GRASSROOTS TO GLOBAL

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SCHOOL OF NATURAL RESOURCES

NDMC
NATIONAL DROUGHT MITIGATION CENTER
UNIVERSITY OF NEBRASKA

Annual Report
2022
The Platte River downstream of Kearney, Nebraska, was one of many rivers across the Midwest and Great Plains that was unusually low in summer of 2022. Photo by Craig Chandler, UNL Communications.
About the cover

Front: A 2002 photo of Earth from space. Nasa photo from Pixabay.

Back: Seashore paspalum on Kapapa Island, Oahu, Hawaii. Wikimedia Commons.

Inside: The summer of 2022 aerial photo of the Platte River downstream of Kearney, Nebraska. Photo by Craig Chandler, UNL Communications.

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20 NDMC welcomes four new staff members in 2022
For the first time in several years, 2022 felt somewhat back to normal from an operational perspective. Most team members (including four new staff!) returned to their offices on East Campus of the University of Nebraska-Lincoln. I was in Stockholm in October for World Water Week with several global collaborators, and, in July, we helped organize the first in-person gathering of the Southwest Drought Learning Network in over two years. Throughout 2022, our researchers and students participated in workshops across the country, from Oklahoma to New Mexico to Alaska and Hawaii. It’s been a pleasure to return to some semblance of normal so we can focus on the critical work of enhancing drought planning and monitoring tools. True to the theme of this Annual Report, we are working across all scales — from local to global.

And the timing couldn’t be better, because, from a drought perspective, 2022 was anything but normal. On the backs of two increasingly hot and dry years, drought tightened its grip on the entire country (all 50 states recorded drought conditions at some point this past year!). In November, over 85% of the contiguous U.S. was abnormally dry or in drought, a record level since the Drought Monitor began in 2000. The extent of the contiguous U.S. that was in drought didn’t even drop below 40% all year (we finally broke that rut just recently in February 2023 after 126 weeks straight). Over the summer, several states in the Southern Plains also experienced a brutal flash drought, degrading four categories on the Drought Monitor in just four weeks, which devastated agricultural operations in those states.

The extremes of 2022 reminded us of the importance of the Drought Center and our efforts to turn data into useful and usable information to build resilience at all levels. In this Annual Report, you will find just a few examples of our work toward that mission.

Our researchers, students and visiting scholars continued to publish cutting-edge research on drought planning and science in top-tier academic journals. Our social science coordinator, Tonya Haigh, was also selected to contribute to the 5th National Climate Assessment for the Northern Plains region. We engaged with organizations at every scale, from individual tribes and ranchers to national agencies to the global programs of the United Nations and World Bank. That includes our first collaboration with the Department of Defense with whom we’re developing a global indicator to help monitor drought “hot spots” using machine learning to fuse climate and socioeconomic vulnerability data.

All the while, we continued to create new drought tools and enhance our existing suite of options. We added new functionality to the Drought Monitor, giving users more control over how they view and access USDM data. We expanded our databases of drought impacts and refined existing tools like the Grassland Productivity Forecast. Two of our graduate students even developed a climate scenario game for agricultural decision-making as part of a workshop in Alaska. As always, our goal is to tirelessly address the unique concerns of communities confronting drought across the globe at all scales of need.

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Drought Center kicks off $1 million Defense project to predict unrest

We know that weather and climate can contribute to civic unrest, especially in countries with little to no social safety net, where people depend on subsistence farming to feed themselves and their families. The question is, can we predict civic unrest, along with the weather?

To begin answering that question, researchers at the National Drought Mitigation Center received the first $1 million of funding from U.S. Air Force Weather in spring of 2022. The funding is for the first phase of a broader effort.

The overarching project, “Building a Global Composite Drought Indicator Hot Spot Early Warning and Information System,” is led by NDMC director Mark Svoboda. The NDMC is teaming up with others on campus, including Ross Miller, Department of Political Science; Tirthankar Roy, College of Engineering; and Brian Wardlow, director of the Center for Advanced Land Management Information Technologies.

