

NATIONAL INTEGRATED DROUGHT INFORMATION SYSTEM



Midwest Drought Early Warning System Kick-Off Meeting: A synopsis

FEBRUARY 2016 – ST. LOUIS, MISSOURI

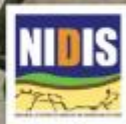


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Introduction to the Midwest DEWS

WHAT IS NIDIS?

The National Oceanic and Atmospheric Administration's (NOAA) National Integrated Drought Information System (NIDIS) program was authorized by Congress in 2006 (Public Law 109-430) with an interagency mandate to coordinate and integrate drought research, building upon existing federal, tribal, state, and local partnerships in support of creating a national drought early warning information system.



WHAT IS A DEWS?

A DEWS utilizes new and existing partner networks to optimize the expertise of a wide range of federal, tribal, state, local and academic partners in order to make climate and drought science readily available, easily understandable and usable for decision makers; and to improve the capacity of stakeholders to better monitor, forecast, plan for and cope with the impacts of drought.

NOAA's National Integrated Drought Information System (NIDIS) is initiating the development and implementation of a Drought Early Warning System (DEWS) in the Midwest. NIDIS is comprised of a network of regional drought early warning systems throughout the United States, where, in accordance with Congressionally authorized Public Laws (P.L. 109-430 and P.L. 113-86), NIDIS is working closely with federal, state and local interagency and intergovernmental partners to improve drought early warning capacity and resilience. The Midwest DEWS also addresses the relationship between high precipitation events and drought, where high precipitation events can significantly affect the duration, severity and impacts associated with drought.

Background

Precipitation extremes in the Midwest (whether it is too wet or dry) have a major impact on the region's resources, economic sectors and residents. Over the last century, period of prolonged and extreme droughts have become less frequent than the Midwest region experienced in the early 20th century. However, the Midwest has still felt adverse impacts during droughts of recent decades, particularly in 1988, 2005, 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 reduced productivity for hydropower.

An added challenge in recent years has been the tendency to transition from drought to flood and

back to drought within short time spans, sometimes within a matter of months. The 2012 drought occurred just a year later after epic flooding throughout the Midwest and Great Plains. In addition, wet April-June periods have been more common over the last 10 years, which also affects important Midwest sectors.





Midwest DEWS Region

Note: While the brown shading denotes the DEWS Midwest region, where the majority of DEWS actions focus, activities may extend beyond the shaded area when needed. The “fuzzy” edges reflect the permeability of the DEWS boundary.

For agriculture, wet springs reduce the number of workable field days, delay planting, and increase nitrogen loss, which further can degrade water quality. The wet springs of 2011 and 2013 were followed by dry summers, which exacerbated the challenges faced by farmers.

The frequency of extreme precipitation events and amount of precipitation in the Midwest is expected to continue to increase in the future. However, recent decades have demonstrated that droughts can and will still occur in a wetter climate. They have also demonstrated the challenges associated with a rapid change between the climatic extremes. Properly planning and preparing for both drought and high precipitation and understanding the relationship between the two events is important for developing climate resilience in the Midwest.

To address these challenges, NIDIS and its partners launched the Midwest DEWS in February 2016. The Midwest DEWS is a collaborative federal, state, and local interagency effort to improve early warning capacity and resilience to both drought and high precipitation events throughout the region. This is accomplished through local stakeholder-driven activities encompassing data collection and monitoring; research; planning for climate extremes; and communication, education, and outreach. Activities will focus on areas throughout the Upper Mississippi River and Ohio River basins in Minnesota, Iowa, Missouri, Wisconsin, Illinois, Indiana, Kentucky, and Ohio.

Mission of the Midwest DEWS

Enhance drought resilience in the Midwest region by improving the ability for communities to collaborate, plan and be prepared for drought, understand the relationship between drought and high precipitation events, better utilize available tools and climate forecasts and to proactively identify, mitigate and respond to

planning and information resources.

Specific objectives of the Midwest DEWS are to:

- Provide a forum for a diverse group of federal, tribal, state, and local stakeholders that represent all economic sectors, including water and land resource management, to strategize and develop appropriate, relevant, useful and readily available drought, climate, weather and water-related information.
- Develop an understanding of the existing observation and monitoring networks, data, tools, research and other planning and mitigation resources available for a drought early warning system.
- Identify the economic sector-specific and geographic needs for future monitoring, prediction,



Midwest DEWS Kick-off Meeting and Planning Process



Attendees at Midwest DEWS Kickoff meeting met in St. Louis in February 2016.

The Midwest DEWS Kickoff Meeting was held February 9-11, 2016 in St. Louis, MO to formally launch the Midwest DEWS. The multi-day event brought together federal, state, local, private industry and academic partners and other stakeholders for an in-depth discussion on drought and high-precipitation events in the Midwest, with attention to water, climate, land resources and emergency management. Discussions centered on improving the capacity to meet the early warning information needs of decision makers in the Midwest.

Partners across the region assisted NIDIS with the launch of the Midwest DEWS, including the Midwestern Regional Climate Center (MRCC), Illinois State Water Survey, Kentucky Climate Center, University of Missouri Extension, National Drought Mitigation Center (NDMC), Federal Emergency Management Agency (FEMA), NOAA, National Weather Service (NWS), U.S. Army Corps of Engineers (USACE), and the U.S. Department of Agriculture (USDA).

The desired outcomes of the Midwest DEWS Kickoff Meeting included:

- Increased knowledge and awareness of available data, monitoring activities, and decision-support tools for drought and high precipitation events.
- Identification of economic sector-specific and geographic data information needs.
- Identification of communication resources that would be most effective for conveying drought information among sectors and geographic areas.
- Recommendations for future actions, collaborative research, and decision support to improve early warning of drought in the Midwest.

Participants in the Midwest DEWS Planning and Kickoff Meetings

| | | |
|---|---|---|
| City of St. Louis Water Division | Minnesota Department of Natural Resources, State Climatology Office | Science Centers |
| Cooperative Institute for Climate and Satellites | Missouri American Water Co. | U.S. Fish and Wildlife Service / Tallgrass Prairie Landscape Conservation Cooperative |
| Eastern Area Coordination Center | Missouri Department of Natural Resources | University Corporation for Atmospheric Research |
| EPA | Missouri Rural Water Association | University of Illinois |
| Farm Bureau | National Drought Mitigation Center | University of Kentucky |
| FEMA | National Weather Service | University of Kentucky Ag Weather Center |
| Great Lakes Integrated Sciences and Assessments, University of Michigan | NIDIS | University of Minnesota |
| Illinois Department of Natural Resources | No-Till Farmer Magazine | University of Missouri |
| Illinois State Geological Survey | NOAA / National Centers for Environmental Information | University of Missouri Extension |
| Illinois State Water Survey, University of Illinois | NOAA / National Weather Service | University of Wisconsin |
| Illinois-Indiana Sea Grant | NOAA / NWS / North Central River Forecast Center | University of Wisconsin Extension |
| Indiana Department of Natural Resources, Division of Water | NOAA / NWS / Ohio River Forecast Center | Upper Mississippi River Basin Association |
| Interstate Council on Water Policy | NOAA / Office for Coastal Management | USDA |
| Iowa Department of Agriculture | North Central Region Water Network | USDA Agricultural Research Service |
| Iowa Department of Natural Resources | Ohio State University | USDA Farm Service Agency |
| Iowa State Climatologist | Ohio State University, State Climate Office of Ohio | USDA Forest Service |
| Iowa State University | Oneida | USDA Joint Ag Weather Facility |
| Kansas City Water Services | Purdue University | USDA Natural Resources Conservation Service |
| Kentucky Climate Center, Western Kentucky University | Sandia National Laboratories | USDA Risk Management Agency |
| Kentucky Division of Water | Smuckers | USDA Rural Development |
| Kentucky Rural Water Association | South Dakota State University, SD State Climate Office | USGS |
| Louisville Gas & Electric | Southern Illinois University | USGS Missouri Water Science Center |
| Michigan State University | U.S. Army Corps of Engineers | Waterways Council, Inc. |
| Midwestern Regional Climate Center, University of Illinois | U.S. Army Corps of Engineers, Louisville District | Western Kentucky University |
| Minnesota Department of Agriculture | U.S. Dept. of the Interior Climate | Wisconsin Department of Natural Resources |
| Minnesota Department of Health | | Wisconsin State Climatology Office |

The planning process for the Midwest DEWS launch in St. Louis in February 2016 included the following workshops:

- [A Midwest Climate and Agriculture workshop on September 29-October 1, 2015 in Champaign, IL](#) (hosted by the MRCC, NIDIS, and the USDA Midwest Climate Hub).
- [A Midwest DEWS planning workshop on November 3, 2015 in Louisville, KY](#) to receive input from the Ohio Valley Basin stakeholders (hosted by NIDIS, MRCC, and NDMC).
- [A Midwest DEWS planning workshop on November 5-6, 2015 in Bloomington, MN](#) to receive input from the Upper Mississippi Basin stakeholders (hosted by NIDIS, MRCC, and NDMC).

The Midwest Climate and Agriculture workshop created a unique opportunity to convene Extension, federal agencies and organizations, private consultants, product developers, and researchers concerned about climate extremes and variability impacts on specialty crops and livestock throughout the Midwest. At the workshop, participants filled out a survey on their current use of drought information and any unmet needs they had for drought data or information to help guide the launch of the Midwest DEWS.

The November 2015 Midwest DEWS planning workshops provided a forum for a diverse group of stakeholders to discuss issues regarding the appropriate, relevant, useful and readily available information on drought, climate, weather, and water. The workshops also identified sector-specific and geographic needs for future tools and informational resources. The primary affiliations of attendees at the planning workshops were federal agencies, state agencies, universities, and businesses, while the main sectors represented were water supply/quality, weather/climate, agriculture, energy, and public health. The information gathered at the November 2015 workshops informed the planning for the Kickoff Meeting in February 2016.

The February 2016 Midwest DEWS Kickoff Meeting in St. Louis included presentations from keynote speakers and content experts, panel discussions, and small discussion groups that identified priority stakeholder needs and proposed actions for the Midwest DEWS.

Keynote Speaker Highlights

Keynote speakers included Mayor Francis G. Slay, mayor of the City of St. Louis; Colleen Callahan, the USDA Rural Development Illinois Director and Coordinator of the 2012 Federal Disaster Recovery Framework for Drought; and Todd Sampsel, the Deputy Director of the Missouri Department of Natural Resources (DNR).

