Annual Report 2023

This photo shows four people cooling off in a branch of the North Loup River in Cherry County, Nebraska, on June 11, 2022. Photo by Michael Forsberg/Platte Basin Timelapse.

About the cover

Front: A series of photos depict a branch of the North Loup River in Cherry County, Nebraska, at various times of the year from 2016 to 2022. Photo by Michael Forsberg/Platte Basin Timelapse, University of Nebraska-Lincoln.

Back: A herd of bison graze near a branch of the North Loup River in Cherry County, Nebraska, on Sept. 24, 2013. Photo by Michael Forsberg/Platte Basin Timelapse.

National Drought Mitigation Center

2023 Annual Report
Shaping the Future
Lincoln, Nebraska

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FROM THE DIRECTOR

It's unsettling but unsurprising: 2023 was the hottest year in NOAA's 174-year global climate record. The U.S. was no exception to the year's record-high global temperature trends, with above-average or higher temperatures in many states, and five states with their warmest year on record since 1895. NOAA climatologists predict more record-breaking temperatures in the coming years.

Widely vacillating temperatures, in addition to more volatile weather events, are disrupting communities, sectors and organizations at every level across the globe. Drought vulnerability is also changing due to many factors such as water and food availability and politics.

Living with new and unpredictable climate norms means we need to build toward a more resilient future. To keep this mindset front and center, we chose Shaping the Future as the 2023 report theme.

At the NDMC, we use many strategies to help organizations, communities and countries position themselves for optimal outcomes. We work with groups close to our offices in Lincoln, Nebraska, and around the world—including the Czech Republic, South Korea and Peru this year—on drought monitoring, preparedness and outreach efforts.

We celebrated a couple milestones in 2023. The first was a decade of the NDMC's partnership with World Bank. Learn more about the most recent result of our combined efforts, a composite drought indicator (CDI) for South Africa, on page 6. The year also marked a new milestone in the development of a new Cooperative Agreement between the NDMC and the United Nations Convention to Combat Desertification aimed at fostering land-based drought risk management, drought resilience, mitigating water security and achieving land degradation neutrality.

One of our successful U.S.-based collaborations from the year happened in March, when we co-facilitated a workshop in New Mexico focused on soil health, drought and climate change. The event convened 20 participants from six different pueblos from across the Middle Rio Grande Basin. It provided an opportunity for Tribal producers and resource managers to engage with state and federal representatives to brainstorm project ideas for regional drought and climate resilience. Read the full story on page 4.

Another way we work to shape the future is through adopting new technologies and developing new drought monitoring techniques. One of these efforts, a new "combined drought indicator" that uses machine learning techniques and new indicators, has been helping USDM authors with decision-making processes. Find out more on page 8. We also developed the Forest Drought Response Index to monitor forest drought in the continental U.S. More information on ForDRI and other new tools are on pages 10–11.

These kinds of efforts exemplify what it means to shape the future. At the NDMC, we develop tools and resources, conduct research and work with partners to bolster drought resilience. Amidst constant change, we prepare for tomorrow by laying the foundation today. ❐

Mark Svoboda, Ph.D., Director

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NDMC partnership works to enhance drought and climate resilience of Indigenous farmers in the Middle Rio Grande basin

What if winter snowpack melts too fast and leads to widespread flooding? What can farmers do when the irrigation ditches are full, but they're not yet ready to plant? What can Tribal farmers do on smaller plots of land where the available options for boosting water supplies are more limited?

These were just a few of the questions raised in a recent workshop on soil health, drought and climate change co-facilitated by the National Drought Mitigation Center and hosted by the Santa Ana Pueblo. The workshop, held on the Santa Ana Pueblo in New Mexico in March 2023, brought together 20 participants from six different pueblos from across the Middle Rio Grande Basin.

It provided an opportunity for Tribal producers and resource managers to engage with state and federal representatives to learn about technical assistance resources, soil health programs and funding opportunities.

The event also allowed agency staff to meet with producers and, together, brainstorm concrete projects for drought and climate resilience on Tribal land in the Southwest, said Maddie Goebel, NDMC social scientist and workshop organizer.

"Our goal is to get people thinking about projects they would be interested in doing on their farms and encourage pueblo staff to reach out to farmers to begin brainstorming tangible plans," Goebel said.

Together, the team is working to enhance agricultural drought and climate adaptation in Middle Rio Grande pueblos by better understanding the needs of Indigenous farmers and ranchers and leveraging their traditional knowledge and practices.

The workshop was the first of a series of outreach programs planned as part of the Climate Smart Indigenous Agriculture Project,

In March 2023, the NDMC hosted a workshop with the Middle Rio Grande pueblos and state partners in New Mexico as part of the Climate Smart Indigenous Agriculture Project.

a collaborative effort of the NDMC, the Santa Ana Pueblo, the U.S. Department of Agriculture Southwest Climate Hub, Southwestern Indian Polytechnic Institute and the Intertribal Agricultural Council. It's funded by the USDA's Natural Resources Conservation Service.

The workshop incorporated several educational sessions and field trips with plenty of opportunity for discussion and relationship building. Participants also had an opportunity to collectively brainstorm on-farm projects to increase resilience and work through potential barriers related to funding and monitoring.

Educational workshops like the Soil Health, Drought and Climate Change Tribal Workshop are just one component of the Climate Smart Indigenous Agriculture project. Since 2022, NDMC staff have been conducting interviews with farmers, ranchers, agricultural producers and natural resource managers from across the Middle Rio Grande Basin. The Climate Smart Indigenous Agriculture project will run through spring 2024. ❐

We're all in this together: Stakeholders work to increase drought resilience of the ACF Basin

In March 2023, 60 stakeholders from across Alabama, Georgia and Florida gathered for a day-long workshop to discuss drought management in the Apalachicola-Chattahoochee-Flint River Basin, facilitated by the National Drought Mitigation Center.

