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U. S. DEPARTMENT OF COMMERCE**

**OVERSIGHT HEARING ON
“FEDERAL FLOOD INSURANCE PROGRAM”**

**BEFORE THE
COMMITTEE ON BANKING, HOUSING, AND URBAN AFFAIRS
UNITED STATES SENATE**

OCTOBER 18, 2005

Good morning, Mr. Chairman and members of the Committee. Thank you for inviting me to discuss the outlook for hurricane activity in the future and the storm surge and inland flooding associated with hurricanes. I am Chris Landsea, with the National Hurricane Center in the National Weather Service (NWS) of the National Oceanic and Atmospheric Administration (NOAA), within the Department of Commerce.

The devastation along the Gulf Coast from Hurricane Katrina and Hurricane Rita is like nothing I have witnessed before. Words cannot convey the physical destruction and personal suffering in that part of our Nation. However, without NOAA’s forecasts and warnings, the devastation and loss of life would have been far greater.

NOAA’s forecasts and warnings for Hurricane Katrina demonstrated the abilities of the state of the art of hurricane prediction. Our continuous research efforts at NOAA, and in partnership with universities and other Federal agencies, have led to our current predictive capabilities and improved ways of describing uncertainty in prediction. Hurricanes pose a major threat to our Nation's coastal communities. The impacts of hurricane winds, storm surge and inland flooding remain major threats to the Nation. Accurate and timely hurricane forecasts provide emergency managers and the public information needed to prepare for an approaching storm, including considering evacuations, if necessary. Understanding the location and severity of hurricane landfall is the key to planning long before the event.

NOAA strives to improve the reliability, accuracy, timeliness, and specificity of predictions of hazardous weather, such as hurricanes, to help society cope with these phenomena. Over the last 15 years, hurricane track forecast errors have decreased by 50%, largely due to advances in hurricane modeling, an increased understanding of hurricane dynamics, improvements in computing and technology, and increased availability of data from the region around the hurricane. Today’s five-day forecasts of a hurricane track are as accurate as three-day predictions were 20 years ago.

Recently there have been questions raised about NOAA's Hurricane Program. Given the importance to the Nation, NOAA and the Department of Commerce appreciate any insights to improve our forecasts and warnings. NOAA continues to develop new satellite technologies, procure and deploy new buoys, upgrade radiosonde instruments and invest in additional modeling efforts. The result has been that Hurricane predictions are better today than they have ever been and will continue to improve in future.

While the North Atlantic hurricane season officially lasts from June 1 to November 30, tropical systems have formed in every month of the year. The tropical storms that turn into hurricanes and threaten the East and Gulf coasts of the United States form in the Gulf of Mexico, Caribbean Sea, and Atlantic; many of these storms develop from tropical waves moving off the west coast of Africa. Hurricanes are fueled by warm water as they travel across the ocean; an abundance of warm water provides more energy allowing the storm to increase in strength. However, data indicate that warm water alone is not enough to determine whether a storm will intensify. The winds between the upper and lower levels of the atmosphere (from just above the ocean to about eight miles up) also play a major role. Strong vertical shear (*i.e.* a large difference in the speed and direction of the wind between these two levels) in the wind inhibits the formation or intensification of tropical cyclones whereas, weak wind shear encourages them.

An active hurricane season does not necessarily mean more storms make landfall, nor does an inactive period mean no landfalling hurricanes. In 1992, a relatively quiet year, Hurricane Andrew became the costliest disaster in U.S. history at the time, and was the only hurricane to make landfall that year. While anticipating a higher level of activity during hurricane seasons for the next few decades due to multi-decadal fluctuations, we do not expect every year to be hyperactive. With more active hurricane seasons, the risk for "major" hurricanes (Category 3 or greater on the Saffir-Simpson scale) to impact the United States or our neighbors in the Caribbean and Central America does increase. It is also important to note that even a weak landfalling storm can cause devastating inland flooding, such as Agnes in 1972 and Allison in 2001. The increase in population and development along our coastline increases the damage potential for an area impacted by a hurricane. The hurricanes of this year and last year provide vivid reminders of the destruction these storms can inflict on our society.

