

**NATIONAL DROUGHT
RESILIENCE PARTNERSHIP**

**REPORT TO THE COUNCIL ON CLIMATE
PREPAREDNESS AND RESILIENCE**

AUGUST 2016

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The National Drought Resilience Partnership

August 2016 Progress Report

Since 2012, significant portions of the country have experienced extreme to exceptional drought conditions, challenging the viability of agricultural production, impacting drinking water supplies, jeopardizing the integrity of critical infrastructure, increasing energy costs, harming ecosystems, and causing extensive economic and health impacts. On March 21, 2016, President Obama signed a [Presidential Memorandum](#) directing Federal agencies to build national capabilities for long-term drought resilience. The President tasked the [National Drought Resilience Partnership \(NDRP\)](#) to work collaboratively to deliver on a [Federal Action Plan](#) including six goals and 27 associated actions to promote drought resilience nationwide. Importantly, these goals reflect many of the priorities identified by the on-the-ground leaders and experts who work daily to build a more resilient future for their communities. The actions are designed to complement state, regional, tribal and local drought preparedness, planning and implementation efforts.

The President's action continues the momentum to help the millions of Americans affected by drought. Federal agencies have mobilized to provide improved information and data, emergency and planning assistance, landscape-scale land management improvements, and investments in new technologies and approaches to water resource management. Continued drought conditions in the West and projections of more extreme droughts in the future underscore the urgency to pursue long term solutions for protecting our water resources and the communities and ecosystems that depend on them. The Presidential Memorandum brings greater vision and precision to our efforts.

This report highlights accomplishments against the President's Action Plan and provides an overview of some of the Administration's work on drought response since 2009. It is the first of what will be regular updates on the NDRP's commitment to work across federal agencies to deliver on-the-ground results.

Sincerely,

The National Drought Resilience Partnership Co-Chairs

Robert Bonnie
Under Secretary for Natural Resources and Environment
U.S. Department of Agriculture

Dr. Christine Blackburn
Performing the Duties of Assistant Secretary of Commerce for Conservation and Management
National Oceanic and Atmospheric Administration
U.S. Department of Commerce

Goal 1: Data Collection and Integration

Objective: Agencies shall share data and information related to drought, water use and water availability, including data on snowpack, groundwater, stream flow and soil moisture with State, regional, tribal and local officials to strengthen decision-making to support more adaptive responses to drought and drought risk.

Using existing resources, the Federal Family is working to improve both the quality and volume of products available for drought planning and decision-making. Agencies have intensified their efforts to share data and information related to drought, water use, and water availability (including data on snowpack, groundwater, stream flow, and soil moisture) with the ultimate goal of providing State, regional, tribal, and local officials with the tools necessary to create more adaptive responses to drought and drought risk.

Initial implementation actions include efforts to integrate existing data and information sources, with a focus on improving the usability of current resources and identifying gaps. Additionally, in acknowledgement of the important role of the citizen scientist, the Administration is encouraging the public to assist in the collection of weather and climate data and record their experiences with drought. These activities will lay the groundwork for a stronger private and public partnership for identifying and mitigating the impacts of drought on vulnerable communities.

Goal Leader: Mark Brusberg, U.S. Department of Agriculture

Action 1: Integrate Data from Key Platforms

A National Conversation on Integrated Water Information for the 21st Century

Lead Coordinating Agency: Department of Commerce, National Oceanic and Atmospheric Administration

From May to June 2016, the National Oceanic and Atmospheric Administration (NOAA) Administrator, Dr. Kathryn Sullivan, convened a series of stakeholder engagements entitled “A National Conversation on Integrated Water Information for the 21st Century.” Two regional meetings were organized by the University Corporation for Atmospheric Research (UCAR), in Tuscaloosa, Alabama, and Sacramento, California. A final national meeting was organized in Washington, DC, by the U.S. Water Partnership and UCAR, along with senior officials from the Department of the Interior (DOI), Army Civil Works, and other Federal agencies.



The objectives of these sessions included: (1) identifying key steps and best practices to deliver more robust and integrated water-related data, information, and prediction services to help communities and businesses manage risk, build resilience, and plan for the future; (2) discussing opportunities and challenges for the future U.S. water information architecture; and (3) exploring potential public-private partnerships to catalyze solutions and “actionable information” that address U.S. and international water data and information challenges. More than 300 experts from government, private sector, universities, and civil society participated in the 3 sessions.

Going forward, NOAA will use these dialogues as a basis for improving its water information services and for stimulating further interagency collaboration to integrate Federal data for water and drought.

Above: Data experts participate in the Roundtable on Water Data for Decisions at the National Conversation on Integrated Water Information for the 21st Century, July 12-14, 2016, organized by NOAA, DOI, Army Civil Works, the US Water Partnership, and UCAR.

Integrating Data into the Remote Automatic Weather Stations Network

Lead Coordinating Agency: Department of Agriculture, Forest Service

Strategically located throughout the United States, 2,200 interagency [Remote Automatic Weather Stations](#) (RAWS) monitor the weather and provide weather data that assist land management agencies with a variety of projects such as monitoring air quality, rating fire danger, and providing information for research applications. RAWS units collect, store, and forward data to a computer system at the National Interagency Fire Center in Boise, Idaho, via the Geostationary Operational Environmental Satellite.



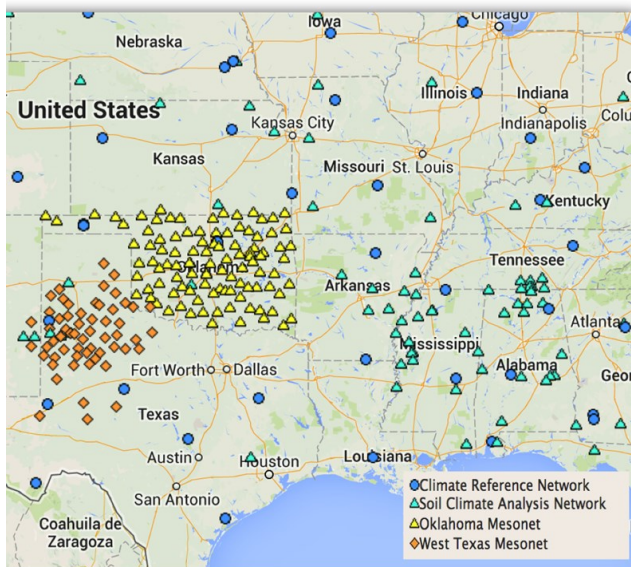
Above: A Forest Service Remote Automatic Weather Station

Going forward, the Department of Agriculture, Forest Service (FS) will work collaboratively with NOAA and the U.S. Department of the Interior, Bureau of Land Management to ensure that data from RAWS stations are available to stakeholders via existing services and platforms. By October 2016, these partners will have completed a scoping document assessing potential next steps and areas for improvement. Additionally, these agencies are working to include soil moisture sensors on FS RAWS stations, and by December 2016, will have completed an initial assessment of current circumstances and opportunity.

Building a Coordinated National Soil Moisture Monitoring Network

Lead Coordinating Agency: Department of Commerce, National Oceanic and Atmospheric Administration, National Integrated Drought Information System

Technical Leadership: Department of Agriculture, Department of the Interior, Department of Commerce, National Oceanic and Atmospheric Administration, and the National Aeronautics and Space Administration



Above: A regional soil moisture network pilot of Oklahoma, Texas and other Southern states created by USGS

Soil moisture data are vital to assessing and understanding the impacts of drought on agriculture and other industries that rely on secure and sustainable supplies of water. Several networks have been created to measure soil moisture at various depths, but data have been of limited use and often incompatible between different networks and data systems. Currently, NOAA, Department of the Interior, U.S. Geological Survey (USGS) and Department of Agriculture, Natural Resources Conservation Service (NRCS) are working with Ohio State University to coordinate the collection of soil moisture data and their integration and dissemination to decisionmakers, the research community, agricultural producers and the general public. To date, these partners have completed a pilot program designed as a proof-of-concept model for real-time integration of distributed soil moisture data and developing products of use to the drought community.

Going forward, organizers plan to establish a common location for soil moisture data and develop standards for installation of new sensors and sharing of data. Additionally, the organizers will work closely with modelers and the satellite community to develop a more comprehensive system for monitoring soil moisture on a national level that integrates remote sensing and modeling with ground-based data.

