NATIONAL DROUGHT RESILIENCE PARTNERSHIP

2016 END OF YEAR REPORT

January 2017

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The National Drought Resilience Partnership
2016 End of Year Report

The five-year Western drought and recent drought conditions in Northeastern and Southeastern United States underscore the continued importance of building national capabilities for long-term drought resilience. Federal agencies have focused on drought response for decades. Under the framework of the National Drought Resilience Partnership (NDRP), a greater emphasis has been placed on improving federal agency collaboration to ensure more efficient use of program dollars and agency expertise. A broad cross-section of stakeholder groups has supported and guided this collaboration. These groups helped shape six broad policy goals, and an associated Federal Action Plan, with 27 specific deliverables. This partnership has yielded products and program priorities that better meet the needs of rural and urban communities; the energy, agricultural and transportation sectors; infrastructure and water managers; business and industry; and ecosystems. As a result, 13 federal agencies and offices are cooperating in new ways under a shared strategy to deliver concrete results.

This 2016 Year End Report builds on the NDRP's August 2016 Progress Report. It is broken out into three sections: a summary of accomplishments on actions since August; updates on regional scale collaborations; and recommendations from stakeholders on priorities in the coming year. Taken together, these two reports summarize the NDRP's results in 2016.

Recent Accomplishments include:

- Improvements in the quality and quantity of groundwater data for use by Federal, state, tribal and local agencies.
- Piloting the use of Light Detection and Ranging (LiDAR) to provide accurate data -- more quickly and at lower cost -- on current and projected future storage volumes for reservoirs, increasing the ability of decision-makers to capitalize on unique draw-down situations or capture sedimentation resulting from floods or wildfires.
- Participation by 400 attendees in a webinar on the U.S. Forest Service response to drought and water challenges.
- Completion of a Community Assessment for Public Health Emergency Response (CASPER) in Mariposa County, CA, to assess populations vulnerable to drought.
- Launch of four prize competitions to incentivize new methods of water-use innovation.
- Release of a new report, "Water Marketing Activities within the Bureau of Reclamation," highlighting how Reclamation has partnered with water users to enable water transactions.
- Release of a best practice guidance to assist water utilities, state governments and federal agencies improve water conservation and efficiency savings.

Regional Scale Collaboration:

- Profiles of successful regional partnerships in Washington, Montana and the Lower Colorado River Basin
- Emerging collaboration efforts in the Southeast, Northeast, Midwest and Southwest that highlight opportunities for future NDRP engagement.

Partner Recommendations to NDRP agencies for 2017 and beyond include:

- Generate additional data and information on soil moisture, groundwater and consumptive use.
- Continue and expand efforts to assist decision makers in responding to the impact of drought on critical infrastructure including energy, transportation and water infrastructure.
- Provide greater focus on the health effects of drought.
- Incorporate work on the connection between wildfire and drought as part of increasing resilience on federal lands.
- Publish a white paper that details the financial structure of market-based tools and how they can be used to build drought resilient infrastructure.
- Continue to support regional work on water reuse, recycling and alternative sources of water.

The NDRP will continue to track progress on its six goals and seek stakeholder input on future priorities. This work will be managed by USDA. Great opportunities lie ahead for effective federal collaboration that will support more water secure communities and economies.

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

Action 1: Integrate Data from Key Platforms

Integrating Groundwater and Water Quality Data
Lead Coordinating Agencies: Department of Agriculture and Department of the Interior, U.S. Geological Survey

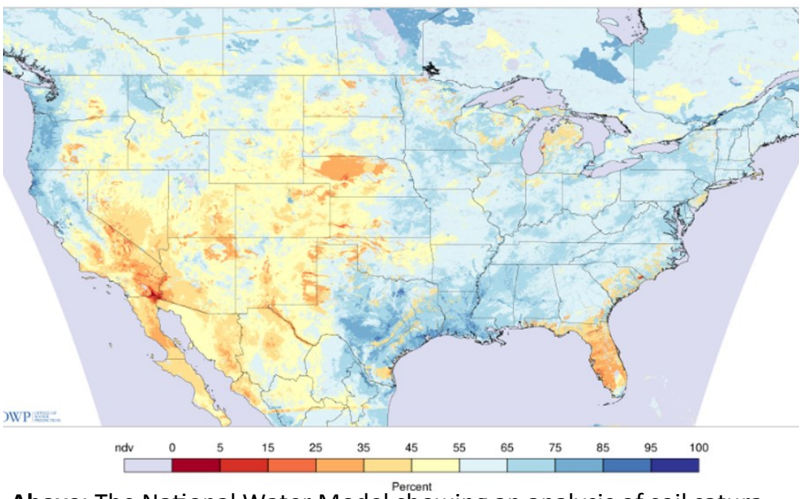
During times of drought, groundwater is often the only source of water. Monitoring the status of this resource is necessary to inform decision making. The Department of the Interior's United States Geological Survey (USGS) has taken steps to improve the quality and quantity of groundwater data to be used by federal, State, tribal and local agencies. In 2016, USGS provided grants to 23 states to further develop and use the National Ground Water Monitoring Network (NGWMN). The NGWMN is designed to take advantage of long-term monitoring by federal, State, tribal and local agencies to create a nationwide network of comparable data that provides necessary information for sustainable management.

Additionally, USGS partnered with the Department of Agriculture's Agricultural Research Service (ARS) to incorporate ARS's water quality database into the Water Quality Portal. The Portal is a cooperative service sponsored by USGS, the Environmental Protection Agency (EPA) and the National Water Quality Monitoring Council that integrates publicly available water quality data. The Portal encompasses information collected by over 400 agencies and provides State and county specific information to federal, State, regional, tribal, and local scientists and decision makers. Additional data from ARS has improved the accuracy and usability of the Portal.

Action 2: Improve Modeling and Prediction

Developing National Water Prediction Capability
Lead Coordinating Agency: Department of Commerce, National Oceanic and Atmospheric Administration

Since the August 2016 release of the National Water Model, Version 1, the National Oceanic and Atmospheric Administration (NOAA) has added new online visualization tools for streamflow, streamflow anomaly, precipitation and soil moisture. The new Model improves the National Weather Service's ability to deliver impact-based decision support services nationwide by providing "street level" water information and guidance, as well as serve as the foundation for additional private sector water services.



