Drought: Science, Monitoring and Early Warning

Robert S. Webb
Roger S. Pulwarty
National Integrated Drought Information System

Precipitation deficit (meteorological drought)
Critical soil moisture deficit (soil moisture drought)
Critical streamflow and groundwater deficit (hydrological drought)
Evapotranspiration
Pre-event soil moisture, surface water, and/or groundwater storage

The great drought
USA experiences the worst drought catastrophe of recent decades, PAGE 16

Munich RE
Drought: a continuum

Droughts span a large range of temporal and spatial scales. Impacts result from a number of complex variables.

- Heat Waves
- Floods
- Storm Track Variations
- Madden-Julian Oscillation
- El Niño-Southern Oscillation
- Decadal Variability
- Solar Variability
- Deep Ocean Circulation
- Greenhouse Gases

Time Scales:
- **Short-term** (30 days - 1 season)
- **Interannual** (3 years - 10 years)
- **Decade-to-century** (30 years - 100 years)
Drought differs from other natural hazards

- Slow onset, “creeping phenomenon”, a non-event
- Difficult to determine drought onset and end
- Absence of a precise, universal definition
- Impacts are nonstructural and spread over large areas—makes assessment and response difficult
- Severity and impacts best defined by multiple indicators
- No consistent methodology for assessing impacts or data base for archiving impacts
- Impacts are complex, affect many people, and vary on spatial and temporal timescales, multiple and migrating epicenters
- Mitigation interventions are less obvious
- Water shortages increase conflict—regulatory, legal authority (interstate & transboundary issues)
National Integrated Drought Information System

“Drought is the most obstinate and pernicious of the dramatic events that Nature conjures up. It can last longer and extend across larger areas than hurricanes, tornadoes, floods and earthquakes…causing hundreds of millions of dollars in losses, and dashing hopes and dreams.”


Public Law 109-430 (The NIDIS Act 2006)

“Enable the Nation to move from a reactive to a more proactive approach to managing drought risks and impacts”

“…better informed and more timely drought-related decisions leading to reduced impacts and costs…”

www.drought.gov
(I) Provide an effective drought early warning system:
   (a) collect and integrate key indicators of drought severity and impacts; and (b)
(II) Coordinate and integrate as practicable, Federal research in support of a drought early warning system
(III) Build upon existing forecasting and assessment programs and partnerships
NIDIS Governance: Executive Council

NATIONAL

NIDIS Program Office

NIDIS Implementation Team:

NIDIS Technical Working Groups

REGIONAL

Public Awareness And Education
Engaging Preparedness Communities
Integrated Monitoring and Forecasting
Interdisciplinary Research and Applications

U.S. Drought Portal

WATERSHED/URBAN/LOCAL

Regional Drought Early Warning Systems
Information clearinghouse, prototypes, and Implementation

Over 50 Federal, state, tribal and private sector representatives nationally
Coping with Drought - Applications and Decision support Research Grants (RISAs, SARP)

Identify socio-economic effects of drought, data and info needs of resource managers and policy/decision makers

Drought Prediction And Monitoring

Climate Test Bed
- CPC
- PSD
- IRI
- Academia
- NCDC
- soil moisture

NIDIS Regional Early Warning Information Systems

- Design, Prototyping, Implementation (multi-agency, multi-state)
- Evaluate/transition drought information products to operations (Regional Climate Centers, State Climatologists)

Drought Portal (NCDC, NDMC)
cross-regional assessments of user needs, test decision support tools

NIDIS Program Office
Producing Actionable Information

- How did we get here? Status and antecedent conditions
- Is this drought like others?
- Why has it been dry/drier than normal?
- What are the impacts and where did they occur?
- What information is being provided and by whom?
- How bad might it get and how long will it last?
- Are information needs being met?
- How are we planning for this year and for longer-term risks and opportunities?
Monitoring Drought

- Sustain and enhance observations of remote ocean surface conditions
- Sustain and enhance *in situ* snow and streamflow observations
- Improved satellite estimates of snow amount
- Improved satellite estimates and *in situ* measurements of soil moisture
- Improved real-time precipitation observations
- Improved estimates of evaporated losses
- Better tracking of ground and surface water interactions
Understanding Drought

