

**2021-2024**

# Midwest

## Drought Early Warning System (DEWS) Strategic Action Plan



Document prepared by the National Integrated Drought Information System (NIDIS) in partnership with key stakeholders in the region ([Appendix 1](#)).

**On the cover:** Aerial view of farmland in Wisconsin. Credit: Alena Mozher

# Contents

<b>1. Executive Summary</b>	<b>4</b>
1.1 Drought in the Midwest.....	4
1.2 The Midwest DEWS.....	4
1.3 Building a Midwest DEWS Strategic Plan.....	4
1.4 Five Key Priorities for 2021–2024.....	5
<b>2. The National Integrated Drought Information System &amp; the Midwest West Drought Early Warning System</b>	<b>8</b>
2.1 National Integrated Drought Early Warning System.....	8
2.2 Components of a Drought Early Warning System.....	9
2.3 Bringing It Together Across Scales.....	10
<b>3. The Midwest DEWS</b>	<b>11</b>
3.1 Launching the Midwest Drought Early Warning System.....	11
3.2 Midwest DEWS Progress To-Date.....	12
<b>4. The Midwest DEWS 2021–2024 Strategic Action Plan</b>	<b>14</b>
4.1 Purpose, Process, and Emerging Issues.....	14
4.2 Five Key Priorities for 2021–2024.....	16
<b>5. Activities for 2021–2024</b>	<b>17</b>
5.1 Midwest DEWS Network Coordination and Integration.....	17
5.2 Predictions and Forecasting.....	20
5.3 Observations and Monitoring.....	22
5.4 Planning and Preparedness.....	24
5.5 Communication and Outreach.....	26
5.6 Interdisciplinary Research and Applications.....	29
<b>6. Linking Outcomes to Priorities</b>	<b>32</b>
<b>7. National &amp; Cross-DEWS Initiatives</b>	<b>34</b>
7.1 Linkages to Regional Partners and Initiatives.....	37
Appendix 1: Partners	38
Appendix 2: Disclaimer	40

# Executive Summary

## 1.1 DROUGHT IN THE MIDWEST

Precipitation extremes in the Midwest have a major impact on the region's resources, economic sectors, and residents. Over the last century, precipitation trends in the Midwest have been moving towards wetter conditions and fewer droughts than the region experienced in the early 20th century. However, the Midwest has still felt adverse impacts during recent droughts, particularly in 1988 and 2012. These adverse impacts include limited barge transportation on major rivers (including the Mississippi River), decreased agricultural production, challenges for municipal water supply and quality, and reduced productivity for hydropower. The 2012 Central U.S. drought alone cost an estimated \$30 billion.<sup>1</sup> An added challenge in recent years has been the tendency to transition from drought to flood or vice versa within short time spans, sometimes within a matter of months. For example, Kentucky experienced a wide swing of conditions in 2019, when several months in early 2019 ranked within the top 10 wettest, followed by the record lowest September precipitation, which led to a rapidly intensifying flash drought in fall 2019.

## 1.2 THE MIDWEST DEWS

The rapid evolution and significant impacts of the 2012 drought emphasized the need for an early warning system in the region that would improve the monitoring, forecasting, and preparedness for droughts in the Midwest. It was in this context that the National Integrated Drought Information System (NIDIS) began developing a Midwest regional Drought Early Warning System (DEWS) in 2015, officially launching the Midwest DEWS in 2016. A DEWS improves the regional capacity to respond to, and cope with drought by utilizing existing networks to make climate and drought science readily available, easily understandable, and usable. The key components of a DEWS include: observations and monitoring, predictions and forecasting, research and applications, planning and preparedness, and communications and outreach.

## 1.3 BUILDING A MIDWEST DEWS STRATEGIC ACTION PLAN

The purpose of the regional Strategic Action Plan is to identify priorities, outcomes, and activities the Midwest DEWS plans to undertake together to improve drought early warning and preparedness for the region. The first Midwest DEWS Strategic Plan

<sup>1</sup> <https://www.ncdc.noaa.gov/billions/events/US/2012>

from 2018–2019 focused on four priorities: (1) to integrate impacts, data, management practices, and research into drought planning, (2) to enhance drought observations and data availability, (3) to improve drought early warning and communication capacity, and (4) to foster stakeholder collaboration, coordination, and relationship building. In May 2018, a communications workshop was held with Midwest DEWS partners to advance the third priority of improving communication



Aerial view of a farm in Wisconsin. Credit: Alena Mozher

capacity around drought, which informed several ongoing activities and others found in this Strategic Action Plan. Additionally, NIDIS launched a partnership in 2019 with the University of Colorado-Boulder’s Masters of the Environment Program to engage the tribal nations of the Midwest and Great Lakes to assess drought information gaps and needs. A Midwest DEWS partners meeting was held in November 2019 to discuss the current activities and priorities moving forward. As a result, five priorities and a series of outcomes and actions organized by the five components of a DEWS were identified to be part of the next iteration of a Midwest DEWS Strategic Action Plan for 2021–2024.

## 1.4 FIVE KEY PRIORITIES FOR 2021–2024

1. Build a comprehensive understanding of the many drought indicators used in the Midwest DEWS to better demonstrate their value, limitations, and sector-specific, seasonal, and geographical applications, which will help users focus on information that is important to the region to better inform drought early warning and preparedness.
2. Increase understanding of the characteristics, predictability, and risk of drought in the Midwest, as well as the characteristics, causes, and risks of rapid transitions between precipitation extremes (e.g., wet to dry) today and in the future.
3. Identify innovative solutions and proactive measures that can be taken prior to or during the development of a drought to build resilience and strengthen drought response, with a focus on identifying actions that increase resilience to the rapid transitions between precipitation extremes.
4. Enhance collaboration, coordination, and communication among national, tribal, state, and local partners and between DEWS regions to strengthen drought early warning, preparedness, and resilience across the Midwest.

5. Integrate the Great Lakes watershed into the Midwest DEWS by establishing new partnerships, taking inventory of existing drought knowledge, impacts, and activities, and assessing the needs and gaps related to drought early warning in the Great Lakes basin.

The following table contains the overarching outcomes within the Midwest DEWS Strategic Action Plan, organized by components of a DEWS. More detailed information on the suite of activities to accomplish these outcomes in the Plan can be found starting on [page 17](#).

<b>Planned Outcomes to be Accomplished by the Midwest DEWS</b>
<b>NETWORK COORDINATION AND INTEGRATION</b>
The Midwest DEWS network is strengthened by improving internal communication and coordination.
Expanded partnerships within the Midwest region ensure inclusion of underrepresented communities, drought-affected sectors, and underexplored impacts.
Federal partnerships around drought are strengthened through coordination with the Midwest DEWS.
The Great Lakes watershed is more resilient to drought through engagement with the Midwest DEWS.
<b>DROUGHT PREDICTIONS AND FORECASTING</b>
Current short-term forecasts are improved by incorporating new and existing research as it becomes available on the characteristics and predictability of Midwest drought into existing products and services.
The effects that climate change may have on the characteristics and risk of drought in the Midwest are better understood.
Drought forecast and outlook information and uncertainty is effectively communicated to stakeholders in various sectors across the Midwest.
<b>DROUGHT OBSERVATIONS AND MONITORING</b>
Increased observational data and indicators improve the ability to monitor drought conditions in the Midwest.
Drought condition monitoring is enhanced through Condition Monitoring Observer Reports (CMOR), Community Collaborative Rain Hail and Snow Network (CoCoRaHS), and other state-based reporting efforts.

<b>Planned Outcomes to be Accomplished by the Midwest DEWS</b>
<b>DROUGHT PLANNING AND PREPAREDNESS</b>
Drought mitigation and response actions and approaches are understood and implemented in the Midwest DEWS.
Drought vulnerability and its impacts across the region and sectors are well understood.
Water management strategies that provide mitigation for multiple hazards (e.g., drought and flood) are identified and shared with partners.
<b>DROUGHT COMMUNICATION AND OUTREACH</b>
Engagement with the general public is increased for drought education, awareness, and response actions through various avenues like social media, <a href="https://drought.gov">Drought.gov</a> , and news media.
Relevant drought information and resources are shared through the Midwest DEWS page on the U.S. Drought Portal ( <a href="https://drought.gov">Drought.gov</a> ).
When drought is <i>active</i> in the region—additional communication and resources are provided through the Midwest DEWS network to increase awareness and response to drought conditions, impacts, and outlooks.
Training and learning opportunities on key tools and products for the region are provided to the Midwest DEWS network.
<b>INTERDISCIPLINARY RESEARCH AND APPLICATIONS</b>
Our understanding of the best application of drought indicators temporally and spatially across the Midwest is improved.
Our understanding of the characteristics, predictability, and risk of drought in the Midwest today and in the future is improved.
Our understanding of the historical and future characteristics of rapid transitions between precipitation extremes in the Midwest (i.e., wet to dry, and vice versa) is improved, and proactive actions that can be taken to address these extremes are identified.
The Midwest region is more resilient to flash drought through improved monitoring, prediction, planning, and communication.
The decision points of various sectors (e.g., agricultural producers, water utilities, navigation, water management, natural resource management, human health) are better understood, and information providers are aligning information products, formats, and timing.

# The National Integrated Drought Information System and the Midwest Drought Early Warning System

## 2.1 NATIONAL INTEGRATED DROUGHT EARLY WARNING SYSTEM

In 2006, the National Integrated Drought Information System (NIDIS) was created by Congress with a mandate for interagency coordination and integrated drought research that builds upon existing federal, tribal, state, and local partnerships to create a national drought early warning system (DEWS). Recognizing that drought characteristics and impacts vary across the country, NIDIS is working toward this goal by developing a network of regional DEWS across the nation (*Figure 1*). These regional DEWS utilize existing networks to make climate and drought science readily available, easily understandable, and usable; and to improve regional capacity to respond to and cope with drought.

