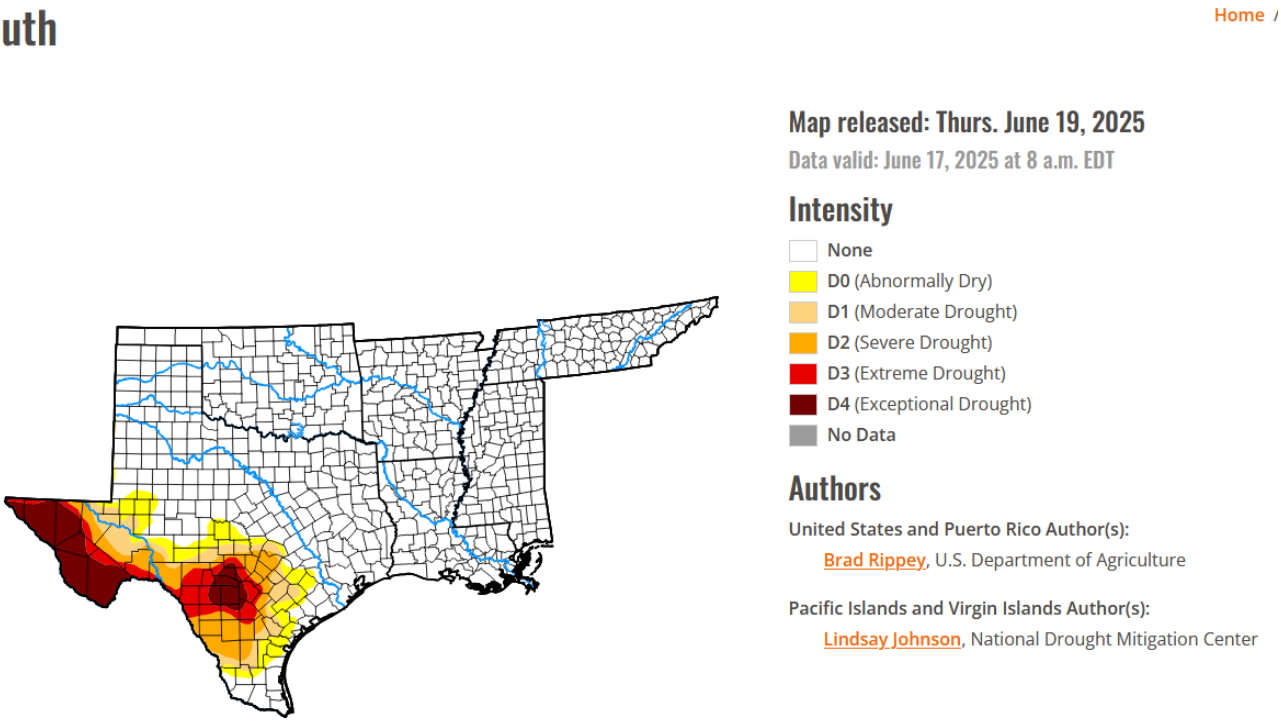
Bi-monthly Educational Topic #11 for CCGCD
by Texas Hill Country Weather Services, LLC
June 19, 2025

Current conditions:

As of June 17, 2025, most of Kendall County has reduced to the D3 extreme drought category (per the latest available US Drought Monitor map provided below) as the region associated with this drought continues. There is a slight sliver of an area of far northeastern Kendall County that is now down to the D2 severe drought category and about ¼ of Kendall County within the far western portion remains in the D4 exceptional drought category. The Spring's seasonal rains are over, and we are now entering into our typical dry Summer weather pattern in which drier than average and warmer than average conditions are still expected. Thus, I do expect our drought to re-intensify for our Summer unless we can experience some anomalous tropical storms or hurricanes – which is always possible for us. CCGCD remains at a Stage 4 drought restriction within this on-going Drought Emergency.



In the previous topic, an introduction to the concepts of evaporation and evapotranspiration were provided where you can learn about these pertinent water cycle topics, especially relative to our on-going drought emergency. The district's drought stage index decision tool (CDSIDT) currently being developed by CCGCD could consider evaporation and evapotranspiration as a couple of its input parameters used internally within the tool's analysis scheme.