Working through different drought scenarios and exercises, participants got to learn more about the challenges facing the watershed and how different agencies prepare for, and respond to, drought. Most importantly, the workshop brought together stakeholders from across the region to collaborate on a more resilient future for the ACF Basin.

Workshop participants included representatives from the U.S. Army Corps of Engineers, the Fish and Wildlife Service, and the U.S. Geological Survey, as well as the University of Alabama, Auburn University, the Atlanta Regional Commission, the Georgia Water Policy Center and various stakeholder groups representing seafood, agriculture, business and water supply interests.

Several state agencies were also involved, including the Alabama Office of Water Resource Management, the Georgia Department of Natural Resources and the Florida Department of Environmental Protection.

The workshop was an important first step in forging new relationships and sharing information about the threats facing the watershed and potential strategies to address drought in the future, said Cody Knutson, NDMC planning coordinator and one of the workshop facilitators.

"It was an opportunity for stakeholders from across the ACF basin to begin meeting in-person again and learn about drought in the basin and how state agencies and the Army Corps of Engineers respond to changing conditions," he said.

NDMC staff members walked participants through an interactive scenario exercise to get them thinking about drought. In the exercise, drought intensified over a year before starting to recover. At critical decision points in the timeline, participants could discuss priorities, management options and strategies.

Workshop participants discussed their organizations' role and responsibilities in drought management and their drought response strategies during a simulated drought scenario exercise.

The workshop was the first multi-stakeholder drought exercise in the watershed, said Chris Manganiello, water policy director at Chattahoochee Riverkeeper and one of the event organizers.

"We pulled together many participants who have not always worked in the same room together," he said.

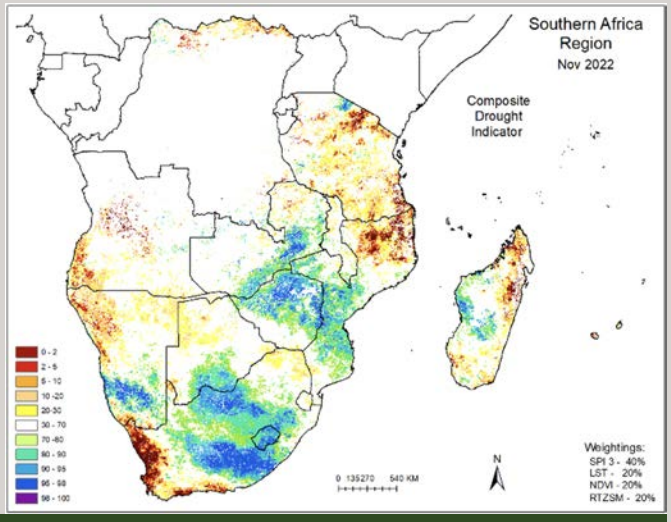
In recent years, drought has emerged not just as a critical issue for the basin but also a potential pathway to rebuild relationships, said Brad Moore, president of the Friends of Lake Eufaula and another workshop organizer.

A follow-up drought scenario exercise is planned for 2024. ❐

NDMC and World Bank partner on drought monitoring tools for southern Africa

The National Drought Mitigation Center and World Bank recently passed their decade-long anniversary of working together on new drought tools that can help countries increase their resilience to drought.

One of the tools, called a composite drought indicator, combines several different elements of the climate and hydrological cycle into one objective measure of drought conditions for monitoring purposes. The NDMC and World Bank have worked together to develop CDIs—and facilitate country-level processes to increase in-house capacity—in several countries and regions. Most recently, the team wrapped up work creating the foundation for a region-wide composite drought indicator for southern Africa.



This map shows the composite drought indicator in November 2022 for the 16-country region represented by the Southern Africa Development Community.

"Right now, there are so many things going on in each of these countries. They're using different tools and different ways of defining drought, even within the same government," said Nathan Engle, a climate change specialist at the World Bank. The CDI "gives them an initial entry point into operationalizing, in a more objective and consistent way, what drought means."

The CDI has several advantages as a drought monitoring tool, especially in areas where weather stations are few and far between or hard to access. The use of remotely sensed data, for example, makes it possible to track conditions consistently across an entire data-scarce region. Meanwhile, new machine learning techniques can help automate the process, making it possible to keep it going on a regular basis even in places with less technical capacity or resources.

"It's a very flexible system," said Mark Svoboda, NDMC director. "We can integrate national and subnational data at the local level, all the way up to these global datasets. It's about using whatever resources and data a country has access to that they trust."

The backbone of the process, Svoboda said, is the convergence-of-evidence approach pioneered by the U.S. Drought Monitor. As with the USDM, developing a composite drought indicator involves pulling together and weighing various sources of data, from physical indicators of the hydrological and climate system to expert knowledge and local reports of conditions, into one standardized measure of drought. But, unlike the USDM, once the weights of the CDI inputs are established and validated for a country or region, the process is entirely computational, with no human interpretation involved.

Through these efforts, the NDMC, World Bank and stakeholders hope to ultimately inform policy and decision making. The shared vision is to enable individual countries to develop the capacity to use the data from tailored CDIs as an objective trigger for potential drought management actions. ❐

NDMC partners with the United Nations Convention to Combat Desertification on drought impacts policy brief

To highlight global drought impacts and the need for related programs, the National Drought Mitigation Center authored a policy brief on drought impacts for the United Nations Convention to Combat Desertification.

"The Cascading and Compounding Impacts of Drought" was released at the 2023 UN Climate Change Conference, COP 28, in Dubai in December 2023.

Investing in the health and well-being of people and ecosystems can reduce the most extreme impacts of drought, said Kelly Smith, NDMC assistant director and drought impacts researcher.

"Water connects all life on Earth, and drought tests our commitment to that connection," Smith said. "The policy brief is a chance to emphasize to the international community that making sure people's basic needs are met pays off in countless ways, including reducing or eliminating drought impacts."

In November, the group of nations that are signatories to the agreement establishing the UNCCD met in Samarkand, Uzbekistan. At the meeting, Smith and Mark Svoboda, director of the NDMC, organized and spoke on a panel, "The Global Impacts of Drought." This discussion fed into the policy brief.

