MIDWEST DROUGHT EARLY WARNING SYSTEM (DEWS)

2018-2019 Strategic Plan

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

2018-2019 MIDWEST STRATEGIC PLAN

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Introduction to the Midwest Drought Early Warning System

National Integrated Drought Information System and Drought Early Warning Systems

In 2006, 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). NIDIS is working toward this goal by developing a network of regional DEWS (see map). 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.

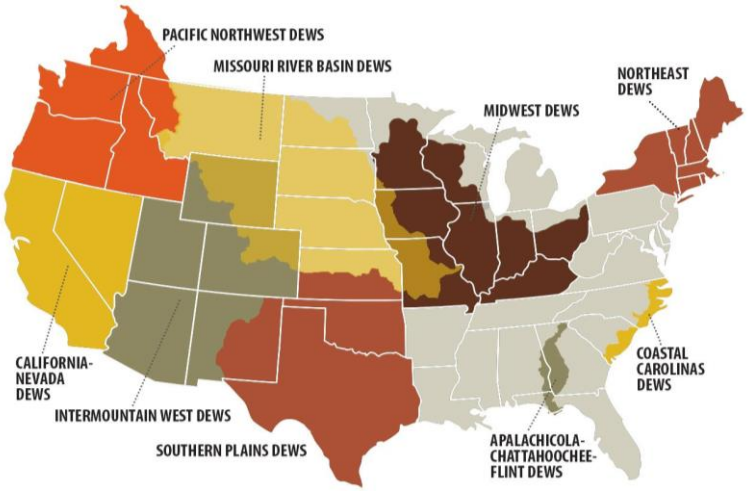

Figure 1 Network of NIDIS Drought Early Warning Systems (DEWS)
Note: While the colored shading denotes the DEWS regions, where the majority of DEWS actions focus, activities may extend beyond the shaded area when needed. The overlapping edges in so some regions reflect the permeability of the DEWS boundaries.

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, and partnerships. The relationship ensures a robust, "ground-up" regional DEWS that is well-

WHAT IS NIDIS?

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

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.

networked and responsive to the specific needs of each region. The National Oceanic and Atmospheric Administration (NOAA) and the NIDIS program did not establish the DEWS, and do not control or manage the DEWS functions or operations; rather, the DEWS constitute the continuation, and leveraging, of existing partnership networks.

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 (see figure below). However, the Midwest has still felt adverse impacts during recent droughts, 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 quality, and reduced productivity for hydropower.

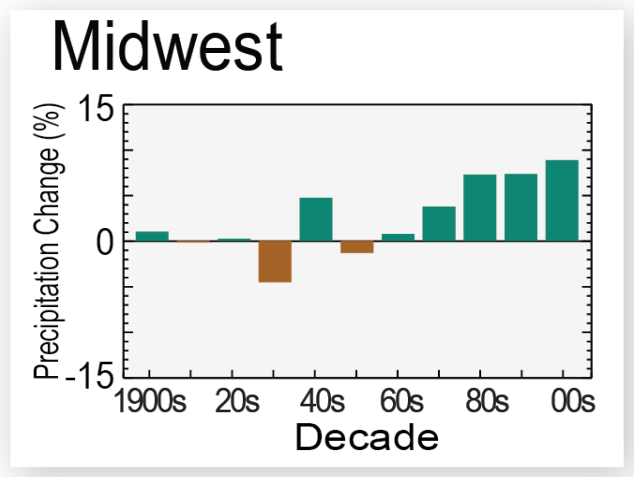

Figure 2 Observed U.S. precipitation change decadal bar graph - Midwest region - for 1901 to 2012 time frame. Graphic: 2014 National Climate Assessment

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 a year after epic floods impacted the Midwest and Great Plains. Wetter springs have also become more common, also affecting important Midwest economic sectors. For agriculture, wetter springs reduce the number of workable field days, delay planting, and increase nitrogen loss. The wet springs of 2011 and 2013 were followed by dry summers, which exacerbated the challenges faced by farmers. This presented such a challenge that the NIDIS Reauthorization Act of 2014 incorporated language to demonstrate the importance of other extreme events and their intersection to drought: "continue ongoing research and monitoring activities related to drought, including research activities relating to length, severity, and impact of drought *and the role of extreme weather events and climate variability in drought*."

Total precipitation in the Midwest, as well as the frequency of extreme precipitation events, are expected to continue to increase in the future, according to the 2014 National Climate Assessment[1]. However, weather patterns in recent decades have demonstrated that droughts can and will still occur in a wetter climate, and the challenges associated with a rapid change between climatic extremes have become increasingly apparent. Properly planning and preparing for both drought and heavy precipitation events, and understanding the relationship between the two events, are important for building drought and climate resilience in the Midwest.

[1] Pryor, S. C., D. Scavia, C. Downer, M. Gaden, L. Iverson, R. Nordstrom, J. Patz, and G. P. Robertson, 2014: Ch. 18: Midwest. *Climate Change Impacts in the United States: The Third National Climate Assessment,* J. M. Melillo, Terese (T.C.) Richmond, and G. W. Yohe, Eds., U.S. Global Change Research Program, 418-440. doi: 10.7930/J0J1)12N.

Background of the Midwest DEWS

NIDIS and its partners launched the **Midwest DEWS** in response to the 2012 drought, which highlighted the need for additional drought early warning and preparedness in the region. The Midwest DEWS includes the states of Kentucky, Illinois, Indiana, Iowa, Minnesota, Missouri, Ohio, and Wisconsin (see right), with the northern border of the region bounded by the Mississippi River and Ohio River watershed basins. After scoping workshops in 2015, the Midwest DEWS Kickoff Meeting was held February 9-11, 2016 in St. Louis, Missouri, bringing together federal, state, local, and academic partners and stakeholders for an in-depth discussion about drought and high precipitation events in the Midwest. Particular attention was placed on water, climate, land resources, and emergency management. Discussions focused on improving the capacity to meet the drought early warning information needs of decision makers in the region.

Partners across the region assisted NIDIS with the launch of the Midwest DEWS, including NOAA's 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), U.S. Army Corps of Engineers (USACE), the U.S. Department of Agriculture (USDA) Midwest Climate Hub, NOAA's National Centers for Environmental Information (NCEI), and NOAA's National Weather Service (NWS).

In preparation for the February 2016 Kickoff Meeting, three workshops were held in 2015 to help inform the launch of the Midwest DEWS:

- Midwest Climate and Agriculture Workshop on September 29-October 1, 2015 in Champaign, Illinois.[2]
- Midwest DEWS Planning Workshop on November 3, 2015 in Louisville, Kentucky, focused on the Ohio River Basin stakeholders[3].
- Midwest DEWS Planning Workshop on November 5-6, 2015 in Bloomington, Minnesota, focused on the Upper Mississippi River Basin stakeholders[4].

As a follow-up to the February 2016 Kickoff Meeting, four Regional Assessment Workshops were held in November and December 2016 to receive local stakeholder input to further refine Midwest DEWS strategies and future actions[5]. Each workshop brought together federal, state and local stakeholders[6], as well as partners in academia, the private sector, and non-governmental organizations. Agenda topics and discussions included a

[2] 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. The workshop was hosted by MRCC, NIDIS, and the USDA Midwest Climate Hub (http://mrcc.isws.illinois.edu/events/MWClimateAg/index.html).

[3] https://www.drought.gov/drought/node/784

[4] https://www.drought.gov/drought/node/782

[5] https://www.drought.gov/drought/documents/2016-regional-assessment-workshops-report-midwest-drought-early-warning-system

[6] The four workshops were held in Rochester, MN (Wisconsin and Minnesota focus); Cedar Rapids, IA (Iowa and Missouri focus); Champaign, IL (Illinois and Indiana focus); and Cincinnati, OH (Kentucky and Ohio focus).

historical drought overview and climate outlook, drought planning and management within each Midwest DEWS state, priority drought-related needs and critical issues, drought and climate tools, and strategies to improve drought early warning capacity and resilience in the Midwest.

