# NIDIS Annual Report 2024

# THE ECONOMICS OF DROUGHT

Water powers the U.S. economy. All sources of energy require water in their production processes, and energy is required to extract, convey, and deliver water. Manufacturers use water for many processes, including fabrication, processing, washing, diluting, cooling, and transporting goods. Water is also often incorporated into products themselves. High volumes of water are used in the production of food, paper, and chemicals and in the refining of petroleum. Our rivers carry our crops and products to sell to other parts of the country and around the world. And our crops, livestock, and of course us, require water to grow and exist in the first place.

Drought reduces the availability of water. But the earlier we know a drought is coming, the earlier we have time to prepare. The more we understand a drought's impacts, the more we can mitigate them. The sooner we know a drought may end, the sooner we can prepare to plant crops, produce energy, and transport goods.

NIDIS is on a mission to make this happen.

**Southeast Boise wildfire in October of 2024. Shutterstock: CSNafzger**

# OUR MISSION

NOAA's National Integrated Drought Information System (NIDIS) mission is to maximize the nation's ability to proactively manage drought related risks by providing those affected with the best available information and resources to assess the potential for drought and to better prepare for, mitigate, and respond to the effects of drought.

***Toward that end, NIDIS is developing a drought early warning system for the Nation.***

**Lettuce Field in Salinas Valley, California. Shutterstock: Ken Wolter**

## OUR PARTNERS AND THE PUBLIC MADE THIS POSSIBLE IN 2024...

Our regional Drought Early Warning Systems (DEWS) served **43 STATES** and **17,817 STAKEHOLDERS** through webinars, workshops, and email communications.

We provided more than **$6.6 MILLION** in funding for research projects to advance drought science and preparedness across the nation.

Our award-winning website, drought.gov, served more than **1.3 MILLION** users who viewed **2.9 MILLION** pages seeking the latest drought conditions, outlooks, and impacts.

Information from Drought.gov was used **584 TIMES** by local & national media outlets in their reporting.

**14,876 PEOPLE** are subscribed to our drought alert emails for locations across the U.S.

Our X community grew to more than **14,200 FOLLOWERS** while our Facebook community passed **4,200 FOLLOWERS**.

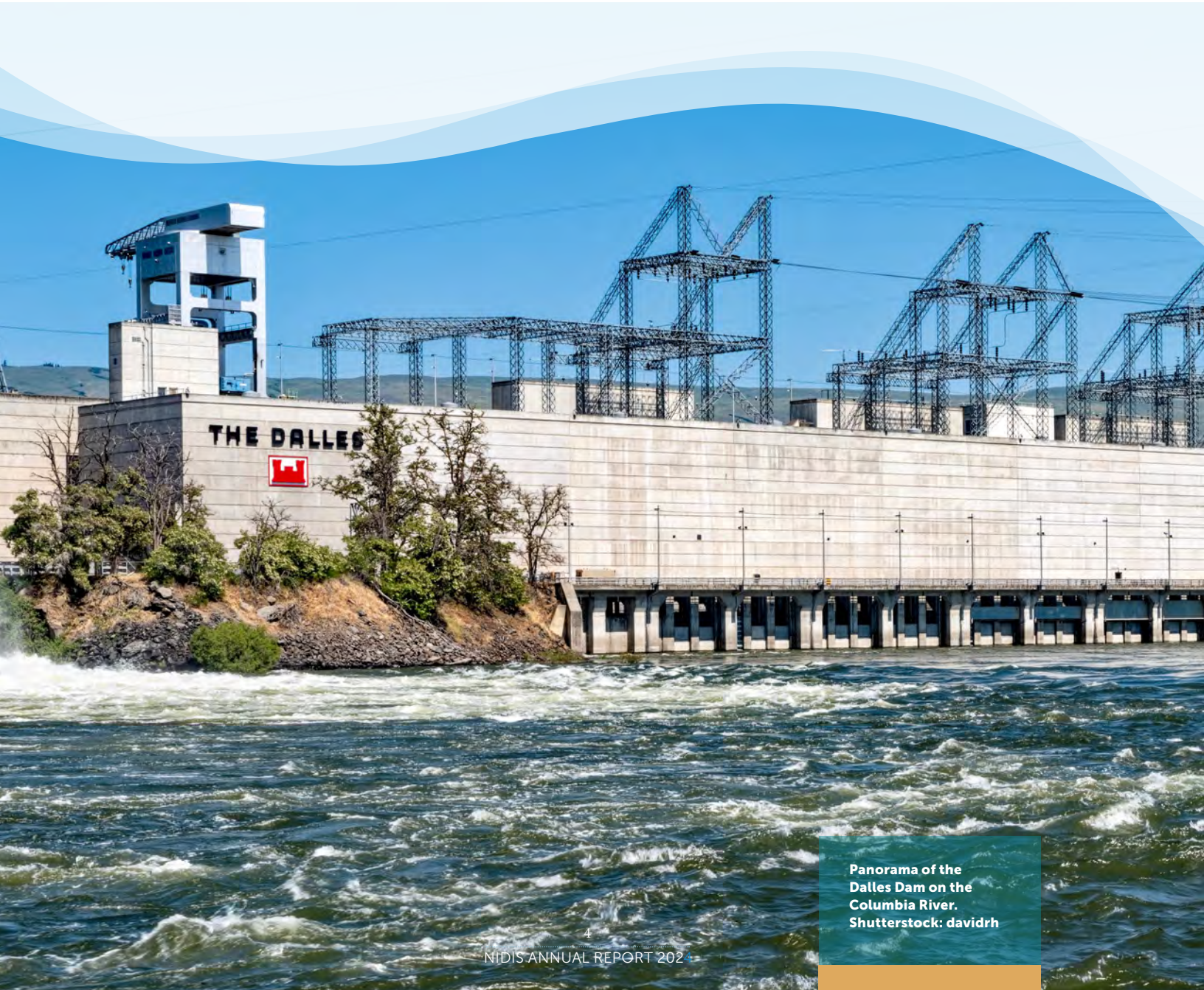
We launched a NIDIS Instagram account in 2024 and ended the year with over **650 FOLLOWERS**.