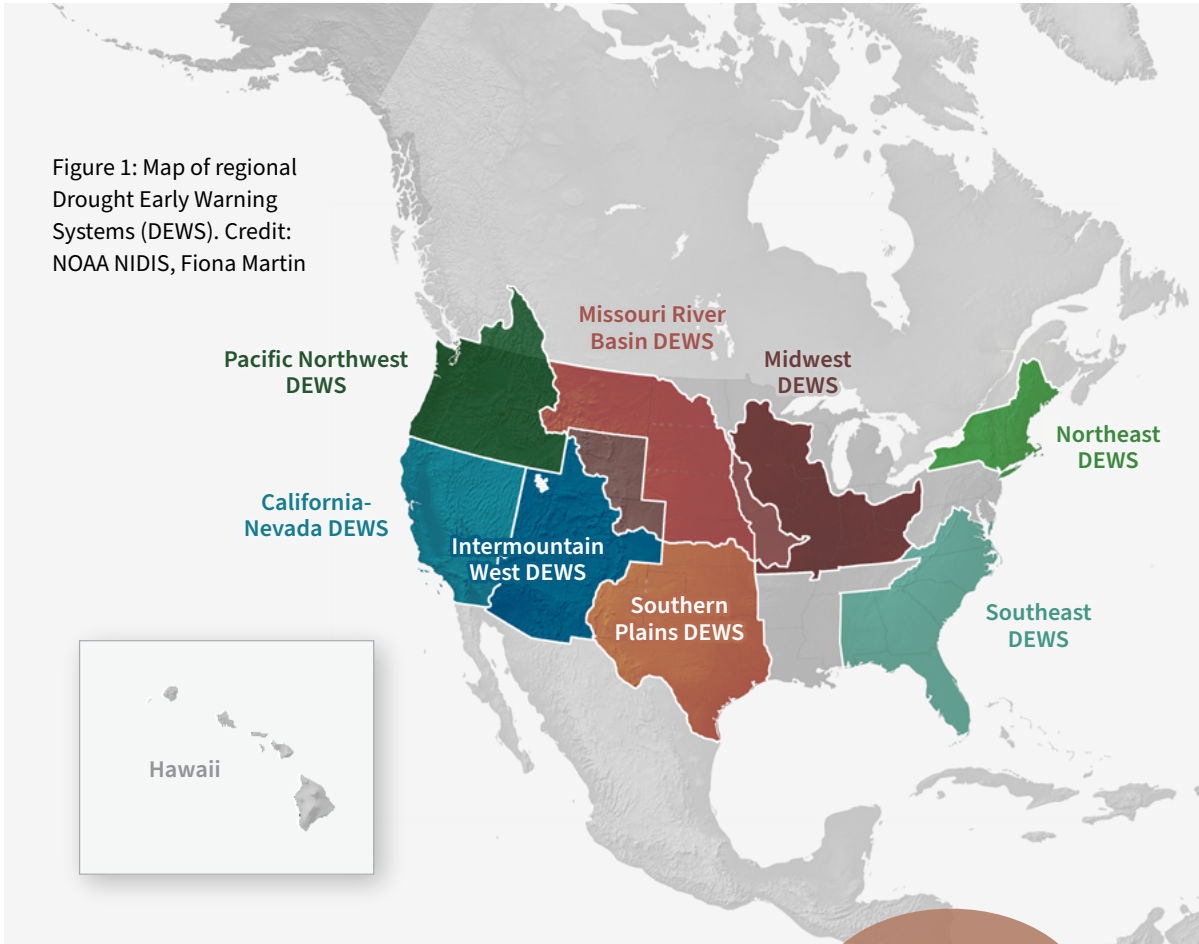
A regional DEWS is supported by stakeholders, comprised of relevant partners and community members across the region, including universities, the private sector, and federal, tribal, state, and local entities. Stakeholders participate in the NIDIS consultation process and they support NIDIS priorities by leveraging existing resources, programs,

**WHAT IS NIDIS?** In 2006 (Public Law 109-430), Congress authorized the National Integrated Drought Information System (NIDIS) with a mandate for interagency coordination and integrated drought research that builds upon existing federal, tribal, state, and local partnerships to create a national drought early warning system (DEWS). The program was reauthorized in 2014 (Public Law 113-86) and again in 2019 (Public Law 115-423).

**WHAT IS A DEWS?** A Drought Early Warning System (DEWS) utilizes new and existing networks of federal, tribal, state, local, and academic partners to make climate and drought science accessible and useful for decision makers; and to improve the capacity of stakeholders to monitor, forecast, plan for, and cope with the impacts of drought.



Figure 1: Map of regional Drought Early Warning Systems (DEWS). Credit: NOAA NIDIS, Fiona Martin



and partnerships. This relationship ensures a robust, “ground-up” regional DEWS that is well-networked and responsive to the specific needs of each region.

## 2.2 COMPONENTS OF A DROUGHT EARLY WARNING SYSTEM

Early warning is the provision of timely and effective information, through identified institutions, that allows individuals exposed to a hazard to act to avoid or reduce their risk and prepare for effective response. In the case of drought, five components have been identified as necessary for drought early warning (*Figure 2*). In order for these systems to be successful, they

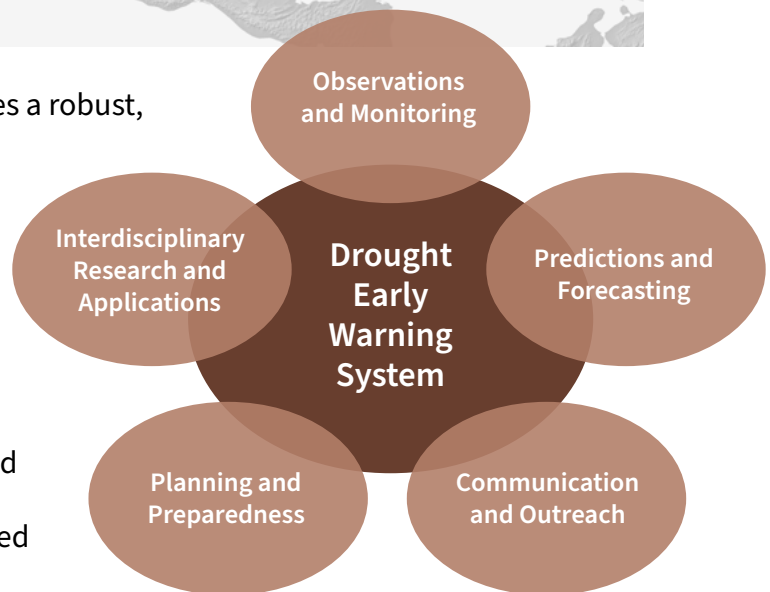


Figure 2: A Drought Early Warning System is made up of five components including Predictions and Forecasting, Observations and Monitoring, Planning and Preparedness, Communications and Outreach, and Interdisciplinary Research and Applications. Credit: NOAA NIDIS, Fiona Martin

must support efforts to understand past, present, and future conditions, and to plan proactively and respond using an adaptive management process that applies learning to improve future outcomes. Activities and actions in one component inform those in other components, and in the early warning system itself there is feedback and learning that informs and improves the system over time.

### 2.3 BRINGING IT TOGETHER ACROSS SCALES

NIDIS employs a systems approach to identify gaps, foster collaboration, facilitate information flow and informed decisions, and integrate the five components of drought early warning both across and within regional DEWS. The regional DEWS provide a foundation on which a national early warning system rests (*Figure 3*). Regional gaps, needs, and input are incorporated into national products and processes. Initiatives that cross DEWS boundaries, or are larger than any one regional DEWS, are elevated to be addressed holistically by NIDIS and partners at a national scale. This includes complex issues such as the close relationship between drought and wildland fire or drought and public health, which require larger investments in research and targeted decision support tools. In the same way, these national efforts, products, and learning can be assessed for relevance, validated, tailored, and then incorporated into the regional DEWS. It is this cross-scale exchange of information and learning that helps to improve our capacity for early warning across diverse sectors of the economy.

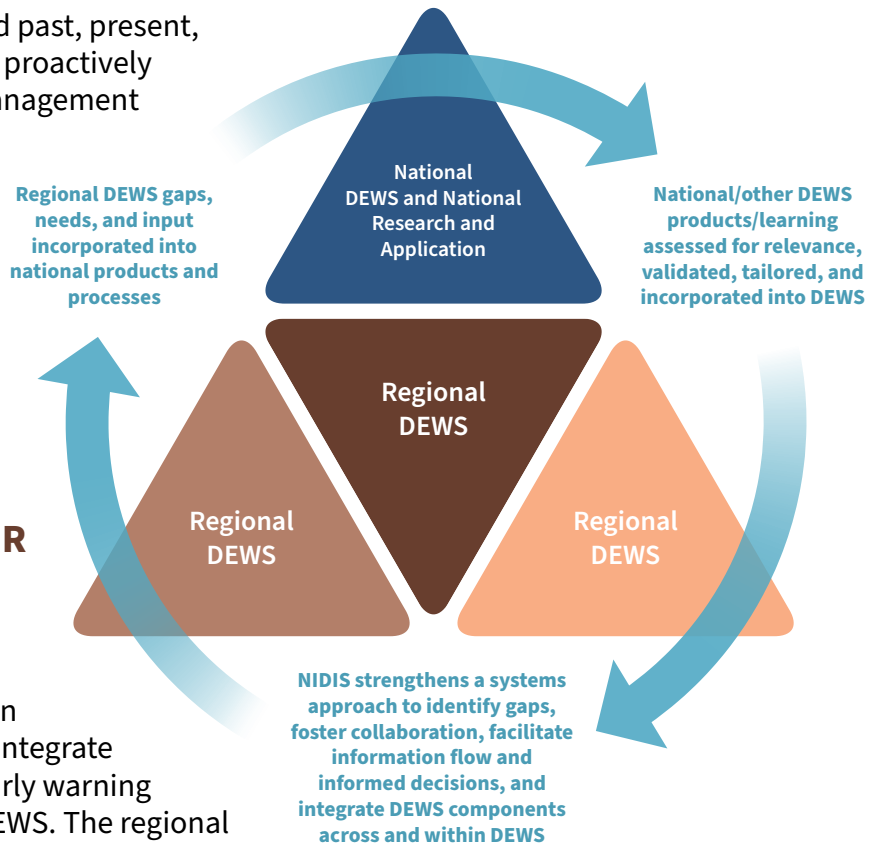


Figure 3: This diagram illustrates the regional DEWS as the foundation of a national DEWS and how the needs of the regions inform activities at the national level and how learning is shared across the components of the system. Credit: NOAA NIDIS, Fiona Martin

# 3

## The Midwest DEWS

### 3.1 LAUNCHING THE MIDWEST DROUGHT EARLY WARNING SYSTEM

Over the course of NIDIS's first 10 years, several regional DEWS were formed to test new approaches for drought early warning and to transfer lessons learned to other regions; over time building a distributed national DEWS.