Purpose of the Midwest DEWS

The Midwest DEWS is a collaborative federal, state, and local interagency effort to improve early warning capacity and long-term resilience to drought and high precipitation events throughout the region. This is accomplished through local stakeholder-driven activities that encompass the key components of NIDIS's regional drought early warning systems: observation and monitoring; prediction and forecasting; planning and preparedness; communication and outreach; and interdisciplinary research and applications.

Figure 3 Key components of NIDIS Regional Drought Early Warning Systems

Specific goals of the Midwest DEWS include:

- Develop a diverse network of federal, tribal, state, and local stakeholders that represent all economic sectors, including water and land resource management.
- Provide a platform for this network to develop relevant, useful, and readily-available drought, climate, weather, and water information to improve drought early warning capacity and drought resilience.
- Increase stakeholder awareness and understanding of the existing observation and monitoring networks, data, tools, research, and other planning and mitigation resources.
- Identify the economic sector-specific and geographic needs for future drought monitoring, prediction, planning, and information resources.

The Midwest DEWS Strategic Plan

Plan Purpose and Development

This Midwest DEWS Strategic Plan (Plan) builds upon existing stakeholder networks and activities to improve drought early warning capacity and long-term resilience in the Midwest. The Plan outlines priority tasks and activities for the implementation of the Midwest DEWS, including a list of partners, outcomes, and key milestone dates. The Plan is a "living document" to which additional actions and partners may be added as needed. While the Plan development is an interagency effort, NIDIS oversaw the development of the Plan and is working with regional stakeholders to manage the content.

The development of the Plan relied upon the knowledge, experience, and contributions of many dedicated individuals, organizations, and partnerships. Stakeholders from across the region, including federal, tribal, state, local, academic, and non-profit organizations and entities assisted NIDIS in developing the Plan (Appendix C). Information and feedback gathered from the Midwest DEWS Planning Workshops in 2015, Midwest DEWS Kickoff Meeting in February 2016, and the Regional Assessment Workshops in fall 2016[7] informed the development of this Plan. Key stakeholders had the opportunity to conduct a review of the 2018-2019 Plan in March 2018.

Midwest DEWS Priorities and Activities

This Plan prioritizes the following objectives as necessary to building drought early warning capacity and long-term drought resilience throughout the Midwest. These are stakeholder-identified priority actions:

- **Priority 1 – Integrate Impacts, Data, Management Practices, and Research into Drought Planning –** The Midwest DEWS will work to advance and integrate better observations of drought impacts, data, drought management actions (e.g., mitigation or response strategies), and research into drought planning and vulnerability assessments. Activities include improving the understanding, collection, and documentation of drought impacts and drought management actions, researching and documenting drought management actions utilized in the Midwest, and prioritizing drought vulnerability assessments for the Midwest region.

- **Priority 2 – Enhance Drought Observations and Data Availability –** Observations of environmental conditions, both atmospheric and hydrologic, are critical to understanding the variability and extremes of the environment, in addition to understanding what is normal or average for a location. The availability and ease of obtaining this data is also important for stakeholders to develop tools and resources for their own need. Activities for the Midwest DEWS within this priority aim to increase the amount and availability of this crucial observational data.

[7] See the *Background on the Midwest DEWS* section of this Plan for more information on these meetings.

- **Priority 3 – Improve Drought Early Warning Outreach and Communication Capacity –** The Midwest DEWS will support and provide increased communication and outreach on drought and drought-related climate events. Activities are focused on establishing and/or maintaining regular modes of communication, developing a regional drought condition notification system, and engaging with key networks to improve outreach to communities and the general public.

- **Priority 4 – Foster Stakeholder Collaboration, Coordination and Relationship Building** – The Midwest DEWS seeks to develop a robust and active network of partners including federal, state, and local agencies, tribal entities, non-governmental organizations, and industries across a variety of sectors dedicated to building drought early warning capacity and long-term resilience in a coordinated manner. This priority focuses on increasing inter-agency and inter-partner collaboration, coordination, and information transfer in the Midwest DEWS. Activities include key stakeholder calls, exchange of drought-related activities in the region, hosting an annual regional Midwest DEWS workshop, and a coordinated approach for improved outreach to targeted economic sectors.

For each priority, some of the associated activities outlined in this Plan have been started while other activities will be initiated over the next two years (January 2018 – December 2019). The corresponding schedule (Appendix A) summarizes the expected timeframe for each activity's implementation. Milestone dates are based on the following quarters: Quarter 1 (Jan, Feb, Mar), Quarter 2 (Apr, May, Jun), Quarter 3 (Jul, Aug, Sep), and Quarter 4 (Oct, Nov, Dec).

Additional activities, partners, outcomes, and milestone dates will be added and/or modified to this Plan in response to meeting evolving stakeholder needs, funding, etc., as the DEWS develops. Some of the activities are funded, other activities require efforts to acquire funding. Funding sources may include NIDIS and other DEWS partners. As the Midwest DEWS develops, it will be important to identify and leverage resources and available funding among DEWS partners.

Coordination with NIDIS Working Groups

Vital to the mission of NIDIS are its six interagency Working Groups, each focused on a different component of NIDIS activities within and across government agencies and throughout the country. These six areas of focus are: (i) education and public awareness, (ii) monitoring and observations, (iii) predictions and forecasting, (iv) interdisciplinary research and applications for risk assessment, (v) planning and preparedness, and (vi) the U.S. Drought Portal for improving accessibility to usable drought risk information. The NIDIS Implementation Plan December 2016 Update provides additional information on the NIDIS Working Groups.

Coordination, communication, and transferability of information and actions between the NIDIS Working Groups and the DEWS is essential to the overall process of building an integrated drought information system. The NIDIS Program Office supports a network of regular communication and exchange of information between these entities to ensure meaningful engagement and effective collaboration on priorities and activities. Appendix D illustrates how each of the activities in this Plan correlates with the Working Group(s).

Priority 1 – Integrate Impacts, Data, Management Practices, and Research into Drought Planning

This priority focuses on advancing and integrating better observations of drought impacts, data, drought management actions (e.g., mitigation or response strategies), and research into drought planning and

vulnerability assessments. Activities include improving the understanding, collection, and documentation of drought impacts and drought management actions, researching and documenting drought management actions utilized in the Midwest, and prioritizing drought vulnerability assessments for the Midwest region.

Activity 1.1 Improving Collection and Reporting of Drought Impacts

Although methods to collect and document drought impacts do exist (e.g., Drought Impact Reporter, CoCoRaHS condition reporting), impacts continue to be underreported. Therefore, there is a need to collect more impacts from the local level in order to better understand how drought affects Midwest stakeholders, particularly in sectors such as energy, public health, and tourism and recreation.

At the Fall 2016 Regional Assessment Workshops, Midwest DEWS stakeholders identified that an activity to develop a drought impact survey template to collect impacts from stakeholders would help partners obtain this information, as well as standardize the impact collection and data. This template would be utilized by state agencies like natural resources, public health, emergency management, etc., across the Midwest to send to stakeholders throughout the state to collect drought impact information. A drought impact survey template was recently developed by NDMC and therefore for this activity, the Midwest DEWS network will first review this template and make edits as needed to to customize it for the Midwest region. In addition, this template will be beta tested to collect more impacts from on the ground through the Midwest DEWS network. The Midwest DEWS network will work with NDMC to strategize the appropriate way to integrate and/or align this information to the Drought Impact Reporter.

