The Future of Drought in the United States Consensus Study

National Academies of Science, Engineering, and Medicine

27 May 2025

Agenda

Introduction - Veva Deheza (NIDIS Executive Director

The Cost of Drought - Joel Lisonbee (NIDIS Drought Information Coordinator)

The Physical Science Context - Andrew Hoell (NOAA Physical Science Laboratory)

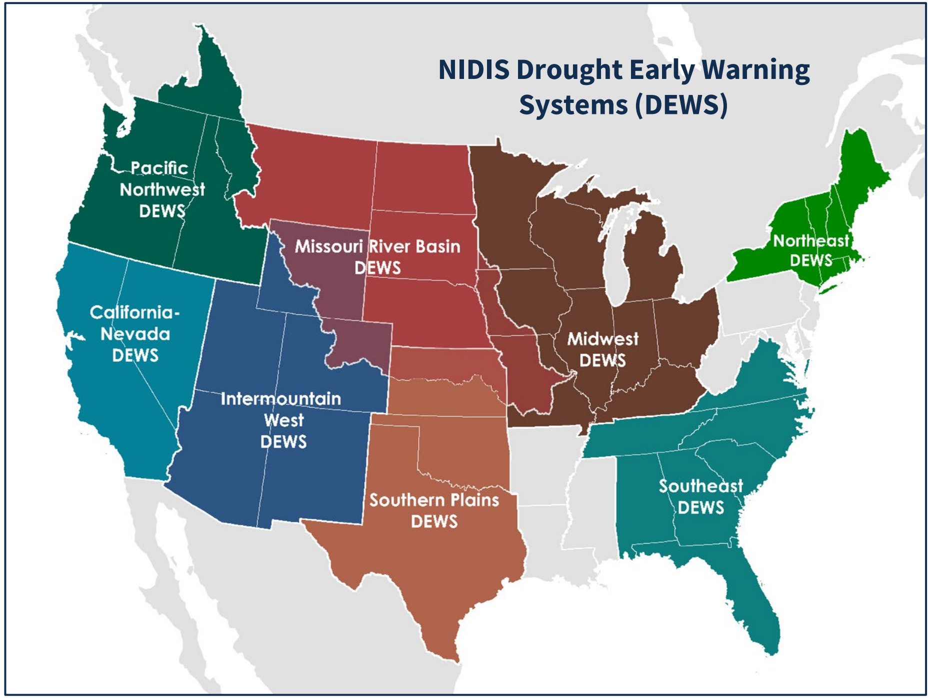
The Foundation for the Study and Statement of Task - Britt Parker (NIDIS Senior Program Manager)

What is the National Integrated Drought Information System (NIDIS)?

NIDIS is a multi-agency partnership with a mission to mitigate the impacts and costs of drought by improving the nation's capacity to proactively manage drought-related risks.

How do we do this work?

- The U.S. Drought Portal: www.drought.gov
- Regional Drought Early Warning Systems
- Improving drought prediction and forecasting
- Collaborate with partners and build state & local drought capacity
  - Supporting drought planning and preparedness
  - Supporting drought impact assessments



NIDIS Public law

“DROUGHT…causes or may cause— (i) substantial economic or social impacts; or (ii) substantial physical damage or injury to individuals, property, or the environment.”

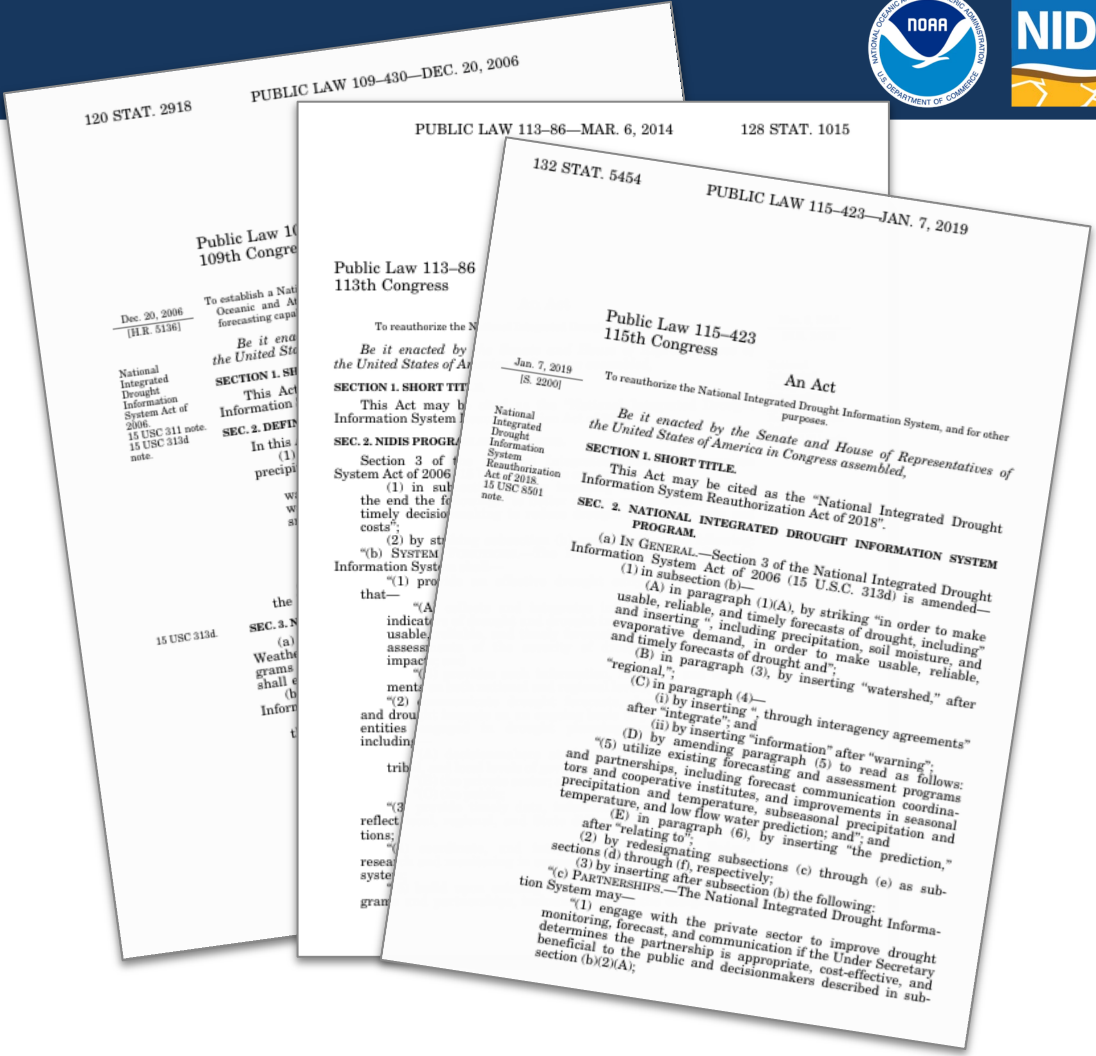
Established the National Integrated Drought Information System