We held **62 WEBINARS AND WORKSHOPS,** delivering the latest drought updates and research to thousands of viewers.

More than **5,700 SUBSCRIBERS** received each issue of Dry Times, our bi-weekly newsletter.

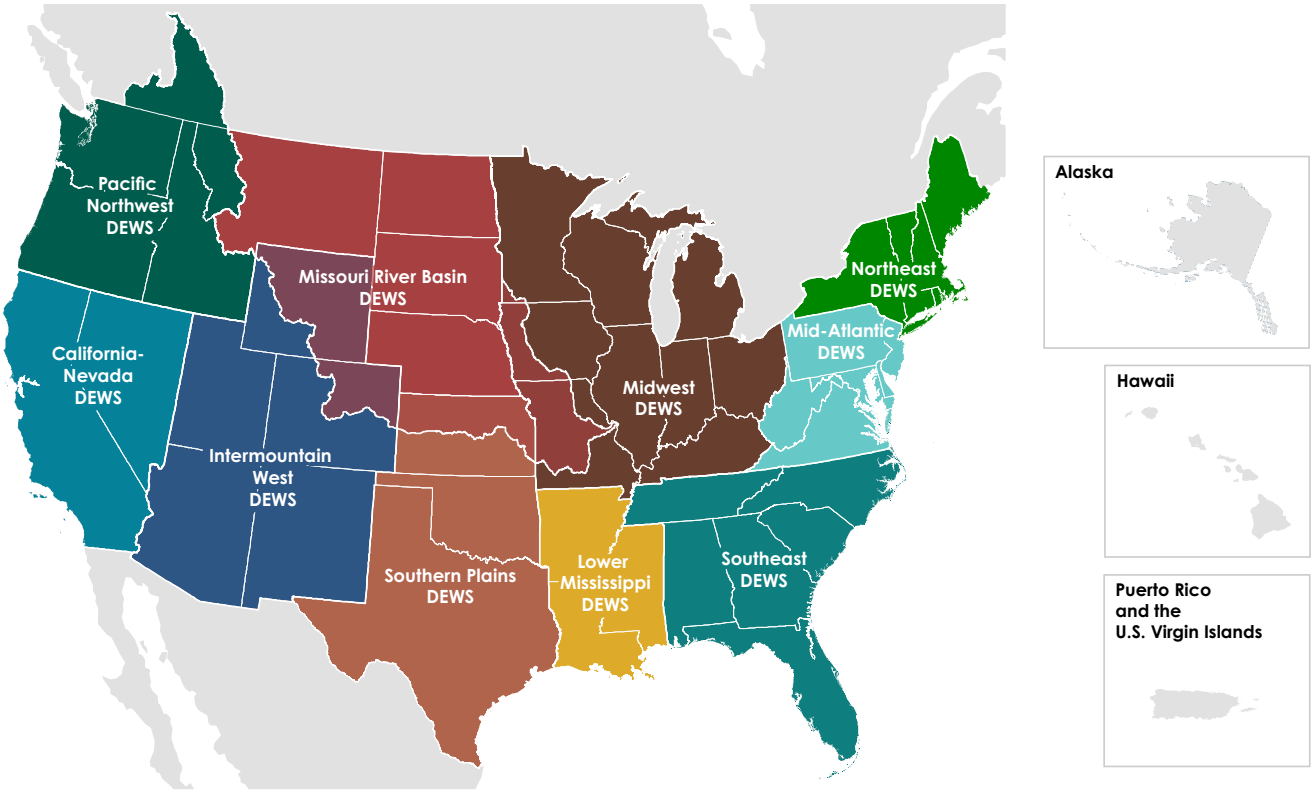
# BUILDING A NATIONAL DROUGHT EARLY WARNING SYSTEM

The 2006 NIDIS Public Law prescribed a comprehensive, interagency approach for drought monitoring, forecasting, and early warning planning and preparedness to help states and local communities cope with the impacts of drought. The law called on NIDIS to develop and provide a national drought early warning system (DEWS).