In addition, the Midwest DEWS will establish a working group to develop a strategy for other activities the Midwest DEWS could do to improve the collection and reporting of drought impacts. Ideas include developing a communication chain, which would show how drought impact reports could be transferred from the local level (e.g., municipality, Extension agent, USDA Service Center) to the national level (e.g., NIDIS, Drought Impact Reporter) for various sectors in each state. Another idea to consider would be completing a “network analysis”, which would analyze who stakeholders in the Midwest talk to when they need drought information, or who they convey their drought impacts to, in order to better understand the knowledge exchange of drought information among Midwest stakeholders. Similar work has been done by the Great Lakes Integrated Sciences and Assessments (GLISA) on climate adaptation network analysis. Partners to help NIDIS carry out this activity may include NDMC, state climatologists from the Midwest, state agencies, GLISA, Extension, and other federal, regional, and state organizations.

Activity 1.1 Outcomes

- Utilizing the draft template from NDMC, develop and beta test the drought impact survey template in coordination with state agencies and the NDMC. [Q3 2018 - Q2 2019]
- A comprehensive strategy from a Midwest DEWS working group on other actions to take for improving the collection and reporting of drought impacts, and how this information aligns and/or is integrated into the Drought Impact Reporter. [Q4 2018 - Q1 2019]

Activity 1.2 Correlate and Validate Regional Sector Drought Impacts to USDM Classification System

Midwest DEWS stakeholders expressed that having more drought impact information by USDM classification level (i.e., D1, D2, D3, and D4) and by sector (e.g., agriculture, navigation, water supply, public health) would be very useful in planning for drought in the Midwest. In coordination with NIDIS and the Midwest DEWS stakeholders, the NDMC will take the lead on conducting this research for two states in the Midwest DEWS region over the next two years. Missouri was selected as one of the two states, and Kentucky is being

considered for the second. NIDIS and its partners will share the initial research with key stakeholders in each state and gather feedback on how well the research represents drought impacts in their state. As needed, additional resources and data will be incorporated to make this a robust process and final product. When the research is complete, this information will be shared broadly across many sectors in these states through entities like state climatologist offices, state drought task forces, and/or state drought plan coordinators to inform drought planning and response. In addition, this information will be added to the Midwest DEWS webpage on the drought.gov portal.

Activity 1.2 Outcomes

- NDMC, in consultation with NIDIS, will perform the correlation and validation research and analysis for two Midwest DEWS states (Missouri and Kentucky - tentative). [Q2 2018 – Q4 2018]
- NIDIS will gather feedback on the initial state-specific drought information from key stakeholders in each state and perform additional analysis as needed. [Q1 2019 - Q3 2019]
- NIDIS will share the final information through state networks and integrate this information onto drought.gov to inform response and mitigation actions in the region. [Q4 2019]

Activity 1.3 Develop Midwest-Specific Repository of Drought Management Actions

Drought management actions include response, mitigation, recovery and adaptation. Midwest DEWS stakeholders have said that a more comprehensive database with drought management action examples utilized in the Midwest region would be beneficial in planning for drought. Using NDMC's database of adaptive capacities as a starting point, NIDIS will coordinate the development of a spreadsheet list of drought management actions currently implemented in each Midwest state. The spreadsheet will include fields for each drought management action type (e.g., response, mitigation, recovery, or adaptation), as well as identifiers for the state and sector. The spreadsheet will be designed to easily transfer to an online, queryable database in the future. Once the list is finalized, it will be made available to the Midwest DEWS stakeholders to inform drought planning in the future. Partners that will help NIDIS carry out this activity include NDMC, state drought plan leads, and other Midwest DEWS stakeholders involved in drought planning.

Activity 1.3 Outcomes

- NIDIS will lead the development of a spreadsheet list of drought management examples in the Midwest. [Q3 2018 – Q2 2019].
- NIDIS, NDMC, and its partners will identify the best strategy to provide this information to the Midwest DEWS network (e.g., online database, PDF from drought.gov). [Q3 2019]

Activity 1.4 Develop Strategy to Support Drought Vulnerability Assessments

Drought vulnerability assessments are of interest to Midwest DEWS stakeholders, but performing these assessments presents some challenges. Few have been done on a large scale, and while they were comprehensive, they were also costly. Participants at the Midwest DEWS Regional Assessment Workshops brainstormed priority topics for vulnerability assessments in the Midwest.

Participants want to better understand the use of and dependence on major river systems (e.g., Mississippi River, Ohio River) to support public, economic, and environmental interests in the Midwest, and how these are affected by drought. The Mississippi River Cities and Towns Initiative (MRCTI) would be close partners on this work, as this coalition of Mayors is interested in determining the vulnerabilities that our nation and the region faces, based on the dependence of the Mississippi River for navigation and trade.

Participants also supported using vulnerability assessments to better understand the utilization of and dependencies upon aquifers and other groundwater sources, which support diverse population, agricultural, and environmental interests in the Midwest. These assessments would be useful for enhancing coordination and cooperation during drought and would focus on major aquifer systems in the region. Particular focus would be on areas where agricultural and municipal water supplies depend on groundwater, as well as where conflicts currently exist or are anticipated to occur in the future.

This activity will focus on hosting a workshop and developing a comprehensive strategy for carrying these two vulnerability assessments forward. NIDIS and MRCTI will host a Trade Footprint Workshop in the Midwest, that focuses on assessing the vulnerability our entire country faces from drought due to the dependence on the Mississippi River for navigation and trade. In addition, NIDIS and its partners will develop a comprehensive strategy on how the Midwest DEWS network can best support and carry out an assessment on the utilization and dependencies upon aquifers in the Midwest. The strategy may consider the following factors: (1) prioritizing geographic areas and economic sectors for analysis; (2) leveraging resources; (3) availability of technical support; (4) how to incorporate assessment results into local, regional and state drought planning efforts; and (5) reporting assessment results to stakeholders and agencies that will benefit. Partners that will help NIDIS carry out this activity include MRCTI, U.S. Geological Survey (USGS), USACE, NDMC, key state agency representatives from the eight-state region, and other Midwest DEWS stakeholders.

Activity 1.4 Outcomes

- NIDIS and MRCTI will plan and host a Trade Footprint Workshop in the Midwest. [Q2 2018 - Q4 2018]
- NIDIS and its partners will develop a strategy to carry out the aquifer dependency vulnerability assessment. [Q1 2019 – Q4 2019]

Priority 2 – Enhance Drought Observations and Data Availability

Observations of environmental conditions, both atmospheric and hydrologic, are critical to understanding the variability and extremes of the environment, in addition to understanding what is normal or average for a location. The availability and ease of obtaining this data is also important so stakeholders can develop the tools and resources they need. Activities within this priority aim to increase the amount of observational data across the Midwest, as well as the availability of this information.

Activity 2.1 Leverage Existing Citizen Science Monitoring Programs

Citizen science monitoring and data collection programs[8] are useful in collecting drought impact information. The Community Collaborative Rain, Hail & Snow Network (CoCoRaHS) is an example of a citizen science program that collects and reports precipitation, and more recently, on-the-ground impacts from climate conditions ("condition monitoring"). CoCoRaHS is a nationwide program sponsored by NOAA, NWS, National Science Foundation, and other state and local agencies. Condition monitoring from CoCoRaHS observers provides regular reporting, rather than intermittent drought impact reports, which can help to create a baseline for comparison of change through time and to improve the understanding of the onset, intensification, and recovery of drought.

[8] Citizen science is the collection and analysis of data relating to the natural world by members of the general public, typically as part of a collaborative project with professional scientists.

The more citizens who participate in CoCoRaHS in the Midwest, the more data and awareness of drought impact information there would be in the region.

This activity will focus on increasing the number of CoCoRaHS observers in the Midwest by engaging with key partners working with citizen networks. This includes entities like Land Grant Extension, local NWS Weather Forecast Offices, the North Central Region Climate Team[9], and the Extension Disaster Education Network (EDEN). NIDIS and its partners will work with these groups to develop an outreach strategy to increase participation in CoCoRaHS that best suits their citizen networks. The strategy will include evaluation criteria to assess whether the work was successful at increasing the number of CoCoRaHS observers. This strategy will also include actions to explore if there are state-based citizen science networks in the Midwest the DEWS should partner with to expand or potentially replicate in other states, like the Indiana Volunteer Groundwater Monitoring Network. Partners to help NIDIS carry out this activity may include CoCoRaHS, NDMC, state climatologists, staff and sponsors of the identified programs above, and other Midwest DEWS stakeholders.