To:

“engender better informed and more timely decisions thereby leading to reduced [drought] impacts and costs”

- **NIDIS is authorized to engage in partnerships with:**
  - Federal,
  - State,
  - Tribal,
  - Local,
  - Private sector,
  - Academic institutions,
  - Citizen scientists

Governments and Agencies



120 STAT. 2918 PUBLIC LAW 109–430—DEC. 20, 2006

PUBLIC LAW 113–86—MAR. 6, 2014 128 STAT. 1015

132 STAT. 5454 PUBLIC LAW 115–423—JAN. 7, 2019

Public Law 115–423
115th Congress

Jan. 7, 2019
[S. 2200]

An Act

To reauthorize the National Integrated Drought Information System, and for other purposes.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled,

National Integrated Drought Information System Reauthorization Act of 2018. 15 USC 8501 note.

SECTION 1. SHORT TITLE.

This Act may be cited as the “National Integrated Drought Information System Reauthorization Act of 2018”.

SEC. 2. NATIONAL INTEGRATED DROUGHT INFORMATION SYSTEM PROGRAM.

(a) IN GENERAL.—Section 3 of the National Integrated Drought Information System Act of 2006 (15 U.S.C. 313d) is amended—

(1) in subsection (b)—

(A) in paragraph (1)(A), by striking “in order to make usable, reliable, and timely forecasts of drought, including” and inserting “, including precipitation, soil moisture, and evaporative demand, in order to make usable, reliable, and timely forecasts of drought and”;

(B) in paragraph (3), by inserting “watershed,” after “regional,”;

(C) in paragraph (4)—

(i) by inserting “, through interagency agreements” after “integrate”; and

(ii) by inserting “information” after “warning”;

(D) by amending paragraph (5) to read as follows:

“(5) utilize existing forecasting and assessment programs and partnerships, including forecast communication coordinators and cooperative institutes, and improvements in seasonal precipitation and temperature, subseasonal precipitation and temperature, and low flow water prediction; and”; and

(E) in paragraph (6), by inserting “the prediction,” after “relating to”;

(2) by redesignating subsections (c) through (e) as subsections (d) through (f), respectively;

(3) by inserting after subsection (b) the following:

“(c) PARTNERSHIPS.—The National Integrated Drought Information System may—

“(1) engage with the private sector to improve drought monitoring, forecast, and communication if the Under Secretary determines the partnership is appropriate, cost-effective, and beneficial to the public and decisionmakers described in subsection (b)(2)(A);

The Ask of this Committee

- The drought assessment challenge is already upon us, given that droughts differ greatly from one to the next and thus our responses must differ as well.
- We would like specific guidance on how to adjust and improve drought assessments
    - Outcomes from this project must be applied for the benefit of those most impacted by drought, such as farmers, ranchers, water managers, and electricity producers.
- **WHY: If we can get drought assessment right, then we can be confident that drought preparations and response actions will be more effective.**
- This is a complex ask -
    - Blend physical science, social science and economic science
    - Provide recommendations for improving the mechanics of drought assessment

Thank you!

Thank you to the **NASEM**,

Thank you to
the Committee
for tackling this issue.

