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TESTIMONY

Statement of

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Before

Committee on Energy and Natural Resources
U.S. Senate

Hearing on

"Short- and Long-Term Solutions to Extreme Drought in the Western United States"

June 14, 2022

Congressional Research Service
7-5700
www.crs.gov

Chairman Manchin, Ranking Member Barrasso, and Members of the committee, thank you for inviting the Congressional Research Service (CRS) to provide testimony on short and long-term solutions to extreme drought in the western United States. My name is Charles Stern. I am a Specialist in Natural Resources Policy at CRS.

In serving Congress on a nonpartisan and objective basis, CRS takes no position on legislation and makes no recommendations. CRS remains available to assist the committee in its development and consideration of water resource and other legislation.

My comments today will largely focus on drought not in any one specific location, but as a broader policy issue. I will start by providing background and context on drought in general, including abbreviated information on the status of the current drought in the western United States and prospects for future droughts. I will then provide a broad survey of federal drought policy and authorities, along with a summary of some current proposals for new and modified approaches to address drought.[1]

Background

Drought is a natural hazard with significant economic, social, and ecological consequences. Drought broadly refers to periods of substantially below-average moisture conditions. Generally, there four drought classifications:

- *Meteorological drought* is typically the degree of dryness, in comparison to a "normal" or average amount of dryness and the duration of a dry period. Meteorological drought is region-specific, because precipitation deficiency varies regionally.
- *Hydrological drought* reflects reduced surface and subsurface water supplies, such as streamflows, reservoir and lake levels, snowpack, and groundwater. The frequency and severity of this type of drought are measured on a watershed or river basin scale.
- *Agricultural and ecological drought* links characteristics of meteorological or hydrological drought to agricultural and ecological effects (such as plant-water-stress contributions to tree mortality), often using precipitation shortfalls, evapotranspiration differences,[2] soil moisture deficits, reduced groundwater or reservoir levels, and other variables.
- *Socioeconomic drought* associates the "supply and demand of some economic goods with elements of meteorological, hydrological, and agricultural drought."

The U.S. Drought Monitor—a partnership between federal and nonfederal entities—uses multiple indicators and indexes, together with expert opinion and stakeholder information, to estimate the intensity and effects of ongoing drought conditions. This information is illustrated weekly in maps. The U.S. Drought Monitor defines "drought" as "a moisture deficit bad enough to have social, environmental or economic effects."[3] It depicts drought intensity in five categories with increasing intensity of drought—D0 (abnormally dry), D1 (moderate), D2 (severe), D3 (extreme), and D4 (exceptional). The U.S. Drought

[1] Nicole Carter, Specialist in Natural Resources Policy, and Eva Lipiec, Analyst in Natural Resources Policy, also assisted in preparing this written testimony.

[2] *Evapotranspiration* may be defined as the loss of water from a land area through transpiration from plants and evaporation from the soil and surface water bodies such as lakes, ponds, and man-made reservoirs. For more about evapotranspiration, see USGS, "Evapotranspiration and the Water Cycle," at https://www.usgs.gov/special-topic/water-science-school/science/evapotranspiration-and-water-cycle?qt-science_center_objects=0.

[3] U.S. Drought Monitor, "Drought Classification," at https://droughtmonitor.unl.edu/About/AbouttheData/DroughtClassification.aspx.

Monitor shows broad-scale regional drought conditions, but not necessarily drought circumstances at the local scale. The estimated drought intensity reported by the U.S. Drought Monitor can serve as a trigger for local, state, and federal responses to drought.

A multiyear drought ("long-term drought") remains widespread across many western states, with some areas in an extended period of extreme and/or exceptional drought.[4] Although this winter's storms were beneficial, they did not end the drought. Much of the mountain snowpack in California and the northern Great Basin are below normal for this time of the year and water levels at Lake Mead and Lake Powell (the basin's two largest reservoirs) have recently fallen to some of the lowest levels since those reservoirs were filled. May 2020 through April 2022 was the second driest two-year period since 1895 in Arizona, California, Nevada, New Mexico, and Utah and the fifth driest two-year period since 1895 in Colorado.[5] Hot, dry, and windy conditions in New Mexico and parts of Arizona and Colorado have increased fuels for wildfires and heighten the fire danger.[6]

The current western drought is the latest in a series of droughts that have affected the nation. Among natural disasters in the United States since 1980, droughts rank third in terms of both total costs and costs per year for damages.[7] According to the National Oceanic and Atmospheric Administration (NOAA), from 1980 to 2021 29 drought events with costs over $1 billion occurred, and total losses from these events exceeded $291 billion (CPI-adjusted dollars).[8] In addition to the effect of drought on agricultural production and local economies, drought can lead to water restrictions affecting municipal and industrial supplies, decreased hydropower generation and power plant cooling efficiency, navigation limitations and disruptions, harm to drought-sensitive ecosystems and species, and increased fire risk, among other effects.

The West has a long history of drought, and many of the most costly droughts were in the 17 arid and semiarid "reclamation states" in the western United States.[9] The geographically widespread nature of extreme and exceptional drought across the western United States over the past two years is notable (**Figure 1**), as is the severity of the drought in some areas. In response to these conditions, Congress appropriated funding and enacted authorities to address drought. Stakeholders and Members of Congress have proposed additional measures as conditions continue and/or worsen.

[4] Non-western states are captured in current national drought conditions map at https://droughtmonitor.unl.edu/CurrentMap.aspx.

[5] Presentation by Dan McEvoy, Western Regional Climate Center, "Drought Update and Wildfire Outlook Webinar for California and the Southwest," June 2, 2022.

[6] Ibid.