Precipitation extremes in the Midwest have a major impact on the region's resources, economic sectors, and residents. Over the last century, precipitation trends in the Midwest have been moving towards wetter conditions and fewer droughts than the region experienced in the early 20th century. However, the Midwest has still felt adverse impacts during recent droughts, particularly in 1988 and 2012. These adverse impacts include limited barge transportation on major rivers (including the Mississippi River), decreased agricultural production, challenges for municipal water supply and quality, and reduced productivity for hydropower. The 2012 Central U.S. drought alone cost an estimated \$30 billion.<sup>2</sup> An added challenge in recent years has been the tendency to transition from



Figure 4: Location and spatial extent of the Midwest Drought Early Warning System (DEWS). Credit: NOAA NIDIS, Fiona Martin

drought to flood or vice versa within short time spans, sometimes within a matter of months. For example, Kentucky experienced a wide swing of conditions in 2019, when several months in early 2019 ranked within the top 10 wettest, followed by the record lowest September precipitation, which led to a rapidly intensifying flash drought in fall 2019.

The rapid evolution and significant impacts of the 2012 drought emphasized the need for an early warning system in the region that would improve the monitoring,

<sup>2</sup> <https://www.ncdc.noaa.gov/billions/events/US/2012>

forecasting, and preparedness for droughts in the Midwest. It was in this context that NIDIS began developing a Midwest regional DEWS in 2015, officially launching the Midwest DEWS in 2016 (*Figure 4, previous page*).

### 3.2 MIDWEST DEWS PROGRESS TO-DATE

The first Midwest DEWS Strategic Plan from 2018–2019 focused on four priorities: (1) to integrate impacts, data, management practices, and research into drought planning, (2) to enhance drought observations and data availability, (3) to improve drought early warning and communication capacity, and (4) to foster stakeholder collaboration, coordination, and relationship building. In May 2018, a communications workshop was held with Midwest DEWS partners to advance the third priority of improving communication capacity around drought, which informed several ongoing activities and others found in this Strategic Action Plan. Additionally, NIDIS launched a partnership in 2019 with the University of Colorado-Boulder’s Masters of the Environment Program to engage the tribal nations of the Midwest and Great Lakes to assess drought information gaps and needs. A Midwest DEWS partners meeting was held in November 2019 to discuss the current activities and priorities moving forward. As a result, five priorities and a series of outcomes and actions organized by the five components of a DEWS were identified to be part of the next iteration of a Midwest DEWS Strategic Action Plan for 2021–2024.

The following table summarizes some of the key outcomes and progress that has been made by partners in the Midwest DEWS since its inception in 2016. This is not meant to be an exhaustive list, but to provide a flavor of what regional partners are doing together as a network.

<b>Midwest DEWS Key Outcomes and Progress</b>
<b>DROUGHT PREDICTIONS AND FORECASTING</b>
A beta Flash Drought Risk Tool (Flash-DRT) has been developed for the Midwest region, which incorporates machine learning to identify at least one week in advance areas that might be favorable for flash drought development.
Researchers at the University of Illinois studied the current attitudes of farmers towards drought forecast information, and how to improve the knowledge transfer.
<b>DROUGHT OBSERVATIONS AND MONITORING</b>
Partnership between University of Missouri Extension, NDMC, and NIDIS resulted in a state-based drought impact survey that was promoted during the 2018 drought in Missouri, resulting in hundreds of submitted reports. This effort provided on-the-ground impact information for decision-makers.
An interactive data visualization and analysis dashboard was developed by the Kentucky Climate Center that integrates and displays data from the Kentucky Mesonet and other partners (e.g., USGS) to monitor drought and climate conditions across the state.

Midwest DEWS Key Outcomes and Progress
<b>DROUGHT PLANNING AND PREPAREDNESS</b>
The 2021–2025 NIDIS Tribal Engagement Strategy was released in November 2020 and was developed through engagement with tribal nations in the Midwest DEWS throughout 2019.
A database of drought response and mitigation actions (by sector) was developed from analyzing the actions identified in nine Midwest states' drought, climate, water, and/or hazard mitigation plans.
A Midwest Drought and Human Health Workshop was held in St. Paul, Minnesota in November 2019 to identify gaps and needs, collaborative opportunities, and ways to integrate the health sector into the Midwest DEWS.
With support from NIDIS, the Indiana State Climate Office hosted three virtual workshops in 2020 with a goal of assessing the current level of coordination across the state, and to identify opportunities to improve drought response and mitigation in Indiana.
<b>DROUGHT COMMUNICATION AND OUTREACH</b>
Established Drought Early Warning Updates in summer 2020 as a way to communicate the potential for developing drought conditions in the coming weeks/months.
When drought is active, release regular Drought Status Updates through an email listserv and <a href="https://www.drought.gov">Drought.gov</a> to provide an update on the conditions, impacts, and outlooks for the region.
Provide monthly email updates to the Midwest DEWS network (since March 2019).
A Midwest DEWS Communications Workshop was held in May 2018 to discuss effective methods to communicate drought information and improve early warning across the Midwest DEWS.
Led by NOAA and USDA, a monthly climate summary and outlook webinar series for the North Central U.S. has been delivered since 2012 and is a key mechanism for providing stakeholders with the latest climate and drought conditions.
Quarterly climate and drought two-page summary focused on the Midwest states have been produced by the Midwestern Regional Climate Center and regional partners since 2014.
A Midwest DEWS Partners Meeting was held in St. Paul, Minnesota in November 2019.
<b>INTERDISCIPLINARY RESEARCH AND APPLICATIONS</b>
Researchers at the NOAA Physical Sciences Laboratory studied the characteristics, predictability, and risk of drought historically in the Midwest region. This study is ongoing and will now focus on the future characteristics of drought under a changing climate.
Researchers at the University of Illinois studied the rapid transition of precipitation extremes (e.g., too much, too little) to improve our understanding of these transitions historically, their causes, and the risk they pose in the future to the Midwest region.

# The Midwest 2021–2024 Strategic Action Plan

## 4.1 PURPOSE, PROCESS, AND EMERGING ISSUES

The purpose of the regional Strategic Action Plan is to identify priorities, outcomes, and activities the Midwest DEWS plans to undertake together to improve drought early warning and preparedness for the region. In order to inform an update to the Midwest DEWS Strategic Plan, a regional partners meeting was held in November 2019 to discuss the current activities and priorities moving forward. A few common themes arose from this meeting and other regional discussions, and these are identified as emerging issues which should lead to priority actions/activities for the region.

- **Rapid transitions of hydrological extremes:** Recent decades have demonstrated that the Midwest region is often dealing with either too much or too little water, and the transition between the two extremes seems faster than before. Preliminary research on the historical occurrence of rapid transitions between extremes was presented at the 2019 meeting, and the Midwest DEWS partners wanted to continue exploring this topic. Not only the historical occurrence and future probability, but also to work as a network to identify potential management solutions and opportunities.
- **Underserved populations:** Increasing engagement with underserved populations was a key takeaway from the 2019 meeting to ensure their needs are met when it comes to drought early warning. Underserved populations mentioned include tribal nations, rural communities, and the Amish/Mennonite communities.
- **Network and peer-to-peer learning:** Attendees of the 2019 meeting expressed

---

**“If we have dry summers every single year, to a farmer, this is a multi-year drought. We need to incorporate this into our planning.”**

—NOVEMBER 2019 ATTENDEE

---

the desire to have opportunities to learn more from one another, whether this is through an annual meeting or virtual conversations around certain topics. They also expressed the desire to learn from other DEWS on topics that are less familiar in the Midwest, such as effectively planning for multi-year drought.

- **Drought monitoring and indicators:** While many data and drought indicators exist, the 2019 meeting brought to the forefront the need to identify the best drought indicators for the Midwest. More information is needed on the best indicators by sector (e.g., agriculture, ecosystem), season (e.g., summer versus winter), and/or subregion (e.g., Upper Mississippi Basin versus Ohio River Basin).
- **Future drought conditions:** Climate projections for the Midwest identify the trend towards overall wetter conditions.<sup>3</sup> However, more research is needed on how climate projections characterize drought in the future across the region. This information is needed in order for states, tribes, and local entities to effectively plan for climate change.

Through this consultative process with regional partners, five priorities and a series of outcomes and actions were identified. These were also vetted through a plan review opportunity for the partners of the Midwest DEWS, virtual input sessions in May 2020, and one-on-one discussions. The list of activities in this Strategic Action Plan are intended to be accomplished in partnership with those and other stakeholders in the region. NIDIS may take a leadership role in some activities, and may take a supportive role in others that are led by partners.

