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The U.S. Drought Monitor

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Introduction

Drought is a complex and slow-moving natural disaster which can cause severe damage comparable to other natural disasters such as hurricanes, tornadoes, fires, and flooding. Drought can be detrimental to crop and livestock production, the water and energy cycles, and wildlife habitat (Vose et al. 2016). Warming temperatures and increased frequency of drought increases wildfire activity and severity throughout western states (Westerling et al. 2006). Droughts can be difficult to discern in arid climates like Arizona where the climate is already relatively dry and warm. Nonetheless, droughts do occur and are infrequent climatic extremes eventually occurring in every location.

Drought is more complex topic than simple precipitation deficits. Factors affecting drought intensity include temporal and spatial variability of precipitation events, rainfall intensity, and temperature and cloud cover which influence evaporation. Similarly, drought impacts vary among different land uses. As a result, we often identify four categories of drought for use in determining impacts: meteorological (precipitation and temperature), agricultural (mainly short-term impacts to soil moisture and the ability to grow crops and forage), hydrological (long-term impacts to streamflow and reservoir storage), and ecological (long-term impacts to vegetation die-back and increased likelihood of wildfire).

The U.S. Drought Monitor (USDM) attempts to represent this complexity of intensity, duration, and impacts to natural resource utilization (land and water) each week using a single map to delineate drought conditions across the U.S. However, the complex nature of drought may be difficult to capture in a single map-based assessment meaning limitations may exist when interpreting the USDM within the scope of local drought conditions and impacts. Despite this limitation, the USDM serves

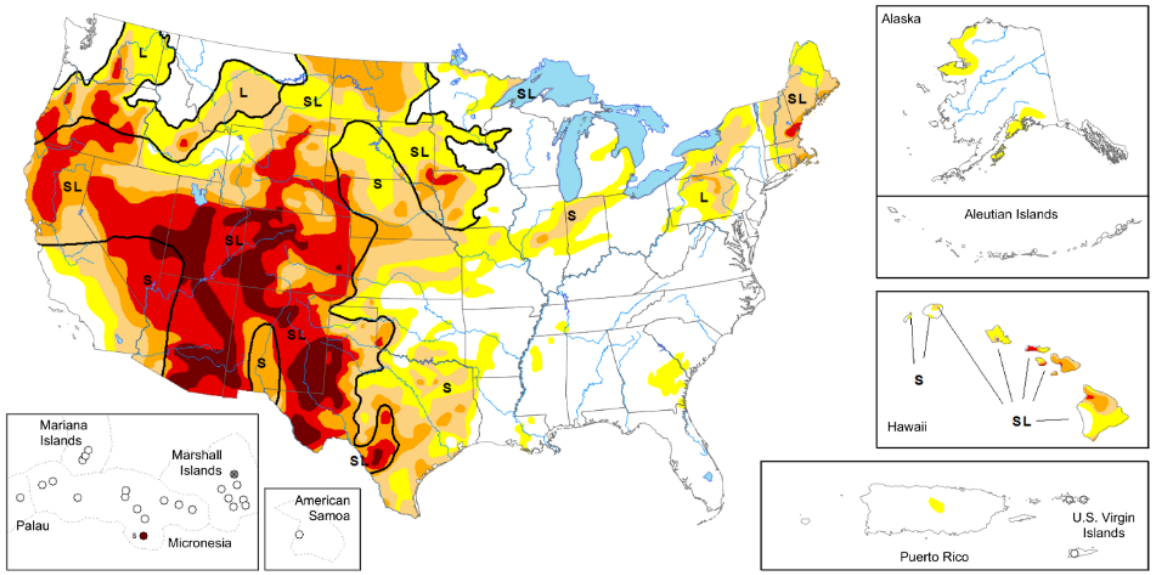

Figure 1. The U.S. Drought Monitor from November 19, 2020 illustrates the extent and intensity of drought. The U.S. Drought Monitor is jointly produced by the National Drought Mitigation Center at the University of Nebraska-Lincoln, the United States Department of Agriculture, and the National Oceanic and Atmospheric Administration. Map courtesy of NDMC-UNL.

as a trigger for some drought relief though the USDM developers never intended it to be used for that purpose. Therefore, it is important for policymakers, land managers, and agriculture producers alike to understand how the USDM is created and what it represents.