**Panorama of the Dalles Dam on the Columbia River. Shutterstock: davidrh**

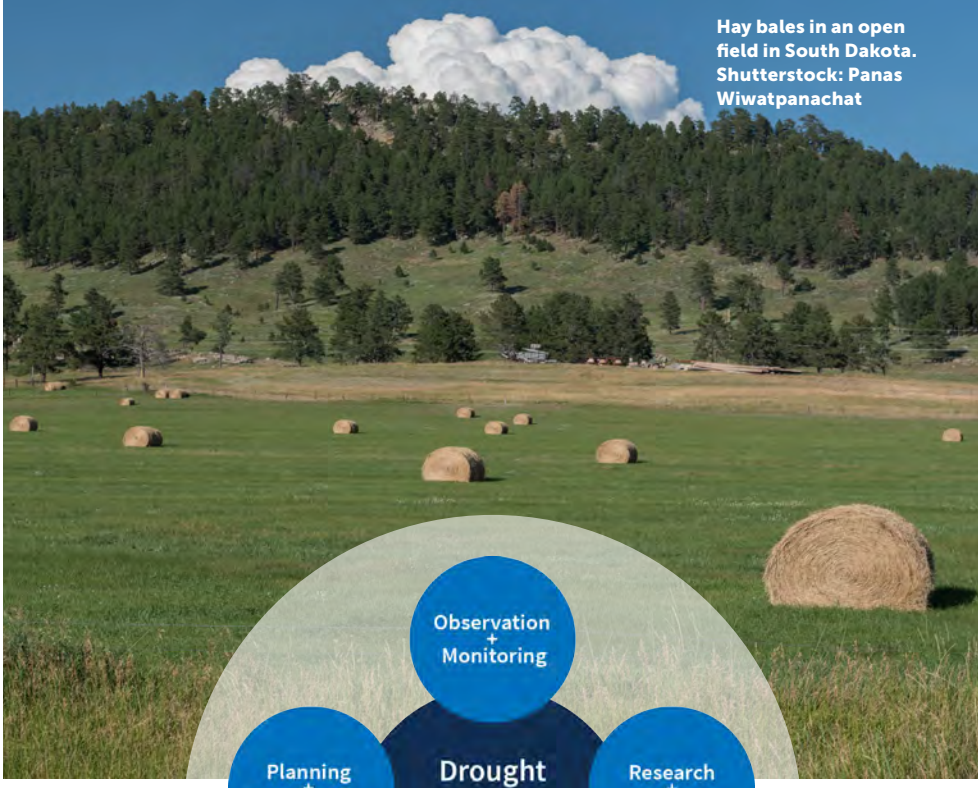
## National Integrated Drought Information System Drought Early Warning Systems (DEWS)




Map of all 8 DEWS regions, plus planned future DEWS (Mid-Atlantic and Lower Mississippi) in the United States, as well as other investment areas.

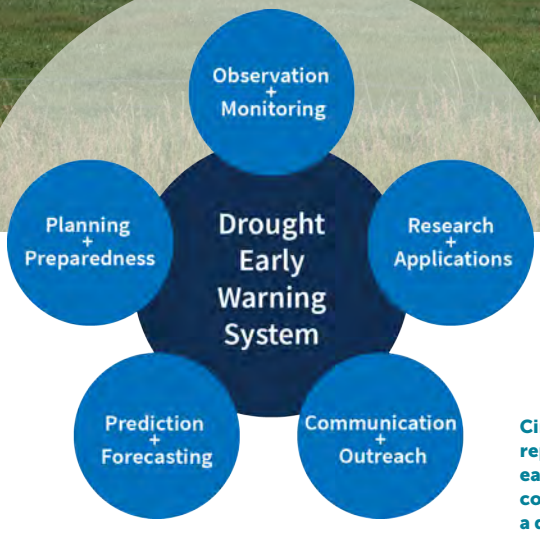
The 2006 NIDIS Public Law prescribed a comprehensive, interagency approach for drought monitoring, forecasting, and early warning planning and preparedness to help states and local communities cope with the impacts of drought. The law called on NIDIS to develop and provide a national drought early warning system (DEWS). Given the diversity of drought impacts, predictability, and stakeholder needs across the Nation, and the need to leverage the capabilities of partner agencies on the ground, NIDIS has taken a regional approach since its inception. Around the country, eight regional DEWS:

| | |
|---|---|
| 1 | Support rich networks of researchers, academics, resource managers, and decision-makers who share information and actions that help communities cope with drought. |
| 2 | Integrate five key components of a drought early warning information system: (a) interdisciplinary research and applications; (b) predictions and forecasting; (c) observations and monitoring; (d) planning and preparedness; and (e) communication and outreach. |
| 3 | Advance the provision of drought early warning information and science-based drought decision support tailored to the region's unique characteristics and needs. |



Hay bales in an open field in South Dakota. Shutterstock: Panas Wiwatpanachat

As these eight regional networks have grown and trusted partnerships have deepened, common stakeholder priorities and best practices across the regional DEWS have emerged, which have informed the launching of several national-level initiatives that cross boundaries, hazards, and disciplines. These programs and key activities include ongoing projects such as building a National Coordinated Soil Moisture Monitoring Network, the Drought Risk and Resilience Planning Platform, and the Tribal Drought Engagement Strategy.