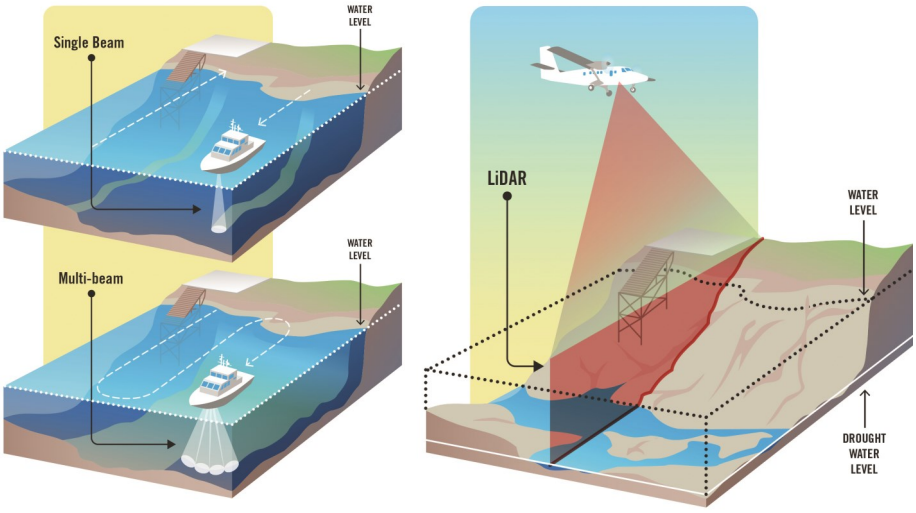
Above: The National Water Model showing an analysis of soil saturation across the U.S.

At a minimum, the Model provides predictive water information for many locations where none previously existed. Users can now click on any point along 2.7 million stream reaches and generate a customized depiction of streamflow guidance. NOAA is continuing to develop the model, and improvements in version 1.1 are planned for release in mid-2017.

Action 4: Encourage Federal Reservoir Surveys

Taking Advantage of Drought-Induced Low Reservoirs Levels to Conduct Surveys
Lead Coordinating Agencies: U.S. Army Corps of Engineers and Department of the Interior, Bureau of Reclamation

Drought decreases the reliability of surface water quantity and quality and increases the nation's reliance on its reservoirs. Federal reservoirs provide the largest percentage of storage volumes in the United States. Monitoring sediment accumulation and changes in the rate of accumulation in these reservoirs is essential to understanding the magnitude and geographic extent of reduced storage volume due to sediment accumulation. Accurate data on reservoir surface area and capacity provide a stronger foundation for decision-making and support system operations of reservoirs within a watershed in response to a drought (or flood).



Above: A graphic outlining the difference between traditional beam surveying and LiDAR surveys . The USACE and Reclamation used LiDAR technology to decrease the costs and processing time for 28 reservoir surveys in the Southeast.

In November 2016, the U.S. Army Corps of Engineers (USACE) and the Department of the Interior's Bureau of Reclamation (Reclamation) teamed up to collect 28 pilot Light Detection and Ranging remote sensing (LiDAR) surveys of drought-lowered reservoirs in California and Arizona. Reservoirs ranged from 0 to 36 percent full on October 1, 2016, with an average level of 7 percent.

Processing is still underway, however, initial results demonstrate the value of obtaining LiDAR data from drought-lowered reservoirs to assess current and projected future storage volumes for reservoirs. First, by partnering with Reclamation on this effort, the total costs of the reservoir surveys was significantly reduced; the pilot surveys were approximately one fifth of the cost accrued by previous methods. In the future, lowering the costs of these assessments will ease the burden for smaller municipalities and agencies. Second, interagency agreements and joint access to contracts with local LiDAR providers can support rapid mobilization and collection of data, particularly when combining funding from several agencies. Third, streamlining and optimizing data collection can increase the ability of decision-makers to capitalize on unique draw-down situations (e.g. reservoir must be lowered to make an emergency repair to a hydroelectric turbine) or capture sedimentation resulting from a flood event following a wildfire.

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 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. In December 2016, CDC created two new datasets of drought indicator variables, using various climate data from NOAA, for public health use in linking drought and health effects. By March 2017, the data will be available to the public online through the National Environmental Public Health Tracking Network.

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.

Goal Leader: Sarah Gambill, Office of Infrastructure Protection, 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 conducted in-depth research analyzing drought impacts to data centers and on the Critical Manufacturing sector. These industries were prioritized because they are major contributors to California's employment and economy. DHS is summarizing its findings on these impacts and will transmit them in the second quarter of FY 2017. In addition, DHS is continuing to research and develop an analysis of how water quality impact thermoelectric power plants. This analysis will highlight the link between thermoelectric power plant generation capacity and the availability and quality of surface water and inform modeling approaches for this going forward. All sectors of critical infrastructure require reliable electric power, so understanding this relationship is foundational to understanding drought impacts to other infrastructure sectors.

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.

Goal Leaders: Claudia Nierenberg and Roger Pulwarty, National Integrated Drought Information System, National Oceanic and Atmospheric Administration

Action 1: Coordinate Planning and Capacity-Building Programs

Building Local Drought Capacities through Collaboration and Geospatial Tools

Lead Coordinating Agencies: Department of Commerce, National Oceanic and Atmospheric Administration and Department of Homeland Security, Federal Emergency Management Agency

Federal Goal 3 partners have been working to advance the relationships and deliverables that augment capacity across State, tribal and local entities for drought response and mitigation planning. Better planning processes and resources are a critical step to managing the risks associated with future drought conditions. Over the past several months, the National Integrated Drought Information System (NIDIS), DHS, and the Federal Emergency Management Agency (FEMA) have been scoping collaborative activities to address the following:

- Opportunities to include subject matter experts who have been involved in State drought planning and NIDIS drought early warning activities in FEMA's Hazard Mitigation Assistance workshops. This would provide a platform for partners to address common challenges in local drought planning and the connection to broader hazard mitigation strategies.
- Opportunities to integrate drought vulnerability into local technical assistance and outreach activities
- Collaboration on training and technical assistance in State-level activities

With support from NIDIS, the National Drought Mitigation Center at the University of Nebraska-Lincoln (NDMC) has been advancing the design of a geospatially referenced mapping project to identify where drought response and mitigation planning exists, either as a discrete activity or within the context of other authorities such as water resources planning, natural hazard plans, natural resource plans, agriculture, or public health. Through iterative conversations with drought and water resource planners across the country, at various levels of government, NDMC is designing an interface for its drought plans database. This interface will highlight the nested scales and multiple agencies that are involved in drought planning in order to promote collaboration and efficiencies. Key next steps include identifying authorities for regional, watershed and landscape based drought planning, and continuing consultations with the Montana Headwaters Project (see page 14) as a first demonstration case for geo-referenced mapping of drought plans.

Communicating Drought Impacts on Forests and Rangelands
Lead Coordinating Agency: Department of Agriculture, U.S. Forest Service

In October 2016, the U.S. Forest Service (USFS), in coordination with the US Department of Agriculture (USDA) Climate Hubs, hosted a webinar with 400 attendees on its response to drought and water challenges. As a follow up, regional workshops will be held in 2017 to help the USFS develop a set of local strategies and tactics to reduce, mitigate and recover from the impacts of drought. These workshops will provide regionally-specific drought information to forest managers and staff, including management constraints and opportunities imposed by drought conditions. Drought webinars will be offered on a monthly basis beginning in January 2017, focusing on fisheries, infrastructure, recreation and other resource areas. The webinars and regional workshops are based on findings from the recently completed assessment, "Effects of Drought on Forests and Rangelands in the United States."