The Economic and Human Costs of Drought

$372 Billion

Total Cost of Drought from 1980-2025
3rd highest for all billion dollar disasters

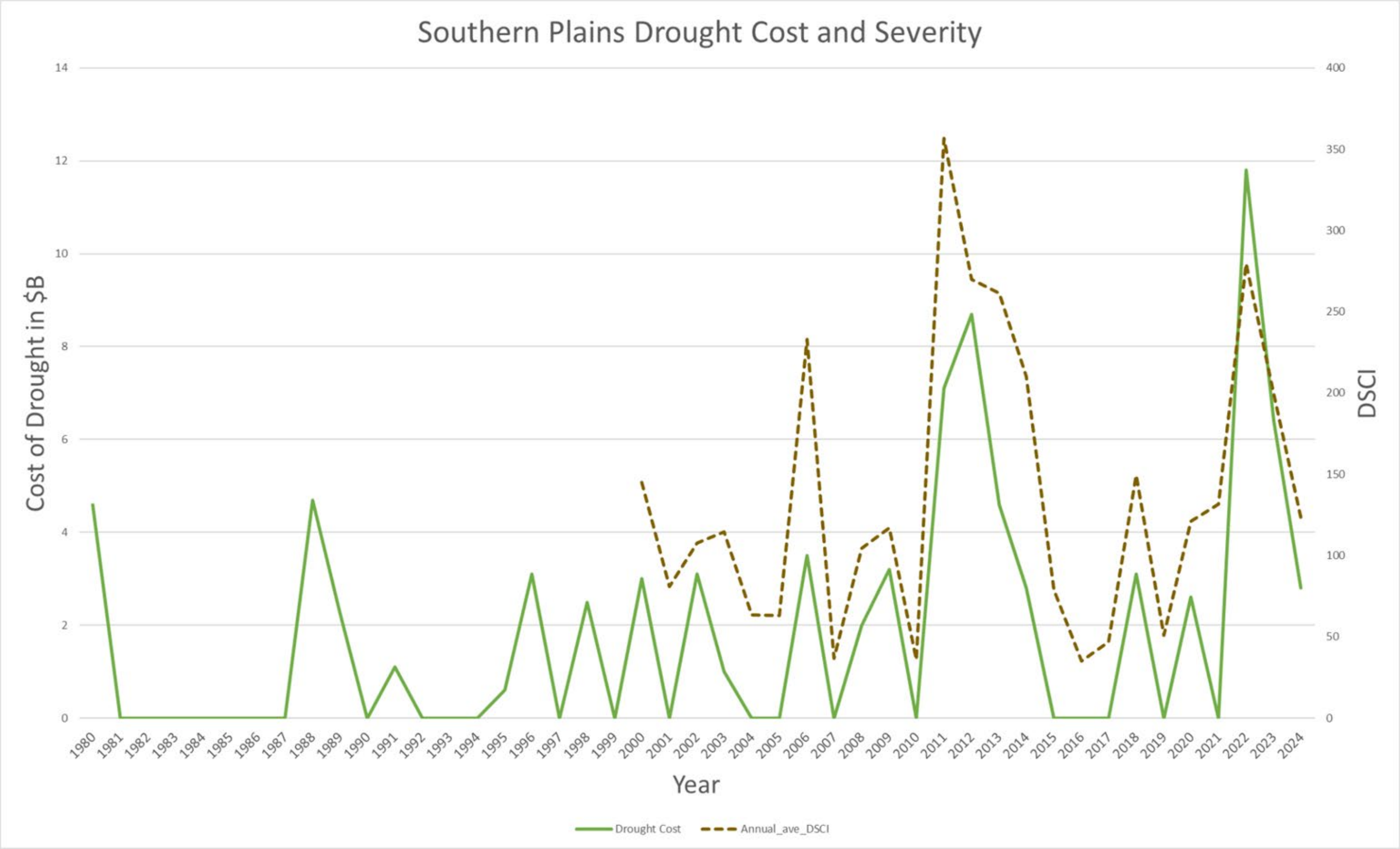
$11.6 Billion

Average Cost Per Drought Event in the U.S.
2nd highest per event for all billion dollar disasters