This 4-year Strategic Action Plan will be in effect from 2021 through 2024. The plan is considered a living document and through Midwest DEWS meetings, priority activities will be selected, actions can be added, and the plan may be adjusted to address emerging issues as needed.

The Strategic Action Plan is organized around the five components of a DEWS. This approach helps to make valuable linkages to the NIDIS Working Groups<sup>4</sup> more explicit, as they are also organized around the components of drought early warning. The Working Groups are in place to provide technical, subject matter expertise and to

<sup>3</sup> <https://nca2018.globalchange.gov/chapter/21/>

<sup>4</sup> <https://www.drought.gov/about/who-we-are>



A farmer in a large combine harvests corn from a field in October 2020. Fairmont, Michigan. Credit: Joseph Kreiss

identify core competencies, gaps, and paths of action on intergovernmental activities as part of the NIDIS consultation process. The NIDIS Program Office supports a network of regular communication and information between these entities to ensure meaningful engagement and effective collaboration on priorities and activities.

## 4.2 FIVE KEY PRIORITIES FOR 2021–2024

1. Build a comprehensive understanding of the many drought indicators used in the Midwest DEWS to better demonstrate their value, limitations, and sector-specific, seasonal, and geographical applications, which will help users focus on information that is important to the region to better inform drought early warning and preparedness.
2. Increase understanding of the characteristics, predictability, and risk of drought in the Midwest, as well as the characteristics, causes, and risks of rapid transitions between precipitation extremes (e.g., wet to dry) today and in the future.
3. Identify innovative solutions and proactive measures that can be taken prior to or during the development of a drought to build resilience and strengthen drought response, with a focus on identifying actions that increase resilience to the rapid transitions between precipitation extremes.
4. Enhance collaboration, coordination, and communication among national, tribal, state, and local partners and between DEWS regions to strengthen drought early warning, preparedness, and resilience across the Midwest.
5. Integrate the Great Lakes watershed into the Midwest DEWS by establishing new partnerships, taking inventory of existing drought knowledge, impacts, and activities, and assessing the needs and gaps related to drought early warning in the Great Lakes basin.



Aerial view of Mississippi river along the Minnesota-Wisconsin border. Credit: Alena Mozher



# 5

## Activities for 2021–2024

### 5.1 MIDWEST DEWS NETWORK COORDINATION AND INTEGRATION

Networks and partnerships require time and attention to be maintained and to grow. The need exists to support partners, convene the network around various drought-related topics, and identify key lessons to share within and across the Midwest DEWS. This convening role is a key aspect of the Midwest DEWS.

#### **Outcome 1.1: The Midwest DEWS network is strengthened by improving internal communication and coordination.**

Activity 1.1a: Host annual DEWS partner meetings (virtual and/or in-person) to bring together drought stakeholders and decision-makers in the region, exchange information and best practices, and coordinate on key Midwest DEWS priorities. Consider partnering with tribal nations to periodically hold annual meetings on tribal lands.

Activity 1.1b: Implement innovative strategies for Midwest DEWS partners to engage and share drought information in real-time, utilizing email communication and online, community-based platforms (such as Slack). Through these platforms, drought-related webinars, resources, tools, research, and opportunities for further engagement may be shared.



Dock at Bowstring Lake. Leech Lake Native American Reservation, Minnesota. Credit: Jacob Boomsma

Activity 1.1c: Establish topic and/or sector-based informal working groups within the Midwest DEWS network as needed, to focus on addressing specific drought information needs. Partner with existing groups where applicable (e.g., NOAA Nutrient Runoff Working Group).

Activity 1.1d: Implement peer-to-peer learning exchanges (e.g., state-to-state or DEWS-to-DEWS) for practitioners, sectors, and/or specific communities. A topic of particular interest for DEWS-to-DEWS exchanges is planning for long-term drought, as several Midwest states have expressed interest in resources to build greater preparedness for droughts that extend beyond a year.

Activity 1.1e: Explore the feasibility and usefulness of completing a “network analysis” of the Midwest DEWS, which could provide insight into core people or programs that are highly connected in the region, and how Midwest partners share information with one another. This activity would also shed light on key groups not currently represented in the Midwest DEWS in which more engagement is needed.

**Outcome 1.2: Expanded partnerships within the Midwest region ensure inclusion of underrepresented communities, drought-affected sectors, and underexplored impacts.**

Activity 1.2a: Increase partnerships with tribal nations, Tribal Colleges and Universities, tribal alliances and other organizations, and other federal programs working on tribal engagement around climate in the Midwest and Great Lakes basin. Align partnerships and activities with the NIDIS Tribal Engagement Strategy.

Activity 1.2b: Ensure underrepresented communities (e.g., tribal nations, rural communities) are integrated into the Midwest DEWS network through email communications, annual meetings, project support, and future planning for the DEWS.

Activity 1.2c: Engage with Amish and Mennonite communities in the Midwest region, and explore potential partnership and learning opportunities with these communities, who are often self-reliant in natural disasters. Consider building partnerships through local NWS Weather Forecast Offices (WFO).

Activity 1.2d: Better understand the characteristics and risks of wildfire in the Midwest and its intersection with drought. Regional entities to collaborate with include USFS Northern Institute of Applied Climate Science (NIACS), Lake States Fire Science Consortium, Tallgrass Prairie and Oak Savanna Fire Science Consortium, and the Eastern Area Coordination Center (EACC) with the National Interagency Fire Center (NIFC). Bridge this understanding and efforts with NIDIS’s Drought and Wildland Fire Nexus (NDAWN) Strategy.

Activity 1.2e: Building off of the Midwest Drought and Human Health Workshop held in late 2019, continue building partnerships with human health practitioners in the region, including state public health departments, emergency management, state Environmental Protection agencies, and academia to ensure human health drought information needs are incorporated into the Midwest DEWS.

Activity 1.2f: Increase dialogue with the navigation and riverboat tourism industry, utilizing partnerships through entities like the U.S. Army Corps of Engineers (USACE), Upper Mississippi River Basin Association (UMRBA), and state transportation agencies,

to understand drought and navigational needs in the areas that are undammed on the Mississippi River (south of St. Louis).

Activity 1.2g: By partnering with state agencies in the Midwest, begin to document the use of hydropower in the region and other energy sources (e.g., power plants) that are reliant upon surface water supply on major rivers in the Midwest to better understand the economic impact that drought has on the energy sector in the region.

Activity 1.2h: Use other federal, tribal, and state meetings as an opportunity to engage new partners in the DEWS and encourage collaboration, coordination, and regular communication.

### **Outcome 1.3: Federal partnerships around drought are strengthened through coordination with the Midwest DEWS.**

Activity 1.3a: Increase coordination on drought activities in the Midwest region with other federal agencies, including but not limited to: U.S. Department of Agriculture (USDA), Federal Emergency Management Agency (FEMA), Environmental Protection Agency (EPA), Bureau of Indian Affairs (BIA), U.S. Geological Survey (USGS), USGS Midwest Climate Adaptation Center (CASC), and the USACE.

Activity 1.3b: Explore the idea of NIDIS regularly convening a regional federal partners virtual meeting to increase coordination on drought activities in the region. Take into consideration other regional interagency groups that might already exist.

Activity 1.3c: Strengthen the partnership between NIDIS and the NWS to deliver timely information concerning drought through WFOs and River Forecast Centers in the region. Partner with the NOAA Central Region Collaboration Team to facilitate this effort.

### **Outcome 1.4: The Great Lakes watershed is more resilient to drought through engagement with the Midwest DEWS.**

Activity 1.4a: Engage with state and local entities, tribal nations, Extension, academic partners, and others in the Great Lakes states that are not currently covered by the Midwest DEWS. These states include Michigan, New York and Pennsylvania (engagement will occur within the Great Lakes basin of these states in coordination with the Northeast DEWS).

Activity 1.4b: Engage with Federal agencies working in the Great Lakes watershed, including others at NOAA (Great Lakes Environmental Research Laboratory [GLERL], Great Lakes Integrated Sciences and Assessments [GLISA], Great Lakes Regional Collaboration Team, Great Lakes Sea Grant Network), and other agencies like FEMA, EPA, USGS, and BIA.

Activity 1.4c: Through partner conversations and associated literature review, document the historical characteristics and impacts of drought in the Great Lakes watershed, and support new research as necessary to better understand drought in

this basin, including droughts of the future. Consider partnerships with GLISA and the Great Lakes Restoration Initiative (GLRI) to co-fund this documentation and research.

Activity 1.4d: Develop an inventory of partner activities related to drought in the Great Lakes basin, and incorporate relevant resources into [Drought.gov](https://www.drought.gov).

Activity 1.4e: Assess the gaps and needs of partners and practitioners in the Great Lakes watershed regarding drought information around the five components of the DEWS.

Activity 1.4f: In coordination with partners in the basin, determine priorities to improve drought early warning in the Great Lakes watershed.

## 5.2 PREDICTIONS AND FORECASTING

There are many challenges to improved drought predictions and forecasting. Drought characteristics and physics must be understood in space and time for droughts to be predicted with skill. While larger efforts are aimed at improvements in areas such as subseasonal-to-seasonal (S2S) forecasting, NIDIS and partners can help better communicate the uncertainties of predictions and forecasting and make this information more accessible and useful in the region.



Dairy cow in Wisconsin. Credit: Alena Mozhjer

### **Outcome 2.1: Current short-term forecasts are improved by incorporating new and existing research as it becomes available on the characteristics and predictability of Midwest drought into existing products and services.**

Activity 2.1a: Support research that uncovers a more holistic understanding of the physics of drought in the region to be able to interpret forecasts and give value-added information to model output, beginning with the *Characteristics, Predictability, and Risk of Mississippi and Ohio River Valley Drought* study.<sup>5</sup>

Activity 2.1b: Support research to identify additional sources of predictability for drought in the Midwest region.

