TESTIMONY OF
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ON
DROUGHT AND THE EFFECT ON ENERGY AND WATER MANAGEMENT DECISIONS

U.S. SENATE COMMITTEE ON ENERGY AND NATURAL RESOURCES

April 25, 2013

My name is Roger S. Pulwarty and I am the Director of the National Integrated Drought Information System (NIDIS) at the National Oceanic and Atmospheric Administration (NOAA). It is my honor to be here today. Thank you for inviting me to speak about our program, report on the information and data that have been made available to local, State, and regional water decision-makers, and how we can improve the information for anticipating and managing current and future drought conditions.

The NIDIS was established via the National Integrated Drought Information System Act of 2006 (Public Law 109-430, hereafter the NIDIS Act), which builds on longstanding efforts among agencies and institutions that have historically focused on drought risk assessment and response. The NIDIS Act prescribes an interagency approach, led by NOAA, to "Enable the Nation to move from a reactive to a more proactive approach to managing drought risks and impacts." Our goals are to (a) improve public awareness of drought and attendant impacts and (b) improve the coordination and capacity of counties, states and watershed to reduce drought risks proactively.

An important feature of the weather conditions in 2012 was the *persistence* of the areas of dryness and warm temperatures, the *magnitude of the extremes*, and the *large area* they encompassed. Broad sectors were affected and continue to be affected by the 2012 drought. Impacts include, but are not limited to, reduction in crop yields and commerce on major river systems.

In my testimony I will highlight what we know about the following questions and issues:

How did we get here? Status and antecedent conditions.
What are the impacts in the energy sector and where are they occurring?
What information is being provided and by whom? Are information needs being met?
How bad might it get and how long will it last?
What can be done to improve the use of drought and other climate information to manage risks and opportunities in the energy sector?

Information for this testimony is drawn from NIDIS and its supporting partners including NOAA's Climate Prediction Center, NOAA's Earth System Research Laboratory's Physical Sciences Division, NOAA's National Climate Data Center, NOAA's River Forecast Centers, NOAA's Regional Integrated Sciences and Assessments, the National Drought Mitigation Center (NDMC) at the University of Nebraska Lincoln, the U.S. Army Corps of Engineers, the Department of the Interior (specifically the U.S. Geological Survey (USGS) and the Bureau of Reclamation), the U.S. Department of Agriculture's (USDA) Office of the Chief Economist and Natural Resources Conservation Services, the National Aeronautics and Space Administration (NASA), the National Interagency Fire Center, the Western Governors' Association, the Western States Water Council, Regional Climate Centers, State Climatologists, and State and Tribal Water Resources Departments, among others.

Drought is part of the American experience. Severe, long-lasting droughts have occurred in the Southwest during the 13th century, and in the central and lower Mississippi Valley in the 14th through 16th centuries. The great Civil War drought of 1861-1864 led to the first water rights agreement in the West - in the San Luis Valley in the state of Colorado where I live. In the 20th century, droughts in the 1930s (Dust Bowl era) and 1950s were particularly severe and widespread. In 1934, 65% of the contiguous United States was affected by severe to extreme drought. These extreme events, including droughts of shorter duration but nevertheless severe, such as in 1977, have been felt throughout economies, ecosystems, and livelihoods, and certainly shaped much of the planning and practice surrounding modern water resources management and related decisions.

Since 2000, the total U.S. land area affected by drought of at least moderate intensity has varied from as little as 7% of the contiguous U.S. (August 3, 2010), to 46% (September 10, 2002) and over 60% of the Nation in the last year (July 3, 2012). Based on weekly estimates of the areal extent of drought conditions since 2000, the average amount of land area across the United States affected by at least moderate-intensity drought annually has been 25%.

As mentioned earlier, an important feature of the weather conditions in 2012 was the *persistence* of the areas of dryness and warm temperatures, the *magnitude of the extremes*, and the *large area* they encompassed.

Figure 1 (attached) shows the progression of drought conditions since 2010 to the present. The year 2012 began with about 32% of the contiguous U.S. in moderate to exceptional drought with three areas of moderate to exceptional drought in the Southern Plains and moderate to extreme drought in the Southeast — with areas of moderate to severe drought in the Upper Mississippi Valley and moderate drought in the Far West. As the year progressed, the western drought expanded to link with the Southern Plains drought area and new drought areas developed along the East Coast, pushing the national drought area to 38.2% by May 1st.