Mayor Francis G. Slay, Mayor of the City of St. Louis

Mayor Slay gave an overview of the Mississippi River Cities and Town Initiative (MRCTI). Mayor Slay was the first mayor to join MRCTI in 2012 and since then, 69 more mayors in ten states along the Mississippi River have joined. With 100 million tons of cargo passing through St. Louis each year, the Mississippi River is crucial to the nation's economy. One goal of MRCTI is to explain to policymakers and lawmakers the importance of the Mississippi River. Efforts of MRCTI include the establishment of a caucus of senators and congressmen in Washington D.C. that is focused on Mississippi River issues, the signing of a food and water security agreement by 15 nations, and a regional assessment of climate risks to the Mississippi River.

Colleen Callahan, USDA Rural Development Illinois Director

Ms. Callahan spoke about the National Disaster Recovery Framework for the 2012 drought and emphasized that there is no quick-fix solution to drought. Essential components to addressing the 2012 drought were listening to those who were impacted, understanding their needs and working

in a collaborative manner with federal agencies and other governmental authorities to address needs. The effort resulted in a [National Disaster Recovery Framework Matrix](#) that tracks existing authorities, programs, and funding designed to address the direct or indirect impacts from drought. Ms. Callahan emphasized that the Matrix can be used as an actionable tool to better prepare for the next drought.

Todd Sampsell, Deputy Director of the Missouri DNR

Mr. Sampsell addressed the flooding and drought issues in Missouri, highlighting the recent December 2015 floods and 2012 flash drought. Agriculture in Missouri is an \$11 billion per year industry and is greatly impacted by both flood and drought. Mr. Sampsell noted that while flooding tends to impact Missouri more frequently than drought, Missouri ranks third in the country when it comes to the adverse impacts drought has on rural communities. Mr. Sampsell said Missouri's needs specific to early warning of drought and high precipitation events are: 1) higher accuracy for temperature and precipitation forecasts, 2) improved satellite-derived soil moisture data compared to what is being experienced on the ground, 3) information on recent trends for high precipitation events and what is expected in the future, and 4) runoff predictions into bodies of water.

Highlights of the Presentations and Panel Discussions

Day 1 Theme: Laying the Foundation for a Midwest DEWS

Presentations and panel discussions on the first day focused on available federal, state, and local resources, and identified tools and capabilities on which the Midwest DEWS will be established.

Highlights included:

- **State mesonets¹ provide a wealth of local data.** [The Regional Mesonets and Partners Project \(ReMAPP\)](#) through the Midwestern Regional Climate Center hosts a suite of operational product maps (i.e.: atmospheric, soil, and moisture conditions) from various mesonet groups within the Midwest and Central U.S.
- **There are many data and tools that may be used to address drought; however, there are challenges to accessing and synthesizing these data and tools.** There is a need to improve the accessibility, understanding, and usability of these tools and data.
- **Soil moisture data is an important indicator for drought early warning. However, improvements need to be made to soil moisture monitoring.** Methods to obtain soil moisture data include satellite measurements, direct observations, modeled data, and combinations of methodologies. Each method provides advantages and disadvantages. The

¹ A mesonet is a system of automated weather stations designed to observe meteorological phenomena at the scale of one to 1,000 km

Coordinated National Soil Moisture Monitoring Network supported by the USGS, USDA, NIDIS, and Texas A&M is addressing some of these issues.

- **There are a variety of federal, state, local and academic drought initiatives currently being implemented across the nation. However, there is a need for better understanding of how these initiatives relate to each other, how they might be coordinated, and how stakeholders may get involved with such efforts.** NIDIS's working groups (i.e. Engaging Preparedness Communities) are designed to help facilitate the transfer of information and coordination among regions throughout the country. In addition, the National Drought Resiliency Partnership (NDRP) is a federal program designed to specifically foster coordination of federal agencies addressing drought. It is important to continue to emphasize this need for coordination at a national level as these initiatives and others continue to mature.
- **USDA Extension and other outreach programs have networks in place to convey information at the local level.** Stakeholders and the Midwest DEWS can engage with these existing networks (such as Extension Disaster Education Network, North Central Region Water Network, Sea Grant and Water Resource Centers) to receive and convey information.
- **Drought planning can tie into other planning efforts, such as comprehensive water plans and local hazard mitigation plans.** Vulnerability assessments can include the review of drought and other related plans including local water, hazard and community plans to characterize the sophistication of drought planning within a region. Drought plans can be mitigation-based (addressing actions prior to a drought), response-based (addressing actions during a drought), or a combination of both.

Day 2 Theme: Current Climate Outlook and Forecasting, Drought Impacts & Vulnerabilities, and Drought Preparedness Resource Needs

Presentations on the second day provided a current climate outlook; information on the state of science around climate predictions; and forecasting and background on drought, high precipitation events, and flooding in the Midwest region. A panel discussion focused on drought impacts and vulnerabilities for individual sectors in the Midwest region. Highlights included:

- **Over-forecasting precipitation during drought is an issue the NWS is addressing.** Weather and climate forecast models have a tendency to over-forecast precipitation during drought, and efforts to improve such forecasts need to continue.
- **Modifying agricultural practices or incorporating additional conservation measures can decrease adverse drought or extreme weather impacts on agricultural workinglands.** Production agricultural practices, such as continuous monoculture or conventional tillage, can reduce soil carbon, soil structural integrity, infiltration, and water holding capacity of soils. Modifying these conventional practices to include cover crops, reduced or no tillage, or grazing lands management will protect soils and reduce the severity of impacts from weather extremes. However, there can be challenges to producers for implementing such practices and more education is needed on a regional basis.

- **Droughts can happen in wetter climates, including the Midwest region.** In the Midwest, it has become increasingly common to transition quickly from drought to flood and back to drought within a short time span. While it is projected that heavy, high-intensity precipitation events will increase in the future and that the Midwest may become wetter on average, drought will continue to occur in the region. The average number of days without precipitation is projected to increase which could lead to agricultural drought and other drought related impacts.
- **There is evidence that public health is impacted by drought; however, there are significant challenges to collecting health-related drought data and quantifying such impacts.** Drought impacts on health include compromised air and water quality, compromised food and nutrition, diminishing living conditions (i.e., energy and air quality), reduced sanitation and hygiene, mental and behavioral health (i.e., farmers struggling during drought), and increased disease incidence.
- **Midwest sectors are impacted by drought; however, the impacts are easier to discern in some economic sectors than others.** Impacts discussed during the panel session are summarized below.
 - Agriculture: Reduced crop quality and yields, reduced income, and reduced revenue of businesses that support agricultural production.
 - Navigation: Operational interruptions and loss of reliability during drought.
 - Ecosystem: The impacts of drought on ecosystems and wildlife management are extremely complex and not well understood. Research is needed to further understand the interactions of climate and drought on these natural systems.
 - Municipalities: Potential loss of water supply reliability and/or poorer water quality. (In St. Louis, poor water quality (taste/odor) is of greater concern than quantity when a drought occurs.)
 - Energy: Higher temperatures can increase energy demands for cooling. Lack of precipitation can reduce the amount of water available for the cooling at power plants and for the production of hydropower.
- **Midwest economic sectors have different needs that can be addressed by the Midwest DEWS.** Sector needs that were discussed during the panel session are summarized below.
 - Municipal water supplies: Earlier notification of the drought could help suppliers address odor and taste issues before they occur.
 - Rural water: In rural areas where water demands are projected to exceed supplies, planning for future water supplies and infrastructure needed for these supplies is critical (i.e. new reservoir, water sources, etc.)
 - Energy: Early warning of specific climate extreme events is not as critical as sound contingency and long-term planning efforts for drought.
 - Agriculture: Increased climate data to provide appropriate lead times for early warning of drought could be very useful. For example, the [U2U project](#) in the Midwest has created tools for improved decision-making regarding planting, fertilizing, and harvesting of corn and soybeans. Improved, reliable seasonal forecasts made available before planting would



enable farmers to choose the most appropriate types of seeds/crop mixtures and choose advantageous management practices for the upcoming season (i.e., drought-tolerant crops, cover crops, weed control).

Day 3 Theme: Drought Early Warning and Preparedness Priorities and Actions

Presentations and small group discussions built upon the needs and priorities identified during the meeting to suggest priority actions for implementation as the Midwest DEWS is established. Presentations introduced drought simulations and soil moisture monitoring activities that are currently being implemented in the region. The highlights for Day 3 are provided below.

- **Drought simulations are an innovative outreach tool to educate stakeholders on the impacts and decision-making processes associated with drought while providing a platform to inform drought planning efforts.** Drought simulations have taken place in Colorado, Oklahoma, and Texas. A simulation will be held in Iowa this summer.
- **Flash drought is a common occurrence in the Midwest. There are ongoing efforts to develop drought indicators that can provide earlier warning of such droughts.** Efforts include the development of the National Soil Moisture Network, coordinated by several agencies and universities including USDA-NRCS, NOAA/NIDIS, USGS, and Texas A&M University. The initial phase of the project was the compilation of soil moisture data from various sources (<http://soilmoisture.tamu.edu/>) into a single user-friendly platform. The indices under development include the Evaporative Demand Drought Index and the Evaporative Stress Index.

Priority Needs and Proposed Actions

Meeting attendees identified information and resource needs, and proposed future actions for the Midwest DEWS. A summary of these needs with priority ranking and proposed actions is provided in Appendix A. The remainder of this section summarizes the prioritized needs and proposed actions according to the themes below.

- Integration of networks to foster collaboration and information sharing
- Integration of data for drought planning and vulnerability assessments
- Hydrologic and climatic processes
- Drought education and public outreach

Integration of Networks to Foster Collaboration and Information Sharing

Meeting attendees emphasized the need for the integration of networks. Many of the high

Development of Needs and Proposed Actions

During the small group discussions, meeting attendees identified resource needs and future actions for the Midwest DEWS. The resource needs included (1) monitoring, observation, and impact data collection; (2) planning and preparedness research; and (3) communication, education, and outreach. The detailed list of these needs is available in Appendix B. These needs were later summarized and prioritized by meeting attendees, as shown in Table A-1. The highest-ranking priority needs were then used to develop proposed actions shown in Table A-2. Priority needs and action were later grouped according to the four themes discussed in this report.



prioritized needs (Table A-1) and actions (Table A-2) identified during the meeting are grouped into this theme. The integration of networks fosters a culture of collaboration and information sharing among organizations in both the private and public sectors. This includes tribal, local, state and federal governments, non-profits, consulting firms, land managers and agricultural producers, etc. Specific examples entail Extension, Extension Disaster Education Network (EDEN), Water Resource Centers, Sea Grant, etc. Integration of networks involves networking and information transfer among individual sectors including climate, water and land management, navigation, agriculture, energy, ecosystem management, health and recreation/tourism. Proposed actions and needs encompassed the following bulleted items.

