State of the Science FACT SHEET

U.S Drought

NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION • UNITED STATES DEPARTMENT OF COMMERCE

This document represents the state of the science as described by NOAA researchers.

Droughts are among the most damaging of all natural hazards, with annual economic losses for the U.S. often in the billions of dollars. Droughts differ from most other hazards because of their gradual onset, accumulation of impacts over weeks, months, seasons, and years, and oftentimes abrupt termination. Droughts can devastate crops, livestock, pastures, and ecosystems while severe heat waves that often accompany summer droughts can increase demands for energy and water resources, adversely impact transportation grids, heighten wildfire risks, and cause serious public health consequences.

How is Drought Defined?

While there isn't a single universally accepted definition, drought is often typically associated with a prolonged deficiency in precipitation, runoff, and soil moisture, over several months or longer, that leads to water shortages having adverse impacts on vegetation, animals, energy production, commerce and people. Flash droughts can develop over much shorter time periods and lead to similar impacts. In snowmelt-driven systems, higher temperatures can induce more precipitation to fall as rain rather than snow and accelerate snowmelt, altering water availability. Droughts occur in virtually all climate zones. There are several types of drought: **meteorological / climatological drought** is defined by how greatly precipitation varies from average values; **agricultural drought** is defined as the soil moisture deficit that impacts crops, pastures, and rangelands; and **hydrological drought** is defined by significant impacts on water supplies. NOAA provides information on all three types of droughts in its U.S. drought data, research and information.

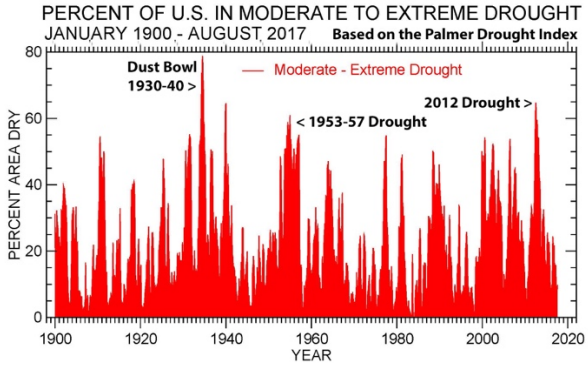

Figure 1. Percent of U.S. in Moderate to Extreme Drought

How is Drought Severity Defined?

Drought severity is defined by the frequency, magnitude and duration of deficits in precipitation, runoff and soil moisture that result in water supplies that fail to meet human and environmental needs. Three drought severity categories are:

- **Moderate drought** is associated with some crop damage and scattered water shortages.
- **Severe drought** is characterized by serious crop and pasture losses, water shortages and water-use restrictions.
- **Extreme drought** causes major crop and pasture losses and widespread water shortages.

For any given part of the U.S., moderate droughts have occurred on average once every five to 10 years, severe droughts once every 10 to 20 years, and extreme droughts once every 20 to 50 years.

How have Droughts and their Impacts Varied over the U.S. During the Past Century?

- Droughts are common over the U.S. The fraction of the country in moderate drought or worse varies tremendously over time, averaging about 20 percent but ranging from less than 5 percent to as much as 80 percent.
- Drought occurrence varies considerably from year to year, over decades and longer.
- The "Dust Bowl" of 1930-1940 was the most extensive drought over the continental U.S. in the modern observational record. It affected 80 percent of the U.S. with 68 percent of the nation experiencing severe to extreme drought (Fig. 1).
- The 1953-57 drought affected up to 60 percent of the country, while the 2012 drought saw 65 percent or more of the country in moderate to extreme drought.
- There were 208 weather-related disasters having impacts over $1 billion from 1980-2016. Among these, 24 droughts cost the nation at least $226 billion, and resulted in 3,000 deaths, with an average cost of more than $9 billion incurred during each event. Only hurricanes were more costly.
- NOAA paleoclimate research has found that over the past two thousand years the climate of the western U.S. was usually more arid than at present, and that future severe droughts could last for decades in the western U.S. and Midwest.
- While there are no long-term trends indicating an increase in drought conditions, the percent of the U.S. experiencing moderate to severe drought increased and remained at elevated levels during the first two decades of the 21st Century. Whether this elevated level will persist is under investigation.
- Assuming no change to current water resources management, climate projections show that chronic, long-duration hydrological drought is increasingly possible by the end of this century.

