestment Act*.
- NOAA is supporting the San Francisco Bay Conservation and Development Commission’s regional planning efforts to adapt to climate change in the Bay Area. NOAA is helping the coastal management agency achieve the objectives of their adaptation plans by supporting their work on mapping shoreline areas vulnerable to sea level rise; organizing a regional program to address climate change in the Bay Area, and updating the San Francisco Bay Plan findings and policies to address global climate change effects on San Francisco Bay.
- NOAA is collaborating with state and academic partners to examine potential changes in the distribution and range of marine animals as well as marine pathogens in response to climate change. This will improve our understanding of how climate-related shifts in previously identified ranges may affect the risk of human exposure to certain pathogens.

Applied Partnerships and Information Services in Support of Adaptation – Applications to Water Resources

Climate variability and change affect the function and operation of existing water infrastructure — including hydropower, structural flood defenses, drainage, and irrigation systems — as well as water management practices. NOAA's climate programs provide the Nation with services and information to improve management of climate sensitive sectors such as water resources through observations, analyses and predictions, decision support tools, and sustained user interaction.

- As requested in the 2004 Western Governors' Association Report, *Creating a Drought Early Warning System for the 21st Century: The National Integrated Drought Information System (NIDIS)*, and codified by the 2006 NIDIS Act (Public Law 109-430), NIDIS is an interagency effort designed to serve as an early warning system for drought and drought related risks enabling society to respond to periods of short-term and sustained drought. The role of NIDIS is to develop the leadership and networks to implement an integrated drought monitoring and forecasting system at federal, state, and local levels; foster and support a research environment focusing on risk assessment, forecasting, and management; create an "early warning system" for drought to provide accurate, timely, and integrated information; develop interactive systems, such as the web-based U.S. Drought Portal, as part of the early warning system; and provide a framework for public awareness and education about drought. NIDIS is providing improved coordination and delivery of more comprehensive and timely drought information, impacts and forecasts, as well as decision support tools, for many users to help mitigate drought-related impacts.
 - NIDIS consolidates activities and inputs from the RISAs, Regional Climate Centers, etc, into an early warning information system for drought.
 - NIDIS has launched the U.S. Drought Portal as a clearinghouse for cross-agency drought related monitoring, forecasts, and impacts information.
 - NIDIS has begun development of the Colorado Basin Drought Information Portal and drought monitor (as a subset of the U.S. Drought Portal).

IMPROVING NOAA'S CLIMATE INFORMATION AND SERVICE FOR THE FUTURE

The above examples are only a small subset of NOAA's work in climate adaptation activities. In 2008, NOAA began an effort to improve its integrated climate services to: (1) develop and deliver a more broad range of operational climate information products and services; (2) in partnership with other federal agencies with trust resource mission mandates, to support research on the impacts of climate variability and change on human and natural environments; (3) support and preserve the climate data record; (4) support the development of assessments and adaptation strategies from international to local levels; and (5) collaborate with stakeholders on enhancing their capacity to use climate information and related decision-support resources.

Early activities of this effort include:

- NOAA offices working across the agency to begin to develop a single point of access for integrated data, models, tools, and information useful to understanding, mitigating, and adapting to a changing climate
- Exploration of high priority areas for climate product enhancement and services in areas such as ocean acidification and sea level;
- Continued development of integrated data products and decision support tools in response to the needs of climate sensitive communities, protected areas, and economic sectors.

CONCLUSION

Despite the substantial efforts by NOAA to date, there still remain significant knowledge gaps and uncertainties for adaptation, as well challenges in communicating knowledge and information relevant for decision makers. In addition, the scale at which reliable information is produced (i.e. global) does not always match what is needed for adaptation decisions (i.e. at the watershed and local levels). New information tools and planning processes are attempting to overcome these barriers at local, regional, and national levels in both developing and developed countries.

An effective response to changing climate conditions will require an integrated, flexible, and responsive Government-wide approach. To help fill this need, NOAA has been working with other agencies to build on existing capacities to create a seamless and integrated process for transferring climate science information to society to allow for informed decision-making and the development of adaptation activities at the federal, state, and local levels.