Like the impacts of a warming planet, droughts occur across large stretches of space and time. In 2021, the fourth-warmest year on record in the U.S., drought again demonstrated its reach. More than 55% of the Lower 48 was experiencing moderate drought or worse as of Jan. 18, 2022, which was a U.S. Drought Monitor-era record. While drought is a disastrous but normal part of most climate cycles, a warming planet is increasing the risks of extreme weather events, which will most likely result in more extreme or more sudden droughts, and more cascading hazards, including droughts exacerbated by heat and wind, or ending with catastrophic flooding.

We at the National Drought Mitigation Center recognize that this calls for us all to adapt. We are living through a period of climate intensification and rapid shifts in the weather. To match this, our efforts to improve drought monitoring systems, track impacts and respond proactively to drought must intensify as well. In our 2021 Annual Report, you will find example after example of ways that we are answering the call, while also developing and enhancing resources that will help you answer it as well.

This year, our staff attended far fewer workshops and conferences in person than we normally would, as the pandemic continued to limit travel. However, we may have reached even more people than in the past with our active virtual presence. Accordingly, the list of places where we have worked is shorter than in the past, but our collection of new products and tools has grown. These tools, data, products and services help ranchers, drought planners, researchers and all of us.

One way we are adapting to the changing speed and scope of drought is by calling on you to send us reports and photos of conditions where you live. More eyes on the ground helps everyone make better decisions. Usage of our public-facing tools, like the Condition Monitoring and Observation Reports (CMOR) system, is highlighted in a story about how Extension agents used it to tell the story of drought across North Dakota. You can use it to tell your stories, too!

While we may not have traveled like we usually do, the NDMC continued to work with local, state, national tribal and international partners to address the nature of drought on numerous scales. In our backyard in Nebraska, one of our graduate students has been hard at work with our staff on a project that addresses water usage across Nebraska’s Republican River Basin. In our continued effort to provide U.S. Drought Monitor information to help underserved communities, we collaborated with the U.S. Department of Agriculture to show drought conditions on over 300 tribal areas located across the U.S. via the U.S. Drought Monitor. Fortunately, I was able to travel to Germany to join the United Nations’ Science Policy Interface team of the Convention to Combat Desertification, one of several working groups I’ve been honored to serve on which I believe will help our partners adapt and build resilience to drought on global scales. After all, it was also the sixth-warmest year on record across the world. On the heels of the large and intense 2021 drought, and coming off a dry winter for many, drought looks ready to expand rapidly eastward across the U.S. early in 2022. Let’s be prepared!

Mark Svoboda, Ph.D., Director

Mark Svoboda, Ph.D., Director
In mid-June, about 42% of the 3,572-square-mile Standing Rock Sioux Reservation was experiencing extreme drought. Home to the Sihasapa and Hunkpapa bands of the Lakota Nation, the reservation straddles the North Dakota-South Dakota border, and the Great Plains tribal area measures about twice the size of Delaware. In an area of that size and scope, drought affects life in many ways, said Doug Crow Ghost, president of the Great Plains Tribal Water Alliance. The drought, he said in June, was affecting annual tribal ceremonies.

“Right now, sage is usually coming up pretty healthy,” Crow Ghost said at the time. “And it’s really dry right now, so a lot of the places where we usually go and pick sage, they’re dry. They’re gone because of the lack of rain of course, because of the drought.”

Visitors to the U.S. Drought Monitor (USDM) website can now search for drought conditions specific to tribal areas like the Standing Rock Sioux Reservation. The National Drought Mitigation Center, in partnership with the U.S. Department of Agriculture, recently introduced search features that provide maps and data specific to 323 tribal areas. While water management experts like Crow Ghost have previously used Drought Monitor data to call attention to water rights and other water-related issues, he said that the new searchable features can help tribal communities see how drought is affecting them specifically. They will help producers better prepare plans for harvesting and help everyone better coexist “with our relatives that are four-legged animals, winged animals and also with Mother Earth and what it produces.”

When you visit droughtmonitor.unl.edu and search the USDM’s numerous data and mapping products, “Tribal Areas” now appears in the dropdown menu of area types. Users can then view drought data or maps for more than 300 tribal areas. As with other defined territories, information and maps of the tribal areas can be cross-referenced with data from more than 20 years of USDM maps.

“We know that drought is a condition of Mother Earth that is saying that she is sick,” Crow Ghost said. “Knowing where she’s sick, knowing where these conditions are, can help us figure out where and why we should be planting or harvesting or not planting or not harvesting, or using more water, or using too much water.”

The project to spotlight tribal area data on the U.S. Drought Monitor site is the latest effort to make the USDM more accessible to underserved populations, said National Drought Mitigation Center climatologist Brian Fuchs. A Spanish-language version of the USDM was previously created to provide weekly drought information for Spanish-speaking populations in the U.S. Both projects were completed by the National Drought Mitigation Center in collaboration with the U.S. Department of Agriculture. Fuchs said it’s a goal of the USDA and NDMC to make the Drought Monitor more accessible. The USDA Office of the Chief Economist provided funding for the project.

