

FORUM REPORT

SOUTHWEST DROUGHT FORUM

KEY TAKEAWAYS & PRIORITY ACTIONS



FORUM REPORT

September 2022

The National Integrated Drought Information System (NIDIS) is authorized under Public Law (P.L. 109-430; P.L. 113-348; P.L. 115-423) with an inter-agency mandate to coordinate and integrate drought research, building upon existing federal, tribal, state, and local networks, to create a national drought early warning system that provides timely and relevant drought and climate information services. NIDIS helps communities prepare for drought, wildfire, and water supply deficits by communicating those conditions, forecasts, impacts, and escalating risks with accessible, localized drought information and decision support services. NIDIS is led by the National Oceanic and Atmospheric Administration (NOAA).

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On the cover: Light shines through the rising grains of a sandstorm in the Mojave Desert in southern California. Credit: Ken Kistler

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SOUTHWEST DROUGHT FORUM

SEPTEMBER 21-22 & 28-29, 2021

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Low water level along the Colorado River and Lake Mead. View from Hoover Dam at Nevada and Arizona border. Source: S-F

EXECUTIVE SUMMARY

How did the Southwest Drought evolve? When will it end? What is being done about it? What more could be done that is not already being done? And how do we work together to realize those new opportunities? These questions and more were explored at the Southwest Drought Forum which took place virtually on September 21–22 and 28–29, 2021.

More than 100 individuals representing diverse institutions across levels of government, disciplines, and sectors came together to discuss challenges and new approaches to drought management in the Southwest, with the goal of supporting communities and building long-term drought resilience in the region. Participants included representatives from Federal agencies with drought and water authorities, Tribal nations, state agencies, major

water utilities, member organizations representing drought-affected industries like agriculture and recreation, and academic institutions. The event was organized by NOAA's National Integrated Drought Information System (NIDIS), in collaboration with a multi-agency, cross-sectoral Forum Planning Committee and the National Drought Resilience Partnership.



A jackrabbit stands alert in dry grass near a thin cactus. Ojito Wilderness, New Mexico. Credit: Raisa Nastukova

“Drought has become an all too familiar phenomenon. Long-term drought in the Southwest is not only a regional concern, but a key issue of national significance... the West is interconnected, and we cannot tackle the challenges presented by long-term drought in the Southwest as a regional issue alone.”

DR. RICK SPINRAD, NOAA ADMINISTRATOR

The Forum achieved three main results:

- First, it established a shared understanding of the Southwest drought including its interconnectedness with other natural hazards like wildfire, emerging risks, and impacts.
- Second, it facilitated productive dialogue to identify research and resource gaps and recommend pathways to greater collaboration in the region.
- Third, it supported the exploration of innovative decision-making frameworks and the development of a shared vision for moving forward together in a changing environment.

Ultimately, the Forum captured many areas in which prioritizing research, action, and investment would lead to greater resilience. From advancing our understanding of aridification, to mitigating the toll drought takes on small businesses in the Southwest, to addressing long-standing inequities exacerbated by drought, panelists and participants alike called for an all-hands-on-deck approach to meeting the drought challenges before us.

The following priority areas were identified for further attention and resources:

1. Enhance drought response to address water scarcity in underserved and overburdened communities.
2. Integrate land use planning and cascading hazards information into drought and climate planning resources.
3. Support small businesses and small communities in drought resilience and response measures.
4. Incorporate drought and climate information into financial sector decision-making
5. Invest in research on drought and aridification in the Southwestern U.S., including social science
6. Strengthen financing, coordination, and research for implementing nature-based drought solutions.
7. Strengthen integration of groundwater data into drought monitoring and planning.
8. Support improvements to subseasonal to seasonal forecasting for drought decision-making.



(Left) Low water in the Dirty Devil river in Utah due to drought conditions. Source: JCA Images. (Top Right) An extreme fire danger warning sign in Arizona. Source: Deva Kaiser. (Bottom Right) Aerial view of agriculture in the desert. Source: Rebekah Zemansky

9. Deliver tools to support decision-making and risk analysis for innovative drought solutions.
10. Address remaining barriers to coordination across levels of government and sectors.

Evaluation and feedback gathering prior to, during, and after the Forum was critical to the success of the event. Prior to the Forum, Forum registrants were surveyed to inform agenda formulation and learn more about primary stakeholder concerns related to drought. Respondents clearly indicated the need for a more proactive approach to drought in the region, beginning with an acknowledgement of a “new (ab)normal” for Southwest drought. Many solutions and strategies were offered to be considered at all levels to advance resilience in impacted areas. Following the Forum, session evaluations showed that nearly all survey respondents found the Forum addressed some if not all of what participants hoped to get out of the Forum discussion, and 100% reported satisfaction or high satisfaction with the content of the Forum. Respondents called for more of what the Forum delivered to them: access to collaborative discussions, emerging

research and data improvements, and information exchange around this pressing issue. More results from the pre-Forum survey and post-Forum evaluation are included throughout this report.

The Southwest Drought Forum Report represents the key themes and actions discussed during the Forum, providing a reference point for decision-makers, academic institutions, and government agencies working to build long-term drought resilience in the Southwest Region.

Note

Below normal precipitation in the winter of 2021–2022 caused reservoirs in the Southwest to be further depleted, some to record low levels. A robust summer monsoon season in 2022 helped short-term drought conditions but, in general, did not improve water supplies throughout the region.

INTRODUCTION

The Southwestern United States, comprising the States of Arizona, California, Colorado, Nevada, New Mexico, and Utah, is experiencing an historic, continuing drought. In early 2020, an extreme deficit in precipitation paired with extremely high temperatures marked a low point in two decades of below average precipitation across the region.

In response to these exceptional conditions, the National Oceanic and Atmospheric Administration's (NOAA) National Integrated Drought Information System (NIDIS) convened the 2021 Southwest Drought Forum. This Forum brought together over 100 drought experts, stakeholders, and decision-makers to discuss the long-term implications of drought in the Southwest, and offer paths forward towards realizing a sustainable and healthy Southwest region.

The American Southwest is known for its hot, dry landscape—a land of rock, canyons, and deserts baked by the sun. Indeed, much of this region has low annual rainfall and seasonally high temperatures that contribute to its characteristic desert climate. Yet, for approximately the last 20 years, the region has become increasingly dry, with particularly significant drought events in 2002–2003, 2006, 2011–2016, 2018, and 2020–2021. As the years have gone by without much respite from profound impacts, many have asked, “Is this still a drought?” implying that the term usually refers to a temporary phenomenon.

Forum participants were asked this question in a survey before the Forum began. When provided

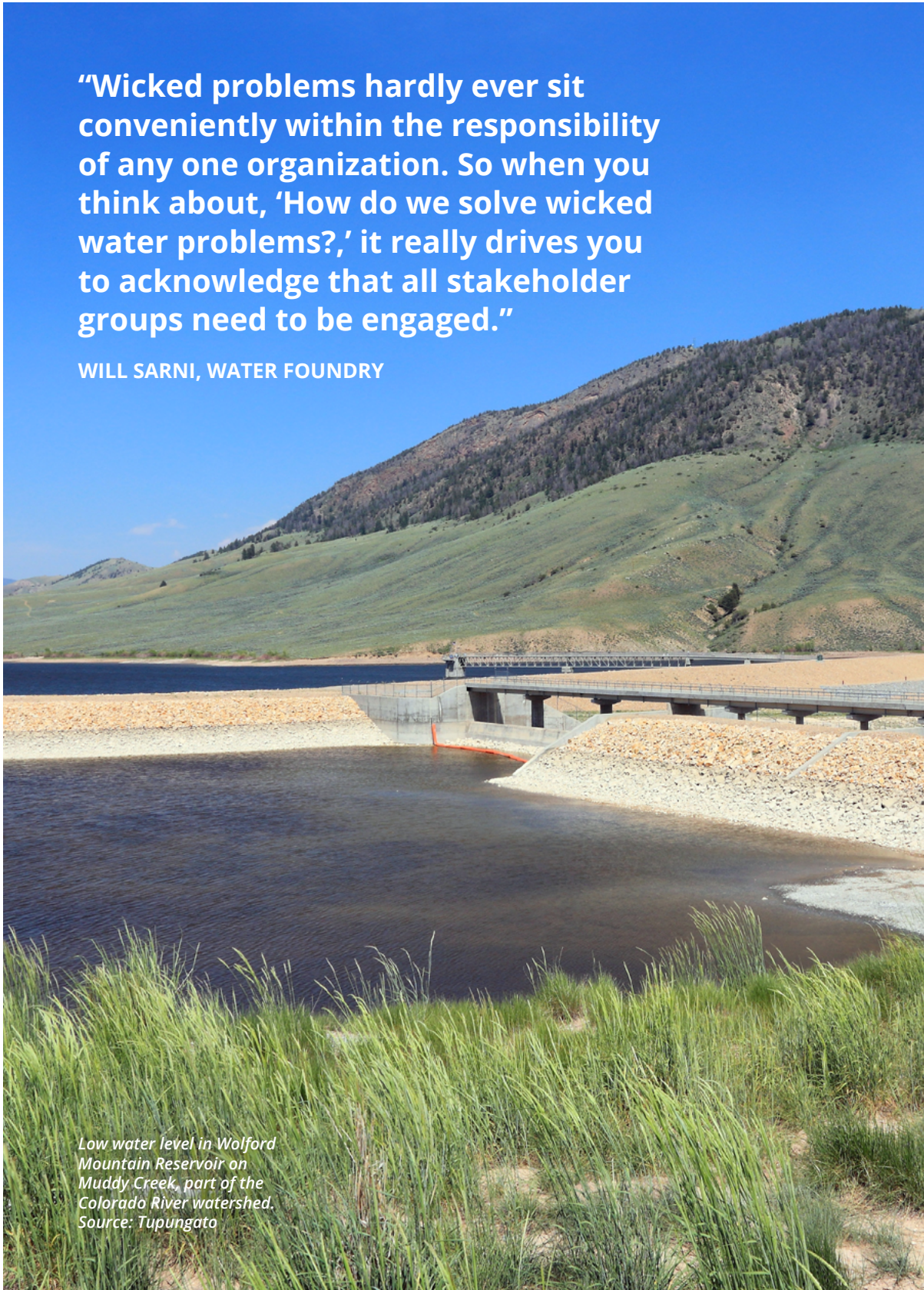
the current general definition of drought, “*a deficiency of precipitation over an extended period of time (usually a season or more), resulting in a water shortage*” and asked if this term is still adequate to describe what is currently happening in the Southwest, only two respondents concurred with the current definition. Using concepts such as “aridification,” “megadrought,” and “high temperatures and a mismatch between water demand and supply,” many participants believed additional factors must be considered to account for the current state of the Southwest. Clearly, a closer examination is warranted, one that looks at not only current conditions and existing resources to address them, but also a new reality accelerating the need for innovation and collaboration.

The Southwest Drought Forum facilitated such an examination through an exchange of state-to-state and local best practices and ideas to build drought resilience in the Southwest region, including those that address the most vulnerable communities and ecosystems. Over the course of four days of virtual dialogue, participants engaged in discussion of timely, relevant Federal resources and programs to support long-term drought resilience strategies. Leading partners suggested ways to address ongoing gaps in actionable data and information for decision-making.

This report summarizes the proceedings of the Forum, and identifies the priority actions and insights for future research, management, and policy identified over the course of the multi-day event.

“Wicked problems hardly ever sit conveniently within the responsibility of any one organization. So when you think about, ‘How do we solve wicked water problems?,’ it really drives you to acknowledge that all stakeholder groups need to be engaged.”

WILL SARNI, WATER FOUNDRY



Low water level in Wolford Mountain Reservoir on Muddy Creek, part of the Colorado River watershed. Source: Tupungato

FORUM SUMMARY

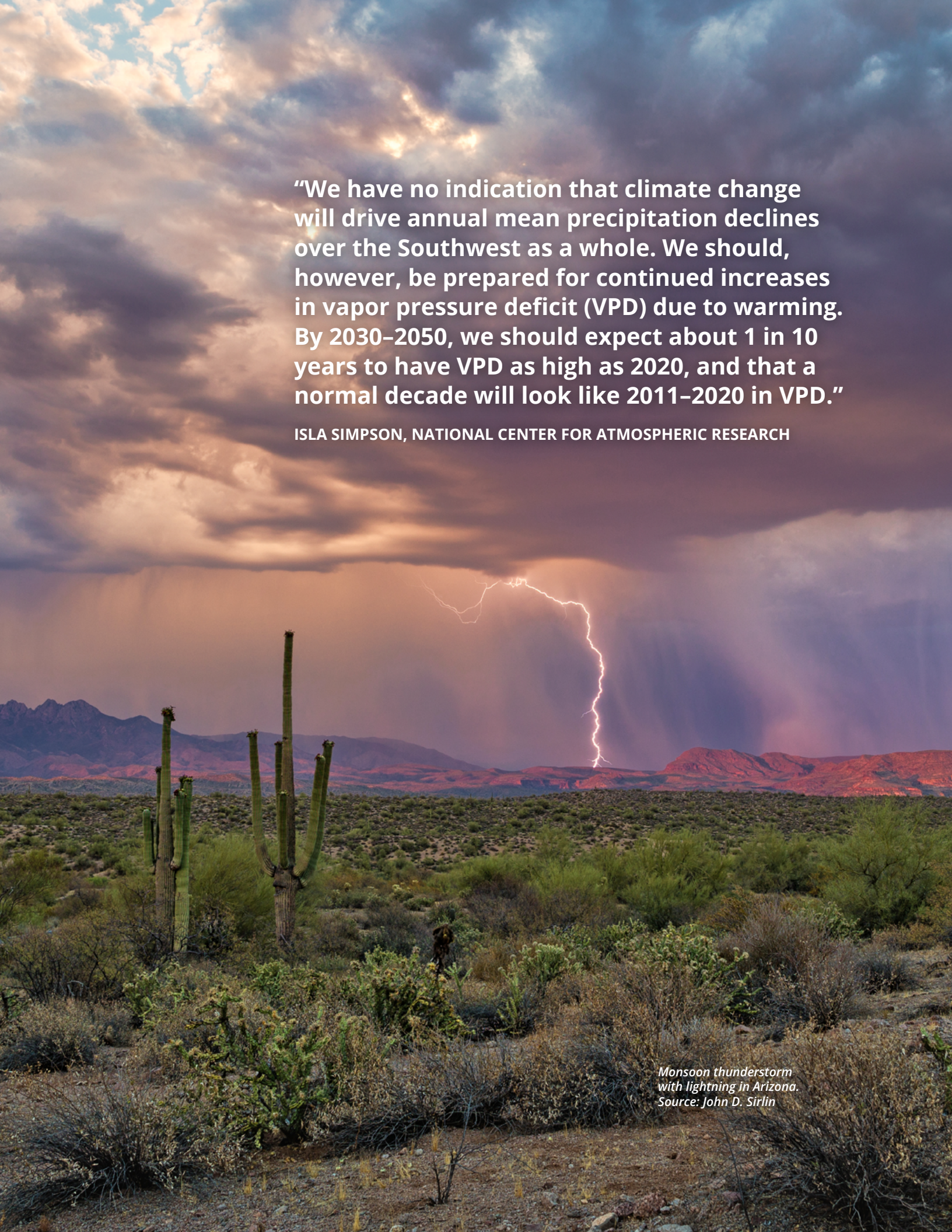
This summary documents key issues raised during the Forum to: (1) understand drought risks in the Southwest; (2) identify current opportunities and barriers; and (3) explore innovative frameworks and partnerships for decision making in light of future trends.