Improvement and Expansion of the United States Drought Monitor to the U.S. Virgin Islands and Affiliated Pacific Islands

Lead Coordinating Agencies: Department of Agriculture and Department of Commerce, National Oceanic and Atmospheric Administration

The [U.S. Drought Monitor](#) is a weekly map of drought conditions that is produced jointly by NOAA, U.S. Department of Agriculture (USDA), and the National Drought Mitigation Center (NDMC) at the University of Nebraska-Lincoln. Policymakers and citizens alike use this vital tool to make informed decisions for drought-affected communities. This year, the U.S. Drought Monitor is expanding to include the U.S. Virgin Islands and the U.S. Affiliated Pacific Islands. On August 30, scientists and decisionmakers around the country will convene in St. Croix, Virgin Islands to discuss the launch of the U.S. Drought Monitor in the Virgin Islands and U.S. Affiliated Pacific Islands. *Going forward*, authors will launch a pilot drought monitor that includes the islands in October 2016.

Action 2: Improve Modeling and Prediction

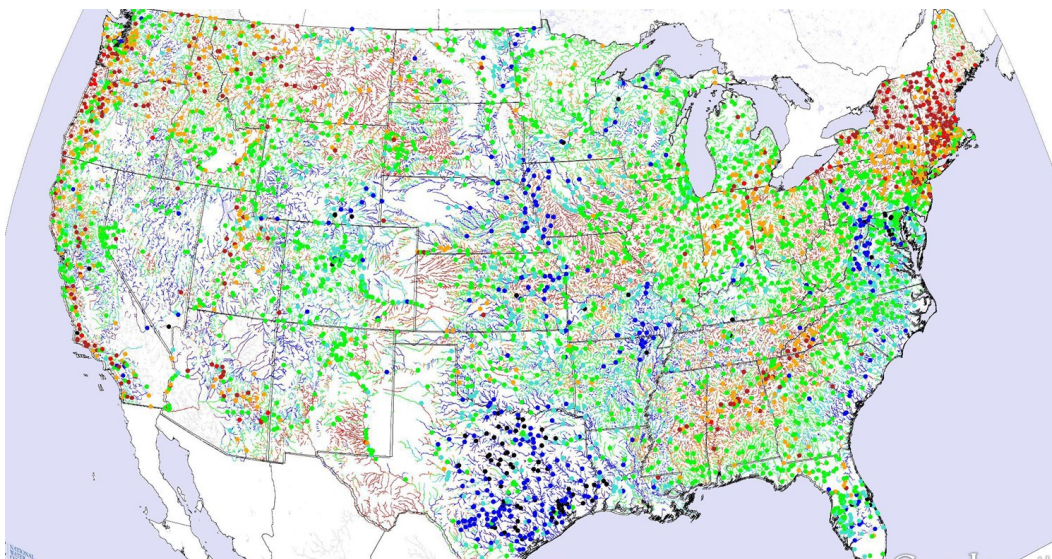
Improving Water Forecasts from Days to Seasons

Lead Coordinating Agency: Department of Commerce, National Oceanic and Atmospheric Administration

On August 16, 2016, Secretary of Commerce Penny Pritzker announced the release of NOAA's new [National Water Model](#) (Version 1.0), a continental-scale model of the Nation's river and stream network to be run alongside the routine weather forecast models of the National Weather Service. This announcement marks a significant step forward in the transformation of the Nation's water-prediction services. The new model expands NOAA's current water quantity forecasts, delivered from approximately 4,000 gauged river locations, to 2.7 million locations in the continental United States. The National Water Model will provide high-resolution gridded forecasts of soil moisture, evapotranspiration, runoff, snow water equivalent, and other parameters vital for integrated water resource management in flood and drought conditions, particularly in flood conditions that follow drought.

In the summer of 2016, NOAA used innovative calibration techniques to upgrade the North American Multi-Model Ensemble (NMME) seasonal climate forecast tool, which will allow for more reliable and skillful seasonal forecasts of precipitation and temperature nationwide. In addition, NOAA released funding solicitations for research to further improve modeling, prediction, and monitoring capabilities at NOAA, with the involvement of other Federal agencies and academic scientists, building on years of previous research.

Going forward, NOAA plans to refine and upgrade the National Water Model to provide enhanced hydrologic guidance to end users through future coupling with weather and coastal models, and in future years, ground water and other modules will be added to further advance long-term drought resilience.

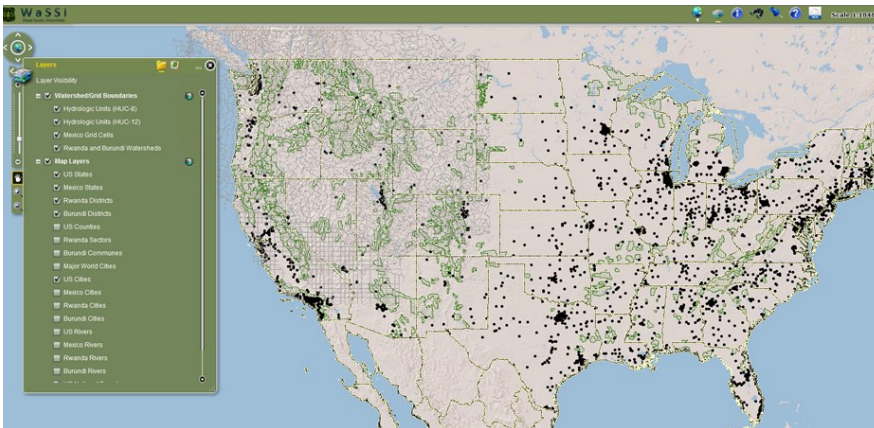


Left: National Water Model: A new continental-scale forecasting model of the nation's river and stream network. Here, the model augments streamflow anomaly data from the USGS (dots) with streamflow anomaly data for the full network (lines). Anomaly data helps decision makers understand whether streams are in high or low flow, as compared to normal conditions.

Integrating Data from the Water Supply Stress Index

Lead Coordinating Agencies: Department of Agriculture, Forest Service and Department of Commerce, National Oceanic and Atmospheric Administration

The recently developed [Water Supply Stress Index \(WaSSI\)](#) ecosystem services model can predict how climate, land cover, and human population change may impact water availability and carbon sequestration at the watershed level



Above: The core of WaSSI is a water balance model that is sensitive to land cover and climate and operates on a monthly time step at the 8-digit Hydrologic Unit Code (HUC) watershed scale across the conterminous U.S.

and across the lower 48 States. For example, FS Research & Development scientists recently used the tool to estimate how water yield and carbon sequestration in the National Forest and Grassland System were impacted by periodic droughts over the past 60 years. This [benchmark study](#) provides a reference point to assess drought impacts for each of the 170 National Forests, and can help land managers better optimize limited resources during watershed restoration efforts in response to climate and land use changes.

Action 3: Facilitate Citizen Science

Expansion of the Community Collaborative Rain, Hail, and Snow Network into Southwestern Tribal Lands
Lead Coordinating Agencies: Department of Agriculture and Department of Commerce, National Oceanic and Atmospheric Administration

The [Community Collaborative Rain, Hail and Snow network \(CoCoRaHS\)](#) is a unique grassroots network of thousands of trained volunteers of all ages and backgrounds working together to improve meteorological science by measuring and reporting precipitation amounts. CoCoRaHS is the largest provider of daily precipitation observations in the United States. USDA and NOAA use the data from these observations for tools such as the United States Drought Monitor.



Above: The latest NWS outreach and training session was held on July 18 in the Navajo Nation community of Chilchibeto. A newly recruited observer is pictured with a CoCoRaHS rain gauge, standing alongside Tony Merriman, NWS Warning Coordination Meteorologist.

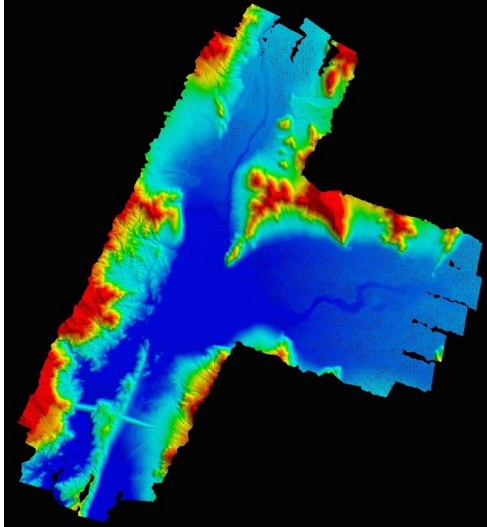
Going forward, FS researchers are working to integrate the WaSSI model into national water-prediction efforts of NOAA's National Water Center. This data will improve prediction of periodic droughts' impacts on water yield and carbon sequestration from forested landscapes to lower watersheds.

