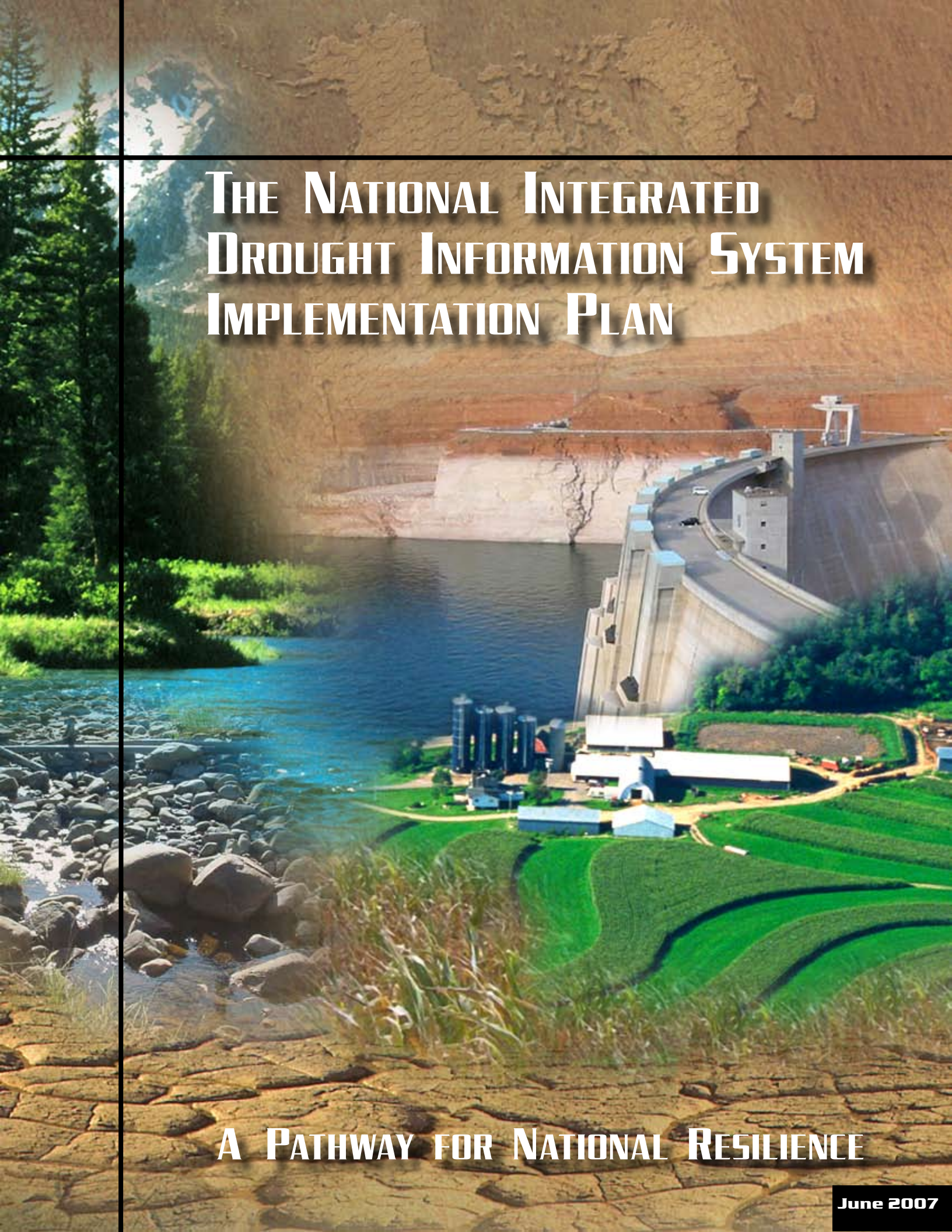

The National Integrated Drought Information System Implementation Plan

A Pathway for National Resilience

June 2007

FOREWORD

Drought is among the most damaging and least understood of all natural hazards. It is a normal part of climate and yet is perceived as infrequent and random. Droughts can last from a single season to multiple decades and impact a few hundred to tens of thousands of square miles. Over the past century, approximately 14% of the United States has been affected by severe or extreme climatological drought in an average year, although it was as high as 65% during the Dust Bowl, and has recently been about 35% for some regions. The paleoclimate record shows that past droughts have lasted decades; many more severe than were experienced over the last century.

Many state and federal agencies are beginning to recognize the need to move forward with a more proactive, risk-based drought management approach. The National Integrated Drought Information System (NIDIS) represents the culmination of many years of experience from scientific inquiry, monitoring insight, socioeconomic impacts, and response partnerships at federal, state, and local levels. This broad experience base and our increasing vulnerability points to the need for a unified federal policy to help states and local communities prepare for and mitigate the damaging effects of drought.

The long-term effect of drought can ripple through the national and local economies, and the environment. NIDIS will enable users to determine the risks associated with drought and provide supporting data and tools to inform drought mitigation.

This NIDIS Implementation Plan describes how an accessible and usable drought information system will be developed, deployed, and operated to facilitate informed decision-making by resource managers and others. Critical to the success of this plan is the continued cooperation with partners at all levels of government, academia, and the private sector.

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NIDIS
NATIONAL INTEGRATED DROUGHT INFORMATION SYSTEM

EXECUTIVE SUMMARY

Drought is a recurring slow-onset natural phenomenon that is often called "the *creeping* disaster." Unlike other natural hazards such as hurricanes, floods, and tornadoes, the onset and duration of a drought event is at once evident and cumulative. Impacts are not measured by the immediate residue of nature's fury, but by a cracked palette of sun-parched browns, oranges, and tans that can take years to recover, if at all. The gradual nature of drought hinders the recognition of the true extent of impacts as they filter through the economy and the environment, often diminishing the sense of urgency that would otherwise trigger a timely and comprehensive response.

Recognition of drought risks in a timely manner is dependent on our ability to monitor and forecast the diverse physical indicators of climatological drought, as well as relevant economic, social, and environmental impacts. The Western Governors' Association Report (2004) *"Creating a Drought Early Warning System for the 21st Century: The National Integrated Drought Information System"* made clear that recent and ongoing droughts expose the critical need for a coordinated, integrated drought monitoring, forecasting, and early warning information system.

To fill this need, the National Integrated Drought Information System Act of 2006 (Public Law 109-430) (NIDIS, 2006) was introduced in the U.S. Congress and subsequently signed by the President in 2006. The goal of NIDIS is to improve the nation's capacity to proactively manage drought-related risks, by providing those affected with the best available information and tools to assess the potential impacts of drought, and to better prepare for and mitigate the effects of drought. Over the past year, several workshops were held with federal, state, and local agencies, academic researchers, and other stakeholders to develop a pathway for meeting the goals of NIDIS as outlined in the Western Governors' Report. This plan is the result of deliberate and broad-based input from those workshops and several national, state, and community-level fora. The NIDIS Implementation Plan is intended to provide pathways and support mechanisms to:

- Develop the *leadership and partnerships* to ensure successful implementation of an integrated national drought monitoring and forecasting system at federal, state, and local levels;
- Foster, and support, a *research* environment that focuses on risk assessment, forecasting, and management;
- Create a *drought "early warning system"* capable of providing accurate, timely, and integrated information on drought conditions and associated risks at relevant spatial scales to facilitate proactive decisions;
- Provide interactive delivery systems including an *internet portal*, as part of the early warning information system, for easily comprehensible and standardized products (databases, forecasts, geographic information system (GIS)-based products, maps, *etc.*); and
- Provide a framework for increasing public awareness and *educating* those affected by drought on how and why droughts occur, and how they impact human and natural systems.

The NIDIS Implementation Plan outlines the governance structure, priorities, and operational requirements needed to meet these objectives. Over the next five years, NIDIS will build on the successes of the U.S. Drought Monitor, Seasonal Outlooks, and other tools to effect fuller coordination of relevant monitoring, forecasting, and impact assessment efforts at national, watershed, state, and local levels to provide a better understanding of how and why droughts affect society, the economy, and the environment, and to improve accessibility, dissemination, and use of early warning information for drought risk management. The goal is to close the gap between what is available and what is needed for proactive drought risk reduction.

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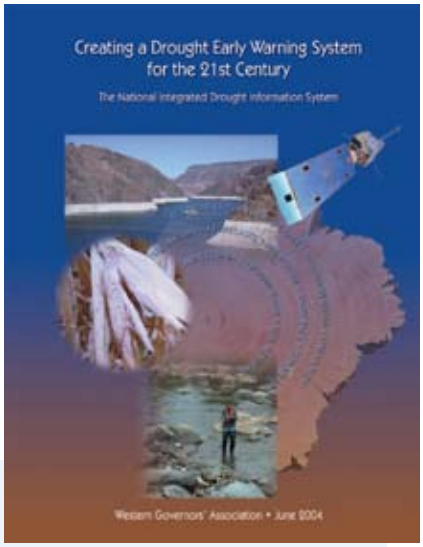
1. INTRODUCTION

The National Integrated Drought Information System (NIDIS) Act of 2006 (Public Law 109-430) prescribes an interagency approach for drought monitoring, forecasting, and early warning. Led by the National Oceanic and Atmospheric Administration (NOAA), this approach will be developed through the consolidation of physical/hydrological and socio-economic impacts data, engaging those affected by drought, the integration of observing networks, the development of a suite of drought decision support and simulation tools, and the interactive delivery of standardized products through an internet portal. NIDIS is envisioned to be a dynamic and accessible drought risk information system that provides users with the capacity to determine the potential impacts of drought, and the decision support tools needed to better prepare for and mitigate the effects of drought.

The National Drought Policy Commission (2000) observed that the United States would benefit from development of a national drought policy with preparedness as its core. The Commission lays out the characteristics of such a coordination and preparedness system that would increase the resilience of the nation and of local communities to drought (Box 1). As requested in the 2004 Western Governors' Association (WGA) Report entitled "Creating a Drought Early Warning System for the 21st Century: The National Integrated Drought Information System", NIDIS is being designed to serve as an early warning system for drought and drought-related risks in the 21st century. With these guidelines in mind, the explicit goal of the NIDIS Program is to enable society to respond to periods of short-term and sustained drought through improved monitoring, prediction, risk assessment, and communication. Over the next five years, NIDIS will focus on coordinating disparate federal, state, and local drought early warning and planning. As part of this effort, NIDIS will act as a clearinghouse for drought mitigation



Box 1: The National Drought Policy Commission Report (2000)

The National Drought Policy Act of 1998 established the National Drought Policy Commission to provide advice and recommendations on the creation of an integrated, coordinated federal policy designed to prepare and respond to serious drought emergencies. The Commission's report was issued in May 2000, and served as a basis for the NIDIS plan. Two key concepts were outlined in the Commission Report:

Preparedness

Preparedness is a fundamental concept in any national drought policy. Preparedness includes *drought planning*, implementation of *proactive mitigation* measures, and *public education*. The Commission report found that preparedness can reduce the social, economic, and environmental impacts of drought and the need for federal emergency relief expenditures in drought-stricken areas. Proactive mitigation activities, such as water conservation, science-based forest management, reuse of wastewater, desalination, pricing strategies, and the identification of back-up water supplies—when initiated *before* an emergency—can reduce vulnerability to drought events. A variety of entities are engaged in some form of drought preparedness. These include individuals, citizen organizations, local and state governments, tribes, and regional bodies. Often, this planning is conducted within the framework of comprehensive water management planning by entities ranging from water districts and large multi-county urban areas to state water resources agencies and regional river basin compacts and commissions. Preparedness measures can reduce the need for future emergency financial and other relief. Individuals, businesses, local/county/state governments, tribes, and nongovernmental organizations with an interest in or responsibilities for drought management would benefit from training and technical assistance to plan for and reduce the impacts of drought.

Coordination

Currently, a coordinated and integrated drought research program does not exist at the national level, despite the enormous impact of droughts every year on the nation's economy, society, and the environment. This fact sets drought apart from other major natural disasters, which have sustained federal research programs and significant interagency coordination. Currently, drought research is scattered across many agencies, universities, and other research institutions, without formal coordination or planning to maximize the value of the research dollars spent, and without effort to ensure that the priority needs of the public and decisionmakers are being addressed. In addition to water resources and agriculture, effective coordination plans would evaluate drought programs to identify and address priority impacts on environmental services and, where possible, improve proactive mitigation of drought's impacts on the environment through training, incentives, technical assistance, research, and public education.

and response innovations at a variety of scales (national, regional, watershed, state, county) and facilitate the diffusion of such innovations to other locations in the United States.

To some extent, federal monitoring and prediction programs are working with universities, private institutions, and other non-federal entities to provide information needed for effective drought preparedness and mitigation. As noted by the Commission and in the WGA Report, such efforts should be coordinated under a broader framework of preparedness. Regional entities generally comprise several states within a common geographic boundary or water management jurisdiction such as a river basin. It is evident that drought planning or embedding drought-oriented concerns into comprehensive water management plans at the regional level is essential for any strategy to be successful.

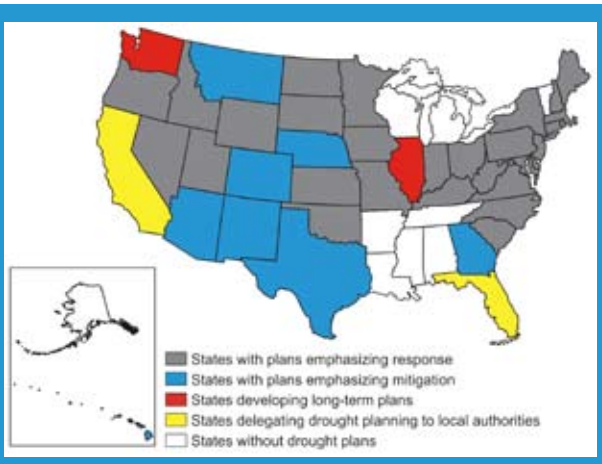


Figure 1: Status of State Drought Plans, October 2006 (*National Drought Mitigation Center*)

2. CURRENT SYSTEM STATUS

Drought characterization requires a combination of two types of information:

- *Observations* of past and current physical states of the environment and their context within the historical record. The necessary physical information includes observations of precipitation, soil moisture, snow water content and snow depth, vegetation health and stress, soil and air temperature, humidity, wind speed and direction, and solar radiation. Integrating data on streamflow, lake and reservoir levels, and ground water status also is required.