[Please note: A summary of the Forum was also featured in the March 2022 edition of the *Bulletin of the American Meteorological Society* (Lisonbee et al. 2022).]

UNDERSTANDING EVOLVING DROUGHT RISKS IN THE SOUTHWEST

The 2020–21 drought in the Southwest set new records for low rainfall and high temperatures. The 18 months from January 2020 to June 2021 were the driest 18-month period on record for Nevada, Utah, and Arizona; the third driest on record for California and Colorado; and the eighth driest for New Mexico. This included record low precipitation during the North American monsoon months (June–September) in the American Southwest. During the same period, Arizona experienced the second hottest 18-month period on record. The hot season (April–September) 2020 was also the hottest such season on record for California, Arizona, and New Mexico (www.ncdc.noaa.gov/cag/). Following the extreme heat of the summer season, the fall soil moisture was at record low levels. The winter snowpack remained below average for most of the Southwest, and what snow had accumulated then melted earlier than usual (Mankin et al. 2021, Hoell et al. 2022).





“We have no indication that climate change will drive annual mean precipitation declines over the Southwest as a whole. We should, however, be prepared for continued increases in vapor pressure deficit (VPD) due to warming. By 2030–2050, we should expect about 1 in 10 years to have VPD as high as 2020, and that a normal decade will look like 2011–2020 in VPD.”

ISLA SIMPSON, NATIONAL CENTER FOR ATMOSPHERIC RESEARCH

*Monsoon thunderstorm
with lightning in Arizona.
Source: John D. Sirlin*

The high temperatures caused both a shortened snow season and increased atmospheric thirst for moisture from the land, or a high vapor pressure deficit, drying out soils and exacerbating drought conditions. A NIDIS-funded report by NOAA's Drought Task Force on the 2020–2021 Southwestern U.S. Drought highlighted this point. The precipitation deficit of 2020 was extremely low, but within known natural variability, whereas the mean vapor pressure deficit for 2020 would have been impossible in the 1950–2000 climate and fits more closely with climate model projections for the 2030–2050 climate (Mankin et al. 2021).

The 2020 drought represents a single data point in the context of a much longer dry period that spans approximately the last 20 years (Mankin et al. 2021). This megadrought (Williams et al. 2020, Williams et al. 2022) may be like megadroughts in the paleo record, and will eventually have an end, but considering the relative permanency of increased temperatures globally and in the American Southwest, policy makers, land managers, and community leaders face shifting paradigms as they consider the potential permanent aridification of the Southwest region (Mankin et al. 2021).

Drought in the American Southwest is interconnected with other natural hazards and impacts, such as wildfire, heatwaves, low river flow, and ailing agriculture. Before tackling drought as a broad-scale natural hazard, it is important to recognize that the actual impacts of drought manifest themselves as secondary and tertiary issues, and risk management practices should acknowledge the broad diversity of impacts to livelihoods and ecosystems. Here are some key areas, identified at the Forum, where drought is impacting the economy and livelihoods across the Southwest region:

Agriculture

Impacts from decades of drought in the Southwest on agriculture have been significant. The region has seen five severe droughts since 2000 with associated growing wildfire risk, heatwaves, dust storms, and diminished farm productivity. According to the Colorado Cattlemen's Association, by 2050 drought may cost Colorado an additional \$830M in annual damages, with \$511M from agriculture alone. To adapt to drought risk, the Colorado Cattlemen's Association recommended:

- (1) state and local policies (e.g. state water plans, etc.) that advance agricultural priorities;
- (2) inter-agency and inter-industry coordination to support community-led response efforts;
- (3) relief programs that can provide direct adaptation support for agricultural communities such as mental health resources, conflict resolution assistance, and risk management guidance;
- (4) changes to disaster aid to ensure it is promptly available based on drought and climate indicators;
- (5) incentives for ecosystem markets,
- (6) disaster-specific recovery funding for multi-hazard resilience; and
- (7) built and green infrastructure solutions for future water management.

Water Utilities

The drought is also impacting previously built infrastructure. The Central Arizona Project (CAP; www.cap-az.com/) is a 540 kilometer (336-mile) aqueduct system that runs from Lake Havasu to Tucson, Arizona. Each year, the CAP delivers more than 500 billion gallons of water to customers in central Arizona. 2021 water restrictions from Lake Mead means less water available for the CAP as per the Lower Basin Drought Contingency Plan (www.usbr.gov/dcp/). Looking forward, the CAP is considering drought adaptation actions that include a broader climate adaptation plan, research and development of improved hydrologic forecasting and data tools, and partnering with the other largest water utilities in the United States through the Water Utility Climate Alliance (www.wucaonline.org).

The last two decades of drought in the Southwest has challenged municipal water providers by decreasing reservoir storage, which acts as a buffer at times of drought. Looking forward, water providers are looking for new ways to stretch existing water supplies, including water recycling projects, and desalination projects.

Tribal Nations

Ten Tribal Nations sit within the Colorado River Basin and these, too, are responding to decades of drought in the Southwest. The Navajo Nation sits at the heart of the Colorado River Basin and it relies on hydro-power from Lake Powell, as well as agricultural and potable water from Colorado River tributaries and from aquifers. The exceptional drought of 2020 impacted agriculture on Tribal lands where water-limited livestock producers resorted to using potable water for their

livestock, thus putting additional strain on the community water systems. The tribal recreational economy at Lake Powell is also at risk due to dropping water levels. The Navajo Nation has worked to settle water rights along the San Juan River and to enhance coordination among other water users.

“Not only are these conversations lengthy and challenging, they also need to include voices such as tribal voices that have historically not always been part of some of these conversations concerning water management issues.”

BIDTAH BECKER, NAVAJO NATION

Outdoor Recreation

The \$788B outdoor recreation and tourism industry, which accounts for about 5.2 million jobs nationwide and 2.1% of the U.S. GDP (recreation-roundtable.org/impact-2/), experienced a drop to both supply (recreational opportunities) and demand (patrons) in the Southwest during the 2020 drought. Changes in outdoor recreational supply are manifested as low reservoirs for boating access, low rivers and warmer river water limiting angler access, forest closures due to wildfire risk, etc. Changes in recreational demand were seen in 2020 when smoke from California wildfires created air quality alerts in western National Parks. Many tourists canceled trips when they learned that iconic vistas were shrouded in a haze of smoke. The Outdoor Recreation Industry is adapting to these changes by promoting and protecting public lands and waters, attracting new visitors by installing electric vehicle charging stations, proposing tax credits for e-bikes, and promoting a more diverse outdoor industry and encouraging new participants in the outdoors.

Human Health

Drought also impacts human health outcomes, degrades air and water quality, increases incidence of disease, increases mental health stresses (www.cdc.gov/nceh/drought/default.htm), and often coincide with intense heat waves leading to increases in mortality and morbidity. Over the last 20 years, heat-related deaths across the Western US have increased, including 494 documented mortalities in Arizona in 2020, and deadly heat waves in the American Northwest and Southwestern Canada in summer 2021 (Popovich and Choi-Schagrin 2021; Lapoint 2021).

Diverse economic sectors and communities are being impacted by increasing aridification in the Southwest (Manning et al. 2021). Representatives from these sectors have called for mitigation efforts to address anthropogenic climate change. In the near term, communities and businesses are being forced to adapt to this new paradigm.

DO MORE OPPORTUNITIES EXIST? CURRENT EFFORTS AND OUTSTANDING NEEDS

Facing a new paradigm of aridity in the Southwest, some groups have identified and begun implementing new adaptation and mitigation strategies. These ongoing efforts to address drought in the Southwest are novel and deliberate. Here are some of the key opportunities and needs identified throughout the Forum.

While the U.S. Federal Government has long-established drought response mechanisms in place across agencies that help farmers, water managers, cities and towns, and businesses withstand and recover from otherwise crippling drought—state and local entities are also acting.

Coconino County, Arizona, is an example of forward-thinking planning to address issues of increasing aridity in the Southwest. Coconino County has identified wildfire and post-wildfire erosion, flooding, and debris flow as its primary drought-related hazard. Mitigation activities have included forest restoration efforts to limit the amount and severity of wildfires and post-fire erosion.

Colorado agriculture is thriving in a region that can experience frequent and prolonged droughts.

Droughts and associated high temperatures, high evapotranspiration, and soil moisture deficits create a year-round cycle of problems for producers, which can also create supply chain issues. A decreasing winter snowpack and increasing population has created competition between municipal and agricultural water users. The Colorado Department of Agriculture is promoting resilience through: initiatives supporting projects benefiting soil health in crop and livestock production and enhancing water, wildlife, and vegetation; increasing water use efficiency through groundwater management and providing multiple user benefits through flood irrigation; and applying lessons learned through previous water administration experiences.

“The farther away from ‘local’ that we get, the more important it is to be actively seeking those relationships with local governments, with local leaders, and with the people who are living it.”

KATE GREENBERG, STATE OF COLORADO

Extending beyond Colorado, agriculture across the west is facing similar challenges and looking for similar solutions. Recent work from the Union of Concerned Scientists has shown that high temperatures and reduced air quality are as equally concerning as water availability concerns for farm workers in California’s Central Valley (Fernandez-Bou et al. 2021). These concerns are increasing due to hot droughts, which have been getting hotter in recent decades. The Union of Concerned Scientists are working to address research gaps and bring attention to the issues faced by food systems in a hotter, drier Southwest.

The nonprofit group WaterNow Alliance has called for improved Federal funding for infrastructure. Currently, 95% of water infrastructure is paid for by the local rate payer, and most State and Federal financial support comes in the form of loans that the local government or utility has to pay back. Drought resilient water infrastructure can be in the form of decentralized, onsite solutions and initiatives that affordably put water-use decisions in the hands of the consumer. Centralized and built infrastructure should emphasize efficiency and reuse.

FUTURE THINKING: DECISION MAKING IN THE FACE OF A NEW PARADIGM

Planning for the future in an increasingly arid Southwest requires innovative frameworks and leveraging existing resources and programs, such as philanthropic initiatives, water markets, and cooperative agreements. Among the ideas for a drought-resilient future was an underlying theme of ethics and equitability in new water projects. One example of this provided by the Community Water Center (www.communitywatercenter.org/) is that drought impacts water availability for shallow wells first, and when wells dry up some people cannot afford to drill deeper wells. This means that many poorer communities and smaller farm businesses are the first to feel the impact of encroaching drought. The following are projects and groups that are working toward a future of ethical, sustainable and drought resistant water.

As a global beverage manufacturer, The Coca-Cola Company is heavily reliant on water availability and the communities in which it operates. The company’s commitment to increasing water security has three parts: (1) reduce local shared water challenges through regenerative water use; (2) improve watershed health and sustainable supply chains, including through watershed stewardship plans and green-infrastructure projects; and (3) enhance community water access and resilience with a focus on women and girls, as they are often the most affected by water scarcity and sanitation challenges (www.coca-colacompany.com/news/2030-water-security-strategy).

“As Engineers, we have to judge the future by the past... About the time we got [the Hoover Dam] built and started operating, nature demonstrated to us that there was a [drier] ten-year period [than had been planned for]... I don’t know what the future is going to hold.”

RANDY RITTER, U.S. BUREAU OF RECLAMATION, 1948



Low water level at Hoover Dam. Nevada-Arizona; October 2, 2021. Credit: Hanna Tor

In the Colorado River Basin, the Walton Family Foundation is committed to ensuring a healthier watershed with improved flows that help the region adapt to climate change. Their strategies for climate resilience in the Colorado River Basin (www.tenstrategies.net/) include three that employ a forward-thinking mindset using existing technologies. These include: (1) forest management and restoration practices to maintain system functionality and biodiversity; (2) regenerative agriculture practices that enrich soils, enhance biodiversity, restore watershed health, and improve overall ecosystem function and community health; and (3) natural distributed storages that restore highly degraded natural meadow systems to improve local aquifer recharge, water retention, reconnect historic floodplains, and support productive meadows and riparian ecosystems.