Going forward, USDA and NOAA plan to continue the expansion of rainfall observations in the Four Corners region and to other Tribal areas. Additionally, NOAA and USDA will continue to encourage CoCoRaHS observers to increase their role as citizen scientists by submitting observations, including photographs, to a coordinated [Drought Impact Reporter](#) maintained by the National Drought Mitigation Center.

Action 4: Encourage Federal Reservoir Surveys

Lead Coordinating Agency: U.S. Army Corps of Engineers

The U.S. Army Corps of Engineers (USACE) is taking advantage of drought-induced low reservoir levels to conduct reservoir surveys that will provide detailed information needed to understand how sedimentation has impacted the available reservoir storage volume. This effort will benefit managers and planners by reducing the cost of reservoir surveys, improving methods of data sharing, and making it possible to develop long-term management plans to extend the reliable performance of reservoirs.



Above: A LiDAR image of Lake Isabella, CA showing data colored by elevation. USCAE collected data of drought-impacted Lake Isabella as a test of potential methods for opportunistic ALS surveys of drought-impacted reservoirs.

USACE has taken steps to improve the utility of [the USGS Reservoir Sedimentation Database](#) to the public, including the incorporation of data from Department of the Interior's Bureau of Reclamation (Reclamation), to provide credible evaluations of reservoir sedimentation and its relationship to drought resilience. In addition, an Airborne Laser Scanning (ALS) system was tested throughout California during the recent drought, to refine the data acquisition process. Light detection and ranging (LiDAR) data was collected for one drought-impacted reservoir in California as a test of potential methods for ALS surveys of drought-impacted reservoirs. Leveraging the development of the LiDAR program within USACE with the Bureau of Reclamation in order to incorporate high-accuracy, high-resolution ALS systems onto low operational cost aircraft, will result in efficient data collection for sharing of reservoir sedimentation data.

Going forward, USACE is creating geospatial analysis tools to allow users to rapidly calculate area and capacity data for reservoir elevations using 3D data from ALS and similar surveys. USGS will produce indicators of sedimentation rates and assessments of how these rates are changing with observed and projected climate change, to better understand reservoir sustainability and drought resilience as well as communicate risks to critical infrastructure. Exploration of various data collection technologies will help to align reservoir characteristics with the most efficient (time and money) techniques to quickly facilitate data collection.

Action 5: Develop Data Models to Identify Populations at Risk to the Health Effects of Drought

Developing Models and Tools to Predict Populations Vulnerable to Drought-Related Disease

Lead Coordinating Agency: Department of Health and Human Services, Centers for Disease Control and Prevention

The [health and quality-of-life impacts](#) of drought can be severe and include infectious and non-infectious diseases as well as mental health conditions. The Department of Health and Human Services, Centers for Disease Control and Prevention (CDC) is working with partners to develop models and tools to better predict locations and populations vulnerable to drought-related disease in order to initiate protective measures. Since many of the health issues associated with drought can occur after substantial periods of time, CDC is committed to long-term surveillance of these outcomes.

Going forward, CDC and partners are developing three tools to assist public health providers serving communities vulnerable to drought. By March 2017, CDC will develop two databases of drought indicator variables, using various climate data from NOAA, and convert the databases into useable data for public health purposes. Ultimately, the databases will be available online through the [National Environmental Public Health Tracking Network](#). By December 2017, CDC will create a data and analysis guide describing the sources, variables, and analyses of climatic and health data to determine the health effects from drought. Additionally, CDC will collaborate with USGS and other partners to develop national-level maps indicating estimated arsenic concentrations in private wells, a priority contaminant of concern. These maps will be used to determine how existing models estimating contaminants in private well water can be used to assess the effects of drought on well water quality, and may be used to monitor the exacerbation of existing contaminants over time. State, local, tribal, and territorial entities will have access to these models.

Goal 2: Communicating Drought Risk to Critical Infrastructure

Objective: Agencies shall communicate with State, regional, tribal, local, and critical infrastructure officials, targeted information about drought risks, including specific risks to critical infrastructure.

Public health, the economy, and our ways of life depend on the reliable functioning of critical infrastructure, including electric power networks, water and wastewater systems, and agricultural production. Critical infrastructure stakeholders at all levels of government and in the private sector must make decisions and tradeoffs that affect their resilience to long-term drought. The Federal Family is committed to providing stakeholders in State, local, tribal, territorial, regional, and private sector roles with the best available information to help them make sound decisions and investments in drought resilience. An essential first step in this process is to assess and describe risks to specific sectors and regions.

The Department of Homeland Security (DHS) is working with other Federal Agencies to strengthen its capability to assess drought impacts to critical infrastructure and provide useful analysis and guides for critical infrastructure stakeholders.

Goal Leader: Katherine Ledesma, National Protection and Programs Directorate, Department of Homeland Security

Action 1: Study Long-Term Drought Impacts on Critical Infrastructure

Assessing and Modeling Long-Term Drought Impacts on Critical Infrastructure

Lead Coordinating Agency: Department of Homeland Security

DHS is developing several products related to understanding drought impacts to critical infrastructure, including an analysis of water dependencies for data centers in California, an analysis of drought impacts on thermal electric generation, and an assessment of drought impacts on critical manufacturing in California. Additionally, DHS is developing modeling and simulation capability to assess the impacts of hydrological drought on dam operations, hydroelectric generation, and electric power dispatch. Additionally, DHS is developing modeling and simulation capability to assess the impacts of hydrological drought on dam operations, hydroelectric generation, and electric power dispatch.

California Drought: Data Center Risk and Resilience

The report will provide leaders and decision makers a brief overview on the effects of the California drought on California data centers. It explores both the nexus between data centers and water and the nexus between data centers and electric power, because electric power availability and cost are affected by drought. Data collection, research, analysis and writing are complete for this product, which is currently being coordinated with external partners. It is expected to be released in November 2016.

Thermoelectric Power Plant Water Quality Dependencies

The recent droughts in California and Texas have highlighted the link between thermoelectric power plant generation capacity and the availability/quality of surface water. All sectors of critical infrastructure require reliable electric power, so understanding this relationship is foundational to understanding drought impacts to other infrastructure sectors. This project is in the data collection and research stage and is tentatively planned for release in early 2017.

California Drought: Impacts to the Critical Manufacturing Sector

This study focuses on key types of critical manufacturing (transportation equipment manufacturing, computer and electronic product manufacturing, fabricated metal product manufacturing, and machinery manufacturing) in the areas of California hardest hit by drought. These industries were prioritized because they are major contributors to California's employment and economy. This project is in the data collection and research stage and is tentatively planned for release in late spring 2017.

Capability Development: Drought

The long-term goal of this effort is to develop a comprehensive approach to assessing the impacts of drought on the operation of critical infrastructure. Connecting water supplies to the ability to generate electricity is the first step along the pathway that will eventually link water supply and availability to other critical infrastructure. When fully mature, this capability will allow DHS to understand better the linkages between water availability and electrical generation (hydroelectric and thermal), water for public (municipal) water systems, transportation and agriculture. It will also allow DHS to understand, on a regional scale, water supply allocations across these competing uses and how reductions in water supply or availability might affect the division of water. Recently completed work in this area focused on hydroelectric power by extending a single dam-single reservoir model to multi dam-multi reservoir model that includes all of the Columbia and Snake river systems. The model solves on an hourly time-step and can simulate periods as long as one year. Continued development will be contingent on funding and competing DHS priorities.

Creating Sustainable Recreation Infrastructure

Lead Coordinating Agency: Department of Agriculture, Forest Service



FS is committed to maintaining safe, accessible infrastructure for recreation, including green infrastructure, on National Forests and Grasslands. *Going forward*, the Forest Service is revising the Sustainable Recreation Site Design Guide to meet current thinking around sustainability and promote best practices. Forest Service employees will use the guide to inform decisionmaking and decisions about recreational spaces. The guide is anticipated to be complete by mid-2017 and include best practices for minimizing water consumption; minimizing impacts to riparian, shoreline, and floodplain resources; and protecting stormwater runoff quality and reducing the volume and velocity of stormwater runoff.

Action 2: Create Drought Decision-Support Guides for Critical Infrastructure Stakeholders

Developing Decision-support Tools for State, Regional, Tribal, and Local Officials

Lead Coordinating Agency: Department of Homeland Security

Going forward, the Department of Homeland Security, Office of Infrastructure Protection (DHS-IP) will conduct analyses regarding the impacts of long-term drought on critical infrastructure and develop decision-support guides for State, regional, tribal, local, and critical infrastructure officials. These guides will incorporate targeted information about drought risks, including specific risks to critical infrastructure. By December 2016, DHS-IP will begin stakeholder engagement and outreach to identify requirements for the decision support guide and develop targeted information about drought risks to critical infrastructure.