Activity 2.1 Outcomes

- A comprehensive strategy for increasing participation in CoCoRaHS. [Q4 2018]
- Carry out strategies identified. [Q1 2019 – Q3 2019]

Activity 2.2 Enhance and Promote Web Service Interface for Sub-Daily Climate Data

NOAA's Regional Climate Centers (RCCs) provide online climate data and value-added products based on daily climate observations (i.e., temperature, precipitation, degree days). However, until recently, the RCCs did not provide a similar suite of products and information based on sub-daily climate observations (i.e., temperature, precipitation, dew point temperature, wind speed/direction, cloud height, barometric pressure, and visibility) and derived parameters (i.e., relative humidity, wind chill, heat index). The MRCC recently partnered with the Western Regional Climate Center (WRCC) to develop a synchronized database that has the capacity to store historical sub-daily data in a manner that allows for faster data access and customization. Utilizing this database, several hourly observed data tools have been developed and are accessible through MRCC's Application Tools Environment (cli-MATE). Tools that have already been developed since late 2016 include:

- Sub-daily data list (Hourly-Observed Data → Sub-Daily → Sub-Daily Data Lister);
- Multi-station data (Hourly-Observed Data → Daily → Multi-Station Data);
- Daily summarized data (Hourly-Observed Data → Daily → Daily Summarized Data);
- Wind roses (Hourly-Observed Data → Wind Roses);
- Frequency distributions (Hourly-Observed Data → Frequency Distributions).

Additional tools that are planned in the near future include threshold searches, climatologies for derived parameters such as heat index and dew point temperature, and access to allowable, non-federal available data (e.g., mesonet data[10]). Users can also access the data via web service calls, through an application programming

[9] The North Central Region Climate Team is comprised of Extension specialists from the North Central Region Water Network, focused on increasing Extension input for the U.S. Drought Monitor and providing climate-ag resources for other Extension specialists in the region.

[10] Such sub-hourly data from mesonets would include additional data like solar radiation, soil temperature, soil moisture, potential evapotranspiration. These hourly data will be particularly useful for the early warning and analysis of high precipitation and drought events. For example, hourly rainfall can capture the intensity of storm events and potential flooding while a combination of solar radiation, temperature and other climate data can be used to calculate hourly

interface (API), in order to develop tools and resources for their own needs (http://mrcc.isws.illinois.edu/data_serv/cli-dap.jsp). There are also data reduction routines that simplify what stakeholders may need to download, including reductions for mean, max, or minimum temperature on an hourly, daily, monthly, or yearly time scale.

For this activity, the MRCC will continue to develop the sub-daily database to add more features, including additional data reduction routines. In addition, the MRCC and NIDIS will promote the availability of this sub-daily database to the Midwest DEWS network (e.g., via Midwest DEWS workshops, newsletter). The NIDIS Comms Team will work with the MRCC to integrate this new data resource onto drought.gov. These efforts will enhance the ability for Midwest DEWS stakeholders to conduct analyses based upon observations that are currently difficult to acquire.

Activity 2.2 Outcomes

- MRCC will add more tools, data reduction routines, and data to the sub-daily web services interface. [Q2 2018 – Q4 2018]
- MRCC and NIDIS will promote this online data resource through the Midwest DEWS network. [Q3 2018]
- MRCC will work with the NIDIS Comms Team to integrate the new data resource onto drought.gov. [Q2 2018 - Q3 2018]

Activity 2.3 Foster Development of the Regional Mesonet Program

Since 2012, the MRCC has helped organize workshops that convene mesonet programs across the Midwest to discuss issues and opportunities for collaboration. As a result of these workshops, the MRCC helped establish the Midwest Mesonet Consortium (MMC), which is a working group comprised of mesonet leaders throughout the region. The MMC leads the Regional Mesonet Program (RMP), and provides guidance on RMP workshops, strategic planning, and provides leadership across this mesonet community. One effort of the RMP is to provide online operational product maps from various mesonet groups around the region, which are updated daily. Current data maps include soil temperature (2-inch, 4-inch) and potential evapotranspiration, available for 24-hour or 7-day periods.

Midwest DEWS stakeholders have continually recognized the need for more observations of precipitation, soil moisture, and potential evapotranspiration to monitor drought. Since much of this data is collected through mesonets, NIDIS supported the MRCC in hosting a Regional Mesonet Program Workshop in Champaign, Illinois in March 2017. The purpose of this workshop was to better coordinate mesonet data and value-added tools that would be beneficial to the Midwest DEWS stakeholders. Some of the key takeaways related to drought early warning from this workshop include:

- More potential evapotranspiration and soil monitoring (i.e., soil moisture and soil temperature) measurements are needed across the region.
- An analysis is needed to validate the accuracy of modeled soil moisture using in situ soil moisture data.
- Mesonets in the region are open to the idea of sharing their data with the MRCC, for incorporation into the MRCC sub-daily database, particularly if there are access restrictions that limit who can access their data.

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evapotranspiration. Hourly temperature data can inform the public and key sectors (e.g. outdoor construction, livestock stress, impacts on crop production, etc.) of potential heat exhaustion risk.

In this activity, the Midwest DEWS network will continue to foster the development of the RMP in order to integrate and improve observation monitoring and availability of data in the DEWS. Based on feedback from the Midwest DEWS Regional Assessment Workshops and RMP workshop, the MRCC will develop and promote regional maps of evapotranspiration data. In addition, NIDIS will work with the MRCC, MMC, and NDMC to survey the RMP users and the Midwest DEWS network on the products developed by the RMP, including the MRCCs evapotranspiration maps. The survey will ask users how they use these products and mesonet data, if they find the RMP products useful, what other regional information from mesonets would be useful, and other questions to assess the products and needs of the stakeholders. Finally, the MMC has monthly conference calls to continue advancing their efforts. For this activity, NIDIS will begin participating in the monthly MMC calls to remain aware of the needs, challenges, and opportunities for mesonet programs. Partners to help NIDIS carry out this activity include MRCC, MMC, and state climatologists.

Activity 2.3 Outcomes

- MRCC will develop and promote regional evapotranspiration maps. [Q2 2018]
- NIDIS and partners will survey RMP users and the Midwest DEWS network to gather feedback on the RMP products. [Q3 2018 – Q4 2019]

Activity 2.4 Advance the Kentucky DEWS

The Kentucky Climate Center (KCC) will advance the Kentucky Drought Early Warning System by enhancing the in situ[11] environmental monitoring infrastructure of the Kentucky Mesonet with additional soil moisture sensors, and by developing an interactive data visualization and analysis dashboard. The Kentucky Mesonet is a network of automated weather and climate monitoring stations developed by the Kentucky Climate Center at Western Kentucky University to service diverse needs in communities across Kentucky. It currently has 69 stations, including 23 that monitor soil moisture and seven with cameras to visually capture landscape conditions. Integral to advancing the Kentucky DEWS will be developing an interactive data visualization and analysis dashboard that integrates and facilitates analysis of both environmental input data (e.g., precipitation, soil moisture, streamflow, reservoir level data, potential evapotranspiration) and environmental impact data (e.g., landscape images or crop and livestock reports). In addition, the KCC will rely on its strong network of relationships at the local and state levels to share this work throughout the state.