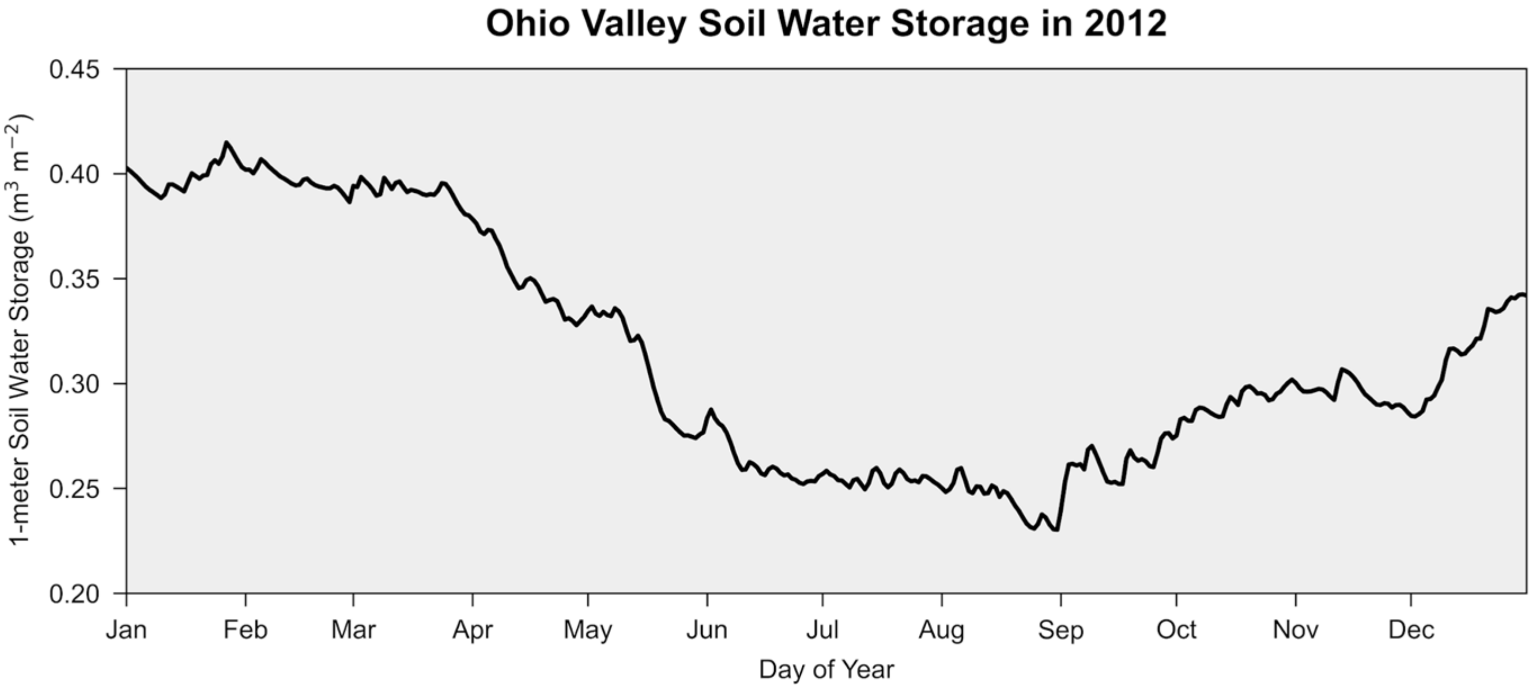
101 People

Average Fatalities from Drought and Heat Waves Each Year
2nd highest per year for all billion dollar disasters

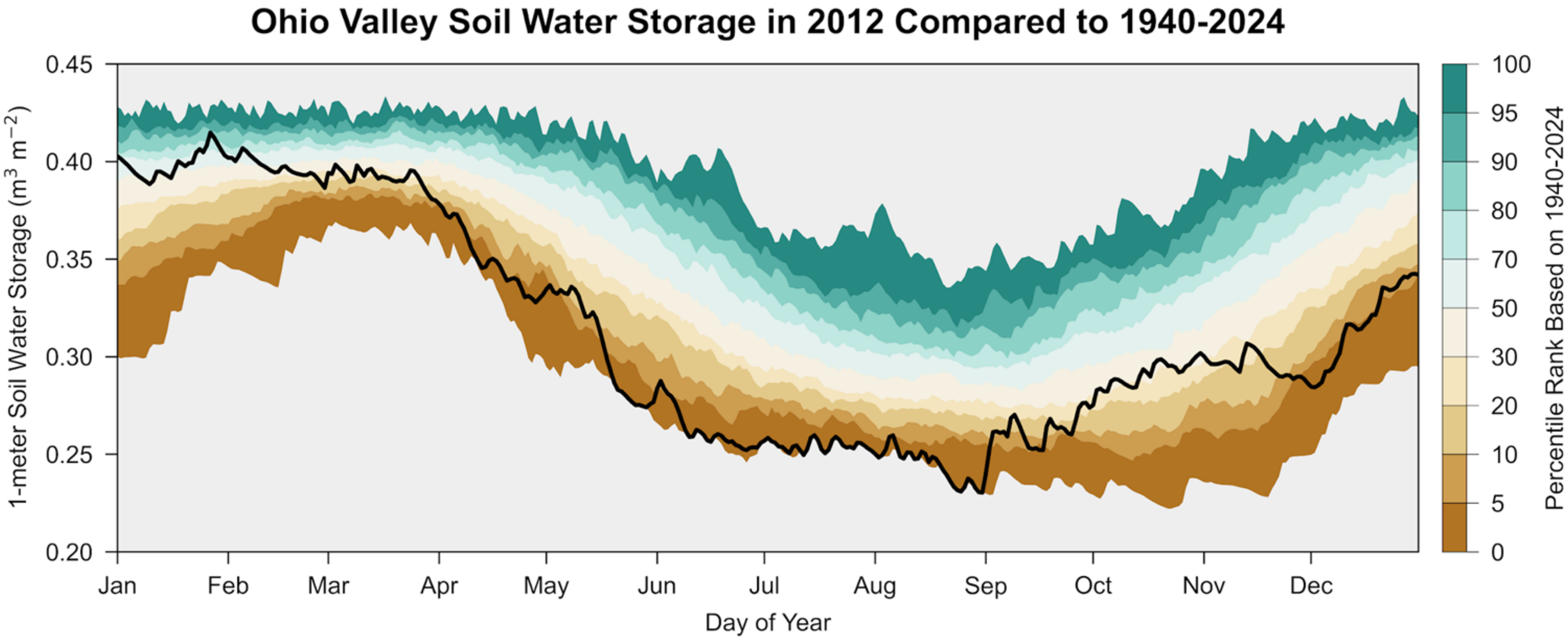
Example: Great Plains—less drought can be more costly