Other panelists included Jesse Bell, the Claire M. Hubbard Professor of Water, Climate and Health at the University of Nebraska Medical Center, as well as partners from the UNCCD, the World Meteorological Organization and the International Drought Management Programme.

The report calls on nations to implement sustainable development goals such as food and water security, access to education and health care, gender equity, ending poverty and sustainable land use practices. Implementing solutions with multiple benefits, particularly enhancing human and ecosystem health and productivity, can reduce the most extreme vulnerability to drought.

United Nations
Convention to Combat Desertification

Drought causes widespread crop loss, land degradation, reduced soil health, ecosystem damage, loss of hydropower production and more, according to the report. While not as noticeable as hurricanes or earthquakes, it is one of the most expensive natural disasters.

Heat waves and dust storms can exacerbate drought, while subsequent events like flooding can leave communities bereft of recovery time. The wide-ranging societal impacts of drought affect sectors including agriculture, energy and tourism. Vulnerable populations including women and girls experience disproportionate effects, impacting education opportunities and quality of life.

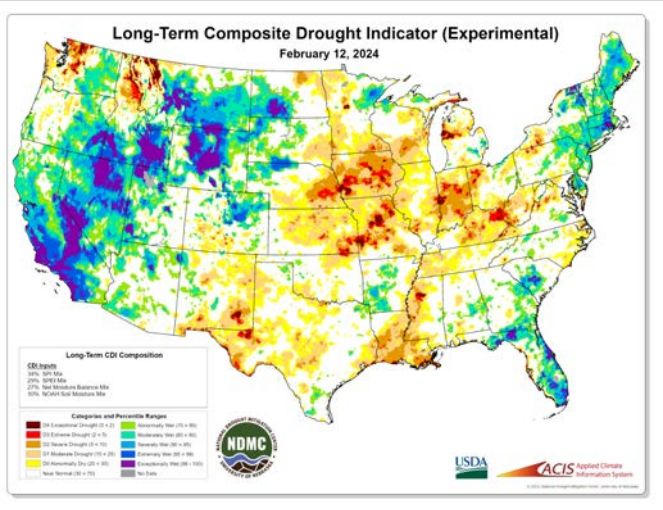
Drought resilience is often the result of astute planning and resource allocation — requiring engagement from all levels of government and sector-specific approaches. The UNCCD drought toolbox includes monitoring and early warning, vulnerability and risk assessment and risk mitigation measures to assist in these efforts.

NDMC's work with the UNCCD follows decades of international involvement with the United Nations, United States Agency for International Development, World Meteorological Organization, World Bank and other partners. This effort was part of a cooperation agreement between NDMC and UNCCD established in January 2023. ❐

Objective blends now include machine learning technology

A new iteration of the "objective blend" composite drought indicators (CDI) uses machine learning techniques and new indicators to help authors make decisions about the U.S. Drought Monitor (USDM).

In October 2023, the National Drought Mitigation Center (NDMC) published a new experimental CDI. This builds upon objective blend tools that have been developed and refined over the years. This effort is funded through a cooperative agreement with the U.S. Department of Agriculture's Office of the Chief Economist.



This map shows the Long-Term Composite Drought Indicator for Feb. 12, 2024.

The objective blends are a useful tool for USDM authors and assessment teams working on weekly timeframes to produce updates to the USDM every week, said Brian Fuchs, NDMC climatologist. Through the updated CDI, authors and others making drought-related decisions will have a new lens to identify rapidly changing situations like flash drought.

"For USDM authors, one of our biggest challenges is determining short-term and long-term drought. It really helped when we started using objective blends," he said. "Now, bringing in machine learning will improve the blends map, especially in classifying short-term and long-term drought."

Through the NDMC Composite Drought Indicators website, users can access the NDMC blends maps, archive, data, inputs and metadata. A legacy section shows the objective blends as they were previously calculated.

The weekly maps are created using a combination of the Standardized Precipitation Index, Standardized Precipitation Evapotranspiration Index and soil moisture data. Datasets for the blends are computed every week using weighted sums of the ranked inputs. The results are then ranked to provide normalized 0.0-1.0 values for comparison.

Inputs added to the new CDI include the Standardized Net Moisture Balance Index — the NDMC's experimental expansion of the SPEI that incorporates snow water equivalent data. The short-term blend also includes the Normalized-Difference Vegetation Index and Enhanced Vegetation Index.

The machine learning component uses a semi-guided iterative process involving two methods of supervised scoring and multi-pass linear regression. Historical drought monitor data was used to train the model.

In 2000, USDM authors started using a weighted model blending several sets of climate division data together to create the short- and long-term objective blends. The National Oceanic and Atmospheric Administration's Climate Prediction Center developed the product and produces the blends every Monday.

The NDMC published an updated gridded dataset system in 2022 to provide a more detailed picture of drought conditions in the U.S. ❐

NDMC researchers conduct national and regional climate research, contribute expertise to assist in state drought planning

NDMC analysis finds changing precipitation trends in the Northeast

Droughts in the Northeast in 2016, 2020 and 2021 strongly affected agricultural producers and raised questions about how growing seasons are changing in the region.

To address gaps in understanding the area's changing drought landscape, the NDMC produced a new analysis of snow and precipitation patterns. A major finding in the data is that heavier precipitation events are increasing, especially during the winter and spring, said NDMC climatologist Curtis Riganti.

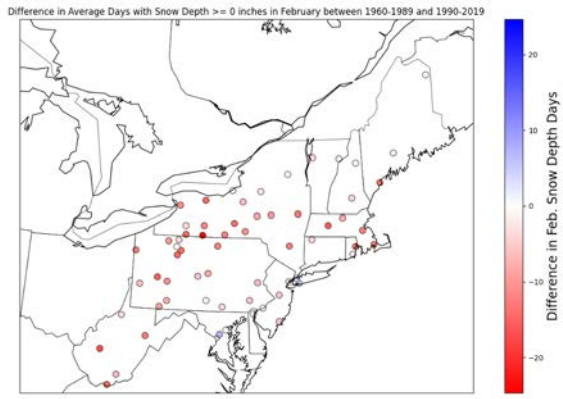
Additionally, snowmelt could be occurring earlier in the spring, Riganti said. The data show fewer days with snow on the ground in February now compared to previous decades.