Drought re-intensified suddenly in May and strengthened through July and August, which inhibited summertime convection/rainfall and some locations experienced exceptionally dry conditions with 30-60 days having no precipitation event. An interagency task force on drought that includes NOAA, NASA, and works with NIDIS, recently released a report on the cause of this re-intensification. One of the causes of this drought re-intensification was the unusual high pressure that reduced the southward push of cold fronts from the North that typically serves to organize rainfall during this time. Only 1934 had more months with more than 60% of the contiguous U.S. in moderate to severe drought.

Year	Month and '% Area under Moderate or stronger drought conditions over the U.S.'					
1934	May-73.1	Jun-74.1	Jul-79.9	Aug-77.5	Sep-70.2	Oct-67.7
1939	Dec-62.1					
1954	Jul-60.4	Dec-59.5				
2012	Jul-62.8	Aug-60.0	Nov-60.0	Dec-61.8		

The 10 driest years in the record since 1895, ranked in order of their summer (May-August) rainfall in the Midwest deficits are: 2012, 1934, 1936, 1901, 1976, 1913, 1988, 1953, 1911, and 1931. The deficit in rainfall over the Midwest in 2012 was -34.2 mm, which was about 53% of the region's long-term mean rainfall (73.5 mm). This deficit broke the record of -28.4 mm observed in 1934. In May and June (Figure 1, attached), a zonal ridge of high pressure anomalies inhibited the typical southward push of cold fronts from Canada that often serve to organize widespread rains.

Many local records were also set last year. For instance, on June 26, Red Willow, Nebraska set a temperature record of 115 degrees, eclipsing the 114-degree mark set in 1932. Twenty eight states east of the Rockies set temperature records for the six-month period, putting further pressure on agricultural irrigation requirements and direct plant crop stress, on energy demands for cooling and water storage management.

The following summarizes key features of the 2012 drought as experienced across different regions of the U.S. over the year (Figure 1, attached):

- Persistent and anomalous heat resulted in the warmest month ever in July 2012, and 2012 was ranked as the warmest year on record for the contiguous U.S.
- During the May – July growing season, dry weather dominated across the agricultural areas in the Central Plains to the Midwest.
- The anomalous warmth increased evaporation and intensified drought conditions during the growing season.
- As the year progressed, the western drought expanded to link with the Southern Plains drought area and new drought areas developed along the East Coast.
- Record heat and near-record dryness occurred in Colorado, contributing to numerous wildfires.
- Several states had record dry seasons: Arkansas (April-June and other seasons), Kansas (May-July), Nebraska (June-August and other seasons), and South Dakota (July-September).
- The prolonged dryness in parts of the Southeast gave Georgia the driest December-November 24-month period (December 2010-November 2012) on record.

- Several river basins have experienced unusually dry conditions during 2012, with the Upper Colorado having one of its driest years in the 1895-2012 period in the record.
- The spatial pattern of drought this year closely overlaid the agricultural area of the U.S. heartland, and the excessive temperatures and lack of rain during the critical growing season severely reduced corn and soybean crop yield.
- The extreme severity of the dryness and evapotranspiration demand over the growing season resulted in a rapid increase in the percent area of this agricultural belt experiencing moderate to extreme drought (as defined by the Palmer Drought Index) and moderate to exceptional drought (for the Midwest and High Plains as defined by the U.S. Drought Monitor (USDM)).

Drought, Water and Energy: Recent impacts across the Nation

Drought affects energy production in a variety of ways. For example, some regions are dependent on water supplies for hydropower and/or thermal power plant cooling; temperature increases during periods of drought reduce overall thermoelectric power generation efficiencies; and altered conditions can affect facility siting decisions. Recent significant droughts have demonstrated how dry conditions and high temperatures affect the energy sector due to their high dependence on water resources. But these events have also highlighted the potential benefits of reliable climate and weather information for improving energy-water strategies. The need for this type of information is increasing as the awareness of the central role of water for energy production, and industry's expanding understanding of the role of energy in water management, also increases.