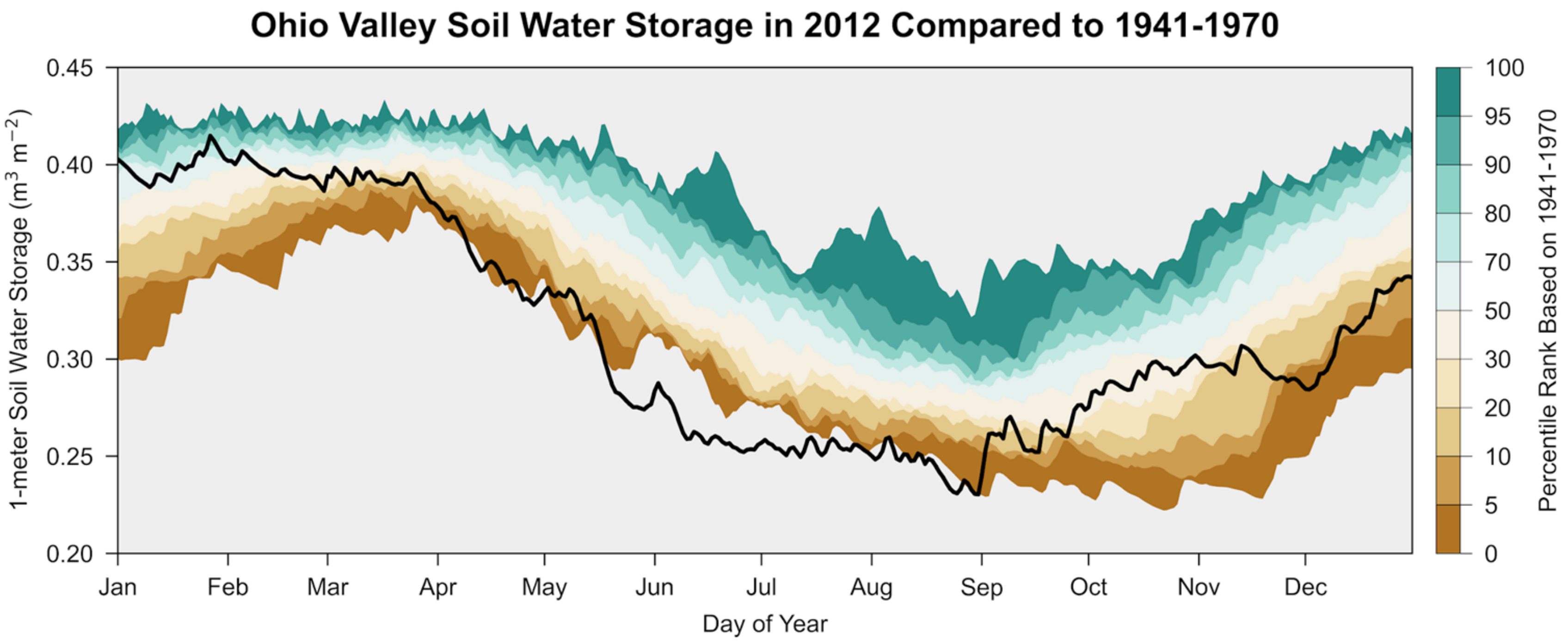
Drought Assessment Requires Context



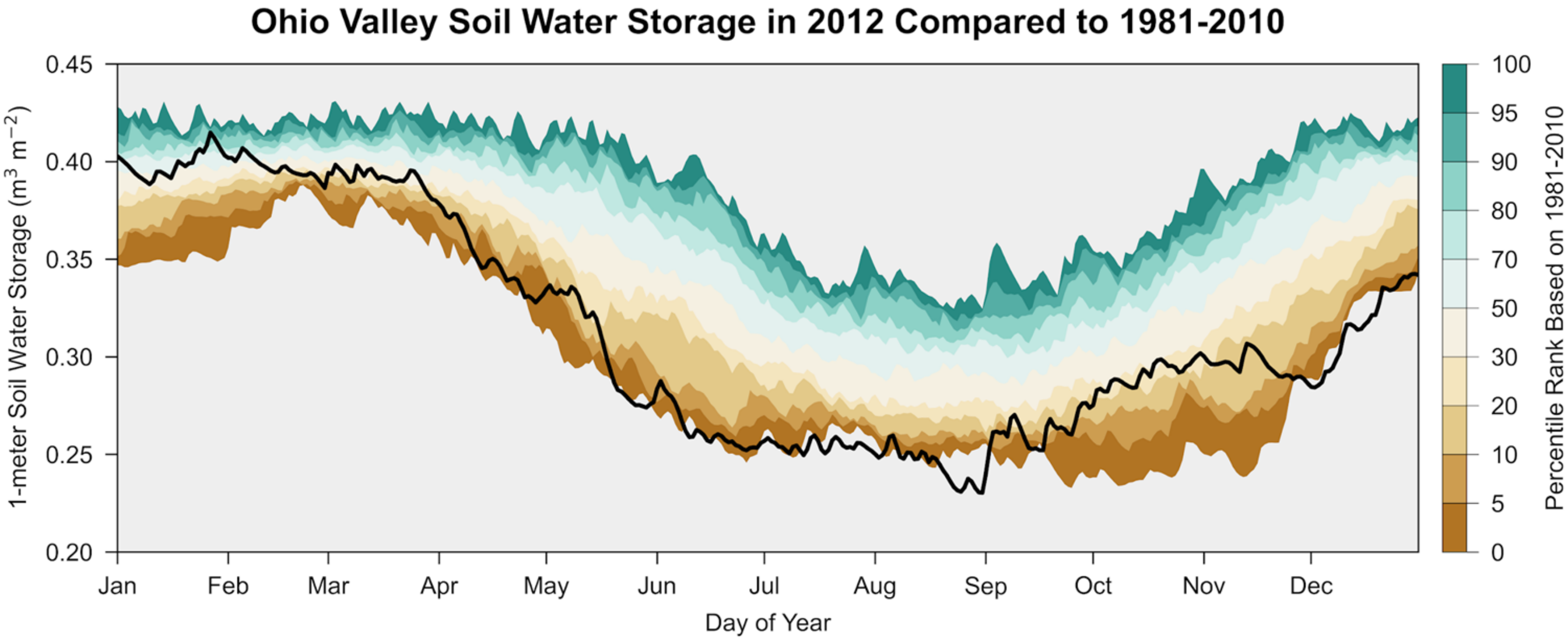
Establish Context Using Like Events Composed of Past Years