The study is a partnership with the USDA Northeast Climate Hub and part of a cooperative agreement with the USDA's Office of the Chief Economist and the NDMC.

NU researchers, alumni contribute to national climate assessment

University of Nebraska researchers and alumni contributed expertise to the Fifth National Climate Assessment. Released by the Biden administration on Nov. 14, the report includes more than 500 authors and 250 contributors.

Contributions from University of Nebraska affiliates are in the Northern Great Plains and Human Health chapters. Authors affiliated with the National Drought Mitigation Center include Tonya Haigh, NDMC social science coordinator; and Jesse Bell, Claire M. Hubbard Professor of Water, Climate and Health, University of Nebraska Medical Center and associate professor, UNL School of Natural Resources. The U.S. Drought Monitor, produced by the National Drought Mitigation Center, is also cited.



Difference in the average number of days in February with measurable snow depth, comparing 1990–2019 with 1960–1989.

Collaborative plan heightens Iowa's response to drought

While Iowa has been in a drought for over three years, state agencies have a new tool to better identify the slow-moving phenomenon and respond to its effects.

Published in January 2023, the Iowa Drought Plan provides comprehensive state-specific guidance on what to do before, during and after drought events.

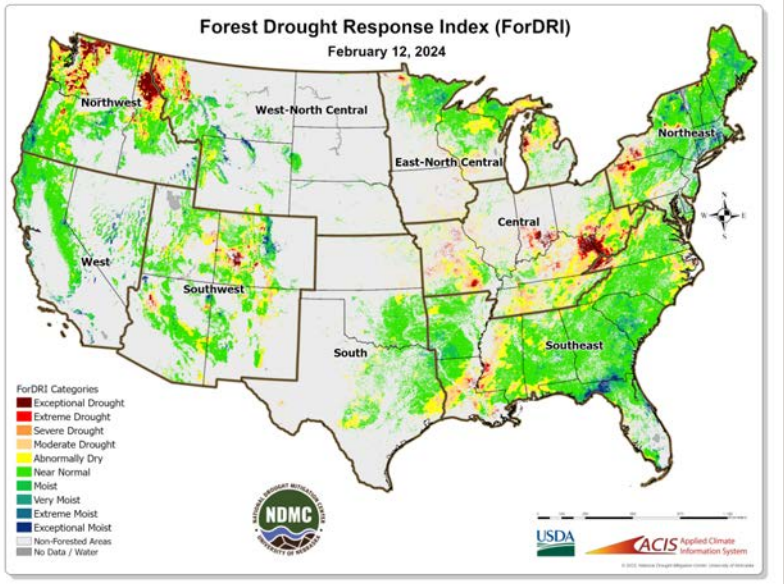
The 47-page document is voluntary in nature, providing communities with relevant information and allowing local leaders to act. It identifies five drought regions, provides a data-driven system for determining one of four drought condition levels, provides a vulnerability and impact assessment, offers mitigation and response guidance and outlines implementation procedures.

Early in the development process, NDMC provided background on other states' drought plans that allowed Iowa partners to adapt key components to the state's unique needs. ❐

New Tools and Products

ForDRI monitors and predicts drought in U.S. forests

A new tool developed by the National Drought Mitigation Center (NDMC), the Forest Drought Response Index (ForDRI), aims to address the intricacies of drought within forest ecosystems.



ForDRI provides a way to monitor forest drought in the continental U.S. This research was funded by a three-year cooperative agreement with the U.S. Department of Agriculture (USDA) Office of the Chief Economist (OCE). ForDRI was developed in collaboration with the USDA, U.S. Forest Service (USFS) and Center for Advanced Land Management Information Technologies (CALMIT) at the University of Nebraska-Lincoln.

Drought scientists use climate- and satellite-based data to depict drought conditions and impacts on vegetation. However, the variety within forest ecosystems makes it difficult to monitor forest drought only with climatic or satellite data.

ForDRI works by combining 12 data types including satellite, climate, evaporative demand, groundwater, and soil moisture. The model uses Principal Components Analysis (PCA), which simplifies multi-dimensional datasets while retaining their trends and patterns.

The ForDRI maps show drought conditions only on the forest cover areas determined by the national forest type dataset. This dataset was produced by the USFS Forest Inventory and Analysis program and the Remote Sensing Applications Center.

NDMC is continuing to evaluate ForDRI and associated products by collecting feedback from experts and users to improve the model. Learn more at *fordri.unl.edu/Home.aspx*.

OWWLS expands to cover the entire U.S., Puerto Rico and Virgin Islands

An expanded map of weather station locations broadens efforts to bring more transparency to the U.S. Drought Monitor (USDM) decision-making process, including highlighting coverage gaps in station-based data.

In 2022, the NDMC produced the Overview of Weather Water Land Sites (OWWLS). OWWLS maps the location of weather stations, stream gauges, ground water monitoring stations and reservoirs that are among the dozens of datasets used in the production of the USDM.

When OWWLS was first developed, it focused on the West, but it has now expanded to the entire U.S. This includes Puerto Rico and the U.S. Virgin Islands as part of the NDMC's work with the USDA Caribbean Climate Hub and its Drought Learning Network.

While it doesn't provide an exhaustive list of data sources, OWWLS shows locations of stations that provide in situ data via several

different networks. Categories on the map include nine types of stations commonly used to assess local conditions for the USDM. Conversely, the map also shows gaps in information.

The project is part of the NDMC's one-year cooperative agreement with the USDA's OCE. View the OWWLS website at *drought.unl.edu/Monitoring/OWWLS.aspx*.

