Advances in drought research

NOAA Drought Task Force, National Integrated Drought Information System

Since 2011, research to advance the understanding, monitoring and prediction of drought in support of NIDIS has been coordinated through an interagency **Drought Task Force** including NASA, USGS, and academic partners, established by the Modeling Analysis Predictions and Projections Program. Its goal is to achieve advances understanding, monitoring and prediction of drought over North America. The NOAA Drought Task Force has published a new report entitled "Research to Advance National Drought Monitoring and Prediction Capabilities." The work documented in this report exemplifies how NOAA has addressed the requests of farmers, ranchers, natural resource managers and other drought-impacted industries and populations by improving drought monitoring and prediction for better planning and mitigation.

cpo.noaa.gov/rtc_report

Drought threatens the natural resources, economy, and health of our Nation. The average cost of a drought event from 1980-2014 was $9.4 billion, and droughts occur across the entire country (Figure 1).

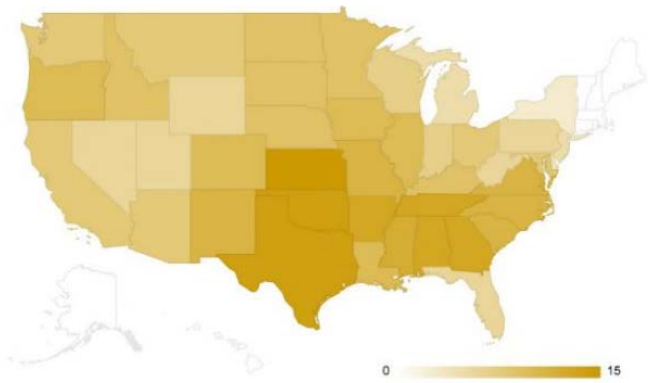

Figure 1. This map, generated by the NOAA NCEI, shows the states that have suffered droughts costing a billion dollars or more in damages from 1980-2014. Darker colors indicate more billion dollar droughts.

Every sector of the economy and all communities across the U.S. depend on reliable water resources and information about those resources for planning and climate-smart decision-making.

Cases of Drought in the United States

Severe Drought Hit the Central U.S. in 2012
Remains of a corn field near Sigel, Illinois, taken on July 1, 2012. Photo courtesy of Aaron Greuel.

Pacific Northwest Drought
A dead apple orchard near Prosser, Washington, 2015. Photo: State of Washington Department of ecology.

Increasingly, NOAA is charged with providing and improving trusted research-based information on how the frequency and intensity of droughts is changing to help people prepare for potential impacts.

The NOAA Climate Program Office (CPO) Modeling, Analysis, Predictions, and Projections (MAPP) Drought Task Force was established by CPO in 2011 to play a coordinating role for drought research funded by MAPP. The Drought Task Force works in partnership with the National Integrated Drought Information System (NIDIS); NOAA Climate Test Bed; other federal agencies such as NASA, NSF, DOE, and USDA; and the drought research and operational community to support research that advances the capacity to build a more drought-resilient nation. This new report describes the state of the science and how the latest research has improved capabilities to monitor the current state of drought, predict its onset and evolution from weeks to seasons, and better understand why drought occurs. The purpose of the report is to communicate the crucial role NOAA research has played over the last decade in advancing the NIDIS early warning system, how these improvements benefit the user community, and opportunities for further progress.

This report highlights a number of key advances in capabilities made over the past decade, which have resulted from NIDIS funding for MAPP program research in the areas of drought monitoring, prediction, and understanding. These key advances are detailed on the back of this document.

Key Advances

Drought Monitoring

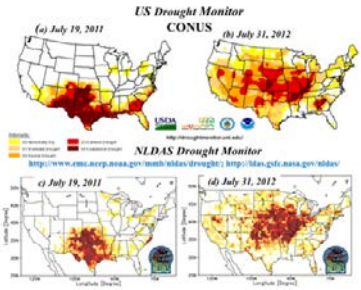

Figure 2. The top images show the US drought monitor for July 2011 and 2012 droughts, while the bottom images are the NLDAS top 1-meter soil moisture profiles expressed as percentiles, with dark red indicating exceptional drought. The NLDAS drought monitor successfully identifies most areas and severities of drought.