Circles representing each of the 5 key components of a drought early warning system

The implementation of these national-level initiatives and many other recent milestones marked an important phase in the growth of NIDIS. But there's more work to do. NIDIS regional DEWS cover 43 of 50 states. The next phase of NIDIS growth centers on building a fully national drought early warning system.

In 2024, NIDIS took a number of key steps towards this goal. First, NIDIS added Michigan to the Midwest Drought Early Warning, completing that regional DEWS. Next, NIDIS held a special drought webinar followed by a regional drought status update to address the record-setting drought in West Virginia, Ohio, and parts of the surrounding mid-Atlantic states. The webinar and drought update made connections with decision-makers in West Virginia and other parts of the Mid-Atlantic responding to drought conditions not often seen in the region.

Another key step that NIDIS took in 2024 was continuing to deliver drought early warning information to communities along the lower Mississippi River Basin impacted by multiple years of below-normal water levels. Besides impacts to shipping along the river, the Lower River Mississippi River Basin saw record-setting wildfires, agricultural production declines, and a threat to parts of the region's drinking water supplies from saltwater intrusion, especially in Louisiana. NIDIS covered the 2022 and 2023 drought conditions with special updates and webinars as well as funding research on the drivers of the Louisiana water crisis.

For the third year in a row, water levels on the Mississippi River dropped below normal in 2024. NIDIS, along with National Weather Service (NWS) partners, regularly updated Federal agency leadership on conditions, outlooks, and impacts on the river. NIDIS also began work on a Mississippi River Drought and Water Dashboard in consultation with partners along the river corridor, a resource that will deliver timely and relevant information on drought conditions, outlooks, and impacts across the entire watershed.

The work in 2023 and 2024 sets the stage for a big year in 2025. The completion of this fully operational national drought early warning system is fundamental to creating a more drought resilient nation. Through continued investment, transformational improvements in drought monitoring, forecasting, planning, and research will help reduce drought's catastrophic economic, wildfire, health, and environmental impacts across the country.

# *Early Warning in Action*

## Drought Outlook Products

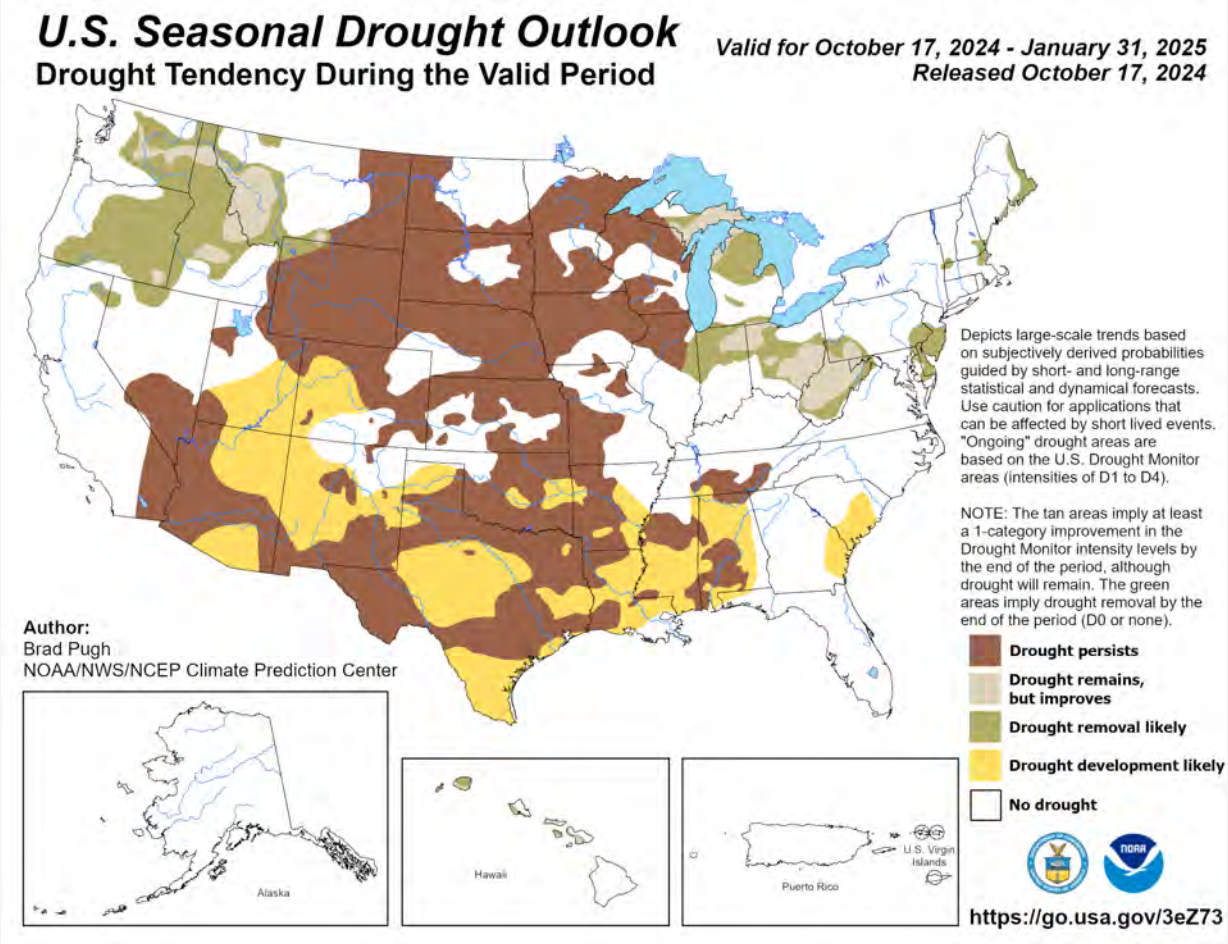
NIDIS and the National Weather Service Climate Prediction Center (CPC) are teaming up to enhance CPC drought outlook products and services by improving the current deterministic drought outlooks and developing new probabilistic drought outlooks. Improved drought outlooks will provide national and regional users with authoritative, official, operational forecasts for drought conditions at lead times of up to six months. They will also inform and enhance the existing NIDIS DEWS by facilitating more timely decision making to prepare for and mitigate drought related impacts and costs.