<sup>5</sup> <https://www.drought.gov/drought-research/characteristics-predictability-and-risk-mississippi-and-ohio-river-valley-drought>

Activity 2.1c: Explore the feasibility of utilizing machine learning for drought early warning forecasts by training the model using historical data and drought impacts.

Activity 2.1d: NIDIS will serve as a liaison between innovative research and NOAA’s Climate Prediction Center (CPC) to incorporate these findings into operational drought outlooks (research to operations/service).

## **Outcome 2.2: The effects that climate change may have on the characteristics and risk of drought in the Midwest are better understood.**

Activity 2.2a: Support research that utilizes climate models to predict the characteristics and frequency of drought in the Midwest at the mid- and end-of-the-century, including examining rapid transitions between hydrological extremes (wet to dry and vice versa).

Activity 2.2b: Support research that identifies the risk for long-term drought in the future.

Activity 2.2c: Ensure these regional studies of future drought scenarios are shared with the Midwest DEWS network for planning purposes, incorporated into [Drought.gov](https://drought.gov) planning resources, and also incorporated into the efforts of the National Climate Assessment.

## **Outcome 2.3: Drought forecast and outlook information and uncertainty is effectively communicated to stakeholders in various sectors across the Midwest.**

Activity 2.3a: Develop effective and simple communication materials for drought outlook and uncertainty information. Consider the following: apply the drought outlook infographics created by the North Carolina Communications Project<sup>6</sup> to the Midwest region, engage Midwest DEWS partners and stakeholders through an iterative process to better understand barriers to improve communication products, and/or incorporate new infographics into [Drought.gov](https://drought.gov) and other Midwest DEWS communication channels.

Activity 2.3b: Incorporate the recommendations from a University of Illinois social science study<sup>7</sup> to guide future engagement with farmers in Illinois to improve the use of drought outlook information.

Activity 2.3c: Explore the idea of conducting similar social science studies/surveys with agricultural producers in other Midwest DEWS states to increase our understanding of if and how drought outlooks are used, and how to better meet their needs for drought prediction. Identify partnership opportunities with USDA, state Farm Bureaus, Land and Sea Grant Extension, and others for this work.

<sup>6</sup> <https://www.drought.gov/node/1481/>

<sup>7</sup> <https://www.drought.gov/drought-research/investigating-role-perceptions-about-drought-information-and-forecast-accuracy>

### 5.3 OBSERVATIONS AND MONITORING

There is a general consensus that more *in situ* measurements, especially of soil moisture, are needed across the Midwest, and that this should be accomplished through the continued support of existing stations and networks, in addition to new stations being deployed in areas lacking coverage. Programs like the National Coordinated Soil Moisture Monitoring Network (NCSMMN) are working to strengthen mesonet networks and are addressing some of these gaps. Additional drought condition monitoring is also needed across the Midwest to better understand the impacts of drought and more effectively plan for drought.



Weather station in Urbana, Illinois. Credit: Trent Ford, Illinois State Climatologist

#### **Outcome 3.1: Increased observational data and indicators improve the ability to monitor drought conditions in the Midwest.**

Activity 3.1a: Understand key gaps in monitoring station density, with analysis including remote sensing data, to determine where additional stations are needed. Develop a roadmap to determine how ongoing programs and initiatives might be leveraged to meet these needs holistically.

Activity 3.1b: Share the value of the state mesonets for drought early warning with key entities at the state, regional, and national level.

Activity 3.1c: Examine the transferability potential of the Kentucky Mesonet Dashboard to other states.

Activity 3.1d: Ensure that DEWS partners are aware of and integrated into as appropriate the efforts of the NCSMMN, and other national monitoring efforts like the National Mesonet Program and USACE monitoring networks.

Activity 3.1e: Engage with tribal nations to install weather/mesonet stations on tribal lands to increase drought monitoring for tribal nations in the Midwest and Great Lakes. This includes identifying funding sources that could be used (e.g., NRCS programs, Conservation District Programs, FEMA) and/or programs with which to coordinate and partner (e.g., Tribal Soil Climate Analysis Network [NRCS]).

Activity 3.1f: Develop partnerships and/or agreements with the Tribal Colleges and Universities (TCUs) to deploy and maintain stations on tribal lands as well as explore

how traditional ecological knowledge (TEK) can be incorporated along with western science to better monitor drought on the landscape.

Activity 3.1g: Collect and disseminate best practices information for lake level monitoring programs in the Midwest.

Activity 3.1h: Identify a research pathway for developing an evapotranspiration climatology for the region, as this is important for assessing current anomalous conditions. Potential data sources to incorporate into the climatology include state mesonets data and/or historical satellite observations.

Activity 3.1i: Through partnership with the NDMC and USFS, evaluate the effectiveness of the Forest Drought Response Index (ForDRI)<sup>8</sup> in capturing drought conditions of forested areas in the Midwest DEWS.

### **Outcome 3.2: Drought condition monitoring is enhanced through CMOR, CoCoRaHS, and other state-based reporting efforts.**

Activity 3.2a: Recruit new networks of citizen and expert observers to submit condition monitoring reports and/or drought impacts through available mechanisms like NDMC’s Condition Monitoring Observer Reports (CMOR), CoCoRaHS Condition Reporting, and other individual state-based impact reporting efforts (e.g., Kentucky Drought Impact Reporter). New networks to recruit include: County Extension, Master Gardeners, Farm Bureau, FSA/USDA county offices, and County Soil and Water Conservation Districts.

Activity 3.2b: Recruit tribal partners (e.g., tribal staff, TCUs) to become CMOR observers or CoCoRaHS observers to better understand the impacts of drought on tribal lands, specifically encouraging the incorporation of TEK in these observations.

Activity 3.2c: During drought events, increase outreach to affected states for more condition monitoring reports to better understand on-the-ground conditions for decision-making, and to assist in the decision-making process for the U.S. Drought Monitor.

Activity 3.2d: Support Ohio State University to develop a framework for identifying drought impacts in Ohio by collecting sector-based datasets from state agencies, and correlating them to drought indicators. Use this information to update the Ohio-specific drought impact table. Example sector-based datasets to be utilized include: state health data, energy demand, state reports of trucking/hauling water, reported water withdrawals, and Chambers of Commerce data.

Activity 3.2e: Share the framework noted in Activity 3.2d (above) with the Midwest DEWS for other states to consider replicating in order to better understand their drought impacts for improved monitoring, planning, and earlier warning.

<sup>8</sup> <https://www.mdpi.com/2072-4292/12/21/3605>

## 5.4 PLANNING AND PREPAREDNESS

Partners in the Midwest DEWS have identified that more information around specific drought mitigation and response actions, and a better understanding of drought vulnerability in the region, would be helpful to proactively plan for drought at various levels (e.g., state, tribal, local). In addition, understanding the role green infrastructure and/or natural systems—often used for flood mitigation and adaptation—can play in drought mitigation and adaptation is important in a region that often deals with having too much water.



A hydroelectric dam on the White River, completed in 1958 by the U.S. Army Corps of Engineers. Branson, Missouri; March 10, 2020. Credit: Chad Robertson Media

### **Outcome 4.1: Drought mitigation and response actions and approaches are understood and implemented in the Midwest DEWS.**

Activity 4.1a: Work with Midwest DEWS partners and the [Drought.gov](https://www.drought.gov) team to determine the best way to display, organize, and share the database of drought mitigation and response actions included in Midwest state-level drought, water, multi-hazard, and/or climate action plans. This database was produced by the Drought Risk Mitigation Research Center (DRMRC), focused on an assessment of state- and county-level plans.<sup>9</sup> Considerations include organizing information by those mitigation and response actions most commonly used, sector, type, and/or topic.

Activity 4.1b: Work with state, tribal, and local entities to incorporate these drought mitigation and response actions noted in Activity 4.1a into their planning efforts, and incorporate into [Drought.gov](https://www.drought.gov) planning resources.

Activity 4.1c: Identify those drought mitigation and/or response actions that are beneficial for other hazards as well (e.g., flooding, extreme heat), and incorporate this information into the shared database.

Activity 4.1d: Conduct cost-benefit analyses of the top drought mitigation and response actions in this database and provide this information to Midwest DEWS partners.

Activity 4.1e: Work with tribal nations and partners to incorporate TEK into western

<sup>9</sup> <https://www.drought.gov/drought-research/midwest-dews-drought-mitigation-research>



knowledge for drought mitigation and response. Explore partnerships through the Great Lakes Indian Fish and Wildlife Commission (GLIFWC)’s and their Tribal Adaptation Menu.

Activity 4.1f: Working with public health partners in the region, identify drought mitigation and response actions for the public health sector, and incorporate this information into the database of actions and future planning efforts.

Activity 4.1g: Partner with EPA Region 5 and their Climate Resilient Water Utilities initiative to host a drought-focused workshop(s) for states and water utility providers within the Midwest DEWS.

Activity 4.1h: Support states and tribal nations who are updating drought and related plans to move to more proactive plans with technical information and lessons learned from other states and tribal nations.

Activity 4.1i: Identify opportunities for partnership with the USDA/USFS’s Climate Change Response Framework for promoting forest resilience during drought throughout the Midwest DEWS.

Activity 4.1j: In the context of a changing climate, assess the most effective drought adaptation strategies for the agricultural sector, partnering with the USDA Midwest Climate Hub.

#### **Outcome 4.2: Drought vulnerability and its impacts across the region and sectors are well understood.**

Activity 4.2a: Conduct an economic assessment for the Mississippi River corridor on the impact of drought on the river system and how this affects the region’s standing within the global trade market, in partnership with the NOAA Office of the Chief Economist, Mississippi River Cities and Towns Initiative (MRCTI), USDA’s Office of the Chief Economist, Upper Mississippi River Basin Association, and other federal, state, local, and private partners.