In this first phase, the NDMC is working to develop a global composite drought indicator, based on physical measurements of water availability such as precipitation, soil moisture, evapotranspiration and vegetation health. The NDMC has extensive experience working with countries around the globe to construct composite drought indices, based on what data is available and what sectors are most vulnerable. Socio-economic indicators that describe vulnerability to drought will be incorporated as a next step. Machine learning techniques will help guide the team along with feedback from key partners within the Air Force.

“Using multiple data sources and adapting to whatever is available for a country or region is consistent with the convergence-of-evidence approach that the U.S. Drought Monitor is based on,” Svoboda said. “A key difference here, besides generating an operational global product for the first time, is that we may have to use remote sensing data for countries that don’t have enough on-the-ground weather stations or in countries where they don’t share data freely. We may also need to use innovative methods to come up with drought assessments in areas where the period of record is short or non-existent. Drought is always a comparison to some normal, and there are places where we don’t have enough data to say what is normal.” Svoboda said the next stage of work will expand to include more partners and to examine more drought hotspots.

The NDMC works extensively with United Nations agencies such as the World Meteorological Organization, the Convention to Combat Desertification and the Food and Agriculture Organization, as well as with federal agencies in the U.S., including NASA, the U.S. Department of Agriculture, the National Oceanic and Atmospheric Administration and the U.S. Agency for International Development. This project, Building the GCDI, is the NDMC’s first foray into working with the Department of Defense.
NDMC’s Haigh contributes to the National Climate Assessment of Northern Great Plains Region

Since its first report was released in 2000, the U.S. Global Change Research Program has produced periodic assessments of climate change impacts across a range of sectors. Each assessment examines the effects of natural and human-induced global change on the environment, agriculture, transportation, biodiversity, human health and more for different regions of the U.S., and is presented to the president and to Congress.

The Climate Assessment process involves teams of authors with expertise across different disciplines in each of 10 regions. The creation of the Fifth National Climate Assessment (NCA5) is currently underway, and Tonya Haigh, the NDMC’s rural sociologist and social science coordinator, is among the co-authors for the Northern Great Plains Region.

In addition to Haigh, who is also a research assistant professor at the University of Nebraska-Lincoln, UNL is represented by Andrea Basche, Department of Agronomy and Horticulture Assistant Professor and Crop Resilience Specialist. Haigh said that agricultural impacts will be a key issue that Northern Great Plains Region authors examine.

“Our five-state region includes Montana, Wyoming, Nebraska, North Dakota and South Dakota. Ranching and farming are among the key economic drivers in those states,” Haigh said. “As we’ve seen recently, extreme weather events, like the drought that hit the Dakotas and Montana particularly hard, can have wide-ranging effects beyond agricultural impacts.” Haigh has conducted interviews with ranchers across the region, observing first-hand some of the economic, environmental, health and community hardships that extreme weather events can cause. “The NCA5 assesses how current and future risks posed by climate change could shape life across the region and the country,” said Haigh.

Haigh said that climate trends, ecological impacts, impacts on resource- and land-based livelihoods, navigating complex trade-offs and building capacity to adapt will be the key issues that Northern Great Plains Region authors examine. The previous NCA Northern Great Plains assessment also examined how climate change could impact water, agriculture, recreation and tourism, energy and Indigenous Peoples.

The authors began discussions of key regional issues in fall 2021, Haigh said. The outline of what NCA5 will cover came out in mid-January 2022, with the first Northern Great Plains Region public engagement sessions held on Jan. 24 and Feb. 7.

“Our goal is to create a report that holistically represents the many different sectors — the environment, economy and more — and perspectives,” said Basche, the professor serving alongside Haigh on the assessment team. “Gathering input from a range of communities and organizations is the only way we can achieve that goal. We look forward to learning more from Northern Great Plains stakeholders.”

Haigh said that the authors use the public sessions to share information gathered during initial examinations of research literature, reports and other data-collecting efforts. Then they listen to what participants have to say and learn more about what issues may not have been addressed. The final report is expected to be published in late 2023.

Tonya Haigh is the social science coordinator at the NDMC and a research assistant professor at the University of Nebraska-Lincoln.
“There are so many things that are different,” said Marleen Lam, comparing Nebraska and the Netherlands.

