THE NATIONAL INTEGRATED DROUGHT INFORMATION SYSTEM

IMPLEMENTATION PLAN

DECEMBER 2016 UPDATE

FOREWORD

Tremendous progress has been made since the National Integrated Drought Information System (NIDIS) was established by Congress in December 2006. Over the course of 10 years, NIDIS has developed a national interagency and interstate implementation team; launched a national web-based drought portal, providing comprehensive, national, regional, and local information on emerging and ongoing drought conditions; helped to tailor climate forecasts and decision-support tools to watersheds and local scales; and fostered collaborative work among federal agencies, tribes, states, and local governments to leverage existing observation and monitoring systems and help communities cope with the impacts of drought.

These achievements could not have been realized without the vital help of NIDIS's partners at all levels of government, academia, and the private sector. By working together with the U.S. Department of Agriculture to better monitor soil moisture through the National Soil Moisture Monitoring Network, supporting drought research through NOAA's Regional Integrated Sciences and Assessments (RISA) Program and its Modeling, Analysis, Predictions, and Projections (MAPP) Program, and sharing resources with regional partners like the Western Governors' Association and academic institutions such as the National Drought Mitigation Center (NDMC) at the University of Nebraska-Lincoln, NIDIS has delivered the best available data, information, and resources to promote drought planning and resilience at all scales. The strength of our diverse partnerships has helped to realize eight regional Drought Early Warning Information Systems across the country, and we continue to improve drought early warning capacity and resilience at regional and local levels.

Drought will continue to affect our communities, and any increases in its frequency and intensity will test our current strategies for managing its negative and costly impacts on local economies, ecosystems, energy resources, and public health. The need for reliable, credible, timely, relevant, and innovative data, information, and tools to manage resources during drought is as pressing as ever. New partnerships at the regional level and new opportunities for integration and collaboration are vital as we look toward building long-term drought resilience nationwide.

This updated NIDIS Implementation Plan reflects the second phase of NIDIS development and deployment as reauthorized by Congress in 2014. It details NIDIS's evolution and lessons learned in moving towards a national drought early warning information system, and reflects the thoughtful feedback and participation of NIDIS's partners. We would like to thank all of the individuals who contributed to this updated document and to the vision that it holds.

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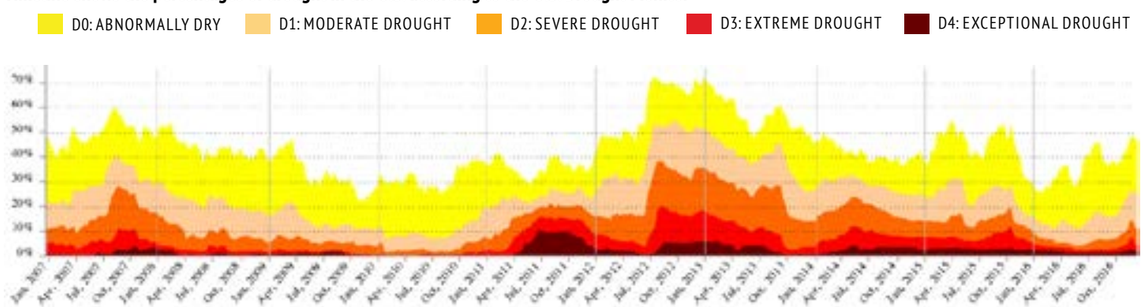
DROUGHT INTENSITY IN THE U.S., JANUARY 2007 - DECEMBER 2016

Timeline shows the percentages of drought in the U.S. according to the U.S. Drought Monitor



HTTPS://WWW.DROUGHT.GOV/DROUGHT/DROUGHT-MONITOR-GRAPHICS

INTRODUCTION

The National Integrated Drought Information System (NIDIS) Act of 2006 (P.L. 109-430) prescribed a comprehensive, interagency approach for drought monitoring, forecasting, and early warning planning and preparedness to help states and local communities cope with the impacts of drought. Over the last 10 years, intense droughts have affected almost every sector of the national economy, costing billions of dollars in primary, secondary, and tertiary impacts. These impacts underscore the importance of NIDIS's role to improve drought early warning capacity and long-term resilience throughout the nation.

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 cooordinating and integrating drought research, and building upon existing federal, tribal, state, and local partnerships.

Mission

NIDIS's mission is to improve the nation's capacity to pro-actively manage drought-related risks, by providing those affected with the best available information and resources to assess the potential for drought and to better prepare for, mitigate, and respond to the effects of drought. Toward that end, NIDIS will create a drought early warning system for the nation. NIDIS is led by the National Oceanic and Atmospheric Administration (NOAA).

Vision

The NIDIS vision is a dynamic and accessible drought information system that provides users with the ability to determine the potential impacts of drought and its associated risks, and the decision support tools needed to better prepare for and mitigate the effects of drought.

Goals

The NIDIS Public Law (P.L.109-430) states the following three goals of NIDIS's system functionality:

1. *Provide an effective drought early warning system that—*

   a. is a comprehensive system that collects and integrates information on the key indicators of drought in order to make usable, reliable, and timely drought forecasts and assessments of drought, including assessments of the severity of drought conditions and impacts;

   b. communicates drought forecasts, drought conditions, and drought impacts on an ongoing basis to

      i. decision makers at the federal, regional, State, tribal, and local levels of government;

      ii. the private sector; and

      iii. the public,

   in order to engender better informed and more timely decisions thereby leading to reduced impacts and costs; and

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Cover image: Autumn dryness on Highway 166 west of Cuyama, California, in October 2016.
PHOTO BY WILL VON DAUSTER

c. includes timely (where possible real-time) data, information, and products that reflect local, regional, and State differences in drought conditions;

2. Coordinate, and integrate as practicable, federal research in support of a drought early warning system and

3. Build upon existing forecasting and assessment programs and partnerships.

The Public Law reauthorizing NIDIS in 2014 (P.L. 113-86) further identifies the following fourth goal of NIDIS:

4. Continue ongoing research and monitoring activities related to drought, including research activities relating to length, severity, and impacts of drought and the role of extreme weather events and climate variability in drought.

In June 2007, NIDIS issued the *NIDIS Implementation Plan: A Pathway for National Resilience*, describing how an accessible and integrated drought information system would be developed, and outlining a five-year road map to meet key milestones.

This updated Implementation Plan for 2016 describes the second phase of NIDIS development and deployment, as reauthorized by Congress through the NIDIS Reauthorization Act of 2014 (Public Law 113-86). It outlines the priorities and implementation requirements for NIDIS to continue to meet its objectives. This plan will enable NIDIS to become more effective and better equipped to provide a comprehensive drought early warning system for our country.

WHAT IS A WEATHER AND CLIMATE INFORMATION SYSTEM?

A climate information system: (1) coherently organizes different types of climate information; and (2) facilitates technical assistance to help decision makers understand how to integrate climate information into their planning processes.

The term "climate information system" describes a systematic approach for coordinating the development, archiving, and use of such climate information by decision makers, with defined roles for federal agencies and nonfederal entities such as academic institutions. (GAO, 2015)

NIDIS IMPLEMENTATION ACTIVITIES

NIDIS realizes its mission of establishing a national drought early warning system through the following activities:

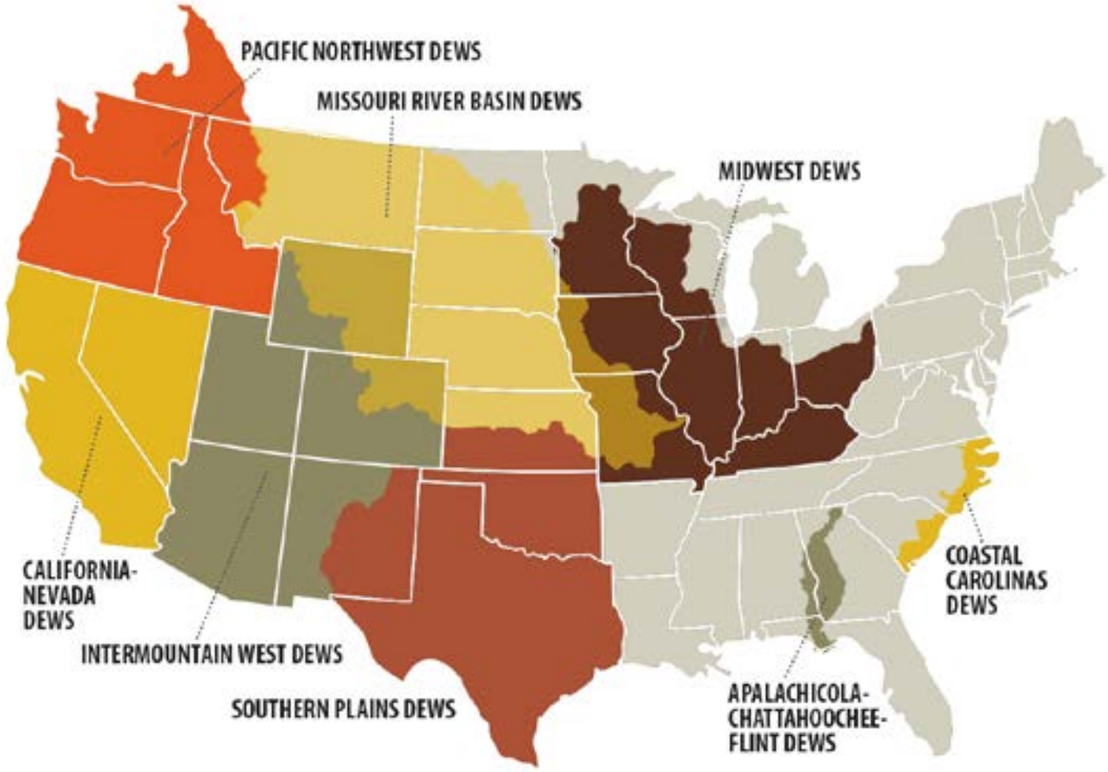
- Regional Drought Early Warning Information Systems
- Integrated Research and Monitoring
- Drought Planning and Preparedness
- Collaboration with Existing Programs and Partners
- The U.S. Drought Portal (www.drought.gov)

Regional Drought Early Warning Information Systems

NIDIS is building a nationwide drought early warning system (DEWS) to improve drought monitoring, forecasting, planning, and preparedness capabilities, and is working towards this objective incrementally through regions of the country. Drought and its impacts vary from region to region. The development and implementation of regional DEWS allows for responsiveness to particular geographic and hydrologic circumstances, as well as value-added information needs specific to stakeholders in the respective areas.

Each regional DEWS focuses on improving early warning capacity for and resilience to drought, including examining the role of extreme weather events and climate variability in drought.