Activity 4.2b: Support assessments that evaluate the economic impact of both short- and long-term drought in the Midwest DEWS region, including a broad range of drought-impacted sectors (e.g., agriculture, navigation, energy, ecosystems, recreation/tourism, water utilities).

Activity 4.2c: Conduct a feasibility assessment of developing a risk atlas for water systems across the Midwest DEWS, which will identify areas more vulnerable to drought due to various issues like chronic water supply issues, soil type, single source dependency, etc. Include vulnerability to type of drought if possible (e.g., flash drought/rapid onset, short-duration, long-duration drought). As part of this, identify and learn from states that have already done this type of assessment (e.g., Kentucky). The water “risk atlas” could be used to identify high-risk areas that might benefit from more precise triggers for early warning in drought plans or drought-scenario planning exercises, for instance.

Activity 4.2d: Conduct a feasibility assessment of the steps needed to carry out a study on the utilization and dependencies upon aquifers in the Midwest.

Activity 4.2e: Share learning, especially amongst the tribal nations and local municipalities, on drought vulnerability assessment methods and how this can inform multiple planning activities (e.g., All Hazard Mitigation Plans, water plans).

**Outcome 4.3: Water management strategies that provide mitigation for multiple hazards (e.g., drought and flood) are identified and shared with partners.**

Activity 4.3a: Conduct a literature review on the role green infrastructure (GI)/natural systems can play in drought mitigation.

Activity 4.3b: Support research as necessary to better understand the role of GI in drought mitigation, and whether GI systems being implemented across the Midwest for flooding mitigation are resilient to drought and/or have co-benefits for increasing drought resilience.

Activity 4.3c: Identify drought resilient water management actions for urban areas (e.g., bioswales) vs. rural areas (e.g., capturing water and recycling for agriculture).

Activity 4.3d: Increase partnerships with other programs/entities in the Midwest DEWS region to better understand water management solutions related to drought (e.g., GI, water reuse, water efficiency), including The Nature Conservancy, USDA NRCS, EPA, NOAA Sea Grant, Association of State Floodplain Managers, American Society of Adaptation Professionals, and others.



Bridge spanning the Ohio River between Louisville, Kentucky and Jeffersonville, Indiana. Louisville skyline. Credit: Sean Pavone

## 5.5 COMMUNICATION AND OUTREACH

Improving communication and outreach has been an important focus of the Midwest DEWS, and several of the activities within this section resulted from priorities identified at the Midwest DEWS Communications Workshop that took place in May 2018.

**Outcome 5.1: Engagement with the general public is increased for drought education, awareness, and response actions through various avenues like social media, [Drought.gov](https://drought.gov), and news media.**

Activity 5.1a: Continue to expand and utilize Midwest DEWS social media through the use of a listserv in which DEWS partners can subscribe to receive an email when there is a Midwest-relevant drought tweet that their organization could retweet. Specifically begin to incorporate more NWS WFOs into this listserv given their significant Twitter following.

Activity 5.1b: Using the Drought Communications Guide developed by the Southern Climate Impacts Planning Program (SCIPP) for NIDIS as a starting point, develop action-based messaging for the public related to drought. Provide these action-based messages on [Drought.gov](https://drought.gov) for others to use to improve drought communication.

Activity 5.1c: Develop impact-based communication resources for drought for the Midwest; in particular, for human health. These communication resources could be used by public health departments across the Midwest to educate their communities on how drought can affect human health.

Activity 5.1d: Explore opportunities to showcase K–12 resources on drought through the Midwest DEWS network.

Activity 5.1e: Integrate news media outreach into the Midwest DEWS communication efforts. Ideas to explore include establishing a network of broadcast meteorologists within the Midwest DEWS, providing training/workshops for broadcast meteorologists, developing a news media outreach strategy, and establishing an annual “Drought Awareness Day”.

Activity 5.1f: Develop a “Local Drought Expert” contact list for the Midwest DEWS by state, and provide this list through [Drought.gov](https://drought.gov) to increase news media engagement.

Activity 5.1g: Invite local media to Midwest DEWS in-person meetings to increase awareness of regional efforts.

**Outcome 5.2: Relevant drought information and resources are shared through the Midwest DEWS page on the U.S. Drought Portal ([Drought.gov](https://drought.gov)).**

Activity 5.2a: Ensure the most updated and relevant resources are provided for drought monitoring, prediction, planning, and communication through the Midwest DEWS page on [Drought.gov](https://drought.gov).

Activity 5.2b: Integrate the resources and tools developed by Midwest DEWS partners into [Drought.gov](https://drought.gov) as appropriate (e.g., state dashboards, regional resources, etc.).

Activity 5.2c: Maintain and expand the list of partner drought activities on the Midwest DEWS page of [Drought.gov](https://drought.gov).

Activity 5.2d: Use the [Drought.gov](https://drought.gov) DEWS, state, and sector pages to share success

stories, innovations, lessons learned, best practices, case studies, guidance, videos, etc. for information sharing/education on drought in the region.

Activity 5.2e: Share information through [Drought.gov](https://drought.gov) about funding opportunities related to drought. Specifically highlight opportunities for funding to implement drought related projects from drought and climate change adaptation plans. Assist tribal nations and other communities in securing funds for these types of projects.

**Outcome 5.3: When drought is active in the region—additional communication and resources are provided through the Midwest DEWS network to increase awareness and response to drought conditions, impacts, and outlooks.**

Activity 5.3a: Communicate drought conditions, impacts, and outlooks to a broad audience through the Midwest DEWS, using mechanisms like Drought Status Updates, [Drought.gov](https://drought.gov), social media, news media, and the monthly North Central Climate and Drought Outlook webinar series.

Activity 5.3b: Document drought conditions and impacts for the Midwest DEWS to assist in communication and post-drought assessment efforts.

Activity 5.3c: Increase communication and coordination with partners like state climatologists, NWS Weather Forecast Offices, state drought task forces, and state/local agencies as needed.

Activity 5.3d: NIDIS will coordinate and support post-drought assessments in the Midwest in partnership with the DEWS network when deemed necessary by the character, duration, or impact of drought.

**Outcome 5.4: Training and learning opportunities on key tools and products for the region are provided to the Midwest DEWS network.**

Activity 5.4a: Beta test the new Flash Drought Risk Tool (Flash-DRT) (in development at Purdue University) with the Midwest DEWS partners.

Activity 5.4b: Support the use of drought-scenario exercises to inform drought early warning and preparedness in the region, and carry out such exercises where appropriate. This could inform drought response activities such as when and how coordination increases as drought progresses in intensity, exploring future drought risk to inform planning, etc.

Activity 5.4c: Provide climate and drought training workshops for tribal nations in the Midwest. Consider partnering with GLIFWC for a Tribal Adaptation Menu workshop or the High Plains Regional Climate Center for a climate data tribal workshop, and explore funding from the BIA Climate Resilience Grants.

Activity 5.4d: Offer tool “deep dive” sessions (through webinars/virtual or in-person meetings) for drought-monitoring tools. Including but not limited to a deep dive into the soil moisture products that are available and the pros/cons of each and their ability to depict drought in the Midwest.

**Activity 5.4e:** Provide continued training opportunities for University Extension, tribal, state, and federal staff on the US Drought Monitor and other key tools in partnership with USDA, NDMC, and NOAA.

## 5.6 INTERDISCIPLINARY RESEARCH AND APPLICATIONS

An important building block of improved drought early warning is understanding the characteristics of drought in the Midwest region, today and in the future, in order to improve monitoring and prediction. Additionally, there would be significant value in identifying which drought indicators and indices are most appropriate to use for the region based on season, geography, type of drought, and impacted sector.



A soybean field in the midwest is watered by a center-pivot irrigation system. Credit: Kenneth Keifer

### **Outcome 6.1: Our understanding of the best application of drought indicators temporally and spatially across the Midwest is improved.**

**Activity 6.1a:** Support research to determine the most appropriate drought indicators by season for the Midwest region and by type of drought.

**Activity 6.1b:** Improve the applicability and utility of the Evaporative Drought Demand Index (EDDI) in the Midwest DEWS by identifying the most appropriate timescale to monitor for various sectors in the region.

**Activity 6.1c:** Incorporate spatial/temporal drought indicator information from existing efforts into [Drought.gov](https://www.drought.gov) as new information becomes available (e.g., NASA drought indicator project<sup>10</sup> and the Ohio State project<sup>11</sup>), and share broadly across the Midwest DEWS. Amplify communication of indicators when conditions are setting up for potential or worsening drought.

**Activity 6.1d:** Support research to identify and/or develop drought indicators for

<sup>10</sup> <https://www.drought.gov/drought-research/quantifying-relative-importance-multiple-drought-indicators-us-drought-monitor>

<sup>11</sup> <https://www.drought.gov/drought-research/developing-objective-impacts-based-framework-drought-mitigation-activities-ohio>

ecological drought in the Midwest.

**Outcome 6.2: Our understanding of the characteristics, predictability, and risk of drought in the Midwest today and in the future is improved.**

Activity 6.2a: Support research to investigate the physical characteristics (e.g., persistence, timing, drivers), potential predictability and risks of those characteristics, and whether climate change alters those risks during drought onset, persistence, and demise for the Midwest. Distribute the findings broadly to the Midwest DEWS network.

Activity 6.2b: Utilizing the expertise of the Midwest DEWS network, identify which findings from this research have actionable information that can be integrated into existing drought response and planning efforts.

**Outcome 6.3: Our understanding of the historical and future characteristics of rapid transitions between precipitation extremes in the Midwest (i.e., wet to dry, and vice versa) is improved, and proactive actions that can be taken to address these extremes are identified.**

Activity 6.3a: Support research to improve our understanding of the rapid transition between precipitation extremes, their causes, and risks they pose to the Midwest today and in the future under climate change scenarios, and distribute the results broadly across the Midwest DEWS network.