Another future-thinking approach to building drought resilience in forests includes financial mechanisms such as the Forest Resilience Bond (www.blueforest.org/forest-resilience-bond). Blue Forest Conservation is a nonprofit organization that leverages financial innovation to create sustainable investment solutions to environmental challenges. They administer the Forest Resilience Bond, a public-private funding mechanism that overcomes the funding gap for forest restoration by allowing private capital to play a role in supporting public land management.

Through regional cooperation, the Del Puerto Water District (www.delpuertowd.org), on the west side of the San Joaquin Valley in California, built a pipeline that allowed recycled municipal water to supplement agricultural water needs in the region. This is one example of public policy supporting and implementing novel solutions to water sharing.

ADDRESSING GROWING CHALLENGES: MOVING FORWARD TOGETHER

Drought and aridification are interconnected with many hazards, such as wildfire, and require a shared vision to address these challenges in a changing environment. The Southwest Drought Forum provided a unique platform to highlight the important role of the private sector in addressing drought and aridification risk. Both the public and private sector have vital roles to play in addressing

drought issues, and public-private partnerships are essential to harnessing the full capabilities of both sectors.

Will Sarni, CEO of the Water Foundry and CEO of the Colorado River Basin Fund, phrased the challenge for the private sector this way, “How do companies with ambitious growth strategies secure the water they need to fuel business growth in a world where paying more for water will not work?”. Consumers are placing increasing pressure on businesses to be good water stewards. New and emerging financial tools and services, such as the Colorado River Basin Fund (<https://www.coloradoriverbasin.com/>), water markets, and drought-aware insurance products can support a business’s desire to be water-conscious while still working within its risk thresholds.

Water utilities and other public or semi-public water-providing organizations have to approach drought risk differently from private companies. For these, the drought risk is twofold: (1) the risk for water users of not having enough water to meet their needs; and (2) the financial risk for a water supply organization—especially an organization supplying urban water users—of not being able to sell enough water to bring in revenue to cover the organization’s fixed costs. To manage these risks, States have the authority to legislate rules governing water ownership, use, re-use, transfer (lease or sell), and storage. For cross-boundary water resources, water sharing compacts are put in place to ensure equitable access to shared water resources (Olmstead et al. 2007).

To conclude, the 2020–2021 drought highlights an extreme low period in nearly two decades of drought in the Southwestern United States. The Southwest Drought Forum allowed researchers and decision makers to come together to talk about the innovations needed in order to support communities in the new paradigm of increased aridity in the American Southwest.

KEY TAKEAWAYS

Through presentations and facilitated conversations, Forum participants conveyed key messages, takeaways, and lessons learned in the Southwest region in responding to drought, as well as identified actionable opportunities for the future. Some key takeaways from the Forum include:

- The U.S. Southwest is a bellwether of climate changes in arid regions. These drought periods are more representative of the future climate than the past climate in the region, primarily due to a background warming of mean global temperatures.
- A single very bad year in the midst of a decades-long drought has exacerbated ongoing environmental and water availability issues.
- Deep uncertainty is now a new reality, and existing water management practices were designed for historic variability and uncertainty that has now changed.
- Water reuse and recycling led by companies and communities offer solid opportunities to identify new sources of local water and better plan for and respond to droughts going forward.
- Any new solutions to enhance drought resilience must consider water ethics and equity.
- Effective coordination and water governance require timely, accessible drought and climate information; cost-benefit analyses to support evidence-based decision making; consistent and inclusive federal, state, local, and tribal engagement; and trust built through shared values and social connectedness.



River guide on Dine (Navajo) youth overnight river trip paddling a raft through a canyon on the Colorado River. Glen Canyon National Recreation Area, Arizona; June 2015. Source: Carolyn Hill

BREAKOUT DISCUSSIONS

During the course of the Forum, attendees also participated in two breakout sessions to identify (1) tangible indicators of success, if we were working as a nationally integrated and coordinated system; and (2) forward-looking, practical solutions for long-term drought outcomes. Results included:

BREAKOUT SESSION 1

“What would be tangible indicators of success, if we were working as a nationally integrated and coordinated system?”

In the first breakout group, attendees were divided into six small groups and each group was asked the same question: “What would be tangible indicators of success, if we were working as a nationally

integrated and coordinated system?” The input from the groups were consolidated and sorted into common themes, which are included below. These are followed by some of the key points from each theme.

1. A Culture Shift to Achieve Alignment

What we heard: Our understanding of drought in the Southwest must change from a temporary disaster that comes and goes to a more permanent state of the climate. Water must be framed as something that invites collaboration, as opposed to discord. Approaches applied to drought policy, drought information, and tools from years ago will not be sufficient, and innovation is required to meet today’s challenges. New levels of coordination should help communities understand the new (ab)

normal at a local scale, including specific indicators of drought by county, drought-vulnerable populations, and sector-based drought impacts.

2. An Equitable and Inclusive Approach

What we heard: Across the Southwest, tribal nations as well as rural communities face particularly daunting challenges in the face of long-term drought. An equitable approach to drought must consider local capacity to mitigate risk and respond. Inclusivity must be institutionalized into relevant agency operations in order to ensure meaningful and timely engagement with those overburdened by drought.

3. Community-based Drought Awareness and Education

What we heard: Advances in analyzing water and drought data at local scales must be leveraged to support community-based drought awareness, including increased understanding of sector-specific impacts, decision trade-offs, and local water use and drought management options.

4. A National Drought Framework

What we heard: A framework for action to build national drought resilience must focus on proactive mitigation measures, accounting for future water and drought scenarios in the Southwest and recognizing differences between regions and river basins. A framework must build bridges at multiple levels, so that collaboration on drought happens between organizations, across levels of government and sectors, and between policy and science disciplines. Agreements around drought and water management must incorporate new and expected future climate conditions.

5. Customized Decision Support

What we heard: Drought data and information must be customized to audiences at different levels for effective decision support. These customized resources must incorporate social science and provide data interpretation in an accessible manner for multiple decision-makers. Drought information must provide enough lead time for stakeholders to take necessary action to reduce impacts. Efforts must be made to minimize duplicative efforts in data sharing and information dissemination.



Cotton bolls ready for harvest in Arizona. Credit: Jim David

BREAKOUT SESSION 2

Exploring Solutions for Long-Term Drought Outcomes

In the second breakout session, Forum participants were again divided into six small groups, but each group was given a separate topic to discuss. Each of the six topics are listed below, followed by some of the key points raised by each group.

1. What options are available to tackle increasing aridity in the agricultural sector?

What we heard: Options include harnessing satellite imagery and remote sensing for real-time monitoring, educating on soil management practices to improve soil moisture retention, employing nature-based solutions such as a riparian buffer for runoff on the edges of a farm, and supporting managed aquifer recharge. Regional collaboration can advance these efforts through robust urban-rural partnerships, dissemination of best practices information, and “farm-to-fork” campaigns to ensure community awareness of local food systems.

2. How can we make data-driven decisions to address long-term water planning challenges?

What we heard: Data management needs and subsequent actions to address long-term water planning challenges should be oriented towards the future, incorporating assessments of multiple scenarios and planning with a range of potential outlooks. Customized decision support tools and robust datasets must integrate the full range of surface water and groundwater data, conditions, and use patterns. An independent entity should serve as a repository and manager for a common data platform. Tailored dashboards can deliver uniform access to water and drought data, so that stakeholders can see the same future.

3. What challenges are we facing in sustainable groundwater management and what innovations are available to address the challenges?

What we heard: Policy-makers need to better understand the surface water–groundwater connection to effectively support the management of recharge efforts and how streams and rivers are impacted. They also need basic data about groundwater use and information about diverse approaches to regulation of that use. Governance structures that support groundwater management should allow for regional collaboration and coordination at the aquifer scale (ex., Coachella Valley Water District regional groundwater management plan).

4. How can we address efficiency and equity challenges in the development of water markets?

What we heard: Vital to addressing the challenges in developing water markets is a keen understanding of water market stakeholders, including the responsibilities of landowners and lessees as well as the buyers of water rights and whether or not those buyers are the highest bidders or if the process is more regulated. Impacts of water sources (such as desalination) and secondary impacts (such as energy consumption) must also be considered in water market development. To ensure greater equity, incentive structures should consider Federal policies to promote efficient agricultural practices, or that the sale of water rights may benefit the local community rather than an individual holding a water right.

5. How can we advance our understanding of drought impacts to ecosystems?

What we heard: Knowledge sharing and lessons learned are critical to improving our understanding of ecosystems in times of drought. Multiple regional mechanisms for that knowledge sharing exist, such as interagency efforts such as West-FAST to regional Drought Early Warning Systems, and must be employed. We must advance the integration of environmental considerations in water triggers and allocation, and support monitoring and research on ecological drought that can inform agreements with environmental commitments.

6. How can we better leverage land use planning across the wild–urban interface (WUI)?

What we heard: Land use planning and water planning must be better aligned, not just across counties, or states, but at the regional level. Development plans should be approved at a higher level/scale at regional or state level by an agency with a more holistic view of water management and climate trends. Framing the WUI challenges under the context of national security may support the need for action and the development of innovative incentives that mitigate risks.



Burmester, Great Salt Lake, Utah. Source: Scott Stringham

PRIORITY NEEDS & ACTIONS

The following list represents the synthesized near-term priority needs and suggested actions from the Forum dialogue that could improve drought early warning and resilience in the Southwestern U.S., in no particular order:

PRIORITY NEED #1

Address Remaining Barriers to Coordination Across Levels of Government and Sectors

In the pre-Forum survey and during the Forum, coordination was identified as the biggest obstacle to progress in tackling long-term drought in the Southwest. For instance, without effective coordination to maximize the value of the research dollars spent on Southwestern drought issues, or to ensure the priority needs of the public and

decision-makers are being addressed, efforts to build drought resilience will fall short. Suggested near-term actions include:

- Continue to host smaller, regional and tribal drought forums that seek to address focused drought-related priorities in which multi-agency, multi-sector, interdisciplinary dialogue can advance understanding and progress
- Support the regular exchange of lessons learned in drought management in the Southwestern region, and consolidate information across platforms into a single information platform for the region.

PRIORITY NEED #2

Enhance Drought Response to Address Water Scarcity in Underserved and Overburdened Communities

Drought resilience can be improved through advancement of equity in water and resource management, considering tribal nations as well as rural and otherwise underserved communities who are on the forefront of drought and climate change. Suggested near-term actions include:

- Ensure equitable development of drought and climate products and services.
- Elevate equity criteria in Federal grant programs and communicate these opportunities to vulnerable communities.
- Promote knowledge exchange around best practices and program models for supporting underserved communities, such as EPA's Environmental Justice pilot through the Clean Water State Revolving Fund (SRF) program.
- Address water–energy nexus challenges that impact drought-prone communities reliant on affordable hydropower.

PRIORITY NEED #3

Integrate Land Use Planning and Cascading Hazards Information into Drought and Climate Planning Resources

The Southwestern United States is one of the fastest growing parts of the country. At county and local levels, government leaders and decision makers can facilitate adaptation and resilience to drought by supporting regular exchange between water providers, land developers, and regulators. Suggested near-term actions include:

- Promote drought resilience through multi-hazard planning tools that integrate cascading hazards and considers the long-term impacts of land use and growth upon limited water resources.
- Enhance existing online resources to support drought planning funding with technical assistance, helping local planners take a proactive approach in the development, evaluation, and improvement of dynamic drought plans.
- Disseminate drought planning guides, scenario-based exercises, and other decision-support

tools that address cascading hazards and the impacts of population growth in the Southwest on agriculture, the price of water, and the landscape.

PRIORITY NEED #4

Support Small Businesses and Small Communities in Drought Resilience and Response Measures

Across the Southwest, the recreation and tourism industry is the lifeblood of many local economies. For instance, Coconino County, AZ, is home to Grand Canyon National Park as well as Lake Powell. The county's tourism-related industry supports 12,000 jobs and generated \$947 million in August 2021 alone. Declining lake levels due to drought, and their implications for small, local recreation and tourism businesses, had a more significant economic consequence than the COVID-19 pandemic on the county in 2021. In times of drought, resilience and response measures must consider the size of an impacted business's operation—from small outdoor recreation businesses to independent agricultural producers—to target resources and help small enterprises mitigate drought risk. Suggested near-term actions include:

- Improve and streamline access to Federal drought assistance for small and under-resourced businesses and communities, including rethinking around matching funds and providing support through technical assistance.
- Host interagency dialogues to further explore the drought and climate information needs of small outdoor recreation businesses, including impact data to help decision makers and business owners quantify and insure economic risks of drought.
- Support small capacity-building grants to help small communities to engage in the Federal grant process.

PRIORITY NEED #5

Incorporate Drought and Climate Information into Financial Sector Decision-Making

Improved tools for financial resilience can help Southwestern communities take a proactive

approach to risk management and avert financial backsliding and diminished capacity for future resilience after a disaster strikes. Financial institutions, including insurance companies, as well as state-level insurance commissioners, and others need access to information and localized decision-support tools that illuminate current conditions and future climate scenarios, as well as short-term and long-term impacts. Near-term suggested actions include:

- Support insurance approaches that link preventative and pre-disaster mitigation measures with post-recovery insurance, including those that incentivize natural infrastructure solutions that have downstream benefits to the availability of insurance.
- Enhance resources for the financial sector to support the integration of drought scenario exercises and impact data analysis into risk management and decision-making.

PRIORITY NEED #6

Invest in Research on Drought and Aridification in the Southwestern U.S., including Social Science

Many scientific questions remain about the origins of the 2020–21 drought, the multi-decadal drought conditions, and historical conditions in the region. Additionally, research questions remain about what these drought conditions imply about future water availability for the rapidly growing and economically crucial U.S. Southwest, and how they are impacting social and cultural norms. Suggested near-term actions include:

- Advancing applied social science research to investigate how seasonal to decadal climate variability is impacting the Southwest U.S. climate and society.
- Conduct research to better understand how drought monitoring and management will change in the presence of a potential megadrought, which may have an end but not for decades to come, or Southwestern U.S. aridification, suggesting that the current state is the new permanent state of the region's climate, at least for the foreseeable future.
- Conduct research to better understand the effects of climate change on atmospheric

behavior leading to regional precipitation patterns.