Visit droughtmonitor.unl.edu to explore the new search features.
North Dakota uses observation system to get clear picture of 2021 drought

From April 1 to Oct. 31, 2021, no less than 30.2% of the Lower 48 experienced severe drought (D2) or worse. Drought covered scores of states and several regions throughout the growing season, and the spatial scale was evidenced in the 1,550 on-the-ground dispatches submitted to the Condition Monitoring Observation Reports (CMOR) system developed at the National Drought Mitigation Center. Californians, Wyomingites, Minnesotans, Oregonians and residents of other drought-affected areas across the country shared condition reports and photographs to CMOR. But no state submitted reports during the growing season at a rate close to that of North Dakota.

North Dakotans submitted 803, more than half the nationwide total, overlapping with a period when the state experienced the worst drought conditions it has experienced in the 21-year history of the U.S. Drought Monitor. For three weeks in May, nearly 85% of the state was experiencing extreme drought (D3) or worse (the largest D3 coverage on record since 2000). The top 29 weeks of D3 or worse coverage across North Dakota occurred in 2021, according to the Drought Monitor.

A concentrated statewide effort before the start of the growing season encouraged North Dakota Extension specialists to contribute to CMOR, said Adnan Akyüz, North Dakota state climatologist and professor of climatological practice at North Dakota State University. Those 803 CMOR submissions, he said, not only helped provide valuable context that shaped his weekly recommendations to U.S. Drought Monitor authors but also unlocked aid for the state’s producers from federal assistance programs tied to the Drought Monitor.

North Dakota’s season-long, statewide effort to submit on-the-ground drought condition reports shows how the CMOR tool can help researchers better understand localized drought impacts, said NDMC impacts researcher Kelly Helm Smith.

The CMOR-based process of providing on-the-ground information that Akyüz examined was markedly different from previous efforts to gather data across the 19th-largest state with the fourth-smallest population and email it to USDN authors.

In early 2021, Akyüz and Miranda Meehan, NDSU Extension livestock environmental stewardship

In 2021, North Dakota experienced the most extreme levels of drought reported in the state since the creation of the U.S. Drought Monitor. Here are how some of the 803 Condition Monitoring Observation Reports collected during the growing season described what that looked like on the ground.

Date: April 1, 2021

County: Golden Valley

Description: Grasshoppers feeding on a sunflower.
specialist, invited Smith to speak to a virtual meeting of Extension agents about how CMOR works. She provided details on how they could provide valuable information to Drought Monitor authors by completing brief surveys that provide key context about current conditions. When users add written descriptions about the conditions, and submit photos too, the data becomes clearer. CMOR reports appear on an interactive map layer that is visible to the general public and to U.S. Drought Monitor authors and state experts such as Akyüz.

By the end of 2020, moisture was depleted in North Dakota and ranchers were overgrazed, particularly in the western part of the state. With a La Niña winter, climatologists were anticipating a dry start to 2021. “We knew the trouble had an early start, so we started early,” Akyüz said. “We started having meetings in winter not only with the National Drought Mitigation Center but also with the state’s emergency managers and the North Dakota Department of Agriculture.”

Smith said she appreciated the willingness of the Extension network to adopt a new system. Some downloaded and used a mobile app to submit reports, while others sent information from their computers. “The results from North Dakota in 2021 really demonstrated how effective it is to have a well-established network with a clearly defined purpose making use of the system,” Smith said. “Adnan and Miranda did a great job of reminding Extension specialists to submit weekly reports, and they helped with some troubleshooting of the system, too.”

For Akyüz, the CMOR archive would greatly streamline data synthesis while also allowing him to continue pointing out to Drought Monitor authors important descriptions of drought from across the state. “It’s a mutual benefit really,” Akyüz said. “You’re understanding how the drought is affecting the local conditions that appear on the map, and also to help us identify the areas that need more attention in real time. They also provided the pictures, which is sometimes worth more than a million words.”

When the growing season concluded, county agents informed producers that they could take a break from CMOR, but Akyüz said that they will recommend that they use CMOR in future seasons. And current CMOR reports, he said, will help future county agents calibrate subjective data. They will be able to look at what reports were filed during portions of 2021 when areas of the state were in exceptional or extreme drought. In the middle of the punishing 2021 drought, Akyüz left Fargo to take a driving tour of some of the areas of the state hardest hit by drought. Talking to producers and seeing the drought conditions for himself provided context that other objective data cannot, he said.

**Date:** July 26, 2021

**County:** Grant

**Description:** The conditions are severely dry throughout the whole county and beyond. The southern part of the county originally was doing better in terms of moisture with significant rainfall received in early June. But they have since eaten through those moisture reserves. All crops are burning up in the constant heat without any rainfall.