**Early Warning in Action:**
**Drought Outlook Products**

## Drought Early Warning and Status Updates

NIDIS works with state climatologists and federal partners to issue Drought Status Updates sent to thousands of stakeholders in each regional DEWS facing drought.

These updates communicate potential areas of concern for drought development and/or expansion based on recent conditions and the upcoming forecast. NIDIS and partners also host a very popular regional webinar program to provide stakeholders with timely information on current and developing drought conditions; discussions on drought impacts on wildfires, water supplies, and ecosystems; as well as impacts to sectors like agriculture, tourism, and public health. In 2024, NIDIS and its partners issued 42 Drought Status Updates and hosted 62 webinars.



## Drought Alerts

NIDIS drought email alerts provide up-to-date local drought information right to your inbox. Since 2021, NIDIS has partnered with NOAA's National Centers for Environmental Information (NCEI) to deliver these alerts with the latest changes to local U.S. Drought Monitor conditions and the latest drought outlooks from the National Weather Service Climate Prediction Center. At the end of 2024, almost 15,000 people across the country have signed up to receive NIDIS drought email alerts.

## Sector-Specific Drought Early Warning Pilot

NIDIS and partners are working to deliver an economic sector-based drought early warning process for the Nation, to address the challenges of managing the impacts of too much and too little water. This partnership is piloting a drought resilience framework for Southern California over the 2024-2025 winter, which will prototype sector-specific drought scenarios based on tailored monitoring and forecasting information that will enable users to make proactive decisions ahead of drought. Targeted sectors for this regional pilot are agriculture, water utilities, and public health. The pilot is a partnership between NIDIS, NOAA's Physical Sciences Laboratory, the California State Climatologist/California Department of Water Resources, NOAA's National Weather Service and National Centers for Environmental Information, and the California-Nevada Adaptation Program, a CAP (Climate Adaptation Partnerships) team.

## Ogallala Aquifer Summit

Agricultural sales from the Ogallala Aquifer region contribute billions of dollars to local economies and national gross domestic product. However, the Ogallala Aquifer is in trouble. Groundwater measurements in the Ogallala Aquifer show ongoing declines in aquifer water quality and quantity. In March 2024, NIDIS and the Irrigation Innovation Consortium at Colorado State University partnered with the Kansas Water Office and others in the region to host the third Ogallala Aquifer Summit. The Summit brought together more than 230 crop and livestock growers, scientists and technical experts, water managers, governments (local, state, and federal), and other partners to work to address water management challenges within the region. Summit opening remarks were delivered by Kansas Governor Laura Kelly and U.S. Senator for Kansas Jerry Moran. Key takeaways from the Summit were summarized in the recently published 2024 Ogallala Aquifer Summit Summary Report.


## Tribal Drought

In 2024, NIDIS awarded $1.95 million in funding for projects to support tribal drought resilience. This investment will help tribal nations address current and future drought risk on tribal lands across the Western U.S. while informing decision-making and strengthening tribal drought resilience. The funding supports four projects led by tribal nations that own lands within the American West, including the Snoqualmie Indian Tribe and the Confederated Tribes of the Colville Reservation in Washington, the Chippewa Cree Tribe of the Rocky Boy Reservation in Montana, and the Rosebud Sioux Tribe in South Dakota. These awards address needs identified in the NIDIS Tribal Drought Engagement Strategy: 2021-2025.