Lam, a student at Wageningen University in the Netherlands, spent six weeks in spring 2022 in Lincoln at the National Drought Mitigation Center doing research for her master’s in International Land and Water Management. Her thesis looks at what motivates people to submit observations to the NDMC’s Condition Monitoring Observer Reports database.

For her first master’s, a more technical one completed in January 2022, Lam focused again on East Africa, Kenya specifically. She combined different indicators of drought, like the Standard Precipitation Index, with drought impacts collected by the National Drought Management Authority, including livestock death and food insecurity. “The goal was to see if you can forecast drought impacts based on drought indicators,” Lam explained.

Lam’s research in Kenya relied on machine learning techniques that were new to her. It also introduced her to drought issues and organizations, like the NDMC, working in that space. From there, her second master’s thesis came together quickly, facilitated by a connection between her advisor and Kelly Helm Smith, assistant director of the NDMC.

During her time at the NDMC for her second thesis, Lam distributed a survey to past contributors to the CMOR database to understand their motivations for reporting on their local conditions. “CMOR wants to have more regular observers, not only in drought time,” explained Lam. “So, you need to look at motivations or drivers for people to report so you can have sustained participation.” For example, one of the explanations participants gave most frequently for why they contributed was to increase the likelihood of financial assistance.

Lam hopes that by understanding why people are reporting to CMOR, the center may be able to recruit more regular observers and improve the year-round availability of conditions data.

Her work in Nebraska, Lam adds, is also part of a larger effort in the field to look at these issues internationally. “Not all countries have the same kind of country-level drought impact database that the U.S. does,” Lam said. Collaborators in the Netherlands are trying to build crowdsourced monitoring platforms like CMOR in places like Brazil, and Lam’s efforts are helping different countries share best practices with each other. That kind of international collaboration will become even more important in the future as drought conditions become more widespread and severe.

“Every event highlights the topic of water and drought,” said Lam. “It’s so relevant nowadays.”
CMOR helps officials respond to drought in Missouri

Missouri was one of several states that struggled with significant and devastating dry conditions in 2022. In July, the state suffered from an intense “flash drought,” during which the extent of drought went from zero to more than 50% in just four weeks. Almost the entire southern third of the state was in severe or worse condition.

During that time, the Condition Monitoring Observer Reports system helped officials monitor the rapidly changing conditions, an important first step in planning for and responding to droughts, particularly in an agriculture-dependent state like Missouri.

“Because of the CMOR reports, we really were able to shine a light on the problem,” said Jennifer Hoggatt, the former deputy director of the Missouri Geological Survey. “We look at photos and think, holy cow, something is going on.”

As conditions started ramping up last summer, so did the rate of reporting to CMOR. For most of June, there was one report a week. By the middle of July, reports went up to almost 10 a day. On the 19th, they peaked at 36 reports in a single day, with observations describing everything from increased fire risk to reduced pasture for livestock and dried up ponds.

On July 21, the governor declared a drought emergency for 53 counties.

The governor’s executive order activated the state’s Drought Assessment Committee, a working group of several agencies, including the Department of Natural Resources, that coordinates the state’s drought monitoring and response efforts. The executive order explicitly called on the Department of Natural Resources to promote CMOR reporting to help the committee identify drought impacts.

“As a resource agency, finding the right resources isn’t always easy. Standard metrics weren’t really showing us how extreme this drought was ramping up to be,” said Hoggatt, who is now director of state resources for the Missouri National Guard. CMOR helped fill that gap.

CMOR has become an essential drought monitoring tool in Missouri. Hoggatt says that reports have a direct effect on decision-making within the state by informing the state’s weekly recommendations to the authors of the U.S. Drought Monitor. They also help capture the particular impacts affecting different communities. For example, in 2018 when drought conditions last covered more than half the state, it was primarily the northern part of Missouri that was affected, and water supplies were the big issue. This time around, drought was concentrated in the south, and livestock issues were more prominent.

Although conditions eventually improved — the state was just 12.5% in drought by the start of the new year — Hoggatt says Missouri and other states need to remain “vigilant” to changing conditions. Crowdsourced observations like CMOR are an easy and effective way for the state to do that and to keep up monitoring efforts so as to be able to respond rapidly to drought.

As Hoggatt says, “Photos truly are worth 1000 words, maybe more.”