First, let's express a simple mathematical water balance equation to calculate evaporation relative to a water body open to the air such as a lake by utilizing the hydrologic equation methodology:

$$E \text{ (units of depth such as millimeters or inches)} = P + R + Qi + Gr + Di - Qo - Do - \Delta S \quad (1)$$

where E is the amount of water evaporated for monthly, seasonal, or annual time periods, P is the precipitation on the water surface, R is the runoff inflow from the drainage basin, Qi and Qo are major channel flows into and out of the water body, Gr is groundwater recharge, Di is deep water infiltration

below the root zone of soil, Do is water discharge from the water body and ΔS is the change in water body storage including soil moisture and groundwater levels.

Secondarily, it is best to consider the American Society of Civil Engineers (ASCE) Standardized Penman-Monteith equation for calculating reference evapotranspiration (ETo) from a hypothetical green grass surface under standard conditions, as follows:

$$ETo = 0.408\Delta(Rn - G) / (\Delta + y(1 + 0.34u)) + 900y / (\Delta + y(1 + 0.34u)) * u*D(T + 273) \quad (2)$$

where Rn is net solar radiation energy at the surface, G is soil heat flux (in and out of the soil), u is wind speed, Δ is the slope of the saturation vapor pressure curve as it changes with temperature, y is the psychrometric constant which is a measure of the relationship between temperature and water vapor, T is air temperature, D is the vapor pressure deficit which is the difference between the saturation vapor pressure and the actual vapor pressure and finally the 0.408 and 900 are coefficients used for converting energy units to equivalent water depths.

The use of these equations alone to calculate evaporation and evapotranspiration to help measure the impact of drought intensity on our water resources as it relates to the development of the index tool not only includes the necessity of data collected by meteorological equipment but also data to be collected by hydrological, geological and agricultural equipment resources. These available resources come at a monetary cost to CCGCD. So, you now might begin to see how big the challenge ahead is with making water resource decisions using a local drought index tool which is essentially a multidisciplinary engineering study that is going to take some significant time and effort to finish and implement.

Surface weather data from meteorological weather stations located within and near Kendall County will be used. Archived daily, weekly and monthly air temperature and precipitation datasets are usually easily attained from the CoCoRaHS network (www.cocorahs.org) and the National Centers for Environmental Information (www.ncei.noaa.gov) at little to no cost for data access and use. However, there is an important issue that needs to be addressed if a local ETo dataset is going to be incorporated into the index. ETo is currently not measured anywhere inside Kendall County and that is a problem. The closest ETo measuring stations are near Kerrville, Helotes and Dripping Springs so one could take these datasets and interpolate this data for Kendall County which is an option. Another option is to purchase a $350 ET gauge from the equipment vender (www.weatheryourway.com) and set it up locally in Boerne where a trained observer can take and report those daily readings into CoCoRaHS. Another option is to purchase and set up in Boerne an approximately $8000 (with a $500 annual operational cost) mesonet-quality (www.texmesonet.org) automated weather station that measures multiple meteorological variables including solar radiation and then participate within the TexasET Network (www.texaset.tamu.edu) in which they will use the meteorological data to compute ETo and provide this data back to CCGCD. Even the automated federal weather station (5C1) located at the Boerne Stage Airfield Airport in northern Bexar County does not collect the needed solar radiation data needed to compute ETo. Another possibility to acquire ETo data for Kendall County is using a remote sensing Geographical Information System (GIS) tool called Google Earth Engine (GEE) and combining it with the most famous ETo model called the Surface Energy Balance Algorithm for Land (SEBAL). Finally, there is a NASA/USGS government program called OpenET that uses publicly available data to provide Landsat 9 satellite-based information to calculate ETo. Each of these options listed above to calculate ETo comes with its own sets of challenges, considerations, costs and limits which will take considerable effort to establish how best to incorporate ET into the index.

In order to account for evaporation within the index, CCGCD will have access to hydrological monitoring equipment and datasets to acquire groundwater recharge and surface water flow rates across Kendall

County. Daily soil moisture values across Kendall County can be attained from the Texas Water Development Board (www.waterdatafortexas.org/reservoirs/statewide).

It is going to take significant time and effort with some cost involved to develop this index. A statistical software package will likely have to be purchased to conduct the statistical calculations to develop the index. Right now, we are looking into all of the available data resources and conducting a thorough literature review on drought-related topics.

If you want to participate with us doing data collection, preparing literature reviews or providing technical assistance, we would be glad to meet with you to discuss such opportunities. One of the ways to get involved is to come to the monthly district meetings held usually every second Monday of the month at the district office.

Stay tuned into CCGCD's website page, as TXHCWS will soon be providing more educational materials.