Activity 2.4 Outcomes

- Expand soil moisture measurements of the Kentucky Mesonet. [Q3 2019 - Q4 2019]
- Develop an interactive data dashboard to display Kentucky Mesonet data and environmental impact data. [Q2 2018 - Q4 2019]

Activity 2.5 Explore Partnership Opportunities to Increase Observational Monitoring

Observational monitoring networks for variables like soil moisture, precipitation, groundwater, and streamflow are essential for understanding the capacity and resilience of systems to meet current and future demands during periods of drought. While observation networks for these variables do exist, the region continues to struggle with an adequate observational network and data integration. For this activity, Midwest DEWS partners will develop an observations and monitoring regional working group focused on identifying the Midwest needs,

[11] https://www.britannica.com/science/in-situ-measurement

gaps, and opportunities for in situ observations. This regional working group will conduct a comprehensive assessment for observational monitoring in the Midwest to determine what in situ observations currently exist, what entities provide these observations, what tools and resources are available to show and/or integrate this data, and what needs/gaps still exist for the region. In two years, this working group will develop a framework for improving observational monitoring in the Midwest region, emphasizing what is still needed and what the roadmap will look like to fill these needs. Having a comprehensive needs assessment and framework for improving observational monitoring in the Midwest will help drive investments in the future. Partners to help NIDIS carry this activity forward include NDMC, NCEI, USGS, USDA Midwest Climate Hub, NWS, state agencies, and other Midwest DEWS partners.

Activity 2.5 Outcomes

- A framework for improving observational monitoring (e.g., soil moisture, groundwater, streamflow) in the Midwest region, emphasizing what is still needed and what the roadmap will look like to fill these needs. [Q3 2018 - Q4 2019]

Priority 3 – Improve Drought Early Warning and Communication Capacity

The Midwest DEWS serves as a centralized communication hub that provides regional information for drought monitoring and outlooks, impacts of drought, integrated research, and drought activities and resources, which is currently provided primarily through drought.gov, webinars, workshops, and briefings. Moving forward, it is important for the Midwest DEWS to establish additional modes of stakeholder communication in order to provide early warning for drought, as well as during and after drought events, which is when increased communication and outreach to stakeholders is paramount. The activities in this priority are focused on establishing and/or maintaining regular modes of communication, tailoring drought.gov portal content to the Midwest, developing a regional drought condition notification system, and engaging with key networks to improve outreach to communities and the general public.

Activity 3.1 Establish Midwest DEWS Communication Working Group

NIDIS and the MRCC will establish a Midwest DEWS Communication Working Group, which will include representatives from multiple states, sectors, and government/tribal/private/academic entities, focusing on those with communication and/or outreach experience like communication coordinators or Land Grant Extension specialists.

The goal of this working group will be to determine and establish new modes of communication to the broader Midwest DEWS network, which might include an electronic newsletter, an email listserv, communication platform for internal group communication, regional water summary updates (modeled after the Iowa Water Summary), and social media. The content will be determined by the working group, but ideas may include communicating the drought conditions and outlooks, best management practices for drought mitigation and response, and/or information on drought data and resources. In addition, this working group will provide additional capacity for the existing modes of communication and outreach to stakeholders (i.e., Activity 3.3 - monthly webinars and quarterly briefings). To decide what new modes of communication will be developed, the MRCC will host a Midwest DEWS Communication Working Group meeting in summer 2018 to discuss options and implementation plans.

Activity 3.1 Outcomes

- Identify the Midwest DEWS Communication Working Group. [Q1 2018]

- Host a Midwest DEWS Communication Working Group meeting, in collaboration with the MRCC. [Q2 2018 - Q3 2018]
- Develop and sustain new mode(s) of communication, based on the findings from the Communication Working Group workshop. [Q4 2018 - Q4 2019]

Activity 3.2 Update and Maintain the Midwest DEWS Information on the U.S. Drought Portal

NIDIS will work with its partners to update and maintain the Midwest DEWS pages on the U.S. Drought Portal. These pages provide up-to-date information on climate news and DEWS activities (e.g. workshop dates and summaries, research, outreach activities, applicable links to climate data, etc.). Additional information will continue to be added, such as innovative studies, drought vulnerability assessments, BMPs, success stories, and lessons learned for drought management.

The Midwest DEWS Communication Working Group will take the lead in brainstorming ideas for improving the Midwest DEWS content on the Portal. The NIDIS Communications Team will help facilitate this discussion, as well as provide expertise and Google Analytics to inform the discussion. Suggested improvements may include a selection of climate tools especially useful for the Midwest, content organized by sector, providing a platform for internal Midwest DEWS communication (e.g., online forum), and more specific content on Midwest DEWS activities in the region. Site content will be updated based on stakeholder feedback. Partners to help NIDIS carry out this activity may include NCEI, NDMC, MRCC, USDA Midwest Climate Hub, state climatologists in the Midwest, and other Midwest DEWS stakeholders.

Activity 3.2 Outcomes

- Recommendations on how to improve the Midwest DEWS content on drought.gov based on feedback from the Midwest DEWS Communication Working Group. [Q3 2018 – Q4 2018]
- Initial content update to the Midwest DEWS section on the U.S. Drought Portal based on recommendations, and routine monthly and/or quarterly updates as needed thereafter. [Q4 2018 – Q4 2019]

Activity 3.3 Provide Climate and Drought Outlooks and Webinars

NOAA, in collaboration with NCEI, NIDIS, MRCC, the American Association of State Climatologists (AASC) and many other climate providers, produce and distribute a Quarterly Climate Impacts and Outlook 2-page report for the Midwest region. These reports have been distributed since March 2013 and are posted on the U.S. Drought Portal and MRCC's website. They provide information on recent (last three months) temperature and precipitation anomalies, regional impacts, and a regional climate outlook for the next three months. They are created for decision makers who want to be informed of recent climate trends and impacts in their particular region, thus they are of a non-technical nature. If conditions warrant, authors may create supplementary documents to focus on other key areas (e.g., Upper Mississippi Basin) or climate events (e.g., El Niño).

In addition, NOAA along with NCEI, AASC, NDMC, NIDIS, USDA, MRCC, and the High Plains Regional Climate Center (HPRCC) provide monthly North Central U.S. Climate Summary and Outlook Webinars which are archived on MRCC and HPRCC websites, as well as the U.S. Drought Portal[12]. These webinars interpret relatively complex climate information at various scales to a non-technical audience, encouraging discussion and

[12] The frequency in which these webinars are provided may increase as climate conditions warrant.

questions from a cross section of governmental, academic, and private attendees. They were initiated in July 2012 and, as of the end of 2017, have received over 5,500 viewers.

The NDMC, MRCC, and NOAA Central Region Climate Services Director conducted an assessment in Spring 2017 of the Midwest Quarterly Climate Impacts and Outlook reports and the North Central U.S. Climate Summary and Outlook Webinar[13]. The assessment surveyed recipients of the Outlooks and webinar participants to identify how the information is being shared locally, how recipients are using the information, and additional needs for information[14]. Results revealed that 75% of users get information they can't find anywhere else from the reports and webinars, and 30% of users make decisions with the information on topics like emergency response planning, insurance and marketing decisions, and state drought declarations. Assessments of the outlook reports and webinars will be conducted every three years[15].

Activity 3.3 Outcomes

- Midwest Quarterly Climate Impacts and Outlook reports provided in March, June, September and December. [Q1 2018 – Q4 2019]
- Climate Summary and Outlook Webinars provided the third Thursday of each month. [Q1 2018 – Q4 2019]

Activity 3.4 Response Activities During Drought Events

During times of drought and other drought-related climate events (e.g., high precipitation events that lessen the impacts of drought), increased drought and climate communication and outreach to stakeholders is necessary. NIDIS will take the lead with key partners like NCEI, USDA Midwest Climate Hub, and the MRCC to initiate a Midwest DEWS stakeholder group discussion to investigate the need for additional information, data, resources and outreach at the onset, during, and after drought events. If needed, NIDIS and its partners will implement additional communication strategies and activities to address stakeholder needs and concerns[16]. Such strategies may include special webinars, presentations, listserv emails, hosting *Managing Drought Risk on the Ranch* workshops, new information on the U.S. Drought Portal and social media. In addition, NIDIS and Midwest DEWS stakeholders will conduct post-drought assessments as needed. Partners to help NIDIS carry out this activity may include NCEI, USDA Midwest Climate Hub, MRCC, state climatologists, state agencies, and other key representatives of federal, state, local governmental and non-governmental community.