REGIONAL DROUGHT EARLY WARNING SYSTEMS



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

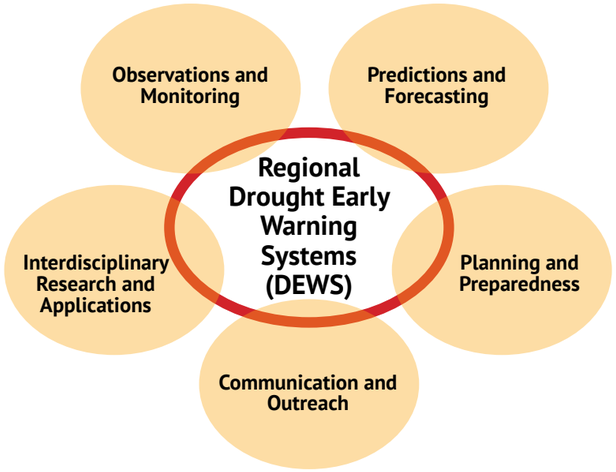
While authority lies with the states to manage water resources, NIDIS facilitates local stakeholder-driven activities including: cultivating an understanding of existing observation and monitoring networks as well as decision-support tools; identifying research, data collection, and monitoring gaps and needs; planning for and mitigating the effects of climate extremes; and conducting education and outreach through webinars, workshops, and other resources for decision makers, resource managers, the private sector, and the general public. For example:

- In the **Coastal Carolinas DEWS**, NIDIS supported research toward a Coastal Salinity Index, working with U.S. Geological Survey gages in coastal rivers to monitor drought conditions in coastal areas.

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.

KEY COMPONENTS OF NIDIS DROUGHT EARLY WARNING SYSTEMS



- As drought conditions in the Southeast persist, the **Apalachicola-Chattahoochee-Flint (ACF) DEWS** has partnered with the Auburn University Water Resources Center to offer biweekly drought assessment webinars for the Southeast, particularly the ACF River Basin.
- In 2015, the Western Water Assessment, a NOAA RISA team, partnered with the **Intermountain West DEWS** to convene a series of one-day workshops in **Colorado, Utah, and Wyoming** to help improve the usability of snowpack monitoring information for runoff forecasting, drought early warning, planning, and other applications.

NIDIS has also developed government agency-led Working Groups which contribute expertise to ensure that all relevant information and advances are brought to bear to improve the DEWS.

Thus, a DEWS is not simply the dissemination of a forecast. These systems encourage innovation by integrating new, locally relevant drought information, and supporting the introduction and testing of technologies that detect and communicate drought risks and warnings. The approaches and tools developed through these activities can often be applied from one region to the next, and help to inform the development of new regional DEWS moving forward.

To complete a national drought early warning system, NIDIS will continue to develop regional DEWS in watersheds and regions across the country, such as the Mid-Atlantic and New England areas.

Participants from more than 40 federal, state, local, and academic partners and stakeholders gathered for the Midwest DEWS kickoff meeting in St. Louis, Missouri, in February 2016. Discussions centered on improving the capacity to meet the early warning information needs of decision makers in the region.

At the same time, existing DEWS are further integrating resources and expanding partnerships. In 2016, each regional DEWS initiated a **two-year strategic planning process** to define priority actions for further implementing the DEWS, supported by a subset of DEWS stakeholders in each region who self-selected to help inform and coordinate the DEWS strategic planning process. Priority actions include: improving coordination of drought-related professional networks; increasing availability and accessibility of climate data; and supporting drought planning and vulnerability assessments, drought-related research and the usability of climate forecasts. Advancing **long-term drought resilience** efforts with new technologies and techniques, as well as a networked community of water professionals and stakeholders, are also a key growth opportunity for the DEWS.

Integrated Research and Monitoring

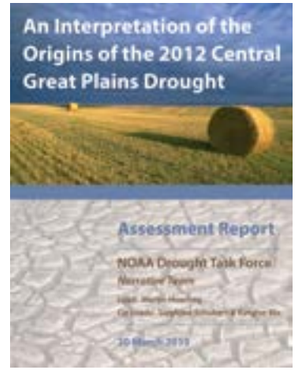
Research to better understand how droughts evolve and how they are ameliorated is critical to providing timely and reliable information, products, and services in support of early warning. In particular, improved monitoring and prediction capabilities on a variety of timescales and spatial scales are needed for water and emergency management decisions, as well as for water-dependent sectors of the economy to efficiently manage their resources. NIDIS works to ensure drought research efforts are effectively coordinated and integrated, and supports drought research objectives which focus on:

1. Advancing the understanding of the weather and climatic mechanisms that lead to drought onset, persistence, and recovery;
2. Improving forecasting by identifying sources of drought predictability across timescales and regions;
3. Translating scientific advances into metrics relevant for various societal sectors; and
4. Strengthening coordination and dissemination of information through improved delivery platforms as well as in-person drought outlook forums and webinars.

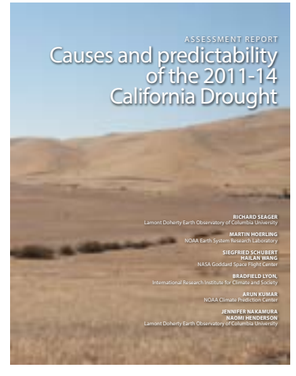
Through NOAA's Modeling, Analysis, Predictions, and Projections (MAPP) program, NIDIS supports projects to enhance the skill with which models and prediction systems can simulate drought conditions and use the resulting data to improve drought preparedness. These efforts have resulted in improvements in the U.S. Drought Monitor (USDM), NOAA Climate Prediction Center's (CPC) Drought Outlooks, and early warning capabilities. MAPP funds collaborative research grants that involve academia, NOAA, and other research laboratories, and it works extensively with the National Weather Service to ensure the sustained transition of research results into improvements of monitoring and prediction capabilities.

NOAA's Climate Program Office's *Coping with Drought in Support of NIDIS Initiative* began in 2007 as a joint Regional Integrated Sciences and Assessments (RISAs), Sectoral Applications and Research Program (SARP), and Transition of Research Applications to Climate Services effort to develop a focused decision-support research and service delivery effort to aid risk management in the context of severe, sustained drought and broader water resource management issues. NIDIS-supported grants under the *Coping with Drought* initiative help

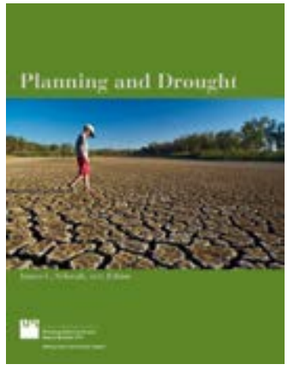
Examples of MAPP-supported work on post-drought assessments include these publications examining two of the most costly and damaging droughts in the past ten years. The reports can be found at the following links:



https://www.esrl.noaa.gov/psd/csi/factsheets/pdf/noaa-gp-drought-assessment-report.pdf



http://docs.lib.noaa.gov/noaa_documents/OAR/CPO/MAPP/california_drought_2011-2014.pdf



NIDIS and the National Drought Mitigation Center worked with the American Planning Association to create the guide, "Planning and Drought" as well as a planning advisory service in 2014, addressing the potential impacts of drought and how communities can respond.

https://www.drought.gov/drought/sites/drought.gov.drought/files/media/resources/planning/Planning%20and%20Drought%20-%20American%20Planning%20Association%20%282014%29.pdf

Nineteen Western states participated in a 2015 workshop for drought coordinators and emergency managers, a first-of-its-kind event to address best practices in managing for drought.

https://www.drought.gov/drought/sites/drought.gov.drought/files/wkshp_Western_States_Drought_Coordinators_2015_final.pdf

researchers and stakeholders who work together to provide regional briefings, outreach, and in-depth workshops on drought conditions, impacts, and forecasts. RISAs are university-based teams, supported by NOAA, that conduct research and engagement activities to help ensure their regions are prepared to cope with hazards and extreme events.

NIDIS expanded its long-term partnership with the National Drought Mitigation Center at the University of Nebraska-Lincoln, through a NOAA SARP grant, to establish the **Drought Risk Management Research Center (DRMRC).** DRMRC conducts and applies research to improve drought resilience across the U.S., helping state and local governments better prepare and plan for drought. DRMRC is developing better information delivery tools and enhanced resources for planning, in order to give regions and economic sectors increased capacity to plan, adapt, and recover in the face of drought conditions and water supply and demand stresses.

Drought Planning and Preparedness

Since the creation of NIDIS, planning for drought has significantly increased. According to the state drought plan database at NDMC, in 2007 ten states had drought mitigation plans in place, and seven states did not have drought plans at all. As of 2016, 13 states have mitigation-based plans, 32 states have response-based drought plans, and only five states are without plans. NIDIS and its partners, including the Climate Assessment for the Southwest (CLIMAS), NDMC, the Southern Climate Impacts Planning Program (SCIPP) and the High Plains Regional Climate Center, have also worked with tribal representatives in the Four Corners region of the U.S. Southwest and the Missouri River Basin to identify the drought and climate information and decision-support needs of tribal leaders to plan for extreme events. Watershed groups, county governments, and local authorities are similarly undertaking drought planning processes.

Strategies and guides for drought planning have proliferated as well, including the "Drought-Ready Communities" initiative, a two-year project sponsored by SARP. This was a collaborative effort by the NDMC, the Oklahoma Climatological Survey, the Illinois State Water Survey and State Climatologist's Office, and the Lower Platte River Corridor Alliance, resulting in the creation of a guide to community drought preparedness in 2010. NIDIS and NDMC also worked together with the American Planning Association (APA) to create a "Planning and Drought" guide for practitioners in 2014, which addresses the potential impacts of drought and explores how communities can respond, with a selection of case studies.

Moving forward, integrating technical information and assessments on climate, ecosystems, and hydrology with locally relevant watershed, state, and tribal experiences will be essential to support effective decision making in the face of drought.

There is ongoing need to address the **timeliness of and ease of access to data analyses** which can facilitate drought planning. Identification and development of temporally and spatially effective drought triggers and indicators require active engagement among information brokers as well as stakeholders in various sectors responsible for managing drought-related risks. In addition, collection and integration of drought impact information, together with monitoring data, are vital to establishing effective drought plans. Integrating all these factors – data, analyses, observation of impacts, identification of indices and trigger points for

Billion-dollar events to affect the U.S. from 1980 to 2016* (CPI-Adjusted)

DISASTER TYPE	NUMBER OF EVENTS	PERCENT FREQUENCY	CPI-ADJUSTED LOSSES *(BILLIONS OF DOLLARS)*	PERCENT OF TOTAL LOSSES	AVERAGE EVENT COST *(BILLIONS OF DOLLARS)*
Drought	23	11.5%	$220.3	19.1%	$9.6
Flooding	26	13.0%	$108.2	9.4%	$4.2
Freeze	7	3.5%	$25.3	2.2%	$3.6
Severe Storm	83	41.5%	$178.9	15.5%	$2.2
Tropical Cyclone	34	17.0%	$550.1	47.6%	$16.2
Wildfire	13	6.5%	$31.0	2.7%	$2.4
Winter Storm	14	7.0%	$41.3	3.6%	$3.0

**Statistics valid as of September 2016*

action – will improve drought preparedness, planning, and mitigation.