- Documented *impacts* on human and natural systems that are a consequence of social, economic, and environmental vulnerability, as well as physical conditions. The necessary information involves single sector outputs (*e.g.,* agricultural yield) and multi-sector impacts such as those affecting water demands, wildfire risks, and recreation.

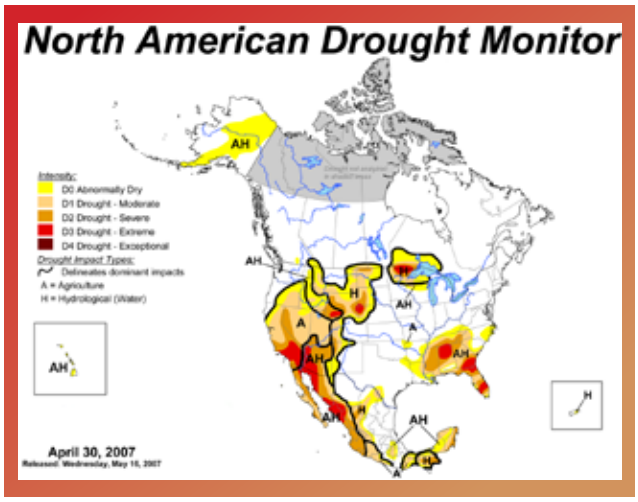
Weather and climate observations have limited value to assessing drought if they are not systematically organized into a larger drought risk mosaic with timely updates. A wide variety of data collection networks currently exists throughout the United States across many federal and non-federal agencies. Many of these networks transmit their observations through telecommunications that balance frequency and reliability with operation and maintenance costs.

Figure 1 highlights the current status of state-level drought planning within the United States as of October 2006. Eight states have drought mitigation plans in place. Both Illinois and Washington have expressed their intent to revise their existing plans by incorporating mitigation actions. Drought mitigation planning has also taken place in other jurisdictions within the United States, with Native American Nations taking a strong interest in developing mitigation plans. In the southwestern United States, the Navajo, Hualapai, Hopi, and Zuni tribes, as well as the Taos Pueblo, have all recently drawn up drought mitigation plans.

More municipalities, counties (four counties in Hawaii have drought mitigation strategies), and regional organizations (river basin commissions) are developing drought plans, and drought planning is beginning to be recognized as an important criterion for hydroelectric plant licensing. State plans are, however, not usually coordinated across shared watersheds, agricultural zones, and ecosystems.

The current methods to monitor, predict, and mitigate drought rely on formal and informal cooperation among federal, state, and local partners that share data and drought-related products and technologies. Each partner's mission area has some relationship to potentially numerous drought-related activities nationwide. The WGA Report recommends the development of a viable plan to maintain, modernize, expand, and coordinate a system of observation networks that meets the needs of the public at large. The WGA Report further recommends that the plan should include cooperation with states, development and improvement of baseline historical data sets, and recognition of the NIDIS recommendations in practice.

Presently, there are significant gaps in spatial coverage of surface station instrument networks. The greatest current data shortfalls are on the local (city/county) and state levels. Physical information and drought impact information at these levels is difficult to obtain in a uniform manner



across the nation. The National Weather Service (NWS) has determined that an effective Cooperative Observer Network for county-level monitoring would require a minimum spatial density of one observing site per 400 square miles across the country, or a separation of about 15 to 20 miles. The placement of soil temperature and soil moisture measurements is also generally too sparse for effective use, and even nonexistent in many areas. The network of ground water climate monitoring wells is also inadequate, and is presently found mainly in the northeastern states with little coverage elsewhere.

A key gap within the present context is that information on physical states and impacts is not optimally integrated into a coherent overall narrative, in real-time, to meaningfully characterize drought conditions. Improving integration of such information would create improvements in decision support for planning, mitigation, early warning, triggering, and response. Such information also provides the basis for research needed to develop improved insights, methods, and technologies for assessing developing drought conditions and mitigating their impacts. The following list was produced by the NIDIS Program Implementation Team **(see below)** and stakeholder groups, identifies core gaps and requirements within the existing drought risk management enterprise.

Core Gaps and Improvements Needed

- *Physical System Data*. Improved drought assessment information, including soil moisture and streamflow/groundwater data within denser networks, is needed to speak to information needs at the local level. This information must be dependable, reliable, and provided in a timely fashion.

- *Accuracy*. With the push for better temporal and spatial resolution of data comes the need for improved accuracy of these data, accompanied by accurate tools and display features.

- *Objective Drought Forecasts*. The skill of current intraseasonal-to-interannual precipitation and temperature forecasts needs to be improved, and drought forecasts should be expanded to include soil moisture, runoff, and hydrological variables. Drought forecasts should be based on an objective multi-model ensemble prediction system to enhance their reliability.

- *Triggers*. Triggers are a major concern issue for all drought-sensitive communities. Drought triggers are threshold values of an indicator that distinguish drought magnitude and determine when management actions should begin and end.

- *Socio-economic Information*. Understanding the economic impacts caused by droughts, and the economic feasibility and costs avoided by mitigation strategies is very important to create visibility and attention for mitigation and response actions. Unfortunately, little such information is available.

- *Educational Materials*. Education needs to take place at all levels, from the scientists interested in developing and using drought-related tools to the decisionmakers, media, and public trying to understand the characteristics of drought in their areas. It was also recognized that drought education, related to water resources information, needs to be included within K-12 curricula so that the concept of mitigation can develop with time.

- *Communication*. The facilitation of better communication at all levels must be established. As part of this, a "web portal" would provide easily understood information for a variety of stakeholders and allow for an information flow back into NIDIS. NIDIS will promote the sharing of experiences and ideas, among those affected by drought and act as a clearinghouse for lessons learned and successful strategies.

- *Client-Oriented Tools*. Capabilities for users to assess drought conditions and impacts and relate these to various drought severity designations. Drought severity designations are not widely advailable.

- *Drought Outlooks/Forecasts*. Stakeholders continually ask about the availability of drought outlooks and forecasts that would

Box 2: The U.S. Drought Monitor and the Seasonal Drought Outlook

The U.S. Drought Monitor is hosted by the National Drought Mitigation Center in Lincoln, Nebraska. The primary entry page is http://www.drought.unl.edu/dm/. The major system components consist of 1) the Drought Monitor, 2) a description of the participants, 3) forecasts, 4) current conditions, 5) product archive, 6) what's new, and 7) who to contact. The components contain links to products that are contained on partner agency web pages.

The creation of the U.S. Drought Monitor was a pivotal event for agencies and states. Prior to 1999, most drought decision-making was based on the Palmer Drought Severity Index. The USDM was created to better integrate data on current conditions in a standard product providing a national overview of drought on a continuous, weekly basis. It provided a forum for discussion among drought monitoring experts around the country, leading to a widely-acknowledged improved product for decision-making, and providing a catalyst for informing drought monitoring product development. Drought fora, organized around the USDM, have been held regularly and are now scheduled every two years. The USDM subsequently inspired the North American Drought Monitor, involving collaboration among Canadian, Mexican, and United States' scientists.

In 2000, the U.S. Seasonal Drought Outlook was created to more systematically present drought forecasts available from the atmospheric science community. In 2005, the U.S. Water Monitor website (http://watermonitor.gov) was brought on line to provide convenient access to stream flow, reservoir, ground water, and snow observational data and forecasts. Also in 2005, the Drought Impact Reporter was launched as an effort to capture the entire impact side of the monitoring equation. These information sources are invaluable steps, but by themselves fall short of full integration of available data to improve monitoring, providing a better understanding of how and why droughts occur, enhancing dissemination of information at the required spatial and temporal scales, and enhancing the forecasting of droughts.

help them with decisionmaking. These products need to be designed for the various stakeholders at the appropriate scales required by the stakeholders. It would be especially effective if the option existed for stakeholders to test a variety of scenarios to assist and guide their decision-making processes.

One goal of NIDIS is to build upon already existing competencies, experience in other hazards management, and technologies developed among agencies from the local to international level. The U.S. Drought Monitor (USDM; Box 2), an example of which is shown in **Figure 2**, is a widely-regarded composite drought hazard assessment tool. It is the result of an innovative effort by the U.S. Department of Agriculture (USDA), NOAA, and the National Drought Mitigation Center (NDMC) to consolidate and synthesize a wide variety of data and information available from state partners into a single map that summarizes the current status of drought in the United States. This "static" map is not intended to represent the complexity of drought impacts which requires consideration of the joint occurrence of drought and vulnerability. There is agreement that a more robust suite of products is needed, as well as improved navigation tools that focus on specific stakeholder needs and cross-scale (federal, state, local) collaboration.

Appendix A-1 describes four additional examples of collaborative products and processes that will provide bases for progressing with NIDIS early warning system development. An additional example includes the Community Collaborative Rain, Hail, and Snow Network (CoCoRaHS), which was expanded during the 2002 drought to include local drought monitoring and increase public awareness (see http://www.cocorahs.org).

The NIDIS Implementation Plan as laid out in the following pages provides a roadmap for improving the current system described above to meet the critical needs identified in the WGA Report (2004) and the NIDIS Act of 2006 (Public Law 109-430).

3. THE NIDIS IMPLEMENTATION STRATEGY

The implementation strategy is intended to effect the design, conduct and maintenance of a national integrated drought early warning information system that:

- Draws upon multiple warning sources (federal, state, local) and partnerships for data gathering;
- Enables state and county level managers to provide more effective public warnings based on drought risk indicators and triggers for particular decisions;
- Ensures that only authorized officials may enter alerts and warnings;
- Is based on an open, non-proprietary architecture;
- Employs uniform alert and warning terminology that is clearly understood by recipients; and

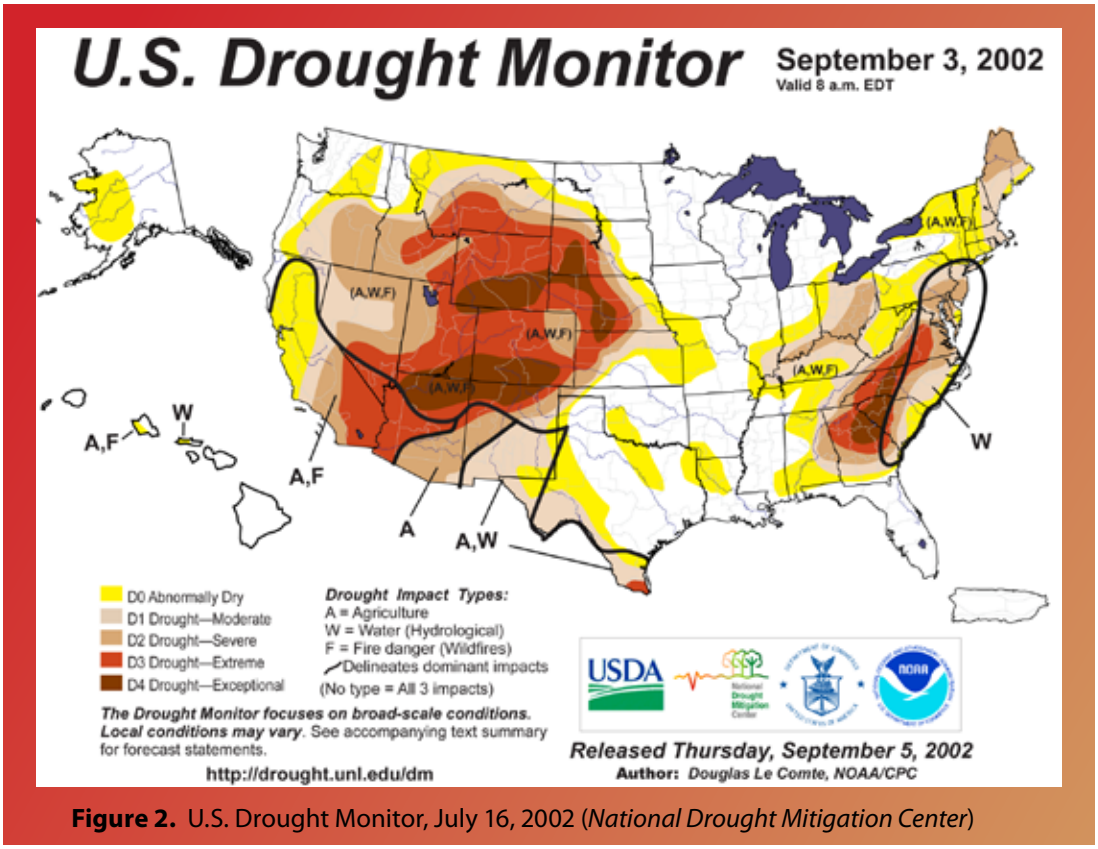


Figure 2. U.S. Drought Monitor, July 16, 2002 (*National Drought Mitigation Center*)

- Supports multiple distribution channels employing multiple technologies.

The Implementation Plan starts from the current system status and goals described above and identifies the following:

- The NIDIS governance structure including
  1. Steering Body roles and responsibilities
  2. Program Director roles and responsibilities
  3. Program Implementation Team roles and responsibilities;
- Core NIDIS activities and working groups;
- Pilot objectives and activities in the near, medium and long term; and
- Activities rollout and anticipated outcomes.