In 2000, U.S. electricity production accounted for 41% of national freshwater withdrawals, roughly the same as for irrigated agriculture.[1] Much of this water is used for cooling purposes and discharged back to the source water body. Electricity production accounts for 3% of all water consumption in the U.S. By 2040, the Energy Information Administration expects U.S. primary electricity demand to grow by roughly 10% (to almost 43% of total withdrawals) — placing an additional burden on freshwater supplies[2] that in many parts of the country will already be stressed by increasing population pressures, climate change, and other factors.

A Summary of Impacts from the Colorado State Drought Plan Energy Sector Vulnerability Assessment of 2010[3] summarizes some of the possible impacts of drought on energy supply in both the short and long term:

- Decreased power generation due to inadequate water supply for evaporative cooling
- Increased costs for power providers to purchase additional water during drought
- Decreased hydropower generation due to lower water reservoir levels

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[1] Averyt, K., J. Macknick, J. Rogers, N. Madden, J. Fisher, J. Meldrum, R. Newmark. 2012. Water use for electricity in the United States: an analysis of reported and calculated water use information for 2008. *Environ. Res. Lett.* **8** 015001 doi: 10.1088/1748-9326/8/1/015001,

[2] EIA 2013 Annual Energy Outlook.

[3] Colorado Water Conservation Board (CWCB). (2010). *Colorado Drought Mitigation and Response Plan*. Annex B. Energy Sector Vulnerability Assessment pp. B119-158. Retrieved from http://cwcb.state.co.us.

- Change in power supply mix and operation costs can result in increased price for electricity
- Discharge temperature limits could result in prolonged plant shutdowns
- Severe power cutbacks could result in rolling blackouts
- Environmental impacts could result from shifts in power production depending for instance on changing peak times for hydropower demand
- Increased intake water temperatures can decrease plant efficiency and cooling ability
- Plant shut downs may occur due to water levels dropping below intake elevations
- Increased costs for mining operations to obtain water rights
- Decreased power generation activity due to inability to obtain additional water rights
- The energy sector's ability to obtain more water rights may require transferring water rights from other sectors (e.g. agriculture) to the energy/power sector to meet the increased water demand

To illustrate the breadth and importance of these above potential impacts on the energy sector, a number of specific examples follow (drawn from NIDIS partners in Federal, state and tribal agencies including NOAA's Regional Integrated Sciences and Assessments (RISAs), National Weather Service Field Offices and River Forecast Centers, Regional Climate Centers, U.S. Army Corps of Engineers, USGS, and the Bureau of Reclamation, all of which contribute directly to the NIDIS early warning systems)[4]:

- The 2007-2009 severe drought in the Southeast threatened the cooling water supplies of more than 24 of the nation's 104 nuclear power reactors.
- When drought affected the Southeast US in 2007, power plants from Atlanta, GA to Raleigh, NC cut back their water use, resulting in North Carolina customers facing blackouts as water problems forced Duke Energy to cut output at its G.G. Allen and Riverbend coal plants on the Catawba River. In addition, Duke Energy was working hard to keep the water intake system for its McGuire nuclear plant underwater as water levels dropped.
- Also in the 2007 Southeast US drought, the Browns Ferry, AL nuclear plant had to drastically reduce its output to avoid exceeding the temperature limit on discharge water to the Tennessee River.
- A severe drought in Texas in 2011 affected many power plants' cooling water reservoirs, while associated heat increased peak electricity (air conditioning) demands:
    - 11,000 megawatts (MW) of Texas power plants had cooling water reservoirs at record low levels and 3,000 MW of plants were considered "at risk" (of shutting down) if drought conditions persisted.

[4] Synthesis of drought impacts reported in the Energy Sector. Reports based on NOAA-funded activities across the Regional Sciences and Assessments Program, Regional Climate Centers, NIDIS Early Warning System partners including the University of Nebraska National Drought Mitigation Center. California Drought Plan 2010, A Synthesis Report in preparation: J. Macknick, S. Satter, K. Averyt, S. Clemmer, J. Rogers, 2012: The water implications of generating electricity: water use across the United States based on different electricity pathways through 2050. *Environ. Res. Lett.* **7** 045803 doi:10.1088/1748-9326/7/4/045803