Context Differs Based on the Years Included



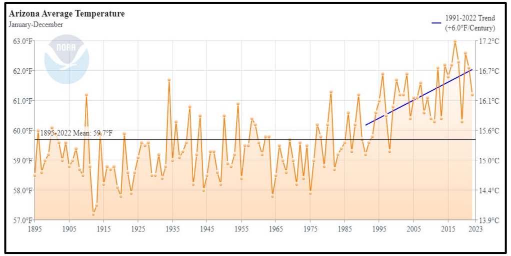
Context Differs Based on the Years Included



QUESTION:

How should drought be assessed?

Should drought be defined using ***all available data***, knowing that there are strong trends in the data and the past is not representative of the present?



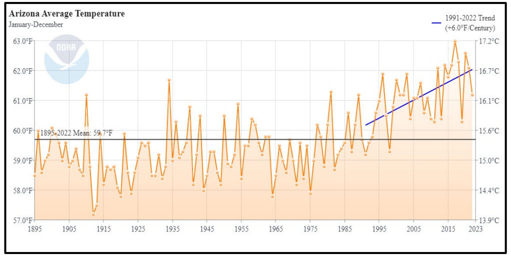
Should drought be defined using a ***shorter modern reference period***, knowing that there have been extreme events in the past that should not be ignored (e.g., the dust bowl)?

Should drought in the ***paleoclimate record*** be considered?

QUESTION:

How should drought be assessed?

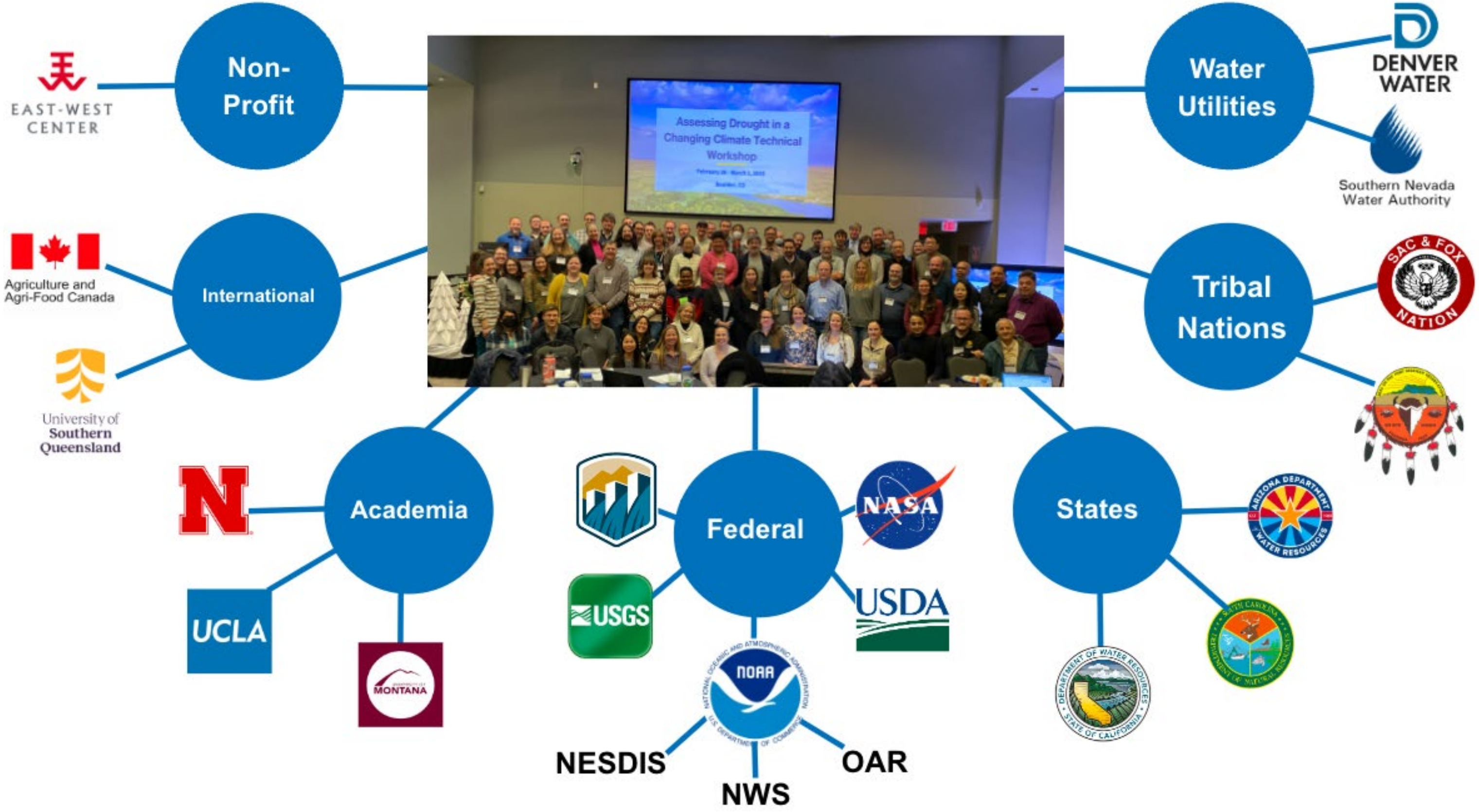
When Should drought be defined using ***all available data***, knowing that there are strong trends in the data and the past is not representative of the present?