4. THE NIDIS GOVERNANCE STRUCTURE

NIDIS will be governed under three interacting components (i) the NIDIS Executive Council, (ii) the NIDIS Program Office, and (iii) the NIDIS Program Implementation Team. The structure is shown in **Figure 3**.

4.1 The NIDIS Executive Council

A NIDIS Executive Council will be established as an oversight committee for the NIDIS Program. The primary role of the Council is to address and assure collaboration among federal and state agencies, including ensuring that drought activities, within each group represented complement the goals of NIDIS. Further, this governing Council will recognize and provide guidance to federal and sate agencies as needed to assure equal partnership with NOAA in implementation. The Council is a permanent group with members serving over an initial period of five years and as agreed upon by Council members thereafter.

The Council will be chaired by the Directors of the NOAA Climate Program Office and the National Drought Mitigation Center, or their designees. Members of the Committee will consist of senior representatives from the lead agencies (such as USDA, DOI, and others) and also include the Regional Governor's Associations and Water Councils, River Basin Commissions, state government, the private sector, and academia. The Director of the NIDIS Program Office is the primary party responsible for informing and updating the Council and will be responsible for relaying information on critical policy and implementation issues and ideas from the core group to others involved in NIDIS activities. This Council will be established during FY08.

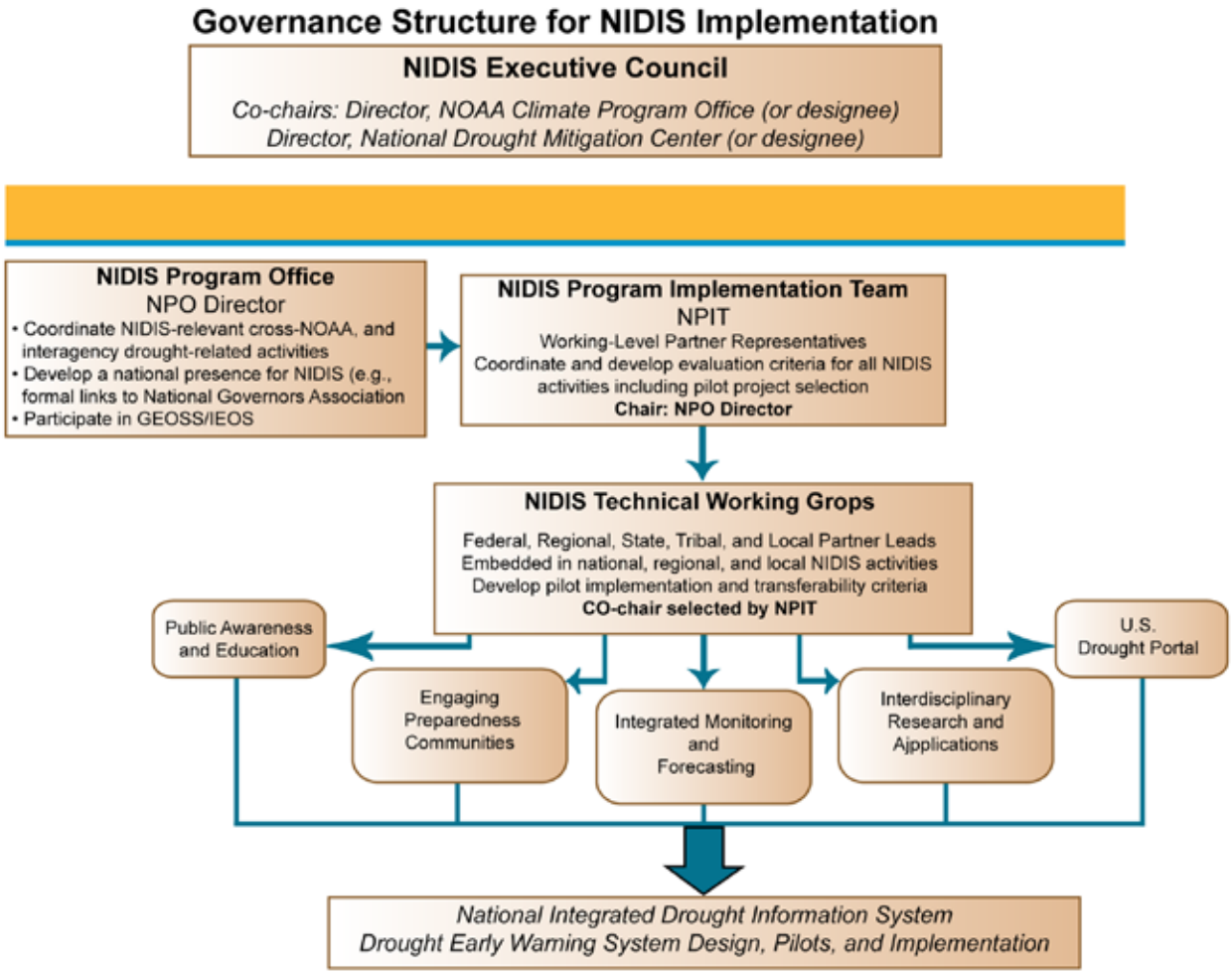


Figure 3. The NIDIS Governance Structure (*leading to a national drought information system*)

4.2 The NIDIS Program Office (NPO)

The NIDIS Program Office (NPO) resides in the NOAA Climate Program Office. The Director of the NIDIS NPO (hereafter, NIDIS Director) reports directly to the Director of the NOAA Climate Program Office and more generally to the multi-sectoral NIDIS Executive Council. The NIDIS Director is to be:

- The point of contact for any interagency NIDIS activity (including participating in activities such as the Integrated Earth Observation System)
- Chair of the NIDIS Program Implementation Team (NPIT)
- The conduit for reporting between the NIDIS field activities and the Executive Council

The NIDIS Director will also provide charges to the NPIT and Working Groups, coordinate and facilitate their work, collate and integrate their deliverables, and communicate their recommendations for action and execution to appropriate agencies, organizations, and offices.

The NPO will provide advice to Agency Leads on drought-related priorities, and monitor and direct external agreements and contracts for:

- The development of blueprints and work plans for NIDIS that will be frames of reference for NPIT and Working Groups:
- Implementation activities, including interagency and other rotation to the NPO;
- Formal collaborative/cooperative memoranda with both federal and non-federal partners for NIDIS implementation, including cost-sharing where possible; and
- Outreach to promote NIDIS and update NIDIS requirements.

As the NIDIS Program develops it is estimated that operational resources for the NPO will evolve to include:

- One (1) Senior Federal Full-Time Equivalency or Individual Personnel Action (IPA) equivalent;
- One rotational assignment funded by the source agency or organization;
- Two (2) Mid-Level Contractors or IPA equivalents;
- Facilitating and funding NPIT Working Groups activities; and
- An assessment of the status of drought early warning and response systems in the United States

4.3 The NIDIS Program Implementation Team (NPIT)

The NIDIS Program Implementation Team (NPIT) is, at present, comprised of representatives of several federal and state agencies, local government, regional and state climate offices, and academia. The NPIT was developed on an interim basis to develop the implementation plan. This "Implementation" team will help to coordinate NIDIS activities as well as participate in implementation and governing decisions in regard to NIDIS. Members of the NPIT act as NIDIS representatives in any capacity as needed and in agreement with the Program Office. A list of current NPIT members, constituting the main contributors to this plan, is given in **Appendix A-2**.

The NPIT will consist of Working Groups focused around critical aspects of drought risk assessment and decision support, including drought prediction, impacts assessment and adaptation mechanisms, and communication. Based upon multi-agency and multi-state input gathered through several workshops, five NIDIS Working Groups have been initiated to provide guidance on system implementation in the areas of (i) education and public awareness, (ii) integrating monitoring and forecasting, (iii) interdisciplinary research and applications for risk assessment, (iv) engaging the preparedness communities, and (v) the web-based drought portal for improving accessibility to usable drought risk information. Each NPIT member will work directly with at least 1 of the 5 Working Groups dealing with key components of NIDIS. The purview and requirements of these Working Groups are discussed in detail below. Each member will report to the Implementation Team as well as through the appropriate working group leads. Group membership will be based upon expertise, sector (federal, private, academic), and program area.

The NPIT will establish Working Group leads for core NIDIS areas and for ensuring the success of pilot activities. General tasks of the groups (sub-area focus below) are to:

- Identify and document guidance for successfully meeting the requirements of NIDIS early warning system design;
- Identify and document activities, products, *etc.*, that are currently available and can contribute to NIDIS;
- Take action where possible and with the approval of the NPIT to develop agreements and direct activities to evaluate and integrate information, technology, and lessons into NIDIS; and
- Periodically review and update documents, memoranda of agreements, and plans for currency and relevance;
- Serve as NIDIS points of contact for relevant interagency and state activities, in agreement with the NPO.

The NPIT group will have a rotating membership. The NPIT Chair will select two additional rotating co-leads with him/her, to represent the research and stakeholder communities at the coordination level. Team activities will be reviewed by the NPIT and funding provided by the NPO as appropriate to support materials development, workshops, sub-group meetings, and related needs. The following are key issues:

- The NPIT will work with the NIDIS Program Office to create Memoranda of Understanding (MOU) or Cooperative Agreements between principal agencies to govern NIDIS operations and ensure integration. This provision covers all aspects of NIDIS.

- NPIT members (in agreement with the Program Office) will represent the NIDIS Program through drought workshops, conferences, and programmatic reviews.

- All projects to be designated as a NIDIS pilot or effort in support of NIDIS will be reviewed and approved by the NPIT or some selected sub-team consisting of NPIT members.

The Working Group leads may add individuals to their particular group. These individuals do not have to be members of the NPIT.

5. NIDIS WORKING GROUPS: KEY ISSUES FOR ADDRESSING GAPS AND REQUIREMENTS

Each Working Group within the NPIT will have 2-3 co-leads responsible for organizing sub-group interagency and interstate activities to identify core competencies, gaps, and paths of action relevant to each specific Working Group or cross-cutting activity as needed.

5.1 Education and Public Awareness

Education and public awareness are essential for effecting drought planning and preparedness. The goals are to provide the public with an awareness of the risk associated with drought conditions in the places that they live and point to mechanisms that increase individual and community capacities for minimizing the social, economic, and environmental impacts of drought. It is essential to have NIDIS partners and stakeholders involved in multiple pathway learning and listening exercises.

This effort will draw on successful existing education and awareness programs used in grass roots disasters and natural resources management. One such example is "Agriculture in the Classroom", a grassroots program coordinated by the USDA. Its goal is to help students gain a greater awareness of the role of agriculture in the economy and society, so that they may become citizens who support wise agricultural policies. Most importantly, the program is carried out in each state, according to state needs and interests, by individuals representing farm organizations, agribusiness, education, and government.

The USDA supports the state organizations by: helping to develop Agriculture in the Classroom programs; acting as a central clearinghouse for materials and information; encouraging USDA agencies to assist in the state programs; and coordinating with national organizations to promote the goal of an increased awareness of agriculture among the nation's students. The Education and Public Awareness Working Group will engage such programs that may serve as low-cost mechanisms for raising awareness of drought risks through local cooperative networks.

Requirements:

This working group effort will:

1. *Identify and Engage Audiences via Local and Regional Partners.* Leverage the role of universities, extension services, and the media to deliver and collect information from business decisionmakers. The best contacts are those that can speak to and are trusted by those businesses and individuals who use the information. This NIDIS component will build on partnerships developed through the Agriculture in the Classroom program, among others.

2. *Develop Formal Education Information* for:
    - K-12
    - University Students
    - Teachers/Instructors
    - Promoting peer review of research in drought education and communication

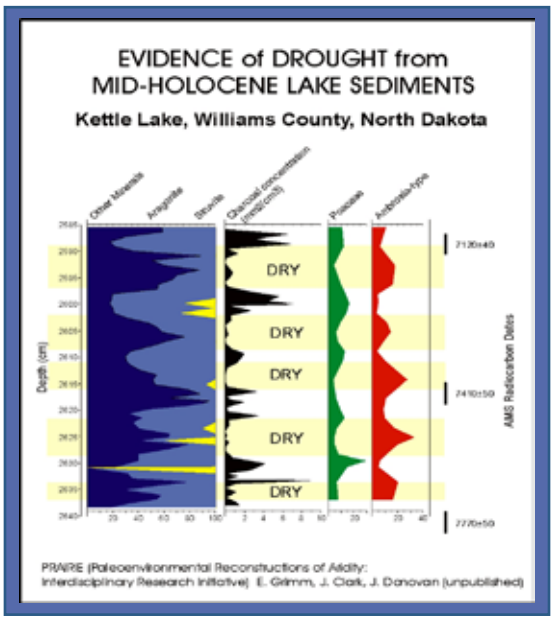
3. *Develop Informal Education Information* and Public Relations for:
    - Policy makers (Congress, state legislatures, counties, and cities)

- Decisionmakers (business, all levels of government)
- Federal/state/university extension units
- Interdisciplinary peer fields

4. *Engage and Improve Public Awareness* of drought hazards, vulnerabilities, and proactive risk reduction: Vulnerabilities are vastly different across the United States and these differences must be recognized and addressed. Real world scenarios and outcomes with a historical or analogue perspective will be developed to address worst case scenarios from the perspective of the intended audience (local, regional, national).

5. *Provide Requirements for Educating Researchers and Decisionmakers* :
   - Catalog and use current successful education and feedback mechanisms
   - Develop a collaborative communication framework between researchers and managers, building on existing programs such as the NOAA Regional Integrated Sciences and Assessments Program (RISA) and agricultural extensions, to bridge differing frames on research and practice on critical drought sensitive issues
   - The NPIT concluded that this would require a staffed or second position strictly devoted to coordinating drought-related public outreach across agencies, states, and academic research efforts

6. *Develop Interdisciplinary Education Teams.* A partnership consisting of RISAs, USDA federal and state extension services, USDA Risk Management Agency, state climate offices, Regional Climate Centers (RCCs), private sector, and media will be entrained (through joint support) to help conduct educational activities. Links via extension services and emergency management are keys to education (multi-way), impacts reporting, developing applicable research, and tapping into what the public/stakeholders deem critical to their decisions and operations.