## Early Warning In Action: Record Drought in Ohio

A key to an effective drought early warning system is having the people and processes in place before drought happens. This is especially true in a state like Ohio that has had less historical drought compared to almost every other U.S. state. In August 2024, parts of Ohio reached Exceptional Drought (D4), the highest level of the U.S. Drought Monitor. This was also the first time ever that Ohio had areas of Exceptional Drought. But even though Ohio has had little historical drought, they were not caught unprepared. Ohio is part of the NIDIS Midwest Drought Early Warning System, which has been working for years to improve drought warning and monitoring and alleviate impacts. In 2023, NIDIS and researchers from Ohio State University completed a project that identified indicators and timescales that work best in Ohio for agricultural and hydrological drought, giving Ohio decision makers access to localized, timely drought information. The project also developed an online dashboard for drought monitoring in Ohio.

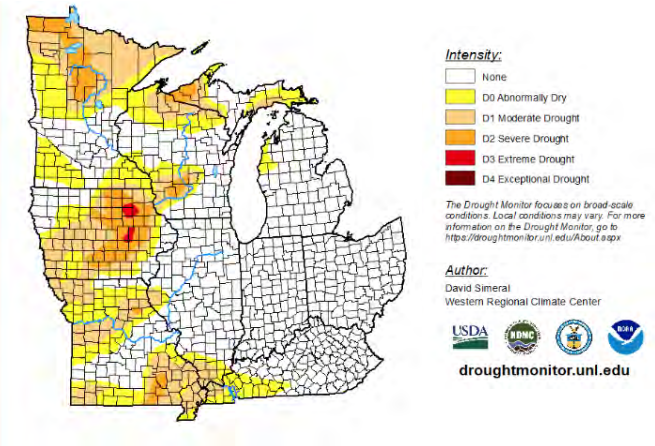
On April 25, 2024, NIDIS and Midwest regional partners issued a drought early warning alert. Even though Ohio and surrounding states were drought free at the time, there were ominous signs due to long-term precipitation deficits in the region. With summer coming, the drought status update warned that "areas that receive below-normal precipitation in the coming months may be at risk for worsening drought conditions due to increased evaporative demand from higher temperatures and a lack of subsoil moisture." Aaron Wilson, Ohio State Climatologist, used the April 25 update to initiate Ohio Agriculture Extension's awareness early, which then turned to action by late June.

> ***"I think it's the people and the network, when the information is communicated effectively, that is the bread and butter of DEWS"***
>
> —AARON WILSON, OHIO STATE CLIMATOLOGIST

The outreach didn't end there. NIDIS issued a flash drought alert for Ohio in June 2024. Flash drought followed soon after, and by August 2024, Exceptional Drought covered much of southeastern Ohio. NIDIS followed up with Drought Status Updates in July and September providing updates on conditions, outlooks, and impacts in the region. In September, NIDIS partnered with Mid-Atlantic and Midwest partners to host a webinar updating stakeholders on the drought that now covered most of West Virginia and Ohio. Webinar viewers included Congressional staffers and the Governor's offices of West Virginia and Ohio. The webinar also included presentations from local experts on impacts on agriculture and water supplies, as well as Federal and state agency resources providing drought relief and assistance. It was on this webinar that NWS and USDA experts declared that the drought was peaking and that conditions would likely improve over the next few months.

As predicted, the drought did slowly begin to dissipate over the next few months. NIDIS issued two more Drought Status Updates in fall and early winter tracking ongoing impacts as well as these improvements. The drought was almost gone by the end of 2024.

### Short-Term Drought Improvements in the Midwest, but Long-Term Deficits Remain—Leading to Increased Vulnerability to Drought, April 25, 2024




**The Midwest Drought Status Update showing the United States Drought Monitor with dryness and drought in the western part of the Midwest**

# DEVELOPING NEW AND IMPROVED PRODUCTS FOR USERS

Co-development of information, products, and tools is a cornerstone of the NIDIS approach to provide improved drought decision-support information and services. NIDIS engages with current and potential users of climate, water, and weather information to determine improvements that can be made to existing products, as well as the need for new products.

**Cotton silos in a field of cotton near Frost, Texas: Shutterstock: Sabrina Janelle Gordon**

A towboat, known as a pusher, pushes barges full of cargo up the Mississippi River near downtown Baton Rouge, Louisiana, USA. Shutterstock: Matt Gush.

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## Mississippi River Basin Drought & Water Dashboard

To improve access and usability of drought and water information across the Mississippi River Basin, NIDIS, in partnership with the U.S. Army Corps of Engineers, is developing a public-facing Mississippi River Basin Drought and Water Dashboard. This online platform, hosted on the U.S. Drought Portal (drought.gov) and modeled after the Apalachicola-Chattahoochee-Flint (ACF) River Basin Drought & Water Dashboard, will include a suite of curated and customized information and tools to provide drought information and support decision-making across the Mississippi River watershed. This Dashboard will be useful to a broad range of users, from water managers to the general public. NIDIS will launch the Dashboard in early 2025.