- In the end of 2011, the Barnett Shoals Dam, near Athens, GA had not been operating at capacity due to the combined low level of the Oconee River and increased levels of sedimentation.
  - According to one of the dam's owners, "We do not have an adequate source of water to operate at anywhere close to capacity, but we are very cognizant of the water levels. In fact, we do minimize the amount of water passing through our turbines." Neighbors downstream of the dam expressed some frustration at the fluctuation in the already low river level when the turbines ran.
  - However, as of April 2013, the U.S. Army Corps of Engineers has ended drought operations in this river basin (the Apalachicola-Chattahoochee-Flint River Basin) due to recent above-normal rainfall. Reservoir storage across the Basin is now at capacity.
- Hydropower generation is an important source of low-cost, clean electricity in California. Hydro units also provide electricity during peak demand periods. During the period. From 2001 to 2011, the contribution of hydropower to the total generation in California varied from 12 to 22 percent depending on drought conditions and other demands. A difference of 10 percent, driven by the availability of water, is a huge amount representing a substantial cost to California. For California, the 2009 winter season snow pack water content was 39 percent below normal impacting the state's ability to generate hydropower, with a 62 percent reduction in hydropower generation at Lake Oroville from October 1, 2008 to January 31, 2009. (Present conditions are discussed further below.)
- In late 2012, according to the U.S. Army Corps of Engineers, six hydropower plants on the Missouri River produced approximately 127 kWh less than average December production. Drought conditions resulted in diminished flow in the Missouri River, yielding less hydropower production. Power generation is expected to be 8 billion kWh in 2013, compared to average production of 10 billion kWh in previous years.
- Ethanol production in Iowa declined, through voluntarily adopted restrictions by ~ 20 percent since the beginning of 2012 as high corn prices, combined with reduced corn production from drought and heat, raised concerns over the amount of corn used in ethanol production.
- At some hydropower facilities, drought conditions may lead utility or power managers to purchase more expensive and/or carbon-intensive power from alternate sources. For example, the Western Area Power Administration (WAPA) saw declining hydroelectric generation starting in 1999, as reservoirs declined due to drought. In response to these conditions, WAPA had to purchase power (typically from thermoelectric power plants in the region) in order to meet energy contract obligations. The WAPA has been forced to add a surcharge to customers' bills to pay for losses incurred during the past decade of drought when hydropower generation was down and alternative power was purchased at a higher cost. The surcharge is intended to end by September 2017, when it is hoped that the agency will have recouped its losses, unless low flow conditions persist.
- Drought conditions may also cause extraordinary demand for electricity, which can lead to adverse effects to communities as power generation fails to meet demand. In July 2012, the Nebraska Public Power District (NPPD) had to turn to temporary electrical outages in north central Nebraska to deal with the extraordinary demand for

electricity on the night of July 18-19. A spokesman for the NPPD stated that demand had exceeded previous daily records for peak utility use on 19 of the previous 22 days, due to heat and drought.

In addition to these specific and direct adverse impacts to the energy/power sector, drought can also lead to other negative impacts, including environmental effects, disruptions to navigation and shipping (that also affects transportation of coal and other fuel), facility siting decisions, impacts to farmers due to necessary transfer of water rights to the energy sector, and impacts to the outdoor recreation economy. A few specific examples include[5]:

- In August 2012**,** the Illinois Environmental Protection Agency was allowing four coal-fired, and four nuclear, power plants to release hundreds of millions of gallons of hot water near 100 degrees Fahrenheit into state lakes and rivers, according to the Chicago Tribune. At the same time, a number of fish kills were reported in the area. None of the fish kills in the state that year, however, were linked directly to the hot water from the power plants.
- In the Mississippi river region, drought affected the area throughout the year and by November 2012, river water levels were severely diminished. This had impacts to power production along the river and its tributaries, as well as impacts to navigation and shipping.
- The manager of Aspen Pipeline placed several requests with NOAA for short- and medium-range (i.e., seasonal) temperature outlook information to help inform his company's decisions about energy production in south Texas.
- As one final example, Duke Energy operates many different types of power plants (nuclear, coal-fired, oil/gas-fired, pumped-storage hydro) in the Carolinas – all of which are dependent on water resources for some part of their operations. Drought affects how Duke Energy - and other companies like them - balance individual plant requirements, energy demand, and water availability within their entire system.
- Colorado Rafting declined 17% in 2012, the lowest since 2002