Most important will be co-support and leveraging of existing weather forecast, water education and watershed initiative efforts, and enhancing professional development in public awareness and communication.

5.2 Engaging Preparedness Communities

Drought preparedness advice and planning are carried out by water-dependent managers such as State Engineers, Water Availability Task Forces, farmers, agribusinesses, land managers, city councils, and others. However, the results of research, including data analyses, are not always disseminated in a timely fashion or through easily accessible or compatible modes for incorporation into risk management. Identification and development of drought triggers and indicators requires active engagement among research, information brokers, and stakeholders in various sectors responsible for managing drought-related risks. Many of the lessons learned following drought events can be documented with post-drought assessments. Without these assessments, many important lessons are lost. Post-drought assessments are a recommended key step within the drought planning process. Bringing such experience from existing networks, such as extension, into NIDIS will be essential for its success. Building links through networks will provide opportunities for communication and collaboration.

Requirements:

1. Facilitate development of a Drought Coordinator network in cooperation with state offices around the nation. Existing Drought Coordinators act as the point of contact within municipalities, tribes, states, and additional organizations with drought plans. For example, each state will be encouraged to appoint (and fund) a Drought Coordinator to serve as a communication focal point. The Drought Coordinators could be located within state climate offices, RCCs, RISAs, Weather Forecast Offices (WFOs), Agricultural Extension Offices, or otherwise. These Coordinators or focal points would help NIDIS by reaching critical user groups and stakeholders, and just as importantly, maintaining the essential human networking called for by NIDIS.

2. Coordinate collaborative (research and stakeholder communities) development of critical indicators and triggers. Triggers ideally specify the indicator, the time period, the spatial scale and whether conditions are progressing or receding. Triggers continue to be a point of confusion for drought officials. NIDIS will focus considerable attention on the trigger issue, working with local officials to make sure that the triggers are appropriate for application in a variety of sectors at the local level.

3. Help to secure funding, develop evaluation criteria, and conduct post-drought assessments with relevant partners including the research community.

4. Facilitate and help to secure funding for drought exercises or drought simulations for risk scenarios and generation of alternative options. Again, these exercises or simulations are important opportunities to identify successful and unsuccessful strategies, and improve on drought plans before drought events occur. The drought planning process also encourages holding drought exercises on a regular basis.

5. Facilitate the improvements of organizational networks to develop and interconnect at every opportunity, creating a network of networks. One important network that could be more effectively utilized around the nation is the Cooperative Extension Service.

This working group in partnership with the Education and Public Awareness Working Group will work with the NPO to coordinate an annual meeting of the drought research, risk assessment, and preparedness communities, to share experiences, lessons learned, and innovative mitigation strategies. It will also facilitate the training of the state and tribal coordinators and field office personnel in communication skills, as well as information dissemination. As noted in numerous studies, once this link is open and trust can be established between information providers and users as co-equal partners in planning and risk reduction, it becomes more likely that discussion of mitigation and preparedness will take hold.

5.3 Integrating Monitoring and Forecasting Requirements and Capabilities

As noted above, current efforts at drought monitoring and forecasting are dispersed throughout numerous federal, state, regional, and local agencies. Twenty-two federal programs share responsibilities for drought monitoring, prediction, and research. Three networks developed through such programs are the USDA Soil Climate Analysis Network (SCAN)/Snow Telemetry Network (SNOTEL), the NOAA/NWS Cooperative Observer Network (COOP), and the U.S. Geological Survey (USGS) Stream Gage and Groundwater Monitoring Network. The U.S. Army Corps of Engineers both uses and supports non-Corps federal monitoring systems and has developed its own remote data sensing network to manage its reservoirs (National Drought Policy Commission, 2000). Regional and state entities also provide considerable data and information services used for drought analysis in real-time. These programs have generally evolved independently, require separate appropriations, and until recently, have not been available to users at a central location due to their complexity and the absence of tools to accomplish data integration. Complementary data from remote sensing (*e.g.*, satellites, radar, aircraft, and other technologies) are used only to a limited extent to fill important gaps in surface data collection networks.

On seasonal to multi-year time scales, the prediction of oceanic conditions and the atmospheric responses to sea surface temperature (SST) forcing and soil moisture feedbacks become important in anticipating drought. Ensemble drought prediction is needed to maximize forecast skill and downscaling is needed to bring coarse resolution drought forecasts from General Circulation Models down to the resolution of a watershed (*e.g.,* 10-20 km). Improved understanding of the dynamical causes of long term trends in both the SST forcing and temperature and precipitation records will enhance the skill of seasonal and longer-term forecasts and hence long term management of water resources.

The Working Group will focus on developing high resolution observational and forecast data bases, including real-time observations, data assimilation products, model simulations and coupled or uncoupled model forecasts to improve data and forecast integration over North America for key NIDIS Pilot areas.

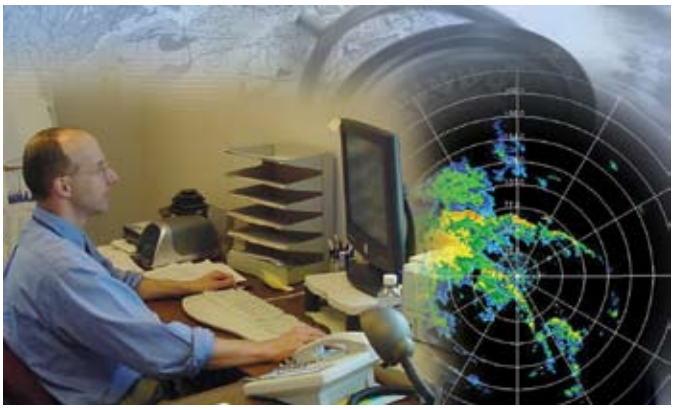
Requirements:

1. Improve coordination of output of federal, state, and local drought monitoring systems. The Working Group will conduct workshops to identify gaps and optimal distribution for drought monitoring coverage.

2. Prototype climate test beds to improve forecasts in the context of drought.

Requirements will be met by supporting improvements of:

i. *Predictions*. Two basic approaches will be used for drought prediction (1) prediction of indices related to drought, and (2) prediction of hydrologi cal conditions related to drought over the region/ river basin of interest. The index approach is the most straightforward for forecasters and is easiest to implement using statistical approaches. Dynami cal forecasts yield information such as soil moisture at different levels, evaporation, precipitation, surface and soil temperature, and snow conditions that can be used in developing drought alert, and manage ment capabilities.



ii. *Time Scales*. The quantities of interest in drought prediction depend strongly on the time scales of interest. For flash droughts, important in the U.S. Northeast, prediction efforts will focus on skillful quantitative precipitation forecasts (QPF) and streamflow prediction at forecast lead times of 1-7 days (week 1). At subseasonal (2 week to monthly) time scales, the focus is on linkages between the leading patterns of climate variability, such as the Madden-Julian Oscillation, and weather extremes associated with drought conditions. At monthly time scales, land conditions also provide a potentially important source of prediction skill in a number of regions.

iii. *Regional Variability*. Drought and persistent long term wet spells are more likely to occur over interior portions of western North America. In this region, when drought sets in, it is also more likely to persist. For river basins in the West, the SST forcing and long term trends have a significant influence on the maintenance of drought; this is clearly the case for the recent (2000-present) long lasting drought.

iv. *Forecast Verification and Initialization*. Precipitation, surface temperature, and streamflow data are required for verification and bias correction of model forecasts. Interagency collaboration in long-

term global and regional reanalyses are required for model forecast initialization and evaluation. This includes a full set of land and ocean conditions necessary for generating the hindcasts that are used to calibrate the model forecasts.

In the near-term, Working Group efforts will be focused on improving the density of soil moisture sensors, improving timeliness of reservoir data, and identifying priorities for improved monitoring as feedback to federal and state agencies. NIDIS will work to augment this capability by installing soil sensors at the 114 Climate Reference Network sites using a phased approach, and also install telecommunications equipment at 200 western reservoirs at the rate of 20 reservoirs per year.

Another major near-term goal of this Working Group will be to identify the impact of soil moisture anomalies based on *e.g.,* North American Land Data Assimilation System (NLDAS) outputs. The soil moisture precipitation

relationships are seasonally and regionally dependent. While differences among soil and hydrological products generated by different NLDAS models are large, anomalies computed with respect to each model's long term mean tend to capture realistic variability. For soil-related properties, ensemble mean anomalies can enhance the signal and decrease uncertainties.

The Working Group will also promote awareness of drought monitoring products derived from satellite remote sensing, work closely with the Integrated Research and Preparedness Working Group to guide the development of user-based drought-related triggers.

5.4 NIDIS Interdisciplinary Research and Applications

Developing and supporting a framework for collaboration between researchers and managers is important to the success of NIDIS. A shortcoming of existing drought research programs is a relative lack of sustained interactions between the research community and beneficiaries. Linking research programs to, for example, the users of the NIDIS Portal would ensure sustained interactions and provide a feedback mechanism to those funding and conducting drought research.

Environmental resources and services often receive inadequate attention during drought emergencies and in drought planning, not necessarily because of lack of concern but because of lack of expertise in this arena, lack of adequate financial resources, and sometimes lack of awareness. Addressing environmental concerns and services (on which economic activities such as recreation and tourism might depend) in relation to drought is best accomplished in the context of existing integrated watershed, coastal, and ecosystem management and restoration programs. NIDIS will actively engage these planning and development programs, especially as drought impacts extend across state boundaries and borders. The goal is to enable decisionmakers, such as urban water managers, to conduct "if-then" scenarios within their planning horizons, in which the frequency, extent, severity, and longevity of past droughts can be used to study potential impacts of emerging drought conditions under alternative management strategies. Such models will characterize the inherent uncertainties associated with forecasts and scenario assessments, and provide guidance on their usability for planning.

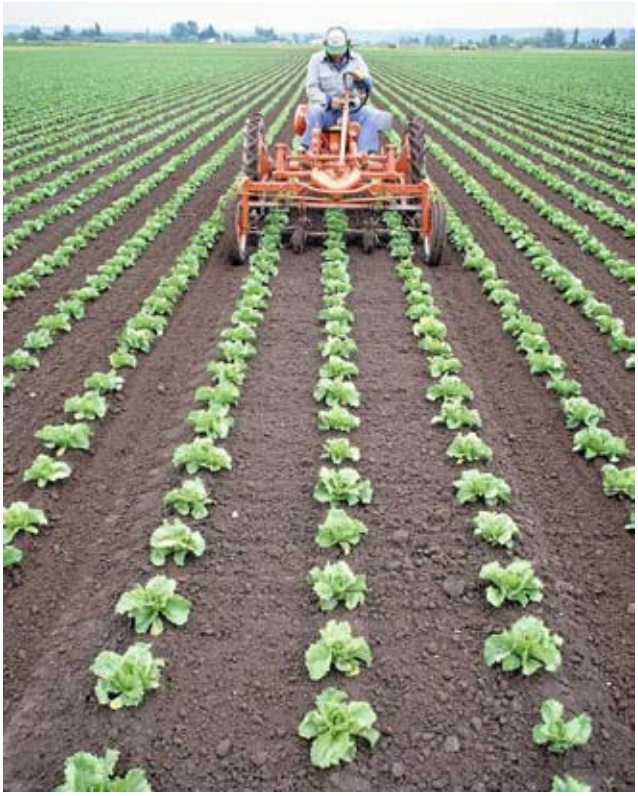
Requirements:

1. Coordination of Existing Drought Research and Applications Activities

An Integrated Research Coordination Board (IRCB) will be created by the NPO and this Working Group to compile an inventory of ongoing drought research, implement a structured process to assess knowledge gaps, conduct sector and regional stakeholder workshops to connect agency activities to applications, and provide guidance to research agencies for drought-related priorities. This Board will consist of no more than 15 members who will be drawn from NIDIS participating federal agencies; local, state, and Native American tribal governments; academia; non-governmental organizations; and other stakeholder representatives. Members shall serve 3-year staggered terms and have an option for reappointment. In the event of a vacancy, the organization from which that member originated shall appoint a successor to fill the remainder of the term. In the interim, the Board will be chaired by the sub-team leads from the NPIT and report to the NIDIS Director. In the long-term, IRCB members shall nominate one member representing the federal agencies and one member external to federal government to be Chair and Co-Chair, subject to approval by the NIDIS Program Director and NPIT.

2. Integrate Causal Factors into Adaptive Management

Regardless of the agency or arena in which research is conducted, it is critical to develop an understanding of the relationships between biophysical measures and models of



drought within the context of economic, ecologic, and social impacts so that responsive management alternatives can be identified and adopted to mitigate losses. To facilitate this research, NIDIS will facilitate development methodologies to conduct assessments for a variety of sectors, such as water resources, crop and livestock agriculture, forestry, energy, wildlife, recreation, and tourism.

3. Develop Guidelines, including Minimum Standards, for Loss Estimation

Guidelines are needed for direct and indirect loss estimation, such as data compilation and metadata standards. Minimum specifications would include: event type, beginning and end date of the event, spatial (physical, administrative) coordinates, sectoral impacts (agriculture losses, tourism visits and spending), incurred fatalities, and others. These would include guidelines for assessing the benefits of drought risk mitigation technology and practice including improved observing and forecasts systems, and proactive management of risks.

4. *Provide Field-tested Methodologies for Developing Drought Risk Indicators and Trigger Definitions based on Management and Planning Priorities*

Integrating drought risk scenarios into actionable information requires the development of sequential critical indicators for planning and operations. Triggers involve issues of scale and sector. There is an urgent need for improved identification and analysis of triggers, cooperatively designed with stakeholders around specific management priorities and system thresholds.