When Should drought be defined using a ***shorter modern reference period***, knowing that there have been extreme events in the past that should not be ignored
(e.g., the dust bowl)?

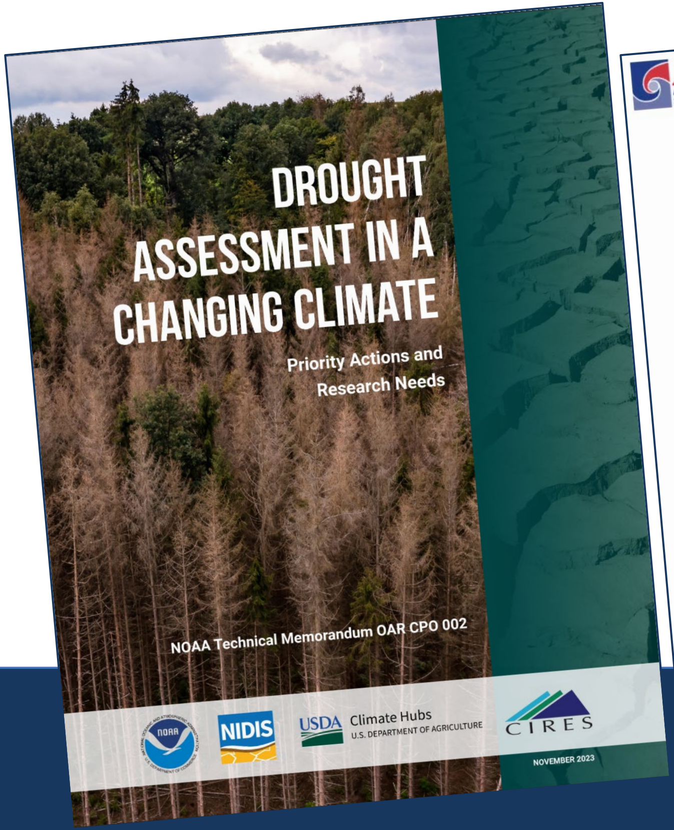
When Should drought in the ***paleoclimate record*** be considered?

Assessing Drought—Accounting for Non-Stationarity



102 subject matter experts attended the workshop representing 44 institutions.

Foundation for this Study



AASC AMERICAN ASSOCIATION OF STATE CLIMATOLOGISTS

Journal of Applied and Service Climatology

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Drought Assessment in a Changing Climate: A Review of Climate Normals for Drought Indices

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Should drought be considered an extreme dry period based on the entire record of available data? Or, should drought be considered a low in precipitation variability within the context of a present, contemporary climate? The two most common reference periods are the full period of record (all observed data or as much as possible) and a 30-year reference climatology. However, climate non-stationarity may render the "all-data" approach an inaccurate or obsolete comparison unless a trend is factored in. The aim of this review is to explore the literature for approaches to addressing these issues.

The World Meteorological Organization (WMO) has recommended a 30-year reference period for most climatological applications since 1935, but for drought assessments and drought indices the modus operandi has been to use as much data as possible. However, in the literature, the "all data" approach has been challenged by evident impacts from climate change-induced non-stationarity. Over the past several years, as potential errors in drought assessments became more apparent due to a stationarity assumption when applying drought indices, several studies have adopted shorter reference periods, with 30-years being the most common. Furthermore, several recent papers have recommended using short reference periods with more frequent data updates for drought assessments to be representative of a contemporary climate. Additionally, at least 18 non-stationary drought indices have been proposed in efforts to retain long datasets and account for non-stationarity in the climate system.

1. Introduction

In 1935 the World Meteorological Organization (WMO) instructed member nations to calculate climate normals using a 30-year period, from 1901 to 1930 (Guttman 1989). For most climatological applications, the 30-year reference period has been the standard. However, for drought, the modus operandi has typically been to include as much data as possible, usually the full period of record. The rationale for this is that a larger dataset reduces the sampling uncertainty and produces a more stable dataset. This is important because drought represents the extremes of climate variability at one tail of the statistical distribution. On the other hand, in regions where the climate system, treating the distant past as "representative" means present or future drought assessments are compared to a very different climate of the past. This issue is especially significant when assessing long-term drought (over periods of multiple years, sometimes referred to as "megadroughts"), as internal variability will generally be lower over longer periods, and hence long-term trends will be larger relative to internal variability.