**Date:**

**County:**

**Description:** The conditions are severely dry throughout the whole county and beyond. The southern part of the county originally was doing better in terms of moisture with significant rainfall received in early June. But they have since eaten through those moisture reserves. All crops are burning up in the constant heat without any rainfall.
“It was a tremendous help,” he said. “I can look at the precipitation departure from normal, for example, I can look at the soil moisture data just like the Drought Monitor author can do. But what I cannot see is (what I can learn by) tapping into local resources such as ranchers and farmers. You’ve got to keep in mind that 90% of the North Dakota economy depends on agriculture. We are less than 1 million population, and we are one of the largest states in the union, and agriculture is everything. And listening to these reports allowed me to see what I couldn’t see by objective data. It allowed me to capture the concern of the very same people that are impacted by the drought. It opened up my mind into the minds of the locals. And I think my job at that time was to make sure that the Drought Monitor author feels the same as I do in my office.”

Every time the Drought Monitor status for North Dakota changed, Akyüz created a PowerPoint presentation for county agents that included not just the changed map, but also bullet points that included anecdotal objective data pulled from CMOR reports from a particular county or region where drought status changed.

“And listening to these reports allowed me to see what I couldn’t see by objective data. It allowed me to capture the concern of the very same people that are impacted by the drought.”

– Adnan Akyüz, North Dakota State Climatologist

“I made a point that their reports made a difference,” he said. “And then it was reinforced by the director of extension services how important their reports are, so they became twice as motivated to participate.” □
Andrew Mwape of Zambia is working with the state of Nebraska and four of its Natural Resources Districts on drought planning for the Republican River Basin. To explain why stakeholders in the region should prepare for drought, he offered a quote from J.R.R. Tolkien: “It does not do to leave a live dragon out of your calculations, if you live near him.”

Mwape is a Ph.D. student in the School of Natural Resources at the University of Nebraska-Lincoln, working with the National Drought Mitigation Center and with the state’s Department of Natural Resources.

In 2019, Nebraska DNR entered into an agreement with the NDMC to provide funding for a graduate student to help evaluate current and potential water management practices in the districts. Mwape, a recent Mandela Washington Fellowship honoree from Zambia, was selected from a competitive field to work on the project in Nebraska.

Mwape learned about the opportunity, and the Drought Center, when he was hosted at UNL as part of the fellowship program. For Mwape, drought is both a professional and personal concern. While in Zambia, he founded an environmental advocacy organization to encourage sustainability practices in one of the world’s most drought-vulnerable regions.

As a Mandela fellow, he wanted to learn about effective policymaking that could lead to better drought resilience in Africa. During his fellowship, he met someone who had some thoughts on the subject: Donald Wilhite, founding director of the National Drought Mitigation Center. Wilhite told Mwape about the Drought Center and introduced him to another former NDMC director, Michael Hayes. The conversations convinced Mwape that enrolling at UNL and working at the Drought Center would be the best place to continue his studies on drought management.

“Africa is one of the most vulnerable places on the planet when you talk about drought, because of the geographical location and also the economic capacity to bounce back,” Mwape said. “It’s always interested me to see how I can be of impact in bringing about policies that would equip people and communities to bounce back from drought.”

Now, Hayes is one of Mwape’s advisors as he works with Nebraska DNR to develop scenario exercises and identify possible gaps in drought preparedness with stakeholders who live in the Republican River Basin. Through the exercises and planning, Nebraska DNR officials say they intend to help develop better understanding of needs and issues related to storing surface and aquifer water to meet crop-water demands during future droughts.

Andy Pedley, integrated water management analyst with Nebraska DNR, said the efforts to organize basin-wide drought planning exercises and analyze the findings are among the many objectives included in the Republican River Basin-Wide Plan. The overarching goal of the plan is to balance water demands and supply across the basin, while remaining in compliance with the Republican River Compact.

The Republican River Basin, Pedley said, is one of the drier regions of Nebraska, and tends to be drier from the Upper Republican NRD in the west toward the Lower Republican NRD to the east. Because water resources are shared not just among the four NRDs but also across the state and across state lines, Pedley said that the effort to identify possible drought preparedness gaps should be as thorough as possible.

The project involves engaging farmers, water planners and other stakeholders to find out how droughts have affected them and how they can strategize together to come up with the best possible responses when the next drought occurs, he said.

“Much of the economic activity there is agricultural,” Mwape said. “Drought affects them not only in water aspects, but also their health — their mental health and mental stress. Everybody matters and everybody must play a role in addressing issues of drought.”

Grad assistant Mwape helping state and resource districts plan scenario exercise

“Everybody matters and everybody must play a role in addressing issues of drought.”
- Andrew Mwape, NDMC graduate research assistant
We realized that not only making them aware of the impacts of drought but also engaging them would be very helpful. They are the ones that live with the droughts.”