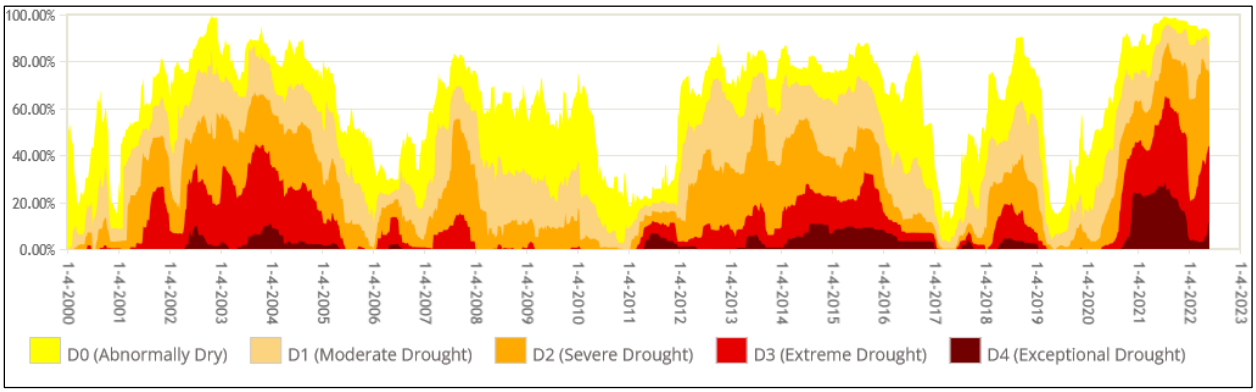
[7] National Oceanic and Atmospheric Administration (NOAA), National Centers for Environmental Information, *Disaster and Risk Mapping*, data for 1980-2021, https://www.ncei.noaa.gov/access/billions/mapping, accessed June 2, 2022.

[8] Ibid.

[9] Reclamation states are the states of Arizona, California, Colorado, Idaho, Kansas, Montana, Nebraska, Nevada, New Mexico, North Dakota, Oklahoma, Oregon, South Dakota, Texas, Utah, Washington, and Wyoming, as categorized in the Reclamation Act of 1902, as amended. 34 Stat. 259.

Figure 1. Drought Classification for Lands in the U.S. West

(percent of land area affected by varying levels of drought over time)



Source: U.S. Drought Monitor Time Series: West Geographic Region, Data as of 5/31/2022, https://droughtmonitor.unl.edu/DmData/TimeSeries.aspx

Notes: Data is based on the western "geographic" region, which encompasses the following nine western states: Arizona, California, Montana, Nevada, New Mexico, Oregon, Utah, Washington, and Wyoming,

The scientific understanding of the various contributors to and types of droughts is evolving. Droughts are challenging to understand because they are shaped by interactions between natural weather and climate variability, climate change, ecosystems, and human activities (e.g., land and water development and use). Multiple researchers are evaluating the contribution of human-induced warming to observed droughts and to droughts under a warmer climate. Some researchers are attempting to identify the role that human-induced warming may have on the severity of observed droughts in specific U.S. regions such as the southwestern United States, which has a history of droughts, including megadroughts.[10]

Experience with trying to understand the ongoing southwestern drought has led to the identification of some ways to improve understanding of future drought risk; these include better understanding of the following:

- effects of climate change on atmospheric behavior leading to regional precipitation patterns;
- the importance of the inter-related variables that influenced the current southwest drought and other droughts;
- the impact and influence of key ocean-atmosphere interactions that influence weather and climate variability over the United States (e.g., the influence of La Niña events);
- changes to western snowpack and its implications; and
- forecast errors that impact water management decisions.[11]

[10] For example, researchers have estimated the human-induced climate change contribution to the 2000-2021 southwestern North American drought, though they indicate there is a large range of uncertainty in the estimates, due in particular to the uncertainty in how humans have affected the region's precipitation (in contrast to more certainty in human effects on southwest drying). See A.P. Williams, et al., "Rapid intensification of the emerging southwestern North American megadrought in 2020-2021," 2022, Nature Climate Change, vol. 12.

[11] NOAA Climate Program Office, Assessment Report: NOAA Drought Task Force Report on the 2020-2021 Southwestern U.S. Drought (website), https://cpo.noaa.gov/MAPP/DTF4SWReport#8405161-highlights.

Regarding observations of changes in drought for North America compared to a pre-industrial baseline (1850-1900), the 2021 Intergovernmental Panel on Climate Change report on the physical science of climate change indicated

- low confidence on the type of changes to dryness relative to normal—**meteorological drought**—for both western and eastern North America, and medium confidence in a decrease in the duration and frequency of meteorological droughts in central North America;[12]
- medium confidence in an increase in **agricultural and ecological drought** in western North America, and low agreement on the type of changes for agricultural and ecological drought in central and eastern North America; and
- low confidence for identifying changes to **hydrologic drought** for western, central, and eastern North America.[13]

Confidence in projected future drought changes for North America with a warming climate varied by region, type of drought, and temperature increase assumed.[14]

Drought Policy

The federal government generally defers to state primacy in surface and groundwater allocation, and therefore states and local entities typically lead efforts to address drought. Most states have drought plans in place, and some of these plans incorporate efforts to reduce drought vulnerabilities.[15] The approach to drought planning and preparedness varies significantly by state. Although many water allocation and other water management responsibilities lie at the state or local level, stakeholders note that localities and individuals often look to the federal government for relief when disasters occur. As a result, Congress has enacted numerous authorities related to drought.

Following a series of droughts in the 1990s, representatives from federal and state governments formed the Western Drought Coordination Council (WDCC) in 1996. Although the WDCC's objectives were focused on the western states, the council brought national attention to the issue of comprehensive drought management.[16] In response, Congress enacted the National Drought Policy Act (P.L. 105-199) in 1996, which created the National Drought Policy Commission (NDPC). In 2000, the NDPC submitted to Congress a report with policy recommendations.[17] Among other things, the NDPC concluded that the

[12] For the drought information in the IPCC report, "low confidence" appears to be assessed for various reasons, including if there is limited evidence, which may be due to a lack of data or studies, and if there is a lack of agreement on the type of change (e.g., mixed signals).