- Conduct research to disentangling the relative importance of the interrelated variables that influenced this and other droughts in the region.
- Conduct research to investigate the changing nature of western snowpack and its implications and impacts.

PRIORITY NEED #7

Strengthen Financing, Coordination, and Research for Implementing Nature-Based Drought Solutions

Nature-based solutions to drought, such as restored wetlands to regulate river flow and agroforestry that reduces evaporation on farmland, can reduce the severity of hydrologic drought impacts and mitigate future risk. Increasing the use of nature-based solutions and innovative practices that use less water requires financing, coordination across levels of government, and research to support science-based decision-making. Suggested near-term actions include:

- Develop cross-sector partnerships and basin-wide funding for nature-based solutions to build resilience at a scale, commensurate with the challenge of historic degradation of watershed health and hydrologic vulnerability to climate change in the region.
- Advance philanthropic and private funding to be used to match or leverage government resources.
- Support a coordinated, interagency approach to water-related climate resilience funding for nature-based solutions.
- Conduct research to better understand the efficacy of existing nature-based solutions to mitigate drought impacts.

PRIORITY NEED #8

Strengthen Integration of Groundwater and Soil Moisture Data into Drought Monitoring and Planning

Water accounting that accurately incorporates groundwater, snowpack, and soil moisture monitoring data is foundational to effective water-resource

management in the Southwest. Today, the region's groundwater resources are among the most over-used in the United States. In particular, accurate water accounting can support Southwestern businesses in better understanding their water-related risks, the impacts of their water use on communities and ecosystems, and responding with informed changes in water management practices. Suggested near-term actions include:

- Develop and disseminate localized, real-time drought and water information that is tailored to water management decisions around conjunctive use of surface water and groundwater.
- Collect case studies and share information on water accounting solutions, groundwater management regimes, innovative opportunities for stormwater recharge and stormwater capture, in partnership with local planners and water managers.

PRIORITY ACTION #9

Support Improvements to Subseasonal to Seasonal Forecasting for Drought Decision-Making

Improved drought early warning, including improved forecasts for drought amelioration or removal as well as for Southwestern monsoons, could be made through advancements in subseasonal to seasonal forecasting. There is limited precipitation predictability on the subseasonal to seasonal timescale, and to improve the usability of and skill of subseasonal to seasonal forecasts, collaboration is required. Suggested near-term actions include:

- Collaboration and co-development of probabilistic, state-of-the-art, usable objective drought outlooks, looking at long historical predictions for skill and confidence levels and a robust framework for testing future improvements.
- Conduct research to better understand atmospheric drivers of drought development or relief and predict the transitions in drought conditions, on a seasonal time scale. This includes research to better predict tropical variability that influences the Jetstream and its contraction and expansion, as well

as the land-atmosphere interaction. This also includes research to examine the effect of changes in the atmospheric composition (temperature gradient between poles) on the jet stream and its seasonal positioning.

PRIORITY NEED #10

Support Science-based Decision-Making and Risk Analysis for Innovative Water Supply and Efficiency Solutions

Across the Southwest, many water management agencies have already explored and developed most of their "cheap" water supplies and conservation options. Water recycling opportunities, desalination, irrigation efficiency, green infrastructure, new storage, and stormwater capture are all more expensive alternatives, but within the toolbox for long-term drought resilience in the region. Suggested near-term actions include:

- Support forums and dialogues that help communities learn more about these alternative solutions to build drought resilience, including Federal funding available and opportunities for public-private partnerships to finance solutions.

To learn more about this event and watch recorded presentations, visit the NIDIS YouTube page at: <https://bit.ly/3Diz460>

Disclaimer

Priority Needs resulting from the Southwest Drought Forum do not represent official Administration policy or position, or an official policy or position of the individual organizations/agencies represented at the Forum.

REFERENCES

- Fernandez-Bou, A. S., and Coauthors, 2021: 3 Challenges, 3 Errors, and 3 Solutions to Integrate Frontline Communities in Climate Change Policy and Research: Lessons From California. *Front. Clim.*, 3, 1–9, <https://doi.org/10.3389/fclim.2021.717554>.
- Hoell, A., and Coauthors, 2022: Record Low North American Monsoon Rainfall in 2020 Reignites Drought over the American Southwest. *Bull. Am. Meteorol. Soc.*, S1–S7, <https://doi.org/10.1175/BAMS-D-21-0129.1>.
- Lapoint, L., 2021: Chief coroner’s statement on public safety during high temperatures. *BC Gov News*, <https://news.gov.bc.ca/releases/2021PSSG0071-001523> (Accessed October 28, 2021).
- Lisonbee, J., E. Ossowski, M. Muth, V. Deheza, and A. Sheffield, 2022: Southwest Drought Forum: Preparing for long-term drought and aridification. *Bull. Am. Meteorol. Soc.*, 103(3), E821–E827, <https://doi.org/10.1175/BAMS-D-21-0321.1>.
- Mankin, J. S., I. Simpson, A. Hoell, R. Fu, J. Lisonbee, A. Sheffield, and D. Barrie, 2021: *NOAA Drought Task Force Report on the 2020–2021 Southwest U.S. Drought*. 20 pp. <https://www.drought.gov/sites/default/files/2021-09/NOAA-Drought-Task-Force-IV-Southwest-Drought-Report-9-23-21.pdf>.
- Manning, D., J. Burkhardt, C. Goemans, and A. Maas, 2021: *An Analysis of the Impact of Drought on Agriculture, Local Economies, Public Health, and Crime Across the Western United States*. 87 pp. <https://www.drought.gov/documents/analysis-impact-drought-agriculture-local-economies-public-health-and-crime-across>.
- Olmstead, S. M., W. Michael Hanemann, and R. N. Stavins, 2007: Water demand under alternative price structures. *J. Environ. Econ. Manage.*, 54, 181–198, <https://doi.org/10.1016/j.jeem.2007.03.002>.
- Popovich, N., and W. Choi-Schagrin, 2021: Hidden Toll of the Northwest Heat Wave: Hundreds of Extra Deaths. *New York Times*, <https://www.nytimes.com/interactive/2021/08/11/climate/deaths-pacific-northwest-heat-wave.html> (Accessed October 28, 2021).
- Williams, A. P., and Coauthors, 2020: Large contribution from anthropogenic warming to an emerging North American megadrought. *Science* (80–), 368, 314–318, <https://doi.org/10.1126/science.aaz9600>.
- Williams, A. P., B. I. Cook, and J. E. Smerdon, 2022: Rapid intensification of the emerging southwestern North American megadrought in 2020–2021. *Nat. Clim. Chang.*, 12, <https://doi.org/10.1038/s41558-022-01290-z>.

APPENDIX A: FORUM AGENDA

DAY I: TUESDAY SEPTEMBER 21, 2021

Current Conditions: Understanding Evolving Drought Risks in the Southwest

Establish a shared understanding of the Southwest drought, its interconnectedness with other natural hazards, emerging risks, and impacts.

11:00 – 11:15 am EDT Welcome and Introductory Remarks

Welcome attendees, introduce partners, and review of the Southwest Drought Virtual Forum objectives and why this discussion is so critical at this time for the region.

- Veva Deheza, NOAA/NIDIS Executive Director
- Dr. Richard (Rick) Spinrad, NOAA Administrator

11:15 – 12:00 pm EDT The 2020–21 Western Drought: What are Current Conditions?

Drought subject matter experts provide an overview of current regional drought conditions and forecasted outlooks, and a wildland fire expert provides a regional wildland fire outlook. Researchers from the scientific community review what is known about the historic nature of drought in the region and what they expect to see in the future. A Q&A period follows.

- Richard Heim, NOAA/NESDIS/National Centers for Environmental Information
- David Dewitt, NOAA/NWS/Climate Prediction Center
- James Wallmann, DOI/BLM/National Interagency Fire Center

12:00 – 12:40 pm EDT Setting the Stage: How did we get here?

Experts share a look back from 2000 to present day with a focus on the last two years and offer a summary of how we got here with respect to drought, setting the stage for the Forum agenda. A moderated Q&A period follows.

- Andy Hoell, NOAA Physical Sciences Laboratory
- Isla Simpson, National Center for Atmospheric Research
- Erica Fleishman, DOI/USGS Southwest Climate Adaptation Science Center

Break (15 Minutes)

12:55 – 1:40 pm EDT Sector and Community-Based Perspectives on Cascading Drought Impacts and Needed Changes

In the face of drought and aridification, there are new and emerging challenges to ensuring adequate quality water supply to meet the needs of Southwestern communities and economies. Speakers illuminate diverse vulnerabilities and how the risk landscape is changing for diverse sectors of our economy. From the losses on agricultural lands, to threats to our nation's energy production, impacts across key economic sectors and communities must be understood, measured, and predicted to mitigate the toll drought takes. This session features sectors and communities responding to the cascading impacts of drought. Panel presentations are followed by moderated Q&A:

- Terry Fankhauser, Colorado Cattlemen's Association
- Deanna Ikeya, Central Arizona Project
- Bidtah Becker, Navajo Nation

1:40 – 2:40 pm EDT Continued: Sector and Community-based Perspectives on Cascading Drought Impacts and Needed Changes

Panel presentations followed by moderated Q&A:

- Kevin Moran, Environmental Defense Fund
- Chris Perkins, Outdoor Recreation Roundtable
- Jesse Bell, University of Nebraska Medical Center
- William Hasencamp, Metropolitan Water District of Southern California

Break (10 Minutes)**2:50 – 3:20 pm EDT Analysis of the Impact of Drought on Agriculture, Local Economies, Public Health, and Crime across the Western United States**

This session presents recent NIDIS-supported research at Colorado State University to assess the impacts of drought on Western agricultural productivity, employment, wages paid, business openings/closings, criminal activity, and health outcomes. A Q&A period follows.

- Christopher Goemans, Colorado State University

3:20 – 3:30 pm EDT Closeout and Review Wednesday's Agenda

DAY 2: WEDNESDAY, SEPTEMBER 22, 2021

Do More Opportunities Exist? Current Efforts and Outstanding Needs

Explore ongoing efforts to address drought in the Southwest, and identify gaps and recommend pathways to greater collaboration.

11:00 – 11:15 am EDT Recap of Day One and Debrief of Pre-Forum Survey

A brief summary of the September 21 session is provided and pre-forum survey results are presented as major messages for the collective community's consideration.

11:15 – 12:15 pm EDT State, Local Government, and NGO Panel: Managing for a Changing Climate in the Southwest

Panelists discuss strategies for managing for the new (ab)normal in the Southwest, including the implications of a changing climate for long-term water planning, community experiences tackling difficult decisions around water management, innovations in water conservation, and what scientists can do to support decision-making in these areas. A Q&A period follows.

- Supervisor Patrice Horstman, Coconino County, AZ
- Kate Greenberg, Commissioner of Agriculture, State of Colorado
- Cynthia Koehler, Water Now Alliance
- Brenda Ekwurzel, Union of Concerned Scientists

Break (15 Minutes)

12:30 – 1:30 pm EDT Drought Coordination: Federal Government Initiatives to Address Long-term Drought Resilience in the Southwest

Federal agency leadership describes recent accomplishments of the Interagency Drought Working Group, the Water Subcabinet, and the role of the National Drought Resilience Partnership. Agencies discuss resources to address long-term drought resilience in the Southwest and manage for increasing dryness in the region. A moderated Q&A period follows.

- Moderator: Roger Gorke, Office of Water, EPA
- Karen Hyun, Chief of Staff, NOAA, Department of Commerce
- Tanya Trujillo, Assistant Secretary for Water and Science, U.S. Department of the Interior
- Gloria Montañó Greene, Deputy Under Secretary for Farm Production and Conservation, U.S. Department of Agriculture

- Zach Schafer, Senior Advisor, Office of Water, Environmental Protection Agency
- Michael Grimm, Acting Deputy Associate Administrator, Federal Insurance and Mitigation Administration

1:30 – 2:15 pm EDT

Breakout Groups Address: “What would be tangible indicators of success if we were working as a nationally integrated and coordinated system? What would it look like at the local, state, Federal, tribal, and business levels?”

Break (15 Minutes)**2:30 – 3:00 pm EDT Debrief of Breakout Group Recommendations**

Breakout group representatives offer recommendations on the way forward to address long-term drought outcomes.

Closeout and Review of Next Week’s Agenda

DAY 3: TUESDAY, SEPTEMBER 28, 2021

Future Thinking: Decision Making in the Face of a New Paradigm

Explore innovative frameworks for decision making and leveraging government resources and programs, in the context of a 20+ year drought event and increasing long term aridity.

11:00 – 11:15 am EDT Welcome and Forum Recap

A NIDIS-produced video looks back at drought in the region from the landmark drought years of 2002–2004 to present, featuring interviews with people from different economic sectors whose livelihoods are affected by drought.

11:15 – 11:35 am EDT Keynote Speaker

- Eric Kuhn, Author and Former General Manager of the Colorado River District

11:35 – 1:00 pm EDT Infrastructure for Managing Drought Risk and Coordination

Panelists highlight critical needs for infrastructure improvements to address long-term drought in the Southwest, including the development of nature-based solutions and innovative practices utilizing infrastructure across sectors that realize co-benefits in water conservation as water scarcity increases in the Southwest. A Q&A period follows.