Action 2: Examining the Ecological Impacts of Drought Across the United States

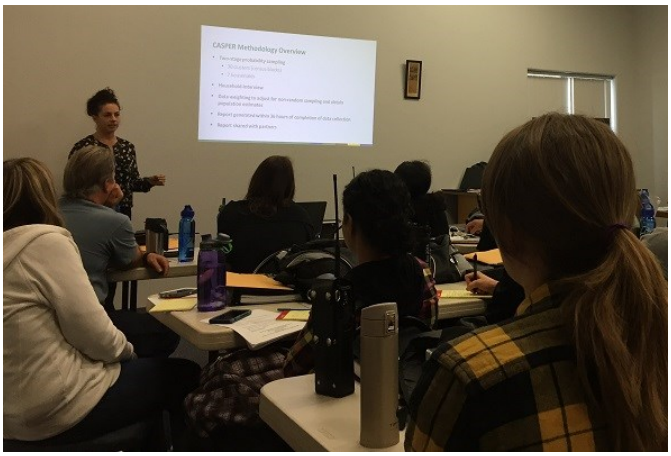
Synthesizing Information and Best Practices to Manage Ecological Drought
Lead Coordinating Agency: Department of the Interior, United States Geological Survey

The Science for Nature and People Partnership (SNAPP) Ecological Drought Working Group has enhanced coordination across the federal government, including specific collaborations between USGS, stakeholders from the Upper Missouri Headwaters Drought Planning team, and practitioners from The Nature Conservancy and Wildlife Conservation Society, working on modeling the hydrological and ecological responses to beaver mimicry and beaver restoration strategies. SNAPP is also partnering with the USFS to incorporate ecological drought concepts into their series of regional drought preparedness workshops, beginning in January 2017. The team has made significant progress on their two-year goal of a National Synthesis on Ecological Drought.

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

Supporting State, Tribal, Local and Territorial Health Departments through Public Health Assessments
Lead Coordinating Agencies: Department of Health and Human Services, Centers for Disease Control and Prevention

In October 2016, the CDC conducted a drought-related Community Assessment for Public Health Emergency Response (CASPER) in Mariposa County, CA. The drought-related CASPER was designed to assess drought-affected populations, identify populations vulnerable to drought in California, and contribute to the identification of California's communication, education, and public-health needs. Key findings from the assessment will be available to State, local, tribal and territorial health departments and decision makers across the nation to guide preparedness, response, and recovery decisions when serving drought-affected and drought-vulnerable populations. A second drought-related CASPER will be held in Oregon during the spring of 2017. Final reports from both CASPERs will be available in summer 2017.



Left: View of valley in Mariposa County, CA shows example of the drought-related increase in tree deaths suffered in the area. **Right:** A CDC staff member conducts training for CASPER interview team volunteers.

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

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

In 2016, the Department of the Interior (DOI) created 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. This map is posted in OMB MAX, to promote information sharing within the relevant federal agencies. In 2017, partners will look into public-facing options for this map and the creation of information-tools for other geographies.

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

In December 2016, USDA and DOI established a goal to expand the partnership between Reclamation's WaterSMART Sustain and Manage America's Resources for Tomorrow) grant program and the Natural Resources Conservation Service (NRCS) Environmental Quality Incentives Program (EQIP). This partnership ensures that federal funding can be leveraged as effectively as possible by providing financial assistance to water districts and growers on private working lands to improve water management and agricultural water-use efficiency. During the next several months the agencies will develop a framework for broader collaboration. In the Spring of 2017, key staff will convene at the regional level to identify complementary activities and authorities to incorporate into the broader collaboration.

Coordinating Federal Assets through the USGS National Integrated Drought Science Strategy

Lead Coordinating Agency: Department of the Interior

The USGS National Integrated Drought Science Strategy, developed in 2016, identifies current USGS drought-related research and products supporting goals in the NDRP Federal Action Plan and presents an approach to facilitate integrated drought science efforts that bring all of USGS capacity to bear on drought challenges nationwide. The strategy seeks to improve understanding of drought processes and impacts on human and natural systems through coordinated and multidisciplinary data collection, synthesis, analysis, and predictions generated from USGS together with a variety of partnerships. The long-term goal is to provide decision-support tools and technologies to stakeholders for enhancing drought resilience, adaptation, and mitigation.

The USGS Drought website has been established for communicating drought-related news, products, data, and other information from across USGS in one location. USGS is committed to continuing to build content and generate automated pathways for highlighting new publications and data on the website. In the future, this outlet will facilitate communication for the ongoing inventory of USGS drought-related research and coordination efforts and become an up-to-date resource for partners and stakeholders.

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 planned several competitions focused within three main theme areas critical to improving the overall reliability of water supplies: water availability, infrastructure sustainability and aquatic ecosystem restoration.

Since August, DOI and its partners have announced three new competitions. The first, *More Water, Less Concentrate*, was launched in December 2016. The challenge is seeking innovative concepts to expand usable water supplies by maximizing fresh water production from inland desalination systems, and thereby reduce the volume of concentrate. Currently, significant water supplies are trapped in concentrate streams that are a byproduct of desalination technologies. The cost to manage or dispose of concentrate is high and limiting to use of desalination in inland applications.

Second, Reclamation launched *Arsenic Sensing in Water* challenge. The challenge seeks new technologies for rapid, low-cost monitoring of arsenic in the environment and in drinking water to limit human exposure and prevent environmental contamination. New technologies would benefit water treatment plant operations, wastewater monitoring, contaminated site remediation, private well owners, scientific research and other interested parties.

Third, Reclamation, in collaboration with NOAA, USDA and USACE, announced a prize competition to improve sub-seasonal forecasts. The competition officially kicks off in March 2017 and solvers will submit sub-seasonal forecasts of temperature and precipitation for one year, competing in real-time against other teams as well as official forecasts from NOAA. Improved sub-seasonal forecasts for weather and climate conditions (lead-times ranging from 15 to 45 days and beyond) would allow water managers to better prepare for shifts in hydrologic regimes such as the onset of drought or occurrence of wet weather extremes.

Fourth, the White House Council on Environmental Quality (CEQ), in partnership with the State of California hosted a Water Data Challenge to strengthen drought-related decision-making and make better use of existing information and data. The Challenge invited participants (developers, coders, companies and universities) to use open source technology and available water data sources to develop innovative tools to help with California water reliability and sustainable use. The Challenge received 35 entries, of which 17 were invited to demonstrate their visual display tools during an event held on December 9th in Sacramento, CA.

Above: Posters advertising Reclamation's prize challenges

Action 4: Increasing Water Management Flexibility

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

Reclamation and the USACE are improving drought preparedness by developing and implementing new processes and considerations for reservoir management. The agencies are coordinating in areas where storage is co-managed to identify opportunities to increase water management flexibility and to balance competing needs while still providing Congressionally-authorized services.

In November 2016, USACE compiled a database of electronic water control information. The database enables USACE to evaluate current water control manuals to assess if revisions are needed. 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. Currently, USACE is conducting a reporting exercise to assess the quality of the data and identify any potential gaps.