Top: Bollinger County, Oct. 12, 2022. “Walking across the field, it just crunches under your feet.”
Middle: Dade County, Sept. 19, 2022. “My fear is how long will my well last if we don’t get rain soon.”
The National Drought Mitigation Center collaborates closely with the U.S. Department of Agriculture’s network of regional Climate Hubs on outreach, research and resources that can increase drought resilience and preparedness. Through these partnerships, the NDMC has helped develop valuable drought monitoring tools like Grass-Cast, a grassland productivity forecast for the Great Plains and Southwest. The NDMC has also presented webinars and participated in workshops for hub stakeholders, in addition to contributing to several of the hubs’ five-year reviews.

In 2022, the NDMC presented at a meeting in Oklahoma City co-sponsored by the Southern Plains Climate Hub on drought tools, drought early warning and climate science in the region. The NDMC also conducted a case study with the Midwest Climate Hub of how drought-related resources are being used in that region, while also continuing to collaborate with the Northeast Climate Hub on a new Forest Drought Response Index.

The NDMC also partnered closely with the Northwest Climate Hub in 2022. In addition to jointly developing the new Overview of Water Weather Land Sites map (see p. 10), the two organizations collaborated on workshops for agricultural producers in Alaska alongside the University of Alaska Fairbanks Cooperative Extension Service. NDMC researchers and graduate students went up to Alaska in November for two workshops to facilitate peer-to-peer learning on drought monitoring and planning. Participants included representatives from the USDA and the University of Alaska Fairbanks, as well as farmers from across the state producing everything from fruits, vegetables and cut flowers to hay, grain and livestock. The workshops provided overviews of the Drought Monitor and the Farm Service Agency disaster declaration process, as well as discussions about the state’s drought challenges and a hands-on climate scenario game around agricultural decision-making.

“These workshops were important to have focused conversation on drought and agriculture in Alaska to better understand drought challenges in the state and share information on disaster assistance programs,” said Holly Prendeville, the coordinator for the Northwest Climate Hub.

This year, the NDMC also continued to build its close relationship with the Southwest Climate Hub. In the summer, resource managers, climate service providers and stakeholders met in Las Cruces, New Mexico, for the third annual meeting of the Southwest Drought Learning Network. The DLN is a peer-to-peer knowledge-sharing network designed to increase the resilience of communities facing current and future drought. It was founded in 2018 as a partnership between the NDMC, the Southwest Climate Hub and the National Integrated Drought Information System.

“The Drought Learning Network was created to try and eliminate the silos in which we are all comfortable working and highlight how ‘peer-to-peer’ learning can benefit everyone,” said Brian Fuchs, the NDMC monitoring coordinator.

The goal of the network is to build mechanisms to share information and knowledge so that climate service providers can best provide information that’s

Participants play an interactive game on agricultural decision-making at a workshop in Palmer, Alaska, on drought and agriculture. (Photo by Grace Campbell, NDMC)
Resource managers, climate service providers and stakeholders gathered in Las Cruces, New Mexico, for the third annual meeting of the Southwest Drought Learning Network, the first in-person gathering of the network in over two years. (Photo by Ruth Sedillo/USDA-ARS-Jornada Experimental Range)

useful and usable to stakeholders. The annual meeting, the first in-person meeting of the entire network in over two years, was an opportunity for members to come up with new strategies, goals and projects for the upcoming year and reinvigorate relationships at a time of unprecedented drought in the region.

Members of the Drought Learning Network, including the NDMC, also came together in 2022 to develop a new podcast to help communicate climate and weather information to a mobile audience. Over the course of the summer, the Drought Discussion podcast aired bi-weekly, providing seasonal outlooks of precipitation, drought conditions and forage production across the Southwest and Southern Plains. Tonya Bernadt, outreach and education specialist for the NDMC, co-hosted the podcast alongside Caiti Steele, the Southwest Climate Hub coordinator.

The partnership between the NDMC and the Southwest Climate Hub goes beyond the Drought Learning Network, however. In May 2022, the NDMC partnered with the Southwest Climate Hub, the USDA Natural Resources Conservation Service and representatives of the Middle Rio Grande pueblos on a new climate-smart Indigenous agricultural project. The Santa Ana Pueblo in New Mexico will host the project, which will provide opportunities for partners to better understand the traditional knowledge and practices of Indigenous farmers and ranchers, as well as their needs in adapting to drought.