- Moderator: Chuck Chaitovitz, U.S. Chamber of Commerce
- Jon Radtke, Coca-Cola
- Morgan Snyder, Walton Family Foundation
- Phil Saksa, Blue Forest Conservation
- Anthea Hansen, Del Puerto Water District
- Susana De Anda, Community Water Center

Break (15 Minutes)

1:15 – 1:20 pm EDT Instructions and Move to Respective Breakout Groups

1:20 – 2:30 pm EDT Breakout Groups: Exploring Solutions for Long-Term Drought Outcomes

An introduction is provided for each challenge to frame group engagement to address challenging questions and identify innovative solutions:

- What options are available to tackle increasing aridity in the agricultural sector?
- How can we make data-driven decisions to address long-term water planning challenges?
- What challenges are we facing in sustainable groundwater management and what innovations are available to address the challenges?
- How can we address efficiency and equity challenges in the development of water markets?
- How can we advance our understanding of drought impacts to ecosystems?
- How can we better leverage land use planning across the wild–urban interface?

DAY 4: WEDNESDAY, SEPTEMBER 29, 2021

Addressing Growing Challenges: Moving Forward Together

Explore the interconnectedness of drought, wildfires, and other hazards, the financial solutions needed to protect communities, and develop a shared vision for moving forward together in a changing environment.

11:00 – 11:10 am EDT Opening Remarks

11:10 – 11:45 am EDT Debrief of Breakout Group Results on Solutions for Long-Term Drought Outcomes

A summary of major messages from breakout groups is presented.

11:45 – 12:00 pm EDT Keynote Speaker

- Will Sarni, Founder and CEO, Water Foundry

12:00 – 12:40 pm EDT Exploring Drought Risk Management through Water Markets and Financial Services

A moderated panel explores diverse approaches to drought and wildfire risk management through water markets and financial services, with discussions on reinsurance, state-led insurance initiatives, water markets, and needs to support improved mitigation and land management efforts. A Q&A period follows.

- Sarah Kapnick, JP Morgan
- Mike Hanemann, Arizona State University
- Mike Peterson, Deputy Commissioner on Climate and Sustainability, California Department of Insurance

Break (15 Minutes)**12:55 – 1:15 pm EDT Congressional Perspectives**

Remarks by Representative Raúl Grijalva (AZ-3), Senator Kyrsten Sinema (AZ), and Representative Joe Neguse (CO-2)

1:15 – 2:30 pm EDT Looking Forward: A Vision for a Sustainable and Healthy West in a Changing Environment

- Introduction and Moderator, Roger Pulwarty, NOAA.

Panelists consider the Forum discussions from the four days and offer paths forward towards realizing a sustainable and healthy West in a changing Environment. A Q&A period follows.

- David Hayes, Executive Office of the President
- Alice Hill, Council on Foreign Relations
- John Fleck, University of New Mexico
- Bidtah Becker, Navajo Nation

2:30 – 2:45 pm EDT Next Steps and Closing Remarks

Host will present closing remarks highlighting the major messages from the Forum and details about next steps, including a report of the Forum, and future drought dialogues.

APPENDIX B: SPEAKER BIOS

BIDTAH BECKER is an Associate Attorney for the Navajo Tribal Utility Authority and the immediate past Director of the Navajo Nation Division of Natural Resources. For more than a decade prior, she served as an attorney for the Nation focusing on water rights and natural resources. She also serves on the Leadership Team for the Water and Tribes Initiative in the Colorado River Basin, on the New Mexico Interstate Stream Commission, and on the Navajo Nation Water Rights Commission. Equally passionate about supporting artists, she serves as a Trustee for the Institute of American Indian Arts and Culture (IAIA). She is a member of the Nation and lives on the Navajo Nation in Fort Defiance with her husband and two school age children.

JESSE E. BELL, PH.D., is the Claire M. Hubbard Professor of Water, Climate, and Health in the Department of Environmental, Agricultural, and Occupational Health at the University of Nebraska Medical Center and the School of Natural Resources within the Institute of Agriculture and Natural Resources at the University of Nebraska-Lincoln. He is also the director of the Water, Climate and Health Program at UNMC and the director of Water, Climate and Health at the University of Nebraska's Daugherty Water for Food Global Institute. He is also serving as a Faculty Fellow for the National Strategic Research Institute and adjunct faculty for the Department of Environmental Health at Emory University.

SUSANA DE ANDA is Co-Founder and Executive Director of the Community Water Center. Susana's experience includes planning and organizing positions at the Center on Race, Poverty and the Environment; the County of Merced Planning Department; the Santa Barbara County Water Agency; and the Santa Barbara nonprofit Community Environmental Council. Susana earned a B.A. from the University of California, Santa Barbara while completing a double major in Environmental Studies and Geography. She currently serves on the Advisory Council for the Water Solutions Network and is a Steering Committee member on the Water

Equity and Climate Resilience Caucus. Susana is also a co-founder and member of the board of Water Education for Latino Leaders (WELL).

DAVID DEWITT has been the Director of the Climate Prediction Center (CPC) of the National Weather Service (NWS) since 2014. At CPC, he leads a team of scientists developing and producing operational products that help stakeholders mitigate risks due to sub-seasonal to seasonal (S2S) climate variability. Prior to coming to NOAA, he worked as a research scientist at the International Research Institute for Climate and Society (IRI) at Columbia University from 1999–2012. While at IRI, David led the Climate Program, which consisted of a team of scientists engaged in the development of seasonal climate forecasts and prototype decision supports systems for the application of climate information in the fields of agriculture, health, and water resources. From 1994–1999, DeWitt worked at the Center for Ocean–Land–Atmosphere Studies developing coupled atmosphere–ocean models for seasonal forecasts and conducting research to better understand short-term climate variability. DeWitt received his Bachelor of Arts (1989) degree in meteorology from Kean University, and his Masters (1992), and Ph.D. (1994) degrees in meteorology from the University of Maryland, College Park. He has published over 30 peer-reviewed journal articles, and is a leading expert on sub-seasonal to seasonal forecasting and diagnostics, and coupled model development. He served as an executive editor of *Climate Dynamics*, and as a member of the World Climate Research Program Working Group on Seasonal to Interannual Prediction.

BRENDA EKWURZEL, PH.D., is Director of Climate Science at the Union of Concerned Scientists (UCS), where she helps ensure that Climate and Energy Program analyses reflect robust climate science. She served as a co-author of the United States fourth National Climate Assessment (NCA4) Volume II (<https://nca2018.globalchange.gov/chapter/29/>). She is lead-author of a publication (bit.ly/GAT_SLR) that was recognized as the 2018 top downloaded

climate article in Springer Climate Journals. Brenda was honored to be named an American Association for the Advancement of Science (AAAS) fellow in 2016 for her “distinguished contributions...and making the science of climate change accessible to diverse audiences.” <https://www.ucsusa.org/about/staff/staff/brenda-ekwurz.html>

TERRY FANKHAUSER was named Executive Vice President of the Colorado Cattlemen’s Association in October of 2001. Fankhauser represents Colorado’s beef cattle industry on state and national issues concerning the future of Colorado’s largest sector of agriculture production. A native Kansan, Fankhauser grew up on a cow-calf operation in the Flint Hills. Fankhauser and his wife Hidi, are actively involved in the fifth generation operation. “I take great pride in the beef industry and making my livelihood from it. The beef industry is not only a business, but a provider of food to the world. Organizations like CCA ensure that this food supply will persevere and that the beef producer’s voice will be heard,” said Fankhauser. Founded in 1867, CCA is the nation’s oldest state cattlemen’s association. CCA serves its members by speaking out on behalf of Colorado’s more than 12,000 beef producers. CCA works closely with state and national legislators, agencies, media and consumers to promote the beef industry.

JOHN FLECK, a former science journalist turned academic, is focused on the problems of the imperiled Colorado River. He is a Professor of Practice in Water Policy and Governance in the University of New Mexico Department of Economics and Writer in Residence at the Utton Center at the University of New Mexico School of Law. He first wrote about water in the 1980s as a beat reporter covering the Metropolitan Water District of Southern California. He is the author of the books *Water is for Fighting Over and Other Myths About Water in the West*, an exploration of solutions to the Colorado River Basin’s water problems, and co-author of *Science Be Dammed: How Ignoring Inconvenient Science Drained the Colorado River*. Erica Fleishman is Director, Oregon Climate Change Research Institute, and Professor, Oregon State University. For the past 30 years, Erica has conducted research on ecological responses to changes in land use, land cover, and climate in the western United States. She also has worked with government agencies and industry on responses of marine mammals to human

activities, and coauthored curricula on applications of remote sensing to ecological modeling. Erica has participated in the science process for management of California’s San Francisco Estuary and in development of multiple Habitat Conservation Plans, which are mechanisms for conservation of private lands consistent with the US Endangered Species Act. Erica is past editor in chief of Conservation Biology and serves on the editorial boards of three international journals.

CHRISTOPHER GOEMANS, PH.D., is a professor in the Department of Agricultural and Resource Economics at Colorado State University. Dr. Goemans holds a Ph.D. in Economics from the University of Colorado. His past academic experience includes serving as a visiting scholar at Victoria University of Wellington, New Zealand and as an adjunct instructor for the University of Colorado at Denver. Dr. Goemans’ research has centered around the following topic areas: the impact of water transfers on regional economies; the relationship between climatic variability, population growth, and the effectiveness of various water management schemes; optimal demand management strategies during periods of drought; and estimating the impact of drought on various economic outcomes.

KATE GREENBERG was appointed to serve as Colorado’s first female Commissioner of Agriculture by Governor Jared Polis in December 2018. As Commissioner, Greenberg provides leadership and direction to the Colorado Department of Agriculture, which serves producers operating more than 38,700 farms and ranches in the state. She is a member of numerous state boards and commissions, current vice president of the Western U.S. Agricultural Trade Association, and secretary/treasurer of the Western Association of State Departments of Agriculture. Commissioner Greenberg is the recipient of the Emerging Conservation Leader Award from Western Resource Advocates and a 2019 Who’s Who In Agriculture honoree. She has worked in and advocated for agriculture for more than 14 years.

MICHAEL GRIMM serves as FEMA’s Assistant Administrator for Risk Management within the Federal Insurance and Mitigation Administration (FIMA). With over 20 years at FEMA, Mr. Grimm has worked to improve coordination, collaboration, and transparency across various levels of

government, to align national mitigation policies on reducing risk, and to create more disaster-resilient communities. Mr. Grimm was appointed to the Senior Executive Service in 2011. Under Mr. Grimm's direction, the Risk Management Directorate (RMD) delivers quality risk data, modeling, and programs that increase the public's awareness of risk from natural hazards. Risk Management programs prioritize federal investments for mitigation and resilience, implement higher codes and standards for federal action, and help communities reduce disaster costs. From 2014 to 2018, Mr. Grimm directed FEMA's pre- and post-disaster mitigation programs, which support sustainable, disaster-resilient communities by helping them avoid or reduce the loss of life and property from natural hazards. From 2011 to 2014, Mr. Grimm directed FEMA's Individual Assistance Division, where he was responsible for a variety of FEMA disaster response and recovery programs. He co-chaired the Mass Care Council and represented FEMA on the Board of Directors for the National Voluntary Agencies Active in Disasters. Before joining FEMA, Mr. Grimm worked with the emergency and floodplain management program in the City of Fort Collins, Colorado; the Wyoming Department of Environmental Quality; and the U.S. Geological Survey's National Research Program.

MICHAEL HANEMANN is a Professor of Economics in the Economics Department and Wrigley Chair in Sustainability at Arizona State University. He is also a Professor of the Graduate School and Chancellor's Professor Emeritus in the Department of Agricultural & Resource Economics and the Goldman School of Public Policy at the University of California, Berkeley. He is an environmental economist who works on the economics of water, the economics of climate change, and the field of nonmarket valuation which he helped create. A Member of the US National Academy of Sciences, he has an undergraduate degree in Philosophy, Politics and Economics from Oxford University, a Master's Degree in Economics from the London School of Economics, and a Ph.D. in Economics from Harvard University.

ANTHEA HANSEN, armed with a BS Degree in Agricultural and Managerial Economics, a minor in English, an MBA, and a farm-girl background, began her career with Del Puerto Water District in 2000, and was named General Manager on March 1,

2014. The District serves 45,000 of highly productive farmland on the Westside of California's San Joaquin Valley. Anthea has led the District and its Landowners through two recent droughts, during which the District received a Zero (0%) allocation from its USBR Contract in three of the last seven years. Her passion for agriculture and desire to protect the multi-generational small family farmers she serves are her daily motivations. Among her greatest joys is being married to a farmer and raising one, as well.

BILL HASENCAMP is the Manager of Colorado River Resources for the Metropolitan Water District of Southern California, where he develops and manages water supply programs to augment Metropolitan's Colorado River supplies. He has been with Metropolitan for 20 years, negotiating transfer agreements with irrigations districts, exchange agreements, and funding new water supply projects which have doubled Metropolitan's Colorado River water supplies since 2003. Bill is one of California's representatives to the Colorado River Salinity Control Forum. Bill's hobbies include long distance bicycle touring, which led him on a three-month bicycle ride across the United States.

DAVID J. HAYES is a Special Assistant to the President for Climate Policy. He is a senior member of National Climate Advisor Gina McCarthy's White House team, which is advancing the Biden administration's climate, conservation, and clean energy priorities. Immediately prior to joining the White House, Hayes was Executive Director of the State Energy & Environmental Impact Center at the NYU School of Law, where he worked with state attorneys general on climate, environmental and clean energy initiatives. He previously served as Deputy Secretary and Chief Operating Officer at the U.S. Department of the Interior for Presidents Barack Obama and Bill Clinton. He was a climate policy advisor for the Biden-Harris Transition in 2020, and led the energy and environmental agency review teams for the Obama-Biden Transition in 2008. Hayes is a former Distinguished Visiting Lecturer at the Stanford Law School; a former Fellow at Stanford University's Precourt Institute for Energy and Woods Institute for the Environment; and the former Chairman of the Board of the Environmental Law Institute. Hayes is a graduate of the University of Notre Dame and Stanford Law School.