As part of its effort to develop web-accessible water data and information, USACE is examining different ways to visualize and analyze reservoir operations to support water managers in updating water control manuals, drought contingency plans, and deviations where appropriate. These new methods include tools such as departures from operating targets over time, descriptive statistics for seasonal departures, operational duration curves, and heat maps of reservoir elevation, inflow, outflow and storage. All of these can be compared to climate conditions such as drought and floods to better understand areas for flexibility in reservoir management consistent with congressionally authorized reservoir purposes.

Action 5: Promoting Stronger Drought Resilience on Federal Lands

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

In 2016, federal agencies, States, non-profit organizations and corporate interests teamed up to protect drinking water supplies, communities and watersheds from the impacts of drought and wildfire. These partnerships ranged from stream restoration in New Mexico to citizen science in the Rocky Mountains, and engaged a wide variety of stakeholders to address watershed health in the face of increasing drought. Examples of partnership projects include:

Drinking Water Providers Partnership in Oregon and Washington: In 2016, National Drought Resilience Partnership (NDRP) agencies including the USFS, EPA, and Department of the Interior's Bureau of Land Management (BLM) participated in a new collaboration, the Working Waters Partnership. These agencies partnered with the Geos Institute, Oregon Department of Environmental Quality, Washington Department of Health, and WildEarth Guardians to develop grassroots partnerships between drinking water providers and local restoration practitioners. In addition to fostering those relationships, the partners developed an annual grant program to fund watershed restoration projects in municipal watersheds.

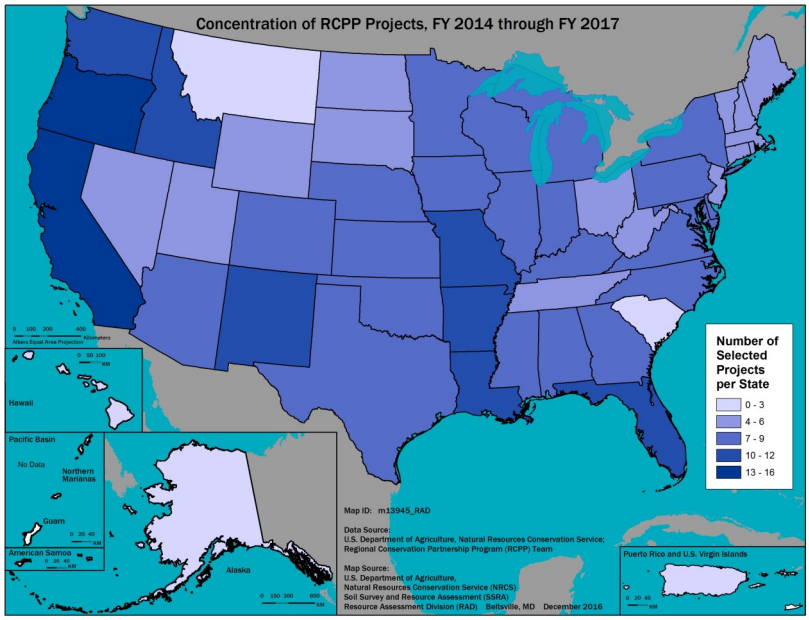
Projects are rated higher for funding if they occur in USFS or BLM priority watersheds. The partners pooled $600,000 to fund 11 projects. These projects included excluding cattle from a city's drinking water source, increasing stream channel complexity to protect water quality and improve high flow floodplain access, improving road-stream crossings for fish passage and to protect water quality, and improving riparian ecosystems to protect stream banks and shade streams.

Supporting forest and watershed health in California: The USFS partnered with the state of California to secure a $70 million grant from the Department of Housing and Urban Development (HUD). This grant will support the State of California's "Community and Watershed Resilience Program" in Tuolumne County, an area severely impacted by the 2013 Rim Fire. The proposal consists of three integrated pillars: forest and watershed health, that includes biomass (dead tree) removal, reforestation, noxious weed eradication, range repairs and fuel breaks; an integrated biomass and wood products facility; and a community resilience center. These pillars will result in long-term economically and environmentally sustainable programs that can be replicated throughout California.

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 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.



Above: A map showing the concentration of RCPP Projects, FY 2014 through FY 2017

In December 2016, NRCS announced that 88 high-impact projects across the country will receive a quarter of a million dollars to improve the nation's water quality, combat drought, enhance soil health, support wildlife habitat and protect agricultural viability, leveraging a total partner match of an additional $500 million. Over $50 million in federal funding, with an estimated partner match of over $110 million, will be directed towards projects where drought or water supply has been identified as a primary resource concern. Projects include:

- $7.5 million to support the Yakima Integrated Plan that will leverage $11.7 million in partner match. This investment will accelerate the ongoing work of the Yakima River Basin Water Enhancement Project Workgroup (see Addressing Drought on a Regional Scale, Yakima Basin on page 13) to increase the basin's water supply and water quality for environmental, economic and cultural purposes.

- $4.8 million for the Little Colorado River Watershed project lead by the Navajo Nation Division of Natural Resources that will leverage $7.8 million in partner resources. This project will establish a five year PL-566 Watershed Planning Team for three sub-watersheds of Arizona's Little Colorado River Basin working with multiple partners -- including the US Army Corps of Engineers and the Bureau of Indian Affairs.

- $7.7 million for the Colorado River Headwaters Project, leveraging $12.6 million in partner match to address the consequences of trans-mountain diversions that supply agricultural and municipal water to Northern Colorado and the Denver Metro area. The project will directly benefit over 30 miles of the Colorado River and 4,500 acres of irrigated lands that provide sage grouse habitat and make 11,000 acre feet of water available to improve the river during low flow conditions.

- $10 million for the Black Rascal Creek Project in Merced County, CA, leveraging more than $25 million in partner contributions to provide flood protection and drought mitigation for communities and surrounding prime agricultural lands.

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

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

Goal 5 focuses 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. Since August, EPA, DOI and USDA have built momentum to work through existing authorities to promote investment in water infrastructure and efficiency projects by the private sector and other non-Federal sources of capital.

- The Centers recently participated 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 included: project prioritization, revenue generation and flexible contracting tools. In early January, the Ash Center will publish its report, "Tapping Private Financing and Delivery to Modernize America's Federal Water Resources."

- EPA's WIRFC has researched the efforts of 13 western state Clean Water State Revolving Fund programs to highlight the types of projects that address drought, with a particular focus on water conservation, water reuse, desalination, and groundwater protection/restoration projects. Additionally, In partnership with EPA's Environmental Finance Center at the University of North Carolina, WIRFC has developed a compendium of water infrastructure case studies that can serve as learning tools for project sponsors seeking information on existing public-private partnerships arrangements, including a number of cases in drought-prone areas, including Santa Paula, Woodland- Davis, and Rialto, California; and Phoenix, Arizona.

- NRIC is maintaining progress toward closure of a water transaction between a large municipal water management district and a private water marketer. The transaction will significantly diversify a city's long-term water supply portfolio; participants in transaction are waiting state-level approval before closing deal.

- Reclamation announced a new funding opportunity that will repurpose $3 million from the WaterSMART grant program to encourage irrigation districts, municipalities, and other entities to explore the use of water markets. Such markets exist in certain locations, but there is opportunity to transfer and scale these markets elsewhere if they are designed and adapted for different conditions.