- **Role of Sea Surface Temperatures (SST) in the various ocean basins**
  - strength and nature of SST and hydrology connections
  - how do the impacts of SSTs in the various ocean basins interact to enhance/reduce predictability on regional scales?
- Improved understanding of the **impact of decadal variability and warming** on regional droughts
- Improved understanding of **role of land surface conditions**
- Comprehensive **assessment of the underlying predictability** of surface temperature, precipitation, soil moisture, snowpack
- **Near real-time explanations of drought** (What happened? Why did it happen? What is the likelihood of persistence or recurrence?)
- **Analysis of significant past events**
Drought Predictions and Modeling

- Improved **prediction capabilities** national laboratories/centers and key academic partners
- Improved **satellite estimates of snow amount** and **satellite estimates of soil moisture** for initialization forecasts
- Improved **predictions of temperature, precipitation, and other hydroclimate variables** as well as extremes
- Increased **climate model ensemble size and higher resolution** for better estimates of extremes
- Understand the **role of extreme weather events**, drought busters and climate variability
- Improvements in the simulation of **atmosphere-land coupling**
- Improvements in the simulation of **warm season climatology** (stationary waves and precipitation over land)
- Improved simulation of the **key modes of climate and weather variability** impacting monthly to seasonal precipitation
Forecasting Drought

- Improve **reliability and skill** of drought forecasts
- Improve **forecasts of onset and termination** (dominant sources of skill and reliability from persistence of conditions and knowledge of antecedent conditions – **thus a critical role for monitoring**)

- **Objective and reproducible Drought Forecasts**
- Improved identification and use of analog year information
- Advances in **Land-Data Assimilation Systems**
- Improved **El Niño/La Niña Forecasts**
- Improved understanding of **decadal trends** in regional temperature & precipitation
- Experimental **Regional Forecasts**
Tracking Drought Impacts

Reports by category in the Drought Impact Reporter, January - August 2012

- Agriculture: 23.7%
- Fire: 12.4%
- General Awareness: 11.9%
- Plants & Wildlife: 8.4%
- Relief, Response & Restrictions: 9.7%
- Society & Public Health: 5.4%
- Tourism & Recreation: 4.6%
- Business & Industry: 4.8%
- Energy: 2.5%
- Water Supply & Quality: 16.5%

Number of impacts: 3,949
Regional Pilots Activities

- Engaging Stakeholders and Users
- Identifying Information and Research Requirements
- Exploring Approaches and Fostering Good Practices
- Capacity Building
- Transitioning Prototypes into Sustained Services
Identifying and transferring indicators, decision support tools and innovative local strategies for risk assessment, communication and preparedness.

Coordinate existing national, state, and local climate-related data and information support activities (e.g., within watersheds and states).
<table>
<thead>
<tr>
<th>Year 1: Scoping the Regional Drought Early Warning Information System</th>
<th>Year 2. Implementation of the Regional Drought Early Warning System (seasonal, multi-year, longer term trends):</th>
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</thead>
<tbody>
<tr>
<td>Gap analyses: What information exists and how is it being coordinated and used? Characterize and communicate risks across timescales—with existing information for 2-3 critical issues</td>
<td>Develop drought sub-portals Embed information into preparedness and adaptation plans Establish network for ongoing briefings on impacts and projections across climate timescales</td>
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<td>Develop subteams to assess (1) Monitoring and Forecasting; (2) Impact Indicators and Triggers (3) Preparedness and Education:</td>
<td>Initiate development of a region or basin specific Drought Information Monitor and Portal (subset of the U.S. Drought Portal)</td>
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<tr>
<td>Assemble drought-sensitive planning indicators and management triggers database; Assess present drought information coordination partnerships and processes</td>
<td>Develop decision support tools for demand projections and revise triggering criteria Prototyping: <strong>Given better data and information coordination would responses have been improved for past events?</strong> Assess (1) value of improved information using past conditions, (2) responses for projections/ scenarios (decadal, climate change), (3) feedback on priorities (e.g. data gaps) to Executive Council. Feedback into regional Drought Monitor and Portal. Early Warning System maintenance (Fed-state-tribal) and transfer to other sub-basins</td>
</tr>
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<td>Identify Federal and state-level partnerships, decision support tools and actions needed (to improve information development, coordination and flow for preparedness and risk reduction)</td>
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<td><strong>Develop an operational plan for designing and implementing an EWS process</strong></td>
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North Carolina Drought Advisory
Released: November 28, 2013
The North Carolina Drought Advisory issued by the Drought Management Advisory Council has been updated to reflect drought conditions on November 26, 2013 indicated on the weekly U.S. Drought Monitor of North Carolina. Until further notice, the NCDMAC strongly urges the implementation of drought response actions, for all water users located in or dependent on water resources from the areas of the state experiencing the following drought conditions: (DO)