Energy companies are forced to use a variety of sources of information for their operations and planning, including in-house resources, private consultants, external drought management advisory group, and many of NOAA's existing products and services. In some instances, however, these existing forecasts and other products might not be accurate enough to be used to make specific operational and management decisions. This is one area where improvements (i.e., seasonal drought forecasts) would be valuable. In summary, many sectors face drought impacts across a broad range, as

[5] Synthesis of drought impacts reported in the Energy Sector. Reports based on NOAA-funded activities across the Regional Sciences and Assessments Program, Regional Climate Centers, NIDIS Early Warning System partners including the University of Nebraska National Drought Mitigation Center. California Drought Plan 2010, A Synthesis Report in preparation: J. Macknick, S. Satter, K. Averyt, S. Clemmer, J. Rogers, 2012: The water implications of generating electricity: water use across the United States based on different electricity pathways through 2050. *Environ. Res. Lett.* **7** 045803 doi:10.1088/1748-9326/7/4/045803

described here, and they require reliable information to balance their operations and meet requirements.

Attached to this testimony is the interagency regional drought outlook from April 12, 2013, developed by NOAA/NIDIS in partnership with its partners in Federal, State, and tribal agencies.

Some improvement is expected across the northeast quarter of Texas with forecasts indicating a wet pattern during early-to-mid April across this region. Persistence and development are forecast for west and south Texas where the CPC seasonal outlook favors below median precipitation and above normal temperatures.

Some improvement forecast for the northern and central Plains is based largely on the annual cycle of precipitation and the absence of a dry signal in the CPC monthly/seasonal precipitation outlooks. Forty to fifty percent of the annual precipitation occurs during April, May, and June (AMJ) across much of the northern and central Plains. However, this designation of improvement does not imply elimination of drought, just a possible easing of conditions. Adequate precipitation during May and June and a lack of early summer heat waves are critical for any improvement to occur.

According to the National Operational Hydrologic Remote Sensing Center on April 2, snow-water equivalent values range from 2 to 5 inches across the upper Mississippi Valley. It is unclear how much of the spring runoff can recharge the dry subsoils. AMJ is a relatively wet time of year for the upper Mississippi Valley. The 6-10/8-14 Day outlooks from April 3 favor above median precipitation in this region. Due to these factors, improvement is expected across the upper Mississippi Valley. Prospects for improvement are highest across southeast Minnesota and Wisconsin where drought levels are less intense and the seasonal outlook favors above median precipitation.

Persistence is expected for much of Colorado, New Mexico, Utah, Nevada, and Arizona due to low snow-water equivalent values (around 75% of normal) and below average streamflows forecast for the spring and early summer. Enhanced odds for below median precipitation and above normal temperatures during AMJ also favor persistence. Recent wetness, expected short-term precipitation, and the lack of a dry signal during AMJ lead to a forecast of some improvement across northeast Colorado. Recent snows last week has brought snowpack up to around 85% but with the Southwest Basins of the San Juan at around 60% of normal. *Forecast confidence for Colorado, New Mexico, Utah, Nevada, and Arizona is high.*

Similar to the interior Southwest, snow-water equivalent values are also below average across California and southern Oregon. Following a wet start to the winter, unseasonably dry conditions affected these areas during the past three months. According to the USDM on April 4, abnormal dryness (DO) covers northern California and parts of southern/eastern Oregon. Below median precipitation is favored during AMJ across these same areas. Therefore, persistence and development is forecast for this region. Precipitation typically decreases rapidly later in the spring with little to no prospects for improvement after April. *Forecast confidence for California and southern Oregon is high.*

Snow-water equivalent values are running slightly below average across the northern Rockies. Since tools on most time scales offer weak precipitation signals, persistence is forecast for the northern Rockies and adjacent Plains. However, forecast confidence is low since AMJ is relatively a wet time of year across most of Montana and Wyoming. *Forecast confidence for the northern Rockies is low.*

Recent above-normal snow (April, 2013) in the mid-Rockies has brought watersheds up to 85% but with snowpack still hovering above 60% in the San Juan and southern Rockies, including the Rio Grande headwaters.

