

Appendix 4-B
Definition of Drought for
Sonoma County Groundwater Sustainability Plans

Definition of Drought for Sonoma County Groundwater Sustainability Plans

Summary

During the planning and implementation phases of the Groundwater Sustainability Plan (GSP) it will be necessary to make the determination if a water year qualifies as a drought or does not. For the groundwater level sustainability indicator the occurrence of a drought may allow for overdraft to occur without qualifying as undesirable results. The Drought Monitor Long Term Drought Indicator Blend (LTDIB) will be used to assess for drought conditions. A drought is considered to occur when the LTDIB water-year averaged value meets or exceeds that of the D1, or moderate, drought.

Background

During periods of drought, the groundwater sustainability plans allow for minimum threshold exceedances that under normal conditions would constitute undesirable results. For the groundwater level sustainability indicator, if minimum threshold exceedances are caused by droughts that extend for longer than the 4-year drought factor already incorporated into the calculated minimum thresholds, it is not considered an undesirable result unless the groundwater levels do not rebound to above the thresholds during future normal and wet years following long-term droughts. This is consistent with GSP regulations which state that, “overdraft during a period of drought is not sufficient to establish a chronic lower of groundwater levels” (California Water Code 10721). Additionally, for the interconnected surface water sustainability indicator the percentage of minimum threshold exceedances that constitute undesirable results is higher during drought years and lower during non-drought years. Here the definition of a drought is detailed for use in the planning and implementation phases of the Sonoma County GSPs.

The US Drought Monitor is a map of drought conditions in the United States that is developed and updated by experts of National Drought Mitigation Center (NDMC) at the University of Nebraska-Lincoln, the National Oceanic and Atmospheric Administration (NOAA), and the U.S. Department of Agriculture (USDA). The map is updated every week and incorporates a number of meteorological, hydrologic, and agricultural inputs to assess conditions. Drought conditions are described by severity through the use of the following codes: abnormally dry (D0), showing areas that may be going into or are coming out of drought, and four levels of drought: moderate (D1), severe (D2), extreme (D3) and exceptional (D4). The effects of each drought category on California are shown in Table 1 and Figure 1 shows a snapshot view of the LTDIB values for April 2021 for the continental US.

A variety of maps are developed by the Drought Monitor. For the SGMA subbasins the Long-Term Drought Indicator Blend (LTDIB) will be used as the metric for establishing drought and non-drought conditions. This is an objective metric that utilizes a scoring system with inputs from the Palmer Drought Severity Index (PDSI), the Z-index, CPC soil moisture storage, and a 180 day, 1-year, 2-year, and 5-year observations of the Standardized Precipitation Index (Guttman, 1998). The PDSI is a standardized index

that uses both precipitation and evapotranspiration in a hydrologic accounting system (Palmer, 1965). The Z-index measures short-term drought on a monthly scale. The Climate Prediction Center Soil moisture storage¹ is a mechanistic model that simulates soil storage for the continental US. The SPI is a meteorological index that calculates the precipitation deficit for a given period, with respect to the observed precipitation variance. A limitation of the SPI is that it does not account for the effect evapotranspiration has on the presence or severity of drought. Under warming climate conditions this effect will become more important. The PDSI, Z-index, and CPC soils moisture storage do account for the effect of increased temperatures and should counteract the limitations of the SPI indices.

Table 1 Impacts on California By Drought Category²

Category	Historically observed impacts
D0 – Abnormally Dry	Soil is dry; irrigation delivery begins early
	Dryland crop germination is stunted
	Active fire season begins
	Winter resort visitation is low; snowpack is minimal
D1 – Moderate Drought	Dryland pasture growth is stunted; producers give supplemental feed to cattle
	Landscaping and gardens need irrigation earlier; wildlife patterns begin to change
	Stock ponds and creeks are lower than usual
D2 – Severe Drought	Grazing land is inadequate
	Producers increase water efficiency methods and drought-resistant crops
	Fire season is longer, with high burn intensity, dry fuels, and large fire spatial extent; more fire crews are on staff
	Wine country tourism increases; lake- and river-based tourism declines; boat ramps close
	Trees are stressed; plants increase reproductive mechanisms; wildlife diseases increase
	Water temperature increases; programs to divert water to protect fish begin

¹ <https://www.cpc.ncep.noaa.gov/soilmst/w.shtml>

² <https://droughtmonitor.unl.edu/About/AbouttheData/DroughtClassification.aspx>

	River flows decrease; reservoir levels are low and banks are exposed
D3 – Extreme Drought	Livestock need expensive supplemental feed, cattle and horses are sold; little pasture remains, producers find it difficult to maintain organic meat requirements
	Fruit trees bud early; producers begin irrigating in the winter
	Federal water is not adequate to meet irrigation contracts; extracting supplemental groundwater is expensive
	Dairy operations close
	Fire season lasts year-round; fires occur in typically wet parts of state; burn bans are implemented
	Ski and rafting business are low, mountain communities suffer
	Orchard removal and well drilling company business increase; panning for gold increases
	Low river levels impede fish migration and cause lower survival rates
	Wildlife encroaches on developed areas; little native food and water is available for bears, which hibernate less
	Water sanitation is a concern, reservoir levels drop significantly, surface water is nearly dry, flows are very low; water theft occurs
	Wells and aquifer levels decrease; homeowners drill new wells
	Water conservation rebate programs increase; water use restrictions are implemented; water transfers increase
	Water is inadequate for agriculture, wildlife, and urban needs; reservoirs are extremely low; hydropower is restricted
	Fields are left fallow; orchards are removed; vegetable yields are low; honey harvest is small