- USDA's ROI is continuing to work 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. Furthermore, ROI is conducting market research on how to encourage bundling of rural projects in order to attract institutional lenders to rural projects in a way that could lower the cost of financing those projects. Project bundling is particularly relevant to the arid West where many rural communities are exploring watershed-level solutions to the impact of drought. In 2017, this research will inform discussions of a pilot transaction that could encourage bundling of rural water infrastructure projects.

- In December 2016, the Centers participated in multiple outreach events including The Nature Conservancy Global Water Summit, U.S. Chamber of Commerce events and the Western Water Roundtable.

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

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

In December 2016, DOI published a report reviewing the role of Reclamation in water markets. For decades, water users in the West have used many different approaches to address water needs particular to their location. In some instances, these approaches have created market conditions in which buyers and sellers voluntarily trade water rights. Such water market transactions can often involve Reclamation facilities.

The new report, "Water marketing activities within the Bureau of Reclamation," highlights the ways Reclamation has partnered with water users to enable such transactions. The report reviews a series of case studies which illustrate locally-led innovation. The cases also illustrate how locally-led transactions have created collaborations and programs that enable greater flexibility in the use of project water or facilities. In conjunction with the release, DOI targeted outreach to more than 75 stakeholders, focusing on the broad portfolio of WaterSMART grant opportunities and the ability to partner with grantees who have been funded over the last 5 years as part of the matching requirement for the program.

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 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

Agriculture accounts for approximately 80 percent of the Nation's consumptive water use and over 90 percent of use in many Western States. Increasing agricultural water use efficiency at the watershed scale is a top NDRP priority and requires research, data, tools and adoption programs on both forest and agricultural systems.

In 2016, USDA and the White House National Science and Technology Council, Subcommittee on Water Availability and Quality (SWAQ) convened 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. In February 2017, the workgroup will release a 2017 work plan that inventories current work in the agriculture water use space and outlines priorities and collaborations moving forward.

Action 4: Highlight Resilience Successes from the Municipal Sector

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

Many communities throughout the country are implementing long-term drought-resilience programs. EPA and SWAQ are creating a venue for local partners in these communities to showcase their ongoing work and to illustrate how they are building long- term resilience. Highlighting these successes increases awareness of the role that municipal water conservation and reuse programs can play in alleviating the effects of drought.

In an effort to assist water utilities, state governments and federal agencies, EPA developed a best practices document to help these entities carry out assessments of opportunities for water conservation and efficiency savings. This will help utilities, agencies and governments avoid or minimize the need for new water supply development. The document can be used by a utility or a third party to conduct assessments of the utility's water resources management from technical, financial and managerial perspectives.

Other successful municipal practices will be drawn from the NDRP Regional demonstration work, including municipalities working on long term drought planning, public acceptance for potable water reuse and effectively meeting the needs of all users including municipal, agricultural and industrial users.

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 soil monitoring network that will provide information on soil water status and agriculture-related demand for water. This network will help identify regionally adapted management systems for improving soil health and preventing future degradation. Information from this project will be used by NRCS and others in tools, policies, and programs to influence adoption of effective soil health management systems.

In November 2016, NRCS began briefing other USDA agencies, stakeholders and potential partners about the soil network project plan. The plan is divided into five subprojects:

1) NRCS, partnering with external scientists, is leading a literature review to identify the current and most promising soil health assessment methods.

2) NRCS is developing a strategy for compiling and using information from existing soil health assessment field studies and modeling projects.

3) NRCS has begun scoping potential collaborating agencies for long-term field studies to inventory, assess and monitor soil health data under different management practices in priority landscapes across the nation. This subproject will assess the utility of potential soil health indicators, and monitor changes in those soil indicators across cropping and management systems.

4) NRCS has convened a technical team to develop a national data management system that can compile, store, analyze and disseminate soil health information to NRCS staff and partners.

5) NRCS is planning to further refine and develop additional field assessment tools for stakeholder engagement.

Action 6: Develop Municipal Water-Recycling Technical Assistance

Lead Coordinating Agency: Environmental Protection Agency

EPA scientists are conducting research to evaluate the potential microbial and chemical risks of contaminants in resource water treatment streams, identify methods for safe and sustainable management of waste residuals, and to advance innovative technologies for water and resource recovery. EPA is developing technical assistance fact sheets for States, tribes, utilities and other stakeholders to assist in the development of local water reuse projects.

Specific research includes:

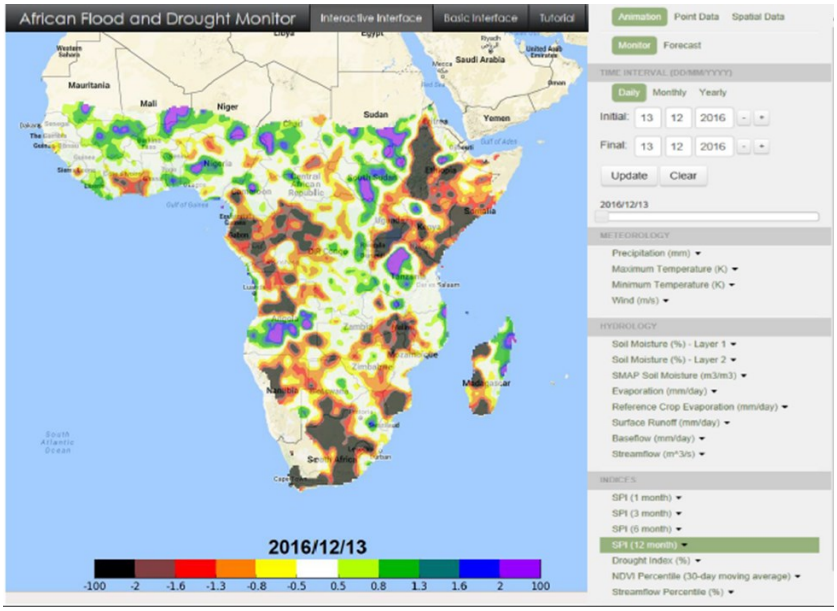
- A microbial risks assessment of direct potable reuse
- An assessment of the impacts and approaches to control the most important waterborne contaminants associated with built infrastructure
- Treatment, monitoring and risk assessment for “fit-for-purpose” water
- System approaches for assessment of transformative “fit-for-purpose” and resource recovery-based water systems, and several other water research grants.

This work is fully integrated with water reuse work under other NDRP Actions.

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 maximizing international technical collaboration opportunities and existing diplomatic platforms by sharing best practices and strengthened global research on drought resilience. Highlights of these activities since August 2016 include:



Left: Map of twelve-month Standard Precipitation Index, showing widespread drought (black/red/orange) in southern and eastern Africa as of December 2016. From the African Drought Monitor, developed by Princeton University with support by the United Nationals Educational, Scientific and Cultural Organization and the International Center for Integrated Water Resources Management

- NOAA participated in the World Meteorological Organization's Integrated Drought Management Programme (IDMP) annual meeting in September 2016. Outcomes from this engagement included further connecting the U.S. Government with IDMP's initiatives, scheduling a multilateral meeting on developing an early warning information system in the southern cone of South America, and convening meetings with the German Meteorological Service and the Global Framework for Climate Services on drought planning in Central Europe.