- **Access to data and information** – Facilitated through centralized communication hubs (such as a drought.gov). Information would include best management practices, vulnerability assessments, success stories, pilot studies for drought management, drought impacts (i.e. NDMC drought reporters) and soil moisture data.
- **Coordination and relationship development** – Targeted to achieve collaboration, trusting and transparent relationships and transfer of information. Needs and proposed actions reflect the concepts of working with existing networks and organizations, focusing on areas of highest priority with greatest need, establishing trusted networks and relationships, inclusivity with federal agencies, and connecting the providers of data and information with the key decision-makers and stakeholders.
- **Data delivery** – Collaborate with federal, state and local agencies and other interested parties in developing data and tools that best meet the needs of stakeholders. The needs and proposed actions reflected the importance of two-way communication where stakeholders have opportunities to convey their needs to data providers and data providers are able to educate stakeholders on available data and tools.
- **Policy and governmental support** – Support policies and governmental actions that improve resilience to drought and high precipitation events. Many of the proposed actions reflected the need for continued support and improvement of existing observation and monitoring networks.

Integration of Data for Drought Planning and Vulnerability Assessments

Meeting attendees also emphasized the importance of integrating data for drought planning and vulnerability assessments where the vulnerability assessment investigates how communities are vulnerable to various intensities and durations of drought. This theme focuses on the following types of actions.

- Collection of drought impact data
- Collection of adaptive capacities (i.e., best management practices and conservation measures)
- Support of local, regional, state and sector-specific drought vulnerability assessments
- Support for the development of drought plans, triggers and consistent messaging at the onset, during and post drought.

Many of the proposed actions in Table A-2 focus on the collection and distribution of sector-specific drought impact data (i.e., drought impacts on health) while adaptive capacity actions and needs focus on the collection of existing best management practices, conservation measures, mitigation

practices and response strategies. Vulnerability assessment actions focus on water demands within a geographic area and assessing how vulnerable these areas are to drought. The drought planning, triggers and messaging actions encompasses the broad spectrum of drought and water resource planning activities that incorporate climate and other drought indicator data (i.e., reservoirs levels) into establishing meaningful drought thresholds/triggers. These triggers can then inform the designation of drought severity; inform drought mitigation and response plans; and help facilitate consistent messaging at the onset, during and after drought.

Hydrologic and Climatic Processes

This theme addresses the improvement of data, climate forecasts and studies specific to climate and the hydrologic cycle encompassing evaporation, precipitation, runoff into surface water bodies and infiltration into subsurface groundwater. Hydrologic and climate processes specifically entail:

- Existing monitoring and observation networks
- Improved seasonal forecasting
- Studies on hydrologic processes including the relationship of surface water flows to water quality and groundwater levels and further characterization of groundwater in local areas.

Improvements to soil moisture networks ranks as the highest need for this particular theme. Climate forecasting is not ranked as high; however, the importance of improved forecasting accuracy and conveyance of this information to stakeholders was stressed. The Climate Prediction Center (CPC) should be brought into forecasting discussion moving forward.

Drought Education and Public Outreach

Drought education and outreach to the public at the early onset of drought was identified as a high-priority need. The proposed actions under this theme encompass the following activities:

- Development of timely and appropriate messaging prior to the onset of a drought
- Conducting marketing research on how to best convey messaging to the public
- Education on how to best utilize existing social media resources including media, TV, newspapers, social media, YouTube, etc.

Next Steps – Midwest DEWS Strategic Plan

Information obtained during the DEWS planning process in addition to the priority needs and actions identified at the February 2016 Kickoff Meeting guided the development of the 2-year Strategic Plan for the Midwest DEWS. The Strategic Plan provides a framework of priority actions that will further develop and implement the DEWS in the Midwest over the next two years. The Plan also outlines the partners involved in implementing the DEWS and key milestone dates. Additional actions and partners may be added to the Plan as the DEWS continues to develop. A copy of the Strategic Plan will be available fall of 2016 on the Drought Portal's [Midwest DEWS "about" page](#).



Appendix A – Summary of Prioritized Needs and Proposed Actions

The summarized needs with priority ranking and proposed actions developed during the February 9-11 Midwest DEWS Kickoff meeting are provided in this appendix. Each need was assigned a priority ranking where 1 is of highest priority and 5 is of lowest priority. These rankings are based on a voting exercise conducted during the workshop, where meeting participants were asked to vote on which needs were of greatest priority. Needs with a ranking of 1 received the highest proportion of votes whereas needs with a ranking of 5 received the lowest proportion. The needs and actions are organized according to the following themes:

- Integration of networks to foster collaboration and information sharing
- Integration of data for drought planning and vulnerability assessments
- Hydrologic and climatic processes
- Drought education and public outreach

Table A-1 Prioritized Needs of the Midwest DEWS

| Subcategory | Priority | Needs |
|---|----------|---|
| Integration of Networks to Foster Collaboration and Information Sharing | | |
| Access to data and information | 1 | Innovative ways to better utilize the many sources of data and information. For example, merging data sources to provide a useful value addition for decision makers. |
| | 1 | Consistent messages across sectors, between agencies, and among decision makers and emergency managers. |
| | 5 | Distribution of information on successful drought related case studies, plans, policies and actions. |
| Coordination and relationship development | 2 | Integration of drought with other natural disasters so that resources addressing such natural hazards can be shared effectively. For example, work with FEMA to incorporate drought into their management strategies. |
| | 2 | Forums convened on a regular basis with decision makers and keyplayers to coordinate and humanize partnerships. |
| | 3 | Established trusting and transparent partnerships. |
| Data delivery | 3 | Improvement on stakeholder confidence with available data and information. This maybe accomplished by providing stakeholders with more detail about the data. |
| | 4 | Education on probabilistic forecasts with decision makers. |
| | 4 | Continued improvement of outreach capacity to convey information on existing tools to decision makers and extension services. |

| Subcategory | Priority | Needs |
|--|----------|---|
| Policy and governmental support | 5 | Integrated assessments of US water law/policy options related to alternative implementations of US water law. New hybrid systems are being adopted in various states. Identify which systems are most effective in enabling states to better prepare for drought. |
| Integration of Data for Drought Planning and Vulnerability Assessments | | |
| Collection of drought impact data | 1 | Improved information on drought impacts on different sectors (i.e.: water, health, energy) including quantitative information on how drought impacted regional economies. |
| | 3 | Identification of public health drought impacts that can assist with future planning efforts. |
| | 3 | Identification of drought ecosystem impacts (i.e. wetland, forest) that help in future planning efforts. |
| | 4 | Clearinghouse of drought impact information through a "natural disaster impact specialist" assigned to each state. |
| | 4 | Information on how drought impacts economies. |
| | 4 | Historical drought studies that simulate the drought of record for a region and identify potential impacts. |
| Collection of adaptive capacities (i.e. best management practices and conservation measures) | 1 | Development of case studies of best management practices for how municipalities/sectors deal with drought. For example: how communities could use full-cost water pricing to address drought concerns; the best ordinances that communities could adopt to address drought; how no-till farming is best for farmers to reduce their impacts to drought. |
| | 4 | Full cost water pricing where water rates reflect the total cost to deliver water (including costs of operations, maintenance, repair, infrastructure etc.). |
| | 4 | Research how to effectively gain social acceptance of drought preparedness activities that while costly can improve drought resilience. |
| | 5 | Information on conservation practices employed during drought. |
| Support of local, regional, state and sector-specific drought vulnerability assessments | 2 | Research on vulnerability by region and sector. |
| | 3 | Economic cost-benefit analysis of the costs of action (i.e. implementation costs, money it will save) vs. inaction (potential losses if nothing is done). |

| Subcategory | Priority | Needs |
|---|----------|--|
| Support of local, regional, state and sector-specific drought vulnerability assessments | 4 | Map of the Midwest post drought, identifying locations of water shortfalls and conflicts. This could be through State Water Surveys/Dept. of Water or state DNR's. |
| | 4 | Improved understanding of water needs and the cascading impacts of drought by sector and geography (i.e. ecosystem vulnerability to drought, wildfire fuel loads, etc.). |
| Support of local, regional, state and sector-specific drought vulnerability assessments | 5 | Support for local drought plans (i.e. at the farm level) where planning assistance is available from Feds, States, Extension networks, etc. |
| | 3 | Use of a variety of different drought indicators and tying them to various impacts to better monitor and plan for drought. |
| | 4 | Drought triggers (i.e. soil moisture and other teleconnections) that can be used to identify the early onset of a drought (especially flash drought). |
| | 4 | Integrated water management planning that addresses potential drought impacts (i.e. need for new wells). |
| Hydrologic and Climate Processes | | |
| Data collection | 2 | Support, expand and improve existing observation networks such as cooperative stations, mesonets, CoCoRaHS, etc. |
| | 2 | Improved soil moisture monitoring |
| | 4 | Time series of photographs that reflect drought and flooding impacts on the landscape. These data could have implications in social and physical research. Such photographs could be connected via Google, extension networks, and through a CoCoRaHS type of network. |
| Forecasting | 3 | Improvement to accuracy of climate forecast outlooks (precipitation, temperature, drought, soil moisture, etc.). |
| | 4 | Continued work on forecasting managed and unmanaged low stream flows. |
| Studies | 4 | Information on water quality in relation to both streamflows and groundwater conditions. |
| | 4 | Better understanding of groundwater including flows, direction of flow and quality. |
| Drought Education and Public Outreach | | |
| Drought Education and Public outreach | 2 | Better-coordinated public education on adverse drought impacts and response activities (i.e. watering, washing cars, how municipalities are impacted). |
| | 4 | Earlier awareness and involvement of the public before, during, and coming out of a drought |