To do that, Mwape is working with his advisors to develop a scenario exercise and bring stakeholders in the four NRDs to the table to assess water management values and drought management strategies. Mwape said that to select the best types of exercises for the NRD stakeholders, he has consulted Collaborative Drought Planning Using Scenario Exercises, co-authored by another of his advisors, NDMC education coordinator Deborah Bathke.

Along with Hayes and Bathke, Mwape is being advised by High Plains Regional Climate Center director Rezaul Mahmood. NDMC assistant director Kelly Helm Smith is a project advisor. The two-year project involves working with researchers and academics at the Drought Center and UNL’s School of Natural Resources, government agencies and on-the-ground stakeholders. That is a combination Mwape sought, as he intends to work on drought management issues with similar partners in Africa upon completion of his graduate studies at Nebraska.
New products help people monitor and plan for drought

In early 2022, the U.S. Drought Monitor recorded its 68th consecutive week of more than 40% drought coverage across the Lower 48 states, a USDM record for drought duration at that outsized footprint. The National Drought Mitigation Center team this year produced or enhanced a number of drought resilience and monitoring products that can help specific groups, as well as the general public, better prepare for drought as well as adapt to living through droughts. It also improved a tool that the public can use to better share conditions where they live with drought-monitoring experts. The NDMC features staff members with expertise in climatology, remote sensing and information technology, community and regional planning, sociology, geography, policy analysis and communications. That knowledge is reflected in these resources.

Dashboard steps ranchers through key questions

When faced with developing drought, ranchers often have questions. How severe is this drought? How long could it last? Is this as bad as the last drought we experienced, or is it the worst one? What are the chances it rains enough to produce normal forage over the coming weeks or months, and how much rain would be needed for a “normal” grazing year?

These are questions frequently asked by ranchers who have taken part in drought management workshops with the National Drought Mitigation Center and partner agencies, said NDMC rural sociologist Tonya Haigh. While many resources can help answer those questions, Haigh said they could be challenging to track
down and sift through. Now, ranchers have a resource on the NDMC website that addresses a number of common drought condition questions on one map, in one place, including some map layers and management information specific to the Great Plains and Southwest U.S.

The Ranch Drought Monitoring Dashboard (drought.unl.edu/ranchplan/monitor.aspx) aims to provide information that will help ranchers reduce risk ahead of time, Haigh said. The dashboard features the latest data on drought and precipitation conditions, outlooks, on-the-ground reports, vegetative stress, forage productivity and more, organized around the key questions.

“There’s a lot of information out there, and sometimes it’s challenging to figure out what you are supposed to do with all of it,” Haigh said. “So that’s why we organized this the way we did, to see if we can make the process easier by trying to tailor information that addresses specific drought monitoring questions that ranchers often ask.”

The Ranch Drought Monitoring Dashboard was developed by the NDMC in collaboration with the USDA Northern Plains and Southwest Climate Hubs, with input by Extension and NRCS range experts in the regions, and funding support by the USDA Office of the Chief Economist.

Interactive guide helps drought planners pick best scenario exercise for different purposes

In times of drought, community and regional water managers must often make decisions on how water is allocated to protect everything from the economy to agronomy to public health. To help with the decision-making process, many communities have put drought plans in place. And over the past decade, as communities have developed or updated those drought plans, water management leaders have increasingly started or furthered the conversation among stakeholders by bringing them to the table to consider realistic what-if scenarios.

Those scenarios are often either a workshop, a tabletop exercise or a game. To know which type of exercise is right for your community, it helps to consider what you want to get out of it, said Deborah Bathke, education coordinator for the NDMC. To help leaders through that process, the NDMC recently released the interactive guide, Collaborative Drought Planning Using Scenario Exercises, thanks to funding from the North Central Region Water Network and North Central Regional Center for Rural Development.

“We think it will help organizers make informed decisions as they decide how to best hold their own drought planning events,” Drought Center director Mark Svoboda said.

NDMC staff collaborated with federal, state and community partners to evaluate the design, function and success rates of holding different types of events to address drought planning in its different stages. Differing in complexity, cost, size and scope, the events are more effective when a community can tailor them to fit their goals, Bathke said. The first stage of research was funded through the National Integrated Drought Information System (NIDIS).

“This guide is a user-friendly, interactive tool that can be used to help figure out what the best type is for the group you’re looking to bring to the table and helps
guide you through the process of developing a drought-based scenario exercise from start to finish,” Bathke said.

The guide is available at: https://drought.unl.edu/scenarioguide/Overview.aspx.