In 2015, NIDIS brought together for the first time lead coordinators for drought-related activities from the 19 western states represented by the Western Governors Association (WGA). State drought coordinators, emergency managers, and state climatologists from across the West discussed emerging best practices in forecasting, planning for and responding to drought, and recent lessons learned. As a result of this meeting, NIDIS hosted a first-of-its-kind, hands-on workshop in 2016 in support of the Pacific Northwest Regional DEWS. This meeting provided an opportunity for regional stakeholders to learn from experts who have successfully developed and integrated drought indicators and triggers into state drought plans to improve drought response and mitigation.

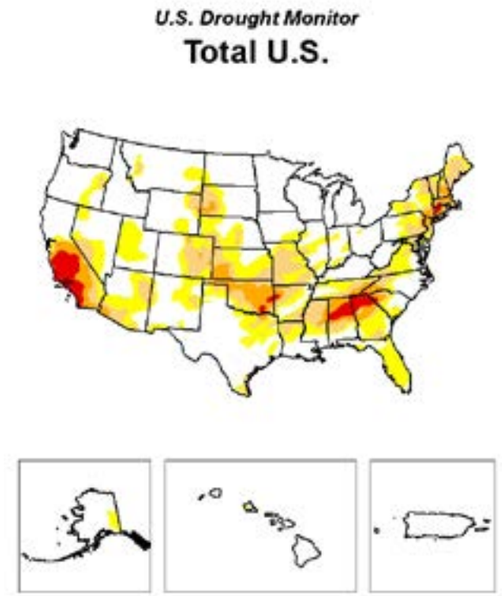
Many of the lessons learned following drought events can be documented with post-drought assessments to ensure that those critical lessons are not lost. Post-drought assessments are a key step within the drought planning process, and NIDIS has worked in the regional DEWS to support these efforts, such as a post-drought assessment after the 2012 drought in the Midwest. NIDIS is also collaborating with existing networks, like the USDA's Cooperative Extension, and working with the American Planning Association to help address and reduce urban impacts of drought.

Instruments to measure the **socio-economic impacts of droughts** have also proliferated since NIDIS was authorized, and yet challenges remain in providing a reliable, complete picture of drought impacts in economic terms. NIDIS will continue to play a role with other federal agencies in developing the global drought monitoring capability to provide information on drought in areas of economic impact and other interests for the United States.

Droughts have cost the U.S. more than $200 billion since 1980. The National Centers for Environmental Information track weather and climate disasters with impacts costing a billion dollars or more. Between 1980 and 2014, 22 droughts have qualified for the list.

NOAA NATIONAL CENTERS FOR ENVIRONMENTAL INFORMATION (NCEI) U.S. BILLION-DOLLAR WEATHER AND CLIMATE DISASTERS (2016). HTTPS://WWW.NCDC.NOAA.GOV/BILLIONS/

Federal partners in NIDIS include the Departments of Commerce, Energy, Interior, Defense and Agriculture; the Federal Emergency Management Agency; Environmental Protection Agency; and Army Corps of Engineers.



The U.S. Drought Monitor (USDM) is produced jointly by NOAA, the USDA, and NDMC. It integrates multiple data sources and derivative products from local to national scales and incorporates feedback from more than 350 experts to create a weekly map reflecting drought conditions nationwide. NIDIS contributes to the USDM by supporting its authors, supporting enhancements through the integration of new data, and by facilitating the development of state-level monitoring groups to improve the quatity and quality of minotiring data and tools going into the map.

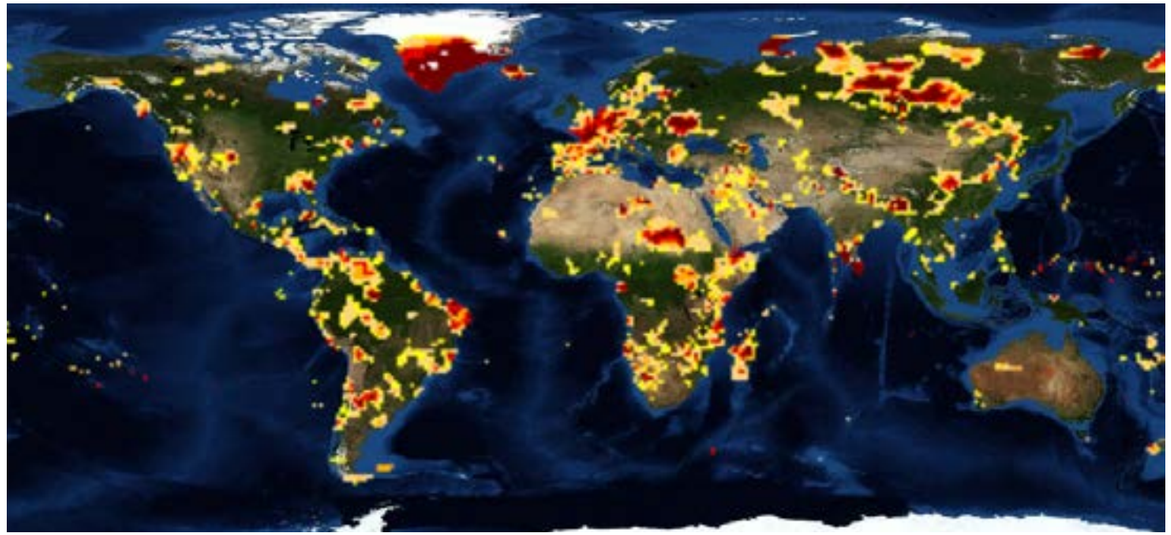
Collaboration with Existing Programs and Partners

NIDIS's ability to address drought information needs involves sustained collaboration with its partners. To achieve its integrated and interagency mission, NIDIS builds upon existing competencies, lessons from other hazards management systems, and technologies developed among agencies from the local to international level. A vivid example of this integration is the U.S. Drought Monitor, established in 1999 through an innovative effort by the U.S. Department of Agriculture (USDA), NOAA, and NDMC. This product consolidates and synthesizes data and information from hundreds of sources into a weekly map that summarizes the current status of drought in the United States. Today, more than 38,000 individuals access Drought Monitor information on a weekly basis. Other tools supported by NIDIS which focus on specific stakeholder needs and cross-scale (federal, tribal, state, local) collaboration, including the Evaporative Demand Drought Index (EDDI) and the National Soil Moisture Network, will add additional value to the Drought Monitor as they become operational.

Moving forward, NIDIS will increase engagement with a wide variety of partners to develop a national drought early warning system. Opportunities exist for greater tribal engagement and collaboration to understand tribal vulnerabilities to drought conditions, and to build tribal capacity for drought mitigation activities, including drought early warning systems. NIDIS will also continue to reach out to regional coalitions as regional DEWS expand, and to organizations representing mayors and county officials, to ensure that drought activities are coordinated across levels of government and regions.

New opportunities for collaboration and coordination have also emerged since NIDIS was first authorized. These offer the promise of heightened levels of risk management and resilience to long-term drought, including the National Drought Resilience Partnership (NDRP) which complements the aims of NIDIS, the USDA's Climate Hubs for Risk Adaptation and Mitigation to Climate Change, and the Department of the Interior's Climate Science Centers. NIDIS will continue to play a key role in ensuring greater cross-cutting efficiencies as well as coordinated activities and decision-making.

NIDIS also engages in national and international partnerships that help advance improvements in drought research, observations, and early warning. In addition to ensuring that increased understanding of the global drivers of drought (e.g. from the Pacific and Atlantic oceans) helps lead to improvements in U.S.



Global drought monitor represents an international effort to pull together the best non-prescriptive drought information from local providers and provide an "apples to apples" comparison of drought conditions around the world.

HTTPS://WWW.DROUGHT.GOV/GDM/CURRENT-CONDITIONS

drought prediction, NIDIS is being asked increasingly to assess information from parts of the world that are important for U.S. interests, such as commodities and national security. NOAA hosts the official U.S. Government Point of Contact for the World Meteorological Organization. NIDIS will continue to work with the WMO International Drought Management Program, the multi-agency Group on Earth Observations Global Drought Information System, and others, to incorporate and transfer new methods for drought research, observations, and risk reduction, and to ensure that these efforts are cognizant of and linked to NIDIS implementation priorities.

U.S. Drought Portal

The U.S. Drought Portal (www.drought.gov) was launched in 2008 as an information clearinghouse for authoritative and easily accessible drought monitoring products, per the mandate of the NIDIS Public Law. Examples of products located on the U.S. Drought Portal include the USDM, the Applied Climate Information System (ACIS, Northeast Regional Climate Center), Seasonal Drought Outlooks from the Climate Prediction Center, or CPC, the High Resolution Drought Trigger Tool (University of North Carolina), the Drought Risk Atlas (NDMC), and EDDI. The portal provides the online home of information regarding the regional DEWS, and links to research and resources for planning and preparedness, recovery, education, news about drought, regional webinars and upcoming drought-related events. Since its launch in 2008, utilization of the U.S. Drought Portal has increased 155 percent.

Over the years, the U.S. Drought Portal has undergone several iterations in response to user feedback, and as NIDIS has evolved, so have web-based tools and new social media platforms. A research team from the University of Colorado Boulder/NOAA-sponsored Cooperative Institute for Research in Environmental Sciences (CIRES) conducted usability testing on the site. NIDIS will use feedback from the testing along with Google Analytics data to help determine future development priorities on the site.

HOW DROUGHT HAS AFFECTED THE NATION SINCE THE 2006 NIDIS AUTHORIZATION

Drought is a global and recurring natural phenomenon. Over the past 10 years, intense droughts have affected almost every sector of the national economy, costing billions of dollars in impacts.

2007-2008: Severe drought in the Southeast was particularly intense in the Apalachicola-Chattahoochee-Flint (ACF) and the Alabama Coosa-Tallapoosa (ACT) River Basins, affecting water supplies for Atlanta and the surrounding region. Economic impacts in terms of lost jobs and lost revenue were estimated at more than $1 billion by the Florida Department of Agriculture and Consumer Services. A subsequent drought in 2011 contributed to devastation of the oyster fishery in Apalachicola Bay.

2008-2009, 2011 and ongoing: Droughts impact California. The drought that started in 2012 is considered the state's drought of record. The U.C. Davis Center for Watershed Sciences estimated economic impacts at more than $5 billion for 2014 and 2015 combined.

2010-2011: New Mexico, Oklahoma, and Texas experienced one of their most extreme droughts, rivaling those of the 1950s. Impacts cut across all economic sectors, particularly affecting ranchers, who resorted to cattle herd liquidations and widespread redistribution of livestock to less affected states. 2011 was the single worst drought year ever recorded for Texas. Texas AgriLife Extension Service estimated agricultural losses for 2011 alone at $5.2 billion.

2012: Extreme drought evolved rapidly and devastated parts of the Great Plains and Midwest, which experienced their worst crop yields in 25 years. According to NOAA's National Centers for Environmental Information (NCEI), impacts were estimated at $31 billion. This followed widespread flooding in 2011.