5. *An initial task of this group is to conduct an inventory of drought-related research portfolios in federal and state agencies and the private sector*

The IRCB will also query NIDIS state and private partners to identify non-federal sources of drought-related funding (including research on water management and precipitation variability). The inventory should be completed within the first year of the Board's operation. As part of this activity the Board will establish partnerships with insurance and reinsurance companies to generate comprehensive assessment of direct, indirect, insured, and uninsured losses.

5.5 The U.S. Drought Portal (USDP)

The U.S. Drought Portal (USDP) concept is based on the need to assimilate and quality control drought data, models, risk information, and impacts, and to create a point of entry for archiving and disseminating data. The USDP will be comprised of information tailored for various user communities. The portal will work by combining NIDIS-related data and information from the other four working groups with tools necessary to exchange and integrate data on various space and time scales, and among various formats. These portal data will incorporate a spectrum of information from both federal interagency and non-federal sources. The USDP will be developed to assimilate national level data but tailored toward various users within each pilot. Feedback within the pilots will shape USDP development. It will allow for customers to choose an interface that meets both their needs and comfort level. The conduit should be flexible enough to allow for novice up to expert users and has the potential to be customizable through a "My page" approach, which would allow the users to select the tools/applications/indicators/content that are most relevant to their information needs.

Requirements:

Develop and designate a national internet-based clearinghouse for data, models, risk information, and impacts of drought, with responsibility for archiving and disseminating data through a Web-based portal. A portal is a "site on the World Wide Web that typically provides personalized capabilities for their visitors." The USDP will serve to provide reliable information on drought conditions at county, regional, and national scales and serve as the primary point of entry for drought-related queries (through the already secured drought.gov URL) for a variety of user groups. Such questions include:

- Where are drought conditions now and where might they develop?

- Does this drought event look like other events in the past?
- Will the drought continue?
- How is the drought affecting me?
- How can I plan for and manage the impacts of drought?

1. U.S. Drought Portal Home Page

Figure 4 provides a first cut at a USDP home page on the internet. This mock-up characterizes key components of the portal, including the U.S. Drought Monitor, the Drought Impacts Reporter, and the Seasonal Drought Outlook. This information, provided through so-called "portlets" will offer the user direct access to understanding drought from the current, recent past, and future perspectives, respectively.

In considering USDP information, the ability to provide county-level granularity is important to stakeholders in terms of near-real-time reporting of precipitation, temperature, soil moisture, streamflow, and reservoir levels. Both pull and push of data (*e.g.*, Drought Impact Reporter) are important. Homogeneity and standardization in reporting are important. There is recognition that prudent scarcity-based reservoir management requires use of probabilistic forecasting, and that there must be a balance of resources between timeliness and data quality (*e.g.*, use of preliminary data).

2. Ensure a User-Friendly Interface: Stakeholder Design Input and Needs

An internet portal to drought information will provide relevant spatial and temporal drought risk information to three distinct user communities:

Figure 4. Mock-up of USDP home page (National Climatic Data Center [*NCDC*])

1. The general public who need to know the status of drought and what actions to take if the drought worsens where they live and work;

2. Decisionmakers and businesses at state and county levels that need to plan for and mitigate drought, and;

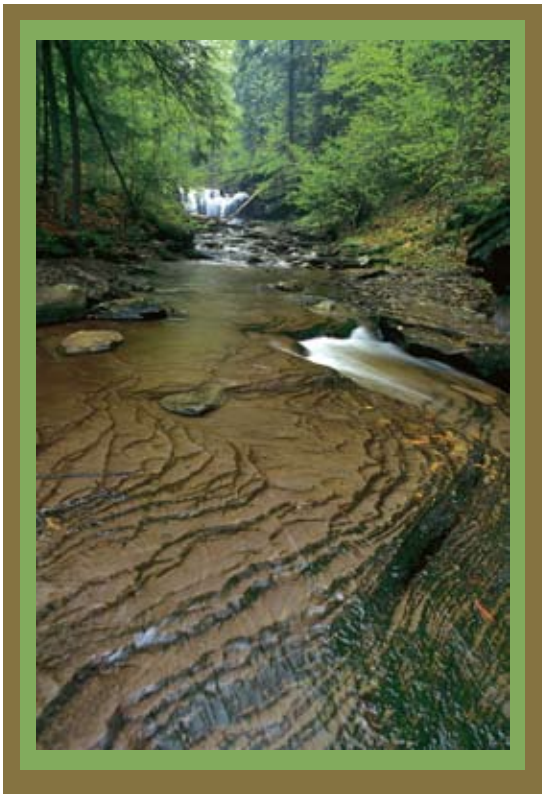
3. Drought experts and scientists tasked with developing more refined decision support systems.

3. Integrate Diverse USDP Data and Products

In cooperation with NOAA, USGS, USDA, National Aeronautics and Space Administration (NASA), and others, a rich collection of drought-related information will be available on the USDP. Examples of products to be included in the USDP are as follows:

1. *Observed Data*: Observed elements at multiple time and spatial scales as both station and gridded datasets: precipitation, snowpack, streamflow, reservoir levels, ground water, crop moisture, soil moisture, temperature, anomalies, and drought impacts.

2. *Derived Products and Indices*: U.S. Drought Monitor, Palmer Drought Severity Index (PDSI), Standardized Precipitation Index (SPI), Objective Blends, Surface Water Supply Index (SWSI), Vegetation Drought Response Index (VegDRI), and the Keetch-Byram Drought Index (KBDI).



3. *Forecast Products*: Water supply, streamflow, climate, snowpack, and U.S. Drought Outlook.

4. *Educational Products*: Information that educates the user on what data are used to construct specific products, uncertainty in the observations, indexes, and forecasts. It will also provide examples of which products should be used to make specific decisions;

5. *Planning and Mitigation*: Decisionmakers and businesses at state and county levels that need to plan for and mitigate drought; and

6. *Decision Support Systems*: Drought experts and scientists tasked with developing more refined decision support systems.

Examples of core websites whose data and applications would be aggregated into a common look and seamless flow of data and information products via the USDP include:

1. *National Drought Mitigation Center (NDMC)*: This site hosts the Drought Monitor and The Drought Impact Reporter. NDMC helps people and institutions develop and implement measures to reduce societal vulnerability to drought. http://www.drought.unl.edu/dm/index.html and http://droughtreporter.unl.edu/

2. *Applied Climate Information System (ACIS)*: ACIS is part of the NOAA National Climatic Data Center (NCDC) National Virtual Data System (NVDS) and is operated by the six RCCs. ACIS provides both real-time and historical climate data from a variety of networks. ACIS also allows execution of user adjustable programs to support drought risk analysis. http://rcc-acis.org/

3. *National Water Information System (NWIS)*: NWIS is operated by the USGS and provides both real-time and historical surface streamflow, reservoir, and groundwater information. http://water.usgs.gov/waterwatch/

4. *Joint Agricultural Weather Facility (JAWF)*: This joint USDA/Department of Commerce operation develops crop weather impact assessments for the United States and the world. http://www.usda.gov/oce/waob/jawf/

5. *National Climatic Data Center (NCDC)*: NCDC is the national archive for climate data and products. http://www.ncdc.noaa.gov/oa/ncdc.html

6. *Climate Prediction Center (CPC)*: CPC provides a variety of climate analysis and prediction products. http://www.cpc.ncep.noaa.gov/

7. *National Water and Climate Center (NWCC)*: NWCC provides access to western water supply forecasts along with SNOTEL and SCAN data. http://www.wcc.nrcs.usda.gov/

8. *National Weather Service – Hydrology*: The River Forecast Centers provide streamflow forecasts for the United States. http://www.nws.noaa.gov/oh/index.html

9. *Center for Earth Resources Observation and Science (EROS):* USGS/EROS provides interactive map access to the Vegetation Drought Response Index (VegDRI) and seasonal greenness images derived from satellite imagery. http://gisdata.usgs.gov/website/Drought_Monitoring

The USDP will also: 1) support the ability to graph relevant data and products spatially and temporally, and interactively compose maps, 2) allow users to arrange and save selected products for a specific geographic area for easy return visits, and 3) support links to specific decision support systems.

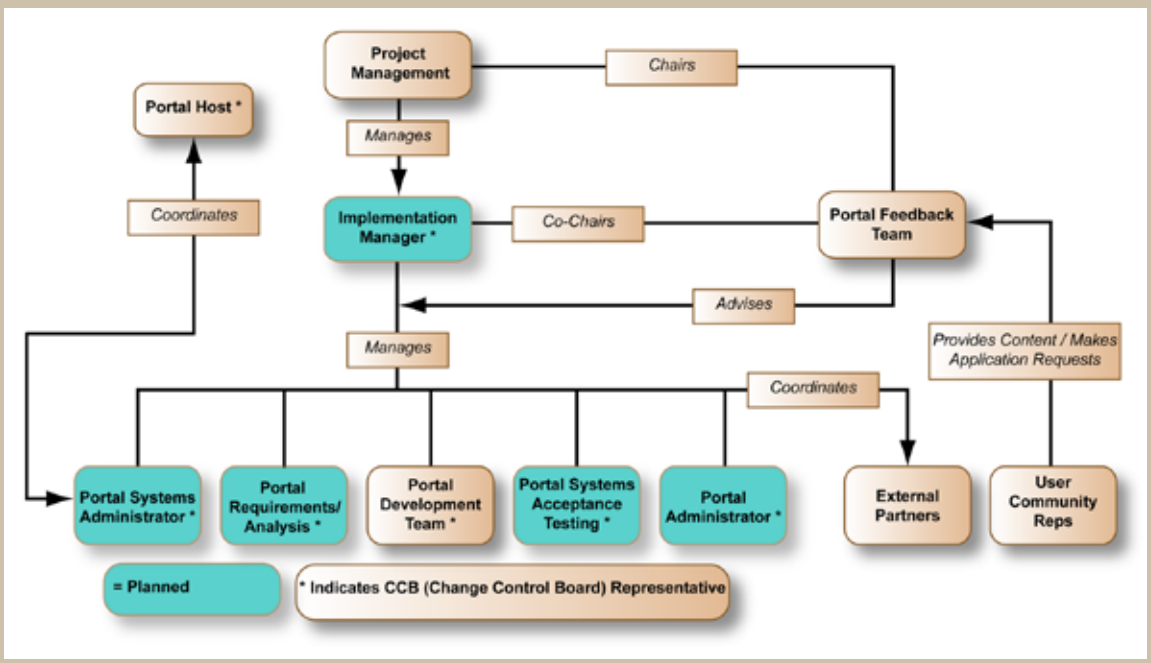


Figure 5. NIDIS USDP Working Group Structure (*NCDC*)

5.5.1 Portal Development Working Group

As the public face of NIDIS, portal development will be essential to both outreach and dissemination efforts of NOAA and its partners. Developing an intuitive, easy-to-navigate site will be the goal to connect people to critical tools. As a critical element in its design, an emphasis should be placed on soliciting input and assessing user needs (via surveys, workshops, focus groups, *etc.*), ideally, prior to or early on, during the development of this drought gateway or "yellow pages".

As the NIDIS USDP activity moves forward, a more formal governance model is planned. Key to the Portal governance is the role of the Portal Feedback Team (PFT). The PFT will serve as consultants and advisors throughout all phases of the Portal effort. As a group, the team will make decisions and set standards concerning style, look and feel, best practices, naming conventions, and roles and permissions. The team will be led by members of the management team and will be comprised of representatives from both the technology and scientific communities (including users), and will be linked to NIDIS through representation on the NPIT. **Figure 5** outlines the roles of Working Group members.

The USDP is being designed to incorporate data resources from a host of U.S. agencies. This is already anticipated to be extensible for the inclusion of data resources from North America for drought monitoring and impact reporting. NCDC, as a co-leader with the NDMC in the USDP effort, will be a contributor of key data resources to the portal through its NOAA National Virtual Data System (NVDS), including a suite of data access tools for U.S. and international data, including the National Operational Model Archive and Distribution System (NOMADS) for model data access, and the Comprehensive Large Array-data Stewardship System (CLASS) for satellite data access to be integrated with NVDS.

6. DESIGNING AND IMPLEMENTING EFFECTIVE DROUGHT EARLY WARNING SYSTEMS: THE NIDIS PILOTS

Early warning systems can be interpreted narrowly as technological instruments for detecting and forecasting impending hazard events and for issuing alerts. This approach, however, does not clarify whether warning information is actually used at the national and local levels to reduce risks (ISDR, 2006). The disaster research and emergency management communities have shown over the past forty years that warnings of impending hazards need to be complemented by information on the risks actually posed by the hazards and likely strategies and pathways to mitigate the loss and damage in the particular context in which they arise.

The NIDIS Pilot activities will provide a major mechanism for the nation to prototype various approaches for developing early warning and information for proactive drought risk reduction. As drought crosses many time and space scales, the initial NIDIS Pilots will span a cross-section of spatial scales, administrative units, and types of drought, as outlined in **Table 1**. The goal of the pilots will be to explore and demonstrate a variety of early warning and

Table 1. Short-, medium-, and long-term NIDIS Pilot activities contributing to national drought preparedness and early warning

Short – Term 1-3yrs	Medium – Term 3-5 yrs	Long – Term >5 yrs
Establish a limited number of NIDIS Pilot projects to explore and demonstrate drought risk reduction strategies using drought monitoring and prediction information in partnership with users and federal, state, regional, and local agencies.	Evaluate effectiveness of Early Warning System Pilot projects; and initiate second series of regional NIDIS Pilot projects using lessons and technologies from the first series of Pilots in conjunction with already existing activities.	Transferability: Complete staging and diffusion of regional Pilot projects to achieve national coverage.
Initiate NIDIS Pilot identified activities needed to improve regional to local capabilities to educate and communicate drought information and awareness.	Develop an understanding of factors contributing to droughts for improving the usefulness of prediction products and for improving drought preparedness.	Use integrated interagency drought information network for education and delivery of products and services at regional to local level.
Initiate NIDIS Pilot defined activities to develop drought impacts assessment methodology and reporting requirements.	Begin process for transferring NIDIS Pilot lessons to non-Pilot projects at state and county levels to assess regional and local drought impacts.	Continued drought information system refinements such as inputs into watershed, state, and local drought plans and operations.

drought risk reduction strategies that incorporate drought monitoring and prediction information in partnership with users and federal, state, regional, and local agencies. The NIDIS Pilots are to chart a collective national pathway to inform other regions of the country of the best practices to establish an integrated drought information system. As such, implementation must be carried out in the context of transferability to under-served regions of the country.