“Indigenous farmers and ranchers in the Southwest face increasing climate stresses such as longer, more intense droughts, rising temperatures, and shifting growing seasons,” said Tonya Haigh, the NDMC’s social science coordinator and project lead. “Pueblos, Tribes and individual farmers and ranchers are challenged with building capacity to increase resilience and implement climate-smart agricultural systems.”

The NDMC will also work with Southwestern Indian Polytechnic Institute, a tribal community college in Albuquerque, and the Intertribal Agricultural Council to co-develop a student training and internship program. The project will run through spring of 2024.
New products provide locally specific drought information

The team at the National Drought Mitigation Center features staff members with expertise across disciplines, from climatology and remote sensing to planning, geography and communications. That knowledge is reflected in the variety of drought resilience and monitoring tools created and hosted by the NDMC. In 2022, in collaboration with partners at the U.S. Department of Agriculture and other agencies, we produced and enhanced a number of these tools to help communities better prepare for and respond to drought.

Overview of Weather Water Land Sites (OWWLS)
drought.unl.edu/monitoring/owwls.aspx

Widespread drought conditions necessitate new resources to assess and track local drought conditions on the ground. The Overview of Weather Water Land Sites is a resource, collaboratively developed by the USDA Northwest and Southwest Climate hubs and the NDMC, that furthers those goals by illuminating gaps in monitoring stations.

OWWLS is a static map of the location of weather stations, stream gauges, reservoirs and ground water monitoring stations across much of the West. By mapping where these stations are, the tool helps highlight areas with limited or no coverage of weather and water data. Identifying these gaps will help climate service providers determine where to deploy future stations and target recruitment campaigns for volunteer initiatives like the Community Collaborative Rain, Hail and Snow Network, or CoCoRaHS. Many of the networks of weather and water stations mapped in OWWLS provide critical data for the U.S. Drought Monitor.

“If people see these monitoring gaps, and see where data are lacking, then maybe we can get momentum to help fill those underserved areas with useful information,” says Tonya Bernadt, the NDMC’s education and outreach specialist.

County Drilldown Tool

For farmers, ranchers and observers of the USDM, the concern is often less about what’s happening on a national or regional scale than what’s happening right in their backyard. Visitors to the USDM website are now able to visualize that local story more clearly than ever with enhanced county-level statistics.

USDM users can zoom in to view current conditions and data for their county directly from the state-level USDM maps, in addition to accessing county-level data through existing time series and data tables. By capturing that geographic nuance and providing mapping tools at a finer scale, the NDMC hopes to make the USDM more accessible and meaningful to stakeholders. For example, eligibility for the Livestock Forage Disaster Program is made at the county level. The tool was developed in partnership with the USDA Office of the Chief Economist.

“We’re always looking for what’s the next thing we can do to the data or add to the website to make it more useful for people,” said Jeff Nothwehr, a GIS specialist with the NDMC.
Enhanced State Impacts Tool
droughtmonitor.unl.edu/DmData/StateImpacts.aspx

The NDMC has collected drought impacts documented in news reports since 2005. Impact data can guide decision-makers on where to direct relief and help planners identify underlying vulnerabilities. A new tool, supported by the USDA Office of the Chief Economist, makes it easier than ever to see how drought has affected a state in the past.

The enhanced State Impacts Tool adds USDM status to existing records from the Drought Impact Reporter, organizing the collection of impacts by drought status, location and date. Results can be filtered by season, weeks in drought, drought severity and sector. The database currently contains impacts through 2022, including some from U.S.-affiliated territories.

“This tool allows users to better understand how the types of impacts change as drought becomes more intense or prolonged, which is essential for identifying and implementing effective drought measures,” said Cody Knutson, the NDMC planning coordinator.

Drought Impacts Multi-Tool
go.unl.edu/multi-tool

The NDMC has various tools for monitoring records of drought impacts. The Media Drought Index, for example, was launched in 2021. It displays fluctuating coverage of drought issues and allows users to filter news stories by state. Since 2021, the NDMC has also provided a weekly map of drought tweets from across the country.