[13] IPCC, "Chapter 11: Weather and Climate Extreme Events in a Changing Climate," in *Climate Change 2021: The Physical Science Basis. Contribution of Working Group I to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change*, 2021, Table 11.21, pp. 1701-1704, and IPCC, "Summary for Policymakers" in *Climate Change 2021: The Physical Science Basis. Contribution of Working Group I to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change*, 2021, p. 10). According to the IPCC Summary for Policymakers, "Each finding is grounded in an evaluation of underlying evidence and agreement. A level of confidence is expressed using five qualifiers: very low, low, medium, high and very high, and typeset in italics, e.g., medium confidence." (p. 4).

[14] For more information, see the references in footnote 12.

[15] The National Drought Mitigation Center provides and collects information on state drought plans. See, http://drought.unl.edu/Planning.aspx.

[16] Among other things, the WDCC recommended the creation of a National Drought Policy Commission. See Western Drought Coordination Council, *The Western Drought Experience, The Western Drought Coordination Council's Report to the National Drought Policy Commission*, Western Governors Association, Denver, Colorado, May 1999.

[17] National Drought Policy Commission, *Preparing for Drought in the 21st Century—A Report of the National Drought Policy Commission*, May 2000. https://govinfo.library.unt.edu/drought/finalreport/fullreport/pdf/reportfull.pdf (hereinafter, "National

United States needed to embrace a national drought policy with preparedness at its core. It noted the policy should support, but not supplant or interfere with, state, tribal, regional, local, and individual efforts to reduce drought impacts.[18] It also recommended that Congress enact a national drought preparedness act to establish a federal-nonfederal "National Drought Council," which , among other things, would coordinate federal programs addressing drought.[19]

Congress, to date, has enacted part of the commission's recommendations. In 2006 Congress approved the creation of a multi-agency partnership administered by NOAA that aims to coordinate "drought monitoring, forecasting, planning, and information at federal, tribal, state, and local levels across the country."[20] Various congresses considered, but did not enact, more comprehensive drought legislation (typically referred to as the "national drought preparedness act"), which would have created of a National Drought Council chaired by the Federal Emergency Management Agency (FEMA) or the U.S. Department of Agriculture (USDA), depending on the proposal.[21] Some elements of the NDCP's recommendations, such as increased federal support for nonfederal drought preparedness planning and resiliency projects, were adopted administratively under other agency authorities.[22]

Current Drought Coordination Efforts

Current federal efforts to coordinate preparations for and responses to drought takes several forms. The two most established federal coordination mechanisms are 1) the National Drought Information System (NIDIS) and 2) the National Drought Resiliency Partnership (NDRP).[23]

In 2006, Congress directed the Under Secretary of Commerce for Oceans and Atmosphere, also known as the *NOAA Administrator*, to create NIDIS (P.L. 109-430).[24] NIDIS coordinates and integrates drought research in partnership with multiple federal agencies and nonfederal entities (e.g., nongovernmental organizations and local governments). It integrates efforts on drought monitoring, forecasting, and planning, and it supports both national drought monitoring and regional drought early warning systems, as well as other drought public awareness and education actions.

The NDRP, initiated in 2013 and formally established by presidential memorandum in 2016 under the Obama Administration, comprises federal agencies that aim to leverage technical and financial federal resources, strengthen communication, and foster collaboration to support efforts to build capacity for

Drought Policy Commission Report"). The commission was disbanded after submitting its report to Congress.

[18] National Drought Policy Commission Report, p. v.

[19] The study found that 88 drought-related federal programs were funded within the past ten years. Seven of these programs provided assistance for drought planning, 42 for drought mitigation, 22 for drought- related monitoring/prediction and research, and 47 for drought response. (The numbers total more than 88 because some programs cover more than one facet of drought.) See National Drought Policy Commission Report, p. 16.

[20] P.L. 109-430, as amended; 15 U.S.C. 313d. For more information on NIDIS, see discussion in "Current Drought Coordination Efforts" and https://www.drought.gov/about.

[21] This legislation was introduced in various iterations in the 107th Congress (S. 2528 and H.R. 4754), 108th Congress (S. 1454 and H.R. 2871), 109th Congress (S. 802 and H.R. 1386), and 113th Congress (H.R. 2642).

[22] For example, under authority provided in Section 9504 of the Omnibus Public Land Management Act of 2009 (P.L. 111-11), the Bureau of Reclamation increased its support for drought preparedness efforts through the creation grant programs for drought contingency and drought resiliency projects. Prior to the initiation of these programs, Reclamation's drought-related activities were largely focused on emergency response actions as authorized in the Reclamation States Drought Relief Act of 1991 (P.L. 102-250).

[23] Other entities, such as the National Climate Task Force and the President's Water Subcabinet, among others, also provide venues for coordination and collaboration related to drought activities.

[24] Congress modified the National Integrated Drought Information System (NIDIS) authorization in 2014 and 2019 (P.L. 113-86 and P.L. 115-423, respectively).

drought resilience. It aims to coordinate federal drought policies among more than 22 federal agencies that have a role in national water policies. In May 2021, the Biden Administration established a new framework for coordination in addition to the NDRP, the White House Drought Resilience Interagency Working Group, which coordinates the actions of 14 federal departments and aims to prioritize federal investments to address drought.[25] The Working Group is chaired by the Secretaries of Agriculture and the Interior.