**Drought Impact Reporter data displayed in dashboard**

The Drought Impact Reporter, established in 2005 to be the nation’s comprehensive archive of drought impacts, has a new look now. It is easier and more intuitive to access the 16 years’ worth of data. The Drought Impact Reporter Dashboard – go.unl.edu/DIRdash – includes an interactive map, counts, timelines, and the text of impacts. Filters are by date, place, and impact category. A companion web app provides more tools for filtering, searching and downloading data.

This upgrade to the user interface was possible thanks to support from the U.S. Department of Agriculture’s Office of the Chief Economist. The data that it displays, drought impacts curated from media reports, is almost entirely the work of Denise Gutzmer, NDMC climatologist and drought impacts specialist. Data and app configuration are the work of Ian Ratcliffe, NDMC GIS developer. Kelly Helm Smith, NDMC drought impacts researcher, led the transition.

**Media Drought Index tracks awareness of drought**

When drought develops somewhere across the country, news reports often chronicle its effects on that area. These reports can be vital resources in trying to understand the impact of drought in the U.S., said National Drought Mitigation Center assistant director Kelly Helm Smith. The Drought Center has developed a mostly automated news search process for drought impacts and is mapping and quantifying the results. The experimental Media Drought Index (MDI), now available to the public, may help detect emerging impacts, said Smith, who led its development.

“The news has been the one source of drought impact information that is the most systematically curated over time since the Drought Center opened its doors in 1995,” said Smith, a former newspaper reporter. “In 2005, we started adding them, by hand, to the Drought Impact Reporter. Now we have the Media Drought Index.”

Both the Media Drought Index and the Drought Impact Reporter are part of the Drought Impacts Toolkit, which has been developed with support from the U.S. Department of Agriculture and the National Integrated Drought Information System and is included in the U.S. Climate Resilience Toolkit.

Smith said that the MDI was created to help researchers, climatologists and the public in their efforts
to track drought impacts and to see where drought-related news is being published at higher or lower rates than normal, based on 10 years of data collected via the Meltwater media tracking database. States each receive an MDI score that quantifies how many more news reports a state is generating than normal for that state and time of year. The map of state MDI levels is updated each Monday. As expected, states in red, signifying high levels of drought-related news, also tend to be experiencing prolonged or intense drought.

“It’s a resource that can be helpful if you’re thinking, ‘Oh, I wonder what’s happening in this place,’” Smith said. “It’s a map-based way to find the news, which is kind of interesting for place-to-place comparisons.”

The Media Drought Index is now publicly available at go.unl.edu/droughtnews.

**U.S. Drought Monitor alerts users to county drought status changes**

The latest U.S. Drought Monitor publishes on Thursday mornings at droughtmonitor.unl.edu, where users can find the weekly nationwide snapshot of drought conditions, along with a set of maps, data and tools that give key context about conditions where they live. Now you can also have the latest local information delivered to your inbox.

The National Drought Mitigation Center offers county-level email alerts when drought conditions reach or recede from a specific drought designation – moderate drought (D1) to exceptional drought (D4). The feature is called the Drought Alert Request.

The product was developed in 2021 as part of the Drought Center’s cooperative agreement with the U.S. Department of Agriculture (USDA) and is one of several efforts to increase accessibility of U.S. Drought Monitor information for users across the U.S. and its territories. Other efforts have included the development of tribal area maps, state-level drought impact tables and Spanish-language editions of the Drought Monitor.

**New objective blends have finer spatial resolution**

The U.S. Drought Monitor map is not strictly objective, in the sense that its authors use expert judgement to reconcile what different streams of data are saying about drought. But objective data is the backbone of the process, and the mix, or blend, of objective data varies by region and season.

So Drought Monitor authors sought to develop a tool that could help them. The author-led effort, which began during the first U.S. Drought Monitor Forum in 2000, led to the creation of a weekly “objective blends” that would provide short-term and long-term depictions of drought conditions based on a weighted model that blended several sets of climate division data together. NOAA’s Climate Prediction Center, which developed the product based on the authors’ input, houses the blends online.

A lot has changed in 22 years. The NDMC completed testing of an updated objective blends tool in 2021, incorporating newer, gridded datasets. The work associated with the development of the new objective blends was funded by USDA’s Office of the Chief Economist. The new objective blends are online: ndmcblends.unl.edu. □
A one-year snapshot like an annual report doesn’t tell the full story of a mission-driven organization like the Drought Center. The NDMC was established in 1995, growing from the experience of the International Drought Information Center, as U.S. policymakers realized that the nation would benefit from an in-country version of that organization. The NDMC, housed at the University of Nebraska-Lincoln’s School of Natural Resources, works to reduce the effects of drought by helping decision-makers with monitoring and planning.

The NDMC creates drought planning and decision-making tools that have been applied across the country and around the world. As NDMC director and drought monitoring expert Mark Svoboda frequently says, monitoring is the relatively easy part. Knowing what you’re going to do about drought is harder.