New Composite Drought Index addresses climate in Alaska

Alaska's climate is changing faster than any other state in the U.S. To address the vast region's unique climate needs and help Alaskans better prepare for drought events, University of Nebraska master's student Grace Kirchner (Campbell) developed a state-specific drought index.

Kirchner developed the Alaska Composite Drought Index (ACDI) and published it as a master's thesis in May 2023. The project was also part of NDMC's cooperative agreement with the OCE.

In a drought Alaska experienced from 2016 to 2019, many villages ran out of water, causing communities to use generators powered by diesel fuel, according to Kirchner's thesis. Despite these rapid climate developments, the state was lacking drought-specific data, making drought research difficult.

To address this multifaceted issue, the ACDI uses a principal components analysis approach. To verify the ACDI, Kirchner compared her outputs with the U.S. Drought Monitor (USDM) and impact reports.

As part of her project, Kirchner joined other NDMC staff on a multidisciplinary trip to Alaska to conduct workshops with farmers about drought, agriculture and water use. While there, she had the opportunity to gain valuable insight from local farmers, scientists and Native community leaders.

Ag In Drought combines drought, crop areas, crop progress and management resources

The NDMC added new features this year to U.S. Agricultural Commodities in Drought website (Ag In Drought) as the result of a cooperative agreement between the NDMC and the USDA's OCE.

Ag in Drought now includes:

- Maps showing how drought is affecting agricultural production areas. The list of areas included has expanded to 13 crops and six kinds of livestock-related production.
- Time-series charts showing what proportion of production areas have been in drought over time.
- The data used to create the time series charts, providing the weekly percentage of each crop production area that is in each category of drought.
- An archive of slides generated each week with similar data, including percent area in drought broken down by state and crop.
- Crop progress, with maps and crop stage information for each of the 13 crops, from the USDA's National Agricultural Statistics Service.
- Drought monitoring and prediction resources for specialty crops such as vegetables, fruit and cranberries.
- Links to other ag-related NDMC sites, such as the Drought Monitoring Dashboard for Ranchers, GrassCast and Condition Monitoring Observer Reports.
- More resources for managing drought, accessing relief programs, and connecting with state and regional drought planning.

Learn more: *agindrought.unl.edu* ❐

Scholarly publications

Need for clear definition of flash drought leads to study

The term "flash drought" was developed to describe the negative impacts of an intense heatwave and a short period of dryness characterized by the rapid onset of drought conditions. Because flash drought is a relatively new phenomenon in drought research, defining the concept is critical for scientists and decision-makers alike. NDMC researchers undertook a study comparing 15 drought events using six quantitative definitions of flash drought. Five of the events were identified from the literature, and stakeholders from a variety of sectors identified 10 additional events as flash drought.

The researchers found that two of the six definitions consistently captured the earliest onset of flash drought. Using survey data, they completed a qualitative analysis of stakeholders' management challenges and needs. The top challenges were managing impacts and better communication and education. The top needs included more data and enhanced and efficient communication to better monitor, manage and respond to flash droughts.

Stakeholders from all sectors stressed the need for a clear definition of flash drought. They considered current definitions confusing, and they also noted that both stakeholders and the public lacked awareness and knowledge of flash droughts. Addressing the need for a clear definition would allow experts and stakeholders to be on the same page when monitoring and communicating the risk of flash drought occurring, and it would also enhance communication and monitoring strategies for flash droughts.

Schwartz, C., Haigh, T., Svoboda, M., and Goebel, M. 2023. How is Flash Drought Understood?—Experts' Definitions and Decision-Makers' Perceptions. *Weather, Climate, and Society* 15 (4): 909–924. *https://doi.org/10.1175/WCAS-D-22-0142.1*.

USDM gets high marks for monitoring drought

Drought monitoring and early detection have improved greatly in recent decades with the development and refinement of numerous indices and other tools. But knowing which of these tools to use in any given location may not always be straightforward. The NDMC's Tonya Haigh collaborated with other drought researchers on a review paper that seeks to improve drought understanding across North America and help users find the most appropriate drought-monitoring tools. The authors used workshops and surveys to assess how users perceived the performance of drought indicators, indices and impact information in monitoring drought in the different climate types across the U.S., Canada, and Mexico.

Users identified the U.S. Drought Monitor (USDM) and Standardized Precipitation Index (SPI) as the most effective indices and indicators for monitoring drought across North America, followed by the Normalized Difference Vegetation Index (NDVI), temperature anomalies, crop status, soil moisture, streamflow, reservoir storage, water use (demand) and reported drought impacts. In general, users thought the drought indices and indicators did not perform equally well across geographies.

The authors integrated and summarized the results of the surveys and workshops with published research on the effectiveness of drought indices to provide guidance on when and where the more popular drought indices and indicators should be used. They note the importance of understanding how drought, its

impacts and its indicators have changed over time and recommend ways to use indices and indicators in drought decision making.

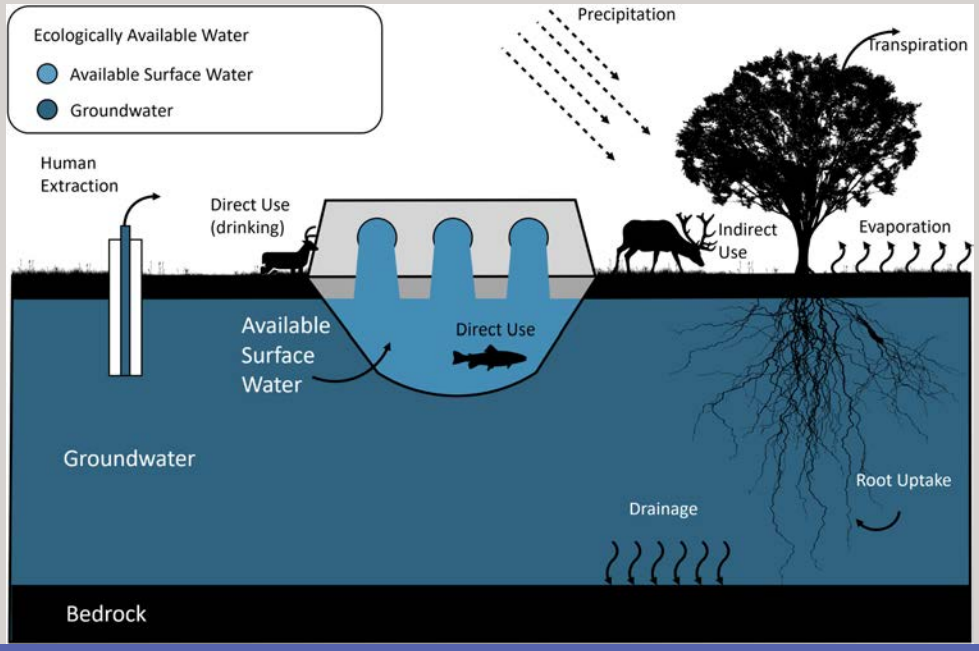
Heim, R.R. Jr., et al. 2023. A Review of User Perceptions of Drought Indices and Indicators Used in the Diverse Climates of North America. *Atmosphere* 14 (12): 1794. *https://doi.org/10.3390/atmos14121794*.

