WATER-LIMITING CONDITIONS BASED ON MONTHLY WATER BALANCES AND POTENTIAL EVAPOTRANSPIRATION AT PANOLA MOUNTAIN RESEARCH WATERSHED, GEORGIA, U.S.A.

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Drought and resulting water-limiting conditions can result in negative ecological impacts such as reduced plant growth and increased stress that can make plants more vulnerable to threats such as insect infestations. The long-term dataset at Panola Mountain Research Watershed, a small 0.41-hectare forested watershed near Atlanta, Georgia, U.S.A., was used to better quantify the important factors leading to water-limiting conditions. Actual evapotranspiration (ET) relative to potential ET (PET) was used as an indicator of water limiting conditions as PET represents the potential maximum ET, assuming no water limitations. Actual and potential ETs were compiled on a monthly basis for the period 1985 through 2011, which contains multiple drought periods. Potential ET was calculated from air temperature and solar radiation using the Priestley–Taylor equation. Actual ET was determined using the watershed water budget, and was calculated as the difference between monthly precipitation, runoff, and changes in water storage within the watershed. Water storage was determined using a water storage-baseflow relation developed for this watershed.

Annual water yields, the proportion of precipitation that occurs as runoff each year, varied greatly, ranging from 9.7 to 46 percent. The magnitude of water yields were largely dependent on the annual precipitation and whether the majority of precipitation occurred during the dormant season, resulting in more runoff, versus the growing season, resulting in more ET. Actual ET averaged about 40 millimeters per month (mm/month) during the dormant season and 88 mm/month during the growing season and peaked with an average of 123 mm/month in July. Actual ET averaged about 89 percent of PET during the dormant season and 70 percent of PET during the growing season. For this analysis, we defined months with water-limiting conditions as those where actual ET was <60 percent of PET. Months with water-limiting conditions were observed during the growing season when monthly precipitation was low (defined as <50 mm) and was irrespective of watershed storage condition. This result may indicate that storage available in shallow soils derived from recent precipitation is a more important control on actual ET than overall watershed storage, with plant transpiration as the driver. The results of this analysis should assist in assessing the effects of future changes in seasonal and long-term climate patterns in precipitation on components of the water budget along with changes in the severity and duration of water-limiting conditions.

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