Now, all the layers of impacts-related data developed over the past several years can be displayed on a single map. In addition to media reports and tweets, the Multi-Tool includes crowdsourced records and citizen science observations from the Condition Monitoring Observer Reports and CoCoRaHS systems.

It links back to each layer separately so users can access more detail. The individual dashboards for CMOR and the Drought Impact Reporter were also updated in 2022.

“Impacts are important because they help tell the story of drought. When we can link physical indicators to impacts, it turns drought into something tangible,” said Deb Bathke, education coordinator for the NDMC.

Drought Monitor Map Viewer and Export Tool
droughtmonitor.unl.edu/Maps/MapViewer.aspx

droughtmonitor.unl.edu/Maps/MapExport.aspx

New tools are giving users a more interactive experience of the traditionally static USDM map.

An interactive interface allows users to zoom and pan across different areas and overlay current and historical drought condition maps with other relevant layers. Options include a suite of jurisdictional reference and environmental data sources, including forecasts, outlooks, current weather data, vegetation stress and crowdsourced condition observations. A new export tool also gives users more control over how they view and download the USDM, allowing them to create customized USDM maps to better meet their needs.

“Our ongoing goal is to find new ways to increase the accessibility and usability of the Drought Monitor. The new interface and download tool are important steps toward that goal of ensuring that we are consistently meeting the needs of USDM users,” said Brian Fuchs, monitoring coordinator for the NDMC.
Publication highlights

Drought-stricken U.S. states have more comprehensive water-related hazard planning

The U.S. does not have a comprehensive national drought plan, and authority and responsibility for drought planning often falls to individual states. Yet, there’s been little research to date on the quality of state plans that address drought. NDMC-affiliated researchers have helped fill that gap by evaluating plans from across the U.S. to understand whether those plans include effective drought preparedness and mitigation measures, as well as what drives certain states to plan for drought.

The researchers statistically compared the quality of each state’s drought-focused plans, its income tax revenue and its drought exposure, based on the U.S. Drought Monitor Drought Severity and Coverage Index. They found that states that are exposed to more frequent or intense droughts, like those in the Southwest, tend to have more comprehensive plans. Surprisingly, there was no relationship between income revenue and planning. These results suggest that drought risk is an intrinsic driver of drought planning, while the availability of financial resources is not.

The research was undertaken by Theresa Jedd, an environmental policy specialist at the Technical University of Munich and a former NDMC postdoc, and Kelly Helm Smith, the Drought Center’s assistant director. To find plans to analyze, Jedd and Smith utilized an NDMC database that contains hundreds of current state-level plans, published as far back as 2000. Since 2019, the database has incorporated water, hazard mitigation and climate plans that address drought, in addition to standalone drought plans.

According to the study’s authors, the database not only allows researchers to look at broad patterns in planning but also provides a resource for planners who are looking to learn best practices from other states.


Planning strategies and barriers to achieving local drought preparedness

Local governments and planners play a critical role in helping communities prepare for, and respond to, the potentially devastating impact of climate extremes like drought. Despite the value of drought mitigation planning for building capacity and increasing resilience, community-level drought planning remains relatively rare. To better understand the current landscape of the field, a team of researchers, led by the NDMC’s Tonya Haigh, set out to understand the perceptions of local planners to different drought mitigation strategies and the barriers they face in addressing drought.

The researchers surveyed hundreds of members of the American Planning Association. As expected, they found that few respondents were interested in, or in the process of, developing standalone drought plans. Where local drought planning was happening, it was...
usually a part of water management, land use or hazard mitigation planning rather than a standalone effort. The planners surveyed pointed to several roadblocks, including political will, data availability and coordination, that help explain the lack of community-level, drought-focused plans.

The study was co-authored by colleagues at the University of Nebraska-Lincoln, including Cody Knutson, the NDMC’s planning coordinator. Their results highlight the need for effective communication between planners at different levels and the potential of local land use plans as a useful, yet underutilized, venue for drought planning.