The U.S. Drought Monitor (USDM)

The U.S. Drought Monitor (Figure 1), established in 1999, is a weekly map of drought intensity and duration produced jointly by the National Drought Mitigation Center at the University of Nebraska-Lincoln (NDMC), U.S. Department of Agriculture (USDA), and National Oceanic and Atmospheric Administration (NOAA). The USDM website (http://droughtmonitor.unl.edu) is hosted and maintained by the NDMC (2020).

A map and explanation are authored, weekly, each Tuesday and published every Thursday. Eleven climatologists from partner organizations rotate as USDM authors biweekly. Observations are gathered from multiple data sources including a network of more than 425 expert observers from around the country (NDMC, 2020). There are six regions: Northeast, Southeast, Midwest, High Plains, South, and West. The West region includes: Montana, Idaho, Washington, Oregon, California, Nevada, Utah, New Mexico, and Arizona. Some of these observational networks that report to the national authors may provide observations at a statewide level while others may provide more specific data from the county level. In Arizona, the Monitoring Technical Committee of the Arizona Governor's Drought Task Force (https://new.azwater.gov/drought/mtc) serves as the conduit through which Arizona observers interact with USDM authors to recommend changes and make adjustments to the map across the state.

The USDM has five drought intensity categories ranging from abnormally dry to exceptional drought (Table 1). Areas in D0 category, or abnormally dry, are not in drought but are experiencing abnormally dry conditions. Areas in D0 may be headed into drought or may be recovering from drought but are not yet back to normal (indicated in white on the USDM map). D1 category, or moderate drought, is the least intensive of the drought categories where D4, or exceptional drought, is the most intensive.

The USDM also indicates the duration of drought an area may be experiencing. Short-term impacts focus on one to three-month windows for drought indicators and typically last less than six months. Short-term drought is usually

Table 1. U.S. Drought Monitor severity categories and commonly associated impacts.

Category	Description	Possible Impacts
None	None	None
D0	Abnormally Dry	Going into drought: · Short-term dryness slowing planting, growth of crops or pastures Coming out of drought: · Some lingering water deficits · Pastures or crops not fully recovered
D1	Moderate Drought	· Some damage to crops, pastures · Streams, reservoirs, or wells low, some water shortages developing or imminent · Voluntary water-use restrictions requested
D2	Severe Drought	· Crop or pasture loss likely · Water shortages common · Water restrictions imposed
D3	Extreme Drought	· Major crop/pasture losses · Widespread water shortages or restrictions
D4	Exceptional Drought	· Exceptional and widespread crop/pasture losses · Shortages of water in reservoirs, streams, and wells creating water emergencies

Adapted from: http://droughtmonitor.unl.edu/AboutUSDM/DroughtClassification.aspx

associated with agricultural and grassland production. These are indicated by a "S" on the USDM map (Figure 1). Agricultural and socioeconomic droughts might vary based on the type of crop or rangeland being impacted. For example, impacts to annual crop production may be easily quantified, but impacts to perennial rangelands may change and compound based on drought severity and longevity (Vose et al. 2016). Likewise, meteorological and hydrologic droughts tend to compare water availability to long-term trends or benchmarks such as mean values. Long-term impacts can focus on six to 60-month windows and last more than six months. Long-term drought can negatively affect water supply/availability, and increase the likelihood of wildfire and ecological impacts Areas deemed in long-term drought are indicated by a "L" on the USDM map (Figure 1). Areas indicated by a "SL" are experiencing both short and long-term drought (Figure 1). In short, duration and severity are important for incorporating characteristics of each drought type to assess impacts.

How is drought extent, intensity, and duration determined for Arizona?