NDMC-affiliated researchers examine governance of ecologically available water

Several current (Deborah Bathke and Tonya Haigh) and former (Michael Hayes, Theresa Jedd and Markéta Poděbradská) NDMC researchers collaborated with other scholars on a study investigating institutional authority and responsibility for allocating water to ecosystems ("ecologically available water," or EAW). Currently, that authority is spread across local, state and federal agencies operating under a range of statutes, mandates and planning processes, and it can be influenced by a range of institutions to determine how scarce water should be allocated between competing uses.

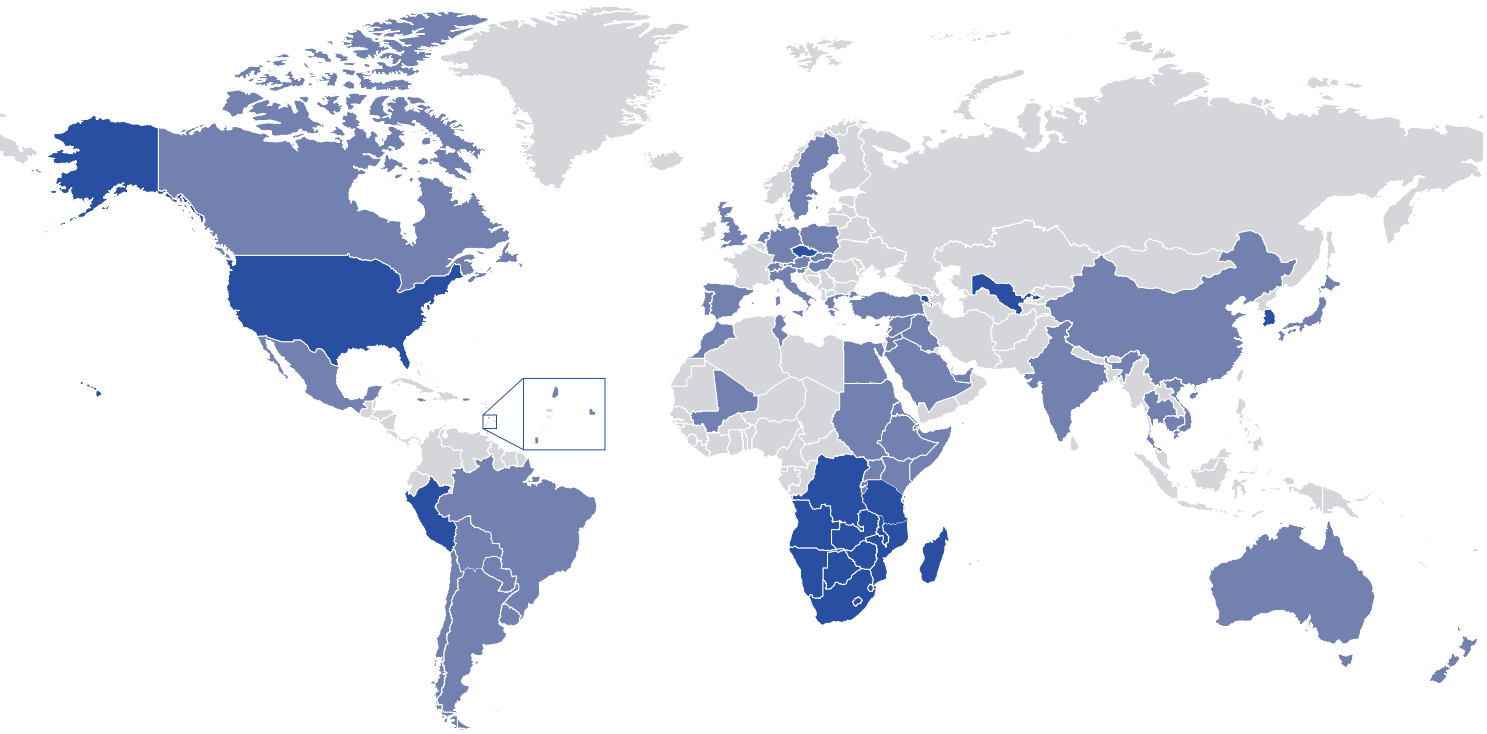
The researchers used a case study of the Upper Missouri Headwaters Basin in southwestern Montana to examine the various agencies and institutional actors with intersecting authorities and actions. They assessed the extent to which this system creates gaps in responsibility and concluded that the current multilevel governance regime does not adequately account for the interconnections between water in different parts of the ecosystem. They recommend more intentional and robust coordination to address these gaps.

Cravens, A.E., et al. 2023. The patchwork governance of ecologically available water: A case study in the Upper Missouri Headwaters, Montana, United States. *Journal of the American Water Resources Association*, Paper No. JAWR-22-0074-P. *https://doi.org/10.1111/1752-1688.13167*.