Table A-2 Proposed Actions for the Midwest DEWS

| Subcategory | Proposed Actions |
|---|---|
| Integration of Networks to Foster Collaboration and Information Sharing | |
| Data and information transfer | Add all drought-related data to existing NDMC/NIDIS portals |
| | Develop a standardized way to report innovative pilot studies, BMPs, success stories and lessons learned for drought management |
| | Educate each sector on using available current and future information. This can also help steer future development and research. |
| | Distribute the results of vulnerability assessments to applicable decision-makers and managers. |
| | Develop scenarios of inputs/outputs of drought for education and outreach. For example, "here is what happened and it affected things in this way." |
| | Advertise NDMC's Drought Impact Reporter tool via press releases, education outreach opportunities and web references. |
| | Manage information flow from a centralized hub where local efforts are organized and scaled up to the national scale (avoid the silos). Involve federal efforts (USDA Climate hubs; NOAA NCEI, NWS, OAR; DOI: CSC, LCC) and state efforts (Extension, DNR, researchers, climatologists). |
| Data and information transfer | Educate end users on tools and information needed for drought preparedness (before, during, after drought). A DEWS portal/web page could do this. |
| Coordination and relationship development | Foster continued development with state governments and agencies to improved coordination of federal, state and local efforts |
| | Create subgroups within Midwest DEWS to better focus efforts in terms of data, monitoring, and needs |
| | Designate entity(ies) to integrate existing data and observations. |
| | Inclusion and coordination with more agencies like FEMA |
| | Semi-annual NIDIS/NDMC/EPC workshops and webinars. Advertise EPC (Engagement Preparedness Communities) by including an online list of practitioners. |
| | Encourage sector-by-sector dialogue with trusted components from sectors (i.e. agriculture has a lot done via U2U). Use existing efforts to encourage dialogue. |
| | Identify the decision makers and key players (i.e., engineers) by sector and various jurisdictions. |
| | Don't spread ourselves too thin. Pick a small segment of a drought related issue and use existing successful efforts as a model or guidance for other efforts to springboard off of. Similarly, establish collaboration "at the ground" to enhance buy-in as opposed to having feds/states push the issues. |
| | Prioritize research in watersheds, sectors, etc. that have the greatest need to help guide feds/states where to focus attention. |
| | Use social science to identify who the trusted advisors are for the decision makers and public. |
| | Investigate including more offices (i.e. FSA offices) in impact reporting via CoCoRaHS |
| | Connect more with the USGS water resources centers, Sea Grant, and Extension. |
| | Invite Extension, the Extension Disaster Education Network (EDEN), and Voluntary Organizations Active in Disaster (VOAD) to future DEWS efforts. |

| Subcategory | Proposed Actions |
|--|---|
| | <p>Continue to expand network by asking meeting attendees to recommend three additional contacts/associations that should be part of the discussion.</p> <p>Work with trusted advisors of DEWS audiences to identify effective formal and informal communications (i.e. 10 minute presentation at a local meeting, FAQ materials, etc). Identify these opportunities to spread the message to build the community.</p> <p>Host a Tribal Drought Summit</p> <p>Identify where the priorities of DEWS align with existing industry groups. Ask, "who would you reach out to in your state or community that has that information?"</p> <p>Leverage the NWS Weather Ready Nation program to be sure there is a DEWS component</p> <p>Build a State Contact Skills Matrix that can be shared across the region and specify the contacts' expertise.</p> <p>Take advantage of existing community and regional entities (i.e. RCC, RISA, Extension) and scale up. Start with "boots on the ground."</p> <p>Encourage stakeholder driven research. The RISA program would be a good model for this where it is asked what data is needed and at what time scale.</p> |
| Data delivery | <p>Organize hands-on workshops on available data and information on how it's used.</p> <p>Conduct needs assessment (lead time, data needed) of decision makers in various sectors affected by drought.</p> <p>Work with new Soil Moisture Network effort to ensure all data is incorporated.</p> <p>Establish a scientist volunteer program where the volunteer scientists would train decision makers and educate them on existing tools and early drought warning efforts similar to the GOES-R Satellite Champion program.</p> <p>Develop standardize geospatial (GIS) products (i.e. color scheme, legends, presentation) for consistent delivery.</p> <p>Increase the number of participants that provide input to the US Drought Monitor.</p> <p>Provide more education/information on the intensification of drought. The DO to D1 drought monitor ratings doesn't provide enough information.</p> <p>Merge satellite and in situ soil moisture data for continuous monitoring.</p> |
| Policy and governmental support | <p>Develop policy statements to better link drought indicators to potential actions and decisions at various levels and sectors. These should be deployed before DO.</p> <p>Lobby state/congressional representatives on budget support for observation networks and forecasts.</p> <p>Continue support of the Midwest Mesonet Consortium at MRCC which fosters mesonet collaboration.</p> <p>Encourage states to lead efforts in their states for observation and monitoring.</p> <p>Demonstrate the value to the state of supporting monitoring networks.</p> |
| Integration of Data for Drought Planning and Vulnerability Assessments | |
| Collection of drought impact data | <p>Work with regional planning councils (i.e. municipalities) to report impacts on water supply</p> <p>Provide CoCoRaHS observers with a drought impact interface to report drought impacts (in a similar way that they do rain) or encourage CoCoRaHS volunteer to report on the existing Drought Impact Reporter.</p> <p>Develop a guidance document on Midwest drought impacts, which could be the findings of vulnerability and needs assessments.</p> |

| Subcategory | Proposed Actions |
|---|--|
| Collection of adaptive capacities (i.e. best management practices and conservation measures) | Survey this group for drought best management practices (BMPs) to highlight. |
| Support of local, regional, state and sector-specific drought vulnerability assessments | Identify important time scales associated with individual sectors, which then inform planning efforts. |
| | Conduct drought vulnerability assessments among sectors and in specific local areas/regions. |
| | Conduct vulnerability assessments that capture "baseline" impacts for sectors (i.e. health, energy, municipal). Use these impact data to develop critical thresholds and triggers. |
| | Develop an approach to consistently measure or quantify drought resiliency in regions and among sectors. |
| Support for the development of drought plans, triggers and consistent messaging at the onset, during and post drought | Develop drought thresholds for the Midwest region by using specified drought categories (similar to the USDM framework) and incorporating EDDI, ESI, and soil moisture coverages. |
| | Develop drought recovery plans which are equally important and needed for recovery funds. |
| | Determine a set of consistent parameters that are the best indicators for drought (ie.: soil moisture), and then tie that to predetermined drought levels (advisory, warning, watch) on a drought messaging Dashboard. |
| Hydrologic and Climate Processes | |
| Data collection | Improve soil moisture monitoring by adding additional stations and improving coordination and access to these data |
| | Continue effort to standardize methods for soil moisture monitoring. |
| | Increase soil moisture sensors under representative landscapes. |
| | Find a way to incorporate soil moisture data from research, not just established networks (i.e.: volunteer network like CoCoRaHS) |
| Studies | Evaluate connections between soil moisture trends and soil type (SSURGO) in Midwest region. |
| Drought Education and Public Outreach | |
| Drought Education and Public Outreach | Engage public on what is specifically needed and connect with existing resources. Assist in modifying current data rather than reinventing the wheel. |
| | Educate the public using conventional communications (i.e.: media, TV, newspaper), social media and starting a YouTube channel for short videos. |
| | Identify messages all agencies want to convey to the public during drought. |
| | Conduct social science marketing research for public messaging to determine what works best. |
| | Begin public messaging earlier during drought. Messaging should be developed before a drought so that it is ready to go. |
| | Educate the public on the vulnerability of regions and sectors to drought using science-based assessments. |

Appendix B – Available Information and Activities and Future Needs

This appendix provides a table of available (1) monitoring, observation, and impact data collection; (2) planning and preparedness research; and (3) communication, education, and outreach. Needs that are not available are also identified. This information was developed during day 2 small breakout group discussions and panel discussions. The needs in this table were later summarized and prioritized (Table A-1). The highest-ranking priority needs were then used to develop proposed actions for the Midwest DEWS (Table A-2).

Table B-1 Data, Information and Resources Needs to Inform Discussion on Priority Needs and Midwest DEWS Actions

| Questions | Available | | Not Available | |
|--|---|---|---|--|
| | Current / Ongoing | Source of Info / Data | Needs | Potential Providers of info / Data |
| Monitoring, Observation, and Impact Data Collection | | | | |
| What monitoring data are/would be useful? | <ol style="list-style-type: none"> 1. Soil moisture (somewhat) 2. Streamflow 3. Groundwater measurements 4. Precipitation 5. Evapotranspiration 6. Vegetation indices 7. Drought Monitor 8. Temperature 9. Rivers, reservoir levels 10. Habitat assessment data 11. Fire 12. Social 13. Market data 14. Transportation data | <ol style="list-style-type: none"> 1. NRCS SCAN, State mesonets (in-situ, satellite, modeled) 2. USGS 3. USGS, state programs; NOAA 4. NOAA, Mesonets, Crowd Sources (e.g., CoCoRaHS), CPC, RCC 5. Crowd Sources (e.g., CoCoRaHS), State Mesonets; NEDSID 6. NOAA/NASA 7. NDMC 8. NOAA, CPC, RCCs, USACE, USGS 9. Natural Resources 10. FWS | <ol style="list-style-type: none"> 1. Improved land data assimilation systems (integration of in-situ / satellite / modeled) 2. Consolidated data analyses (composite drought indices) 3. Better use of satellite soil moisture 4. Simplified user interface / common format – specialization - tailored to end-user’s needs 5. Soil moisture 6. Sectoral water demand from utilities, sectors 7. Data on changing demographics that could impact water demand 8. Stream temperatures 9. Health surveillance 10. Improve observation networks (COOP, mesonet support, CoCoRaHS) | <ol style="list-style-type: none"> 1. Not identified 1. Not identified 2. Not identified 3. Not identified 4. USDA, NASA 5. Utilities 6. Not identified 7. Not identified 8. Not identified 9. CDC 10. NOAA, states, public 11. Not identified 12. Not identified 13. Not identified |

Legend

- More than one group mentioned this during the small group Day 2 discussion
- Identified as priority need (summary of needs posted on the sticky wall for prioritization)
- Identified as priority need AND mentioned more than once during Day 2 small group discussions



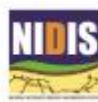
| Questions | Available | | Not Available | |
|--|--|---|--|---|
| | Current / Ongoing | Source of Info / Data | Needs | Potential Providers of info / Data |
| | 15. Intra-utility information sharing 16. Commodity markets 17. International data 18. Private climate data 19. Quasi-private data 20. Locations of major water withdrawal facilities 21. Water Quality 22. Snowpack 23. Water temperature 24. Economic Information 25. MRCC's Midwest Climate Watch's Drought information page 26. | 11. NIFC 12. Not identified 13. Not identified 14. Not identified 15. Not identified 16. Not identified 17. Not identified 18. Not identified 19. Not identified 20. EPA, Natural Resources 21. EPA 22. NWS 23. USACE 24. USACE, Natural Resources | 11. Improved coverage of precipitation and streamflow 12. Develop a clearinghouse of drought impact information through a "natural disaster impact specialist" for each state 13. Identify ecosystem impacts (wetlands, forests) – helps future planning | |
| What forecasting information data are/would be useful for drought preparedness ? | 1. CFSv2 2. Short-range ensembles (QPCF) 3. CPC Outlooks 4. Full suite of weather forecasts 5. US Drought Outlook | 1. NWS 2. NWS 3. CPC 4. NWS, private sector 5. NDMC | 1. Land-surface analysis driven by global NWP ensembles 2. Forecasts of evaporative demand (ET; long-range forecasts of temperature trends to be more accurate than long-range forecasts of precipitation during the warm season; soil moisture) – mainly prediction of extreme heat / high demand are more tied to synoptic scale than convection which operates more on the mesoscale 3. Water demand forecast 4. Water quality / toxicity issues (tied to water flow and temperature) 5. Ability to downscale models to improve scale of monthly and seasonal outlooks. The US map is not applicable locally; it should focus on most vulnerable areas 6. Forecasting is relying too much on historical record and statistics, so do more research on climate processes and how they work rather | 1. Not identified 2. NOAA 3. Sector specific 4. Feds, ACE, State agencies 5. Not identified 6. Not identified 7. Not identified 8. Not identified 9. Not identified 10. Not identified 11. Not identified |