2015: Severe drought in the Pacific Northwest affected agricultural interests and contributed to an intense wildfire season.

Above: A water-efficient center pivot irrigation device stands idle in Kittitas County, Washington State, in September 2015 because the irrigation ditch is dry.

WASHINGTON DEPARTMENT OF ECOLOGY PHOTO

At left: Marooned on mud, rafts that once floated in the Don Pedro Reservoir in California lie at an angle near the boat launch in the background during the 2014 drought.

ANDREW WILLIAMS PHOTO

The NIDIS Executive Council met in October 2016 in Washington , D.C. for an update on NIDIS activities. Members include senior resource officials from NIDIS's leading federal partners as well as leaders from state and local government, academia, nongovernmental organizations, and the private sector.

IMPLEMENTING THE NEXT PHASE OF NIDIS

NIDIS's implementation strategy to realize the objectives outlined in the authorization and reauthorization language will be integrated into decision making, reflected in resource allocations, and supported by strong, active consultation with NIDIS stakeholders. Management processes will support strategic decisions at all levels; and tasks, time lines, and outcomes will be measured with regularity.

The Role of Consultation in the Development of NIDIS

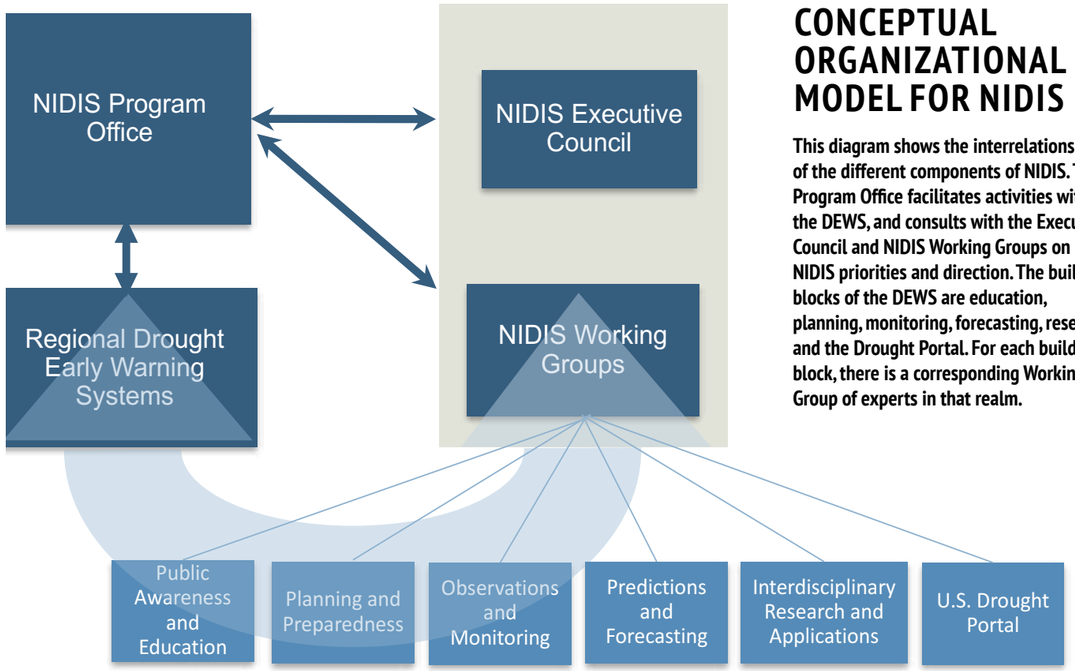
The NIDIS Public Law calls for consultation with "relevant federal, regional, state, tribal, and local government agencies, research institutions, and the private sector" in the development of NIDIS. NIDIS aims to construct and reconstitute a NIDIS Executive Council and NIDIS Working Groups around this mandate, to encourage consultation and information-sharing with a wide variety of stakeholders. This updated description of these entities replaces the description of the Executive Council and the Working Groups in the 2007 Implementation Plan.

Through the Executive Council and the Working Groups, NIDIS shares information about its current status and gathers individual feedback on NIDIS challenges and priorities, and how they relate to the organizations and agencies represented among Council and Working Group participants. NIDIS does not obtain consensus advice from the NIDIS Executive Council or the Working Groups.

Collectively, the information and individual feedback received from and shared with the Executive Council and the Working Groups supports the development of the regional DEWS.

NIDIS Executive Council

The NIDIS Executive Council provides the NIDIS Program Office with an opportunity to engage in individual consultation with senior resource officials from NIDIS's leading federal partners (such as USDA, DOI, and others) as



CONCEPTUAL ORGANIZATIONAL MODEL FOR NIDIS

This diagram shows the interrelationships of the different components of NIDIS. The Program Office facilitates activities with the DEWS, and consults with the Executive Council and NIDIS Working Groups on NIDIS priorities and direction. The building blocks of the DEWS are education, planning, monitoring, forecasting, research, and the Drought Portal. For each building block, there is a corresponding Working Group of experts in that realm.

well as leaders from state and local government, academia, nongovernmental organizations, and the private sector. That consultation includes: collaboration and information sharing in support of a national drought early warning system; encouraging the development of new partnerships that strengthen the integration of NIDIS activities across levels of government and community; and providing a forum for NIDIS to discuss policy and implementation issues, ideas, and recommendations from those engaged with NIDIS. The Council is comprised of approximately 25 members reflecting the diversity of NIDIS's partners across sectors, and includes two Co-Chairs. The NIDIS Program Office may invite the participation of additional members as appropriate.

All Council Members are asked to serve an initial term of five years, with staggered rotational participation as needed and as certain positions within organizations are rotational themselves. The Council meets bi-annually, and additionally as necessary. All Council meetings are open to the public, and are announced in advance on the Federal Register and the U.S. Drought Portal.

The Executive Director of the NIDIS Program Office is the primary party responsible for informing and engaging the Executive Council and relays information on policy and implementation issues raised in consultation with individual Council members to those involved in the regional DEWS.

NIDIS Program Office

The NIDIS Program Office (NPO) resides within the NOAA Climate Program Office, which is part of NOAA's Office of Oceanic and Atmospheric Research (OAR). The NPO is located in Boulder, Colorado and hosted by the Physical

Sciences Division in NOAA's Earth System Research Laboratory there. The NPO Executive Director is responsible for overseeing the integration and planning activities of NIDIS as well as the implementation of interagency efforts on behalf of NIDIS. He/She also directs the activities of the NPO.

The NPO provides day-to-day program coordination and counsel on NIDIS implementation activities and relevant external issues impacting NIDIS objectives; conducts outreach to promote NIDIS; facilitates communication among the Executive Council, the NIDIS Working Groups, and the DEWS; and serves as a lead facilitator to each of the regional DEWS.

The NPO also facilitates the NIDIS Working Groups, helping to coordinate deliverables, identify innovations, and communicate the activities of the Working Groups to appropriate agencies, organizations, and offices.

Operational resources for the NPO currently include:

- One (1) Senior Federal Full-Time Equivalency or Individual Personnel Action (IPA) equivalent. Working as NIDIS Executive Director;
- One (1) Mid-Level Contractor for Program Coordination/Implementation;
- Two and a half (2 ½) Mid-Level Contractors working as Regional Drought Information Coordinators;
- One (1) Mid-Level Contractor for Communications and Web Content Management;
- One (1) Mid-Level Contractor for Budget/ Contracts Management; and
- One (1) Mid-Level Federal Full-Time Equivalency working as U.S. Drought Portal Manager, who leads a staff of contractors as appropriate for Portal activities, administered through a work agreement with NOAA's National Centers for Environmental Information (NCEI) in Asheville, North Carolina.

As NIDIS continues to implement the Public Law and expand the national integrated drought early warning system model into new regions, additional staff may be added as needs dictate.

NIDIS Working Groups

Vital to the mission of NIDIS are its six Working Groups, each focused on a different component of NIDIS activities within and across 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.

Puneet Srivastava, Director of the Water Resources Center at Auburn University in Alabama, makes a point at the April 2016 NIDIS meeting in Lincoln, Nebraska, where Working Group members and other partners discussed updates to the 2007 NIDIS Implementation Plan.

Planning and Preparedness Working Group participants discuss priorities through 2020. The group focuses on increasing drought resilience through engagement, networking, and collaboration.

The Working Groups include members from multiple federal, tribal, state, and local government agencies, and from diverse areas of expertise spread across the country. Each Working Group's co-chairs organize activities around the Group's area of focus, identifying core competencies, gaps, and paths of action or intergovernmental activities as needed. Group membership is based upon expertise, level of government, geographic distribution, and program area.

General efforts of the NIDIS Working Groups are to:

- Advance the incorporation of research on drought indicators and triggers, drought impacts, and the use of drought information in adaptation and sustainability to manage water resources and mitigate impacts;
- Develop evaluation criteria and conduct post-drought assessments with relevant partners, including the research community;
- Support and provide expert input in the design of drought simulations utilized to assess risk and potential impacts under different climatological and hydrological scenarios;
- Identify guidance for successfully meeting the requirements of the NIDIS drought early warning system design
- Identify and document activities, products, resources, that are currently available and can contribute to NIDIS.

NIDIS Working Group Co-Chairs meet at least annually, with individual working groups meeting quarterly to review objectives and progress towards their goals and the integration of their efforts in the regional DEWS.

Coordination, communication, and transferability of information and actions between the NIDIS Working Groups and the DEWS is essential to the overall process of building a collaborative information system. A network of regular communication and exchange of information between these entities will be supported by the NPO to ensure meaningful engagement and effective collaboration on action items.

Through the Working Groups, NIDIS conducts ongoing knowledge assessments, engaging in individual consultation with non-governmental stakeholders including research institutions, observations and practitioner communities, and the private sector to: (1) assess major advances, gaps, and opportunities for integration in data, forecasts, communication, and information delivery; (2) identify opportunities for transferability of drought risk assessment and management innovations and tools at state and local levels: and (3) methods and approaches for advancing engagement of constituents in improving the effectiveness of NIDIS.

NIDIS Priorities for 2016-2020

This Implementation Plan identifies the following priorities, each of which is the result of consultation and information-sharing with relevant federal, tribal, regional, state, and local government agencies, research institutions, and the private sector.

- **Improve the characterization and prediction of the onset, duration, and severity of drought across a variety of timescales**
- **Assess and respond to regionally-specific drought impacts, leveraging pre-existing networks and improving coordination**
- **Explore the role of extreme weather events in drought planning and risk management, and incorporate into drought early warning systems**
- **Strengthen National, tribal, regional, state, local, and international partnerships**
- **Expand the breadth of resources and accessibility of information available on the U.S. Drought Portal**

This Plan sets forth a process and approach for attaining the above priorities for the next phase of NIDIS.