NIDIS Pilot funding levels will be scalable to maturity and the scope of effort already underway. Some of these pilots may initially be supported to fund exploration and assessment of the regional needs, whereas the readiness of other NIDIS Pilot locations may merit more significant commitment of resources. In addition, while there will only be incremental growth in the limited number of NIDIS Pilots that are financially supported, the NPIT will sanction a broad range of existing and funded drought related activities supporting one or more aspects of drought early warning but not necessarily intending to meet the full complement of NIDIS Pilot criteria.

6.1 NIDIS Pilot Design and Implementation

The NIDIS Pilots are intended to foster development of information, tools and pathways for drought-sensitive communities across the nation to assess current situations (stakeholder and information networks, the spectra of drought impacts, identification of monitoring, and forecasting gaps), and identify and test innovations across all early warning subsystem components (see below). Rapid/broad needs assessments will be crucial to provide an initial framing for region/watershed/state/county critical issues and information needs. However, essential components of the NIDIS Pilots must meet well-established criteria for effective early warning systems. An assessment of successful design criteria for a variety of early warning systems (health, hurricanes, technology, and others) suggests that several sub-systems are needed for effective actionable warnings. **Appendix A-1** provides one such example, the FEWS (Famine Early Warning System). Each pilot will have sub-components that meet the following requirements for early warning system design:

- *Education and Public Awareness Sub-systems*: Assess and improve where necessary public awareness of drought related risks and sensitivities.

- *Integrate Monitoring and Forecasting Sub-systems:* Project emerging conditions in the physical environment and contribute to the better understanding of present conditions and past events.

- *Develop Risk Assessment Sub-systems*: Enable resource and other management authorities to generate risk and impact scenarios (*e.g.*, monitoring and forecast tailoring for trigger definition).

- *Engage Preparedness Sub-systems*: Outline and inform actions required to reduce the loss and damage expected from an impending hazard event.

- *Communication Sub-system*: Delivery of timely information on impending events, potential risk scenarios, and preparedness strategies for at-risk communities.

- *Evaluation and Feedback:* Work on sub-systems to refine the NIDIS process and for transferability to similar locations/regions. This will help foster development of new technologies and technology transfer for more efficient water resource management.

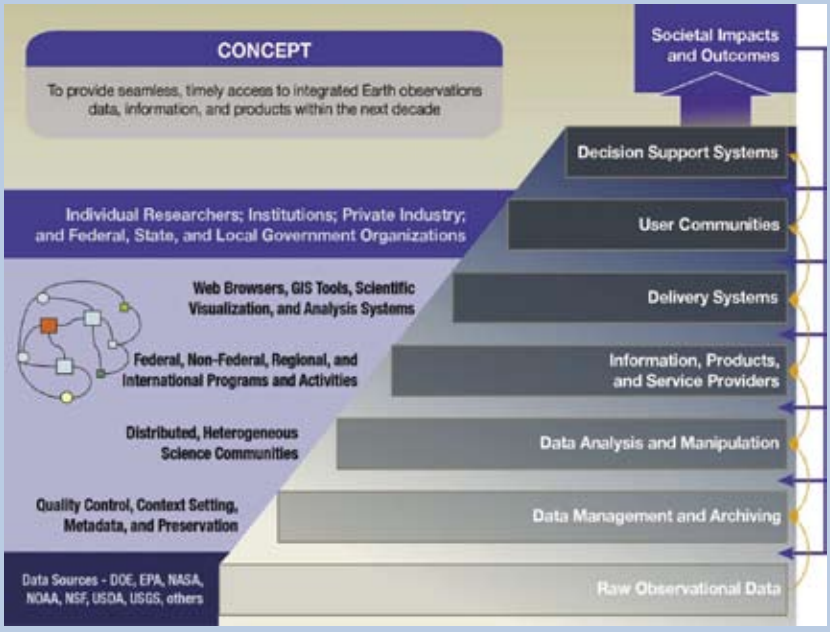


Figure 6. NIDIS Data Information and Assimilation Conceptual Model (*USDA*)

The five NIDIS Working Groups will integrate their activities with locl teams at the scale of each pilot. The NIDIS data assimilation conceptual model to be employed is shown in **Figure 6**. The Drought Portal is a key to coupling the raw data to the decision support systems. In this role, the portal serves as the primary information clearinghouse for the early warning subsystems in the context of larger multi-objective observations and analysis systems conducted by federal, state, and private sectors. As such, the NPIT Working Group must ensure that input to and retrieval from the portal within the pilots range across a *variety of users, whose livelihoods are impacted by drought, to large businesses, water managers, and the research community.* Box 3 outlines the first series of NIDIS prototype activities and anticipated outcomes.

Based on discussions in various for a, the NIDIS Program Implementation Team has selected several pilot states/ regions as first stage NIDIS activities. These are shown in **Figure 7**:

Colorado River Basin/Southwest: Water management issues with growing population (demand) in an arid region representing seven states; immediate problem with long-term (multi-year) drought. Focus will be placed on the Upper Basin with second stage activities in the Lower Basin.

Montana/Northern Plains: Tourism and recreation, farming and ranching in a semi-arid area dependent upon rainfall / snowfall; short-term, rapid-onset drought in a transboundary state (Montana)

Missouri/Middle and Southern Plains: Transition area between semi-arid (west) to abundant precipitation; rain-fed agriculture, aquifers, and small reservoirs to manage; technology transfer issues such as those from the well-developed Oklahoma system to Missouri.

Chesapeake Bay/Northeast: Densely-populated, urbanized environment with multiple environmental stressors and low water storage capacity; water quality issues during drought (saltwater intrusion, pollutant concentrations, water temperature/ fish kills). This pilot will focus on instream flows from the Susquehanna, James, and Potomac Rivers.

Mississippi/South: This prototype activity will begin at least a year after initiating the above pilots.

Figure 7. NIDIS Pilot Project Locations (blue)

Lessons will be used from these in the development of institutional and observational capacities and tailoring of the Drought Portal into areas with as yet little formalized drought activities. The NPIT working group members will work with local pilot sub-teams to ensure that NIDIS requirements are met.

The second stage pilots will be selected as the design lessons from the above pilots are being evaluated.

Pilots will follow an agreed upon protocol (see guidelines below) with adjustments to be made as needed in the context of each pilot location:

- Assess capacity for conducting pilot projects in different administrative units (county, watershed, tribal, state, and regional) and drought types.
- Explicitly engage multiagency entities (WFOs, RISAs, and RCCs), State Climatologists, and Agricultural Extension and Natural Resources Conservation Service (NRCS) personnel as communication and dissemination resources. Identify complementary activities across criteria for effective early warning systems design.
- Choose the unit or units of analysis within the respective watershed or state.
- Select federal-state-local sub-team for implementation across early warning subsystems in each setting.
- Conduct capacity assessment in the context of early warning system criteria. Assess how the present system has responded in the context of recent droughts and how it would respond in the context of major events retrospectively (paleodroughts, 1930s, 1950s, etc.), vertically (i.e., from the national down to a particular county or municipality), and horizontally (i.e., agencies and organizations across the region, state, or watershed).
- Revisit steps to date and adjust protocol as needed for particular contexts, sectors, and community considered.
- Develop and test monitoring and forecast tailoring at appropriate scales of warning, drought risk assessment tools, and early warning products and services. This process includes coordinating existing federal, state, and local drought monitoring, forecasting, and planning activities in order to tailor products to users in the pilot regions.
- Refine the Drought Portal regionally and locally to provide timely surface observations and forecasts on a regional basis for planning and decision-making with respect to drought (temperature, precipitation, soil moisture) events, extreme events (intensity, frequency, trends, duration, etc.).
- Re-evaluate response potential for recent droughts, past significant events and projections of long-term changes. What improvements in relationships or mix of relationships (e.g., among State Climatologists, RISAs, agricultural extension, county-level) are needed?
- Test transferability to a state, watershed, or locale that has limited localized observational capacity and early warning infrastructure. Coordinate and improve monitoring and forecasting sub-systems in that location.

Pilot activities are anticipated to be completed over a period of two years. The ultimate success of the NIDIS Pilots will be measured in local-to-regional success stories, increased awareness of drought-related risks across the nation, and centralized and decentralized risk reduction approaches that recognize the value of moving beyond proof-of-concept to implementation of proactive management strategies.

7. CORE NIDIS ACTIVITIES AND TIMELINES

In response to the NIDIS Act of 2006 (Public Law 109-430), the following key areas are being emphasized in resource allocations. Each of these will have specific NPIT attention from the relevant Working Groups.

- *Drought Portal development and tailoring*
- Coping with Drought (Integrated research and applications, Engaging preparedness

communities, Education and Public Awareness)

- Integrating Data and Predictions (Climate Test-beds, new monitoring)
- NIDIS Pilots (Early Warning System design and implementation in selected locations)

The NIDIS Program Office (including NPIT supporting activities) requires resources to manage these areas. Since the NPIT is a cross-agency and cross-state group, it is anticipated that the NIDIS Executive Council will seek in-kind support for NPIT members and activities from respective agencies and organizations.

Table 2 provides NIDIS Implementation Milestones for the FY 2007 through FY 2013 period. The table lists key objectives based on the requirement to support the National Integrated Drought Information System (NIDIS) Act of 2006 (Public Law 109-430), the Western Governors' NIDIS recommendations, the National Drought Policy Commission Report (2000), and the U.S. Group on Earth Observations (USGEO) NIDIS Near-Term Opportunity recommendations.

Near-Term objectives (FY 2007-08) include development of governance, enhancement of observations, data management and distribution, and drought predictions and impacts research. In this time frame, planning for pilot project selection and implementation and assessment of the national status of drought early warning will take place. *Medium-Term objectives* (FY 2009-13) include the implementation of pilot studies on several scales (watershed, state, region, county) and across timescales (seasonal to decadal and longer), as well as the enhancement of regional impacts and adaptation research and improvement of prediction resolution. By FY 2014, NIDIS is anticipated to be fully operational.

8. INFORMING CLIMATE SERVICES AND THE GLOBAL EARTH OBSERVATION SYSTEM OF SYSTEMS (GEOSS)

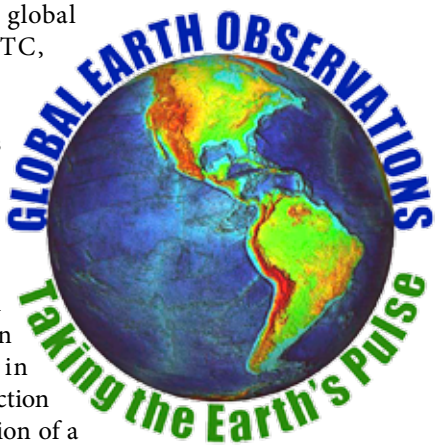
8.1 Climate Services

The National Research Council (2001) defined Climate Services as: "The timely production and delivery of useful climate data, information, and knowledge to decisionmakers." "Production and delivery" involves supporting strategic or physical system monitoring and research, applied research to develop impacts assessments and risk scenarios, and adaptation or embedding such knowledge into practice in particular contexts. No one structure can be optimal for all purposes. As the NIDIS program develops it will expand this definition to include design criteria that elucidates the partnerships that are needed and the transaction costs incurred in securing and maintaining those partnerships. In addition, NIDIS informs the development of services across all climate timescales from seasonal to decadal and longer, and across spatial scales to develop an understanding of how near-term adjustments to immediate events can be employed to decrease vulnerability in the context of climatic change.

NIDIS Pilots will help to define the network of activities that is needed to maintain well-structured paths from observations, modeling, and research to the development of relevant place-based knowledge and usable information.

8.2 The Global Earth Observation System of Systems

In February 2005, nearly 60 nations at the Earth Observations Summit III in Brussels adopted a 10-Year Implementation Plan for the Global Earth Observation System of Systems (GEOSS), and establishing the new Group on Earth Observations (GEO). GEOSS and International Earth Observing System (IEOS) will facilitate the sharing and applied usage of global, regional, and local data from satellites, ocean buoys, weather stations, and other surface and airborne Earth observing instruments. The United States Group on Earth Observations (USGEO) was established in March 2005 as a standing subcommittee of the National Science and Technology Council (NSTC) Committee on Environment and Natural Resources. The USDP will provide a critical link between the User Communities and the Information, Product and Service providers, and will support the USGEO concept "*to provide seamless, timely access to integrated Earth observations data, information, and products within the next decade.*" As USGEO considers building on NIDIS to develop a so-called Global Integrated Drought Information System (GIDIS), it is important to consider the contributions that the current NIDIS Early Warning System design and the USDP effort can provide for this activity. Requirements for the international activity are to be determined, but the current effort to develop the USDP is sufficiently nimble to be extended to a global framework (NSTC, 2006).