## Upper Missouri River Basin Soil Moisture and Plains Snow Data Value Study

At Congress's direction, NIDIS is leading the Upper Missouri River Basin Data Value Study as part of an interagency Upper Missouri River Basin Soil Moisture and Plains Snow Monitoring Build-Out to support improvements to water resource models, drought monitoring capabilities, and other applications. The Data Value Study is a 4-year, $1 million effort, with a report to Congress due by the end of Fiscal Year 2025. The study's interagency team includes the NOAA, U.S. Army Corps of Engineers, U.S. Department of Agriculture's Natural Resources Conservation Service, U.S. Geological Survey, U.S. Bureau of Reclamation, and National Aeronautics

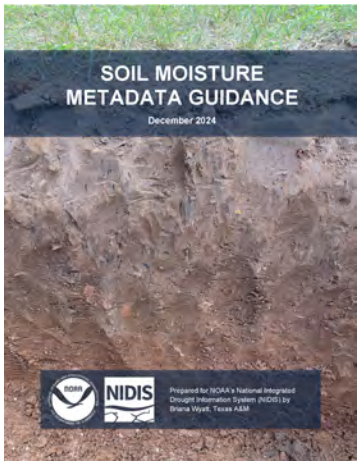
The South Dakota State University mesonet ribbon cutting ceremony. From left to right: Karla Trautman, Elizabeth Wakeman, Reno Red Cloud (hidden), Jerry Schmitz, Col. Mark Himes, Governor Kristi Noem, Dr. Bill Gibbons, Senator Mike Rounds, Nathan Edwards, Dr. Barry Dunn, Kevin Low, Marina Skumanich, and Andrew Berg.
Photo credit: SDSU.

and Space Administration, as well as the state mesonets involved in the build-out.

The study will show how Upper Missouri River Basin data will:

- *Improve weather and climate forecasting products at the local, regional, and national levels*
- *Enhance NIDIS, the National Water Model, and the U.S. Drought Monitor*
- *Contribute to remote sensing products*
- *Support other appropriate applications identified by the research team*

In addition to the focus on data use, the study also involves an assessment of the viability of the ownership and operational structure of the Upper Missouri River Basin project, including network data acquisition by NOAA's National Mesonet Program. This project is a component of the ongoing NIDIS-sponsored National Coordinated Soil Moisture Monitoring Network.




## Soil Moisture Data Quality and Metadata Guidance Documents

For decision-makers to effectively use soil moisture data collected by various monitoring agencies, it is essential to create a standardized guidance document for measuring and reporting soil moisture data. In 2024, NIDIS, in collaboration with partners across the National Coordinated Soil Moisture Monitoring Network (NCSMMN), published two technical assistance resources that synthesize best practices for soil moisture data providers: Soil Moisture Data Quality Guidance and Soil Moisture Metadata Guidance. These essential technical resources provide standardized guidance for soil moisture data quality and metadata that helps fulfill the NCSMMN's mission to "advance coordinated, high quality, nationwide soil moisture information for the public good".

## H-RIP: Customized Drought Info for Hawaiian Ag Lands

During drought, ranchers in the Hawaiian islands face significant challenges associated with the loss of pasture and forage resources, such as increased costs for supplemental feed, increased cattle mortality, and reduced calving rates. Producers face a persistent hurdle to making proactive management decisions due to a lack of timely and accurate drought-related information. The Hawai'i Rangeland Information Portal (H-RIP) was developed to help ranchers fill these critical information needs. H-RIP is a powerful decision support tool designed for ranchers to get site-specific climate information and a near-term projection of forage growth at their area of interest. The H-RIP tool was funded by NIDIS with support from the Pacific Drought Knowledge Exchange, Hawai'i Cattlemen's Council, the University of Hawai'i, the East-West Center, and the U.S. Department of Agriculture Natural Resources Conservation Service.

## Climate Engine Website Facilitates Drought and Vegetation Monitoring on Bureau of Land Management Lands

ClimateEngine.org is an innovative tool that provides satellite and climate data in a user-friendly manner to facilitate water conservation, wildfire risk management, agricultural productivity monitoring, and ecological restoration. Created through a partnership between researchers at the Desert Research Institute, the University of California Merced, Google, NIDIS, and other federal partners, Climate Engine allows users to create maps and time series plots for visualizing complex climate data. Now, the team has launched a new publicly accessible platform designed to produce comprehensive and detailed reports for all Bureau of Land Management-managed lands in the contiguous United States. Users of the new site will see both long-term (up to 5 years) and short-term (up to 9 months) drought information that combines several drought monitoring indices into a single map for each BLM grazing allotment. The reports combine scalable drought summaries and near real-time vegetation conditions to help inform planning and decision-making.