NIDIS DEVELOPMENT AND MILESTONES

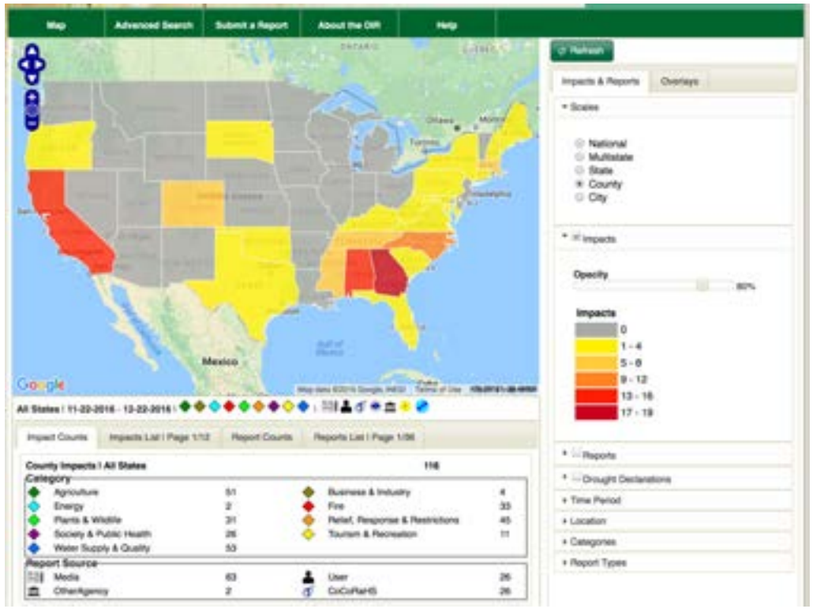
Each of the regional DEWS integrates key components of a drought early warning system (communication and outreach, planning and preparedness, observations and monitoring, predictions and forecasting, and interdisciplinary research and applications) and implements them according to regional needs and assets.

Similarly, each of the six NIDIS Working Groups pursues key elements of implementation, to help realize specific NIDIS goals. NIDIS Working Group members and partners gathered in Lincoln, Nebraska in April 2016 to revisit the 2007 NIDIS Implementation Plan and consider future milestones in light of NIDIS's evolution. The outcomes of that meeting are reflected in the following priorities, which the NIDIS Working Groups and regional DEWS share in their efforts toward building a national drought early warning system.

Wildland fire management professionals participate in an impact classification exercise during a 2015 NIDIS-sponsored workshop in Boise, Idaho.

Education and Public Awareness

Education and public awareness are essential for effective drought early warning, planning, and preparedness. NIDIS provides information on current drought conditions, forecasts, sectoral impacts, and information about the risks associated with drought conditions, and points to tools that increase individual



The National Drought Mitigation Center launched the Drought Impact Reporter in July 2005 as the nation's first comprehensive database of drought impacts.

and community capacity for minimizing the social, economic, and environmental impacts of drought. Through our partners and stakeholder, NIDIS leverages existing education and awareness programs in federal, tribal, state, watershed, and local disaster and natural resources management.

The Education and Public Awareness Working Group guides where informal education on drought can be most useful and identifies the appropriate outreach and educational mechanisms to communicate directly to communities. This Group collects stories, lessons learned, and educational resources to share through various communication mediums. This Group prioritizes consistent outreach and interaction with the DEWS to better understand their public awareness and education needs. Where possible, this Group will collaborate with the Planning and Preparedness, U.S. Drought Portal, and Interdisciplinary Research and Applications Working Groups to exchange information and coordinate related activities.

2016-2020 Priorities:

1. Collect and share case studies and educational resources.

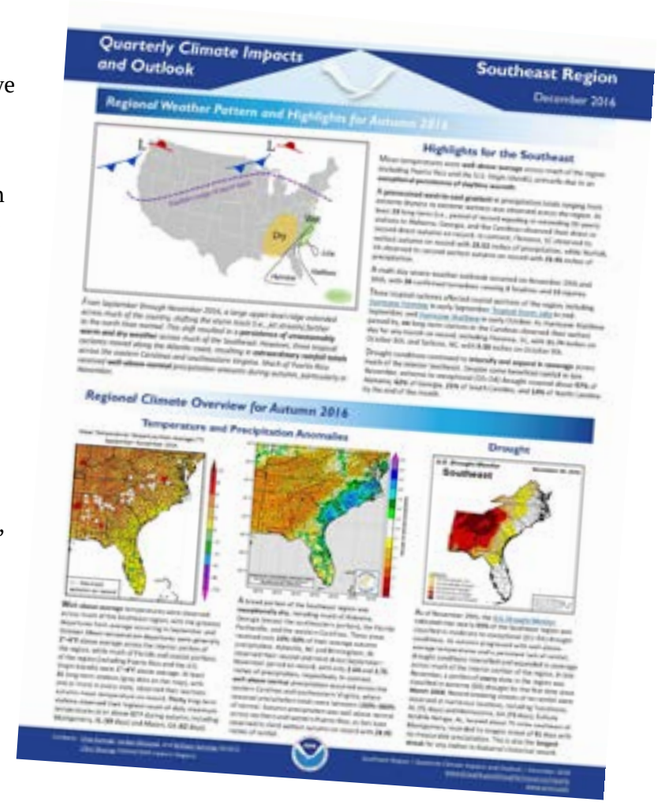
This Group will assess the current landscape of educational resources, including those that are in production or released routinely. New case studies and stories from various sources including the media will continue to be collected in the DEWS regions during drought events. Many of these resources are already collected in the Drought Impact Reporter, and will be shared with the DEWS for educational purposes and further distribution among key stakeholder groups. In addition, information resources will be identified for each of the DEWS to help communities understand how and why droughts occur, how they are monitored, and how drought impacts the human and natural systems upon which they depend. Finally, this Group will place a focus on education for under-served communities with stressed land and water resources that are particularly affected by drought, and that may be without adequate access to drought information.

2. Disseminate drought information through many vehicles to many audiences.

The U.S. Drought Portal will be the primary instrument for presenting educational stories on drought. Additional materials will be developed by this Group, for inclusion and dissemination by NIDIS in their outreach efforts, such as blogs, newsletters, two-page briefings for the media and stakeholders, brochures, regular and special webinars, short videos, as well as extensive use of social media to promote engagement with the general public. This Group will also analyze its disseminated stories and education materials to understand what is effective and actionable, in order to evaluate the communication techniques used and the reaction to them.

3. Build communities and partnerships.

This Group will help build partnerships for drought education, outreach, and awareness. This effort will leverage other groups that have already developed information materials and dissemination processes, such as the Extension Disaster Education Network (EDEN), 4-H, the Environmental Protection Agency (EPA), the Federal Emergency Management Agency (FEMA), tribal efforts, state and regional agencies, non-profit organizations, and the international community. One of the primary priorities of the Group is to conduct a national education and capacity-building workshop in conjunction with other national or regional meetings convened by organizations such as the American Meteorological Society (AMS)'s Committee on Applied Climatology, the American Association of State Climatologists (AASC), and a NIDIS regional DEWS, to tap into wider networks of education expertise. This Group will partner with NOAA and other federal, state, and local offices in these efforts.



NIDIS, NOAA and partners create regional Quarterly Climate Impacts and Outlook two-pagers that give an overview of and highlights from the previous season, and an outlook for drought-related conditions in the coming quarter. When conditions warrant, Outlooks may appear more frequently, such as during prolonged droughts or when El Niño or La Niña conditions appear to be a factor. Current and past documents can be found at https://www.drought.gov/drought/resources/reports.

Planning and Preparedness

Drought is a complex problem that goes beyond the capacity, resources, and jurisdiction of any single person, program, organization, or sector. By nature, monitoring, planning for, and reducing drought risk must be a collaborative process. Building links and partnerships through combined networks can provide opportunities for increased communication in planning and risk reduction, promote the sharing of lessons learned and successful strategies, and foster a more effective use of resources.

The Planning and Preparedness Working Group focuses on increasing drought resilience through engagement, networking, and collaboration. This Group's efforts center around coordinating with the regional DEWS and their respective networks, as well as building on existing partnerships, to improve the dissemination of drought research, tools, and planning information in formats that are timely, accessible, and useful for drought management and decision making. This Group partners with other NIDIS Working Groups to identify the latest drought-related research, interpret the findings, and disseminate and implement those findings into planning processes. Related to this effort are the development of case studies, planning tutorials, and guidelines.

Referees, facilitators and organizers confer among the team tables at the Water Supply Reliability and Management Challenge, staged at the National Weather Center in Norman, Oklahoma in 2014. The event, a drought simulation exercise, was intended to increase readiness, characterize the disaster without the risk, identify strengths and weaknesses of plans, and train participants before a drought event occured.

Long-term efforts include expanding networking and collaboration to include public-private partnerships, relevant organized networks, and other prepared communities' initiatives to integrate drought into planning processes.

2016-2020 Priorities:

1. Facilitate network building among DEWS; community, state, regional, and tribal drought coordinators; and others that work in drought mitigation and response, monitoring, and early warning, and research.

This Group will work with those engaged in drought management as well as professional societies to disseminate relevant and timely drought planning information, research, and tools. These encompass various levels of government agencies, universities, and professional organizations. Examples include, but are not limited to: state climate offices, NOAA Regional Climate Centers (RCCs) and RISAs, USDA Climate Hubs, Agricultural Extension agencies, divisions of emergency management or natural resources, and organizations such as regional Governors' Associations.

2. Promote the development and successful implementation of drought simulation exercises and post-drought assessments.

Proactive drought risk management must balance competing priorities and incorporate multiple levels of decision-making. Drought simulation exercises provide a way to increase readiness, characterize the disaster without the risk, identify strengths and weaknesses of plans, and train participants before a drought event occurs. After a drought event, a post-drought assessment can help identify and document lessons learned. By working with entities that have participated in drought plan exercises and assessments, this Group will develop case studies, tutorials, and guidelines for the use of these activities, and use this content to update the planning resources available on the U.S. Drought Portal.

3. Share lessons learned and innovative strategies for reducing drought vulnerability and coping with its impacts.

By working with a network of drought professionals, this Group will collect and disseminate the knowledge, insight, and experience gained during a drought event. These valuable resources will be documented through meetings, workshops, publications, and web-based media.

4. Provide guidance on the development and use of critical indicators and triggers for drought planning.

Indicators will detect and characterize drought conditions, and triggers can activate and guide response actions. Indicators and triggers should be regionally specific, because drought has different meanings for different regions. This Group will work with the Interdisciplinary Research and Applications Working Group to engage researchers, drought management leaders, and other drought professionals to identify and disseminate information on the identification, development, and use of appropriate indicators and triggers.

Observations and Monitoring

This Group helps guide the implementation and use of drought monitoring products across a broad range of observational technologies, from in situ networks to remote sensing platforms. These efforts will expand NIDIS's capabilities in monitoring and observing relevant impacts in hydrology, agriculture, and other related and necessary fields at a variety of spatial and temporal scales as well as promoting the effective use of existing data and monitoring tools to NIDIS stakeholders and end users of the data that is collected.