The NDMC curates a one-of-a-kind collection of state-level plans (drought.unl.edu/droughtplanning/InfobyState.aspx) that deal with drought, including drought plans, hazard mitigation plans, water plans and climate plans. When the NDMC was formed, only a handful of states had drought plans, and there are now 46 states with plans on the books. The NDMC has worked with most in some form or capacity over the years.

The NDMC develops tools that step decision-makers at all scales through drought planning (drought.unl.edu/droughtplanning/AboutPlanning/PlanningProcesses.aspx), including the newly released dashboard for ranchers, Drought-Ready Communities, guidance for urban planners developed in collaboration with the American Planning Association, and the original 10-step drought-planning process that has been adapted and built upon by states, tribal groups and countries around the world. The Drought Preparedness 10-Step Process established by Don Wilhite, NDMC founding director, has been adapted globally into the “3-Pillar Approach” promoted by United Nations agencies. The three pillars — monitoring and early warning, vulnerability and risk assessment, and planning mitigation and response actions — are the cornerstone of our drought planning approach.

The NDMC advances state-of-the-art drought-monitoring science. The NDMC has developed and maintains several state-of-the-art tools for monitoring drought, and is the academic partner and web host for the U.S. Drought Monitor (droughtmonitor.unl.edu). Svoboda was a co-founder of the USDM in 1999. The USDM incorporates many data sources into a single depiction of drought each week, literally helping the nation get on the same page for coping with drought. The USDM triggers billions of dollars in federal assistance for livestock producers and others.

The USDM is also available in Spanish, and associated statistics, maps and timelines are tailored for geographic regions including 323 tribal nations, all 50 states and U.S. island nations and territories. The USDM is a unique product that countries around the world would like to emulate, made possible by data that is freely shared within the U.S., and by a network of nearly 500 state and regional expert observers who help interpret data for their area. Expert judgment reconciles conflicting data to produce a single depiction of drought.

The NDMC has worked with several countries around the world to tailor Composite Drought Indexes for their needs, based on available data and specific vulnerabilities. This “convergence of evidence” approach that Svoboda co-founded, the backbone of the U.S. Drought Monitor, has become the state-of-the-science globally.

We wrote the book on drought monitoring. NDMC climatologists Mark Svoboda and Brian Fuchs co-authored the Handbook on Drought Indicators and Indices (www.droughtmanagement.info/indices) for the United Nations Integrated Drought Management Programme.

Contributing at home: The NDMC also contributes locally, serving on the Nebraska Climate Assessment and Response Committee and the Water Availability and Outlook Committee as well as working with the state’s Natural Resources Districts.

Welcoming collaborators: We have hosted over a thousand scientists/students and government officials and other professionals over the years, many who come to UNL to study and/or work in the drought risk management arena.
Drought planning in a nutshell. The NDMC advocates impact-driven planning, based on a few key questions:

- **Impacts, risk and vulnerability assessment**: What do you want to protect from drought? How does drought affect you, your livelihood, your city or community?
- **Monitoring**: How will you know when you are in drought? How will you monitor drought? If you don’t have a plan it can sneak up on you.
- **Mitigation**: What can you do to reduce vulnerability to drought ahead of time?
- **Response**: What can you do to reduce the effects during the next drought?

### Highlighted NDMC tools and resources

- The U.S. Drought Monitor ([droughtmonitor.unl.edu](http://droughtmonitor.unl.edu)), in partnership with NOAA and USDA
- The Drought Impacts Toolkit ([droughtimpacts.unl.edu](http://droughtimpacts.unl.edu)), including Condition Monitoring Observer Reports (go.unl.edu/cmor_drought) and the Drought Impact Reporter ([droughtreporter.unl.edu](http://droughtreporter.unl.edu))
- The ranch planning dashboard ([drought.unl.edu/ranchplan/Monitor.aspx](http://drought.unl.edu/ranchplan/Monitor.aspx)), a decision-making site recently developed based upon common questions that ranchers have posed at drought workshops; it serves as a one-stop shop for several useful tools such as Grass-Cast ([grasscast.unl.edu](http://grasscast.unl.edu))
- Guide to scenario-based drought planning ([drought.unl.edu/ScenarioGuide](http://drought.unl.edu/ScenarioGuide)), helping planners envision solutions to problems before they happen
- The NDMC’s website, [drought.unl.edu](http://drought.unl.edu), and [Monitoring Tools](http://drought.unl.edu/Monitoring/DroughtMonitoringTools.aspx)
- The Drought Risk Atlas ([droughtatlas.unl.edu](http://droughtatlas.unl.edu)), pre-computed drought indices and visualizations based on high-quality station data
- QuickDRI ([quickdri.unl.edu](http://quickdri.unl.edu)) and VegDRI ([vegdri.unl.edu](http://vegdri.unl.edu)), which incorporate remote sensing data to depict drought’s effects on vegetation at different time scales, with QuickDRI being especially responsive to flash drought
- NASA GRACE groundwater and soil moisture maps ([nasagrace.unl.edu](http://nasagrace.unl.edu)) and forecasts, web-hosted and distributed by NDMC