### Meeting the drought information needs of Midwest perennial specialty crop producers

Drought early warning is essential for increasing the resilience of agriculture, especially in a region like the Midwest that is expected to see more frequent periods of flash drought in the future. Yet, most resources are geared toward producers of commodity row crops like soybeans and corn. There’s far less information available for specialty crops, like tree fruits and nuts, even though those producers tend to be more vulnerable to extreme weather and less able to cope with changing conditions. To remedy that, Tonya Haigh, the NDMC’s social science coordinator, led a team of researchers trying to understand the unique decision-making needs and risks facing specialty crop producers in the Midwest.

The researchers focused on apple, grape and cranberry operations. They found that growers are concerned about both the short-term effects of drought on crop yields and quality, as well as longer-term impacts on production. And yet, there are significant gaps in the availability of information about how to respond to drought. To that end, the researchers developed decision calendars specific to each crop to highlight critical moments over the course of the growing season in which climate service providers should focus on distributing relevant resources. By increasing the accessibility of monitoring and prediction tools tailored to their unique needs and concerns, the team hopes to enhance the drought resilience of specialty crop producers.


A graphical representation of a decision calendar for Midwest apple growers showing informational needs, decisions and challenges at different points in the growing season during a drought year. Recent work led by researchers at the NDMC found that producers of specialty crops like apples are often the least able to cope with changing conditions, and yet there is a lack of information and resources on drought early warning and response tailored toward their specific needs. (*Journal of Applied Meteorology and Climatology*)
Global

The NDMC kicked off a $1 million project with the Department of Defense, U.S. Air Force Weather Agency, to monitor drought “hot spots” around the globe. The NDMC is developing a global composite drought indicator that combines several elements of the climate and hydrological cycle into one objective measure of drought conditions that can be fused with socioeconomic vulnerability data using machine learning.
**Germany and Switzerland**

NDMC Director Mark Svoboda, is one of 15 independent experts engaged with the United Nations Convention to Combat Desertification Intergovernmental Working Group based in Bonn, Germany. The NDMC is also partnering with the United Nations’ Science-Policy Interface and the Integrated Drought Management Programme, a joint effort of the UN World Meteorological Organization and the Global Water Partnership based in Geneva, Switzerland. These non-governmental, international collaborations are designed to promote knowledge sharing and facilitate the development of actionable policy measures focused on drought and drought impacts, desertification and land degradation.

**South America**

The NDMC continued its work with the Drought Information System for Southern South America, or SISSA, and the World Meteorological Organization to enhance regional drought resilience. The NDMC worked with the six member countries of SISSA (Argentina, Bolivia, Brazil, Chile, Paraguay and Uruguay) on a workshop focused on drought preparedness and strategies for regional drought risk management. The NDMC also began working in partnership with the USDA Foreign Agricultural Service to develop drought monitoring and planning tools for Peru’s agricultural industry.

**Southern Africa**

The NDMC continued its ongoing effort with the World Bank and the Southern African Development Community to build composite drought indicators and drought monitoring capacity across southern Africa. The goal of the partnership is to develop objective measures for monitoring conditions in the drought-prone region, tailored for each country’s needs and priorities, and eventually facilitate a standardized, trans-boundary tool for drought monitoring and early warning across the region that can be incorporated into drought planning and response.

**Republic of Korea**

The NDMC partnered with collaborators in South Korea, including a former NDMC postdoc, to develop a report on how the U.S. monitors drought and its impacts. The goal is to provide guidance to the South Koreans on how they can apply best practices from the U.S. to enhance their own monitoring programs and drought mitigation and response efforts.

**Caribbean**

The NDMC continued to build its long-term partnership with the Caribbean Institute of Meteorology and Hydrology with backing from the U.S. Agency for International Development. The NDMC and local partners wrapped up a series of workshops on historical drought impacts to the region, agricultural drought risk and strategies for proactive drought response.