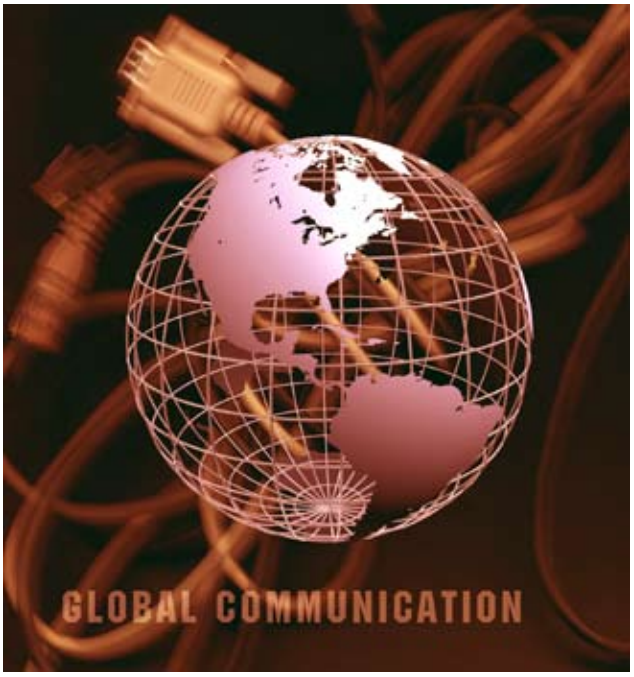
The USDP is anticipated to be ready for demonstration at the GEO Ministerial Meeting in November 2007 in South Africa. Selection and implementation of a focused capability to provide

Table 2. NIDIS Implementation Milestones (*FY 2007 – FY 2013, by year*)

#	Milestone	07	08	09	10	11	12	13
1	Initial portal operational capability at *drought.gov*							
1	Advanced portal mapping capability with GIS tools							
1	Populate *drought.gov* website (portal, plans, reports, agency links)							
1	Operational portal communities and collaborations							
1	Enhance data management and distribution							
1	Portal extension to hemispheric and global domains							
2	Drought forecast regionalization studies							
2	Enhance soil moisture and temperature measurements							
2	Forecast verification and calibration to measurements							
3	Coordinate with CPO Program Managers/agencies on interdisciplinary research goals							
3	Inventory drought-related service (federal/state/private)							
3	Assess national status of drought early warning							
3	Inventory drought-related research (federal/state/private)							
3	Coordinate drought preparedness plans							
3	Planning for adaptation							
3	Institutionalize “Drought Coordinator” network							
3	Enhanced regional impacts research							
3	Implement adaptive management strategies							
4	Pilot study scoping and selection							
4	NPIT workshops: Define criteria and assess partner interest and capacity for pilots							
4	First Workshop: Assessment of Drought Early Warning System Status in the United States							
4	Pilot study implementation							
4	Initial early warning prototypes							
4	Pilot study assessment and follow-on work							
5	Establish NIDIS Program Office, governance structure, and final Program Implementation Team							
5	Establish regional sub-team leads within NPIT							
5	Establish initial agency/state rotational assignment to NIDIS Program							
5	Establish NIDIS Interdisciplinary Research Coordination Board							
5	Extend NIDIS to National Governors’ Association and Interbasin Watershed Commission							
5	Operational workshops to assess national drought monitoring and forecasting gaps							

Activity Legend:

1. *U.S. Drought Portal:* Development and tailoring
2. *Climate Test Beds*: Integrating data and enhanced predictions
3. *Coping with Drought:* Integrated research and applications, Engaging preparedness communities, Education and Public Awareness
4. *NIDIS Pilots:* Early Warning System design and implementation in selected locations
5. *NIDIS Program Office*



global drought-related data and information through the portal should be identified, optimally including China, Europe, and Latin America.

9. PARTNERSHIPS AND STAKEHOLDERS

Various agencies and programs represent a range of activities as either producers of basic or applied knowledge or primary stakeholders. For example, the National Science Foundation's research on social sciences informs how NIDIS outreach and education activities should be structured. Others, such as the Tennessee Valley Authority, are envisioned to be primary users of the Drought Portal. Still others, such as the Internal Revenue Service and Small Business Administration, administer assistance programs when individuals report losses due to drought. Representatives from some of these agencies will serve on the Integrated Research Coordination Board (IRCB), including one member as a Chair or Co-Chair. Others will be engaged in stakeholder workgroups and be asked to contribute information during the research assessment. Contacts within each of these agencies should be identified by the NIDIS Program Office at the time the IRCB is established to assure access for the Board in a timely fashion.

Non-federal stakeholders are expected to be an important component of NIDIS research activities including:

- *Western Governors' Association:* A key sponsor of early NIDIS development efforts and ongoing concerns representing drought in the Western States;
- *Western States Water Council*: Represents water managers in the Western United States;
- *National Conference of State Legislatures*: Drought monitoring and mitigation activities will require state support, much of which require state legislative involvement;
- *National League of Cities*: Focus on water availability and quality issues;
- *American Association of State Climatologists*: An organization of state-appointed individuals, many of whom are active participants in the Drought Monitor or serve on drought monitoring committees within their respective states. Most are housed at universities and also conduct applied climate research;
- *Regional Climate Centers (RCCs)*: The six centers contribute to near-real-time *in situ* data provision, climate information services, and applied research associated with multiple aspects of drought;
- *National Drought Mitigation Center*: A national clearinghouse for drought-related information, research, mitigation measures, and operational home of the Drought Monitor;
- *Native American Tribal Governments*: Mostly located in arid regions in which water is a vital concern. Linked to Integrated Research and Applications work (impacts and indicators for coping with drought).

In addition to these listed, most professions have a national organization or organization which may be identified as a lead NIDIS stakeholder, such as water managers, engineers, or environmental scientists. Environmental non-profit organizations such as the Sierra Club or Nature Conservancy are key stakeholders as well. Members of some of these non-federal governmental or non-profit organizations will be invited to serve on the Research Coordination Board. Others will be participants in stakeholder workgroups.

The federal agencies and programs in Box 3 have been identified as critical components of a NIDIS partnership.

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APPENDIX A-1: EXAMPLES OF EXISTING CAPABILITIES AND TOOLS

NIDIS will draw heavily on existing capabilities and innovations in federal, state, and local systems. The examples below represent four such systems that will provide guidance for NIDIS subsystems design.

Regional Climate Centers: The Applied Climate Information System (ACIS)

The Applied Climate Information System (ACIS), developed and maintained by the Regional Climate Centers (RCCs) under NOAA's National Virtual Data System (NVDS), is designed to manage the complex flow of information from climate data collectors to the end users of climate information. Its purpose is to alleviate the burden of climate information management for people that use climate information to make management decisions and manipulate data for basic and applied research. ACIS integrates historical climate information with data collected in near real-time to provide quality products that can be used to assess historical climate trends, enhance daily operational decisions, or assist with any number of climate dependent activities. Product quality is assured through rigorous definition of station and individual station element compatibility defined in a metadata database.

Box 3: Key Federal Agency/Program Participation in NIDIS

U.S. Army Corps of Engineers

U.S. Department of Agriculture (USDA)
- Agricultural Research Service
- Cooperative State Research, Education
- Farm Service Agency
- Forest Service
- National Agricultural Statistics Service
- Natural Resources Conservation Service
- Risk Management Agency

U.S. Department of Commerce (DoC)
- International Trade Administration
- National Oceanic and Atmospheric Administration

U.S. Department of Energy (DoE)
- Office of Electricity Delivery and Energy Reliability
- Office of Energy Efficiency & Renewable Energy
- Office of Science

U.S. Department of Homeland Security (DHS)
- Federal Emergency Management (FEMA) Directorate

U.S. Department of the Interior (DoI)
- Bureau of Indian Affairs
- Bureau of Land Management
- Bureau of Reclamation
- National Park Service
- U.S. Fish and Wildlife Service
- U.S. Geological Survey

U.S. Department of Transportation (DoT)
- Federal Aviation Administration
- Federal Highway Administration
- Surface Transportation Board

Environmental Protection Agency (EPA)

Farm Credit Administration (FCA)

Federal Energy Regulatory Commission (FERC)

Internal Revenue Service (IRS)

International Trade Commission (USITC)

National Aeronautics and Space Administration (NASA)

National Science Foundation (NSF)

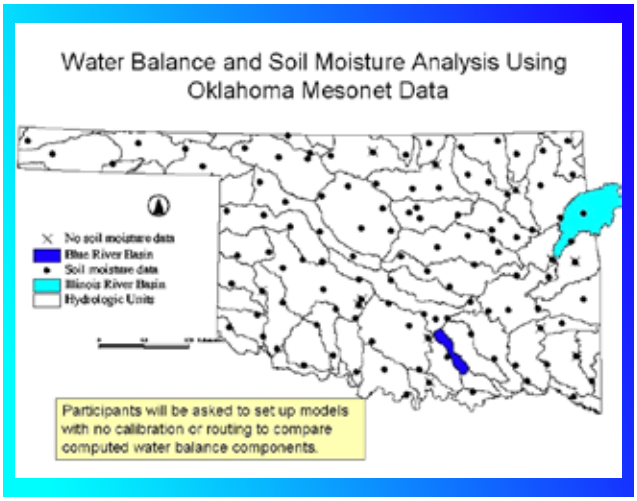
Small Business Administration (SBA)

Climate data available in ACIS consists of archive quality historical data and near real-time data ingested from operational data transmission streams. The data consists of *in situ* observations collected from land-based stations from a variety of federal, regional, state, and local weather and climate networks. ACIS data are primarily used for the generation of operational climate products, but ACIS also has the capability to provide archive quality datasets as a specified product.

Data and metadata archives, product access interfaces, and product generation capabilities exist at multiple RCCs. Synchronization of datasets among the RCC data centers ensures that identical information is received regardless of point of access. This "behind the scenes" feature of ACIS enables a user to specify a product without having to know where data within the ACIS system are managed.

A more comprehensive system has been developed for ACIS that includes enhanced checks based on per-station statistical limits and an advanced geospatial regression model. This system is scheduled for operational implementation in 2008. Products are tailored to user needs, easily accessed, and delivered in a format specified by the user. The products can be pulled from web sites, automatically delivered to the user via scripting programs, or integrated directly into locally developed computer simulation or management models. Currently, ACIS is used by a myriad of state and federal agencies to enhance their operations. These include NOAA's National Weather Service, USDA's Natural Resources Conservation Service, USDA's Joint Agricultural Weather Facility, the University of Washington RISA, and numerous state climatologists.

ACIS data management includes more than physical infrastructure and information technology experts. ACIS is an evolving system that is continually updated with new sources of information, new products to meet specific user demands, and state of the art technologies to effectively deliver these products to users in efficient and cost-effective ways.



The Oklahoma Mesonet: Real-Time Drought Monitoring

Since the onset of an extended drought in 1995, the Oklahoma Climatological Survey (OCS) has been the key provider of precipitation-based drought assessments to state officials in Oklahoma. In response to the drought, OCS began producing weekly summaries of precipitation totals and departures for each climate division in the state. Since 1995, through interaction with officials at the Oklahoma Water Resources Board (OWRB), other state agencies, and U.S. Drought Monitor authors, the system has developed into a mature real-time decision support system.

Each morning before dawn, precipitation totals from the Oklahoma Mesonet are incorporated into a suite of tables and maps that provide assessments on precipitation departures, historical context, and key drought indices. The Mesonet data are merged with historical National Weather Service (NWS) Cooperative Observer data to determine rankings, records, and analog periods. Assessments for selected time periods ranging from 30 days to 365 days plus standard measures such as calendar year, water year, and current season, are available through the decision support system.

The OCS drought report is automatically updated and immediately available via the World Wide Web (**Figure A-1**). The timing and automation of the report allow drought decisionmakers instant access to the latest precipitation, fire danger, and soil moisture data when they arrive at their desk, 24 hours per day, seven days per week. Each morning's report contains information complete through midnight, a turnaround time of less than five hours. The automation helps maximize the reader's efficiency by eliminating the need to prompt (and wait for) action from OCS. It also helps OCS staff reduce the time spent preparing reports and focus on more valuable interpretive and explanatory support.

OCS represents the meteorological/climatological community's input into the state drought assessment processes. OCS collects the data and develops tools to portray information for state decisionmakers. OWRB officials, who are charged by statute with monitoring responsibilities, monitors the decision support system and includes information from it in its *Water Resources Bulletin*, sent to top agency officials, legislative leaders, and Governor's staff to keep informed on drought status by region in Oklahoma.