Supporting Water Utilities Serving Communities Vulnerable to Drought

Lead Coordinating Agency: Environmental Protection Agency

As part of ongoing efforts to highlight the importance of drought preparedness to water utilities and impacts of drought on our critical infrastructure, the Environmental Protection Agency (EPA) Office of Water developed an online tool, [Drought Response and Recovery: A Basic Guide for Water Utilities](#), which relays lessons learned from analyzing seven, diverse, drought-impacted small- to medium-sized water utilities. Using an interactive format, the Guide features worksheets, best practices, and overview videos that outline key emergency response actions that also build long-term drought resilience. The Guide contains three main sections: (1) staffing, response plans, and funding; (2) water supply and demand management; and (3) communication and partnerships.

Goal 3: Drought Planning and Capacity Building

Objective: Agencies shall assist State, regional, tribal and local officials in building local planning capacity for drought preparedness and resilience.

Although drought is a normal part of our climate system, its effects are magnified when it is perceived to be an unanticipated surprise. Reducing and effectively mitigating the impacts of drought requires planning and preparation that is integrated into regular practice well before drought conditions become critical and in ways that carry through specific events into long-term resilience efforts.

With partnerships across mission and science agencies and collaboration across local, state, tribal, and regional entities, Goal 3 partners will focus on opening new opportunities for drought planning and capacity development that bridge the diverse challenges of securing water resources for people, communities, and the environment. This portfolio of Federal activities reaches across sectors and geographies to focus on building connections across various types, stages, and administrative units of drought planning, improving our understanding of drought impacts on ecosystems and strengthening resources for identifying and addressing risks to water supplies, energy, and human health risks associated with dry conditions.

Goal Leader: Claudia Nierenberg, National Integrated Drought Information System, National Oceanic and Atmospheric Administration; **Co-Leader:** Roger Pulwarty, National Integrated Drought Information System, National Oceanic and Atmospheric Administration

Action 1: Coordinate Planning and Capacity-Building Programs

Lead Coordinating Agency: Department of Commerce, National Oceanic and Atmospheric Administration, National Integrated Drought Information System; **Supporting Agency:** Department of Agriculture

NIDIS and USDA are collaborating with the National Drought Mitigation Center at the University of Nebraska, Lincoln, to supplement their existing drought-plan clearinghouse with a geospatial capability that will enable drought planning to be viewed in a map form. These plans correspond to ongoing and potentially complementary implementation of drought at the State, tribal, and local watershed scale. As this tool develops, layers of maps will be added. The effort will start in prototype mode, to test the concept, with a focus in the Missouri River Basin.

The first set of maps will identify where elements of drought planning exist (e.g. contexts such as states' emergency/hazard management plans, river compacts, state water plans) and will depict the geographical scope of relevant plans. Potential users of an enhanced map-based interface will be consulted on an ongoing basis and different use-case questions explored. For example: Are there coordination opportunities across plans and how best might such coordination occur? What resources or policies might be associated or leveraged with planning processes? Is it useful to be able to search by zip code? Promoting connectivity and coordination on planning and implementation across larger geographic drought-sensitive areas will enhance the effectiveness of risk mitigation policies and practices.



Left: National Integrated Drought Information System Oklahoma Drought Planning Meeting, 2014

Disseminating Science-based Knowledge at a Regional Scale

Lead Coordinating Agencies: Department of Agriculture, Department of the Interior, and Department of Commerce, National Oceanic and Atmospheric Administration

Science-based regional support for capacity building with respect to planning for extremes is provided in part through programs such as the USDA Climate Hubs, the NOAA Regional Integrated Science and Assessment (RISA) teams, and the DOI Climate Science Centers and their partnerships across Federal agencies and university communities. [Emerging coordination](#) across these regional research and outreach assets is evident in new work on drought and ecosystem resilience, community-level impacts, and strategies for coping with changes in water resources. This growing coordination allows communities, land managers, and State and local governments to know where they should go for comprehensive information and expertise to allow them to recognize opportunities, and to prepare for and respond to risks.

For example, USDA's Forest Service, in coordination with USDA Climate Hubs, is planning to host nine regional workshops starting in October 2016. The goal of these workshops is to provide regionally-specific drought information to forest managers and staff, including management constraints and opportunities imposed by future drought conditions. The information will be based on findings from the recently completed assessment, "[Effects of Drought on Forests and Rangelands in the United States.](#)" Likewise, many RISA teams are conducting research and engagement around drought impacts and preparedness through partnerships in their respective regions. Coordination helps ensure that these efforts take an integrated approach to addressing needs, preparation, and responses in integrated ways to best meet the needs of the public, and that information and products are shared across diverse sets of stakeholders.

Going forward, Federal investments in understanding and communicating risks associated with extreme events such as drought will be undertaken in coordination and in close collaboration with the affected communities. Specific drought related research and engagement activities across federal entities (USDA Hubs, NOAA RISAs, and DOI Climate Science Centers) will continue to be coordinated regionally, and where relevant, in partnership with the development of Regional Drought Early Warning Systems of NIDIS. The Climate Hubs will promote climate literacy in the agricultural community, engaging agricultural service provider partners and audiences. NDRP place-based activity will work to enhance connections that identify pathways and innovations necessary for long term drought resilience.

Action 2: Examine the Ecological Impacts of Drought across the United States

Synthesizing Information and Best Practices to Manage Ecological Drought

Lead Coordinating Agency: Department of the Interior, U.S. Geological Survey

USGS is leading the Science for Nature and People Partnership (SNAPP) ecological drought working group with stakeholders and partners. The group aims to help people and nature prepare for climate-change enhanced drought and to provide information, tools, and strategies that help planners and practitioners reduce risks, anticipate surprise, and decrease the chances that people will take actions to prepare for drought that could result in degraded ecosystems. To achieve these goals, the working group is focused on synthesizing the available information on ecological effects of drought under current and future climates, and examining potential approaches for reducing drought impacts that could benefit people and nature. Additionally, the group is analyzing risks facing biodiversity conservation and human well-being, and connecting these risks to ecosystem-based solutions.

Currently, the SNAPP ecological drought working group is in the process of publishing a synthesis paper, "Framing Ecological Drought in the 21st Century." The paper highlights the need for a new way to view drought that considers human drivers of drought alongside more typical natural and climatic drivers. This approach will improve the Federal government's ability to predict future drought impacts to ecosystems and human communities. The paper also provides insight into innovative policy solutions and management actions that can reduce the negative effects of ecological drought in the future. *Going forward*, the group plans to publish several analyses including *Modeling Ecological Drought Vulnerabilities and Impacts* in March 2017; working papers on subtopics of ecological drought including *Impacts on Ecosystem Services* and case studies of *Strategies for Reducing Ecological Drought Impacts on People and Nature* in June 2017; and a comprehensive *National Synthesis on Ecological Drought* in December 2017.

Action 3: Strengthen Rural Drinking Water Contingency Plans

Lead Coordinating Agency: Department of Agriculture, Rural Development

USDA's Rural Development (RD) has been working with States and tribes to identify rural communities most at risk for compromised drinking water supplies as a result of drought, including those that are at risk as a result of depleted or contaminated groundwater. RD has included drought impact planning in emergency response plans as a condition of funding for new water and waste infrastructure projects. Additionally, RD created an El Nino-related fact sheet for communities, particularly in drought and fire areas, related to potential impacts of increased and rapid precipitation due to El Nino. The fact sheet encouraged updating emergency response plans.

USDA supports the National Rural Water Association (NRWA) and Rural Community Assistance Partnership (RCAP) which provide technical assistance to rural communities and the water and waste utilities that serve them, including assistance with developing, updating, and exercising emergency response plans. In 2016, USDA RD funded 116 NRWA Circuit Riders, serving 50 States and territories, as well as 150 RCAP technical assistance providers. In June 2016, Rural Development provided training to the Circuit Riders including guidance on inclusion of drought scenarios and impacts into vulnerability and emergency response plans for rural water and waste systems.

Action 4: Support State, Tribal, Local and Territorial Health Departments






Lead Coordinating Agency: Department of Health and Human Services, Centers for Disease Control and Prevention

CDC is committed to serving communities affected by extreme weather and drought. The agency is currently working on a drought-related Community Assessment for Public Health Emergency Response (CASPER) reports for Arizona and Oregon. The reports will assess the two states' drought-affected populations, identify populations vulnerable to drought in those states, and identify each states' communication, education and public-health needs. Ultimately, these assessments will be available to State, local, tribal and territorial health departments and decisionmakers across the nation to guide better-informed decisions when serving drought-affected and drought-vulnerable populations.