Federal Drought Authorities

Congress over time has enacted a range of authorities related to drought. Most federal financial aid for drought addresses agricultural production loss and rural water supplies; other authorities address drought-related monitoring and research, including early warning and tracking of various drought metrics and conditions; whereas others involve emergency drinking water supply assistance. Still other authorities focus on short and long-term drought response and mitigation. These authorities can take multiple forms, including federal assistance for local and state drought planning and nonfederal water supply projects that increase drought resilience or develop new water supplies, as well as for the construction of new or expanded federal water storage projects and operational modifications of existing facilities to yield additional water supplies. In some cases, the federal government, at congressional direction, has provided targeted regulatory relief for drought-stricken areas (e.g., changes to environmental requirements to facilitate water transfers in specific areas).

Multiple federal agencies contribute to efforts to predict, plan for, and respond to drought.[26] NOAA, the U.S. Bureau of Reclamation (Reclamation), the U.S. Army Corps of Engineers (USACE), the USDA, the U.S. Geological Survey (USGS), and the National Aeronautics and Space Administration all play roles in drought-related forecasting, warning, monitoring, and research. Some examples of major agency drought-programs and activities include:

- NOAA's NIDIS program serves as a coordinating mechanism for federal drought-related monitoring, forecasting, planning, and research.[27]
- Multiple USDA programs provides the primary federal financial aid to lessen drought's impacts and compensate producers for loss in agricultural production after the onset of drought. Congress has also authorized financial and technical support for farmers and ranchers to manage drought risk and heighten adaptive measures.[28]
- Federal water resource agencies such as the Reclamation and USACE face tradeoffs in operating federal water projects during drought, and in many cases have worked with users to develop project-specific drought contingency plans to address dry conditions. Both agencies also have programmatic authorities to conduct activities to mitigate drought impacts and provide support for nonfederal drought preparedness, resiliency and mitigation projects.

[25] A progress report on the Working Group's first year is available at https://www.whitehouse.gov/wp-content/uploads/2022/05/DroughtIWGReport_Final_Embargoed-Until-June-1-at-6AM-ET.pdf.

[26] For an overview of federal drought preparedness and response authorities related to agricultural, environmental, and natural resources policy, see CRS Report R46911, *Drought in the United States: Science, Policy, and Selected Federal Authorities*, coordinated by Charles V. Stern and Eva Lipiec.

[27] NIDIS, "Advancing Drought Science and Preparedness Across the Nation," at https://www.drought.gov/.

[28] For additional information on the USDA disaster assistance programs, see CRS Report RS21212, *Agricultural Disaster Assistance*, by Megan Stubbs; and CRS Report R42854, *Emergency Assistance for Agricultural Land Rehabilitation*, by Megan Stubbs.

- Various other federal agencies and emergency authorities also play a role in drought response and mitigation, for example:
    - the U.S. Environmental Protection Agency (EPA) provides financial assistance for nonfederal water supply projects and other water resiliency-related programs, and
    - FEMA funds programs which may assist communities to prepare for and reduce drought risks, such as the Hazard Mitigation Grant Program and the Building Resilient Infrastructure and Communities (BRIC) program.[29]

Recent Developments

In 2021, Congress appropriated new financial resources to respond to drought, including activities expected to improve drought monitoring, preparedness, and resiliency support provided by multiple agencies. These resources included funding in Disaster Relief Supplemental Appropriations for FY2022 (Division B of P.L. 117-43) and in the Infrastructure Investment and Jobs Act (IIJA; P.L. 117-58). The former funding included $10 billion for USDA to cover qualifying agricultural losses in areas categorized as D2-D4 from 2020 and 2021, as well as $200 million for Reclamation-related drought efforts. P.L. 117-58, the IIJA, included funding for a number broad and geographically-targeted categories related to drought:

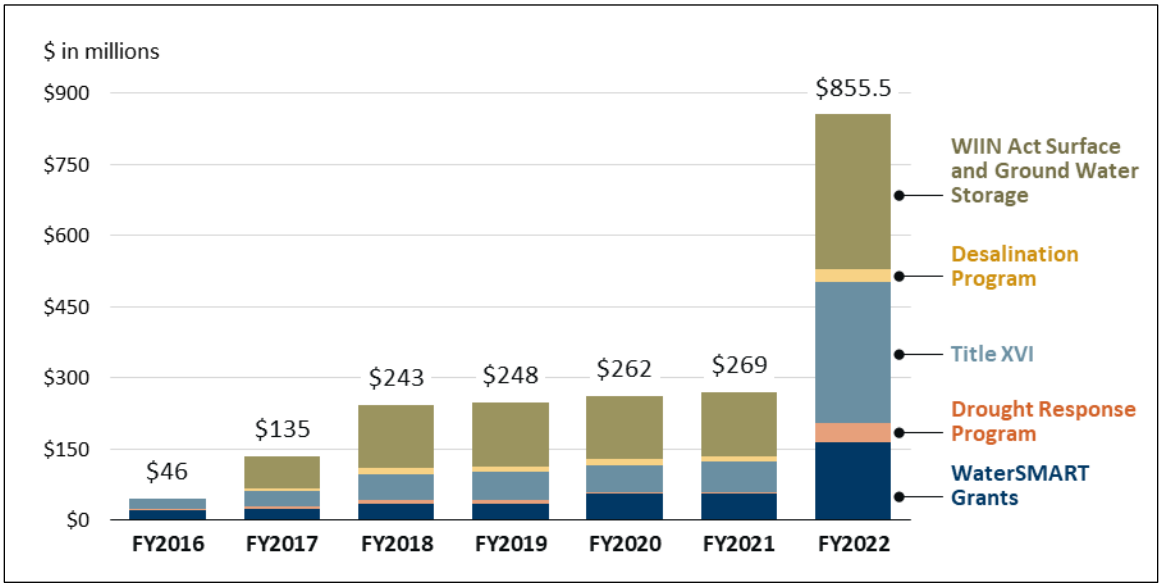
- $300 million over five fiscal years to Reclamation for Colorado River Basin Drought Contingency Plan funding.
- $1 billion over five fiscal years for Reclamation's Title XVI water reuse and recycling program.
- $250 million over five fiscal years for Reclamation contributions to eligible desalination projects.
- $400 million over five fiscal years for Reclamation WaterSMART water and energy efficiency grants.
- $80 million over five fiscal years to NOAA for high-performance computing to improve climate and weather modeling capabilities, related to drought, flood, and wildfire prediction, detection, and forecasting
- $492 million over five fiscal years to NOAA for coastal and inland flood and inundation mapping and forecasting and for next-generation water modeling activities, including modernized precipitation frequency and maximum studies.
- $25 million over three fiscal years to NOAA for data acquisition activities pursuant to a soil moisture and snowpack monitoring pilot program in the Upper Missouri River Basin and an additional $1 million to NOAA over four fiscal years to NOAA to study the pilot program.
- $40 million to USACE for Upper Missouri River Basin soil moisture and snowpack monitoring.

