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Validation of remotely sensed drought indices from Google Earth Engine using *in situ* observations

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Abstract

Drought poses a significant environmental challenge in the arid and semi-arid regions of South Africa, primarily due to low and erratic rainfall coupled with rising temperatures. Effective monitoring of drought conditions requires continuous spatial and temporal data; however, this is often compromised by uneven distribution and malfunctioning ground stations, leading to inconsistent datasets. Remote sensing offers a promising alternative, providing extensive spatial coverage and near-real-time data, although its use in South African dry regions remains underexplored.

The current study evaluates the performance of remotely sensed drought indices derived from Google Earth Engine (GEE) by validating them against data from ground stations. Additionally, the study examined the spatio-temporal variations of drought using the Standardized Precipitation Index (SPI) and the Standardized Precipitation Evapotranspiration Index (SPEI) at 3-, 6-, and 12-month timescales. The results indicate that the SPI derived from CHIRPS data shows moderate to strong agreement with ground observations, particularly at longer timescales, achieving R^2 values of up to 0.88 and demonstrating reduced Root Mean Square Error (RMSE) and Mean Absolute Error (MAE) values. However, some spatial inconsistencies remain at certain stations. In contrast, the SPEI demonstrates consistently strong agreement across all stations and timescales, with R^2 values ranging from 0.95 to 0.99 at shorter and medium timescales, indicating high reliability.

Spatial analysis reveals that drought severity increases with longer accumulation periods. The SPI indicates widespread dry conditions across central, northern, and eastern regions, while the southwestern areas remain relatively wetter. The SPEI highlights a persistent west-east gradient, showing wetter conditions in the west and more severe drought in the central and eastern regions. Temporal analysis identifies a prolonged drought from 2015 to 2020, followed by wetter conditions beginning in 2021 onwards. Overall, GEE-derived indices, particularly the SPEI, are effective tools for monitoring drought in data-scarce environments.

Keywords: Drought, standardised precipitation evapotranspiration index, standardised precipitation index

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