The National Land Data Assimilation System (NLDAS) serves as a backbone for our ability to monitor drought conditions and predict their onset, evolution, and demise. NLDAS serves as a critical input to the widely-used U.S. Drought Monitor. The NLDAS brings together an enormous amount of observations and modeling of the Earth system toward producing a reliable, objective, and accurate view of drought conditions. NLDAS currently provides the most realistic view of soil moisture, and supports a higher resolution and higher quality version of the U.S. Drought Monitor, which results in more actionable local- and regional-scale information. The NLDAS has also supported the development of over 10 new drought monitoring products describing surface water availability.

Drought Prediction

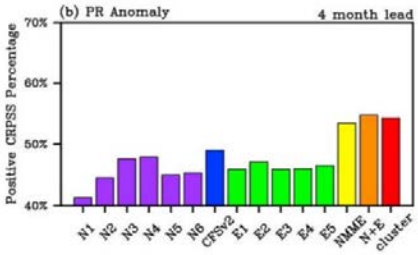

Figure 3. This graph from research by Xing Yuan and Eric Wood (Princeton University) shows the percentages of skillful precipitation forecasts at a lead time of 4 months for different climate models. The performance of the NMME (in yellow) is about 10% better than the best individual model.

The North American Multi-Model Ensemble, a major seasonal prediction system that combines forecasts from the best climate models in the U.S. and Canada, is now routinely used for drought forecasts. On average, the NMME performs better than any individual model and has increased the skill of seasonal precipitation forecasts by about 15% compared to the next best model (Figure 3). This system offers the potential to greatly enhance drought prediction beyond its current state, providing more reliable and actionable forecasts for decision makers, managers, and the general public. NMME is the result of several years of research and testing led by NOAA involving key partner agencies and the academic community. Research is developing a suite of new drought prediction tools based on the NMME.

Drought Understanding

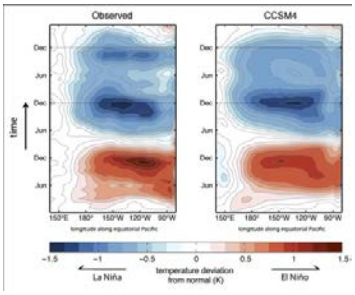

Figure 4. This image from research led by Pedro DiNezio (University of Texas) shows the evolution of sea-surface temperature anomalies during 2-year La Niña events in nature (left image) and simulated by the CCSM4, on the right. Red colors indicate warm temperatures (associated with El Niño) and blue corresponds to cold temperatures (La Niña).

Scientists work to better understand what causes drought development and evolution, whether models can capture this improved understanding, and how to improve forecasts as a result. For example, the importance of La Niña in driving drought is well established -- the 2011 Texas drought serves as a vivid example of how this tropical Pacific phenomenon can have far-reaching effects on the united states. Fifty percent of La Niña events last two or more years, and the second year in particular has been shown to be associated with multi-year droughts. The ability of models to skillfully simulate this persistence of La Niña and its impacts is a subject of ongoing, promising research (Figure 4). Research like this offers an opportunity to improve our understanding of and capabilities to dal with drought.

Assessing the Benefits of Drought Research – A New Protocol

In order to benchmark whether and by how much new research is improving capabilities, a Drought Capability Assessment Protocol was developed. This new assessment method is being applied to ensure that research addresses user needs effectively and advances capabilities. The protocol will apply the following elements:

1. Assessment metrics
2. Verification periods and datasets
3. Baselines and benchmarking

Looking forward

Despite significant progress made over the past decade, there are remaining gaps and challenges in drought monitoring, forecasting, and understanding. These include:

- Moving the community toward using increasingly objective means of drought monitoring, including fully exploiting the power of NLDAS, using new datasets, and advancing models and analysis systems for drought.
- Increasing the resolution of drought monitoring and prediction products to provide more local- and regional-scale information, and focusing research efforts on flash droughts, predictions, and sources of predictability on timescales of weeks to months.
- Ensuring that improved understanding of what drives droughts in the climate system is translated into improved predictions of drought conditions.
- Focusing on improved predictions of precipitation seasons in advance for use by water utility managers.