Activity 3.4 Outcomes

- Additional drought information, data, resources and outreach efforts will be provided by NIDIS and its partners during times of drought to the Midwest DEWS stakeholders. [Q1 2018 – Q4 2019]

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[13] This assessment was also conducted for Outlook Briefings provided for the Missouri River Basin and Great Lakes regions, which border the Midwest DEWS region.

[14] Infographic available on results here: http://mrcc.isws.illinois.edu/pubs/docs/ClimateSummarySurvey.pdf

[15] Therefore, the next assessment will be conducted in Spring 2020.

[16] For instance, NIDIS collaborated with the Mississippi River Cities and Towns Initiative (MRCTI) in June of 2016 when there was heightened concern of potential dry conditions occurring during the summer. NIDIS in collaboration with NCEI provided an outlook on upcoming Midwest climate conditions to MRCTI. This is a partnership that NIDIS will continue to foster as the DEWS is developed.

Activity 3.5 Develop Regional Drought Condition Notification System

Workshop participants at the Fall 2016 Regional Assessment Workshops identified that developing a drought notification system, where stakeholders could sign up to directly receive drought and other climate information, would be an effective way to increase drought early warning across the region. The user could customize information preferences (e.g., "when local precipitation has been less than 25% of normal over the last two weeks") and platform (e.g., text message, email). The MRCC will lead the development of such notification system in partnership with NIDIS and key stakeholders who have expressed interest in this system (e.g., state climatologists in Missouri, Illinois, and Ohio), and NIDIS will lead efforts with the MRCC to beta test it through the Midwest DEWS network.

Activity 3.5 Outcomes

- MRCC will develop the prototype for the user-customized drought notification system, and work with NIDIS to beta test it through the Midwest DEWS network. [Q1 2018 – Q3 2018]
- Integrate the final user-customized drought notification system into the Midwest DEWS. [Q4 2018 – Q4 2019]

Activity 3.6 Engage with Existing Disaster Networks

Drought is one of the many disasters that this country faces. There are organizations in place to help citizens of the United States before and after disasters, including the National Voluntary Organizations Active in Disaster (VOAD) and the Extension Disaster Education Network (EDEN). National VOAD, an association of organizations that mitigate and alleviate the impact of disasters, provides a forum promoting cooperation, communication, coordination, and collaboration; and fosters more effective delivery of services to communities affected by disaster. EDEN is a collaborative multi-state effort by Cooperative Extension Services and the USDA's National Institute of Food and Agriculture (NIFA) to improve the delivery of services to citizens affected by disasters across the country. EDEN's mission is to reduce the impact of disasters through research-based education. By engaging with state VOADs and EDEN programs in the Midwest, as well as EDEN's national Drought Task Force, the Midwest DEWS can increase communication and outreach to local communities and the general public.

For this activity, NIDIS and its key partners will work to establish and foster relationships with VOAD and EDEN, and explore how the Midwest DEWS could strengthen their networks (e.g., providing training on drought, leveraging resources), and vice versa. Also, the end goal of these expanded partnerships would be to provide additional drought early warning information to communities and the general public through these existing disaster networks.

Activity 3.6 Outcomes

- NIDIS will develop a list of contacts for the state VOAD and EDEN programs in the Midwest. [Q3 2018]
- A framework on how to provide drought early warning to communities and the general public through the VOAD and EDEN state organizations in the Midwest will be determined and implemented. [Q4 2018 – Q4 2019]

Activity 3.7 Develop a Network of Broadcast Meteorologists

Broadcast meteorologists and other journalists provide one of the most direct connections for delivering weather information to the general public. Therefore, this an important group to engage with on providing accurate and consistent messaging for drought. NIDIS, along with key stakeholders like the NWS, will develop a

network of broadcast meteorologists and other journalists in the Midwest in order to better understand their needs for drought messaging, and suggest ways to most accurately message drought, its impacts, and related predictions. One way to accomplish this would be to engage through the NWS-hosted "Integrated Warning Team" meetings around the country, which gathers the media, storm spotters, and emergency managers on weather-related topics. In addition, social media will be utilized to engage and build a network of broadcast meteorologists in the region.

Activity 3.7 Outcomes

- NIDIS will develop a network of broadcast meteorologists for the Midwest DEWS through partnerships with NWS local offices and social media. [Q2 2018 – Q4 2018]
- NWS offices in at least two Midwest states will incorporate NIDIS into their trainings for broadcast meteorologists and will gather feedback on their needs for drought messaging and resources. [Q1 2019 – Q4 2019]

Activity 3.8 Provide Drought Communication Support for NWS Weather Forecast Offices

The local Weather Forecast Offices (WFO) of the NWS provide a direct connection to the general public for drought early warning, and as a federal partner, local WFOs are an integral part of the Midwest DEWS. This activity will focus on ensuring that the drought/climate focal point at all the WFOs throughout the eight Midwest states are engaged with the Midwest DEWS network and activities. In addition, NIDIS will provide opportunities for local WFOs to enhance their drought early warning capability through workshops or other means.

Activity 3.8 Outcomes

- NIDIS will ensure all WFOs in the Midwest are engaged with the Midwest DEWS, and provide workshops or added capacity for drought early warning as needed. [Q2 2018 – Q4 2019]

Priority 4 – Foster Stakeholder Collaboration, Coordination and Relationship Building

The Midwest DEWS seeks to develop a robust and active network of partners including federal, state, and local agencies, tribal entities, non-governmental organizations, and industries across a variety of sectors dedicated to building drought early warning capacity and long-term resilience in a coordinated manner. The following activities focus on increasing interagency collaboration, coordination, and information transfer in the Midwest DEWS.

Activity 4.1 Increase Federal Interagency Coordination on Drought

NIDIS will establish and/or strengthen partnerships with federal agencies in the Midwest and provide a platform for increased federal interagency coordination on drought through conference calls and/or working groups. The goal of this activity is to explore enhanced partnership and collaboration opportunities to further develop and implement the Midwest DEWS. This activity will produce more active participation in the Midwest DEWS from federal partners in the region, which will further carry out the interagency mandate in the NIDIS Public Law. The information gathered and potential opportunities identified in this activity will be incorporated into and strengthen the outcomes and deliverables of many of the activities below.

Participants may include, NOAA line offices (such as the NWS and NCEI), USACE, FEMA, USDA, Bureau of Indian Affairs (BIA), USGS, U.S. National Park Service (NPS), U.S. Forest Service (USFS), Natural Resources Conservation

Service (NRCS), Environmental Protection Agency (EPA), U.S. Fish and Wildlife Service (USFWS), Centers for Disease Control (CDC), and other interested and relevant federal agencies.

Activity 4.1 Outcomes

- Identify federal points of contact in the Midwest [Q1 2018 - Q2 2018].
- Federal partners will determine best method for establishing regular lines of communication for Midwest federal coordination (e.g., working groups, email listserv, conference calls), leveraging other federal coordination networks in the region, and NIDIS will provide this platform. [Q4 2018 - Q4 2019]

Activity 4.2 Increase Collaboration on Drought-Related Activities in the Midwest

Partner agencies and organizations at the federal, tribal, state, and local levels are actively engaged in a variety of drought-related activities. In an effort to improve awareness and collaboration among these stakeholders, and to avoid the duplication of efforts, NIDIS will develop a matrix that utilizes the regional network to document current drought activities and resources in the Midwest. The matrix will also help identify sectors and communities that are lacking attention and highlight potential opportunities to leverage resources. In addition, the matrix will help delineate activities within the various federal climate entities in the region (i.e., USDA Midwest Climate Hub, MRCC, USGS Northeast Climate Science Center (CSC), Upper Midwest and Great Lakes Landscape Conservation Cooperative (LCC), Eastern Tallgrass Prairie and Big Rivers LCC, and GLISA to leverage each other's programs and avoid duplication.