Activity 6.3b: Through engaging with the Midwest DEWS network and other stakeholders (e.g., listening sessions) or data-driven analysis, identify sector-based impacts that result from the rapid transition between precipitation extremes, and the time of year when this rapid shift can have the most negative impact on sectors across the region.

Activity 6.3c: Convene a regional working group with expertise in drought response and mitigation to develop a management framework that incorporates proactive planning and response actions for dealing with rapid transitions between precipitation extremes.

Activity 6.3d: Utilize the Midwest DEWS network to incorporate this management framework into local, regional, and state planning efforts.

**Outcome 6.4: The Midwest region is more resilient to flash drought through improved monitoring, prediction, planning, and communication.**

Activity 6.4a: Support research to determine the best indicators by location/season to monitor flash drought development and its evolution in the Midwest region.

Activity 6.4b: Support the development of flash drought indicators and tools as appropriate to improve flash drought monitoring capabilities (including the Flash Drought Risk Tool and the EDDI-based Flash Drought Detection Metric).

Activity 6.4c: Develop a database of the sector-based impacts of flash drought in the Midwest by time of year and location.

Activity 6.4d: Engage with practitioners across the Midwest DEWS to identify which management or response actions have been taken during flash droughts in the past, and whether or not they were successful at mitigating the impacts of flash drought.

Activity 6.4e: Support research to identify if any actions taken for flash drought historically could be counterproductive if the duration of the flash drought persists (e.g., hauling water, pumping of water, etc.).

**Outcome 6.5: The decision points of various sectors (e.g., agricultural producers, water utilities, navigation, water management, natural resource management, human health) are better understood, and information providers are aligning information products, formats, and timing.**

Activity 6.5a: Develop decision calendars for economic sectors in the Midwest to inform product and information development and delivery to better target information. Midwest DEWS partners have identified the water utility and navigation sectors as the two they'd like to initially pursue.

Activity 6.5b: Research how climate/drought decision calendars have informed better decision making and/or information sharing, including the NDMC's Specialty Crops Decision Calendars.<sup>12</sup>

Activity 6.5c: Make existing and new decision calendars available through [Drought.gov](https://www.drought.gov) and share broadly throughout the Midwest DEWS network.

---

12 <https://www.drought.gov/documents/midwest-crop-production-decision-calendars-and-fact-sheets>



DuSable Bridge, Chicago, at twilight. Credit: Oleg Podzorov

---

## 6 Linking Outcomes to Priorities

Given that the outcomes and activities in the Plan are organized by DEWS components, it might be difficult to discern at first glance how they contribute to the five key priorities. The table below indicates how the outcomes are linked with the five priorities.

**Priority 1:** Build a comprehensive understanding of drought indicators.

**Priority 2:** Increase our understanding of the characteristics, predictability, and risk of drought and rapid transitions between precipitation extremes in the Midwest.

**Priority 3:** Identify and communicate innovative solutions and proactive measures to build resilience.

**Priority 4:** Enhance collaboration, coordination, and communication among partners.

**Priority 5:** Integrate the Great Lakes watershed into the Midwest DEWS.



<b>Mapping Outcomes to Priorities in the Midwest DEWS Strategic Action Plan</b>					
	<b>PRIORITY 1</b> Drought Indicators	<b>PRIORITY 2</b> Characteristics, Probability, Risk	<b>PRIORITY 3</b> Innovative Solutions	<b>PRIORITY 4</b> Collaboration, Communication, Coordination	<b>PRIORITY 5</b> Great Lakes
Outcome 1.1				<b>X</b>	
Outcome 1.2				<b>X</b>	<b>X</b>
Outcome 1.3				<b>X</b>	
Outcome 1.4		<b>X</b>		<b>X</b>	<b>X</b>
Outcome 2.1	<b>X</b>	<b>X</b>			
Outcome 2.2		<b>X</b>			
Outcome 2.3	<b>X</b>			<b>X</b>	
Outcome 3.1	<b>X</b>			<b>X</b>	
Outcome 3.2				<b>X</b>	
Outcome 4.1			<b>X</b>		
Outcome 4.2		<b>X</b>	<b>X</b>		
Outcome 4.3			<b>X</b>		<b>X</b>
Outcome 5.1			<b>X</b>	<b>X</b>	<b>X</b>
Outcome 5.2				<b>X</b>	<b>X</b>
Outcome 5.3				<b>X</b>	
Outcome 5.4			<b>X</b>	<b>X</b>	
Outcome 6.1	<b>X</b>				
Outcome 6.2		<b>X</b>	<b>X</b>		
Outcome 6.3		<b>X</b>	<b>X</b>		<b>X</b>
Outcome 6.4	<b>X</b>	<b>X</b>	<b>X</b>		
Outcome 6.5			<b>X</b>	<b>X</b>	



North America from space.  
Credit: NASA, Darryl Fonseca

---

## 7 National & Cross-DEWS Initiatives

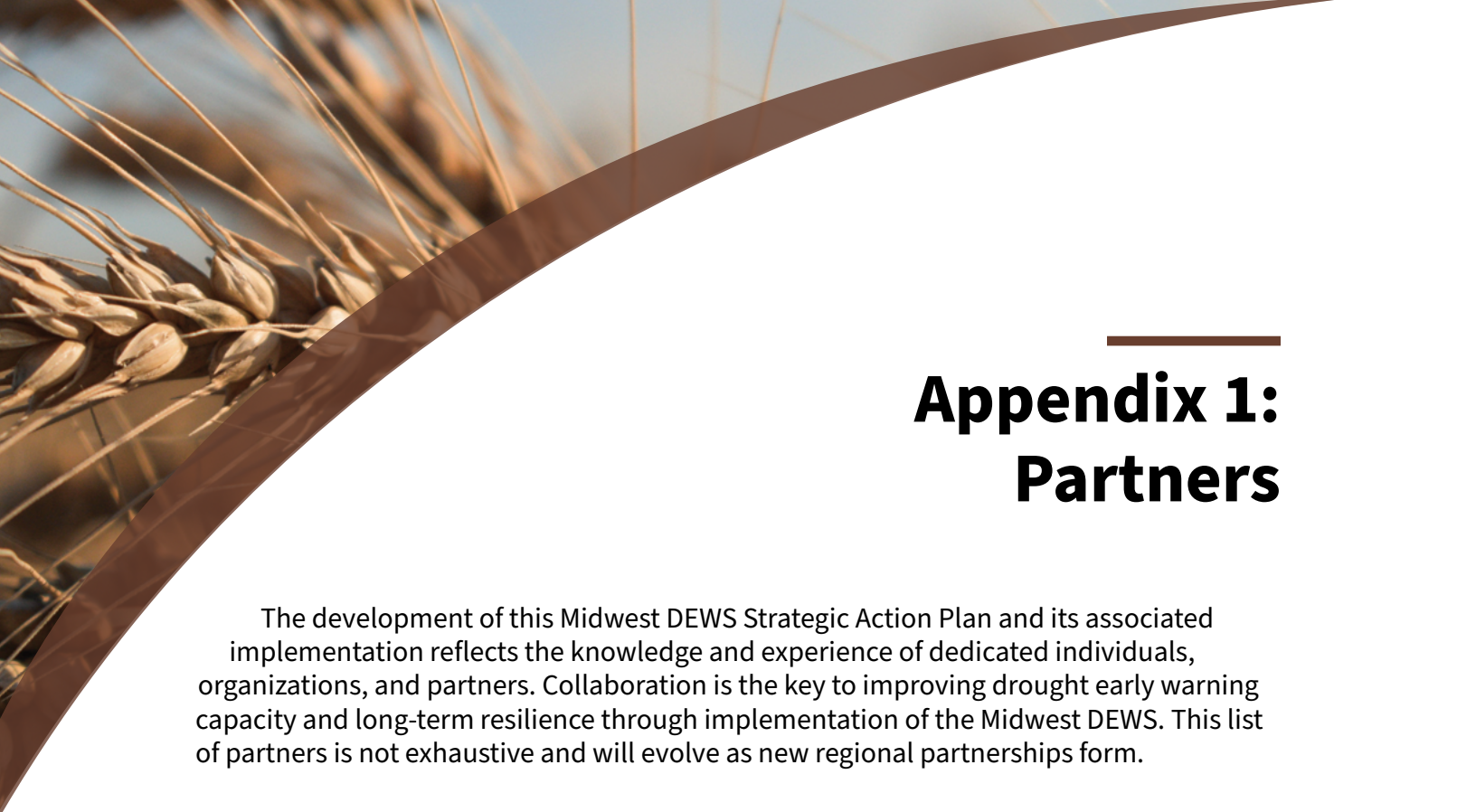
NIDIS has implemented regional DEWS as the foundation on which to provide national drought early warning, in recognition that impacts and early warning information differ across the regions. There are also challenges that cross multiple regions or require a coordinated effort at the national level. These include issues like the complex interactions of drought and wildland fire, drought and human health, tribal engagement, drought impact reporting and analysis, linking drought triggers and indicators, the NIDIS Coping with Drought grant program, understanding a healthy water cycle and healthy soil, and soil moisture monitoring. Regional DEWS have the ability to tap into these larger initiatives where there is interest and need, again providing an opportunity for cross regional and scalable (regional to national) learning and progress. The table below illustrates some of these linkages as they apply in the Midwest.