**Impending drought conditions (abnormally dry conditions).**

http://www.ncdrought.org/
Grains and oilseeds dominate the southbound (downstream) traffic, accounting for about half of the ~80 million metric tons of cargo.

Coal makes up 22 percent of southbound tonnage moving through this section of the river.

The fertilizer sector makes up 21 percent of the northbound traffic.

Coal makes up 20 percent of the northbound traffic.

The Corps of Engineers’- Low water levels December through February for this section of the Mississippi between -2m well below the level for minimum navigation.
In the Colorado River’s 100-year recorded history, 1999 through 2010 ranks as the second-driest 12-year period.
California NIDIS Four Pilot Activities

Klamath River Basin: *integrated* hydroclimate information system

Central Valley *remote sensing* of fallowed land extent

Southern California Urban: *imported* water and a well-plumbed system

Russian River Basin: *droughts draining reservoirs and floods filling reservoirs*

- Developing **Dynamic Regional Drought Index**.
- Common set of **high quality drought indicators**
- **User defined weights** to reflect priorities (*urban water supply, dry land farming, environmental flows, ecosystem services, recreation and tourism*)
- **Tailored Index** to identify management-relevant thresholds and triggers

- Climate data
- Soil moisture
- Stream flow
- Ground water
- Reservoirs/lake levels
- Snowpack
- Short, medium and long range forecasts
- Vegetation health
- Fire danger
- Impacts
Actions Taken as a Result of NIDIS

Percent

Communicate
Collaborate
Generate
Change my
Share
Incorporate
Incorporate
Make or
Formulate
Implement
Other
None

Compare your readiness for drought before 2002 with now, information is...

- N/A
- Agreed/Strongly Agreed
- Neither agreed nor disagreed
## Some Metrics of Success

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<th>Success Measure</th>
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<td>Centralized location for information for decision-making</td>
<td>Reduced impacts and costs</td>
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<td>Improved institutional capacity</td>
<td>Addressed focused objectives</td>
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<td>Did not contribute to stakeholder fatigue but instead responded to informational needs</td>
<td>Testimonials of the use and value of NIDIS information</td>
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<tr>
<td>Demonstrated quantitative success</td>
<td>Improved decision-making capacity</td>
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<td>Demand for expansion</td>
<td>Return on investment</td>
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<td>Transferability to other regions, basins, or sectors</td>
<td>Ability to communicate uncertainty</td>
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<td>Tangible products and outcomes that are institutionalized and applied</td>
<td>Used social networking capabilities to maximize dissemination of information</td>
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<td>Compared benefits to basin with pilot activity versus one without</td>
<td>Quantified measures of increased use of data, products, resources</td>
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<td>Influenced content for national drought portal and products</td>
<td>Defining criteria for failure</td>
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Evidence of Progress?

- The number of states, communities, and institutions with improved capacity to inform risk management and reduce exposure to climatic risks (compared to previous droughts)
- The number of staff in or working with those institutions trained to develop and communicate local drought information and help reduce impacts
- The number of research projects that conduct and update drought impacts and user needs assessments in drought-sensitive parts of the US and communicate results to the public
- Increased percentage of the U.S. population covered by adequate climate risk and early warning information systems
NIDIS-International Partners
Multiple Pathways of Transferability

- FEWSNet
- GEO Water Resources
- Mediterranean and Iberian Peninsula
- Australia (MDB/Colorado)
- India NIDIS
- Caribbean Basin
- US-Canada PNW
- GDIS