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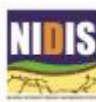
| Questions | Available | | Not Available | |
|--|---|---|---|--|
| | Current / Ongoing | Source of Info / Data | Needs | Potential Providers of info / Data |
| | | | than using statistics 7. Probability of exceedance forecasts (e.g., peak temperatures) 8. Improvement of skill for long-term outlooks 9. Match up census projections with climate and water demand projections 10. Low-flow forecasts 11. Ground water and soil moisture recharge 12. Ecosystem sensitivity to drought 13. Wildfire fuel load forecasts 14. Uncertainty detail for water budget terms | 12. Not identified 13. Not identified 14. Not identified |
| What type of observation and impact data needs to be collected during and after a drought to inform future planning efforts and studies? | During Drought 1. Amt of population impacted 2. Acres burned 3. Fish kills 4. NASS reports 5. SC climate summaries 6. Drought Impact Report | 1. State agencies? 2. State agencies? 3. State agencies? 4. USDA 5. SC 6. NDMC | 1. Water Use (demand and capacity limits) 2. Conservation efforts 3. Public health impacts 4. Ag strategies 5. Soil moisture 6. ET 7. Vegetation Indices 8. Need temporal and spatial details from communities who are not reporting 9. Picture over time to better understand impacts 10. Economic impact 11. Ecosystem impacts (wet lands, riparian forests, birds, wildlife) | 1. Not identified 2. Not identified 3. Not identified 4. Not identified 5. Not identified 6. Not identified 7. Not identified 8. Not identified 9. Not identified 10. Not identified 11. LCCs; USFS; BLM; FWS; NPS |

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| Questions | Available | | Not Available | | |
|---|--|--|--|--|---|
| | Current / Ongoing | Source of Info / Data | Needs | Potential Providers of info / Data | |
| | After Drought | 1. Drought Impact Reporter | 1. NDMC | <ol style="list-style-type: none"> 1. Crop Yield Loss (weekly estimates) 2. Maps of health / populations at risk 3. Energy demand / capacity impacts 4. Conservation practices and efforts 5. Drought impact reporter (beyond just ag) 6. Private sector well levels 7. Damage assessments 8. List of actions that communities have implemented, including their success and failures 9. Better access to FSA "situation reports" | <ol style="list-style-type: none"> 1. USDA (but difficult to access weekly) 2. Not identified 3. Not identified 4. Not identified 5. NDMC 6. Public 7. Not identified 8. Not identified 9. FSA |
| Planning and Preparedness Research | | | | | |
| What plans are/would be useful to prepare for and address drought impacts? Please note if current plans need to be updated. | <ol style="list-style-type: none"> 1. Some local and state emergency management plans 2. Drought ready communities 3. Contingency plans for communities / water suppliers 4. Wellhead protection program 5. Watershed management plans 6. Water 2050 plan for Chicago 7. National Climate Assessment 8. Multi-hazard plans | <ol style="list-style-type: none"> 1. Not identified 2. Not identified 3. Not identified 4. EPA 5. Clean Water Act Section 319 (EPA) 6. Not identified 7. NOAA 8. Emergency Management | <ol style="list-style-type: none"> 1. Knowing if state water/drought plans exist (do they feed into /from local plans?) Sub-basin drought contingency plans 2. Triggers are unclear 3. Known=actions, better communication, vested interests + more effective actions 4. Resources allocated to provide assistance / accountability 5. Public health drought plans 6. Integrate / update state, county, local laws to address legal, policy issues (integration of plans from small, medium to larger scales – provide plenty of examples for other communities to not feel so overwhelmed); include historical drought lessons learned 7. Case studies of BMPs | <ol style="list-style-type: none"> 1. Not identified 2. Not identified 3. Not identified 4. Not identified 5. Not identified 6. Not identified 7. Not identified | |
| If applicable, what sort of triggers and indices are/would be beneficial for | <ol style="list-style-type: none"> 1. Drought Monitor 2. State disaster proclamations to derive triggers 3. Iowa flow stream triggers 4. Low flow stream | <ol style="list-style-type: none"> 1. NDMC 2. states 3. Iowa plans? 4. USGS?; Iowa plans? 5. N/A 6. Networks of stations | <ol style="list-style-type: none"> 1. When does a mitigation plan get triggered – should "triggers" for mitigation steps be determined a priori – a move from a more proactive planning from a reactive planning 2. Move to probabilistic forecasts of drought improvement/degradation | <ol style="list-style-type: none"> 1. Not identified 2. Not identified 3. Not identified 4. Not identified 5. Not identified 6. Not identified | |

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| Questions | Available | | Not Available | |
|--|---|---|---|--|
| | Current / Ongoing | Source of Info / Data | Needs | Potential Providers of info / Data |
| early drought warning and preparedness ? | 5. percentiles; triggers Biological indicators (vectors that might be more prevalent – related to surface water; might see pathogens before agricultural indicators) 6. Precip anomalies 7. Soil moisture 8. Communication from ground-truthers 9. ET 10. Drought Outlook 11. Air quality alerts 12. Nighttime RH | 7. N/A 8. Producers; Extension; NWS; hydrologists; Farm Bureau; associations, etc. 9. CoCoRaHS? 10. NDMC? 11. EPA? 12. NWS | 3. “Trigger charts” – mobilization of triggers (before D0) – plan trigger (D0) [by community] 4. When do we declare a drought, without over-warning? 5. Vapor pressure deficit 6. Analogue forecasts to quantify how many times we’ve been ripe for a drought, but haven’t had it 7. Conduct stress test exercises to integrate sectors/agencies/municipal to simulate scenarios 8. System of communication from the ground-truthers 9. Data on water use spikes | 7. Not identified 8. Not identified 9. Utilities |
| What should research focus on to better prepare for future droughts? | 1. Drought forecasting 2. Teleconnections and drought 3. Improving outlooks / mid-term forecasts 4. Research by LCCs for management by ecosystem types (monarch butterflies as indicators of healthy ecosystems) | 1. NOAA 2. Not identified 3. Not identified 4. Not identified | 1. Find innovative ways to ingest large number of datasets and provide a reduced data volume to end-users through “value” added merging of data 2. More focus on drought recovery 3. Vulnerability by sector and region of the state 4. Better analyze past droughts (strength, intensity, duration) 5. Better linkage between drought indices and impacts 6. International studies (studies from other parts of the world) 7. Crop insurance and other forms of risk assessments 8. Social science research on what it takes for social acceptance for environmental preparedness 9. Cost-benefit analyses to guide action vs. inaction (what is the cost to applying | 1. Not identified 2. Not identified 3. Not identified 4. Not identified 5. Not identified 6. WMO, international agencies 7. Not identified 8. Not identified 9. Not identified 10. Not identified 11. Not identified 12. Not identified 13. Not identified 14. Not identified 15. Not identified 16. N/A 17. N/A 18. Not identified 19. Not identified 20. Not identified |

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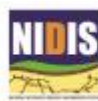
| Questions | Available | | Not Available | |
|---|--|--|---|---|
| | Current / Ongoing | Source of Info / Data | Needs | Potential Providers of info / Data |
| | | | 10. What is the relationships between soil moisture and drought? 11. At what point does drought affect a certain area? (flash drought triggers?) 12. Better integration of existing groundwater data / collection of improved data on flow and direction 13. More scalable information, site-specific information on groundwater and soil moisture, perhaps merging models and data 14. More information on teleconnections (integrations of them) 15. Integrated assessment (and models) of US water law/ policy options related to alternative implementations of US water law. New hybrid systems are being adopted in various states – which ones are working, which states are better prepared for drought? 16. Toolbox for applicable triggers 17. Supply v Demand triggers 18. Policy research: Integrated assessment of US water law 19. Integrate drought with other natural disasters (FEMA; move from the dichotomy) 20. Determining indicators to use as triggers | |
| Communication, education, and outreach | | | | |
| What information is/should be conveyed among decision makers? | 1. quarterly climate 2-page regional reports monthly Midwest and Great Plains 2. climate outlook webinars Current climate conditions 3. Weekly crop report | 1. NOAA; SCs 2. NOAA; SCs 3. USDA 4. Private forecasters 5. NDMC 6. EPA 7. City / county associations 8. FEMA | 1. Better use of probabilistic forecasts on drought improvement/degradation 2. How to educate decision-makers to use probabilistic forecasts? 3. How do you use probabilistic forecasts for trigger on binary decisions (yes/no)? 4. Detailed, scientific / technical analysis of drought situation, need to address long-term | 1. Not identified 2. Not identified 3. Not identified 4. Not identified 5. Not identified 6. Not identified 7. Not identified 8. SCs; Extension climatologists |

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| Questions | Available | | Not Available | |
|--|--|--|---|------------------------------------|
| | Current / Ongoing | Source of Info / Data | Needs | Potential Providers of info / Data |
| 4. Whatever the media (e.g., Weather Channel) provides 5. Drought Monitor 6. EPA created tools and management tools (Climate Ready Water Utilities) 7. ICMA Newsletter 8. Climate Resilient Mitigation Activities, Plan and Prepare for a Drought, HMA (hazard mitigation) programs 9. When Every Drop Counts 10. Community Collaborative Rain, Hail, and Snow Network (CoCoRaHS) 11. Cooperative observers and CPC leaky bucket/VIC model 12. U.S. Drought Monitor, VegDRI, Drought Risk Atlas, Drought Impact Reporter, Drought-Ready Communities 13. Midwest Climate Watch's Drought Information page, Drought Trigger Tool, ReMAPP, climate Keetch-Byram Drought Index products | 9. CDC 10. Citizen Science 11. NWS 12. NDMC 13. MRCC | issues 5. Need contingency forecasts 6. Establish regular (annual?) meetings with local communities who's findings feed into annual (?) meetings at the state level, who's findings feed into annual (?) meetings regionally. This builds partnerships with faces and impacts all levels 7. Relationships between ecological health and stream temperature 8. Put current drought into context 9. Cost analyses, comparisons (what are the costs of water under drought or periods of excess?) 10. Outreach capacity to put these tools and information into practice 11. Case studies of BMPs/ Success stories 12. Constraints drought may put on development 13. Relationships between risk and uncertainty 14. Have regional maps of water use impacts after drought (state water divisions, DNR) | 9. Not identified 10. Not identified 11. Not identified 12. Not identified 13. Not identified 14. Not identified | |