- As host of the International Center for Integrated Water Resources Management, USACE and partners led activities under the Global Network on Water and Development Information for Arid Lands (G-WADI). G-WADI supports drought-related products and systems, including University of California, Irvine's precipitation and drought products, and Princeton University's Flood and Drought Monitors. These were featured at a Drought Monitoring Workshop for Southern African Development Community Countries in Zimbabwe in November 2016 and at the UN Climate Change Conference in Marrakech, Morocco. The products will also be presented at an upcoming G-WADI Regional Workshop on "Drought Monitoring in Southeastern Europe" in Serbia in January 2017.

- In September 2016, the DOS participated in a joint U.S. Water Partnership-Australian Water Partnership event on "Building Resilience for Water Scarcity and Drought" at the Stockholm International Water Institute's World Water Week. Experts from Australia, South Africa, Denmark, Brazil, and the U.S. shared experiences and lessons learned regarding drought management at national and local scales.

- In October 2016, the DOS participated in Australia's Water Partnership's "Drought Summit," held on the first day of the International Water Association's World Water Congress in Brisbane, Australia. Intended to inspire a new, collaborative approach to addressing drought, 100 participants from across government, private sector, and other institutions engaged in a day-long structured discussion of challenges, opportunities and areas for action. The NRDP was noted as a significant effort by several participants, and leadership from the Australia Water Partnership expressed an interest in exploring stronger ties between the Australian Partnership and U.S.-based organizations on the issue of drought.

II. Addressing Drought on a Regional Scale: Supporting Local Partners

Federal agencies recognize that meeting the drought resilience needs of our stakeholders requires providing effective support at a local or regional scale. Most decisions on water management are made at the state and local level, and the variation in rainfall and hydrologic balance across watersheds requires specific water, land and infrastructure management solutions. Across the country, states, tribes, agricultural producers, NGOs, irrigation districts and other partners either have or are in the process of developing strategies to reduce the risk and uncertainty of drought and extreme heat. The NDRP sees significant opportunities to improve how federal agencies tailor their program support and expertise to meet the unique needs of a basin or watershed. The Yakima Basin Plan and Missouri Headwaters Demonstration Project are two examples of successful collaborations that can serve as models for other regions of the nation.

The Yakima Basin Integrated Plan, Washington

The Yakima River Basin Integrated Water Resource Management Plan was launched to create common ground among more than two dozen stakeholders and leverage their expertise and resources and test an integrated management approach to balancing water resource needs in the Yakima River. The basin is a rapidly growing region in central Washington State, home to 360,000 people, supporting $2.04 billion in agricultural production and a $1.5 billion food processing industry that includes apples, peaches, pears, cherries, hops, wine grapes and dairies. The Yakima River and its tributaries provide critical habitat to major salmon and steelhead runs, important to the culture and economy of the Yakama Nation.

Above: Cle Elum is the largest of the Yakima Project's five reservoirs. Reclamation has committed to storing more water for in-stream purposes.

Like many other watersheds it the West, the basin is facing the challenge of water shortages for irrigation, municipal and recreational use, power generation, and threats to aquatic and terrestrial habitat. In 2009, Reclamation and the Washington State Department of Ecology convened the Yakima River Basin Water Enhancement Project Workgroup – that includes the Yakama Nation; irrigation districts; environmental groups; and local, county, state and federal governments -- to overcome often historically adversarial relationships in pursuit of a comprehensive approach for improving water supply reliability during drought years.

These partners developed goals and a 30-year package of actions to be implemented in three 10-year increments. The goals are to: improve water supply reliability during drought years for agricultural and municipal needs; develop a comprehensive approach for efficient management of water supplies for irrigated agriculture, municipal and domestic uses, and power generation; improve the ability of water managers to respond to and adapt to the potential effects of climate change; and contribute to the vitality of the regional economy and sustain the riverine environment.

The initial 10-year development phase, budgeted at $900 million, is already underway. It advances seven key elements: enhancing fish passage; making structural and operational changes to Reclamations' Yakima Project; expanding surface water storage for instream and out of stream flows; increasing groundwater storage; enhancing and protecting habitats and watershed health; increasing water conservation by agricultural and municipal users; and market reallocation. Taken together, these elements ensure a balanced approach to addressing the core needs of the basin's stakeholders.

In 2016, the Yakima Integrated Workgroup accomplishments included:

- Completion of Phase I of the Cle Elum Dam Fish Passage facilities – an access road and bridge for construction equipment to break ground for a juvenile fish passage facility;
- Continuation of the successful 2015 tributary supplementation program spearheaded by the Kittitas Reclamation District in partnership with the Yakama Nation, State and Federal agencies agreed to deliver water to creeks during the 2015 drought, thus rescuing ESA-listed species from being stranded in dry creek beds. Historically, no irrigation district in the Yakima Basin has ever used their infrastructure to help endangered fish;
- Initiation of a supplemental draft environmental impact statement for projects that will provide up to 200,000 acre -feet of water for pro-ratable irrigation districts in a drought year;
- Completion of seven agricultural water conservation and 14 habitat restoration projects, improving irrigation efficiencies and augmenting tributary restoration efforts basin-wide;
- Raising the Cle Elum Dam spillway gates by three feet, enabling the reservoir to hold an additional 14,600 acre-feet of storage water when the shoreline protection is installed (projected to take 5 years). This new storage will augment instream flows;
- Successful removal of a diversion dam on Manastash Creek, reopening 30 miles of high-elevation habitat to Endangered Species Act (ESA)-listed steelhead.

In 2017, the Workgroup will:

- Continue construction of the Cle Elum Fish Passage facility to provide passage for out-migrating smolts and aid in restoration of annual salmon and steelhead runs;
- Advance the Cle Elum Pool Raise project by installing shoreline protection along U.S. Forest Service facilities to reinforce and protect recreation facilities;
- Release the supplemental draft environmental impact statement for comment;
- Implement 21 projects aligning with the habitat/watershed protection and enhancement, enhanced conservation and groundwater recharge elements, including the KRD Tributary Supplementation Program.

The Integrated Plan has successfully integrated federal partners and programs to support the Workgroup's vision. The years invested in building partner trust and understanding creates opportunity for innovation and expedited problem solving. By "going slow to go fast" they have the relationships and roadmap to more effectively navigate the challenges created by drought and extreme weather.

The Colorado River Basin

DOI is negotiating strategies with the seven basin states and Mexico in order to deal with water supply shortages driven by a 17-year drought of record. Given DOI's responsibilities managing the two main reservoirs on the Colorado River (Lake Powell and Lake Mead) and as the water master of the Lower Colorado River, DOI has led the drought contingency discussions with the states and Mexico. However, the NDRP has recognized the mission-related risks and programmatic capabilities of other federal agencies, in particular USDA and the Department of Defense (DOD). As a result of the NDRP, DOI and USDA are making coordinated investments in water use efficiencies for agricultural water use and other sectors. Similarly, DOI is working with DOD to assess the risk of water supply shortages to military installations, and the adjacent communities and services that support them, and to determine appropriate joint activities to stave off shortage in the Basin. This is the kind of interagency collaboration that NDRP was created to foster, and it results in more coordinated federal strategies in service of on-the-ground stakeholders in the Colorado River Basin.