The in situ and remotely sensed observations required for effective drought monitoring continue to be dispersed throughout numerous federal, state, regional, and local agencies. These programs have generally evolved independently and garnered financial support from a range of sources. Since the establishment of NIDIS, substantial progress has been made to assemble the many in situ federal meteorological data sources into a consistent format via a centralized access system. However, the number of state and regional data networks and remotely sensed data resources have also proliferated. Thus,

Melissa Webb removes a soil plug from a snow tube while maintaining snowpack monitoring equipment on Mt. Hood in Oregon in 2013.

PHOTO BY JULIE KOEBERLE, NRCS; HTTP://WWW.WCC.NRCS.USDA.GOV/PHOTO_CONTEST/2013/INDEX.HTML

drought-monitoring efforts continue to be hindered by the lack of a framework that truly integrates the comprehensive array of necessary observations. Newly developed indices and complementary data from remote sensing platforms (e.g., satellites, radar, aircraft, and other technologies) and model-based systems are also underutilized due to weak integration of different data sources and difficulties in assessing the real-time agreement and complementary nature of drought information.

The growth of state, local, and specialized observational networks and drought indices derived from non-traditional data sources will likely continue over the foreseeable future. The Observations and Monitoring Working Group promotes such expansion as a means of increasing the data resources available for drought monitoring, filling spatial and temporal gaps in data coverage where the gaps exist. Examples of such networks include the National Soil Moisture Network and the Community Collaborative Rain, Hail, and Snow Network (CoCoRaHS), a citizen science observation network.

The Observations and Monitoring Group helps inform the priorities for NIDIS agency partners in monitoring and observations. However, more data does not necessary mean better data. This Group's efforts focus not just on filling gaps, but assuring compatibility of new data resources and promoting the use of the most appropriate monitoring products and data sources for specific spatial scales and applications.

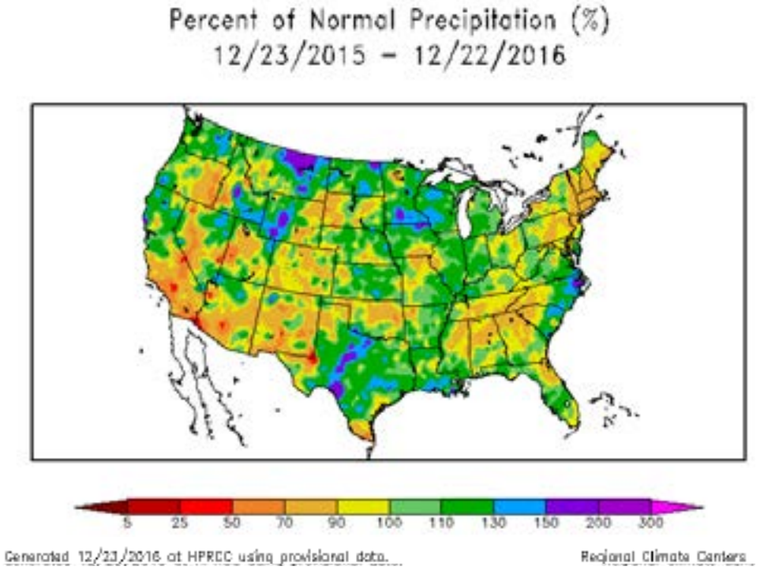
2016-2020 Priorities:

1. Establish preferred guidelines for in situ drought monitoring observations.

Although the proliferation of state and regional networks has helped fill important spatial data gaps, especially in under-measured variables such as soil moisture, these data sets have not reached their full potential in national drought monitoring. This is partly due to differences among the networks in terms of instrument siting, placement, and type, which limit the spatial consistency of the data for monitoring and hamper the use of the different data sets for validating and comparing remotely sensed data. Starting with soil moisture, this Group will outline conventional ways to describe monitoring methods, instruments, sites, etc. and then build upon this by drafting a set of standardized guidelines addressing features such a preferred sensor depths, sensor types, site characterization (e.g. soil type, irrigation), etc. In addition, the guidelines will also address data transmission, formatting, archival and dissemination issues. The goal will not be to necessarily adopt a set of national standards, but rather provide guidance that balances network owner needs with broader national needs.

2. Inventory data resources derived from different monitoring platforms.

The number of drought monitoring tools and resources has grown considerably since the inception of NIDIS. This includes similar indices that use different data sources (e.g. in situ vs. remotely sensed) as input. This Group plans to implement an inventory of different drought monitoring tools and data platforms. The inventory describes the intended application, key strengths, important caveats of the approach, references, etc., and is anticipated to be similar in design to the NDMC's catalogue of major drought indices. Case studies comparing tools based on new data platforms (e.g. radar) with those using traditional data sources (e.g. rain gauge) are also envisioned. The inventory will serve as a resource for drafting and supporting recommendations for new or continued remote sensing observations that prove valuable to drought monitoring. Based on this and the outcomes of Priority 1 (above), this Group will be better able to advocate for data continuity in satellite missions of particular interest to drought monitoring.



Users of the map tool of the Applied Climate Information System (ACIS) can generate maps of different drought climate indices from various regions at differrent timescales.

HTTP://HPRCC.UNL.EDU/MAPS.

3. Formalize a framework for "ensemble" drought monitoring.

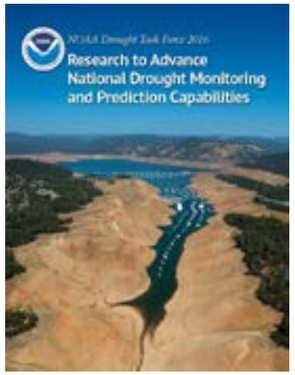
The novelty of drought indices derived from remotely sensed data often delays their operational use. In connection to one or more of the DEWS, this Group will prototype an "ensemble" drought index tool combining several data platforms (e.g. a conventional drought index, soil moisture, observations from a Mesonet, and a model/remotely sensed approach). This tool will help increase the use and user-comfort level of indices derived from new observing technologies by facilitating side-by-side comparison and providing users with a mechanism to observe and learn the different methods' strengths and weaknesses. This will also provide a broader means to assess the uncertainty of drought status in complex situations and subregions. This effort will also clarify gaps and or weaknesses in data resources and, through one or more of the DEWS, initiate efforts to close such gaps.

4. Draft requirements for data delivery.

To help communities monitor drought across scales, NIDIS fosters common access to data from differences sources. At the national level, integration of state Mesonet data into operational drought monitoring tools is vitally important. Likewise, the ability to replicate national products using available gridded model

WHAT IS A MESONET?

A mesonet is a regional network of observing stations (usually surface stations) designed to diagnose mesoscale weather features and their associated processes. The National Mesonet Program (NMP) brings non-federal meteorological data sources to NOAA for use in operations at Weather Forecast Offices (WFO) and numerical modeling at the National Centers for Environmental Prediction (NCEP).



This report documents how research has been improving operational capabilities to monitor the current state of drought, predict its onset and evolution from weeks to seasons, and better understand why drought occurs. The work reported here has involved a focused collaboration among the NOAA Office of Oceanic and Atmospheric Research laboratories, Cooperative Institutes, and National Weather Service operational centers; other federal agencies and their laboratories; and critical involvement by the academic community. Such collaborations are central to the NIDIS mission.

HTTP://CPO.NOAA.GOV/SITES/CPO/MAPP/PDF/RTC_REPORT.PDF

and remotely sensed data sources also requires implementation. At state and regional levels, some users value the ability to access the underlying data for incorporation into their own models.

This Group supports continued leveraging of the Applied Climate Information System (ACIS) as a NIDIS data delivery system. Operated by the six NOAA RCCs, ACIS currently provides web services access to data (in addition to products) and integration of gridded and in situ station data. Existing connections between the RCCs and AASC will serve as a means of establishing a centralized access point to state and local data resources for cross-scale drought monitoring. A proof-of-concept approach within multiple DEWS regions will be developed as a way to achieve "ensemble" drought monitoring (Priority 3, above) and build upon ACIS as a NIDIS resource for observations and monitoring.

Predictions and Forecasting

An important component of any Drought Early Warning System is the preparation, reliability, and usefulness of official drought forecasts and outlooks and the prediction tools and models that inform them. The goal of the Predictions and Forecasts Working Group is to provide inputs to improve the current monthly, sub-seasonal and seasonal drought outlooks with consideration for extending the forecast service to longer lead times. Key partners include NOAA's CPC, NOAA's Physical Sciences Division, and other operational and research entities.

In the 2016 report, Research to Advance National Drought Monitoring and Prediction Capabilities, NOAA's MAPP Drought Task Force recommended jointly with NIDIS the goal of "improving drought prediction skill by identifying and exploiting sources of drought predictability and related aspects such as the dependence on time scales, regions, seasons and variables, and improvements in forecast models and procedures." To contribute to this goal, the Predictions and Forecasts Working Group leverages advancements in drought research and expands or enhances current work to include operational drought prediction systems where possible. This Group also investigates how new findings may be applied to improve the information supporting the monthly and seasonal drought outlooks.

2016-2020 Priorities:

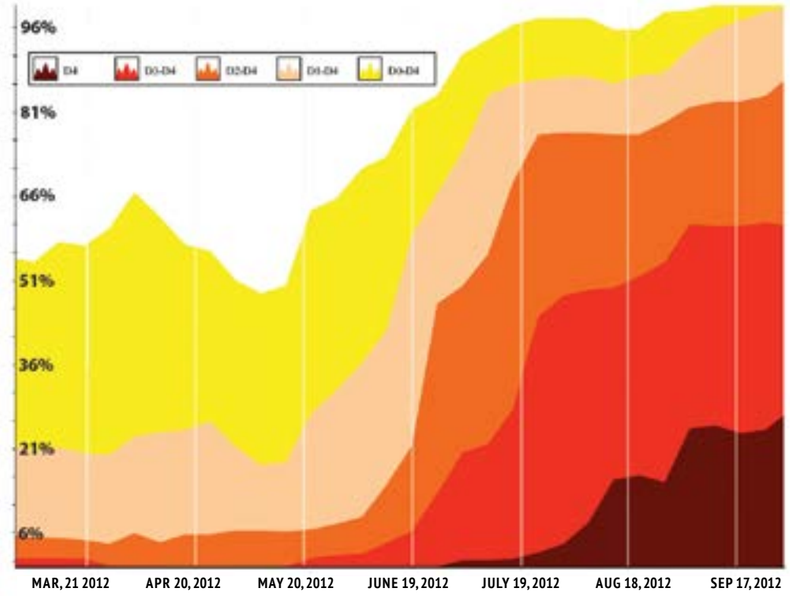
1. Conduct simulations of sub-seasonal to seasonal climate variability and their impact on U.S. drought.