Going forward, CDC is creating a resource guide describing the current state of drought-related public health activities, including resources to help States prepare for and respond to drought. The resource guide will describe the recent and current involvement of the public health sector in drought planning and response, and will include best practices, data sources and tools, lessons learned, and any gaps in data and information. The resource guide will serve to update the public health community about drought-related activities since the 2010 publication of "When Every Drop Counts" and be completed by March 2018.

How drought can affect health

Drought can have many harsh effects on plants, animals, and the environment. This can contribute to increased risk to human health. Here are only a few examples of what drought can do:

				
Cause stress, anxiety, and depression. Drought causes economic losses to businesses that rely on water (for example, farms and landscape companies) and job loss for people who work in these areas.	Change the amount and patterns of certain diseases. For example, mosquitoes carrying West Nile virus can move into new areas when stagnant bodies of water create new breeding grounds. Also, dry and dusty soil conditions can increase the risk of Valley Fever, a lung infection caused by a fungus in the soil.	Intensify wildfires and dust storms, thus increasing the number of particulates in the air. This can worsen asthma and other heart and lung diseases.	Intensify heatwaves causing increased risk of injury and death from heat exhaustion or heat stroke.	Stress city- or county-wide water systems that supply water not only to households but also at-risk populations such as people in hospitals and nursing homes.

Goal 4: Coordination of Federal Drought Activity

Objective: Agencies shall improve the coordination and integration of drought-related activities to enhance the collective benefits of Federal programs and investments

Agencies throughout the Federal Government have been taking significant action, working with State, local, and tribal governments along with private entities to help plan, adapt, and mitigate drought. Recognizing the collective benefits of greater integration of these efforts, Federal agencies have been working to coordinate funding and programs and extend best practices.

Goal Leader: David Raff, Bureau of Reclamation, Department of the Interior

Action 1: Drive Coordination and Sharing of Information Related to Federal Investments in Water Infrastructure

Mapping Federal Investments in the Yakima Basin

Lead Coordinating Agencies: Department of Agriculture and Department of the Interior

DOI and USDA are partnering to create a pilot geospatial map of Federal investments in Washington State's Yakima Basin. Over the last several years, federal agencies have worked with local stakeholders to develop a table of Federal investments made since 2010, in order to support the implementation of a comprehensive water management plan for the Basin. Going forward, by December 2016, DOI and USDA will work to provide a geospatial framework to map investments on the landscape. This geospatial tool will be used by local, state and Federal officials to prompt broad collaboration by providing visibility on existing Federal investments and to coordinate pending applications within a watershed.

Action 2: Extend Best Practices of Coordinated Federal Water-Resource Programs

Expansion of the EQIP-WaterSMART Partnership

Lead Coordinating Agencies: Department of Agriculture and Department of the Interior

Since 2011, The Bureau of Reclamation WaterSMART (Sustain and Manage America's Resources for Tomorrow) grant program and the Natural Resources Conservation Service Environmental Quality Incentives Program (EQIP) have provided millions of dollars in financial assistance to water districts and growers on private working lands to improve wa-



Above: Reclamation Commissioner Estevan López and Agriculture Secretary Tom Vilsack announce a new partnership and investments that will better conserve water resources in 13 Western states, including the Colorado River Basin, in Brighton, CO on June 23, 2016.

ter management and agricultural water-use efficiency. In California, Reclamation and NRCS have worked together to focus and complement their water efficiency investments. Reclamation works with water and irrigation districts to improve operations of water delivery systems, water districts, and water basins. NRCS then works with producers within the delivery system area or district to increase on-farm efficiencies and introduce conservation practices such as drip irrigation, low center pivots, and cover crops.

On June 23, 2016, USDA Secretary Tom Vilsack and Reclamation Commissioner Estevan Lopez announced more than \$47 million in investments to help water districts and producers on private working lands through an expansion of the EQIP-WaterSMART partnership. The funds include \$15 million from USDA and \$25.6 million from Reclamation for local projects to provide a strengthened Federal response to ongoing and potential drought across 11 States in the West. Reclamation funding will support 53 projects through the Department of the Interior's WaterSMART program. Funding from

NRCS will support on-farm water delivery system improvements through EQIP, in tandem with the 56 Interior-funded projects. *Going forward*, USDA and DOI are holding stakeholder engagements and identifying a more strategic approach to leveraging these two programs. The agencies will submit a plan outlining the approach by December 2016.

Action 3: Launch a Prize Competition or Ideation Challenge

Lead Coordinating Agency: Department of the Interior

DOI is leading an effort with multiple agencies to help incentivize new technologies or scale up existing methods of water-use innovation through prize competitions and ideation challenges. In 2016, Reclamation and collaborating agencies are planning several competitions focused on finding better solutions for problems within three main theme areas critical to improving the overall reliability of water supplies: water availability, infrastructure sustainability, and aquatic ecosystem restoration.

Going forward, DOI and partners will host four competitions in 2016: [Preventing Rodent Burrows in Earthen Embankments](#), September 2016; [Improving Arsenic Detection in Source Waters in Order to Optimize Water Treatment Processes](#), October 2016; [Managing Desalination Concentrate](#), November 2016; and [Forecasting Drought and Water Supply](#), December 2016. The challenges will be posted publically on [Challenge.gov](#).

Action 4: Increasing Water Management Flexibility

Lead Coordinating Agencies: Army Corps of Engineers and Department of the Interior, Bureau of Reclamation



Above: Lake Powell is one of five reservoir operations pilots studies initiated by the Bureau of Reclamation. The others include Upper Washita, Fort Cobb and Foss Reservoirs; Klamath River Basin, Klamath Project; Ochoco Creek and Crooked River; Upper Colorado River Drought Contingency Plan, Climate and Operations Assessment Methodology; and the Salt River Project, Salt and Verde Rivers.

Reclamation is improving drought preparedness by developing and implementing new processes and considerations into reservoir management. In January 2016, Reclamation implemented five pilot activities to explore the tracking of water supplies affected by climate change and other reservoir operations opportunities. Reclamation is coordinating with USACE where storage is co-managed, to identify opportunities to leverage deviation requests through updates to Drought Contingency Plans in USACE Water Control Manuals. Reclamation is also collaborating with USACE to explore updates to Water Control Manuals that include forecast-based operations.

Going forward, USACE will use assessments from the pilot activities, to examine methods to develop and incorporate drought contingency language from water control manuals for real-time application. This will enable USACE to develop site-specific, actionable guidance as part of specific projects' drought contingency plans. This guidance will help streamline real-time decision making for daily operations of projects under drought conditions

Additionally, USACE is working to update and compile a database of electronic water control information. The database will enable USACE to evaluate current water control manuals to assess if revisions are warranted. Revisions could encompass a wide array of needs, including assessment of changed conditions from a meteorological standpoint (to include climate change indicators); watershed characteristics (including land

use alterations); increased forecast capabilities that may influence water management release decisions; and alteration of water management regulation schedule guidance. USACE plans to finish updating the database by November 2016.

Action 5: Promoting Stronger Drought Resilience on Federal Lands

Federal Coordination through the Western Watershed Enhancement Partnership

Lead Coordinating Agencies: Department of the Interior and Department of Agriculture, Forest Service



Above: The Glacier Creek to Mill Creek Fuel Reduction Project focuses on reduction of fuel loads to help prevent wildfires from spreading and improve watershed health by focusing on enhancing existing fire barriers such as roads, trails and rivers on 210 acres in Rocky Mountain National Park in the headwaters of the Colorado-Big Thompson Project.

The Western Watershed Enhancement Partnership was formally established in July 2013, by Secretary of the Interior Sally Jewell and Secretary of Agriculture Tom Vilsack. The partnership is a part of President Obama's Climate Action Plan, and is part of a comprehensive approach to preparing the United States for the impacts of climate change, including increased risk of wildfires and drought. In May 2016, DOI [announced](#) \$500,000 in Western Watershed Enhancement Partnership grants to five projects to improve watershed health, reduce wildfire risk, restore wildlife habitat and mitigate the impacts of post-wildfire erosion and sedimentation loss. Projects included: Boise River Pilot Project (Idaho), Cragin Watershed Protection Project (Arizona), Hemlock Project (California), Glacier Creek to Mill Creek Fuel Reduction Project (Colorado), and the Yakima Watershed Enhancement Project (Washington).