# MITIGATING THE IMPACTS OF CASCADING HAZARDS

Drought can have far-reaching effects on a community and intersect with other natural hazards, such as wildfires and illness. Hazard mitigation planning is conducted to reduce the impact of natural disasters, including drought, by reducing loss of life and property. NIDIS facilitates the connection and coordination between research and assessment efforts around drought and cascading hazards and jointly develops and implements coherent strategies and priorities.

**Very low water level in Cheat Lake near Morgantown, West Virginia. Shutterstock: Nature s Charm**

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## Severe Drought Increases Mortality Risk in the Northern Rockies and Plains

To better understand the potential impacts of drought on human health, a NIDIS-funded study, led by the University of Nebraska Medical Center, examined the effects of severe drought exposure on all-cause (deaths from any cause) and cardiovascular-related deaths in the Northern Rockies and Plains. The study found that mortality associated with severe drought increased overall in this region, and several factors—including age groups, gender, and residing in an urban area—influenced the impact of drought on all-cause and cardiovascular mortality. Dust may explain the increase in death due to all-cause and cardiovascular illness. As soils dry out during a drought, dust and other particles are more likely to circulate in the air, affecting cardiovascular and respiratory diseases. Poor air quality can both cause and exacerbate respiratory and cardiovascular disease, as fine particulate matter penetrates the lungs and bloodstream following inhalation.

## Drought Response Guide for Health Professionals

To better prepare health professionals for responding to the health effects of drought, a research team from the University of Nebraska Medical Center's College of Public Health released a guide, Drought and Health: A Messaging Framework for Public Health Professionals and Healthcare Providers. Incorporating contributions from an interdisciplinary team of experts representing healthcare, public health, mental and behavioral health, and health communication, the guide includes practical steps and guidance that health professionals can take to discuss drought with their patients and communities. The guide is a product of a multi-year effort supported by NIDIS, the National Aeronautics and Space Administration (NASA) Health & Air Quality Program, and the Claire M. Hubbard Foundation.

Hiking on a boardwalk in Yosemite National Park. Shutterstock:summercloud

## Impacts of Drought on National Park Visitation

Two NIDIS-funded studies led by researchers at the University of California, Merced examined relationships between national park visitation and drought indicators. The first study examined relationships between overnight wilderness use in Yosemite National Park and spring snowpack. The study found a park-wide increase in overall overnight wilderness use during snow drought years due to greater wilderness use at high-elevation sites, but the authors also found a sustained increase in wilderness use at the lower-elevation park units during heavy snow years. This increase was likely a byproduct of both (1) the

View of the Colorado River running through Glenwood Canyon. Shutterstock: LanaG

displacement of wilderness users within the park because high-elevation areas were inaccessible in heavy snow years and (2) more plentiful surface water supplies in late summer.

The second study examined relationships between drought and park visitation across different national parks in California. In mountain parks, the authors found drought conditions negatively impacted park visitation during the summer and autumn months but were associated with increased use during the spring. Reductions in park visitation in summer and fall during drought years are likely associated with direct impacts to water-based recreation activities, such as reduced river flow or low water elevations in lakes, or indirect impacts from wildfires in the parks or adjacent areas that reduced access or degraded air quality. By contrast, desert parks saw reduced spring visitation during drought and increased spring visitation during wet years. Wet winters contribute to super blooms in the California desert that draw more visitors, while drought conditions limit desert wildflowers and contribute to declines in park visitation.

## Understanding Water Supply Forecast Error on the Colorado River

Seasonal Colorado River water supply forecasts incorporate data from high-elevation Snowpack Telemetry (SNOTEL) stations, offering water managers insight into how much water to expect each year. However, 2020 and 2021 were low water supply years, much lower than one would expect based on snowpack values alone. NIDIS-funded research by the Colorado Climate Center questioned whether very low, if not record low, soil moisture levels at high elevation were causing a smaller fraction of snowmelt to runoff than in a normal year. The researchers p
aid special attention to hindcasts using the data available on April 1. April 1 is near peak snowpack season, and these numbers have historically been used as a benchmark for how much water to expect in the coming spring. Results indicated that a much larger fraction of the error is attributable to the weather that occurs after April 1. While antecedent soil moisture conditions were record-low in western Colorado, 2021 also had a much drier-than-normal spring for western Colorado with a record dry April. This was not well predicted or incorporated in operational streamflow forecasts. The findings establish a ceiling for how skillful we can expect water supply forecasts to be without significant, successful investments in sub-seasonal to seasonal forecasting over the Intermountain West.

**Have questions about the report?** Please contact:
Adam Lang | **adam.lang@noaa.gov**
Veva Deheza | **veva.deheza@noaa.gov**

**AUTHOR**
National Integrated Drought Information System
2024 Annual Report, Boulder, CO

**EDITORIAL COORDINATION**
**Adam Lang**
Communications Coordinator
CIRES/NOAA/NIDIS

**Elizabeth Ossowski**
Program Manager
NOAA/NIDIS

**Veva Deheza**
Executive Director
NOAA/NIDIS

**DESIGN AND LAYOUT**
Cordelia Norris
Luna Creative

drought.gov