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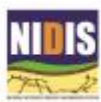
| Questions | Available | | Not Available | |
|-----------|-------------------|-----------------------|---|------------------------------------|
| | Current / Ongoing | Source of Info / Data | Needs | Potential Providers of info / Data |
| | | | 20. Knowledge of how hydrology is interconnected – impacts that you have on downstream users 21. Convey message with pictures and visualization 22. Better incorporate social science when packaging public information 23. Establish a consistent message | |

Legend

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FEMA

Appendix C– Midwest DEWS Kickoff Meeting Agenda

Midwest Climate Outlook and Drought Early Warning System (DEWS) Kickoff Meeting

February 9 – 11, 2016
Embassy Suites Downtown, St. Louis, Missouri
Laurel Ballroom



#MidwestDEWS

Day One – Tuesday, February 9

Theme: Laying the Foundation for a Midwest DEWS

Participants will hear from a variety of speakers on the foundation and planning for a Midwest DEWS. Panel discussions and presentations will focus on available federal, state, and local resources and provide an opportunity to identify the tools and capabilities upon which the Midwest DEWS will be established and developed.

- 11:00 am Registration begins
- 12:30 pm Welcome and Update on NIDIS and its Priorities
Roger Pulwarty, Director, National Integrated Drought Information System (NIDIS)
- 12:50 pm Missouri's Challenges in Both Drought and Flooding
Todd Sampsell, Deputy Director, Missouri Department of Natural Resources
- 1:15 pm The Midwest DEWS Planning Process, Launch, and Next Steps
Courtney Black, Regional Drought Information Coordinator, NIDIS
- 1:30 pm Participant Feedback Session
- 1:45 pm Panel Discussion: Decision Support in Context of Drought Early Warning: Now What?
Moderator: Mark Svoboda, Climatologist and Monitoring Program Area Leader, National Drought Mitigation Center (NDMC)
Panelists:
- *Beth Hall, Director, Midwest Regional Climate Center*
 - *Jim Angel, Illinois State Climatologist*
 - *Pat Guinan, Missouri State Climatologist*
 - *Brian Fuchs, Climatologist, National Drought Mitigation Center*
 - *Mark Fuchs, Senior Service Hydrologist, St. Louis Weather Forecast Office, National Weather Service*
 - *Amy Beussink, Director, Missouri Water Science Center, USGS*



- 3:30 pm Break
- 3:45 pm Panel Discussion: Federal Drought Perspective
Moderator: Doug Kluck, Regional Climate Services Director, NOAA's National Centers for Environmental Information
Panelists:
- *Steve Buan, Service Coordination Hydrologist, National Weather Service River Forecast Center, Minneapolis, MN*
 - *Dave Baker, Principal Consultant, University of Missouri Extension*
 - *Tom Maier, Biologist, Pittsburgh District, Planning & Environmental Branch, U.S. Army Corps of Engineers*
 - *Beth Freeman, Region VII Administrator, Federal Emergency Management Agency*
 - *Mike Wilson, National Leader for Climate Change, Natural Resources Conservation Service*
 - *Amy Shields, Environmental Scientist, Environmental Protection Agency*
- 4:30 pm Panel Discussion: State and Local Drought Plans and Policies
Moderator: Mark Svoboda, Climatologist and Monitoring Program Area Leader, NDMC
Panelists:
- *Chip Zimmer, Environmental Scientist and Bill Caldwell, Drought Coordinator, Kentucky Division of Water*
 - *Charlie DuCharme, Senior Hydrologist, Missouri Department of Natural Resources*
 - *Tim Hall, Chief of the Geological & Water Survey Bureau / Hydrology Coordinator, Iowa Department of Natural Resources*
- 5:25 pm Synthesis of Day 1
- 5:30 pm Adjourn
- 6:00 pm Networking Opportunity
Location: Laurel Ballroom Foyer

Day Two - Wednesday, February 10

Theme: Current Climate Outlook and Forecasting, Drought Impacts & Vulnerabilities and Drought Preparedness Resource Needs

This day will provide a current climate outlook, presentation on the state of the science around climate predictions and forecasting, and a background on drought in the Midwest. In addition, a panel discussion will focus on drought impacts and vulnerabilities followed by small group discussions to identify drought early warning and preparedness resource needs and priorities for the region. This information will inform the development of the Midwest DEWS.

- 9:00 am Current Climate Outlook
Ray Wolf, Science and Operations Officer, Quad Cities, IA Weather Forecast Office, National Weather Service
- 9:30 am Predictions and Forecasting: Current State of the Science
Pat Spoden, Science and Operations Officer, Paducah, KY Weather Forecast Office, National Weather Service
- 10:00 am Break



- 10:30 am Background on Drought in the Midwest
Brian Fuchs, Climatologist, NDMC and Jim Angel, Illinois State Climatologist
- 11:15 am Drought Impacts on Human Health
Jesse Bell, Research Associate, Cooperative Institute for Climate and Satellites, North Carolina State University, NOAA's National Centers for Environmental Information
- 11:45 am Participant Feedback Session
- 12:00 pm Working Lunch – Federal Drought Recovery Coordination and Approaches for Interagency Collaboration – National Disaster Recovery Framework
Colleen Callahan, USDA Rural Development Illinois Director
- 1:15 pm Panel Discussion: Drought and High Precipitation Impacts and Vulnerabilities within Sectors
Moderator: Brian Fuchs, Climatologist, NDMC
- Agriculture - *John Dobberstein, Senior Editor, No-Till Farmer*
 - Navigation - *Paul Rohde, Vice President, Midwest Area, Waterways Council*
 - Municipalities - *Frank Genovese, Water Production Engineer, St. Louis Water Division*
 - Rural Water – *Eric Fuchs, Source Water Technician, MO Rural Water Association*
 - Natural Resources Management - *Gwen White, Science Coordinator, Eastern Tallgrass Prairie and Big Rivers Landscape Conservation Cooperative, USFWS*
 - Energy – *Vince Tidwell, Principle Member of the Technical Staff, Sandia Energy Lab*
- 2:30 pm Break
- 2:45 pm Small Group Facilitated Discussion:
Participants will identify and discuss data, information and resources needed to inform future actions and priorities for the DEWS. Topics will include:
- Monitoring, observation and impact data collection
 - Planning and preparedness research
 - Communication, education and outreach
- 4:45 pm Synthesis of Day 2
- 5:00 Adjourn

Day Three – Thursday, February 11

Theme: Drought Early Warning and Preparedness Priorities and Actions

Participants will build upon the needs and priorities identified throughout the meeting, and discuss priority actions to implement as the Midwest DEWS is established.

- 8:30 am Welcome Back and Participant Feedback Session
- 8:45 am Facilitated Discussion:
Participants will review findings from Day 2 discussions on needs and identify priorities to inform future actions for the Midwest DEWS.
- 9:15 am Competitive Drought Simulations: An Innovative Approach for Stakeholder Engagement Informing Water Resource and Multi-Hazard Planning
Harvey Hill, AAAS Policy Fellow, U.S. Army Corps of Engineers
- 9:30 am Mississippi River Cities Town Initiative
Mayor Francis G. Slay, City of St. Louis



10:00 am Soil Moisture Monitoring

- Building a Coordinated National Soil Moisture Monitoring Network
Jessica Lucido, Soil Moisture Project Manager, USGS
- Evaporative Stress and Soil Moisture as Early Warning Drought Indicators
Christopher Hain, Assistant Research Scientist, Earth System Science Interdisciplinary Center, University of Maryland

10:25 am Break**10:40 am Small Group Facilitated Discussion:**

Participants will develop short and long term priority actions to implement in the Midwest DEWS over the next two years. Topics will include:

- Monitoring, observation and impact data collection
- Planning and preparedness research
- Communication, education and outreach

11:55 am Synthesis of Meeting**12:00 pm Adjourn**

Appendix D– Midwest DEWS Kickoff Meeting Attendees

City of St. Louis Water Division
 Cooperative Institute for Climate and Satellites
 Earth System Science Interdisciplinary Center, University of Maryland
 Eastern Area Coordination Center
 EPA
 FEMA
 Great Lakes Integrated Sciences and Assessments, University of Michigan
 Illinois Department of Natural Resources
 Illinois State Geological Survey
 Illinois State Water Survey, University of Illinois
 Illinois-Indiana Sea Grant
 Interstate Council on Water Policy
 Iowa Department of Natural Resources
 Iowa State Climatologist
 Iowa State University
 Kansas City Water Services
 Kentucky Climate Center, Western Kentucky University
 Kentucky Division of Water
 Midwestern Regional Climate Center
 Missouri American Water Co.
 Missouri Department of Natural Resources
 Missouri Rural Water Association
 National Drought Mitigation Center
 National Weather Service
 NIDIS
 No-Till Farmer Magazine
 NOAA
 NOAA / National Centers for Environmental Information
 NOAA / National Weather Service
 NOAA / NWS / North Central River Forecast Center
 North Central Region Water Network
 Ohio State University, State Climate Office of Ohio
 Purdue University
 Sandia National Laboratories
 Southern Illinois University
 U.S. Army Corps of Engineers
 U.S. Army Corps of Engineers



U.S. Fish and Wildlife Service / Tallgrass Prairie Landscape Conservation Cooperative
University Corporation for Atmospheric Research
University of Kentucky Ag Weather Center
University of Missouri
University of Missouri Extension
University of Missouri Extension
Upper Mississippi River Basin Association
USDA Natural Resources Conservation Service
USDA Rural Development
USGS
Waterways Council, Inc.