This diagram illustrates ecologically available water as it relates to selected components of the hydrologic cycle. Image from "The patchwork governance of ecologically available water: A case study in the Upper Missouri Headwaters, Montana, United States."

Where we worked 2023



Global

To highlight global drought impacts and the need for related programs, the NDMC authored a policy brief on drought impacts for the United Nations Convention to Combat Desertification. "The Cascading and Compounding Impacts of Drought" was released at the 2023 UN Climate Change Conference, COP 28, in Dubai in December.

Southern Africa

The NDMC and World Bank worked together to develop Composite Drought Indicators and facilitate country-level processes to increase in-house capacity, in several countries and regions. Most recently, the team wrapped up work creating the foundation for a region-wide composite drought indicator for southern Africa.

Uzbekistan

The NDMC Drought Impacts Researcher Kelly Smith, NDMC Director Mark Svoboda and University of Nebraska Medical Center Professor of Water, Climate and Health Jesse Bell attended the United Nations Convention to Combat Desertification from Nov. 13–17, 2023, held in Samarkand, Uzbekistan. They presented a session on the Global Impacts of Drought.

Peru

The NDMC conducted a workshop in Peru to develop a Composite Drought Index with the Peru Ministry of Agricultural Development and Irrigation and the National Service of Meteorology and Hydrology of Peru.

Czech Republic

The NDMC is in ongoing communication to share knowledge with a team of climatologists at Mendel University in Brno, Czech Republic, as they develop and refine a drought early warning system for monitoring and forecasting agricultural drought and impacts.

South Korea

The NDMC worked with Hankyong National University in South Korea. A delegation from HNU visited the NDMC in 2023 to discuss flash drought, student projects and the development of a drought early warning system for South Korea.

United States

The NDMC continues to work with agencies, local governments and individuals at every level on drought monitoring, response, preparedness and planning in the U.S. The Oregon Water Resources Department contracted with the NDMC and academic centers in Oregon to conduct a drought vulnerability assessment in 2023. The NDMC focused on risks to agriculture, drinking water and water-related recreation.

Published in January 2023, the Iowa Drought Plan provides comprehensive state-specific guidance on what to do before, during and after drought events. The NDMC provided background on other states' drought plans that allowed Iowa partners to adapt key components to the state's unique needs.

We partnered with the USDA Regional Climate Hubs to develop workshops and develop new drought tools across almost every region. We're working with tribal governments, agricultural producers and climate service providers in the Southwest on climate-smart strategies for Indigenous farmers and drought resilience knowledge sharing. We're providing guidance on the National Climate Assessment for the Northern Great Plains Region, and we continue to be supported by the USDA Office of the Chief Economist to enhance the capabilities of the U.S. Drought Monitor.

Daniel Tsegai of UNCCD, Kelly Smith, Mark Svoboda and Jesse Bell at the United Nations Convention to Combat Desertification from Nov. 13–17, 2023, in Samarkand, Uzbekistan.

2023
By the Numbers

EARNED MEDIA

Reference	Mentions	Ad Value Equivalence*
National Drought Mitigation Center	2,536	$77,079,240
U.S. Drought Monitor	32,216	$1,807,864,654
University of Nebraska + NDMC or USDM	2,334	$64,181,731
University of Nebraska and Huskers or Cornhuskers	8,644	$232,892,662

Percent of University of Nebraska media mentions related to NDMC or USDM: 2.4%

Percent of University of Nebraska media mentions related to Huskers: 8.2%

The National Drought Mitigation Center and the U.S. Drought Monitor accounted for 2,334 of the University of Nebraska's 105,392 mentions in news around the world in 2023, 2.4% of the total. For perspective, the Huskers contributed 8,644 of Nebraska's mentions, or 8.2%. That means the NDMC and USDM generated 27% of the amount of publicity for Nebraska that the Huskers did – not bad for a "dry" topic!

The NDMC uses the Meltwater media service to track the impacts of drought. But we can also use it to track media mentions and estimate value. "Earned media" refers to news coverage. In this case we are looking at references to the National Drought Mitigation Center, the U.S. Drought Monitor, and the University of Nebraska, separately and together. "Mentions" is the number of times NDMC, the USDM and/or NU are named in news coverage.

* "Ad Value Equivalence" (AVE) is a formula for translating mentions into dollars, based on how much it would cost to buy an equivalent amount of advertising. AVE is a way to put a dollar figure on the results of public relations campaigns. Meltwater calculates AVE based on the monthly number of visitors for each media source, and the assumptions that 2.5% of visitors will read any given article and that each visitor's viewing is worth 37 cents, so AVE = mentions x 0.025 x 0.37.

2023
By the Numbers

OUR ORGANIZATION

29
Faculty and staff

18
Scholarly publications

14
Active projects

11
Students and interns

$5 MILLION
Total active grants

$12.4 BILLION
Livestock forage disaster program assistance
triggered by the USDM through 2023

The U.S. Department of Agriculture's Farm Service Agency administers the Livestock Forage Disaster Program. Livestock producers are eligible for different amounts of assistance depending on the U.S. Drought Monitor status for their county.

SOCIAL MEDIA FOLLOWERS

11,845 3,259
579 139
December 2023

WEB PAGE VIEWS

NDMC Tools

Drought Risk Atlas	7,182
Drought Impacts Toolkit	46,146
Grass-Cast	7,809
NASA GRACE	65,937
NDMC Blends	15,059
QuickDRI	3,526
Ranch Planning Guide	71,572
Scenario Guide	3,351
VegDRI	18,078

Drought Monitor Sites

U.S. Drought Monitor	17,382,131
Ag in Drought	201,746
FSA Livestock Eligibility Tool	30,779
North American Drought Monitor	84,324
USDM Spanish	46,299
USDM Tutorial	5,864