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**NDMC Media and Online Presence**

When drought is in the news, people turn to the National Drought Mitigation Center for answers, help and context. As web host of the U.S. Drought Monitor, the NDMC plays a significant role in interpreting the product through associated data and visualizations, and through regular social media posts. The NDMC’s media contacts in 2021 ranged from national and metropolitan outlets such as The Weather Channel, USA Today, The Washington Post, CBS News, Fox News, the New York Times and Seattle Post Intelligencer, to Nebraska news organizations such as the Beatrice Daily Sun and the Hastings Tribune. NDMC climatologists and others help interpret drought and drought’s impacts.

The U.S. Drought Monitor website ([droughtmonitor.unl.edu](http://droughtmonitor.unl.edu)) is hosted on University of Nebraska servers and it, along with the NDMC website ([drought.unl.edu](http://drought.unl.edu)), routinely draws millions of pageviews each year. In busy drought years, like the current one, NDMC and USDM pageviews have averaged over a million per month.
Where we worked

In normal years, members of the National Drought Mitigation Center team travel across the country and the globe to share and further develop best practices in better preparing populations for future droughts. The pandemic changed how the NDMC staff worked with our collaborators and partner agencies, but it did not change what we do. The past two years put a stop to most in-person meetings and led to far more teleconferences than normal, but the NDMC continued to work in partnership on improving drought monitoring and readiness around the world. Here are some of the most recent projects that are moving forward or were recently completed in 2021.

1. Africa (World Bank/SADC)
   The World Bank and the National Drought Mitigation Center are teaming up to work with the countries of the Southern African Development Community to enhance drought preparedness. The work will include helping countries develop composite drought indicators based on available data, tailored for key sectors and vulnerabilities, with an aim to help better trigger mitigation measures.

2. United Nations (Germany)
   The NDMC is working with the United Nations’ Science-Policy Interface, with the Intergovernmental Working Group of the Convention to Combat Desertification, and with the Integrated Drought Management Programme. Both efforts are centered on developing and recommending actionable policy measures to build and/or enhance resilience to drought, desertification and land degradation.

3. Caribbean
   The NDMC and long-time partner, the Caribbean Institute of Meteorology and Hydrology, with backing from the U.S. Agency for International Development, are hosting a series of workshops to enhance annexes to agricultural drought risk management plans for Grenada, Saint Lucia and other countries, with drought response stages incorporating information about historically observed impacts in each nation.

4. South America (SIISSA)
   The NDMC continued its work with the Drought Information System for southern South America (Spanish acronym, SIISSA) and the World Meteorological Organization. At a virtual workshop focused in Uruguay, country representatives assessed how well their nations were prepared for drought. The overall aim is to help countries in this region implement an integrated, proactive risk management approach in dealing with drought. Participating countries are Argentina, Bolivia, Brazil, Chile, Paraguay and Uruguay.

5. United States
   The Drought Center continues to work with the U.S. Department of Agriculture’s Office of the Chief Economist and Climate Hubs, as well as states, tribes, and many other agencies and organizations that are involved in drought monitoring, response, preparedness, and planning. The center also recently wrapped up a 5-year project with the National Integrated Drought Information System (NIDIS) in 2021.
2021 By the Numbers

**PARTNERS**

- **24** Federal Projects
- **6** State Partners
- **13** International Partners
- **15** Academic Partners
- **7** Other Organizations

**2021 By the Numbers**

**NEWS**

- **$1.15** Billion USDM References*
- **$23.8** Million NDMC References*
- **$54.4** Million USDM + UNL References*

**ACTIVE**

- **24** Projects
- **10.8 Million** Pageviews of all NDMC websites
- **3.1 Million** Users of all NDMC websites
- **239.4 Thousand** File Downloads across all websites

**RESEARCHERS**

- **23** Faculty & Staff
- **24** Peer-Reviewed Publications
- **8** Students
- **$7.2 Million** in total active grants in 2021

**WEB**

- **9,181** Followers (up 1,340 since 2020)

**SOCIAL**

- **2,646** Followers (up 188 since 2020)

* Media statistics and AVE calculations per Meltwater
Publication highlights


A “triple-whammy” of bad growing conditions left Missouri’s farmers and ranchers in dire conditions in 2018, and they used the then-new Condition Monitoring Observer Report crowdsourcing system to describe what they were experiencing. The 1,400 reports submitted by residents of the Show-Me State in 2018 represented a notably high rate of participation. This article examines what led to the high number of reports over a short time; how the crowd-sourced reports were of use to state decision-makers and U.S. Drought Monitor authors; and the potential for complementary use of reports from different types of observers. An accompanying interactive timeline (go.unl.edu/MO2018_timeline) and map (go.unl.edu/ MO_2018) facilitate comparisons of what news, CoCoRaHS citizen scientists and CMOR observers were saying across the year.