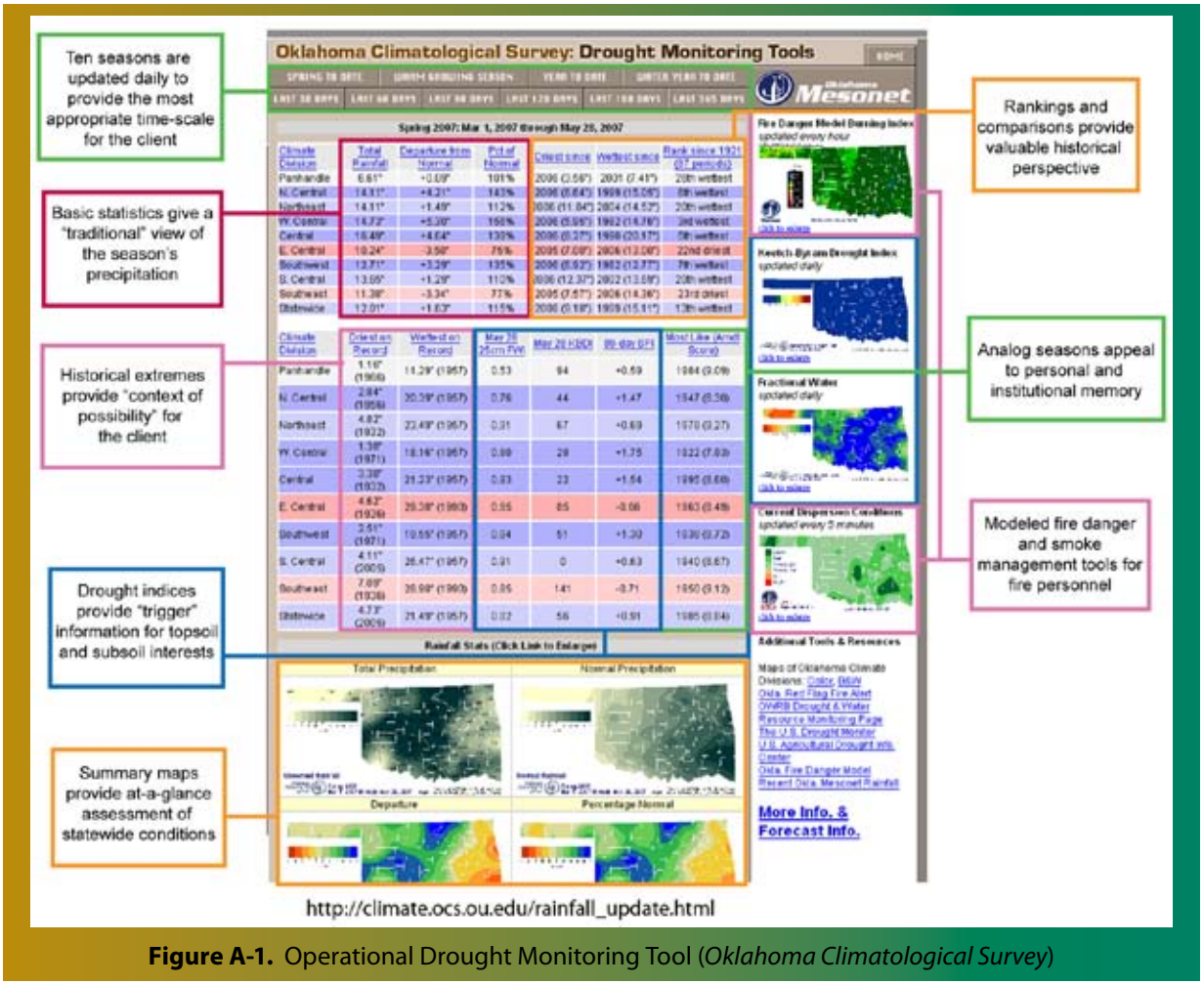


Figure A-1. Operational Drought Monitoring Tool (*Oklahoma Climatological Survey*)

The system has solidified the relationship between state agency officials and the climate community. One official stated: "I really trust the information and the data that you guys put on your website or the information that you give me personally, I don't even question it." This success was achieved because of responsiveness and attentiveness to the decisionmakers' needs. New indices, maps, time periods, and links have been added at the request of individual decisionmakers. Prototypes were tested by these key user groups as new changes were implemented.

Although this system is built upon real-time quality-controlled information from the Mesonet, the decision support system has been expanded to use a real-time cooperative observer data feed. A parallel feed of cooperative observer data was developed utilizing the Applied Climate Information System, supplied by the Southern RCC. Results indicated that even without a real-time Mesonet, reasonable real-time depictions of drought conditions could be obtained with existing daily observations. Similar climate division tables are now being produced for the rest of the United States.

RISA and State Climate Offices: Regional-Scale Drought Monitor for the Carolinas

Drought mitigation and planning require a monitoring system that considers a range of spatial and temporal scales, includes indices that relate to different impacts, and meets the needs of diverse decisionmakers. As the U.S. Drought Monitor evolves from its current form to a National Integrated Drought Information System (NIDIS), prototypes for the display of drought intensity can guide its scope and design.

The Regional Drought Monitor for the Carolinas (**Figure A-2, A-3**) demonstrates one prototype that emerged in response to the 1998-2002 record drought, as well as to water management negotiations associated with dam relicensing in two large river basins. This regional drought monitoring system accommodates diverse decisionmakers through customizable index weights and map boundary aggregation features. Such flexibilty is essential for decisionmaking to consider drought across different physical and political units and in the context of state and local ordinances. Its flexible, open-architecture design meets these needs as well as the reality of wide-ranging definitions of and sensitivity to drought.

The Famine Early Warning Systems Network

Food security monitoring in Sub-Saharan Africa provides the early warning needed to save lives and livelihoods in the face of a wide range of potential socioeconomic and environmental shocks. Climate monitoring and forecasting are especially important given the large number of rural people dependent on subsistence agriculture and pastoralism. Because conventional climate station networks are sparse, remote sensing and modeling methods have been developed to supplement conventional climate analysis.

The Famine Early Warning Systems Network (FEWS NET) is an activity of the U.S. Agency for International Development (USAID), Office of Food for Peace. FEWS NET employs a livelihoods framework to geographically characterize vulnerability and interpret hazards. By assembling information on how households access food and income, routine monitoring of rainfall, vegetation, crops, and market prices is made more meaningful. Key food security questions are more readily answered, such as: Which population groups are facing food insecurity, and for how long? What are the best ways to mitigate adverse trends or shocks to their livelihood systems?

Steps in FEWS Early Warning

1. *Pre-season Vulnerability Assessment and Profiles of At-Risk Groups*. FEWS analysis conducted prior to the growing season to identify populations likely to be hit hard in the case of a drought or other shock.

2. *Seasonal Monitoring*. Reading and reporting of satellite imagery on rainfall and crop growth and cereal price data produced by a number of different groups and collated by FEWS.

3. *Special Alerts and Warning*. Briefings, cables, and emails to USAID by FEWS to inform of potential food emergencies.

4. *Contingency Planning*. Intra-USAID mission effort, undertaken during poor production years, to monitor food security situation and determine appropriate responses. The contingency planning group, which includes the FEWS Report, uses a number of monitoring instruments.

5. *Aid Intervention Evaluation*. Selective assessments carried out, with FEWS involvement, to (i) understand targeting methods used by NGOs; (ii) gain insight into nature of vulnerability; and (iii) observe community status after intervention.

Figure A-2. Drought Monitor Weighting Interface (Carolinas Integrated Sciences and Assessments, [*CISA*])

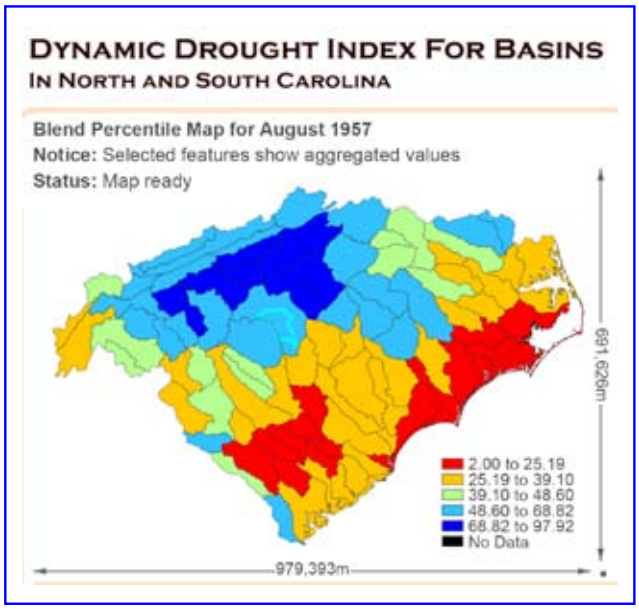
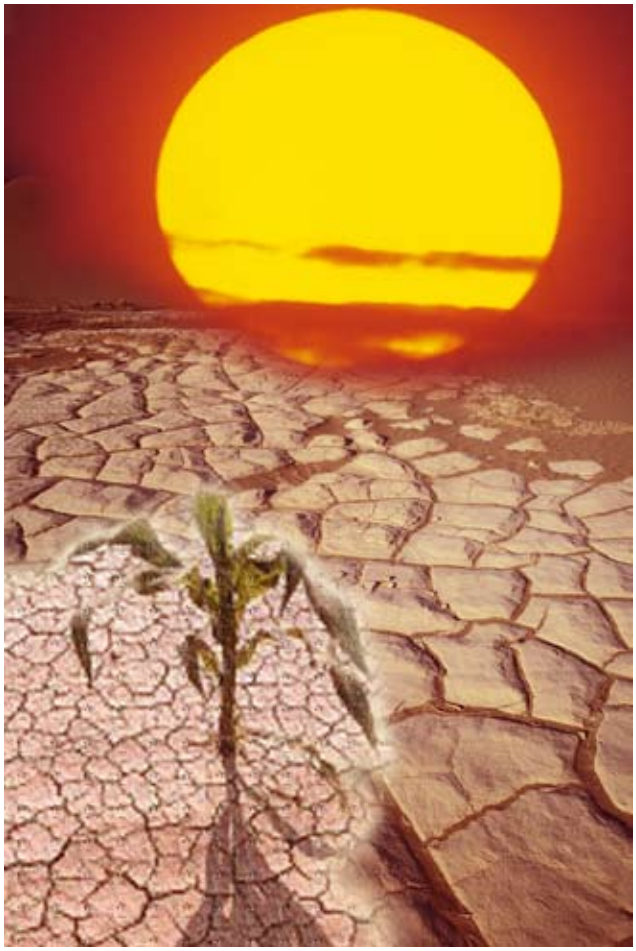


Figure A-3. Drought Monitor Geographic Information Systems (GIS) Interface (*CISA*)



Hazards monitoring provides continuous information regarding potential shocks or adverse trends affecting livelihoods. Market prices for food, livestock, and cash crops are key economic variables. Climatically speaking, drought, floods, and tropical cyclones are of greatest concern. Hazard information products are used as input to food security scenario modeling. Hazards are superimposed on livelihood zones, and each source of food and income is evaluated to determine if a gap will result. In this way, logical and informed conclusions can be drawn in an objective and reproducible manner. Population groups at high risk of acute food insecurity can be identified and quantified, as can prospects for the duration of the problem.

Conventional hydrometeorological networks are sparse and often report with significant delays. Consequently, creative uses of remote sensing, numerical modeling, and geographic information systems (GIS) have emerged to adapt traditional methods of climate monitoring. Current season monitoring makes extensive use of satellite image products to achieve early detection of drought. Vegetation index images have been used since the mid-1980s to monitor the crop and rangelands of semi-arid Sub-Saharan Africa. Satellite rainfall estimates have been especially useful as input to geospatial crop water balance modeling over the course of the growing season. The resulting maps reveal zones of poor crop performance due to dry spells or drought, as corroborated by field reports.

APPENDIX A-2: THE NIDIS PROGRAM IMPLEMENTATION TEAM (TO DATE)

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Mark Brusberg, USDA/OCE
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Art Degaetano, Northeast Regional Climate Center
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Wayne Higgins, NOAA/National Weather Service
Steve Hilberg, Midwestern Regional Climate Center
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Hope Mizzell, Southeast Regional Climate Center
Phil Mote, University of Washington
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Tim Owen, NOAA/National Climatic Data Center
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Jean Steiner, USDA/Agricultural Research Service
Mark Svoboda, National Drought Mitigation Center
Dennis Todey, South Dakota State University
Jim Verdin, U.S. Geological Survey
Robert Webb, NOAA/Earth Systems Research Laboratory

APPENDIX A-3: ACRONYM LIST

ACIS	Applied Climate Information System
CISA	Carolinas Integrated Sciences and Assessments
CLASS	Comprehensive Large Array-data Stewardship System
CoCoRAHS	Community Collaborative Rain, Hail, and Snow Network
COOP	NWS's Cooperative Observer Network
CPC	Climate Prediction Center
EPA	Environmental Protection Agency
EROS	Center for Earth Science Observation and Science
FEWS	Famine Early Warning Systems
FEWS NET	Famine Early Warning Systems Network

GEO	Group on Earth Observations
GEOSS	Global Earth Observation System of Systems
GIDIS	Global Integrated Drought Information System
GIS	geographic information systems
IEOS	International Earth Observing System
IMS	Interactive Multisensor Snow and Ice Mapping System
IRCB	Integrated Research Coordination Board
JAWF	Joint Agricultural Weather Facility
KBDI	Keetch-Byram Drought Index
km	kilometer(10^3 meters) (unit of length)
MOU	Memoranda of Understanding
NASA	National Aeronautics and Space Administration
NWS	NOAA National Weather Service
NCDC	NOAA National Climatic Data Center
NDMC	National Drought Mitigation Center
NDPC	National Drought Policy Commission
NIDIS	National Integrated Drought Information System
NLDAS	North American Land Data Assimilation Systems
NOAA	National Oceanic and Atmospheric Administration
NOMADS	National Operational Model Archive and Distribution System
NPIT	NIDIS Program Implementation Team
NPO	NIDIS Program Office
NRC	National Research Council
NRCS	Natural Resources Conservation Service
NSTC	National Science and Technology Council
NSF	National Science Foundation
NVDS	NOAA National Virtual Data System
NWCC	National Water and Climate Center
NWIS	National Water Information System
OCS	Oklahoma Climatological Survey
OWRB	Oklahoma Water Resources Board
PDSI	Palmer Drought Severity Index
PFT	Portal Feedback Team
QPF	quantitative precipitation forecasts
RCC	Regional Climate Centers
RISA	Regional Integrated Sciences and Assessments
SCAN	USDA Soil Climate Analysis Network
SNOTEL	USDA Snow Telemetry Network
SPI	Standardized Precipitation Index
SST	sea surface temperature
SWSI	Surface Water Supply Index
USAID	U.S. Agency for International Development
USDM	U.S. Drought Monitor
USDA	U.S. Department of Agriculture
USPD	U.S. Drought Portal
USGEO	U.S. Global Earth Observations
USGS	U.S. Geological Survey
VegDRI	Vegetation Drought Response Index
VHI	Vegetation Health Index
WFO	Weather Forecast Offices
WGA	Western Governors' Association

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