There are a number of leading modes of climate variability at various time scales that can affect drought attributes and serve as potential sources of drought predictability. This Group will assess current operational and near real-time prediction systems (e.g. Climate Forecast System, Sub-seasonal to Seasonal, National Multi-Model Ensemble) for representation of the climate modes on sub-seasonal to seasonal timescales and their impact on U.S. drought. The climate modes to be assessed will include: (1) The El Niño Southern Oscillation (ENSO), the primary predictable driver for seasonal and longer term droughts; (2) the Madden-Julian oscillation (MJO), the critical tropical intra-seasonal variability that can augment the frequency, timing, intensity and duration of precipitation extremes which subsequently affect U.S. drought development; and (3) other key variability that can impact U.S. drought via precipitation and temperature pattern

changes, including atmospheric river events and persistence of leading modes of extra-tropical sub-seasonal atmospheric circulation variability during warm seasons.

2. Assess "flash droughts".

"Flash droughts," or droughts that develop quickly, on the order of weeks as opposed to months or years, are still not well understood. Although much has been learned in recent years, there remain questions on physical processes that drive flash droughts, predictability of these droughts, and the capability of current models to predict them. For instance, are certain flash droughts more predictable than others, and if so why? Which events are primarily temperature vs. precipitation controlled? Although the latter question is applicable to multiple time scales of drought duration, this Group plans to focus on sub-seasonal events.



This timeline shows the rapid onset of drought in the Midwest in 2012, where conditions worsened significantly over the summer. In May 2012, less than 20 percent of the region was in drought, accelerating to more than 80 percent by early September. The Predictions and Forecasting Working Group intends to explore the physical processes that drive "flash" droughts such as this, and the predictability of these droughts, and the capability of current models to predict them.

3. Pursue dynamical model post-processing strategies.

Precipitation prediction at leads greater than two weeks remains considerably challenging. This Group will continue to evaluate and develop dynamical model post processing strategies. Hybrid statistical-dynamical type techniques that use large scale model information, along with statistical algorithms, may increase forecast skills incrementally over time under certain conditions for key drought-related variables such as precipitation, soil moisture or surface runoff. Both sub-seasonal and seasonal time scales will be targeted. In addition, methodologies for consolidation or merging of information that span multiple time scales will be a point of emphasis in the coming years.

4. Link land surface initial conditions with modeling.

Land surface initial conditions provide an important source for skillful drought forecasts for one or two months, so it remains critical to continue to improve initialization of land surface states in operational systems. Existing Land Data Assimilation Systems (LDAS)-type offline land initialization strategies should be augmented with the assimilation of state-of-the-art observational datasets such as satellite-based soil moisture estimates from SMAP (Soil Moisture Active Passive).

Along with new datasets for improved land states, high resolution land surface modeling plays an important role. In 2016, the National Water Center National Water Model became operational at the National Centers for Environmental Prediction (NCEP). Usage and evaluation of this additional operational modeling capacity should be a focus in the coming years. Efforts at NCEP for

a quasi-operational, multi-model seasonal hydrological forecast extending out six months will be developed in collaboration with ongoing partners. These advances can help inform a strategy for the development of probabilistic drought outlook products and services.

5. Assess decadal drought prediction.

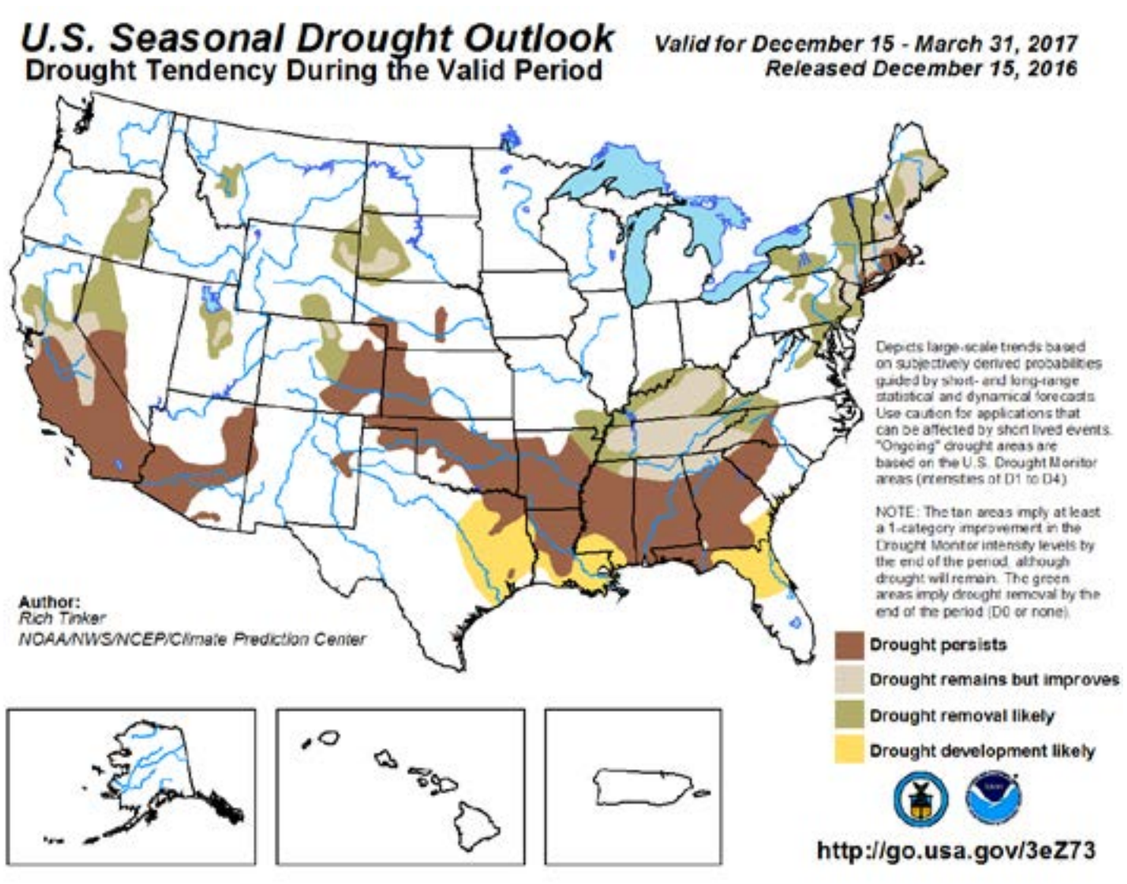
To address interest in decadal prediction of U.S. drought for long-term planning, this Group will prioritize assessmenty of decadal drought prediction skill and predictability in Coupled Model Intercomparison Project Phase 5 (CMIP5) decadal predictions. Such assessment will document the latest understanding of sources of decadal drought predictability (e.g., ocean variability, deep soil moisture variability and anthropogenic change) and drought impacts. Thereafter, evaluation of CMIP6 coupled model performance in decadal prediction is advocated when required model data is available.

6. Strengthen communication with operational forecasters.

Communication with operational forecasters regarding their forecast needs and the challenges they face in making official outlooks is a vitally important, and too often overlooked, aspect to strengthening the research dialogue. This

NIDIS supports research that has resulted in improvements to various drought early warning information tools, including the NWS Climate Prediction Center's Seasonal Drought Outlook product.

HTTP://WWW.CPC.NCEP.NOAA.GOV/PRODUCTS/EXPERT_ASSESSMENT/SDO_SUMMARY.PHP



Group will continue to build on current successes in this area and consider end-to-end approaches in evaluating model guidance as part of research activities. This Group will also foster better communication between the research community and the DEWS, and work to ensure that the latest drought prediction information is on the U.S. Drought Portal.

The anticipated outcome of this Group's activities, coordination, and recommendations is an assessment of current operational drought forecast system capabilities and development of a strategy for how this information can improve official drought outlooks.

California firefighters approach a wildfire near Sonora in August 2014. A spark from a passing vehicle ignited the blaze in the parched grassland next to Highway 49.
ANDREW WILLIAMS PHOTO

Interdisciplinary Research and Applications

A key NIDIS priority is to ensure federal research is as coordinated and integrated into decision-making as practicable, inspiring interaction between the research community and beneficiaries. Maintaining a strong connection between sponsored research and the U.S. Drought Portal helps cultivate these interactions and engenders better informed and more timely decisions by vulnerable stakeholders and leaders from all levels of government.

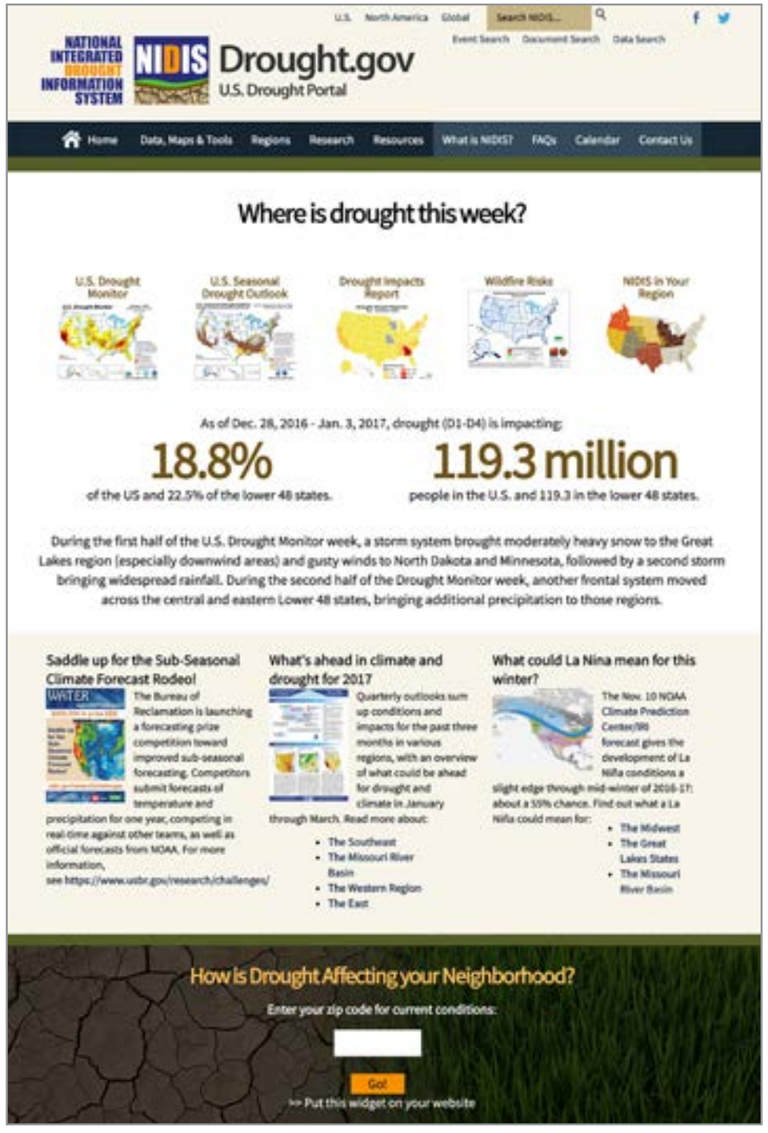
2016-2020 Priorities:

1. Inventory existing drought-related research.

The Interdisciplinary Research and Applications Working Group will develop an inventory of existing drought research, and will make this inventory available on the U.S. Drought Portal, including an analysis of current gaps in research. The inventory will be searchable by keyword, and will include a catalog of: (1) agency calls for proposals, (2) recent publications related to drought causes, impacts, and planning, and (3) professional meetings that include discussion of drought. By cataloging this information in a central location, this effort will help streamline research activities among federal agencies, increase awareness of knowledge gaps, and minimize duplication of effort between disparate groups.