Increasing Drought Resilience on Public and Private Lands through the Collaborative Forest Landscape Restoration Program and the Joint Chiefs Landscape Restoration Partnership

Lead Coordinating Agency: Department of Agriculture

The Forest Service is working to foster and enhance collaborative restoration partnerships across large forested landscapes through the [Collaborative Forest Landscape Restoration Program](#) (CFLRP) and the Forest Service and Natural Resources Conservation Service (NRCS) Joint Chiefs Landscape Restoration Partnership. Through the CFLRP, over 200 partner organizations are working with the Forest Service to implement 23 ten-year projects on landscapes ranging from 130,000 to 2,400,000 acres. The projects are reducing the risk of catastrophic wildfire and improving watershed health, which will increase the resilience of these lands to drought. Between 2012 and 2015, CFLRP projects leveraged over \$200 million in partnership support for projects underway in 15 States.

One example of this is the Ozark Highlands Ecosystem Collaborative Project. Over the life of the project, from 2011-2020, the Forest Service will invest over \$20 million, with a partnership match of over \$6 million. This investment is improving the stream and lake health with fewer invasive species, less silt and sedimentation, better habitat for fish, and improved recreation opportunities for visitors.

In 2014, the Forest Service and NRCS initiated the [Joint Chiefs Landscape Restoration Partnership](#) to address landscape-scale objectives for reducing wildfire threats, protecting water quality and supply, and improving habitat quality for at-risk species. The Joint Chiefs Partnership enables the two agencies to design and implement treatments where private and public lands meet and where restoration objectives cross ownership boundaries. Activities such as thinning, prescribed burning, invasive species eradication, and riparian road decommissioning on and off national Forest Service lands have resulted in improved resiliency and land health on thousands of acres across the country.

One example of this work is in the Hiwassee River Watershed. In cooperation with the Tennessee Division of Forestry, U.S. Fish and Wildlife Service, and other partners, USDA will invest over \$1 million in the watershed to improve water quality and an at-risk aquatic ecosystem which serves as the surface water source for over 150,000 residents and multiple industrial users. Currently, 28 Joint Chiefs' cross-boundary projects are partnering to accomplish restoration objectives. *Going forward*, new projects will be selected in January 2017.

Action 6: Enhance Federal Drought Resilience Investments at the Watershed Scale

Building Drought-Resilient Private Working Lands through the Regional Conservation Partnership Program

Lead Coordinating Agency: Department of Agriculture, Natural Resources Conservation Service

Created by the 2014 Farm Bill, the Regional Conservation Partnership Program (RCPP) is a partner-driven, locally led approach to conservation. It offers new opportunities for USDA's Natural Resources Conservation Service (NRCS) to harness innovation, welcome new partners to the conservation mission, and demonstrate the value and efficacy of voluntary, private lands conservation. The program creates opportunities for partners to develop regionally appropriate strategies to address conservation challenges across the country, including challenges created by drought and water scarcity. NRCS plans to invest up to \$1.2 billion through 2018, with a partner match of at least \$2.4 billion.

In 2016, NRCS funded 84 high-impact projects, many of which focused on water conservation and drought resilience. One example of this is a project through Nebraska Game and Parks Commission supporting cropland cover for soil health and wildlife. In Nebraska, the lack of sufficient water, frequent drought and soil erosion cause significant impacts to yields and producers' bottom lines. Similarly, vanishing habitat and increasingly intensive agricultural practices create struggles for wildlife. This project helps both producers and wildlife cope with constantly changing conditions by encouraging producers to enact practices such as tall standing stubble, cover crops, and diverse seedings. These practices can help improve water quantity, soil erosion, soil quality, and air quality while also providing valuable habitat for grassland birds, including at-risk species and pollinators like honey bees and monarchs.

Going forward, USDA-NRCS is reviewing project proposals for FY 2017 and will make selection announcements in December 2016. NRCS is encouraging Federal agencies to join State, regional, tribal, and local partners in drafting project proposals for innovative approaches to enhancing drought resilience on farms, ranches, and private forest lands. Additionally, NRCS is encouraging applicants to submit proposals that build on other Federal, State, and private resilience investments—including those made through DOI's WaterSMART program and the EPA's State Revolving Loan programs.

Goal 5: Market-Based Approaches for Infrastructure and Efficiency

Objective: Agencies shall support the advancement of innovative investment models and market-based approaches to increase resilience, flexibility, and efficiency of water use and water-supply systems

The President's Drought Resilience Goals encourage Federal agencies to use their existing authorities in support of market-based approaches to increase investment in water infrastructure and promote water efficiency. EPA, USDA, and DOI, who are supporting this work, have established financing centers connected to the Administration's efforts to promote private investment in infrastructure under the President's Build America Investment Initiative.

The first action included in this goal is focused on the work of EPA's Water Infrastructure and Resiliency Finance Center (WIRFC), USDA's Rural Opportunity Investment Initiative (ROI), and DOI's Natural Resource Investment Center (NRIC). The centers are staffed with experts versed in alternative approaches to project finance that include financial partnerships between the public and private sectors. This action seeks to focus and highlight the work of the centers on alternative financing solutions for water infrastructure and efficiency in drought prone areas of the West.

The second and third actions included under this goal are focused on DOI and its efforts to encourage private investors to increase their participation in financing irrigation infrastructure and water markets in the West. These actions include supporting state and local strategies for more flexible water management and disseminating information on water pricing and construction cost repayments. Taken together, the three actions under this goal reflect a concentrated effort by EPA, USDA, and DOI to lower some of the barriers that discouraged private investors from participating in financing water infrastructure and trading in water markets.

Goal Leader: Jim Gebhardt, Water Infrastructure and Resilience Finance Center, Environmental Protection Agency

Action 1: Explore Innovative Financing Options for Drought Resilience

Lead Coordinating Agencies: Environmental Protection Agency, Department of Agriculture, and Department of the Interior

EPA, DOI and USDA have been working through their existing authorities to promote additional investment in water infrastructure and efficiency projects by the private sector and other non-Federal sources of capital. Additionally, these agencies have begun to focus efforts on projects and investments that have specific application to the arid West. Recent efforts include:

EPA's Water Infrastructure and Resiliency Finance Center (WIRFC) is working with State managers of its Clean Water and Drinking Water State Revolving Funds (SRF) to highlight projects that address drought, with a particular focus on water conservation, water reuse, desalination, and groundwater protection/restoration projects. WIRFC is also exploring new financing models to advance market-based solutions in drought prevention, mitigation banking, and municipal separate storm sewer systems. Additionally, WIRFC is working with EPA's Environmental Finance Center at the University of North Carolina to develop case studies that serve as resources for project sponsors seeking reviews of existing public-private partnerships in drought-prone areas, including Santa Paula, Woodland- Davis, and Rialto, California; and Phoenix, Arizona.

USDA's Rural Opportunity Investment Initiative (ROI) is working with the managers of the Department's rural water infrastructure programs on increasing engagement with private sector lenders that finance similar or related water infrastructure projects. The goal of this increased engagement is to develop financial partnerships that will allow USDA to expand the reach and impact of its current programs. One focus of this market research is how to encourage bundling of rural projects in order to attract institutional lenders to the projects and lower the cost of financing. Project bundling is particularly relevant to the arid West where many rural communities are exploring watershed-level solutions to the impact of drought.

DOI's Natural Resource Investment Center (NRIC) is providing technical assistance to a number of water infrastructure projects in the West that are in the early stages of development. For example, in one major project, the NRIC is working to facilitate federal review and the use of federal infrastructure to enable a locally-designed water management strategy that would significantly diversify a large municipal water district's long-term water supply portfolio. The NRIC is also working with agricultural water users in Colorado, Washington and Oregon to design new investments in water efficiency, reuse and hydropower that can increase drought resilience for farmers and improve aquatic ecosystems.

Going forward, WIRFC, ROI, and NRIC will work collaboratively to:

- ◆ Build support for their recent efforts across the Administration through agencies participating in the Build America Investment Initiative. Launched by President Obama in July 2014, this initiative promotes increased investment in infrastructure projects.
- ◆ Identify new initiatives and pilot projects to support drought resilience financing. Some recent opportunities include partnering public, private and social impact capital to suppress forest fire risk and protect water supplies on both federally owned and private lands; exploring lessons-learned from a recent public-private partnership that encourages better water management in order to protect/restore groundwater supplies; and supporting local infrastructure exchanges in drought prone areas, such as the Intermountain Infrastructure Exchange and the West Coast Infrastructure Exchange.
- ◆ Participate in a high-level dialogue organized by the Harvard Kennedy School's Ash Center to explore policy solutions to the underinvestment in federally owned and operated water infrastructure. Some topics include: project prioritization, revenue generation, and flexible contracting tools.
- ◆ Support NRIC's work coordinating with the Bureau of Reclamation as Reclamation develops a new funding category under the WaterSMART program to encourage irrigation districts, municipalities, and other entities to explore the use of water markets. In addition, support NRIC's work coordinating with Reclamation to identify ways that WaterSMART grant recipients could attract private capital to maximize project benefits.