Appendix E– Midwest DEWS Survey Assessment

The November 2015 planning workshops in Louisville, KY, and Bloomington, MN, and the February 2016 Midwest DEWS kickoff meeting in St. Louis, MO, provided many opportunities for federal, tribal, state, local, and academic stakeholders to discuss and document drought early warning and preparedness needs, opportunities, and potential activities moving forward. Stakeholders at the kickoff meeting also had the opportunity to fill out surveys before and after the meeting to provide input as to the types of climate-related problems they are dealing with and decisions they are making, the types of drought-related information they seek out and how well that information fulfills their decision-making needs, and their priorities and vision for the DEWS. This document provides a summary of the survey results and highlights how those results might be considered as the Midwest DEWS strategic plan is developed. The results of these surveys will also be relevant as evaluations of DEWS activities are conducted for the Midwest DEWS. Information from the survey and report will be used to inform a set of metrics and baseline information to evaluate the DEWS in the future. Survey administration and reporting was provided by the National Drought Mitigation Center.

Of the 54 participants attending the February 2016 Midwest DEWS kickoff meeting, 48 filled out all or part of a pre-meeting survey and

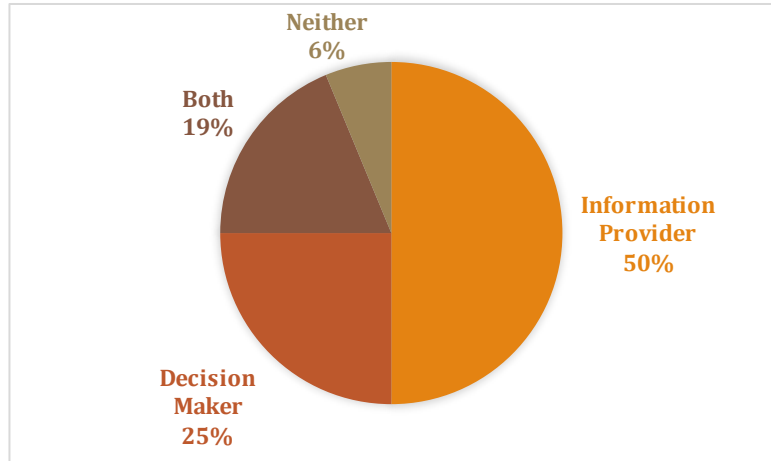


FIGURE 1: REPRESENTATION OF DECISION MAKERS AND INFO PROVIDERS

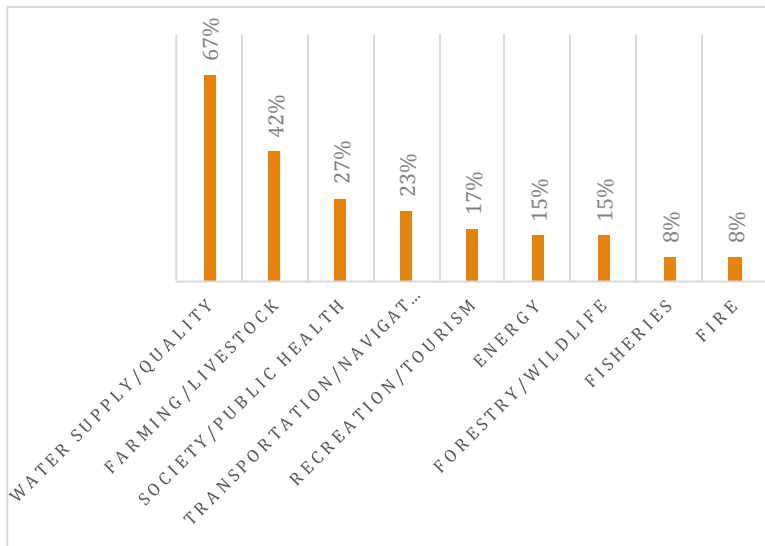


FIGURE 2: SECTOR REPRESENTATION IN SURVEY



post-meeting survey. Of those, 42% worked for universities, 31% for federal agencies, 8% for state agencies, 10% for non-profits, NGOs, or business, and 2% for local government. Figure 1 shows that 25% of respondents used drought and climate information in decision making while 50% provided information and data. Figure 2 shows that the majority of participants worked with either the water supply/quality sector or farming/livestock production, although many other sectors were also represented.

Climate Impacts

Drought is not the only climate-related hazard in the region, and climate hazards affect different sectors in unique ways. Participants were asked how much of a problem their sector and area had experienced with regard to a variety of hazards.

As shown in Figure 3, high precipitation/runoff and increased flooding were most

frequently listed as major problems for the region (64% and 61% of respondents, respectively). Drought concerns (drought length, severity, frequency) were cited as major problems by approximately 10% of respondents, as shown in Figure 4. The region had recently experienced flooding before the kickoff meeting and was not experiencing drought at the time.

Figure 5 depicts concern about other climate trend-related problems. Approximately one-quarter of respondents said that

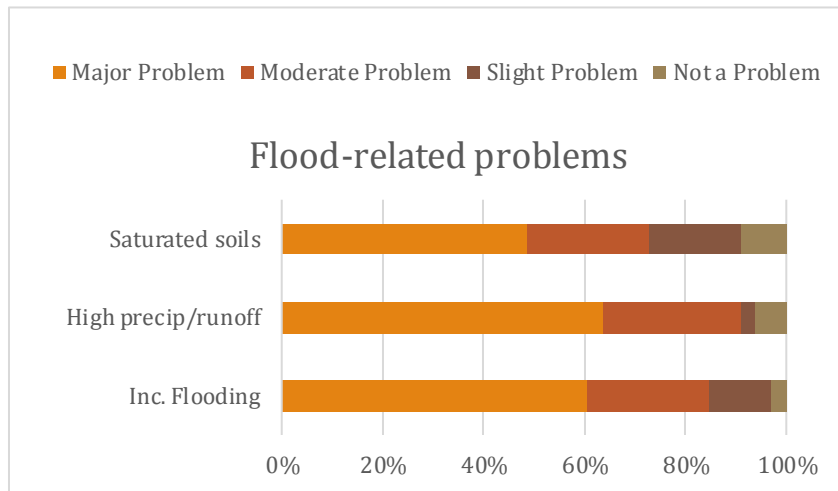


FIGURE 4: PERCENT OF RESPONDENTS CONCERNED ABOUT FLOOD-RELATED PROBLEMS

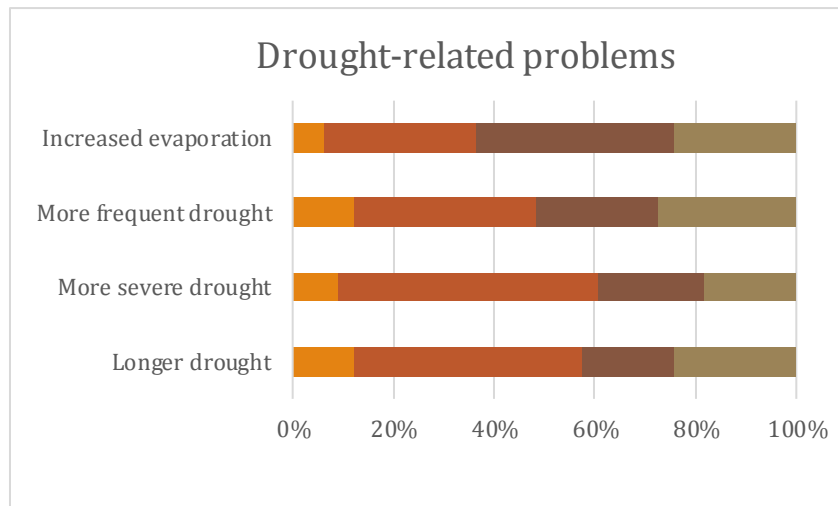


FIGURE 3: PERCENT OF RESPONDENTS CONCERNED ABOUT DROUGHT-RELATED PROBLEMS (LEGEND IN FIGURE 3)



precipitation falling as rain rather than snow (22%) and dramatic shifts in weather patterns (29%) were major problems.

Dramatic shifts in weather patterns was seen as a major problem in some sectors more than others; approximately 70% of respondents working with the fire and forestry sectors said this was a major problem, while only 22% of those working with the transportation/navigation sector said it was a major problem.

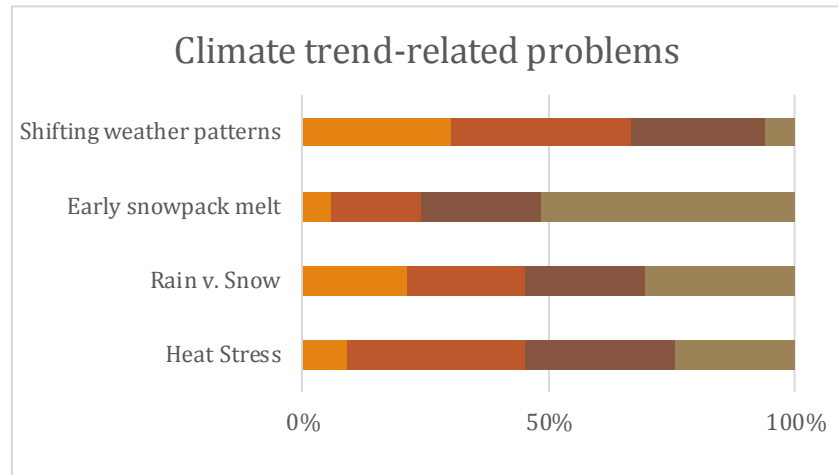


FIGURE 5: PERCENT OF RESPONDENTS CONCERNED ABOUT OTHER CLIMATE TREND-RELATED PROBLEMS (LEGEND IN FIGURE 3)

Preparing for Drought and Decision Making

The survey asked respondents to describe the decisions they were involved with from February through August that depended on drought and/or climate information. The survey also asked how (if at all) their agency or organization prepared in advance specifically for drought. Respondents in many sectors described the need to communicate drought information as local drought status changes. Respondents working with water supply said they regularly made operational decisions regarding drought, flood, and weather conditions, including water allocation decisions and permitting. Further, one respondent shared that “Interstate Council on Water Quality member states and interstate basin commissions/organizations have tiered drought plans that are enacted at various trigger points”. Water managers may prepare for drought by addressing the supply side, and/or by decreasing demand by creating conservation plans in conjunction with local governments. One respondent described a project on the Mississippi River to identify conservation practices that provide multiple benefits for wildlife, water quality, and agriculture in the basin as a mechanism for reducing nutrient loading to the Gulf.

Agricultural managers have a number of management decisions to make throughout the growing season. For drought preparation, respondents referred to the federal programs and processes that are in place to support farmers during drought.

Respondents working with the fire/forestry sector said they make medium- and long-term fire potential outlooks/forecasts for an interagency fire community, and that as a whole, this interagency effort responds to short- to medium-range dry periods more swiftly in areas where longer-term drought planning is in place.