Drought Management Norms: Is the Middle East and North Africa Region Managing Risks or Crises?

Building on the NDMC’s extensive work in the Middle East and North Africa, participatory engagement research revealed the complexity of fully implementing drought risk management policies. Data gathered in focus groups, interviews, workshops, and policy documents were analyzed through the theoretical lens of norm diffusion to determine whether the international standard of drought risk management is put into practice. The study found that stakeholders recognize the value of drought mitigation in four selected MENA countries—Tunisia, Jordan, Morocco, and Lebanon. However, in practice, droughts are still managed as crises. Having early warning data and drought declaration procedures would help, but only if backed up by policy measures and financial mechanisms.


Valuation of Drought Information: Understanding the Value of the US Drought Monitor in Land Management

This article takes an avoided-cost approach to estimate the value of the U.S. Drought Monitor to state and federal decision-makers. It is based on survey research. In addition to grazing, drought-related decisions pertain to wildfire protection, wildlife and habitat, recreation and tourism, and wild horse herds. Most respondents said they use the U.S. Drought Monitor for communication both with the public and within their organizations. They also consult other drought indices. The estimated avoided cost was based on time saved.

Our team

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Partnerships

International
- U.S. Agency for International Development
  - Caribbean Institute of Meteorology and Hydrology
  - Grenada Airports Authority
  - Saint Lucia Meteorological Services
- Global Water Partnership
- International Water Management Institute
- Integrated Drought Management Programme
- Korea Water Resources Corporation
- United Nations
  - Convention to Combat Desertification, Science-Policy Interface, Intergovernmental Working Group
  - Environment Program
  - Food and Agriculture Organization
  - World Food Programme
  - World Meteorological Organization
- World Bank

Federal
- NASA
  - Jet Propulsion Lab
  - Goddard and Marshall Space Flight Centers
- U.S. Department of Agriculture
  - Agricultural Research Service
  - Office of the Chief Economist
  - World Agriculture Outlook Board (USDA Chief Meteorologist)
  - Climate Hubs
  - Natural Resources Conservation Service
  - Forest Service
- U.S. Department of the Interior
  - Bureau of Indian Affairs
  - U.S. Fish & Wildlife Service
  - U.S. Bureau of Reclamation
  - U.S. Geological Survey
  - Earth Resources Observation and Science (EROS) System
- U.S. Department of Commerce
  - National Integrated Drought Information System
  - National Centers for Environmental Information
- U.S. Army Corps of Engineers
- USGS
  - National Weather Service
    - River Forecast Centers
  - NOAA Office of Atmospheric Research
  - NOAA Climate Program Office
    - Sectoral Applications Research Program
    - Modeling, Analysis, Predictions and Projections
    - National Water Center
- U.S. Department of Commerce
  - National Integrated Drought Information System
  - National Centers for Environmental Information

International
- U.S. Agency for International Development
  - Caribbean Institute of Meteorology and Hydrology
  - Grenada Airports Authority
  - Saint Lucia Meteorological Services
- Global Water Partnership
- International Water Management Institute
- Integrated Drought Management Programme
- Korea Water Resources Corporation
- United Nations
  - Convention to Combat Desertification, Science-Policy Interface, Intergovernmental Working Group
  - Environment Program
  - Food and Agriculture Organization
  - World Food Programme
  - World Meteorological Organization
- World Bank

Academic
- Nebraska University
  - University of Nebraska Medical Center
  - Daugherty Water for Food Global Institute
  - Extension
  - Public Policy Center
  - High Plains Regional Climate Center
  - State Climate Office
  - School of Natural Resources
  - Nebraska Water Center
- Colorado State University
  - Colorado State University Extension, Western Region
  - North Dakota State University Extension
  - University of Colorado-Boulder
  - Southern Climate Impacts Planning Program
  - Desert Research Institute, University of Nevada, Reno
  - University of Wisconsin Cooperative Institute for Meteorological Satellite Studies
  - North Central Climate Collaborative (NC3)

State of Nebraska
- Nebraska Governor’s Climate Assessment and Response Committee, Water Availability and Outlook Committee
- Nebraska Department of Agriculture
- Nebraska Department of Natural Resources
- Nebraska Emergency Management Association
- Nebraska Department of Environment and Energy
- Nebraska Natural Resources Districts

Other Organizations
- Community Collaborative Rain, Hail and Snow Network
- Ute Mountain Ute Tribe
- Intertribal Agriculture Council
- Conservation Science Partners
- Iowa Department of Natural Resources
- State Grazing Lands Coalition
- Santa Ana Pueblo Department of Natural Resources
ADAPTING TO CHANGE

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