Action 2: Support State and Local Strategies for more Flexible Water Management

Lead Coordinating Agency: U.S. Department of the Interior

In many cases, States and local water users are exploring new strategies to increase water-use flexibility during drought, including the use of water transactions. The DOI Natural Resource Investment Center is developing a document to facilitate locally led water transactions and to promote best practices at Reclamation facilities. The paper will provide a focused look at transfers occurring on selected Reclamation projects, where locally and regionally led water transfers have occurred in the past and are currently occurring. The document will seek to identify opportunities where Reclamation can further support local and regional entities who are engaged in water transfers. Additionally, it will include examples of several cases where Reclamation has acquired water to support fish and wildlife management objectives. The document is slated to be publically available in autumn 2016.

Action 3: Disseminate Information on Water Pricing and Construction Cost Repayments

Lead Coordinating Agency: U.S. Department of the Interior, Bureau of Reclamation

In order to promote greater transparency about the per-unit price of water resourced from Federal reservoirs and to better inform water users and other market suppliers about current market pricing, Reclamation made Project Construction Cost and Repayment Statements [available by request](#).

Reclamation has been accumulating construction cost and repayment data since the first reimbursable project began and created the Statement of Project Construction Cost and Repayment to capture cost and repayment data by project for internal use. These statements are now available through Reclamation regional finance offices: Pacific Northwest Region, Mid-Pacific Region, Lower Colorado Region, Upper Colorado, and Great Plains Region.

Goal 6: Innovative Water Use, Efficiency and Technology

Objective: Agencies shall support the advancement of innovative investment models and market-based approaches to increase resilience, flexibility, and efficiency of water use and water-supply systems

Goal 6 exemplifies the diversity of sectors where drought has a specific impact: from agricultural water-use efficiency, to the needs of the energy sector, to providing clean and safe drinking water for municipalities, to what we can learn from active engagement with our international partners who are also struggling with drought conditions.

The Actions under Goal 6 require significant input and collaboration from stakeholders on the ground in order to ensure that the NDRP is meeting specific needs. Additionally, the Actions under Goal 6 align with actions under the other NDRP Action Plan Goals. For example, Action 4: Highlight Resilience Successes from the Municipal Sector will showcase where cities and towns have successfully implemented actions to build long-term resilience to drought. These successes will serve as case studies that connect to the work under Goal 3 for capacity building and contingency planning. Making these cross-goal connections will continue to break down barriers so the NDRP and all Federal agencies can more effectively support long-term drought resilience at the State, regional, local, and tribal levels.

Goal Leader: Roger Gorke, Office of Water, Environmental Protection Agency

Action 1: Conduct Research to Optimize and Improve Agricultural Water Use

Lead Coordinating Agencies: U.S. Department of Agriculture and the White House National Science and Technology Council, Subcommittee on Water Availability and Quality

In April 2016, the White House Office of Science and Technology Policy (OSTP) re-chartered the Subcommittee on Water Availability and Quality (SWAQ), whose mission is to advise and assist on policies, procedures, plans, issues, scientific developments, and research needs related to the availability and quality of water resources of the United States. The SWAQ focuses on science issues and associated policy options related to research and improvements in technology to advance the goal of ensuring a safe and sustainable supply of water in the United States.

Currently, USDA and the re-established SWAQ are convening a workgroup of Federal technical specialists and managers to identify and promote more efficient agricultural water use methods that can be implemented throughout Federal, State, tribal, local, and academic institutions. The workgroup will include career experts from across the Federal family including the Department of the Interior, U.S. Geological Survey, Bureau of Reclamation; Department of Commerce, NOAA, National Institute of Standards and Technology; Environmental Protection Agency; National Science Foundation; Department of Energy; USACE; National Aeronautics and Space Administration; and The White House Office of Science and Technology Policy to participate in the agricultural water use working group. *Going forward*, by December 2016, the workgroup will convene and discuss a plan for researching the five focus areas outlined in the President's Memorandum.

Action 2: Conduct Research to Optimize and Improve Energy-Sector Water Use

Lead Coordinating Agency: Department of Energy

The Department of Energy (DOE) is pursuing research into technologies that reduce the need for cooling water in thermoelectric generation and related industrial processes. In furtherance of that research agenda, in May 2016, DOE organized a joint workshop with the Electric Power Research Institute (EPRI) where attendees from industry, government, academia, and non-governmental organizations were asked to develop regional water goals for the U.S. power sector and outline strategies to reach those goals. *Going forward*, DOE will use the meaningful insights gained through this workshop to help inform ongoing efforts, including Research and Development investments and policy analysis.

Action 3: Conduct Research to Improve Performance and Reduce Energy Requirements and Carbon Emissions from Water-Treatment Technologies

Lead Coordinating Agency: U.S. Department of Energy

DOE is pursuing research into technologies that reduce energy requirements and carbon emissions of water-treatment technologies in order to make alternative water resources more accessible. Recently, DOE has taken steps to catalyze this research. In May 2016, eight selections were made for desalination research by DOE's Advanced Manufacturing Office through a Small Business Innovation Research funding opportunity announcement. In support of small businesses and innovation research, these water desalination projects will pursue a range of cost effective solutions to meet the growing need for more secure sources of water and power.

Additionally, DOE is working to establish a network of water resource recovery test bed facilities that will link these facilities to one another and to innovators, manufacturers, utilities, regulators, policymakers, and educators. The goal of this network is to reduce the energy footprint for resource recovery and water treatment by accelerating energy efficiency and energy positive wastewater recovery technology. In June, DOE, EPA, and the National Science Foundation (NSF) held a workshop to envision the structure of a national test bed network and define several key metrics that new technologies should measure and report when being evaluated at the national test bed network. This workshop focused on identifying stakeholder needs and objectives, and developing plans for the formation, operation, and assessment of the test bed network.



Above: A desalination plant in California. DOE's Advanced Manufacturing Office recently funded 8 projects to undertake innovative research on desalination.

Action 4: Highlight Resilience Successes from the Municipal Sector

Lead Coordinating Agencies: U.S. Environmental Protection Agency and the White House National Science and Technology Council, Subcommittee on Water Availability and Quality

Many communities throughout the country are successfully implementing long-term drought-resilience action and programs. These communities span the entire Nation from the Southeast to the Pacific Northwest, to the desert Southwest. EPA, in conjunction with the White House National Science and Technology Council, Subcommittee on Water Availability and Quality (SWAQ), has begun identifying these successful local programs.

Going forward, EPA and SWAQ will work with communities to identify best practices and case studies that highlight effective planning, multi-sector collaboration, and financing for drought resilience. EPA has identified several websites to host the case studies once they are developed, including Drought.gov and EPA's Climate Ready Water Utilities website. By December 2016, EPA and SWAQ anticipate developing six or more case studies. Additionally, EPA and SWAQ are investigating how communities can develop and submit their own case studies for inclusion.

Action 5: Establish a Soil Health Monitoring and Enhancement Network

Lead Coordinating Agency: U.S. Department of Agriculture, Natural Resources Conservation Service

NRCS is working to establish a network to provide geographically-referenced information on soil health to assess the effect of management practices on different soils and under various climate and land uses that will serve as a significant indicator of agriculture-related demand for water and to identify methods for improving soil health and preventing future degradation. NRCS is developing a project plan for a soil health network that will be complete by December 2016. In June, NRCS finalized the initial plan and will present it to the NRCS Chief for concurrence and approval.



Going forward, NRCS is laying the groundwork for implementation of the proposed plan. By October 2016, NRCS will assign staff and teams to work on one or more specific sub-project components, and by November, the teams will begin initiating data collection and database development.

Action 6: Develop Municipal Water-Recycling Technical Assistance

Lead Coordinating Agency: Environmental Protection Agency

The EPA Office of Water conducted a risk assessment to evaluate the potential microbial risks associated with various potable reuse treatment combinations for recycled water. The results illustrated human health-based advantages for potable reuse projects in which product water is introduced into the raw water supply immediately upstream of a conventional drinking water treatment facility, compared to those in which product water is introduced directly into a potable water supply distribution system. *Going forward*, EPA plans to create a Technical Guide highlighting some of the findings of this work. This work will be useful to Federal and State regulators considering highly treated reused water as source water, State and local decisionmakers considering whether to permit a particular potable reuse project, or engineers considering which unit treatment processes should be employed for particular projects.