Drought/Climate Information Use, Usability, Needs, Gaps

Building upon this understanding of stakeholders' experience with climate impacts and decisions that must be made to manage those risks, this section describes how the stakeholders in the Midwest seek out and use climate information.

Information Needs

Respondents were asked what types of information they looked for during drought. Figure 6 shows that during recent severe drought (as self-defined by respondents), the highest proportion of survey respondents (n=42) sought information on drought severity (56%) or impacts (51%). Fewer sought information on the onset of drought (37%),

drought response (30%), decision support information or tools (28%), drought preparedness (21%), or drought recovery (23%). Climate information providers and decision makers were similar in the types of information they sought during drought.

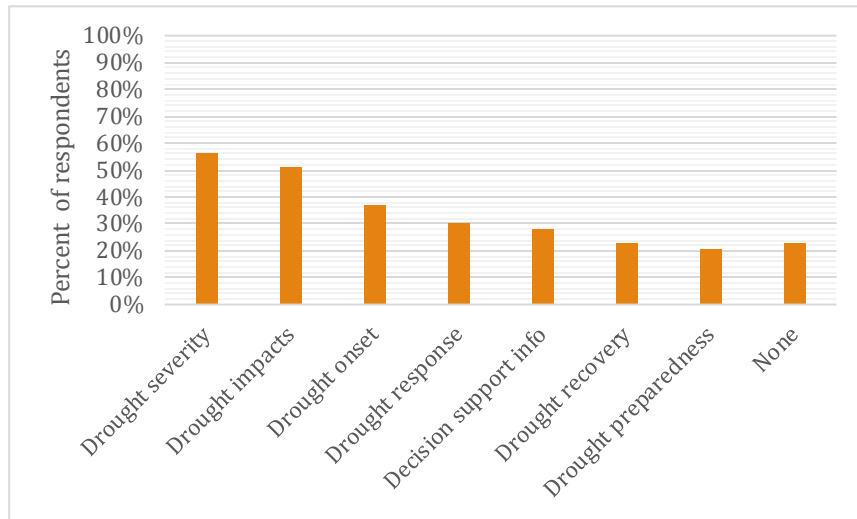


FIGURE 6: PERCENT OF ALL RESPONDENTS SEEKING INFO DURING DROUGHT

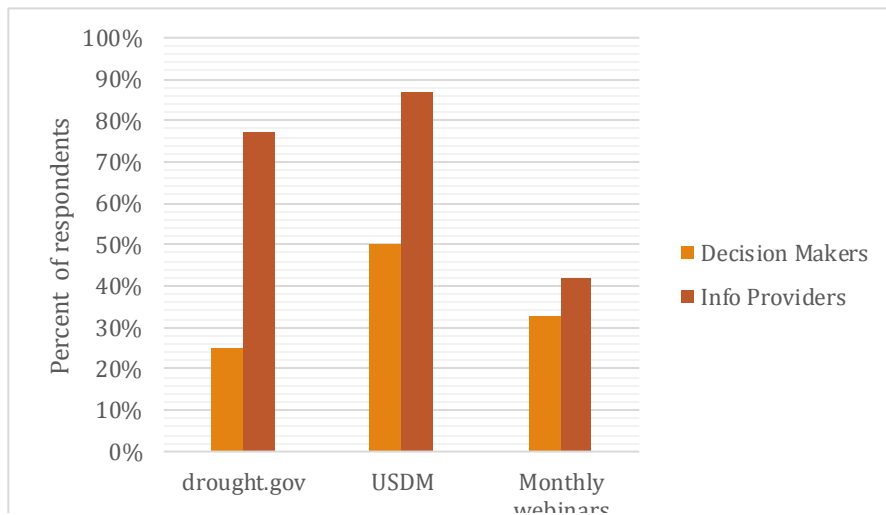


FIGURE 7: PERCENT OF RESPONDENTS USING DROUGHT.GOV, THE USDM, AND MONTHLY GREAT PLAINS AND MIDWEST CLIMATE/DROUGHT WEBINARS

Information Sources and Gaps

Respondents were asked about their current use of specific climate tools, resources, and services (largely sponsored by DEWS partners). Overall, 59% of respondents had used the Midwest



Regional Climate Center (MRCC) website and/or tools, and 56% had used or accessed NOAA's climate.gov or Climate Resilience Toolkit.

As shown in Figure 7, there was a gap between info providers and decision makers in use of the NIDIS Drought Portal (drought.gov), with 77% of info providers and 25% of decision makers saying they used or accessed this resource. Similarly, while 87% of climate information providers said they used the U.S. Drought Monitor, the proportion of decision makers using the USDM was 50%. While fewer overall had used the monthly Great Plains and Midwest Climate/Drought webinar series, the proportion was more similar among decision makers and information providers.

In an open-ended question, we asked about other important sources of drought early warning information.

- Decision makers in the water supply sector mentioned the Corps of Engineers and EPA water utility tools such as CREAT.
- Decision makers in the fisheries sector mentioned the USGS National Climate Change and Wildlife Science Center and the Northeast Climate Science Center at the University of Massachusetts.
- Decision makers in the fire/forestry sector mentioned using drought indices such as the Standard Precipitation Index and Palmer Drought Index directly, and working with both the Midwest and Northeast Regional Climate Centers as well as the USFS Rocky Mountain Center for drought early warning information.

Given the sources of information listed in the survey and provided by respondents, only 22% of respondents said that current drought information meets all of their needs. While it may be unrealistic to expect to meet all of the drought information needs of most stakeholders, tracking changes in perceptions related to this question may be a useful gauge of DEWS success.

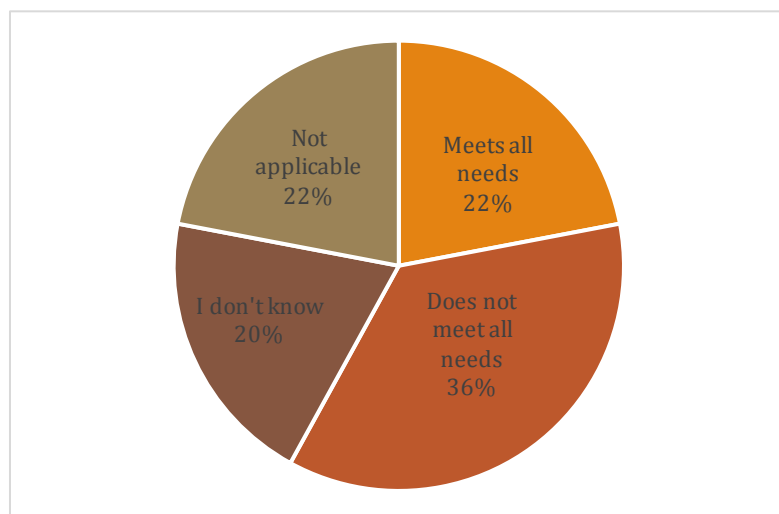


FIGURE 8: PERCENT RESPONSE, HOW WELL DOES CURRENT INFO MEET DECISION-MAKING NEEDS RELATED TO DROUGHT MANAGEMENT

For decision makers, information gaps include: interpretation of data on how drought impacts



affect management of land use, wildlife and water quality/hydrology, and U.S. Drought Monitor maps that distinguish between different types of drought (agricultural, hydrologic, etc.).

Others suggested there was a need for either better links to existing monitoring networks or for new/better monitoring networks in the areas of soil moisture data, groundwater availability, and aquifer characteristics. Perceived information gaps also included drought prediction, impact information, and planning.

Finally, when they sought drought-related information, approximately 20% of respondents (n=36) said it was “pretty or extremely difficult” to use the information to identify specific triggers to inform operational decisions, and about the same number said it was “pretty or extremely difficult” to find drought-related information at the spatial scale needed.

Surveyed Priorities

As organizers of the new Midwest Drought Early Warning System develop a strategic plan for the Midwest, the following priorities will be taken into consideration.

Top Priority: Improved Communication

Fifty-eight percent of survey respondents (n=36) said that a critically important role of the DEWS should be to improve communication among agencies or sectors in the region. Supporting this, some of the “best things” that participants thought might come of the DEWS effort included “improved information flow between/among actors,” “inter-institutional cooperation and information sharing,” and “stronger relationships between staff of different states.” Participants envisioned a successful DEWS as “constant and consistent information flow, and...small group of leaders for the region as the go-to people for information and questions,” “a community of practitioners sharing information, expertise and resources,” and “semi-annual workshops with agencies and stakeholders [that are] planning focused, and develop a culture of proactive, adaptive approaches within and between states in the Midwest.” Improved awareness of drought resources and understanding of the information was also listed as “best things” that could come from the DEWS.

Second Priority: Improved Drought Early Warning and Ability to Use Information for Decision Making

Approximately 50% of survey respondents (n=36) said improving drought early warning information and improving the ability to use that information to make decisions was a critically important role of the DEWS. Respondents suggested the following benefits: “better monitoring information with emphasis on improvement of existing monitoring efforts (NWS coop, mesonet, CoCoRaHs),” and a “toolbox of resources that state drought teams can tap and interpret; support for integration of state mesonet (including soil monitoring) in Midwest through MRCC and SCOs.” One respondent said “broad sector engagement means hopefully our actions are capturing really what’s



most important,” and another emphasized the “accessibility” of tools and resources to communities and local decision makers. One specifically listed the need to address “decisions related to agricultural management and production in the Midwest.” Participants envisioned a successful DEWS as “centralized, publicly available, frequently updated, drought-threat summaries and projections that everyone can understand,” “effective early warning that is easy to interpret for users – communication of forecasts and what to expect, timely and accurate communication of drought impacts and recovery,” “a one-stop shop with guidance on how to use it – examples of plans, case studies,” “a system for identifying early impacts and potential future impacts (lake levels, soil moisture) that transmit “advisories” to stakeholders,” and “a coordinated effort among agencies at different levels (federal, state, local) to communicate impacts and conditions. This group can help determine thresholds/triggers for action.”

Next Steps/Suggestions for the Midwest Strategic Plan

Respondents provided the following suggestions as the Midwest DEWS is developed:

- *Regular opportunities for sub groups to work together on regional projects.*
- *Working with individual states to incorporate DEWS into drought plans.*
- *Regular meetings would be great! Perhaps encourage pre-meetings among local communities ...*
- *Regular webinar series to discuss progress and tasks, allowing meeting attendees to spread the word.*
- *Explore research needs and find funding to fill data gaps.*
- *Engage SCO's; build relationships with state drought committees; develop plan for engaging various economic sectors beyond agriculture in drought planning*
- *Core group focused on region-wide / broad representation of state/fed/academic with revolving sector interests.*

Series of sector meetings across region to bring in more interest, awareness