D4 –
Exceptional
Drought

Fire season is very costly; number of fires and area burned are extensive

Many recreational activities are affected

Fish rescue and relocation begins; pine beetle infestation occurs; forest mortality is high; wetlands dry up; survival of native plants and animals is low; fewer wildflowers bloom; wildlife death is widespread; algae blooms appear

Policy change; agriculture unemployment is high, food aid is needed

Poor air quality affects health; greenhouse gas emissions increase as hydropower production decreases; West Nile Virus outbreaks rise

Water shortages are widespread; surface water is depleted; federal irrigation water deliveries are extremely low; junior water rights are curtailed; water prices are extremely high; wells are dry, more and deeper wells are drilled; water quality is poor;

Objective Long-Term Drought Indicator Blend Percentiles

Apr 24, 2021

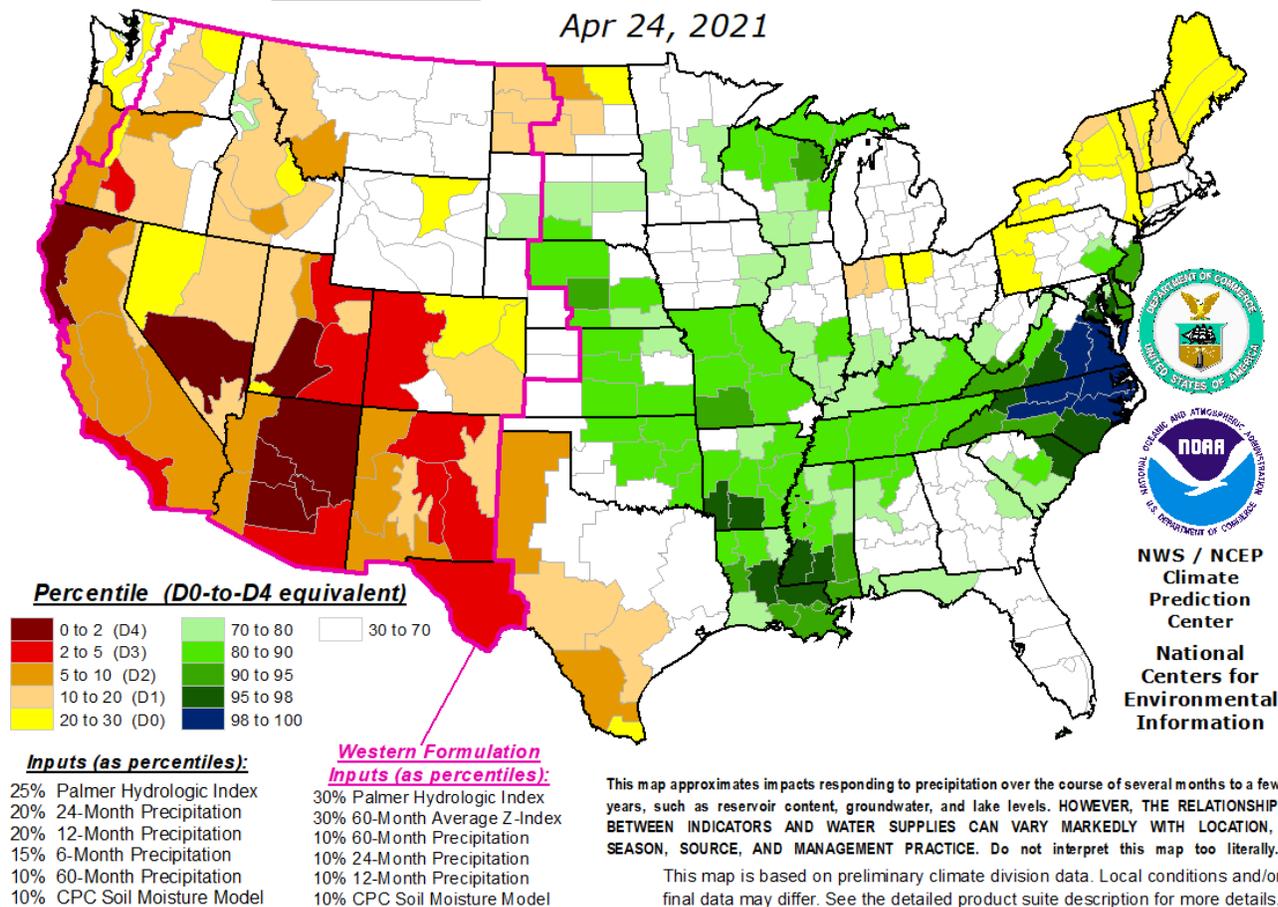


Figure 1 Snapshot of the Objective Long-Term Drought Indicator Blend for April 24, 2021