NIDIS will develop a template matrix and circulate among Midwest DEWS stakeholders to collect information on existing and planned drought-related activities. Information collected will include: project or resource information, lead agency/organization, funding, associated timelines, and primary contact(s). The completed matrix will be converted into an interactive GIS format and made available on drought.gov, so that stakeholders can visually see where the projects are happening throughout the region. The matrix will be reviewed at least twice a year, and the GIS map will be updated as needed. This matrix will help identify priorities for the Midwest DEWS region.

Activity 4.2 Outcomes

- First version of matrix and interactive GIS map completed and posted to the U.S. Drought Portal. [Q3 2018]
- Review the matrix at least twice a year with input from Midwest DEWS stakeholders and update the GIS map as needed. [Q4 2018 – Q4 2019]

Activity 4.3 Increase Engagement to Key Economic Sectors in the Midwest

NIDIS and its Midwest DEWS partners recognize that increasing engagement with stakeholders in key economic sectors in the Midwest will advance the understanding of drought management needs, as well as identify potential partnership opportunities to help these stakeholders manage their sector's risk to drought. Sectors important to the Midwest's economy that are vulnerable to drought include agriculture, energy, navigation/transportation, public health, municipal/local government, and recreation/tourism. Several of these key sectors are currently underrepresented in the Midwest DEWS network. This activity initially focuses on the

development and implementation of a coordinated outreach strategy for engaging with the public health[17], navigation/transportation, and energy sectors in the Midwest.

Engagement with these stakeholders may include fostering relationships with key sector representatives and including them in Midwest DEWS activities, conducting interviews with representatives from the key economic sectors, hosting sector-specific drought forums, developing sector-specific decision calendars for drought, starting sector-specific working groups, and sponsoring and/or presenting at sector-specific events. Partners to help NIDIS carry out this activity may include USACE, NWS, MRCTI, MRCC, Upper Mississippi River Basin Association (UMRBA), CDC, USDA Midwest Climate Hub, U.S. Department of Energy (DoE), and other Midwest DEWS stakeholders, including commodity groups.

Activity 4.3 Outcomes

- A coordinated outreach strategy for the public health, navigation/transportation, and energy sectors. This strategy will identify actions, partners involved, roles, timelines and a means of documenting coordinated efforts. [Q3 2018 - Q4 2018]
- Implementation of coordinated strategy. [Q1 2019 - Q4 2019]

Activity 4.4 Enhance Drought Early Warning Capacity for Midwest Tribes

Tribal nations and other entities (e.g., BIA, tribal alliances) are important stakeholders for the Midwest DEWS network. It will be critical to establish relationships with these stakeholders in order to ensure that they are receiving the data, resources, and early warning they need to make decisions regarding drought. In this activity, NIDIS and its partners will attend a Midwest-based tribal conference(s) to begin gathering and establishing tribal contacts in the region. Through conversations and/or a conference exhibit booth, an informal needs assessment will gather more information on the drought and climate concerns of tribal entities in the Midwest, as well as what resources or information is needed to make decisions regarding drought. The findings of this informal needs assessment will guide future tribal work in the Midwest DEWS (e.g., training workshops, resource development, focus groups, etc.). Partners to help NIDIS carry out this activity include NDMC, other NOAA entities, BIA, Northeast CSC, NWS, and other Midwest DEWS stakeholders with tribal connections or interests.

Activity 4.4 Outcomes

- Attend Midwest-based tribal conference. [Q3 2018 - Q4 2018]
- A report of the informal needs assessment findings, highlighting the drought and climate concerns and needs of Midwest tribes, and a strategy on how to provide those needs moving forward. [Q4 2018]

[17] A NIDIS-NDMC led expert group including CDC, NOAA's Cooperative Institute for Climate and Satellites at NC State University and NCEI is actively engaged in addressing how drought impacts the health sector at a national level. Activities include a conducting a series of interviews to identify gaps and barriers in drought preparedness in the health sector, providing updates to the CDC Drought Resource Guide, and conducting assessments of public emergency responses related to drought. Midwest DEWS efforts to reach out to the health sector will be coordinated with this national effort.

Activity 4.5 Develop an Interactive Platform for Midwest DEWS Stakeholders

NIDIS will create a comprehensive database of stakeholders in the Midwest DEWS region. By collaborating with the MRCC, this reference database will be made accessible to the Midwest DEWS stakeholders to aid in streamlined communication across Midwest DEWS partner networks. The online database will be comprised of queryable fields such as sector, organization, and location. In addition, the MRCC will develop an interactive GIS map with the database information, which will also be available to the Midwest DEWS network.

Activity 4.5 Outcomes

- Consolidation of existing contact lists to create a master Midwest DEWS stakeholder database. [Q1 2018]
- Online database and interactive GIS map of Midwest DEWS stakeholders, in collaboration with the MRCC. [Q2 2018 – Q4 2018]

Activity 4.6 Quarterly Key Stakeholder Calls to Coordinate Midwest DEWS Activities

The Midwest DEWS collaborative network consists of a diverse group of federal, state, local, tribal, and academic partners. On a quarterly basis, a conference call will be held to bring together a broad spectrum of stakeholders in the region and discuss progress and updates to the DEWS Strategic Plan, regional activities, and identify opportunities to leverage resources.

Activity 4.6 Outcomes

- Quarterly calls with key stakeholders, highlighting key actions and opportunities. [Ongoing, Q3 2018 – Q4 2019]

Activity 4.7 Host Annual Midwest DEWS Regional Forum

Although the states in the Midwest have unique DEWS needs, the region as a whole benefits from improved collaboration and information sharing among the network. To this end, the next major stakeholder meeting for the Midwest DEWS will be held in May 2018 for the purpose of establishing a communications working group and creating a plan for information sharing. Following this, NIDIS and the Midwest DEWS key stakeholders will host an annual Midwest DEWS Regional Workshop, the first of which will occur in 2019. The meetings will rotate location between the Mississippi River Basin and the Ohio River Basin, and could piggyback off of other regional meetings.

The focus of the annual regional workshops will be guided by the Midwest DEWS key partners. The goals of this forum may be to share innovative research, including advancements in seasonal to sub-seasonal forecasting capabilities, status of national efforts like soil moisture monitoring, sharing and discussing best management practices and response coordination for drought, providing training on available data or resources, sharing information on Midwest DEWS activities, exploring new partnerships for drought resilience activities in the region, and collecting regional drought impacts and vulnerabilities.

Activity 4.7 Outcomes

- Host annual Midwest DEWS Regional Workshop with key NIDIS partners. [Q4 2018 - Q4 2019]
- Meeting report shared with participants, highlighting key themes and actions from each meeting. [Q4 2018 - Q4 2019]

Appendix A – Schedule

Q1: Jan, Feb, Mar | **Q2:** Apr, May, Jun | **Q3:** Jul, Aug, Sep | **Q4:** Oct, Nov, Dec

Activity	Start Date	End Date
Priority 1 – Integrate Impacts, Data, Management Practices, and Research into Drought Planning		
Activity 1.1 Improving Collection and Reporting of Drought Impacts	Q3 2018	Q1 2019
Activity 1.2 Correlate and Validate Regional Sector Drought Impacts to USDM Classification System	Q2 2018	Q4 2019
Activity 1.3 Develop Midwest-Specific Repository of Drought Management Actions	Q3 2018	Q3 2019
Activity 1.4 Develop Strategy to Support Drought Vulnerability Assessments	Q2 2018	Q4 2019
Priority 2 – Enhance Drought Observations and Data Availability		
Activity 2.1 Leverage Existing Citizen Science Monitoring Programs	Q4 2018	Q3 2019
Activity 2.2 Enhance and Promote Web Service Interface for Sub-Daily Climate Data	Q2 2018	Q4 2018
Activity 2.3 Foster Development of the Regional Mesonet Program	Q2 2018	Q4 2019
Activity 2.4 Advance the Kentucky DEWS	Q2 2018	Q4 2019
Activity 2.5 Explore Partnership Opportunities to Increase Observational Monitoring	Q3 2018	Q4 2019
Priority 3 – Improve Drought Early Warning Outreach and Communication Capacity		
Activity 3.1 Establish Midwest DEWS Communication Working Group	Q1 2018	Q4 2019
Activity 3.2 Update and Maintain the Midwest DEWS Information on the U.S. Drought Portal	Q3 2018	Q4 2019
Activity 3.3 Provide Climate and Drought Outlooks and Webinars	Q1 2018	Q4 2019
Activity 3.4 Response Activities During Drought Events	Q1 2018	Q4 2019