National/Cross-DEWS Initiatives	Midwest DEWS Activities
<p><b>Weather Research and Forecasting Innovation Act of 2017 (Weather Act)</b></p>	<p>The Weather Act calls for NOAA to prioritize weather research in part to improve forecasts and warnings for protection of life and economy, to improve understanding of forecast capabilities for atmospheric events and their impacts, and to make reliable and timely foundational forecasts of subseasonal (2 weeks – 3 months) to seasonal (3 months to 2 years) forecasts of temperature and precipitation. While there are many other initiatives included in the Weather Act, these are the areas that NIDIS also has a strong interest in, in terms of drought early warning. NIDIS is making and leveraging investments in regards to the same temporal scale as they apply to drought in partnership with the NWS regional and local forecast offices, the Climate Prediction Center, and the Office for Oceanic and Atmospheric Research. The Midwest is a location where predictability is challenging. Hopefully efforts such as the <i>Characteristics, Predictability, and Risk of Mississippi and Ohio River Valley</i>, and <i>Toward an Improved Understanding of Rapid Transitions in Precipitation Extremes and Risk Assessment for the Midwest</i> studies will help inform these efforts.</p>
<p><b>Water Prediction Center/NOAA Water Initiative</b></p>	<p>NOAA has multiple efforts aimed at water security that NIDIS plays a role in. The Water Initiative aims to improve the Nation’s water security by providing science-based information and services that address vulnerability to water risks and enabling greater efficiency and effectiveness in the management of water resources. NOAA will advance this mission primarily through transforming integrated water prediction services in collaboration with decision makers, partners, and users. In addition the Water Prediction Center focuses on collaborative research to inform essential emergency management and water resources decisions across all time scales. NIDIS is involved in efforts to enhance drought prediction and monitoring, looking at applications of the National Water Model to drought early warning and serving as part of these initiatives where they intersect with drought.</p>
<p><b>Tribal Engagement Strategy</b></p>	<p>There are many similarities in the gaps and needs in the Midwest, whether the recipient of the information and services be a tribal nation or a state or community. By considering the principals of engagement that are enumerated in the <i>Tribal Engagement Strategy</i> and engaging the tribal nations of the Midwest in a meaningful way, we will achieve many of the outcomes in both documents.</p>
<p><b>NIDIS Drought and Wildland Fire Nexus Strategy (NDAWN)</b></p>	<p>The Western Regional Climate Center, Desert Research Institute, and NIDIS partnered to form the <i>Drought and Wildland Fire Nexus (NDAWN)</i> to identify priorities and actions to improve products and communication in the drought and fire communities. NDAWN defines the needs and challenges of fire managers to effectively utilize drought information and aims to meet those needs to establish a robust drought and wildland fire decision-support information network. As the Midwest DEWS begins to understand the characteristics and risk of wildfire in the Midwest, we will bridge this understanding and efforts with NDAWN.</p>

<b>National/Cross-DEWS Initiatives</b>	<b>Midwest DEWS Activities</b>
<b>National Coordinated Soil Moisture Monitoring Network (NCSMMN)</b>	There is a clear need in the Midwest to fill gaps in spatial coverage of soil moisture sensors and other in situ data. The efforts of the NCSMMN will work to build increased coverage across the U.S., including the Midwest. This effort will also make more soil moisture products available for drought monitoring.
<b>NIDIS “Coping with Drought” Grant Competition</b>	NIDIS uses the “Coping with Drought” federal funding opportunity to address research needs gathered through the consultative process within the DEWS. The outcomes of applied research funded through the CWD program will be transferred to the DEWS. For example, the FY22 competition is focused on applied research for ecological drought and building tribal drought resilience, which aligns with priorities 1 and 4 in this region.
<b>Drought and Human Health</b>	NIDIS is working with the University of Nebraska Medical Center to develop a Drought and Human Health Strategy. To inform the Strategy, UNMC and NIDIS are hosting regional workshops with stakeholders around the topic of drought and health. The Midwest DEWS had a Midwest-focused drought and health workshop in November 2019. Feedback and needs identified at the workshop will be incorporated into the overall Strategy for NIDIS.
<b>Drought Impact Reporting and Analysis</b>	Through a partnership with the National Drought Mitigation Center, NIDIS is involved in efforts nationally to improve reporting and analysis that can inform what is happening across the region and at the state level. There are many efforts in the Midwest around impact reporting and analysis that will transfer to other states as well as to our national efforts and vice versa. Missouri has been working with the NDMC and the National Drought Impact Reporter to improve reporting and use that information in decisions. This two-way learning is optimal on these complex issues.
<b>Improving Indicator Use and Linking to Triggers</b>	Midwest DEWS partners have expressed the desire to better understand which indicators and indices should be used for a region/state both spatially and temporally as well as for different sectors. There are efforts within the Midwest DEWS as well as nationally to make progress toward this effort, including a study by NASA and the Commission on Environmental Cooperation (CEC). Deliberate efforts to share learning across these initiatives will hopefully accelerate this work.
<b>National Drought Forum</b>	The National Drought Forum held in 2019 resulted in ten priority actions, many of which are reflected in the Midwest DEWS Strategic Action Plan. These include, but are not limited to, work to improve flash drought forecasts, enhancements to observations and monitoring and decision support tools, better quantification of drought impacts, and ecosystem restoration to mitigate drought impacts. The synergies between priorities at the regional and national effort should amplify our progress in addressing these complex challenges.

## **7.1 LINKAGES TO REGIONAL PARTNERS AND INITIATIVES**

NIDIS has a mandate to work across the federal government, coordinating drought related activities with other federal agencies, and to build upon and leverage existing partnerships, networks, and initiatives. This is especially important in the regional DEWS where these partners and regional organizations are key to realizing success in the region. In the Midwest, key regional partners include the USDA Midwest Climate Hub, the National Drought Mitigation Center, the Department of the Interior Midwest Climate Adaptation Science Center, and the NOAA Midwestern Regional Climate Center, NCEI Regional Climate Services and National Weather Service Central Region Headquarters. The activities above call out many places where linkages are being made with these regional partners and programs. These linkages have been key in much of the past progress and will continue to be key moving forward. Additional partners, programs, assistance, and activities offer additional beneficial linkages that can be developed and built upon to identify more resources, to work across more agencies, to leverage more partnerships, and to utilize more assistance that will result in more efficiency and effectiveness of everyone's contributions and increase co-benefits.



---

# Appendix 1: Partners

The development of this Midwest DEWS Strategic Action Plan and its associated implementation reflects the knowledge and experience of dedicated individuals, organizations, and partners. Collaboration is the key to improving drought early warning capacity and long-term resilience through implementation of the Midwest DEWS. This list of partners is not exhaustive and will evolve as new regional partnerships form.

<b>Partner Agencies and Organizations</b>
<b>Federal Emergency Management Agency (FEMA) Region 5 and 7</b>
<b>Illinois Department of Natural Resources</b>
<b>Indiana Department of Homeland Security</b>
<b>Indiana Department of Natural Resources</b>
<b>Iowa Department of Natural Resources</b>
<b>Kentucky Division of Water</b>
<b>Minnesota Department of Natural Resources</b>
<b>Mississippi River Cities and Towns Initiative</b>
<b>Missouri Department of Natural Resources</b>
<b>National Aeronautics and Space Administration (NASA)</b>
<b>National Drought Mitigation Center (NDMC)</b>

<b>Partner Agencies and Organizations</b>
<p><b>National Oceanic and Atmospheric Administration (NOAA)</b>            Central Region Collaboration            Central Region Regional Operations Center (ROC)            Climate Prediction Center (CPC)            Earth Systems Research Laboratory (ERSL)            Midwest Regional Climate Center (MRCC)            National Center for Environmental Information (NCEI) Regional Climate Services            National Weather Service (NWS) Weather Forecast Offices (WFO)            NWS North Central Forecast Center            NWS Ohio River Forecast Center</p>
<p><b>Ohio State University</b></p>
<p><b>Purdue University</b></p>
<p><b>University of Illinois</b></p>
<p><b>University of Minnesota</b></p>
<p><b>University of Missouri</b></p>
<p><b>University of Wisconsin</b></p>
<p><b>Upper Mississippi River Basin Association (UMRBA)</b></p>
<p><b>US Army Corps of Engineers (USACE)</b></p>
<p><b>U.S. Department of the Interior (DOI)</b>            Bureau of Indian Affairs (BIA)            U.S. Geological Survey (USGS)            Midwest Climate Adaptation Science Center (CASC)</p>
<p><b>U.S. Environmental Protection Agency (USEPA) Region 5</b></p>
<p><b>U.S. Department of Agriculture (USDA)</b>            Agricultural Research Service (ARS)            Farm Service Agency (FSA)            U.S. Forest Service (USFS)            Midwest and Northern Forests Climate Hubs            Northern Institute of Applied Climate Science (NIACS)            Natural Resources Conservation Service (NRCS)            Risk Management Agency (RMA)</p>
<p><b>Western Kentucky University</b></p>



---

## Appendix 2: Disclaimer

The Midwest DEWS 2021–2024 Strategic Action Plan is a collaborative federal, state, tribal, and local interagency effort to improve early warning capacity and resilience to drought in the Midwest. The contents of this plan should not be used as evidence against any Midwest DEWS state; any federally recognized tribe; or the federal government in any administrative, judicial, or other proceeding. The assumptions, conclusions, and other information contained in the Plan do not represent a legal interpretation or legal position related to any issue raised in, or otherwise relevant to, litigation, nor do they represent a consensus view of federal agencies or other stakeholders involved in the Plan’s development. The Plan is not intended as an attempt to resolve any particular dispute within the Midwest. Nothing in the Plan is intended to, nor shall the Plan be construed so as to, interpret, diminish, or modify the rights of any Midwest state, any federally recognized tribe, or the Federal government under Federal or state law or administrative rule, regulation, or guideline.

Finally, all parties recognize that partners participating in this process may disagree over the appropriate scope, methods, results, or interpretation of technical analyses performed in developing or implementing this DEWS. As such, neither the Plan, nor any work performed pursuant to it, shall be attributed to any organizations or individuals by virtue of their participation as a partner in this process. Nor shall any party be deemed to accept or agree with any particular assumption, conclusion, and other information contained in the Plan or its resulting studies, unless explicitly stated by those parties.







Document prepared by NIDIS  
in partnership with key  
stakeholders in the region.