The USDM is a mixture of objective measures of deficits in precipitation, soil moisture, and streamflow, as well as subjective interpretation of conditions based on observations of on-the-ground conditions by the 425 expert observers. The subjective interpretation is particularly important in Arizona where there are few official rain gauges and rainfall patterns can vary greatly across short distances. Given the aforementioned complexities associated with assessing drought intensity and duration for many different land and water uses, as well as the sparse coverage of monitoring stations, the USDM may lag in depicting the development or improvement of drought conditions by over or underestimate local intensities.

Drought monitoring experts consult many different forms of data available including:

- Daily and monthly total precipitation observations (from stations) and gridded estimates (from statistical models and remote sensing)
- Measurements of snowpack, streamflow and reservoir levels
- Remote sensing imagery of vegetation and crop conditions
- Drought indices that combine different statistical aspects of precipitation and temperature to portray intensity of drought conditions

A snapshot of national-scale drought information consulted by authors is available here at: http://droughtmonitor.unl.edu/CurrentConditionsandOutlooks/CurrentConditions.aspx with an even more exhaustive catalog of tools available here: https://www.drought.gov/drought/data-maps-tools

Local Observations

Interpretations by local experts (e.g. Extension agents, land managers, farmers, and ranchers) are important to USDM authors. Due to gaps in objective data collection and the complexity of rainfall effects, local observations are often useful to help interpret data. Data such as photographs, low or unexpected loss of water resources, vegetation response, and other types of drought impacts help paint a more definitive picture of ground conditions. In addition to on the ground interpretations of drought conditions, local resources expand the network and increase USDM accuracy.

There are several ways a local observer can contribute data to USDM authors. The first is to contact your local Extension agent or state climatologist. A current list of state climatologists can be found at: www.stateclimate.org. Other ways to contribute include submitting emails to: droughtmonitor@unl.edu, becoming a Community Collaborative Rain, Hail & Snow (CoCoRaHS) observer and submitting drought reports along with daily precipitation observations (learn more at www.cocorahs.org), or by submitting an assessment of local conditions at regular intervals to droughtreporter.unl.edu (for how-to information: see droughtreporter.unl.edu/submitreport). It is critical to document both conditions leading up-to , during, and after drought. Systematic techniques such as photo points or daily recording of precipitation data is recommended (see: Rain Gauges for Range Management, az1751-2017).

Summary

Drought is a cyclical event that will eventually happen in all locations of Arizona. Impacts depend on the timing, frequency, and intensity of drought and vary over different time and spatial scales. The categories of drought (i.e. meteorological, agricultural, hydrological, and ecological) depend on the land and water uses at a location, each reacting differently to dry conditions.

The USDM attempts the very challenging task of identifying the extent of drought, its intensity, and the impact on all possible land and water uses across the US every week. This is challenging because there is no single measure that perfectly represents drought intensity and impacts for these uses. Therefore, the USDM authors

interpret many objective measures as well as subjective interpretations of conditions on the ground.

Despite the inherent imperfections in the USDM, it is used to trigger the implementation of drought plans for federal, state, or local governments, as well as disaster relief programs such as the Livestock Forage Disaster Program. Although the creators of the USDM never intended it to be used this way, the current authors now receive more input from on-the-ground sources each week and are under greater scrutiny in regards to the accuracy of drought condition estimations.

It is important for the USDM to accurately identify areas of drought, particularly when it is used to trigger the implementation of drought plans for federal, state, or local governments, as well as disaster relief programs. One way to increase accuracy of the USDM is to participate in the process and join the network of observers. To learn more about the USDM and share on-the-ground information about impacts, use any of the following resources:

Local Extension Agent: https://extension.arizona.edu

State Climatologist: www.stateclimate.org.

Drought Monitor: droughtmonitor@unl.edu

NIDIS: www.drought.gov/drought/contact-us

CoCoRaHS observer: www.cocorahs.org.

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This information has been reviewed by University faculty.
extension.arizona.edu/pubs/az1865-2020.pdf

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