Missouri Headwaters Demonstration Project, Montana

Above: An MT Fish, Wildlife and Parks department biologist and a local rancher discuss water management in the Big Hole Valley, MT

The Missouri Headwaters Drought Resilience Demonstration Project was launched in July 2014 to demonstrate how federal agencies can best support a state strategy to build long term drought resilience. The project leverages federal and state resources and engages communities in the development and implementation of local watershed drought resilience plans and activities. NDRP agencies and Montana believe that successful drought strategies must be locally led, reflect the watershed's unique water management issues, and produce on-the-ground results.

The Missouri Headwaters plays an important role in landscape connectivity in the northern Rockies, experiences frequent drought and faces rapidly changing population and land use. Agriculture – including cattle and sheep, alfalfa and hay production and recreational tourism are important to the local and state economy.

Recognizing the urgency for action, the State of Montana has directed the Department of Natural Resources and Conservation to lead the demonstration project at the state level, helping develop the vision and convening federal, state and local stakeholders. The US Environmental Protection Agency is the point of contact to the National Drought Resilience Partnership, facilitating connections with NRCS, the USFS, FEMA, NOAA/NIDIS, the Army Corps of Engineers, the USFWS, BOR, BLM, USFWS, BIA and USGS. More than 20 local watershed groups and conservation districts are contributing to the project and more than 14 local, regional and national NGOs are actively participating in delivering government drought mitigation tools and resources to the watershed stakeholders in direct contact with the landscape. This project will produce a replicable model for connecting federal and state resources to watershed communities to build drought preparedness and effective water management across a 14,000 mile headwaters basin.

Collaborators have developed a workplan that identifies specific objectives and tasks. The workplan is organized within three overarching goals: Organize and Engage Watershed Communities for Local Drought Planning; Provide the Tools for Drought Monitoring, Assessing and Forecasting; and Initiate Local Projects to Build Regional Resiliency.

In 2016, project collaborators accomplishments included:

- Secured funding from Reclamation and the Great Northern Landscape Conservation Cooperative to support local drought coordinators and their Big Sky Watershed AmeriCorps members to implement the *Building Drought Resilience* training model developed collaboratively by NDMC, NOAA/NIDIS and project partners;
- Partnered with The Nature Conservancy to complete multiple on-the-ground climate resilience projects including: restoring 13 miles of streams and acres of wetlands; installing 35 streamflow gauges and 18 monitoring wells that can be used to recognize drought conditions and implement response plans; improving 11.2 miles of native fish habitat; building 44 beaver mimicry structures; and leveraging 900 volunteer hours to plant 11,000 cottonwoods and willows;

- Working with BLM and the Montana Climate Office to evaluate soil moisture data needs and establish a statewide monitoring network;
- Worked with NRCS and DNRC to identify new stream gauge locations to improve water supply forecasts, and paved the way for the USFS to install two additional SNOwpack TELemetry (SNOTEL) sites in the Beaverhead and Big Hole River Basins;
- Secured EPA funding to develop landscape scale models to assess baseline conditions associated with drought impacts;
- Secured NRCS funding to implement more than $1.3 million to support landowner and producer projects that will improve irrigation efficiency 15% on over 750 acres;
- Coordinated with FEMA and the Montana Department of Emergency Services to incorporate drought planning in local pre-disaster mitigation plans;
- Provided input on adaptations strategies based on results of Reclamation's Upper Missouri Basin Impact Assessment and DNRC's Basin Study.

The demonstration's 2017 actions include:

- Build on the BOR/DNRC Impact assessment and Missouri Headwaters Basin Study, and the local drought resilience plans, to develop a regional drought plan for the Missouri Headwaters Basin;
- Continue to incorporate the drought planning framework into the State's Drought Management Plan update;
- Collaborate with the USDA Forest Service to host a March workshop on drought impacts titled, "Forest to Valley Bottom: Building Drought Resilience";
- NOAA/NIDIS and the NDMC will work with MT DNRC and EPA to identify next steps for the Missouri Basin Early Warning System and how it will integrate with the ongoing drought planning and monitoring work across Montana and the Missouri Headwaters;
- Assist watershed groups and local communities as they develop local drought plans and implement drought resilience measures;
- Work with the SNAPP Ecological Drought Workshop Group to understand ecological effects of drought that affect both human communities and natural resources in the UMH, and identify strategies for drought preparedness that can benefit both people and nature in the region;
- Install additional SNOTEL sites in the Missouri Headwaters to monitor snowpack, precipitation, air temperature and other metrics useful for determining seasonal water supply volumes;
- Work with other watersheds to transfer the Building Drought Resilience model and lessons learned.

Above: A ranch outside of Dillion, MT

Emerging Opportunities for Collaboration

Understanding the barriers to effective drought mitigation strategies informs the identification of actions, programs and policies to improve long-term resilience. The NDRP has benefited from conversations and interaction with stakeholders with deep experience in managing drought on a regional scale. Particularly in areas where there are existing or emerging NIDIS Drought Early Warning Systems and DOI Basin Studies underway, NDRP can work to advance federal coordination to support the best ideas that are emerging to promote long-term resilience planning. Examples of recent collaboration and emerging opportunities are below.

The Southeast

The USDA Southeast Regional Climate Hub (SERCH) has developed a drought alert tool that notifies subscribers when NOAA's Monthly Drought Outlook is forecasting a drought condition for the subscriber's location. NOAA's Monthly Drought Outlook uses temperature and precipitation outlooks and various short and medium term forecasts to produce a monthly outlook of drought conditions. SERCH has also led an effort to create a state-of-the-science report relevant to drought resilience in the southeastern U.S. The report assesses climate impacts and adaptive management actions, including those related to water availability and drought. It is designed to be useful to policy makers, planners and working land managers who must respond to the effects of a changing climate. Additionally, SERCH is currently conducting a social network analysis to determine how this drought information flows through networks of natural resource management professionals to improve communication methods around drought.

The Northeast

In July and August, NOAA worked with partners including the USDA's Northeast Climate Hub to produce a special report on "Drought Outlook and Impacts" for the Northeast. To further disseminate this information, these partners hosted a webinar for State and local decision makers. The NE Hub has built a relationship with NOAA's Northeast Regional Climate Center (NRCC) through participation in a three-state road show designed to bring climate adaptation tools to state and private users and collaboration on regional crop and livestock vulnerability assessments. The Hub, with support from NRCC, is leading development of a climate tool using down-scaled climate data to tell stories about NE farm climate adaptation.

In October, a Northeast Drought and Climate Outlook Forum was held at UMASS Boston to discuss the drought conditions in the region, impacts of the drought, response and preparedness resources, and climate outlooks for the coming seasons. The forum was developed and hosted through a partnership with NOAA, NIDIS, the NRCC, U.S. Representative Seth Moulton (MA-6) and the American Association of State Climatologists.

