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 networks, heighten wildfire risks, and cause serious public health consequences.

How is Drought Defined?

Drought definitions vary depending on the impacts to a user group and the temporal component of onset. The basic drought definition is a deficiency in precipitation, runoff, and soil moisture leading to water shortages, creating adverse impacts on vegetation, animals, energy product, commerce, and people.

- Flash droughts can develop over much shorter time periods and lead to similar impacts as more prolonged periods of precipitation, runoff, and soil moisture.
- 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.
- Hydrological drought is defined by significant impacts on water supplies.

How have Droughts and 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.
- 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.
- According to NOAA's National Centers for Environmental Information, there were 258 weather-related disasters each having impacts over $1 billion from 1980-2019. Among these, 26 droughts cost the nation at least $249 billion, and resulted in almost 3,000 deaths, with an average cost of more than $9.6 billion incurred during each event. Only hurricanes were more costly.
- NOAA paleoclimate research indicates that more severe and sustained droughts occurred in the several centuries prior to 1900 than those that have occurred in more recent times.
- 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.

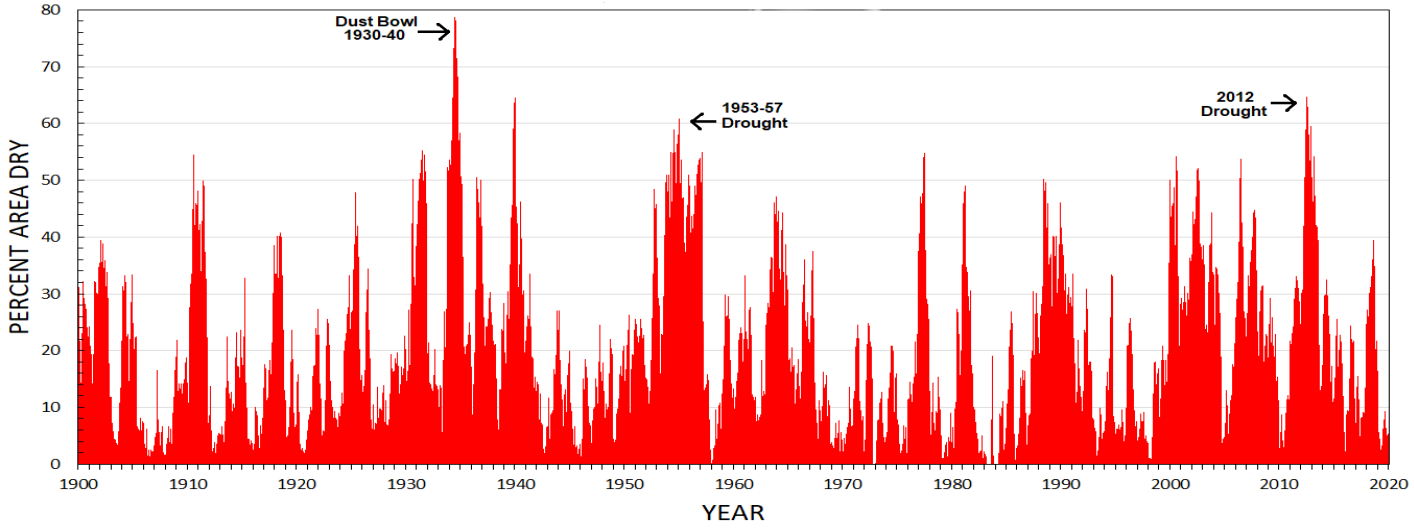

Figure 1. Percent of U.S. in Moderate to Extreme Drought based on the Palmer Drought Index

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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. 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, such as atmospheric circulation patterns and soil moisture content.

NOAA Priorities

- Improving precipitation prediction, particularly to subseasonal scales, through NOAA's Precipitation Prediction Grand Challenge.
- 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 through programs such as the Earth Prediction Innovation Center (EPIC).
- Improving understanding of the causes of droughts, as well as effects of land surface and vegetation.
- Improving drought monitoring, especially estimates of snow water storage and soil moisture, including development of a National Coordinated Soil Moisture Monitoring Network.
- 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.
- Incorporating satellite observations and remote sensed data to provide critical drought information
- 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)
- The US drought information portal is at drought.gov.
- Earth System Research Laboratory
- Geophysical Fluid Dynamics Laboratory

National Weather Service (NWS)

- Climate Prediction Center
- Environmental Modeling Center
- River Forecast Centers
- Office of Water Prediction (including National Water Center and National Operational Hydrological Remote Sensing Center)

National Environmental Satellite, Data, and Information Service (NESDIS)

- National Centers for Environmental Information
- Center for Satellite Applications and Research