Several recent publications have helped frame the issue of drought assessment in a non-stationary climate (Paulo et al. 2016; Wang et al. 2021; Mi et al. 2022; Hoylman et al. 2022). For example, following their analysis of mega-drought and pluvial events in climate projections over the 21st century, Stevenson et al. (2022) point out that "background trends are so large that if traditional stationary definitions are used to identify megadrought or pluvial, in those places where the trend emerges, the entire late 21st century is identified as a single large event" (Stevenson et al. 202, p.6).

These findings shed light on the broader question of how to define drought. The Glossary of Meteorology defines

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AGU ADVANCING EARTH AND SPACE SCIENCES

Earth's Future

RESEARCH ARTICLE
10.1029/2024EF005276

Prioritization of Research on Drought Assessment in a Changing Climate

Joel Lisonbee[1], Britt Parker[2], Erica Fleishman[3], Trent W. Ford[4], R. Kyle Bocinsky[5], Gretel Follingstad[1], Abby G. Frazier[6], Zachary H. Hoylman[7], Amy R. Hudson[7], John W. Nielsen-Gammon[8], Natalie A. Umphlett[9], Elliot Wickham[10], Aparna Bamzai-Dodson[11], Royce Fontenot[12], Brian Fuchs[13], John Hammond[14], Jeffrey E. Herrick[15], Mike Hobbins[16], Andrew Hoell[17], Jacob Jones[18], Erin Lane[19], Zachary Leasor[20], Yongqiang Liu[21], Jason A. Otkin[22], Amanda Sheffield[1], Dennis Todey[23], and Roger Pulwarty[17]

Key Points:
- Climate change adds conceptual and quantitative challenges to traditional drought assessments
- Reducing the sensitivity of drought indicators to non-stationarity is essential for accurately assessing future drought
- Multiple drought definitions or concepts are possible, and needed, to correctly assess drought in a changing climate

Abstract Drought is a period of abnormally dry weather that leads to hydrological imbalance. Drought assessments determine the characteristics, severity, and impacts of a drought. Climate change adds conceptual and quantitative challenges to traditional drought assessments. This paper highlights the challenges of assessing drought in a climate made non-stationary by human activities or natural variability. To address these challenges, we then identify 10 key research priorities for advancing drought science and improving assessments in a changing climate. The priorities focus on improving drought indicators to account for non-stationarity, determining the evaluating drought impacts and their trends, addressing regional differences in non-stationarity, and understanding physical drivers of drought and how they are changing, capturing precipitation variability, will inform better risk management, the drivers of aridification. Ultimately, improved drought assessments where climate change significantly alters drought adaptation strategies, and planning, especially in areas where more accurate and effective drought management in a non-stationary climate system.

Plain Language Summary Drought is a period of abnormally dry weather that impacts water availability. Drought is commonly assessed to determine how abnormal it is, how severe its impacts are, or both. Climate change complicates traditional drought assessments. For example, some climates are becoming drier, making it more difficult to discern when a drought begins or ends. This paper highlights the challenges of assessing drought in a changing climate. It also identifies 10 key research priorities for advancing drought science and improving drought assessments in response to these challenges. These priorities include improving drought indicators to account for climate change; evaluating trends in drought impacts; acknowledging that the climate isn't changing in the same way or at the same rate everywhere, so drought assessments must address regional differences; determining how the underlying causes of drought are changing; exploring how changing precipitation characteristics, such as storm intensity and duration, impact drought; and better distinguishing drought in climates that are trending drier or wetter. We hope this

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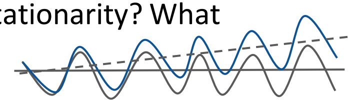
Statement of Task

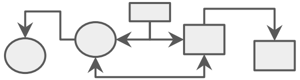
The study will:

- Discuss the drought-to-aridification continuum and differentiate among drought, multidecadal drought, and aridification. How do factors such as periods of record, drought type, regionality, and seasonality affect these classifications? How do current periods of record affect drought outlooks and predictions?

- Evaluate data sources currently used for drought assessment. What data will be needed to address non-stationarity? What methodologies can be used to improve future drought assessment, taking into account non-stationarity?



- Discuss metrics and indicators used in drought assessment and identify opportunities to inform decision making, including increasing integration of non-stationarity and incorporating uncertainty and/or confidence.



- Review existing and emerging approaches, both nationally and globally, for incorporating non-stationarity in drought assessment. Contrast these approaches with those of other natural hazard assessments. Are there best practices that can be applied to drought management? Are some approaches more appropriate for specific regions and/or time periods?

The committee will: Recommend a framework for incorporating non-stationarity considerations into drought assessment, for use across a range of geographic regions and of spatial and temporal scales.

Audience for this Work

The study will inform:

- public- and private-sector entities charged with assessing drought
- decision makers and policy makers who rely on accurate drought assessments for water and natural resources management and risk reduction ahead of and during times of low water availability
- information providers who may need to adjust products and tools based on recommendations. This would ensure that the necessary science, data, and metrics needed are available to inform sound decisions.
- NOAA/NIDIS and other federal agencies who are involved in drought assessment or make decisions based on drought assessment