A Hydroclimatic Indexing Concept for Monitoring Drought

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Introduction

A method for indexing the hydroclimate of any location on any timeframe was derived from the hydroclimate of the southwestern United States. The focus is on the difference between precipitation (P) and the climatic demand for water, or potential evapotranspiration (PE). The hydroclimatic index (HI) was directly compared to the popular Palmer Drought Severity Index (PDSI) and the Standardized Precipitation Index (SPI). The PDSI has been criticized for spatial variability in its statistical properties, erratic short-term response to drought, and the use of an arbitrary scale. The SPI is limited to one-half of the water budget equation by only representing precipitation. The HI aims to resolve these issues.

Data

Monthly temperature and precipitation data were gathered in support of representing the hydroclimate of the Colorado River Basin (CRB) from 1895 through 2004. Data were collected for the 23 “climate divisions” that are at least partially contained within the CRB. The wetness or dryness of a location can best be described by the difference between moisture input and the climatic demand for moisture, or P-PE. For example, annual precipitation across Arizona fails to meet the natural climatic demand for water by nearly 500 mm on average, indicating the extreme dryness of the climate.

Method

The Thornthwaite-Mather Climatic Water Budget Model was used to create records of monthly PE from the temperature and precipitation data. Once monthly P-PE values were constructed, aggregate means were calculated for periods of 3-, 6-, 12-, 24-, 36-, and 48-months to represent the running short-, intermediate-, and long-term hydroclimatic conditions. Values for each time period were placed within a frequency distribution to assign each a percentile value to create the HI.

To further improve upon the SPI specifically, we wanted to devise a method for emphasizing the more important portions of the annual hydroclimatology when representing conditions for periods of 12 months or greater.

Results

For short timeframes, the inclusion of the climatic demand for water in the HI significantly differentiates it from the SPI in the warmer portions of the region where climatic demand is greatest. The PDSI is most different from the HI in the coldest and wettest areas in winter and the warmest and driest areas in summer due to the upper and lower limits and inherent lag in soil moisture as calculated in the PDSI.

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