RICHARD HEIM is a U.S. Drought Monitor and North American Drought Monitor author who has been involved in drought monitoring and drought research for the last three decades. Mr. Heim is a meteorologist in the Climate Monitoring section of the NOAA National Centers for Environmental Information who has been doing climate monitoring since 1988. In his years with NCEI, Mr. Heim has also managed the 1961–1990 U.S. and Global climate normals project, developed the U.S. snow climatologies, and served as the first program manager for the Climate Reference Network. Recently Mr. Heim has been managing the entire suite of drought products at the NCEI. He has been involved in NCEI’s user engagement activities of the last several years to improve the drought monitoring suite.

ALICE HILL is the David M. Rubenstein Senior Fellow for Energy and the Environment at the Council on Foreign Relations. Hill previously served as special assistant to President Obama and senior director for resilience policy on the National Security Council where she led the development of national policy to build resilience to catastrophic risks. Prior to this, Hill served as senior counselor to the secretary of the U.S. Department of Homeland Security (DHS), in which she led the formulation of DHS’s first-ever climate adaptation plan. Earlier in her career, she was a supervising judge on the Los Angeles Superior Court and chief of the white-collar crime unit at the United States Attorney’s Office in Los Angeles, California. Oxford University Press published her coauthored book, *Building a Resilient Tomorrow*, in 2019. She currently serves on the boards of the Environmental Defense Fund and Munich Re Group’s U.S.-based companies. In 2020, Yale University and the Op-Ed Project awarded her the Public Voices Fellowship on the Climate Crisis. Hill’s new book, *The Fight for Climate After COVID-19*, was published in September 2021.

DR. ANDREW HOELL is a research meteorologist at the NOAA Physical Sciences Laboratory. He researches the predictability and prediction of weather and climate extremes related to water and food security across the globe. Andy co-leads the NOAA Drought Task Force, is an editor of the *Journal of Climate*, and will be an author of the Earth System Processes chapter in the 5th National Climate Assessment.

PATRICE HORSTMAN is the District 1 Supervisor on the Coconino County, Arizona Board of Supervisors. Coconino County is the second-largest county by area in the contiguous United States. Coconino County is home to the Navajo, Hopi, Havasupai, Southern-Paiute Apache, and Hualapai people and includes four national forests, four national monuments, and the Grand Canyon National Park. Supervisor Horstman sits on the National Association of Counties Public Lands Steering Committee, is the elected alternate member for Arizona on the Western Interstate Region and sits on the Four Forest Restoration Initiative Stakeholders group. In 1979, Supervisor Horstman co-founded the law practice of Hufford and Horstman. Over her 45 years in practice, she specialized in Indian law, education law, municipal law, and healthcare law.

KAREN HYUN, PH.D., is the Chief of Staff at the National Oceanic and Atmospheric Administration. Prior to joining NOAA in January 2021, she spent four years at the National Audubon Society where she served as the Vice President for Coastal Conservation, as well as Director of Water and Coastal Policy. Dr. Hyun has championed conservation issues across the Executive Branch, including as the Deputy Assistant Secretary for Fish, Wildlife and Parks at the Department of the Interior; Senior Advisor to the Administrator of the National Oceanic and Atmospheric Administration; Chief of Staff to the Deputy Secretary of Commerce; and Senior Policy Advisor to the Secretary of Commerce. She also served as professional staff and NOAA Sea Grant Knauss Fellow on the Natural Resources Committee in the U.S. House of Representatives. Dr. Hyun received her Ph.D. in Marine Affairs at the University of Rhode Island, and an M.S. and B.S. from Stanford University.

DEANNA IKEYA is a Senior Water Policy Analyst at Central Arizona Project (CAP), focused on implementing policies and programs to protect and enhance CAP’s Colorado River water supply. Her efforts include Basin-wide conservation and demand management programs, implementation of DCP within Arizona, water supply projections and shortage impact analysis, and development and implementation of CAP’s Intentionally Created Surplus program. Deanna’s career spans more than 20 years in water resources. She previously worked for the Arizona Department of Water Resources and Arizona municipalities. Her work has included

groundwater and river system modeling, water conservation, water resources and infrastructure planning and Colorado River water policy projects. Deanna has a Bachelor's Degree in Engineering from the Colorado School of Mines and a Master's Degree in Civil Engineering from Arizona State University.

DR. SARAH KAPNICK, Managing Director, is Senior Climate Scientist and Sustainability Strategist for the Asset and Wealth Management (AWM) Strategy & Business Development organization at JPMorgan Chase & Co. Dr. Kapnick supports AWM's sustainability and climate action efforts and serves as an advisor on new business and investment opportunities and risks. She previously worked at the NOAA Geophysical Fluid Dynamics Laboratory as a Deputy Division Leader on Seasonal to Decadal Variability and Predictability. While at NOAA, her research included seasonal climate prediction, hydroclimate, and climate impacts. Prior to graduate studies, she covered financial institutions at Goldman Sachs. Dr. Kapnick received a Ph.D. in Atmospheric and Oceanic Sciences with a Certificate in Sustainability from UCLA, and an A.B in Mathematics with a Certificate in Finance from Princeton University.

CYNTHIA KOEHLER is an environmental attorney and water policy expert with 20 years of experience working on federal and state water issues and legislation. As Executive Director of the WaterNow Alliance, she leads efforts to help communities build sustainable and resilient water infrastructure projects. She is also in her 4th term on the Marin Municipal Water District in California and is the current board President. Previously, she worked as the Environmental Defense Fund's Legislative Director for California water issues, and the Legal Director for Save San Francisco Bay. She also serves on the Water Education Foundation Board and Sierra Nevada Research Institute Directors' Council and has received numerous awards for leadership on water issues, including the Hero of the Bay Award.

ERIC KUHN is the retired General Manager of the Colorado River Water Conservation District and co-author with John Fleck of *Science Be Dammed: How Ignoring Inconvenient Science Drained the Colorado River*, University of Arizona Press, 2019. Eric started employment with the Colorado River

District in 1981 as Assistant Secretary-Engineer. In 1996 he was appointed General Manager, a position he held until his retirement in 2018. Eric and John's book, *Science Be Dammed*, is about Colorado River hydrology, what we knew, when we knew it, and how we used it to shape the over-allocation of the river under the 1922 compact, the other major provisions of the law-of-the-river, and the projects we have in place today.

KEVIN MORAN directs state and federal water policy advocacy for EDF's Resilient Water Systems program. EDF works in the Colorado River basin work to reverse groundwater depletion, incentivize conservation, and balance supply and demand. In 2018 Kevin represented the ENGO sector on the Arizona Drought Contingency Plan Steering Committee and serves on Arizona's stakeholder committee for the 2026 river operating guidelines. Before joining EDF in 2014 Kevin worked in various public affairs and business roles including 11 years as a Cox Communications executive. Kevin earned a B.A., History, from Brown University, a J.D. from ASU's Sandra Day O'Connor College of Law, and an MBA, ASU Thunderbird School of Global Management. He is based in Phoenix.

CHRIS PERKINS is a Senior Director at the Outdoor Recreation Roundtable, where he works to promote the sustainable growth of the outdoor recreation economy. This work focuses on rural economic development through outdoor recreation, outdoor recreation infrastructure, and building a more inclusive outdoor recreation community. Chris received a Masters in Environmental Management and Masters in Business Administration at the Yale School of the Environment (YSE) and Yale School of Management (SOM). Chris has also worked for the U.S. House of Representatives Natural Resources Committee, Oversight and Investigations Subcommittee. Chris supports Founder Teresa Baker on the Outdoor CEO Diversity Pledge ("The Pledge"), a commitment for outdoor businesses and organizations to improve on DEI efforts. The Pledge now has over 180 corporate and nonprofit partners. He lives in Victor, ID with his wife and dog.

MICHAEL PETERSON is currently the inaugural Deputy Commissioner of the Climate and Sustainability Branch for Commissioner Ricardo Lara at the California Department of Insurance. In this role, Peterson is leading multiple initiatives to

reduce climate risk and increase resilience, including partnering with the United Nations Principles for Sustainable Insurance to develop the California Sustainable Insurance Roadmap, envisioned to pave the way for innovative risk management, insurance and investment solutions that reduce climate risks and protect natural ecosystems. This is the first time the United Nations has partnered with a US state to create a sustainable insurance strategy and action plan. Prior to his current position, Peterson was a policy consultant in the California State Senate, focusing on climate change, natural resources, air quality, and energy policy. Peterson has a background researching biology and physiology, earning a PhD in Environmental Science, Policy and Management from the University of California, Berkeley, and a Masters degree at Western Washington University.

JON RADTKE is the Water and Agriculture Sustainability Program Director for Coca-Cola North America. In this role, he manages the company's water stewardship and sustainable agricultural ingredient sourcing programs, which assess and mitigate water and supply chain risks facing Coca-Cola operations, with an emphasis on creating business value. Primary areas of focus include water conservation in manufacturing, source water protection, community water partnerships, sustainable agriculture initiatives, and marine litter strategies. Mr. Radtke's leadership has helped to position The Coca-Cola Company as an industry leader in water stewardship. Jon holds a B.S. degree in Geology and a M.S. in Hydrogeology with 30 years of professional experience in sustainable resource management.

PHIL SAKSA is Chief Scientist and Co-Founder at Blue Forest and has a background in ecosystem services and watershed management. At Blue Forest, Phil manages research partnerships to quantify the environmental and economic benefits of ecosystem restoration projects, supports the development of Forest Resilience Bonds, and informs state and federal policy efforts in conservation finance.

WILL SARNI is an internationally recognized thought leader on water strategy and innovation. He was ranked as; A Key Player Pressuring Businesses to Care About Water and one of the Top 15 Interviews In Smart Water Magazine 2019. He has been a sustainability and water strategy advisor

to multinationals, water technology companies, investors and nongovernmental organizations for his entire career. Will has written numerous books and articles and continues to present on subjects such as the value of water, innovations in digital water technology, the circular economy, and the energy–water–food nexus. Will is The Founder and General Partner of the Colorado River Basin Fund is the first placed-based water-focused investment fund in the United States. The Colorado River basin Fund is a private equity fund which seeks to invest in technologies addressing water scarcity and quality issues in the basin.

ISLA SIMPSON is a Scientist 2 in the Climate and Global Dynamics Laboratory at the National Center for Atmospheric Research. Her research focuses on understanding the dynamics behind climate variability and change and in assessing the ability of Earth System Models to accurately simulate the climate system.

MORGAN SNYDER is a Senior Program Officer for the Walton Family Foundation's Environment Program with a focus on the Colorado River Basin. He joined the Foundation in 2010 and is based in Washington, DC. In his role, he develops and refines internal strategy, identifies grantees, makes resource decisions, and supports program evaluation. He received a Masters degree from Uppsala University's Peace and Conflict department with a focus on international freshwater policy and a Bachelors degree from Sonoma State University in environmental conservation and restoration. He grew up in Santa Cruz, California.

APPENDIX C: PARTICIPANT LIST

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APPENDIX D: PRE-FORUM SURVEY RESULTS

BACKGROUND

In early July, the NIDIS Program Office launched a survey to the greater community to inform agenda formulation for the September 21–22, 28–29 SW Virtual Drought Forum. The survey was posted on the Forum website and also distributed widely to the entire community of individuals, organizations and institutions across the nation. Results were analyzed to inform the Forum agenda, and it remained open after the Forum until October 01, 2021, collecting a total of 44 responses.

The survey questions were:

1. Do you plan to attend the Drought Forum?
2. What state are you from?
3. What organization/company/agency are you from?
4. What is your role within the organization/company/agency?
5. Drought is generally defined as “a deficiency of precipitation over an extended period of time (usually a season or more), resulting in a water shortage.” Do you think that this definition of drought is adequate to describe what is currently happening?
6. What is your primary concern related to the Southwest drought?
7. Based on the drought-related activities and actions you are aware of to address the drought situation, what steps are NOT being taken that would help address drought in your region (at the local, state, Federal, tribal, or business level)?
8. What is your community or sector’s biggest obstacle to managing for current drought conditions and achieving meaningful long-term drought resilience (at the local, state, Federal, tribal, or business level)?
9. If drought conditions persist in the region with little improvement, do you think your community is prepared today to adapt?

This report summarizes the survey results by question.

PROFILE OF SURVEY RESPONDENTS

A total of 44 individuals responded to the survey. Of the total respondents, 15 planned to attend all of the Forum and 27 planned to attend at least partially.