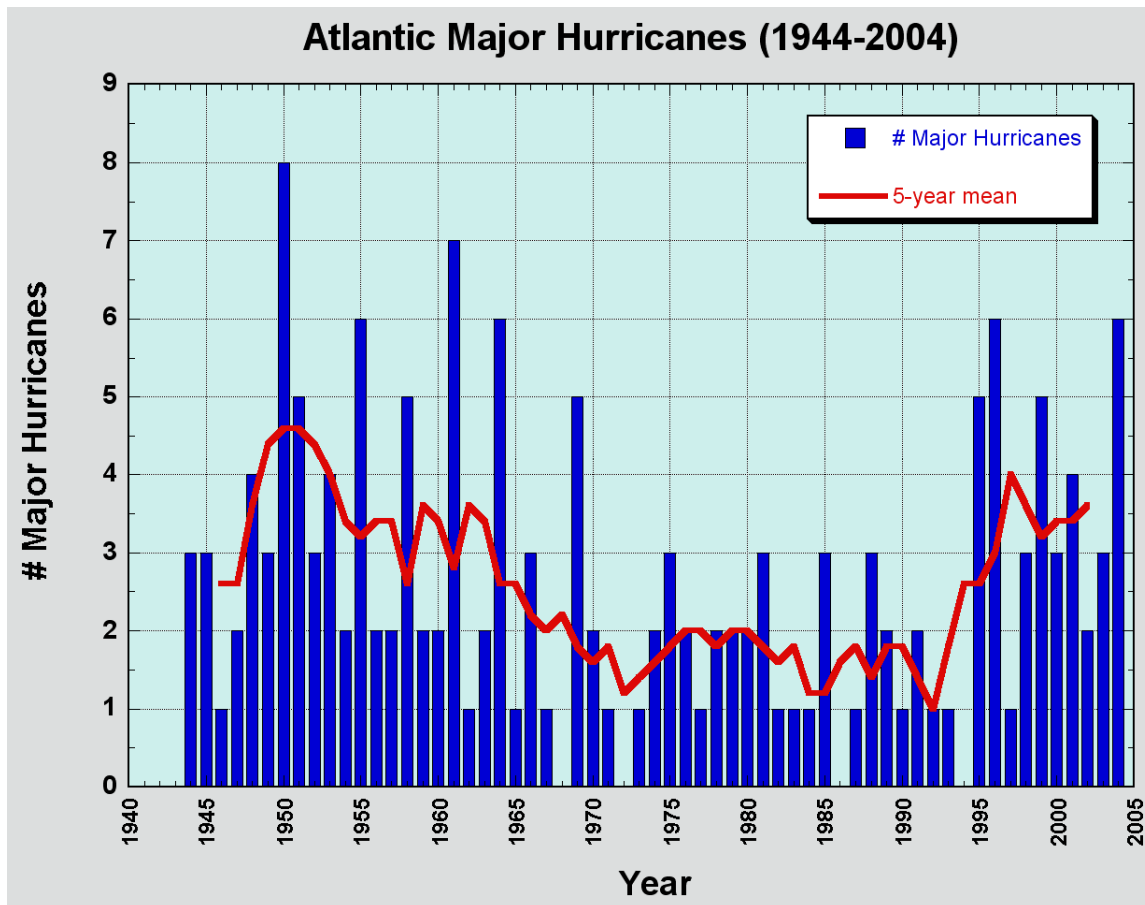
Outlook for Future Hurricanes

In recent decades, the United States had experienced relatively few hurricane landfalls and, in particular, very few "major" hurricanes — those of Category 3 or higher on the Saffir-Simpson hurricane scale (Category 1-5). Our good fortune ended last year when six hurricanes hit the United States, and three of those were major hurricanes. This year to date we have had twenty tropical storms, eleven of which have become hurricanes, and five of those have been major hurricanes. Of these five, Dennis, Katrina and Rita struck the United States as major hurricanes. Most of the deadliest and costliest Atlantic tropical cyclones are major hurricanes. Today, major hurricanes account for just over 20% of the landfalling United States tropical storms and hurricanes but cause more than 80% of the damage.