Activity	Start Date	End Date
Activity 3.5 Develop Regional Drought Condition Notification System	Q1 2018	Q4 2019
Activity 3.6 Engage with Existing Disaster Networks	Q3 2018	Q4 2019
Activity 3.7 Develop a Network of Broadcast Meteorologists	Q2 2018	Q4 2019
Activity 3.8 Provide Drought Communication Support for NWS Weather Forecast Offices	Q2 2018	Q4 2019
Priority 4 – Foster Stakeholder Collaboration, Coordination and Relationship Building		
Activity 4.1 Increase Federal Interagency Coordination on Drought	Q1 2018	Q4 2019
Activity 4.2 Increase Collaboration on Drought-Related Activities in the Midwest	Q3 2018	Q4 2019
Activity 4.3 Increase Engagement to Key Economic Sectors in the Midwest	Q3 2018	Q4 2019
Activity 4.4 Enhance Drought Early Warning Capacity for Midwest Tribes	Q3 2018	Q4 2018
Activity 4.5 Develop an Interactive Platform for Midwest DEWS Stakeholders	Q1 2018	Q4 2018
Activity 4.6 Quarterly Key Stakeholder Calls to Coordinate Midwest DEWS Activities	Q3 2018	Q4 2019
Activity 4.7 Host Annual Midwest DEWS Regional Forum	Q4 2018	Q4 2019

Appendix B – References

National Integrated Drought Information System (NIDIS). January 2016. Midwest DEWS Two-Page Summary – "Collaborating for resilience."

NIDIS et al. April 2016. *Synopsis of the Midwest DEWS Kickoff Meeting February 2016 – St. Louis, MO.*

NIDIS. February 2016. *The Midwest Drought Early Warning System (DEWS) Planning Process, Launch and Next Steps.* Presentation at the Midwest DEWS Kickoff Meeting.

NIDIS et al. December 2016. Missouri River Basin DEWS Strategic Plan.

NIDIS et al. January 2018. *Midwest DEWS 2016 Regional Assessment Workshops Report*.

Public Law 109-430. National Integrated Drought Information System Act of 2006.

Public Law 113-86. National Integrated Drought Information System Reauthorization Act of 2014.

Appendix C – Midwest DEWS Partners in Development of the Strategic Plan

The development of this Midwest DEWS 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 are formed.

Table A – Partner Agencies and Organizations

Partner Agencies and Organizations
Kentucky Climate Center
Mississippi River Cities and Towns Initiative
National Drought Mitigation Center
National Resource Conservation Service
National Oceanic and Atmospheric Administration *Midwestern Regional Climate Center* *National Weather Service* *National Center for Environmental Information*
State Climatologist Office for Illinois
University Missouri Extension
Upper Mississippi River Basin Association
U.S. Army Corps of Engineers
U.S. Department of Agriculture *Midwest Climate Hub*

Appendix D – NIDIS Working Groups

Coordination, communication, and transferability of information and actions between the NIDIS Working Groups and the Midwest DEWS is essential the overall process of building a collaborative information system. The table below highlights how each of the priority activities in the Plan correspond with the individual Working Groups. As the Midwest DEWS and Working Groups continue to develop, activities among each of these groups will be leveraged and coordinated.

Table B - Midwest DEWS and NIDIS Working Groups

Activity	Education and Public Awareness	Monitoring and Observations	Predictions and Forecasting	Interdisciplinary Research Applications for Risk Assessment	Planning & Preparedness	U.S. Drought Portal
Priority 1 – Integrate Impacts, Data, Management Practices, and Research into Drought Planning						
Activity 1.1 Improving Collection and Reporting of Drought Impacts		X			X	
Activity 1.2 Correlate and Validate Regional Sector Drought Impacts to USDM Classification System	X	X			X	
Activity 1.3 Develop Midwest-Specific Repository of Drought Management Actions				X	X	
Activity 1.4 Develop Strategy to Support Drought Vulnerability Assessments				X	X	
Priority 2 – Enhance Drought Observations and Data Availability						
Activity 2.1 Leverage Existing Citizen Science Monitoring Programs		X			X	

Activity	Education and Public Awareness	Monitoring and Observations	Predictions and Forecasting	Interdisciplinary Research Applications for Risk Assessment	Planning & Preparedness	U.S. Drought Portal
Activity 2.3 Foster Development of the Regional Mesonet Program		X	X		X	
Activity 2.4 Advance the Kentucky DEWS		X			X	
Activity 2.5 Explore Partnership Opportunities to Increase Observational Monitoring		X			X	
Priority 3 – Improve Drought Early Warning Outreach and Communication Capacity						
Activity 3.1 Establish Midwest DEWS Communication Working Group	X				X	
Activity 3.2 Update and Maintain the Midwest DEWS Information on the U.S. Drought Portal						X
Activity 3.3 Provide Climate and Drought Outlooks and Webinars	X	X	X		X	X
Activity 3.4 Response Activities During Drought Events	X	X	X		X	X
Activity 3.5 Develop Regional Drought Condition Notification System	X	X			X	
Activity 3.6 Engage with Existing Disaster Networks	X					

Activity	Education and Public Awareness	Monitoring and Observations	Predictions and Forecasting	Interdisciplinary Research Applications for Risk Assessment	Planning & Preparedness	U.S. Drought Portal
Activity 3.7 Develop a Network of Broadcast Meteorologists	X					
Activity 3.8 Provide Drought Communication Support for NWS Weather Forecast Offices	X					
Priority 4 – Foster Stakeholder Collaboration, Coordination and Relationship Building						
Activity 4.1 Increase Federal Interagency Coordination on Drought					X	
Activity 4.2 Increase Collaboration on Drought-Related Activities in the Midwest	X			X	X	X
Activity 4.3 Increase Engagement to Key Economic Sectors in the Midwest					X	
Activity 4.4 Enhance Drought Early Warning Capacity for Midwest Tribes					X	
Activity 4.5 Develop an Interactive Platform for Midwest DEWS Stakeholders						
Activity 4.6 Quarterly Key Stakeholder Calls to Coordinate Midwest DEWS Activities		X	X	X	X	
Activity 4.7 Host Annual Midwest DEWS Regional Forum	X				X	

Appendix E – Acronyms

AASC - Association of State Climatologists
BMPs - Best Management Practices
CDC - Centers for Disease Control and Prevention
CSC - Climate Science Centers
CoCoRaHS - Community Collaborative Rain, Hail & Snow Network
DEWS - Drought Early Warning System
EDEN - Extension Disaster Education Network
EPA - Environmental Protection Agency
FEMA - Federal Emergency Management Agency
MRCC - Midwestern Regional Climate Center
MRCTI - Mississippi River Cities and Towns Initiative
NCEI - National Centers for Environmental Information
NDMC - National Drought Mitigation Center
NIDIS - National Integrated Drought Information System
NOAA - National Oceanic Atmospheric Administration
NPS - United States National Park Service
NWS - National Weather Service
RCCs - Regional Climate Centers
RMP - Regional Mesonet Program
SCIPP - Southern Climate Impact Planning Program
U.S. - United States
USACE - United States Army Corps of Engineers
USDA - United States Department of Agriculture
USFWS - United States Fish and Wildlife Service
USGS - United States Geological Survey
WRCC - Western Regional Climate Center