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What are the Primary Causes of Drought?

- The causes of a particular drought event can be diverse, interwoven, and regionally-dependent. In many cases, a strong and persistent blocking weather pattern is a common feature. Blocking patterns are associated with shifts of precipitation-bearing storms away from the affected region that can lead to prolonged dry conditions. Persistent blocking patterns also favor abundant sunshine, leading to higher daytime temperatures and increased evaporation, exacerbating drought impacts.
- Large-scale sea surface temperature patterns are an important factor in producing many U.S. droughts, and serve as a source of drought predictability.
- The El Niño-Southern Oscillation (ENSO), a coupled ocean-atmosphere phenomenon that has its origins in the equatorial Pacific, plays a significant role in drought development and persistence, especially during winter and spring.
- NOAA research indicates that a failure of moisture transport from the Gulf of Mexico and lack of storm systems led to the 2012 Great Plains drought. 2012's cross-country drought caused approximately $32.4 billion in losses. Research looking at the recent California drought found much of it was driven by remote sea surface temperature anomalies, and was maintained by continued failure of rains.
- Droughts over the U.S. are also caused by other factors unrelated to sea surface temperature patterns in the Pacific.

NOAA Priorities

- Applying advances in ocean/land/atmospheric observations, data assimilation, and hydrologic modeling to improve drought outlooks.
- Expanding products and models across international boundaries when necessary to capture basin-wide hydrologic conditions, including in the Great Lakes.
- Advancing prediction systems and products for improved early-warning information.
- Improving understanding of the causes of droughts, as well as effects of land surface and vegetation.
- Improving drought monitoring, especially estimates of soil moisture and snow water storage.
- Incorporating real-time analysis and monitoring of precipitation, temperature, soil moisture, snowpack, vegetation/crop stress, and river and lake levels into a national drought early warning information system.
- Improving understanding of the effects of increasing emissions of greenhouse gases and changing aerosol concentrations on drought frequency and severity, and on projections of long-term trends in aridity.
- Incorporating paleo-hydrologic records into resource management and drought planning.
- Determining effects of long-term temperature changes on drought severity and impacts.
- Reducing uncertainty in climate model predictions and projections of regional precipitation, stream flow, and lake volume changes.
- NOAA will continue to lead the National Integrated Drought Information System (NIDIS) in collaboration with other federal agencies, state and local governments, to enhance drought early warning capabilities to better serve the public and decision-makers.

NOAA Resources for Additional Information

Office of Oceanic and Atmospheric Research (OAR) Programs and Laboratories -

National Integrated Drought Information System (NIDIS) – Coordination of drought monitoring, forecasting, and planning and information at national, state, and local levels across the country, to help the nation to move to a more proactive approach to managing drought risks and impacts, and to improve long-term drought resilience. The NIDIS drought information portal is at drought.gov.

Drought Task Force - Overall goals are to achieve significant advances in understanding and in the ability to monitor and predict drought over North America; help advance basic understanding of drought mechanisms, official national drought products, the development of early warning systems by the NIDIS, and experimental drought monitoring and prediction activities and tools for operational and service purposes.

Geophysical Fluid Dynamics Laboratory – Studies of long-term climate variability and change; development of climate models for use in multi-decadal climate projections and projections of climate change for the next 50 to 100 years.

Earth System Research Laboratory – Research on causes of droughts and other high impact climate events; methods for improving climate analyses and forecasts; impacts assessments and regional applications of climate information.

National Weather Service (NWS) Climate Prediction Center and Environmental Modeling Center – Intra-seasonal to inter-annual climate variability modeling and outlooks; diagnostic studies of major climate anomalies; real time monitoring of climate; seasonal drought outlooks.

NWS River Forecast Centers and Office of Water Prediction (including National Water Center and National Operational Hydrological Remote Sensing Center) – current river levels and flow volumes, plus their outlooks from days to months, and current U.S. snowpack conditions.

National Environmental Satellite, Data, and Information Service (NESDIS), National Centers for Environmental Information – Official archive for drought data sets; analyses of climate trends, monitoring and historical perspective on current seasons, and paleo-climatic reconstructions of drought.

NESDIS/ Center for Satellite Applications and Research – Global satellite vegetation indices for monitoring plant health.