The 2005 hurricane season has already been one of the most active on record. In the last ten years, we have experienced a higher level of North Atlantic hurricane activity. Compared with the previous two and a half decades, more than twice as many major hurricanes have occurred annually (3 to 4 hurricanes on average since 1995 versus 1 to 2 during the period from 1971 to 1994).

Based on changes in oceanic and atmospheric conditions, we believe this increased activity is due to a natural cycle called the Atlantic Multidecadal Mode, a shift in the surface temperature of the north Atlantic and Caribbean Sea between warm and cool phases, with each phase lasting 20 to 40 years. Data suggest we are currently in a warm Atlantic phase; thus, an active Atlantic hurricane era is underway, similar to that last seen from the late 1920s to the late 1960s. Our research suggests that many of the hurricane seasons in the next two or three decades may be much more active than they were in the 1970's through the early 1990's. Warmer sea surface temperatures are expected to contribute to conditions that foster increased hurricane development over this period (see chart below).

Recent research papers by respected scientists have linked global warming changes to increased hurricane intensity. While these researchers have brought up very important questions that need to be addressed, it can still be concluded that the increase in hurricane activity in recent years is due to a natural cycle, rather than man-made causes.



Inland Flooding and Storm Surge

Both storm surge and inland flooding pose significant challenges to both coastal and inland communities. As experienced with Hurricane Katrina, storm surge can be a deadly aspect of hurricanes for which we need to be prepared. Storm surge is water pushed over the shoreline by the force of the winds associated with a hurricane. An advancing storm surge combines with normal tides to create a hurricane storm tide, which can increase the water level to as much as 30 feet or more above normal levels. The direct and indirect effects associated with the massive storm surge from Katrina were responsible for hundreds of lives lost in Louisiana and Mississippi. Loss of life is a function of the physical factors of a storm surge and inland flooding, as well as storm frequency and many sociological conditions, including population density, land use, design and implementation of local and regional preparedness plans, past storm experience, communication, and forecast accuracy.

For coastal counties, storm surge has historically represented the primary tropical cyclone threat. The dangers associated with storm surge apply along the coast, bays, sounds, and coastal sections of rivers. The severity of a surge, as measured by the depth and how far inland the water reaches, depends on a number of natural factors, such as cyclone intensity (surface wind speed) and forward speed of motion, local bathymetry, coastal topographic gradients, and barrier (e.g., dune) structure. The level of surge in a particular area is also determined by the slope of the continental shelf. A shallow slope off the coast will allow a greater surge to inundate coastal communities. This rise in water level can cause severe flooding in coastal areas, particularly when the storm surge coincides with the normal high tides. Because much of the densely populated United States Atlantic and Gulf coastlines lie less than 10 feet above mean sea level, the danger from storm surge is tremendous. Communities with a steeper continental shelf will not see as much surge inundation, although large breaking waves can also cause serious damage in those areas. Storm surge, waves, and currents in confined harbors result in severe damage to ships, marinas, and pleasure boats.

Freshwater floods from rain present another great threat to life and property in tropical cyclones, and these effects occasionally exceed the coastal impact. While public attention often shifts away as hurricanes move inland, additional death and property damage can occur due to inland flooding from excessive rainfall. For example, the devastation experienced throughout much of eastern North Carolina in the wake of Hurricane Floyd in 1999 was a result of inland flooding. Such floods can occur hundreds of miles inland. As tropical cyclones move inland, their environments, structures, and risks can change markedly from their marine forms. Intense rainfall, not directly related to the wind speed of a tropical cyclone, often causes significant damage. In our Nation, inland flooding is the second leading cause of loss of life from tropical cyclones, behind storm surge. Typically, greater rainfall amounts and flooding are associated with tropical cyclones that have a slow forward speed or stall over an area. Significant rainfall and inland flooding are not only associated with hurricane-strength storms. Some of the more severe flood events have been associated with tropical cyclones which only reach tropical storm strength. The devastation in southeast Texas and the Houston area in 2001 was a result of Tropical Storm Allison.