[29] See CRS Report R46989, *FEMA Hazard Mitigation: A First Step Toward Climate Adaptation*, by Diane P. Horn. FEMA uses the term *mitigation* and defines mitigation as "any sustained action to reduce or eliminate long-term risk to people and property from natural hazards and their effects."

- $918 million over five fiscal years for USDA's Natural Resources Conservation Service watershed programs, including the Watershed and Flood Prevention Operations, Watershed Rehabilitation, and Emergency Watershed Protection Programs.[30]

Some of these programs address drought directly, while others address it indirectly or among other priorities. Broadly, these funding increases significantly add to the financial resources available for drought mitigation and resiliency efforts relative to existing funding baselines. For example, **Figure 2** shows the funding ramp-up for several of Reclamation's primary drought-related programs over the FY2016-FY2022 time period.[31] However, due to the expected "lag" in obligating these funds, it will take several years before their effects are fully realized.

Figure 2. Funding for Selected Bureau of Reclamation Drought-Related Programs



Source: Congressional Research Service, based on recent enacted appropriations and Bureau of Reclamation Spend Plan data.

Notes: FY2022 totals reflect additional supplemental funding in P.L. 117-43 and P.L. 117-58. Title XVI = Reclamation's Title XVI Water Reuse and Recycling Program.

Despite these funding increases, drought challenges remain. In many cases, drought is increasing competition for already-scarce water supplies, contributing to conflicts among users and other stakeholders. These conflicts stress existing institutional water management frameworks and existing water sources. For instance, one of the most common reactions to drought is for users to rely more on groundwater resources. Increased groundwater pumping or drilling of additional wells can cause aquifers to decline, leading to lost access for some users.

Policy Options for Addressing Drought

The prospect of extended droughts and more arid baseline conditions in parts of the United States represents a challenge to existing public policy responses for preparing and responding to drought, and to

[30] For additional information, see CRS In Focus IF11990, *Infrastructure Investment and Jobs Act (IIJA): Funding for USDA Broadband, Watershed, and Bioproduct Programs*, by Lisa S. Benson, Megan Stubbs, and Kelsi Bracmort.

[31] Spend plans showing Reclamation's allocation of funds for specific programs and projects are available at https://www.usbr.gov/budget/.

federal water resource projects in particular. In addition to making avaialble new resources to existing programs and authorities discussed above, some have proposed other, often interrelated, actions to help plan for and respond to drought. Several of these proposals are discussed below, with an emphasis on activities within this Committee's jurisdiction. The proposals are broadly divided into planning and preparedness, data and monitoring, augmented supplies, and demand management.

Supporting Planning and Preparedness

Drought resilience is determined not only by actions in the midst of a drought, but also by investments, decisions, and behaviors in place at the onset of a drought. The 2000 NDPC report highlighted the need for better drought preparedness and the need to move away from the reactive or crisis management mode of dealing with drought.[32] Today, most states and some communities have some form of drought plan to prepare and plan for drought. Various sources of federal assistance are available for states and communities for drought planning; some federal programs may fund drought planning efforts directly, whereas others may offer technical assistance.

One of the National Drought Resilience Partnership's 2019 priorities for federal agencies (the last such priorities that were published) was to better coordinate drought planning and capacity-building programs.[33] This goal included enhancing state and sub-state drought planning capabilities for more effective coordination of their drought planning efforts, as well as increased coordination of drought planning in hazard mitigation strategies. Achieving greater drought resilience through drought planning and related actions may necessitate more progress on these priority actions. It also may involve planners placing increased emphasis on drought mitigation projects. A September 2021 letter to 10 western governors from National Climate Advisor Gina McCarthy highlighted the availability of FEMA BRIC and Hazard Mitigation funds to support planning and related actions that reduce drought vulnerabilities.[34]

Drought planning and preparedness are also being increasingly considered in the context of conserving ecosystems and fish and wildlife species. Scientists studying the impacts of drought on ecosystems and species and are being supported by federal efforts aimed at creating "baseline" science to inform management of the ecological impacts of drought.[35] Some have proposed increased resources to plan for sustaining biodiversity and fisheries during drought.[36]

Expanding Data and Monitoring

Drought data collection and integration has been a point of emphasis by federal agencies in recent years, and constituted one of six NDRP priority actions in 2019.[37] Various efforts are underway to share and improve drought information, including monitoring networks (e.g., the National Soil Moisture Network,

[32] National Drought Policy Commission Report, p. 2.

[33] National Drought Resilience Partnership, Priority Actions Supporting Long-Term Drought Resilience, 2019 (hereinafter, NDRP *Priority Actions)*.

[34] Letter from Gina McCarthy, National Climate Advisor, to The Honorable Gavin C. Newsome, Governor of California, September 15, 2021.