Mountain snowpack was 50 to 75 percent of normal on March 1, 2013 across the drought area in north-central Alaska which is a slight increase from one month ago. Some improvement is forecast for this region.

Moderate to extreme drought covers western sections of the individual Hawaiian Islands from Oahu southeastward through the Big Island. Persistence is forecast for these leeward areas since odds for improvement decrease significantly during May and June. Individual basins in California, Oregon, Nevada, Arizona and New Mexico are at 25-49 percent of normal, with some in the Southwest at below 25 percent of normal. Only some basins in Washington have snow- water equivalent (SWE) in excess of 110 percent at this time. In sum, drought will persist or intensify in much of the western U.S. Improvement is anticipated in the center of the U.S. and in areas of the southeast, including much of Florida. In April and May significant fire potential will exist over most of Florida as lingering drought keeps fuels dry. Most of the rest of the eastern U.S. will have below-normal significant fire potential as active storm patterns keep conditions wet and cool. Cool and wet conditions will keep southern Alaska significant fire potential below normal. In June and July the wildland fire potential shifts from the red and gray hatched areas to the western U.S. Significant fire potential will be above -normal in the mountains and foothills of southern California. Significant fire potential will increase to above normal over northern California and the Northwest. Significant fire potential will decrease to normal in Florida, Minnesota, Iowa, New Mexico and Arizona. Water levels are recovering to some extent on the Mississippi River due to recent rain, and now easing transportation problems along the river. Great Lakes water levels are forecast to remain well below long-term averages.

Working together to increase the Nation's Resilience to Drought

The number of watershed, State, and local drought and water plans using NOAA-based information has significantly increased since NIDIS was initiated in 2007. Part of the support that NIDIS has generated and the ability of the program to meet the needs of the Nation are a result of the strong partnerships that the program has with other agencies, outreach organizations, and an enabling set of programs and observational capabilities.

Together with the U. S. Army Corps of Engineers, NOAA, and the USGS, the Bureau of Reclamation has formed the Climate Change and Water Working Group (C-CAWWG) to bring the water managers and climate scientists together to create efficient research and development (R&D) collaborations and information sharing across the federal agencies toward understanding and addressing climate change impacts on Western water supplies and water use.

In addition to joint reports, the Bureau of Reclamation, the U.S. Army Corps of Engineers, NOAA and the USGS, as part of C-CAWWG coordination, are developing detailed descriptions of information and tools that water managers need from the science agencies and other researchers. Furthermore, the Interagency group WESTFasT (with representatives from 12 Federal agencies) was established in 2008 to support the Western States Water Council (WSWC) and the Western Governors Association in coordinating Federal efforts regarding water resources.

Perspectives from both State and local water managers have been sought and the Bureau of Reclamation is providing input to NOAA as it plans for the next generation of Global Circulation Models (GCMs) to define the types of outputs that will be of most value to water managers. NOAA and the Bureau of Reclamation are participating in the Postdocs Applying Climate Expertise (PACE) Fellowship program to sponsor research activities focused on water management needs.

In December 2012 NIDIS and its partners convened a National Drought Forum (hereafter, "the Forum") hosted at the National Governors Association Hall of States here in Washington D.C. The Forum was co-chaired by Dr. Robert Detrick, the NOAA Assistant Administrator for Oceanic and Atmospheric Research and Dr. Donald Wilhite, founder of the NDMC. The Forum featured keynote addresses from Secretary Vilsack (USDA), Gov. Brownback of Kansas and the NOAA Deputy Administrator Dr. Kathryn Sullivan (currently NOAA Acting Administrator). The Forum was co-sponsored by the National, Mid-Western, Southern and Western Governors' Associations, the U.S. Army Corps of Engineers, and the Department of the Interior and saw significant participation at high levels by these agencies and by regional and local agriculture, health, and water managers. The goals of the Forum were: "To understand the extent of 2012 drought impacts and response in 2012, and help provide new information and coordination for improving the nation's drought readiness for 2013 and in the future."

Among other issues, discussions at the National Forum highlighted the need to:
- Increase public awareness of last year's drought and potential impacts for this year;
- Increase technical assistance for the communication and use of drought-related information in impacted communities including efforts through the NIDIS regional early warning systems in partnership with NDMC; and
- Ensure sustained support for monitoring programs and equipment critical to understand and respond to drought, e.g. the National Resources Conservation Service SNOwpack TELemetry (SNOTEL) sites; and the Water Census led by the USGS.