Two types of inland flooding occur from tropical cyclones: flash flooding and river flooding. Flash flooding occurs in creeks, streams, and urban areas within a few minutes or hours of

excessive rainfall. Rapidly rising water in confined valleys or canyons can reach heights of 30 feet or more. Streets can become swift moving rivers and underpasses can become death traps. River flooding occurs from heavy rains associated with decaying hurricanes or tropical storms, and in extreme cases, river floods can last a week or more.

Since Hurricane Floyd and Tropical Storm Allison, we have taken steps to improve our forecasts of rainfall amounts, extended those forecasts out to five days, and incorporated those rainfall forecasts into our river and flood predictions. The NWS conveys the magnitude of observed or forecast flooding using flood severity categories. These flood severity categories include minor flooding, moderate flooding, and major flooding. Each category has a definition based on property damage and public threat. *Minor Flooding* indicates minimal or no property damage, but possibly some public threat or inconvenience. *Moderate Flooding* indicates some inundation of structures and roads near streams. Some evacuations of people and/or transfer of property to higher elevations may be necessary. *Major Flooding* is defined as extensive inundation of structures and roads. Significant evacuations of people and/or transfer of property to higher elevations may be necessary. NWS precipitation frequency estimates are used as design standards for civil infrastructure built to cope with rainfall and runoff, such as storm water drainage systems, roads, bridges, culverts, small dams, etc. These precipitation frequency estimates also contribute to computing flood insurance rate maps and support various planning activities. The estimates help ensure an objective assessment of the probability of heavy rainfall in planning and design.

The impacts of a flood vary locally. For each NWS river forecast location, flood stage and the stage associated with each of the NWS flood severity categories are established in cooperation with local public officials. Impacts vary from one river location to another because a certain river stage (height) in one location may have an entirely different impact than the same level above flood stage at another location.

Future Plans

A key program for increasing our ability to monitor hurricanes, particularly over the data-sparse ocean areas, will be addressed through the Global Earth Observation System of Systems (GEOSS), a 10-year international endeavor of which the United States is a member and NOAA, the National Aeronautic and Space Administration (NASA), and U.S. Geological Survey are key participants.

Using a combination of atmospheric and ocean observations from satellites, aircraft, and all available surface data over the oceans, NOAA, NASA, the National Science Foundation, other federal agencies, and universities conduct experiments to better understand internal storm dynamics and interactions between a hurricane and the surrounding atmosphere and ocean. Much of NOAA's improvement in tropical cyclone forecasting is attributed to advances in Numerical Weather Prediction (NWP). In collaboration with many scientists and developers in the domestic and international operational NWP centers, the NOAA Environmental Modeling Center develops state of the art numerical modeling systems.

Predicting hurricane intensity, which includes wind structure, storm surge, and rainfall amounts, remains one of our acute challenges. For example, even though we knew conditions were favorable for Katrina and Rita to intensify, and we forecast strengthening, there was some error for both storms in the intensity forecast for the eastern Gulf due to their rapid intensification. To advance hurricane prediction, especially hurricane intensity and size forecasts, NOAA is developing the Hurricane Weather and Research Forecasting (HWRF) system. The HWRF system uses a collaborative approach among the research community and will apply advanced model physics as HWRF couples the atmosphere, land, and ocean into an integrated model. Our goal is to couple an advanced wave model with a dynamic storm surge model to better predict coastal impacts of waves and storm surge.

We have increased our efforts to transfer research into operations. The United States Weather Research Program (USWRP) Joint Hurricane Testbed (JHT) was formed in late 2000. The mission of the JHT is to facilitate the transfer of new technology, research results, and observational advances of the USWRP, its sponsoring agencies, the academic community, and the private sector for improved operational tropical cyclone analysis and prediction. A large portion of my job at the National Hurricane Center is to facilitate and test these new projects for possible implementation into operations. While there are no quick fixes, we expect our continued efforts along these lines will continue to improve predictions of the path of these storms, their intensity, and inland flooding caused by the precipitation from these tropical systems.

Conclusion

Thank you Mr. Chairman and members of the Committee for this opportunity to discuss the outlook for hurricane activity in the future and the storm surge and inland flooding associated with hurricanes, and how we are working to better prepare our country for these changes. I would be happy to address any questions you may have.