**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. We partnered with the USDA Regional Climate Hubs to develop workshops and 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.
## EARNED MEDIA

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<td>USDM + University of Nebraska</td>
<td>1,240</td>
<td>$47.0M</td>
</tr>
</tbody>
</table>

*Media statistics and AVE calculations per Meltwater

## OUR ORGANIZATION

- **21** Projects
- **15** Peer-reviewed pubs
- **24** Faculty and Staff
- **9** Students and interns
WEB STATISTICS

14.9M Page views of all NDMC websites

13.9M Page views of the USDM

4.11M Users of all NDMC websites

248K File downloads across all NDMC websites

3.58M Users of the USDM

MONETARY IMPACT

$10.5B Livestock forage disaster program payments triggered by the USDM 2008–2022

$9.05M Total active grants

SOCIAL

10,999 2,929
↑ 283
1,818
from 2021 from 2021

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Partnerships

International

- Agriculture and Agri-Food Canada
- Botswana Department of Water Affairs
- Caribbean Institute for Meteorology and Hydrology
- CONAGUA
- 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
- United Nations
  - Convention to Combat Desertification
  - Environment Programme
  - Food and Agricultural Organization
  - World Meteorological Organization
  - World Food Programme
- U.S. Agency for International Development
- 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 Flood Global Institute
  - Extension
  - Institute of Agricultural and Natural Resources
  - Nebraska Water Center
  - University of Nebraska Medical Center
  - UNL Department of Biological Systems Engineering
  - UNL Department of Earth and Atmospheric Sciences
  - UNL Public Policy Center
  - UNL School of Natural Resources
- Colorado State University, Extension Western Region
- East-West Center
- Emerson College
- Iowa State University
- Kansas State University
- Montana State University
- Nebraska Indian Community College
- New Mexico State University
- North Central Climate Collaborative
- North Dakota State University, Extension
- 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 Colorado-Boulder
- 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
- Comunidad Maya Pixan Ixim
- 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
NDMC welcomes four new staff members in 2022

Hasnat Aslam
GIS Specialist

Hasnat Aslam joined the National Drought Mitigation Center in August 2022 as a Geographic Information Systems specialist. Originally from Pakistan, Hasnat did his undergraduate work at the University of the Punjab in physics and math, before receiving three different master’s degrees in GIS, remote sensing and computer science.

In 2020, Hasnat moved to Lincoln to begin his Ph.D. in Natural Resource Sciences at UNL, with a specialization in climate assessment and impacts. At the NDMC, he assists with different types of spatial analysis and data management and helps build machine learning models to predict drought. “This is a unique opportunity that provides me the flexibility to work in both an operational and research environment,” said Aslam.

Brie Paladino
GIS Specialist

In August 2022, the NDMC welcomed Brie Paladino, another GIS specialist, to the team. Brie hails from the Bay Area of California but has spent the last several years in Tennessee. She did her undergraduate and graduate work in geology at Middle Tennessee State University, recently graduating with a master’s degree in geosciences. Her thesis examined the impact of meteorological drought on groundwater aquifers using NASA’s state-of-the-art GRACE satellites.

At the NDMC, Brie supports the center’s various geospatial research and modeling efforts. “I’ve lived in places severely impacted by drought,” said Paladino of her decision to join the NDMC. “Working at the Drought Center is a wonderful opportunity to help further drought science.”

Leah Campbell
Communications Specialist

In June 2022, Leah Campbell joined the NDMC as the new communications specialist. She’s focused on translating and sharing with the public the work the NDMC and our partners are doing around drought monitoring and planning. She also assists with outreach and technical writing and editing.

Prior to moving to Lincoln, Leah received her master’s degree in science communications from MIT, working as a freelance science journalist and as a writer for the MIT School of Science communications office. Before that, she did her undergraduate work in Earth sciences at Yale and spent several years as a disaster researcher in North Carolina and in the environmental nonprofit sector back in her home state of California.

Daniel Whitesel
Climatologist

Daniel Whitesel joined the NDMC in August through a joint appointment with the High Plains Regional Climate Center. At the Drought Center, Daniel does research to improve existing drought monitoring tools and create new ones in response to user needs. It’s those tools, like the U.S. Drought Monitor, that first drew Daniel to working at the NDMC.

A native of Louisville, Kentucky, Daniel received his undergraduate degree in meteorology at Western Kentucky University in 2020. Prior to his work with the center, he did his master’s degree in Natural Resource Sciences with a specialization in climate assessment and impacts at the UNL School of Natural Resources.
The Platte River downstream of Kearney, Nebraska, was one of many rivers across the Midwest and Great Plains that was unusually low in summer of 2022. Photo by Craig Chandler, UNL Communications.