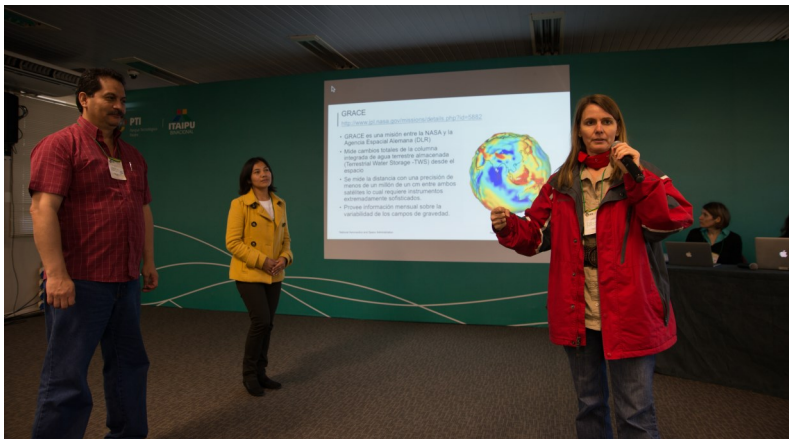
EPA's Office of Research and Development's Safe and Sustainable Water Resources Research Program (SSWR) is conducting studies on risk assessment methods for potable and non-potable reuse systems, and on the application of innovative bioassays for use in safety screening of fit-for-purpose treatment of reused water. *Going forward*, EPA scientists are using existing data from internal studies and external projects to provide transformative water management systems for communities where water reuse and stormwater capture plays a central role. SSWR funded 5 water reuse-related STAR grants for quantifying water reuse impacts in the Potomac watershed. Projects included topics such as advancing ultraviolet light and solar disinfection systems to reduce viral pathogens, stormwater harvesting, quantifying microbial risk and sustainability of potable reuse systems, and assessing plant accumulation of chemicals from reused irrigation water in agriculture. EPA is developing technical guides based upon this research.

Action 7: Maximize Use of Existing Diplomatic Engagement Structures to Advance International Drought-Related Research and Collaboration

Lead Coordinating Agencies: Department of State, Department of the Interior and Army Corps of Engineers

The Department of State (DOS) DOI, and USACE are engaging with key countries and multilateral institutions to share best practices and research on drought with United States technical experts. The agencies have identified three main strategies for engagement.

First, enhancing interagency participation in global intergovernmental drought initiatives, including multilateral institutions such as the World Meteorological Organization Integrated Drought Management Program and the United Nations International Hydrological Program. For example, in July 2016 the United States hosted a training course on “Application of Satellite Remote Sensing to Support Water Resources Management in Latin America and the Caribbean,” in Foz do Iguacu, Brazil. This course presented U.S.-based tools to an international audience, including several days on drought tools. Additionally, the event offered an opportunity to learn from other countries' knowledge and experiences.



Left: The GRACE satellite is presented at the remote sensing international training course in Foz do Iguacu, Brazil.

Secondly, Federal partners are working to enhance bilateral interagency collaboration on drought, based on existing diplomatic engagements, specifically with countries such as Australia and South Africa. A few examples of this collaboration include:

- ◆ *Boulder, Colorado, USA*- June 2016- Federal partners from NOAA, DOS, DOI, and EPA attended the Drought in Federal Rivers Symposium and Martz Conference on Water Scarcity. The conference hosted officials, researchers, and practitioners from Australia, Spain, South Africa, and Brazil to discuss drought and water management.
- ◆ *Johannesburg, South Africa*- June 2016- The United States participated in a roundtable discussion on Drought/Climate Resilience in Johannesburg, South Africa. The bilateral and interagency dialogue focused on the establishment of a hydrology center/facility for South Africa.
- ◆ *Washington, D.C., USA* - July 2016- DOI, DOS, and USACE met with the Center for Water Security and Cooperation about participating in a new US-Spain cooperative program that will focus on drought resilience and governance.
- ◆ *Washington, D.C., USA*- July 2016- State hosted a Science & Technology information exchange between the South African Water Research Commission and members of the U.S. Government, including Reclamation, USGS, NASA, and the Air Force.

Third, partners are enhancing interagency communication on international drought activities and upcoming events internally through channels such as Drought.gov.

- ◆ USACE is working to expand the existing Federal portal (watertoolbox.com) to help partners, stakeholders, and the private sector understand climate risks for international investments and drought-related issues, and to incorporate Integrated Regional Water Management case studies. This project is expected to be complete by December 2016.
- ◆ USACE will also expand the portal to include information on international techniques useful for communities in the United States, especially information helpful for remote, low-income or isolated communities or tribes.

Appendix A: List of Abbreviations

ALS	Airborne Laser Scanning
CASPER	Community Assessment for Public Health Emergency Response
CDC	Centers for Disease Control and Prevention, Department of Health and Human Services
CFLRP	Collaborative Forest Landscape Restoration Program, U.S. Forest Service
CoCoRaHS	Community Collaborative Rain, Hail and Snow Network
DHS	Department of Homeland Security
DHS-FEMA	Department of Homeland Security, Federal Emergency Management Agency
DHS-IP	Department of Homeland Security, Office of Infrastructure Protection
DOC	Department of Commerce
DOE	Department of Energy
DOI	Department of the Interior
DOS	Department of State
EPA	Environmental Protection Agency
EPRI	Electric Power Research Institute
EQIP	Environmental Quality Incentives Program, U.S. Department of Agriculture
FS	U.S. Forest Service, U.S. Department of Agriculture
HHS	Department of Health and Human Services
LiDAR	Light Detection and Ranging Remote Sensing
NASA	National Aeronautics and Space Administration
NDMC	National Drought Mitigation Center, University of Nebraska, Lincoln
NDRP	National Drought Resilience Partnership
NIDIS	National Integrated Drought Information System
NMME	North American Multi-Model Ensemble
NOAA	National Oceanic and Atmospheric Administration, Department of Commerce
NRCS	Natural Resources Conservation Service, U.S. Department of Agriculture
NRIC	Natural Resources Investment Center, U.S. Department of the Interior
NRWA	National Rural Water Association
NSF	National Science Foundation
NSTC	National Science and Technology Council
NWS	National Weather Service, National Oceanic and Atmospheric Administration
OSTP	Office of Science and Technology Policy, The White House
PM	Presidential Memorandum, Building National Capabilities for Long-Term Drought Resilience
RAWS	Remote Automatic Weather Stations
RCAP	Rural Community Assistance Partnership
RCPP	Regional Conservation Partnership Program
RD	Rural Development, U.S. Department of Agriculture
Reclamation	Department of the Interior, United States Bureau of Reclamation
ROI	Rural Opportunity Investment Initiative, U.S. Department of Agriculture
RISA	Regional Integrated Science and Assessment, National Oceanic and Atmospheric Administration
SNAPP	Science for Nature and People Partnership
SRF	Clean Water and Drinking Water State Revolving Funds
SSWR	Safe and Sustainable Water Resources Research Program, Environmental Protection Agency
SWAQ	Subcommittee on Water Availability and Quality
UCAR	University Corporation for Atmospheric Research
USACE	U.S. Army Corps of Engineers
USDA	U.S. Department of Agriculture
USGS	U.S. Geological Survey, Department of the Interior
WaSSI	Water Supply Stress Index
WaterSMART	Water (Sustain and Manage American Resources for Tomorrow) Program, Department of the Interior
WIRFC	Water Infrastructure and Resiliency Finance Center, Environmental Protection Agency

Appendix B: National Drought Resilience Partnership Leadership

Principals Committee Co-Chairs

Robert Bonnie

Under Secretary for Natural Resources and Environment
Department of Agriculture

Dr. Christine Blackburn

Performing the Duties of Assistant Secretary of Commerce for Conservation and Management
National Oceanic and Atmospheric Administration
Department of Commerce

Steering Committee Co-Chairs

Ann Mills

Deputy Under Secretary for Natural Resources and Environment
Department of Agriculture

Peter Colohan

National Oceanic and Atmospheric Administration
Department of Commerce

Executive Officer:

Caroline Dvorsky

Department of Agriculture
Caroline.dvorsky@osec.usda.gov

Goal Leaders:

- Goal 1: Mark Brusberg**, Department of Agriculture
- Goal 2: Katherine Ledesma**, Department of Homeland Security
- Goal 3: Claudia Nierenberg**, Department of Commerce,
National Oceanic and Atmospheric Administration
- Goal 4: David Raff**, Department of the Interior
- Goal 5: Jim Gebhardt**, Environmental Protection Agency
- Goal 6: Roger Gorke**, Environmental Protection Agency