Midwest

NIDIS, the Midwest Climate Hub, and partners conducted four regional workshops in late 2016 to help develop the Midwest Drought Early Warning System (DEWS) and build a drought networking community in the region. The workshops provided a historical drought overview and climate outlook; discussion of drought and climate tools, drought-related needs, and critical issues; information from state agencies on how drought events are planned for and managed; and development of strategies to improve drought early warning and resiliency in the Midwest.

Southwest

The Southwest Climate Hub, NDMC and NIDIS hosted the first of two drought and La Nina workshops for producers and ranchers in New Mexico and Texas. The audience included USDA's Farm Service Agency, NRCS, BLM and Cooperative Extension personnel as well as local ranchers and farmers. One of the outcomes from this workshop is a new collaboration between the Southwest hub and local Farm Service Agency offices. Furthermore, the Southwest Hub will be holding smaller meetings for ranchers and farmers to introduce the Community Collaborative Rain, Hail and Snow Network and how the data from the network feeds into the National Drought Monitor.

Furthermore, local partners in SW Oklahoma including the State of Oklahoma and representatives from the Altus Air Force Base, recently developed the Southwest Oklahoma Water Supply Action to build long term resilience in drought-stricken OK. The Plan identifies short-term and long-term actions to ensure reliable water supplies. NDRP and the Western States Federal Agency Support Team (WestFAST), are collaborating with these partners to prioritize areas where federal technical and financial assistance could support the locally-developed actions.

III. Recommended Priorities for 2017 and beyond

The NDRP has engaged local and regional stakeholders throughout the process of setting goals and developing priority actions. Following publication of the August 2016 Report, the NDRP convened two roundtables to solicit feedback on progress to date and guidance on future priorities. The priorities below represent a distillation of stakeholder input and recommendations for NDRP priorities going forward.

Goal 1: Data Collection and Integration

- Generate additional data and information on soil moisture, groundwater and consumptive use.
- Support the development of a National Soil Moisture Network.
- Expand the Community Collaborative Rain, Hail and Snow observation network to data poor areas of the country to promote citizen science and improve the accuracy of federal resources, such as the US Drought Monitor.
- Continue to support the CDC in their efforts to develop data models to identify populations at risk to the health effects of drought.

Goal 2: Communicating Drought Risk to Critical Infrastructure

- Expand and enhance Goal 2 to ensure a continued focus on protecting critical infrastructure.
- DHS will continue to assess and analyze drought impacts on critical infrastructure as appropriate.
- Expand Goal 2 to focus on green infrastructure.

Goal 3: Drought Planning and Capacity Building

- Incorporate multiple agencies' resources and expertise on ecological drought in the implementation of Action 2– including the USDA Forest Service.
- Provide greater focus on the health effects of drought and connecting drought to health outcomes to better serve drought-vulnerable communities and the professionals that support them. Draw on capacities from the CDC and USDA Rural Development.

Goal 4: Coordination of Federal Drought Activity

- Implement and expand the EQIP-WaterSMART partnership. In Western States, DOI and USDA should expand their partnership to include other programs, such as the Systems Conservation Pilot Project.
- Incorporate work on the connection between fire and drought to continue to increase resilience on Federal lands. Draw on capacities from the USDA Forest Service, NOAA and Reclamation.

Goal 5: Market-Based Approaches for Infrastructure and Efficiency

- Publish a white paper that details the financial structure of market-based tools and discuss how such tools can be best used to economically build drought resilient infrastructure.
- Host finance forums in one or more regions to highlight the value of available tools and to showcase successful examples of both public and private infrastructure service delivery benefiting federal, State and local assets.

Goal 6: Innovative Water Use, Efficiency and Technology

- Expand Action 6.1 to include a whole-watershed approach to increasing water use efficiency, from forested headwater systems to lower-lying agricultural systems.
- Support State, tribal and local water reuse and recycling work including public involvement to consider policy and non-technical elements such as operator certification, public outreach, communications, and technical, managerial and financial capacity.
- Support State, tribal and local water use of alternative sources of water such as brackish and saline waters, agricultural return flows and produced waters from oil and gas operations.
- Continue to strengthen bilateral, multilateral and interagency cooperation in international drought science and applications to bolster both domestic and international water security.

Appendix A: List of Abbreviations

ARS	Agricultural Research Service, Department of Agriculture
BLM	Bureau of Land Management, Department of the Interior
CASPER	Community Assessment for Public Health Emergency Response
CDC	Centers for Disease Control and Prevention, Department of Health and Human Services
CEQ	Council on Environmental Quality, The White House
DEWS	Drought Early Warning System
DHS	Department of Homeland Security
DOD	Department of Defense
DOI	Department of the Interior
DOS	Department of State
EPA	Environmental Protection Agency
EQIP	Environmental Quality Incentives Program, Department of Agriculture
FEMA	Department of Homeland Security, Federal Emergency Management Agency
G-WADI	Global Network on Water and Development Information for Arid Lands
HUD	Department of Housing and Urban Development
IDMP	Integrated Drought Management Programme, World Meteorological Organization
LiDAR	Light Detection and Ranging Remote Sensing
NDMC	National Drought Mitigation Center, University of Nebraska, Lincoln
NDRP	National Drought Resilience Partnership
NGWMN	National Ground Water Monitoring Network
NIDIS	National Integrated Drought Information System
NOAA	National Oceanic and Atmospheric Administration, Department of Commerce
NRCS	Natural Resources Conservation Service, Department of Agriculture
NRCC	Northeast Regional Climate Center
NRIC	Natural Resources Investment Center, Department of the Interior
NSTC	National Science and Technology Council
RCPP	Regional Conservation Partnership Program
Reclamation	Department of the Interior, United States Bureau of Reclamation
ROI	Rural Opportunity Investment Initiative, Department of Agriculture
SERCH	Southeast Regional Climate Hub
SNAPP	Science for Nature and People Partnership
SWAQ	Subcommittee on Water Availability and Quality
USACE	U.S. Army Corps of Engineers
USDA	U.S. Department of Agriculture
USFS	U.S. Forest Service, 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
WestFAST	Western States Federal Agency Support Team
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
Director for Service Innovation and Partnership
Office of Water Prediction, National Weather Service
National Oceanic and Atmospheric Administration
Department of Commerce

Executive Officer

Caroline Dvorsky
Natural Resources and Environment
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Incoming: **Erin Foster West**
Management Analyst | Presidential Management Fellow
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Goal Leaders

Goal 1: Mark Brusberg, Department of Agriculture
Goal 2: Sarah Gambill, Department of Homeland Security
Goal 3: Claudia Nierenberg and Roger Pulwarty, Department of Commerce,
National Oceanic and Atmospheric Administration, National Integrated Drought Information System
Goal 4: David Raff, Department of the Interior
Goal 5: Jim Gebhardt, Environmental Protection Agency
Goal 6: Roger Gorke, Environmental Protection Agency