Respondents represented a total 16 states with 30 respondents from Southwestern states. They represented the following organizations and sectors:

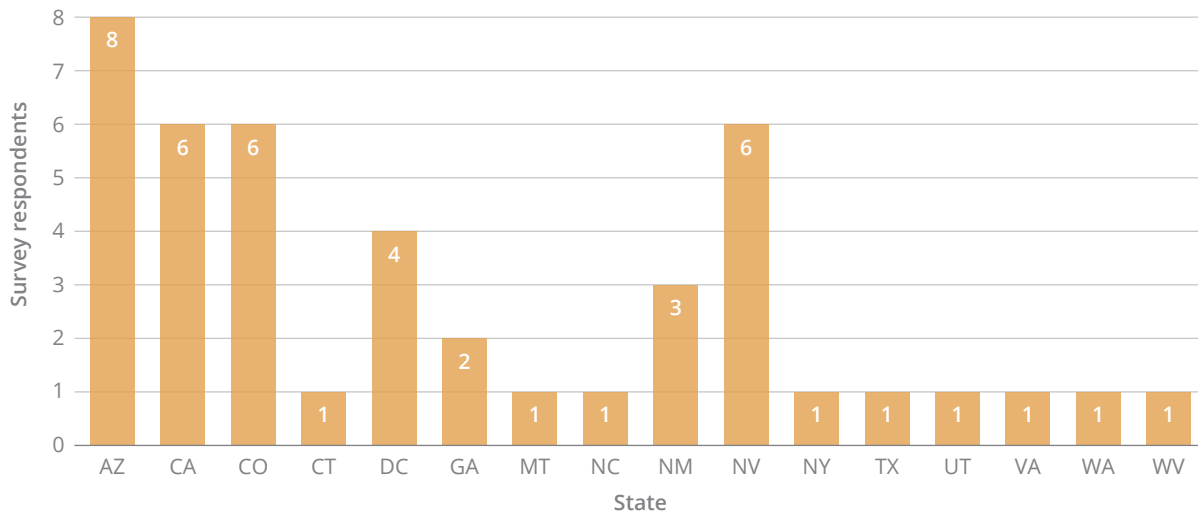
- Federal Agencies (13)
- State Agencies (9)
- NGOs (8)
- City/County Governments (6)
- Academic Institutions (3)
- Private Sector (2)
- U.S. Congressional Offices (2)
- Tribal Community (1)

A diversity of roles in organizations were represented by survey respondents including:

- Program and Project Management and Coordination (15)
- Academia, Research, and Science (11)
- Senior Leadership (10)
- Outreach and Communication (5)
- Policy (3)

At least half of the respondents were decision-makers within their respective organizations.

What state are you from?



IS THE DEFINITION OF DROUGHT ADEQUATE?

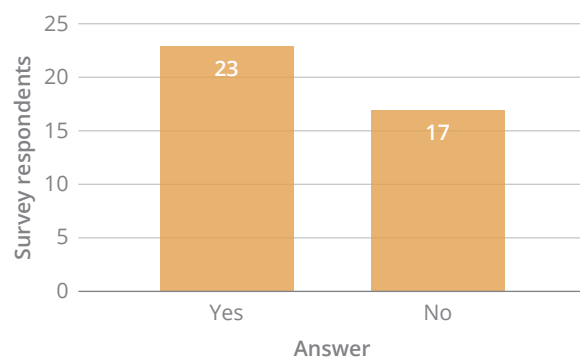
When provided the current general definition of drought “a deficiency of precipitation over an extended period of time (usually a season or more), resulting in a water shortage” and asked if this is still adequate to describe what is currently happening, only two individuals concurred with the current definition.

Alternatively, the remaining respondents offered the following concepts as additional factors required to adequately define the current drought state:

- Aridification
- High evapotranspiration
- New normal conditions in the Southwest
- Thermodynamic aspects
- The role of warming temperatures, declining snowpacks, increased winds
- Impacts of long duration of deficiency and resulting demand on models
- Megadrought
- The definition is location dependent – simple “drought” is not adequate.
- Incorporate coinciding environmental/climate factors contributing to water shortages.
- Recognize the dynamic nature of drought to understand drought.
- Drought is much more than precipitation deficit. It included high temperatures and mismatch between water demand/supply.
- It needs to address impacts ranging from agricultural to social.
- It must reflect a co-mingling of precipitation and temperature.
- The term should define the common good of understanding and build on complexity.

Drought is generally defined as “a deficiency of precipitation over an extended period of time (usually a season or more), resulting in a water shortage.”

Do you think that this definition of drought is adequate to describe what is currently happening in your community?



AGREE

- It could be a little more nuanced, but without getting to complex or specific this is a good starting point.
- Yes, over the years our rainfall has declined. We are currently working with our water supplier (EPCOR) as well as working to complete the Ute water project.

DISAGREE, THE DEFINITION SHOULD ACCOUNT FOR:

Definition Is Location Dependent and Simple “Drought” Is Not Adequate

- Defining drought is difficult since it is location dependent. So “less precipitation than normal” when the public doesn’t know normal is challenging. Also, drought implies temporary and a return to normal, so the ongoing public conversation about “aridification,” “mega-drought,” “long-term drought,” is necessary. Simple “drought” doesn’t adequately describe western water of the last two decades.
- That definition seems to suggest that droughts will end and hydrology will return to what

is was before. But hydrologic conditions are constantly evolving and what we think of a drought today might be normal tomorrow.

- Deficient precipitation could be occurring; however different watersheds may have differing results in whether this results in a water shortage or the timing of potential shortages.
- While overdraft of groundwater aquifers is an issue all over California, in the Central Valley (Sacramento and especially San Joaquin River valleys) groundwater pumping is increased greatly during drought.

New Normal Conditions

- Droughts are usually defined as a deficiency of precipitation compared to normal conditions, and are usually temporary. The Southwest is re-establishing a new “normal” condition.
- That definition seems to suggest that droughts will end and hydrology will return to what is was before. But hydrologic conditions are constantly evolving and what we think of a drought today might be normal tomorrow.
- Occurring in Eastern Washington.

Comingling of Precipitation and Temperature

- Comingling of precipitation and temperature.
- Heat and evaporative demand are a factor.
- I think that temperature also needs to be factored into it.

Role of Warming Temperatures, Decline Snowpacks, and Increased Winds

- We need to include role of warming temperatures, decline snowpacks, increased winds in the definition, e.g., ecological and hydrological droughts, warm vs wet droughts, etc.
- Needs to incorporate temperature anomalies as well, which is becoming an increasing driver making droughts more severe.

Aridification

Drought has been on-going, as we have defined it. However, I think a more accurate term is aridification—strong evidence that we have entered a condition of a permanently drier climate.

High Evapotranspiration

It does not take into account the high evapotranspiration which is making the drought worse and exacerbating wildfire risk.

Thermodynamic Aspects

I think the thermodynamic aspects should be considered too. The clearest signal of anthropogenic climate change is in the vapor-pressure deficit resulting from warming of the atmosphere which will lead to increased evaporative demand and seems like it should be a factor that is considered.

Impacts of Long Duration of Deficiency and Resulting Demand on Models

The deficiency has extended for such a long duration (20 years) that the consecutive deficit in precipitation 18 out of past 21 years has created such dry conditions that the ET and seepage losses along River appears to have greatly increased well beyond the normal and poses a new demand that current models do not appear to adequately address.

Megadrought

Historically, drought has been very difficult to define due the many sectors impacted, its many forms (meteorological, hydrological, agricultural, socioeconomic, ecosystem), and time scales (slow development of drought vs. flash droughts). Plus complications arising from climate change/global warming altering characteristics of drought. The Southwest (and West in general) are in a major drought episode and may be in a megadrought.

Incorporate Coinciding Environmental/Climate Factors Contributing to Water Shortages

The definition could be improved to incorporate coinciding environmental/climate factors that contribute to water shortages like extreme heat, high evapotranspiration rates during precipitation, and forest conditions affecting headwaters snowpack and runoff.

Understand the Dynamics Understanding of Drought

Water shortages come from an imbalance of demand and supply across both sides of the system. Supply is much more than precipitation, and should include snow and ice pack,

groundwater, grey water, and desalination. Similarly demand is moderated by all kinds of intervening factors. Western water is moved across regions according to specific institutional arrangements (water rights, operational rules, interstate compacts, etc.). Those are altered all the time to change point of demand, as well as localized changes in consumption patterns, technologies, behavior, and other aspects of human water use on the demand side. So demand is not static and today's water uses are not necessarily tomorrow's. I doubt this is what you were looking for, but I prefer more dynamic understandings of drought.

Much More Than Precipitation Deficit— High Temperatures and Mismatch Between Water Demand/Supply

There is definitely a precipitation deficit, but there's much more to it. For example, we're seeing

high temperatures playing a significant role, as well as some pretty significant mismatches between customary water demand and supply.

Needs to Address Impacts Ranging from Agricultural to Social

It's insufficient in addressing the potential impacts, ranging from agricultural to social.

Defining the Common Good of Understanding and Build on Complexity

You need to start with a basic explanation for the common good of understanding. From there you can build on the complexity of what drought might mean outside and beyond the basic definition.

PRIMARY CONCERNS RELATED TO THE SOUTHWEST DROUGHT

The survey solicited respondents' primary concerns related to the Southwest drought. Responses fell into the following two categories of concerns: understanding the impacts and preparing for the future with innovative solutions.

Understanding the Impacts of Drought and its Related Components:

- Understand and keep current on the impacts of drought (9)
- Understand the viability of sector-based activities. (8)
- Determine long-term water availability. (6)
- Increase community access to water. (6)
- Understand drought and wildfire. (2)

Preparing for the Future and Developing Innovative Solutions:

- Engage in collaborative decision-making and solutions. (5)
- Apply mitigation alternatives and preparation strategies/action. (5)
- Apply Lessons learned for sharing and to promote behavior change. (4)
- Expand activities in planning, monitoring, and response. (3)

UNDERSTANDING THE IMPACTS OF DROUGHT AND ITS RELATED COMPONENTS

Understanding and Keeping Current on the Impacts of Drought

- Understanding the impacts of drought.
- That the consequences might be more extensive and further reaching than we currently

widely acknowledged. For example, feedbacks between drought and heat waves seem to have taken people by surprise, as have the potential for power shortages.

- Keeping current on information about resilience.
- The likelihood of drought with these characteristics and drought in a changing climate
- Status updates and where we go from here.
- My primary concern is that the current drought condition in the new normal, and future droughts might be much worse.
- Changing the nature of hazards NWS deals with including mega-wildfires, smoke prediction, flood risk, and water supply forecasts.
- Learn more about potential shortages and impacts.
- Water levels in the Colorado River.

Viability of Sector-Based Activities

- Impact on tribal agriculture, health, cultural resources.
- The long-term viability of current activities, including farming, ranching, and energy production.
- Short- and long-term impact on public health and resources.
- Short- and long-term public health consequences.
- Responsiveness of waivers for ranchers to let land be ungrazed during drought.
- Agriculture and population growth are at odds with one another over water use and need. During the last ten years many new almond trees (which are a highly valuable crop but use a lot of water) were planted in the Central Valley.
- Long term availability of water for all sectors.
- Long-term resilience (economically, environmentally, and for human populations).

Long Term Water Availability

- Water supplies.
- Longevity.
- Permanent drying / aridification.

- The Southwest (and West in general) are in a major drought episode that has lasted two decades so far. With global warming/climate change altering the hydrology of the West, they may be in a megadrought which will last far longer.
- Less precip or more precip—and a changing “normal” cycle.
- Less water available in streams.

Community Access to Water

- Making sure that we are able to supply and supplement our current water supply to provide water to our community.
- Dependable water resource over a long period of time.
- Water supply issues and more people living and recreating here.
- My primary concern is the impacts on water supply (groundwater and surface water) at different scales—from small water providers (including residents who get water from their own well) to large water providers. The constant minimal or lack of precipitation throughout Arizona has a great impact on water supply recharge, which represents a great challenge.
- Insufficient water to meet the needs of people, particularly vulnerable communities, and reasonable environmental resilience.
- I am concerned about drought across the Nation—not just the Southwest. I view drought as a long-term issue—which may substantially impact many communities across the Nation.

Wildfire

- Wildfire risks
- Wildfire.

PREPARING FOR THE FUTURE AND DEVELOPING INNOVATIVE SOLUTIONS

Collaborative Decision-Making and Solutions

- That we need to accelerate collaborative decision-making on water conservation to

match the rapid pace of declining Colorado River supplies.

- A lack of interest by governing bodies in regional solutions that do result in enforce one-size-fits-all regulations/actions
- Transboundary water demands on the Colorado River. Ties with water demand and drought contingency planning.
- Colorado River water supplies and the management of those resources.
- The limited options available to water managers once a drought situation reaches a critical status.

Mitigation Alternatives and Preparation

- Drought mitigation alternatives, preparation
- Current infrastructure and community resilience unprepared for 21st century climate changes ahead.
- Helping the public to understand it and the actions they will need to take to have a more resilient community if the drought continues.
- Drought also builds a public complacency to weather hazards due to decreasing frequency which is a problem when we do eventually get major storms or floods.
- We have not built enough current infrastructure to accommodate the competing demands for limited resources.

Lessons Learned for Sharing and Behavior Change

- Drought occurs in the northeast US less frequently than in the southwest but there are lessons to be learned and shared relevant to drought experiences in both regions.
- That we are not using today's lessons to adequately prepare for the future.
- How can we apply what we know right now to address the drought conditions, what don't we know and where are the research needs and gaps, how can we increase communication and synergy of all of the efforts going on in the SW to benefit from one another.
- Long term recovery and return to business as usual when it is over

Planning, Monitoring, Response

- Drought planning, monitoring, and response for drought resiliency now and in the future.
- Contingency Planning and shortage sharing alternatives and compliance with River compacts.
- My primary concern is that moving forward, the thermodynamic drivers of drought are only going to get more intense. I think in terms of precipitation, we don't need to worry so much, we don't have clear evidence that 2020 was part of a longer term forced trend. But this is not true for temperature or VPD.

GAPS IN ADDRESSING DROUGHT

In response to the question of drought related activities or actions that are NOT being taken to address drought in your region at the local, state, federal, tribal or business level, themes for unmet needs emerged with solutions for the way forward offered related to community engagement and coordination, enhanced federal/state/regional solutions and a more proactive approach to facing and acting on the new reality.

Community Engagement and Communications:

- Invest in community engagement where understanding and action needs to be enhanced.
- Identify long-term solutions/adaptation and communicate to the public.
- Increase tribal understanding of impacts and resilience strategies.

Federal/State/Regional Solutions:

- Accelerate deployment and enable taking advantage of federal resources.
- Provide Federal/state support for creative water management solutions.
- Reduce reliance on the U.S. Drought Monitor for agricultural payments.
- Reduce dependence on the Ute project for community water supply.
- Leverage drought mitigation grants for long-term resiliency.
- Increased financial/social support for land management solutions to build resilience.
- Provide more financial incentives to reduce water consumption and incentivize water efficiency.
- Implement Federal improvement of drought prediction for local scales to inform planning and mitigation.
- Increase Regional water trading and sharing agreements.