[35] One major ongoing effort is the U.S. Geological Survey (USGS) Climate Adaptation Science Centers effort to synthesize the "state of the science" on transformational drought. For more information, see https://cascprojects.org/#/project/4f8c64d2e4b0546c0c397b46/5d40ac2fe4b01d82ce8d9db0.

[36] Jeffrey Mount, et al., *Managing Drought in a Changing Climate*, Public Policy Institute of California, 2018, at https://www.ppic.org/publication/managing-drought-in-a-changing-climate-four-essential-reforms/. For legislative proposals, see Sections 304 and 307 of S. 953 and H.R. 3404, respectively.

[37] NDRP *Priority Actions*.

innovations through the USGS Next Generation Water Observation System, or NGWOS).[38] These and other efforts are ongoing, but have the potential to improve overall understanding of drought and strengthen NIDIS's National Drought Early Warning System.[39] Some also have advocated for additional resources for NOAA subseasonal to seasonal forecasting efforts (sometimes referred to as "S2S forecasting").[40] If improved, these forecasts could help water managers and other stakeholders better prepare for and respond to drought conditions.[41]

Some have advocated for additional drought-related data collection, dissemination, and coordination by federal agencies. For example, one proposal in the 117th Congress would direct federal agencies to develop a national water data framework, including national water data standards to improve the integration, sharing, and use of water data across federal and nonfederal entities.[42] Another proposal would direct the USGS to provide estimates of evapotranspiration across large landscapes to a variety of users.[43]

There may be additional opportunities to employ emerging and novel techniques to analyze drought-related data. For example, the use of artificial intelligence (AI) has and may continue to improve weather and climate understanding and forecasting, while saving on computational costs and using greater amounts of available observations.[44] Several individual federal agencies and NIDIS have supported the use of these techniques to better understand and forecast drought, among other climate phenomena.[45]

Experts have also begun to characterize drought by how quickly drought conditions begin, with some scientists using the term *flash drought* to identify rapid-onset drought conditions. Flash droughts often develop with little warning; they are usually caused by anomalously high temperatures, winds, and/or solar radiation rather than by precipitation deficits. NOAA has been releasing experimental flash drought monitors and forecasts on various timescales as part of its subseasonal prediction products.[46]

[38] For more information on the National Soil Moisture Network, see http://nationalsoilmoisture.com/. For more information on the USGS Next Generation Water Observation System, see CRS Report R45695, *U.S. Geological Survey (USGS) Streamgaging Network: Overview and Issues for Congress*, by Anna E. Normand.

[39] For more information, and drought early warning, see NOAA, NIDIS, "About Drought Early Warning," at https://www.drought.gov/about/drought-early-warning.

[40] "Subseasonal" is generally considered to be forecasts in the period of two weeks to three months, whereas "seasonal" consists of the period from three months to two years. For more information, see NOAA, Subseasonal and Seasonal Forecasting Innovation: Plans for the Twenty-First Century, Report pursuant to Section 201 of the Weather Research and Forecasting Innovation Act of 2017 P.L. 115-525.

[41] See Testimony of Earl Lewis, Chief Engineer, Western States Water Council, in U.S. Congress, Senate Committee on Agriculture, Nutrition, and Forestry, Subcommittee on Conservation, Climate, Forestry, and Natural Resources, *The Western Water Crisis: Confronting Persistent Drought and Building Resilience on our Forests and Farmland*, hearing, 117th Cong., 2nd sess., June 7, 2022.

[42] See H.R. 7792, 117th Congress.

[43] See S. 2568, 117th Congress.

[44] Sue Ellen Haupt et al., "The History and Practice of AI in the Environmental Sciences," *Bulletin of the American Meteorological Society*, vol. 103, no. 5 (May 24, 2022), pp. E1351-E1370. For more about artificial intelligence, see CRS Report R46795, *Artificial Intelligence: Background, Selected Issues, and Policy Considerations*, by Laurie A. Harris.

[45] For example, see NIDIS, "Quantifying the Relative Importance of Multiple Drought Indicators in the U.S. Drought Monitor as a Function of Location and Time of Year," at https://www.drought.gov/drought-research/quantifying-relative-importance-multiple-drought-indicators-us-drought-monitor.

[46] NOAA National Weather Service Climate Prediction Center, "Flash/Subseasonal Drought Information," at https://www.cpc.ncep.noaa.gov/products/Drought/Subseasonal/. For more information on flash droughts in general, see https://www.drought.gov/what-is-drought/flash-drought.

Forecast-Informed Reservoir Operations

Potential alterations to federal and nonfederal reservoir operations to address drought conditions are another area of recent interest among some stakeholders. Pilot projects of Forecast-Informed Reservoir Operation (FIRO) illustrate how dams may be operated more dynamically, in lieu of fixed release and storage schedules (e.g., by retaining water in storage that would have been released to create space for a flood control pool to remain in storage). These operations are informed by advancements in weather and hydrologic forecasting and watershed modeling.[47] To date the most prominent applications of FIRO in the United States have been to improve water supply reliability without compromising flood risk management. Scientists at the USGS, NOAA, and academic institutions have worked with federal operational agencies (i.e., USACE and Reclamation) and state and local agencies on a limited number of pilot FIRO projects at reservoirs in California and the Pacific Northwest.

