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Drought propagation from meteorological to hydrological drought in the Krishna River Basin of India

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Understanding the propagation of drought from one form to another has become a prime topic of research during recent decades. The majority of research has used a correlation-based approach to study drought propagation; however, such techniques are ineffective in areas with considerable seasonality in precipitation, such as India. Only a few studies have employed an event-based approach to study drought propagation. Moreover, none of the previous studies considered the sequential propagation of drought, starting from meteorological to hydrological drought through agricultural drought. This work aims to analyse drought propagation from meteorological to hydrological drought through agricultural drought using an event-based approach in the Krishna River Basin of India. The Standardised Precipitation Evapotranspiration Index (SPEI) represents meteorological drought, the Standardised Soil Moisture Index (SSMI) represents agricultural drought, and the Standardized Streamflow Index (SSI) represents hydrological drought is estimated at a 1-month timescale at sub-basin scale. The precipitation and temperature data are procured from the India Meteorological Department (IMD) Pune, the soil moisture data is obtained from the European Space Agency (ESA) Climate Change Initiative (CCI) v03.3, and the streamflow data is downloaded from India-WRIS. Two different cases of drought propagation are analysed: meteorological to agricultural drought (SPEI-SSMI) and agricultural to hydrological drought (SSMI-SSI). Propagation of drought is quantified through the estimation of three-time matrices: (1) the time difference between the initiation of droughts, (2) the time difference between the peak of droughts, and (3) the time difference between the termination of droughts. The results from the study revealed that the SSMI drought was initiated after 6.4 months of the SPEI drought, while the SSI drought was initiated after 8.4 months of the SSMI drought. The peak of SSMI drought is found to be after 6.3 months of the peak of SPEI drought, while the peak of SSI drought is found to be after 34.7 months of the peak of SSMI drought. Once the SPEI drought terminates, it lasts for 8.3 months for the SSMI drought to terminate, while after the SSMI drought terminates, it lasts for 30.7 months for the SSI drought to terminate. Thus, it was found that the propagation of drought from SPEI-SSMI is faster than the propagation of drought from SSMI-SSI. The present work will provide essential information on drought propagation, which will be helpful in the management and mitigation of droughts in India.

Keywords: Drought Propagation, Propagation Time, SPEI, SSMI, SSI.