NDMC Main

National Drought Mitigation Center	405,792
Dust Bowl	160,066

All Sites

18,565,897

Partnerships

International

- Agriculture and Agri-Food Canada
- Botswana Department of Water Affairs
- Caribbean Institute for Meteorology and Hydrology
- CONAGUA (Mexico)
- Environment and Climate Change Canada
- Eswatini National Disaster Management Agency
- Global Water Partnership
- International Water Management Institute
- Integrated Drought Management Programme
- Korea Water Resources Corporation
- Peru Ministry of Agricultural Development and Irrigation
- United Nations
  - Convention to Combat Desertification
  - Environment Programme
  - Food and Agricultural Organization
  - World Meteorological Organization
  - World Food Programme
- World Bank
- Zimbabwe Department of Civil Protection

Federal

- 557th Weather Wing (formerly Air Force Weather)
- Federal Emergency Management Agency
- U.S. Army Corps of Engineers
- Bureau of Indian Affairs
- Bureau of Reclamation
- U.S. Fish and Wildlife Service
- National Aeronautics and Space Administration
  - Jet Propulsion Lab
  - Goddard and Marshall Flight Centers
- National Oceanic and Atmospheric Administration
  - Climate Program Office
  - National Centers for Environmental Information
  - National Integrated Drought Information System
  - National Water Center
  - National Weather Service Climate Prediction Center
  - National Weather Service River Forecast Centers
  - Regional Climate Centers
  - Office of Atmospheric Research
- U.S. Department of Agriculture
  - Agricultural Research Service
  - Climate Hubs
  - Farm Service Agency
  - Foreign Agricultural Service
  - Forest Service
  - National Agricultural Statistics Service
  - Natural Resources Conservation Service
  - Office of the Chief Economist
  - Risk Management Agency
  - World Agricultural Outlook Board
- U.S. Geological Survey
  - Climate Adaptation Science Centers
  - Earth Resources Observation and Sciences System
  - Social and Economic Analysis Branch

Academic

- Nebraska University
  - Center for Great Plains Studies
  - Daugherty Water for Food Global Institute
  - Extension
  - Institute of Agricultural and Natural Resources
  - Nebraska Water Center
  - University of Nebraska Medical Center
  - UNL Department of Biological Systems Engineering
  - UNL Public Policy Center
  - UNL School of Natural Resources
- Colorado State University, Extension Western Region
- East-West Center, Honolulu
- Emerson College
- Iowa State University
- Kansas State University
- Montana State University
- New Mexico State University
- North Central Climate Collaborative
- North Dakota State University, Extension
- Oklahoma State University
- Purdue University, North Central Regional Center for Rural Development
- South Dakota State University, Extension
- Southern Climate Impacts Planning Program
- Southwestern Indian Polytechnic Institute
- University of Alaska-Fairbanks, Cooperative Extension
- University of Alaska-Fairbanks, Alaska Center for Climate Assessment and Policy
- University of Arizona
- University of California, Santa Barbara
- University of Colorado-Boulder
- University of Illinois
- University of Iowa
- University of Nevada-Reno, Desert Research Institute
- University of Nevada-Reno, Department of Geography
- University of Texas-Austin
- University of Wisconsin-Madison

State

- State of Iowa
  - Department of Homeland Security
  - Department of Natural Resources
- Nebraska State Government
  - Department of Agriculture
  - Department of Environment and Energy
  - Department of Natural Resources
  - Emergency Management Association
  - Governor's Climate Assessment and Response Committee
  - Natural Resources Districts
  - State Climate Office
- Nevada State Climate Office
- New Mexico Department of Agriculture

Private, Tribal and Nonprofit Organizations

- ACF Stakeholders
- Community Collaborative Rain, Hail and Snow Network
- Conservation Science Partners
- Intertribal Agricultural Council
- Middle Rio Grande Pueblos Coalition
- North Central Region Water Network
- Santa Ana Pueblo Department of Natural Resources
- Southern Ute Indian Tribe
- State Grazing Lands Coalition
- Ute Indian Tribe
- Ute Mountain Ute Tribe

Two new staff members join NDMC in 2023

Lindsay Johnson
Climatologist

Lindsay joined the National Drought Mitigation Center staff in January 2023. Originally from Aurora, Colorado, she grew up skiing, rafting, hiking and playing soccer.

Her duties at the NDMC include authoring the U.S. Drought Monitor, writing monthly and quarterly drought climate summaries, and assisting in facilitating drought workshops with groups across the country.

Lindsay earned a bachelor's degree in meteorology/climatology from the University of Nebraska-Lincoln in 2011. Following graduation, she worked as an operational meteorologist at Amundsen-Scott South Pole Station, Antarctica in 2013. In 2016, she earned a master's in Earth Science with a specialty in climatology from the University of Northern Colorado.

During her time in the master's program, she worked as an intern at The COMET Program within the University Corporation for Atmospheric Research (UCAR). Upon graduation, she continued working at The COMET Program as an associate scientist until she started Ph.D. work in climate assessment and impacts at the UNL School of Natural Resources in 2018.

In her free time, she enjoys traveling, watching soccer, and spending time with her dog.

Emily Case-Buskirk
Communications Specialist

Emily joined the NDMC team in June 2023. She is passionate about applying her multimedia skillset to environmental communications and collaborating with researchers to inform the public.

At the NDMC, she is responsible for creating and coordinating content for publications, reports and digital communications. This includes writing news articles, editing technical summaries, managing the quarterly DroughtScape newsletter and providing communications-related support for various projects.

Emily earned a bachelor's degree in English with a writing emphasis from Hastings College in 2014 and a master's in Journalism and Mass Communications from UNL in 2018. Her background in media and communications includes experience working at the Norfolk Daily News, the Nebraska Department of Environment and Energy and the UNL Department of Biological Systems Engineering.

Her work has appeared in the Lincoln Journal Star, Nebraska Life magazine, Grand Island Independent and other publications. She has also served on boards including the Friends of Pioneers Park Nature Center in Lincoln.

Outside of work, Emily enjoys going on bike adventures with her spouse, exploring the Lincoln community, trying new recipes and spending time with her pets.

NDMC

NATIONAL DROUGHT MITIGATION CENTER

UNIVERSITY OF NEBRASKA

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