How widely and how quickly benefits of forecast-informed operations may assist in drought preparedness is an area of interest and ongoing research. In late 2020, Congress directed the Secretary of the Army to produce a report identifying additional opportunities for applying FIRO across the United States.[48]

Augmenting Water Supplies

New and Expanded Water Storage Projects

Historically, the federal approach to the arid West's seasonal and multi-year variability in water availability was to improve reliability through construction of large federal water storage and conveyance systems. Congress's 2016 enactment of Section 4007 of the Water Infrastructure Improvements for the Nation Act (WIIN Act, P.L. 116-322) authorized the first significant Reclamation financial support for new water storage project construction in decades. Since the WIIN Act's enactment, Reclamation has allocated $603 million for the study or construction of 13 projects in three western states, with hundreds of millions in additional funding for these projects appropriated by Congress but currently pending allocation.[49]

Some stakeholders support extension of the WIIN Act's authorities, which are largely being used to provide federal support for nonfederal storage projects in lieu of new, federally-owned projects (although some federal projects also have been funded by Reclamation).[50] Extension of these authorities, along with any new authorization or reporting process that Congress determines preferable, likely would result in the construction of additional projects. Some in Congress argue that if this authority is reauthorized, it should

[47] Dams with federal flood control storage have often used runoff measurements and other observations (e.g., snowpack or soil moisture) to inform decisions related to storing or releasing water. FIRO augments that data with watershed monitoring and weather and water forecasting (including atmospheric river forecasting) to inform water management decisions.

[48] The Water Resources Development Act of 2020 (WRDA 2020, Division AA of P.L. 116-260), Section 157. Also in Section 157 of WRDA 2020, Congress directed that the USACE assessment of the viability of Forecast-Informed Operation (FIRO) in two specific basins. Section 3404 of H.R. 3404, as introduced, would require that the U.S. Army Corps of Engineers (USACE) to use $10 million of its appropriations annually to prepare forecast-informed water control manuals and to integrate FIRO into the Corps Water Management System (a system USACE uses to evaluate watershed hydrology including before it makes reservoir releases).

[49] Eight projects were found feasible prior to the WIIN Act's deadline of a positive feasibility study finding by January 1, 2021, and are thus eligible for ongoing funding. See CRS In Focus IF10626, *Reclamation Water Storage Projects: Section 4007 of the Water Infrastructure Improvements for the Nation Act*, by Charles V. Stern. Also see **Figure 2** above.

[50] See for example H.R. 737, H.R. 1015, and H.R. 1563, 117th Congress.

be amended to incentivize certain types of storage projects, such as multi-benefit projects or projects that contribute to sustainable yield goals.[51] To date, the authority has been used to fund a mix of projects.[52]

Groundwater storage, aquifer recharge, and other similar projects are increasingly viewed as an option in lieu of (or in addition to) traditional water development projects or as a means to reduce groundwater pumping.[53] In Section 40910 of the IIJA, Congress authorized the Secretary of the Interior to provide technical or financial assistance for groundwater recharge, aquifer storage and recovery projects, and water source substitution for aquifer protection projects.[54] This authority has yet to be funded. Congress is also considering authorization of a USACE feasibility study on carrying out managed aquifer recharge projects to address drought, water resiliency, and aquifer depletion on a nationwide basis.[55]

Alternative Water Supplies

Apart from new water storage, alternative water supply projects—such as water reuse, recycling and desalination— are rapidly expanding throughout the West and hold promise for augmenting water supplies in drought-prone areas. Although these projects take time to develop and typically are more expensive than traditional water supplies, in some locations they are cost competitive and are preferred for their increased reliability.

Reclamation's Title XVI Program provides cost-shared financial assistance for authorized nonfederal studies and construction projects that provide supplemental water supplies by recycling or reusing agricultural drainage water, wastewater, brackish surface and groundwater, and other sources of contaminated water. Similarly, Reclamation's Desalination Program provides federal financial support for selected nonfederal desalination projects approved by Congress. EPA's Clean Water and Drinking Water State Revolving Funds also may be used for these and related projects.[56]

Barriers to wider adoption of these approaches vary depending on the technology, water source, and location, and are also influenced by financial, regulatory, and political contexts. EPA's Water Reuse Action Plan aims to drive progress in many of these areas as they relate to water reuse and recycling.[57] Areas of significant potential growth include potable reuse (i.e., the use of treated wastewater for drinking), the use of treated water for agricultural production, and reuse of produced waters (i.e., water from oil and gas operations).[58] Some in Congress have proposed increased prioritization for alternative supplies with multiple benefits and/or stakeholders,[59] or for projects that are constructed in rural areas.[60]

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[51] "In the context of water resources, "sustainable yield" is typically referred to as the amount of water that can be withdrawn from a system with acceptable consequences. For legislative proposal examples, see Section 106 of S. 4231 and H.R. 3404, 117th Congress.

[52] This has included new traditional on and off-stream water storage (storage in a surface reservoir off of the mainstream of a water body), expanded storage at existing projects, restoration of canal conveyance capacity, and groundwater banking.

[53] For more information on groundwater issues, see CRS Report R45259, *The Federal Role in Groundwater Supply*, by Peter Folger et al.

[54] P.L. 117-58, Section 409010(a).

[55] See Section 112 of H.R. 7776, as passed by the House, 117th Congress.

[56] For more information about these and other water supply programs, see CRS Report RL30478, *Federally Supported Water Supply and Wastewater Treatment Programs*, coordinated by Jonathan L. Ramseur.

[57] See United States Environmental Protection Agency, *Water Reuse Action Plan*, https://www.epa.gov/waterreuse/water-reuse-action-plan. Accessed June 6, 2022.

[58] Western States Water Council, *Water Reuse in the West, Western State Water Reuse Governance and Programs*, June 2021, p. 7. https://westernstateswater.org/publications/other-reports/2021/2021-water-reuse-report/ (hereinafter, "*Water Reuse in the West*.")

[59] For example, see Section 101 of H.R. 3404 and S. 4231, 117th Congress.

[60] For example, see Section 104 of S. 4231, 117th Congress.