Approach for Future Drought Conditions

The LTDIB for all of Sonoma County is shown in Figure 2. The values represent the spatially averaged value for the entire county averaged for the entire water year. It should be emphasized that this value is averaged over the entire water year, so that, for example, water year 2021 ends in a D4 drought, but the water year is categorized only as D3 due to yearly averaging. The Water Year types for the three subbasins are also shown for comparison on Figure 2. Years classified as Moderate Drought (D1) will be used as the definition of Drought for the Subbasins. Given this definition there are nine years in the period spanning Water Year 1984 to the end of Water Year 2021 that qualify as drought conditions. In the same period there are 7 years classified as dry or very dry based on the water year type classifications developed by the GSA's. Four of these years are categorized as D1 drought conditions, one of the dry years is classified as D2, and water year 2021 is classified as an extreme dry year. There is good correspondence between the GSA water year type classifications and the LTDIB classifications. It should be noted that these years have not officially been classified as drought or non-drought years by the Drought Monitor.

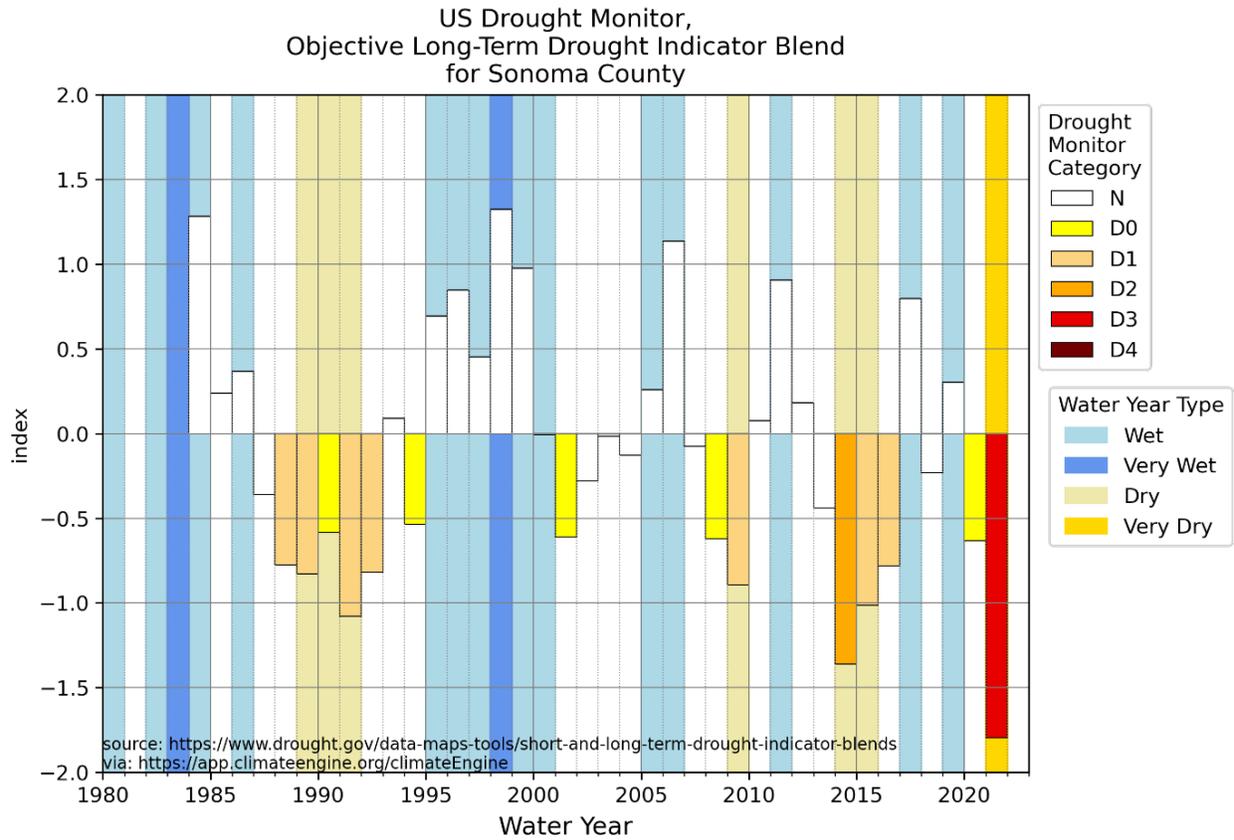


Figure 2 US Drought Monitor, Objective Long-Term Drought Indicator Blend for Sonoma County

Method of Calculation

The Earth Engine website (<https://app.climateengine.org/climateEngine>) stores the raw data and also calculates the LTDIB values. The sub-weekly values are averaged over the water year and then categorized based on the LTDIB value. The cutoffs for each classification are detailed in Table 2.

Table 2 Drought categories by LTDIB value

Range	Category
(-2.5, -2.0]	D4
(-2.0, -1.5]	D3
(-1.5, -1.2]	D2
(-1.2, -0.7]	D1
(-0.7, -0.5]	D0
(-0.5, 10.0]	N