A Proactive Approach Facing the New Reality:

- Expand monitoring activities.
- Reach consensus on science and projections for Colorado River operating guidelines.
- Place more emphasis on long-term planning, mitigation, adaptation and resilience.
- Apply a multi-level approach with shared objectives to increase “on the ground” impacts.
- Assess and communicate drought health risks.
- Implement impactful agricultural solutions for sustainability.
- Provide more focused local level solutions and actions on conservation and land use.
- Apply proactive management support for community leaders.
- Advance wastewater reuse initiatives.
- Shift focus from drought to aridification.
- Apply a national approach for desalinization.
- Implement lessons learned from the current situation for the future to accurately represent the risk of future drought.

BEING PROACTIVE FACING THE NEW REALITY

Expand Monitoring Activities

- Expand monitoring on tribal lands to get better estimate of drought conditions.
- Second, insufficient monitoring of groundwater–surface water interaction.
- First, insufficient monitoring network of snowpack.
- More robust monitoring systems would help.

More emphasis on Long-Term Planning, Mitigation, Adaptation and Resilience

- There needs to be a more consistent message for long-term mitigation and adaptation, rather than a focus on temporary relief measures.

- Research knowledge (science) is not always being used or tapped to provide solutions because those solutions are not always clear cut in how to make landscapes resilient.
- Pre-planning on growth of cities and towns to stop growth when water supplies are not sufficient. For example why let a development mover forward or build new businesses and homes when water supplies are critically over drafted.

More Focused Local Level Solutions and Actions on Conservation and Land Use

- Generally more focused on local level: land use guidelines to help increase fire safety (noncombustible zone, ember-resistant zone) which also helps to reduce the amount of plantings that require water.
- Requirements around types of plantings and irrigation systems to decrease the overall amount of water required.
- More needs to be done to encourage water conservation in cities, especially in terms of landscaping.

Proactive Management Support for Community Leaders

- While proactive management is present throughout state and private sectors, there is a need for community leaders who work with stakeholders on preparing for drought impacts before they happen on a local scale. Different agencies may put together tools to empower stakeholders and aid in this level or organization and preparation.
- Vulnerability studies would help target where assistance/what kind of assistance is needed.

Assessment and Communication of Health Risks

- Assess and communicate health risks and impacts of drought.
- Green infrastructure.

Impactful Agricultural Solutions for Sustainability

- Allowing for removal of livestock from the land base to protect it and the natural resources

- Why allow farmers to drain groundwater without controls? The sustainable groundwater Management Act encourages sustainability in areas already seriously over drafted. Issues with drinking waters wells drying due to overdraft, pollution increasing in well waters, and other issues abound.

Reach Consensus on Science and Projections for Colorado River Operating Guidelines

Clear consensus on using the best climate science and related hydrologic projections, in making new plans for Colorado River operating guidelines.

Need for a Multi-Level Approach with Shared Objectives

We are not yet seeing the kind of attention and resources required to achieve a necessary level of investment in long-term water use efficiency and reuse at local, state or Federal levels (I am not well situated to opine about whether this is occurring at tribal and business levels).

Wastewater Reuse

Increased wastewater reuse.

Shift focus from Drought to Aridification

Move discussion from anticipating impacts from just “drought” (which implies a finite duration) to “acidification” (which implies a lost-term change in state for the region).

National Approach for Desalinization

We need to address source of water, including determining whether or not the Nation should be embarking on more desalinization plants. It is not clear who has pre-eminent responsibility for desalinization plants, which should be a strategy going forward.

Lessons learned from Current for the Future and Accurately Representing Risk of Future Drought

Adequately representing risk of future drought conditions; not using current conditions to learn for the future

FEDERAL/STATE/ REGIONAL SOLUTIONS

Accelerate Deployment and Taking Advantage of Federal Resources

- Accelerated planning to deploy new federal resources wisely to benefit the basin.
- Federal agricultural assistance programs do not seem to be taken advantage of
- Streamline approval processes.

Federal improvement of Drought Prediction for Local Scales to Inform Planning

- Federal coordination and improvement of drought prediction for more local scales to allow for more information to drive resilience planning. If “drought” is the new normal, is it still drought
- Conducting economic analyses would help tell the story.
- Improved seasonal and sub-seasonal weather forecasts. From my perspective there is not a lot of progress being made here, even though there is a tremendous benefit across the drought and water supply enterprise.

Federal/State Support for Creative Water Management Solutions

- Third, Federal and State support for creative water management solutions including water transfer agreements between irrigators, municipalities, Tribes etc.
- Build more storage and conveyance.

More Financial Incentives to Reduce Water Consumption and Incentivize Water Efficiency

- Tax or other financial incentives to reduce water consumption or incentivize innovative water efficiency solutions for both municipal and agricultural uses. Protection and support of water rights holders voluntarily reducing usage—not enforcing a “use it or lose it” mentality during drought.
- State water law has not changed in a way that incentivizes more efficient practices.

Reduce Reliance on Drought Monitor for Agricultural Payments

Reduce reliance on the Drought Monitor to decide agricultural payments to farmers/ranchers.

Dependence on the Ute Project for Community Water Supply

We are depending on the Ute project to help supply water to our communities, under our agreement the State supplies 15% funding the Federal government provides 75% and the communities that are involved supply 10% of the funding.

Leverage Drought Mitigation Grants for Long-Term Resiliency

Leverage resources/grants for drought mitigation projects for long term drought resiliency.

Increased Financial/Social Support for Land Management Solutions to Build Resilience

Increased financial/social support for changing land management aligned with healthy soil principles to build resilience.

Regional Water Trading and Sharing Agreements

Building larger scale regional water trading and sharing agreements; incentivizing water reuse and conservation.

COMMUNITY ENGAGEMENT AND COMMUNICATIONS

Invest in Community Engagement

- Significant investment in community engagement of key stakeholders, opinion leaders, etc.
- More interconnected discussion forums with actual action steps to connect efforts.

Identify Long-Term Solutions/Adaptation Communicated to Public

Identifying long term solutions/adaptation, even if these are being addressed/discussed, they are not being communicated to the public.

Increase Tribal Understanding of Impacts and Resilience

Include Tribal understanding of drought impacts and resilience.

BIGGEST OBSTACLES

With a multiple-choice question, the following challenges were indicated as the biggest obstacles to managing for current drought conditions and achieving meaningful long-term drought resilience. The number of respondents is indicated in parentheses for each obstacle.

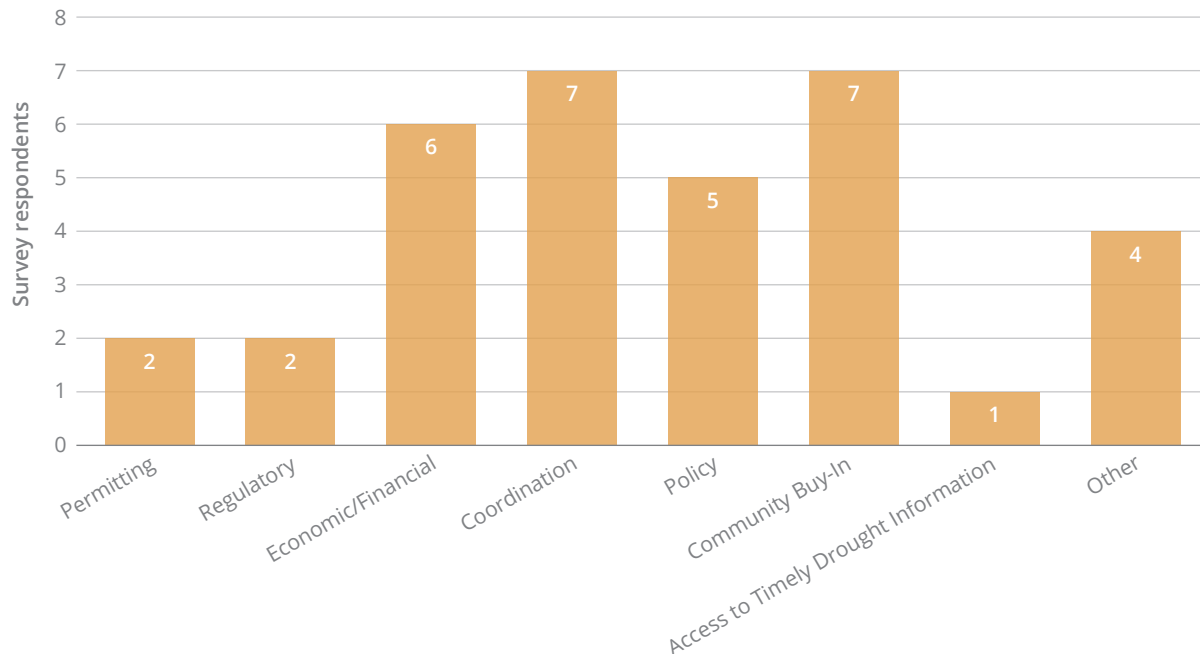
- Coordination (7)
- Community Buy-In (7)
- Economic/Financial (6)
- Policy (4)
- Permitting (2)
- Regulatory (2)
- Access to timely drought information (1)
- Other (4)

OTHER COMMENTS

Federal/State/Local Coordination

- Coordination between federal, state, local entities and water managers could be improved; integrated task forces/workgroups would be helpful in relaying on-the-ground experiences to policy makers.
- Local level: Small Community Water Systems (provide water to residents) throughout Arizona face challenges preparing for shortage conditions, sometimes this may be tied to the lack of understanding of the impacts of drought on water supply.
- At the Federal level, coordination of existing programs and assets can be difficult.
- Working at a state level, local communities have different attitudes towards drought

What is your community or sector’s biggest obstacle to managing for current drought conditions and achieving meaningful long-term drought resilience (at the local, state, Federal, tribal, or business level)?



Farming and Livestock Grazing

- Livestock owners seeking political assistance to keep livestock grazing without considering the destruction of the land base and its natural resources
- Farmers provide billions to the state's economy. Little regulation of what farmers use in terms of water has been applied.

Federal Level Action on Climate

We must take bold action on climate at the federal level, to eliminate greenhouse gasses as fast as possible and make other clean energy and resilience investments, to meet the scale and urgency of our western water challenges.

Long-Term Funding

Continue to fund this important project

Permit Timelines

Unreasonable timelines to complete permits to address water shortages such as aquifer storage and recovery, reclaimed water, etc. Opponents with no standing (water rights) are able to derail the permit process.

Finer Spatial Resolution

As a U.S. Drought Monitor author, timely drought information, with a finer spatial resolution than what currently exists and a better focus on the

water demand component of the drought equation (e.g., evapotranspiration), is crucial.

Better Hydro Data

Better hydro data is also important (groundwater, soil moisture, reservoir, snowpack).

Ecological Descriptions and Impacts

- Focus on managing to ecological site descriptions that do not account for future changes in the mean and variance of climatic conditions
- Ecological impact to traditional resources on tribal lands.

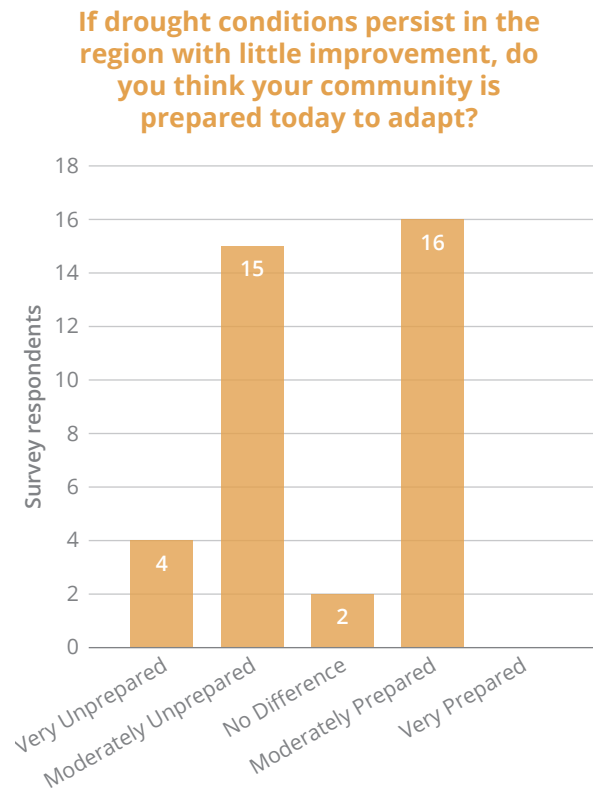
Increase Home/Business Understanding of Water Use

- Most homes and businesses don't understand their water use, nor the impact on water sources. Lots of local government buy-in and support but it's at the individual homeowner level to collectively make a difference in reducing overall water use.
- Everyone will have to sacrifice something to ensure a stable water supply for the long haul.
- Preparation for Wildfires and Impacts
- The biggest thing is preparing for more frequent intense, large wildfires and their impacts including prolonged smoke episodes.

COMMUNITY PREPAREDNESS

The last survey question asked if drought conditions persist in the region with little improvement, whether respondents think that their community is prepared today to adapt. The results were that about half of the respondents feel unprepared or moderately unprepared while the other half feel moderately prepared. The stark reality is that not even one respondent indicated “very prepared”.

- Very unprepared (4)
- Moderately unprepared (15)
- No difference (2)
- Moderately prepared (16)
- Very prepared (0)



CONCLUSION

While the survey response rate was small, the messages clearly indicate the need for a more proactive approach beginning with an acknowledgement of a new normal for Southwest drought. Many solutions and strategies were offered to be considered at all levels to work collaboratively to advance toward a state of resilience for impacted areas.

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