2. Facilitate field-tested methodologies for developing drought risk indicators and trigger definitions.

This Group will help guide and inform discussions with a range of relevant stakeholders to identify critical indicators and triggers for drought planning and operational decisions. Drought triggers vary by economic sector and involve issues of scale, intensity, and duration. This diversity means that there is an urgent need for improved identification and analysis of indicators and triggers



The home page of the U.S. Drought Portal gives a snapshot of current conditions, impacts, and the outlook for drought and wildfire in the next few months. It offers a few selected news items and a simple tool where users can find out their local drought situation by enbtering their ZIP code.

cooperatively designed around specific management priorities and system thresholds. This Group will work together with the Planning and Preparedness Working Group to help inform the development of a matrix for decision-making in drought-vulnerable communities based on different drought indices and relevant decision calendars, while accounting for regional variance in drought vulnerabilities.

3. Support the collection and organization of data and information to inform the socio-economic loss estimation process.

The NIDIS Public Law calls for NIDIS to build a national DEWS in order to "engender better informed and more timely decisions, thereby leading to reduced impacts and costs." To better understand socio-economic losses due to drought and reduce those losses and costs in the future, decision makers must have access to impact data and information that informs their ability to calculate loss estimates, qualitatively and quantitatively. At a minimum, measurements for this information include: event type, duration, spatial coordinates, sectoral impacts (agriculture, tourism, etc.), public health impacts, ecosystem impacts, and others. These data points comprise the timely information needed to understand local, regional, tribal, and state differences in drought conditions, and help strengthen decision-making. This Group will engage with researchers who are developing guidelines and methodologies that inform the loss estimation process, including ongoing discussion about barriers to collecting loss estimates and opportunities to increase the availability of these datasets.

4. Facilitate the integration of drought early warning information into long-term adaptive management strategies.

It is critical to understand the relationship between biophysical measures and models of drought within the context of economic, ecologic, and social impacts

so that timely and responsive management alternatives can be identified and adopted, and potential impacts and losses can be mitigated – not just for the immediate event, but also for those in the future. This Group will facilitate awareness among research programs of the need for methodologies to assess impacts out across a variety of sectors, such as water resources, crop and livestock agriculture, forestry, energy, wildlife, recreation, and tourism, and at different timescales.

Users of the ZIP code widget on drought.gov get a quick look at where drought stands in their neighborhoods: the level of drought, according to the U.S. Drought Monitor, temperature and precipitation data, a Palmer Drought Severity Index rating and links to related content. Other websites can arrange to use the widget as well, on their own pages.

The U.S. Drought Portal

The U.S. Drought Portal is a national internet-based clearinghouse for collection, integration, provision, and communication of drought information, including data and models; forecasts and assessments, resources for planning, impacts collection and analysis, and mitigation; and relevant events and reports, with responsibility for archiving and disseminating that information. The U.S. Drought Portal incorporates expert information on drought from federal interagency and non-federal sources, at county, state, regional, and national scales, using multiple time scales in various formats. It seeks to answer these questions:

- Where are drought conditions now and where might they develop?
- Does this drought event look like other events in the past?
- How long will the drought continue?
- How is the drought affecting me and my region?
- How can I plan and prepare for and manage the impacts of drought?
- Where should I go for additional information and assistance?

The U.S. Drought Portal serves hundreds of thousands of users each year. Since the site's inception, content and functionality has been continually refined in response to user input and the evolution of digital platforms, in order to keep up with advances in the way users consume data and information.

Since 2008, the U.S. Drought Portal has become a central source for drought information in the United States, across North America, and around the world. The Portal has informed and led key international activities such as the North American Climate Services Partnership, the Global Earth Observing System's work plan, and the World Meteorological Organization's Global Framework on Climate Services.

The content of the U.S. Drought Portal serves several user communities: decision makers at the federal, tribal, regional, state, and local levels of government; the private sector; and the public.

Feedback from all the user groups as well as the DEWS stakeholders and partners, the U.S. Drought Portal Working Group's ongoing recommendations, and regular NIDIS Program Office and Portal team input continue to shape the U.S. Drought Portal's development through regular collaborations and usability studies.

This Group works together with the Drought Portal Manager, the Portal team, and the NIDIS Program Office to set standards for content, functionality, style, and best practices. This Group, the Portal Manager, and the NIDIS Program Office coordinate with the other five Working Groups to develop content for the portions of the U.S. Drought Portal that refer to their areas of oversight.

2016-2020 Priorities:

1. Incorporate feedback from usability studies and Google Analytics to inform development of the U.S. Drought Portal (drought.gov).

In 2016, NIDIS worked with a research team at the Cooperative Institute for Research in Environmental Sciences to conduct website usability studies after the implementation of an April 2016 site redesign of the U.S. Drought Portal. These studies included feedback through specified Google Analytics, a five-month pop-up survey taken by more than 1,000 users of the site, and 13 hands-on interviews with site users who had little familiarity with drought.gov. Additionally, the staff generates periodic Google Analytics reports to measure traffic on the site, to identify the most-read content and track user behavior.

Using this information, this Group will help guide development on the site, including updates to navigation, identifying gaps in content, and exploring needs and opportunities for new content.

This Group will also review analytics data generated by changes to the site to help assess the success of new efforts to develop content.

ACRONYM LIST

AASC	American Association of State Climatologists
ACIS	Applied Climate Information System
ACF	Apalachicola-Chattahoochee-Flint
AMS	American Meteorological Society
APA	American Planning Association
CIRES	Cooperative Institute for Research in Environmental Sciences
CLIMAS	Climate Assessment for the Southwest
CoCoRaHS	Community Collaborative Rain, Hail, and Snow Network
CPC	Climate Prediction Center
DEWS	Drought Early Warning System
DOI	U.S. Department of the Interior
DRMRC	Drought Risk Management Research Center
EDDI	Evaporative Demand Drought Index
EDEN	Extension Disaster Education Network
EPA	Environmental Protection Agency
FEMA	Federal Emergency Management Agency
GAO	Government Accountability Office
MAPP	NOAA's Modeling, Analysis, Predictions, & Projections Program
NCEI	National Centers for Environmental Information
NCEP	National Center for Environmental Prediction
NDMC	National Drought Mitigation Center
NIDIS	National Integrated Drought Information System
NOAA	National Oceanic and Atmospheric Administration
NPO	NIDIS Program Office
NWS	National Weather Service
OAR	NOAA's Office of Atmospheric Research
RCC	Regional Climate Centers
RISA	Regional Integrated Sciences and Assessments
SARP	Sectoral Applications and Research Program
SCIPP	Southern Climate Impacts Planning Program
USDA	U.S. Department of Agriculture
USDM	U.S. Drought Monitor
WFO	Weather Forecast Offices
WGA	Western Governors' Association

2. Coordinate U.S. Drought Portal development with other NIDIS Working Groups and with the regional DEWS.

All NIDIS Working Groups and regional DEWS have a presence on the U.S. Drought Portal, from Research and Monitoring to specific DEWS locations like the Apalachicola-Chattahoochee-Flint (ACF) River Basin. The Drought Portal Working Group will help coordinate the development of Portal content with the other NIDIS Working Groups, with the regional DEWS, and with the NIDIS Program staff.

This Group will support efforts to include data and information applicable on many time and spatial scales including county, municipal and regional (watershed/basin), by identifying needs for and sources of that information, with guidance from the DEWS, other NIDIS partners and stakeholders, and Working Groups.

3. Contribute knowledge and experience of best practices in web development and social media for promoting web content.

The internet is constantly growing and evolving as new applications, platforms, software and other aspects of digital communication change and develop over time. For example, consider the number of users whose primary device is now a tablet or smartphone, as opposed to a desktop computer, since the original implementation of NIDIS in 2006. This Group will assist the Portal Team in keeping abreast of innovations and changes in the way users access and utilize information.

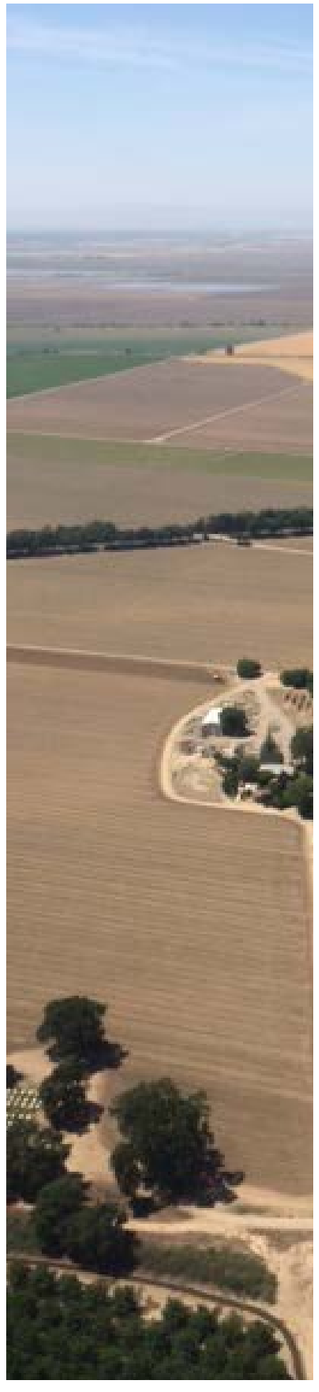
4. Facilitate integration of actionable information from multiple agencies and sources.

Working Group members will explore opportunities to further integrate drought-related information and innovations from multiple credible, reliable sources, particularly from NIDIS' federal, tribal, state and local partners, and non-governmental organizations. The Group will offer expertise and insight on how this integrated information can inform drought response, mitigation and resilience strategies for multiple communities, in collaboration with other NIDIS Working Groups.

This Group will also help foster and facilitate consistent messaging on drought early warning information indicators and indices across temporal and spatial scales.

CONCLUSION

The completion of a fully operational national integrated drought early warning information system is fundamental to creating a more drought resilient nation. NIDIS, with its strong interagency, intergovernmental, and private partnerships, is well positioned to deliver that system to the Nation, by directing efforts toward reducing risk in drought sensitive sectors and regions and engendering awareness of the drought hazard, its links to vulnerability, and opportunities for action. By building upon existing programs and partnerships to create an effective national drought early warning system, NIDIS is advancing proactive responses to drought-related risk, and strengthening preparedness strategies and plans that increase our country's resilience in the face of drought.



Fields lie fallow outside Sacramento, California in 2014

This report was authored by the NIDIS Program Office and supported by the individual feedback of many key partners across sectors and levels of government.