NOAA will be happy to provide a copy of the Forum Report to this Committee when it is final. Through the Economic Development Administration and NIDIS, the Department of Commerce (DOC) is working closely with USDA and other agencies within the National Disaster Recovery Framework for Drought, with a strong focus on the recovery needs and sustainability of rural communities. Critical preliminary efforts will be built on the DOC-USDA Memorandum of Understanding (MOU) announced at the Forum and signed by the Secretary of Agriculture and the Acting Secretary of Commerce in December 2012. This MOU is aimed at improving cross-agency collaboration on drought risk reduction. The agreement is intended to (1) strengthen Commerce's and USDA's development and delivery of relevant local and regional drought information services to agricultural, forestry, rural economies, and related sectors; and (2) foster improved understanding by end-users in these sectors of the value and use of weather and climatological information and its integration with social and economic information, in planning and operational activities for farming and forestry communities.

For some regions actions in preparation for the upcoming season are being undertaken. In the Midwest, land dedicated to sorghum — which tolerates drought better than other grains — will rise by 22 percent, or 566,000 hectares (1.4 million acres) over last year. It is both the largest absolute and largest relative increase of any crop for the 2013 season. The USDA expects farmers to plant a total of 3.1 million hectares (7.6 million acres) of sorghum, which is the most since 2008. Sorghum acreage has climbed 40 percent in the last two years.[6]

NOAA-supported projects are examining potential climate change and variability adaptation strategies in the water and energy sectors in the Southwest, including how climate influences the market price of water. Researchers are developing tools, as well as guidelines for using these tools, to enhance water supply forecast reliability and management. Researchers are developing improved methods for predicting and adapting to climate impacts for the generation of electricity. Partners include NOAA/University of Colorado Western Water Assessment, U.S. Bureau of Reclamation, USDA, Arizona Dept. of Water Resources, Central Arizona Project, Salt River Project, Arizona Electric Power Cooperative, Arizona Public Service Corporation, Tucson Electric Power, Nature Conservancy-Western Regional Office, Environmental Defense, and the Sonoran Institute. NOAA is also working with California Energy Commission on climate forecasts and change for energy applications.

The following actions could be taken to improve the Nation's energy resilience to drought:

- Greater understanding of which energy plants and sources are susceptible to water shortages in particular drought-sensitive locations. For instance, the impact of increased biofuel production on water resources will depend on where the feedstock is grown and whether or not irrigation is required. Collaborative activities among

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[6] USDA, 2013: Prospective Plantings Report. National Agricultural Statistics Service (NASS), Agricultural Statistics Board, United States Department of Agriculture (USDA) www.**usda**.gov/nass/PUBS/TODAYRPT/pspl0313.pdf

NOAA and other agencies could include evaluating the likelihood and consequences of the shortages, and options that are available to prevent/mitigate the consequences in the short to long term.
- Improved understanding of links between climate and hydrological processes, including aquifer recharge rates and groundwater movement. In the absence of such data and research, developing and implementing effective policies could continue to be a challenge for Congress and federal agencies.
- Improved coordination among federal agencies and other stakeholders especially regarding the quality and use of climate and weather information at the energy-water interface. Some agencies, including NOAA, have taken steps to improve coordination.

To achieve a more comprehensive vision of a truly “national integrated drought information system” requires improvements that NIDIS has already begun to address. These include:
- Improving the understanding and predictability of droughts across a variety of timescales for seasonal, to interannual and decadal time scales including the role of precipitation events in reducing drought duration and intensity;
- Improving collaboration among scientists and managers to enhance the public awareness and effectiveness of observation networks, monitoring, prediction, information delivery, and applied research;
- Improving the national and regional drought information framework by transferring successful approaches (information development, products, capacity, and coordination) to areas covered by the drought portal, but not yet having active early warning systems;
- Improving coordination between institutions that provide different types of drought early warning**;**
- Developing impact indicators to form part of a comprehensive early warning system; and
- Working with the private sector and others on guidance and standards for developing value-added products to support drought preparedness plans.

Thank you for the opportunity to be with you today.