Evaluation of Satellite-Based Precipitation Products for Hydrological Modeling: A Case Study of the Upper Ziz Basin, Morocco

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Abstract

Accurate estimation of precipitation over large spatial and temporal scales remains a major challenge in hydrology and meteorology, particularly in regions with sparse ground-based observation networks. Recent advances in satellite remote sensing have provided alternative data sources to monitor the spatiotemporal variability of rainfall. This study aims to evaluate the performance of two satellite-based precipitation products, IMERG-F and CHIRPS, in estimating rainfall and assessing their potential use in hydrological modeling over the Upper Ziz watershed in southeastern Morocco.

The study area is characterized by a semi-arid to arid climate, strong spatial and temporal variability in rainfall, and limited hydro-climatic monitoring infrastructure. To address these challenges, a comparative analysis was conducted between satellite-derived precipitation data and ground-based observations from six pluviometric stations over the period 2000–2020. The evaluation was performed at both monthly and annual time scales using statistical performance indicators, including the Pearson correlation coefficient, bias, root mean square error (RMSE), mean error (ME), and mean absolute error (MAE). Subsequently, their suitability for hydrological applications was tested by integrating them as input data into the GR2M rainfall-runoff model.

The results indicate that IMERG-F generally outperforms CHIRPS in estimating precipitation over the study area, showing stronger correlation with ground observations and lower error metrics across different temporal scales. Furthermore, hydrological simulations driven by IMERG-F data demonstrate satisfactory reproduction of the watershed's hydrological behavior. Consequently, IMERG-F is recommended as a reliable alternative or complement to ground-based rainfall measurements in the upper Ziz basin.

Overall, this study highlights the potential of satellite-based precipitation products as effective tools for hydrological modeling in data-scarce regions. Their integration can significantly enhance the monitoring and management of water resources in arid environments such as the Upper Ziz basin.

Keywords: Remote sensing, IMERG-F, CHIRPS, hydrological modeling, Ziz watershed