Some have also proposed tax incentives for some of those adopting alternative water supply approaches.[61] In addition to funding and policy options, some states have also expressed that increased federal technical assistance for water reuse projects would also be helpful.[62]

Water Infrastructure Investment Financing Options

Other sources of infrastructure financing for nonfederal drought resiliency-related water infrastructure projects include EPA's Water Infrastructure Finance and Innovation Act (WIFIA) program and USACE's Civil Works Infrastructure Financing Program (CWIFP), both of which are authorized to fund drought mitigation projects.[63] To date, the WIFIA program has financed several drought-related projects, including multiple water reuse/recycling, desalination, and groundwater management projects.[64] Some have proposed enactment of a similar program for Reclamation (a "Reclamation Infrastructure Finance and Innovation Act," or "RIFIA," which would be limited to water supply projects in reclamation states).[65]

Water Infrastructure Efficiency Improvements and New Technologies

Multiple federal authorities promote the adoption of water efficient infrastructure or incentivize the development of new technologies. Reclamation's WaterSMART grants program provides financial assistance for projects that increase water and energy efficiency, as well as for other projects that aid local partners in preparing for and/or mitigating the effects of drought. Some have proposed changes to WaterSMART itself, such as the expansion of WaterSMART grants to other methods of "water management improvement," or requiring that these projects not increase consumptive water uses. Previously, the NDRP highlighted the potential benefits of better aligning WaterSMART with other water conservation programs to maximize potential benefits.[66] For example, the USDA's Natural Resources Conservation Service (NRCS) provides technical and financial assistance for watershed activities that conserve, develop, and use land and water resources, among other things, and projects could be aligned more between the two programs.[67] Since 2011, NRCS has partnered with BOR to complement WaterSMART funded projects by using NRCS programs to fund water conservation improvements on farm and ranch land that align with WaterSMART projects.[68]

Several federal agencies, including Reclamation, EPA, NRCS, and the Department of Energy are supporting various grants and other programs to incentivize new water technologies and scale-up existing

[61] See Water Reuse Foundation, *Investment Tax Credit for Industrial Reuse*, Position Paper, at https://watereuse.org/wp-content/uploads/2016/09/Policy-Paper-Investment-Tax-Credit-July-2017.pdf.

[62] *Water Reuse in the West.*

[63] Se Title V, Subtitle C of P.L. 113-121, as amended (33 U.S.C. §§3901-3914). While both EPA and USACE funding is authorized to support drought mitigation projects, to date CWIFP funding has only been used to fund non-federal dam safety projects. See CRS Insight IN11577, *U.S. Army Corps of Engineers Civil Works Infrastructure Financing Program (CWIFP): Status and Issues*, by Nicole T. Carter, Anna E. Normand, and Elena H. Humphreys.

[64] For more information, see EPA, "WIFIA Letters of Interest Table," at https://www.epa.gov/wifia/wifia-letters-interest-table, accessed June 6, 2022. EPA has also created a Water Finance Clearinghouse to help communities locate information on funding resources and financing mechanisms to help communities meet their water infrastructure needs. See United States Environmental Protection Agency Water Infrastructure and Resiliency Finance Center, Water Finance Clearinghouse, https://clearinghouse.epa.gov/ords/wfc/f?p=165:6:2382918520683:::6::, accessed June 6, 2022.

[65] For example, see Section 105 of S. 4231, 117th Congress.

[66] NDRP, *Priority Actions*.

[67] For more information, see CRS Report R46471, *Federally Supported Projects and Programs for Wastewater, Drinking Water, and Water Supply Infrastructure*, coordinated by Jonathan L. Ramseur.

[68] For additional information, see USDA, NRCS, "EQIP WaterSMART Initiative (WSI): FY2021 Progress Report," https://www.nrcs.usda.gov/Internet/FSE_MEDIA/nrcseprd1919237.pdf.

methods. In some cases, these investments have the potential to facilitate improved water management practices for various project types. Some have proposed formal authorization and expansion of these efforts, including authorization of a Reclamation prize competitions for water technology innovation.[69]

Managing Demand for Scarce Water Resources

A policy issue particularly relevant to state and local decision makers is the role and types of *demand management* tools to employ during a drought. Demand management is a broad term in water policy that may encompass a number of different approaches that serve to decrease overall demand for water during a drought (or in other periods). Demand management can include programs such as

- payments for temporary fallowing of land,
- voluntary or mandatory water restrictions or conservation targets (e.g., state or local landscape watering limitations),
- industrial and residential water pricing that may apply during periods of drought (often referred to *scarcity pricing*).

Another facet of demand management can be facilitation of mechanisms that allow or foster users to move water to where it is perceived to be most needed during times of scarcity. This can be done through water markets and water transfers. Reclamation makes available some of its WaterSMART funding for state and local programs that encourage the adoption of water markets (Water Marketing Strategy Grants). Demand management also can be used to encourage specific types of transactions. For example, Congress has enacted multiple authorities for Reclamation and other agencies to fund projects that acquire water for environmental purposes during drought.[70] Some have proposed amendments and additions to these authorities, such as temporary payments for water transfers and/or idling of crops for water conservation and habitat creation activities.[71] Others have backed more permanent solutions, such as using funds to acquire water and/or land to protect headwaters or groundwater aquifers, or to purchase senior water rights that can be used to permanently benefit instream flows for fisheries habitat.[72]

[69] See Section 203 of H.R. 3404 , 117th Congress.
[70] Specifically, see Section 40907 of P.L. 117-58 and Section 102 of P.L. 102-250. Congress has also authorized these programs in specific locations, such as in the Colorado River Basin. See 43 U.S.C. §620 note.
[71] See for example, Section 301 of S. 4231 and Section 201 of S. 953, 117th Congress.
[72] See for example, California State Senate, Committee on Budget and Fiscal Review, *Senate Climate Budget Plan,* May 10, 2022. https://sbud.senate.ca.gov/sites/sbud.senate.ca.gov/files/Agenda_Sub_2_May_10_Final.pdf.