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FROM OBSERVED TO CHIRPS: ASSESSING SATELLITE-BASED PRECIPITATION IMPACT ON SWAT MODEL HYDROLOGICAL PERFORMANCE

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Abstract

Hydrological modeling in semi-arid basins is often constrained by scarce and variable quality of ground precipitation data. Satellite rainfall products such as CHIRPS offer an alternative but their capacity to reliably replace observed precipitation in an already calibrated hydrological model, without recalibration, remains insufficiently investigated, particularly in semi-arid Mediterranean environments. In this study, SWAT model was applied to the Chiba River basin to evaluate the robustness of a gauge-calibrated model when forced with CHIRPS. The model was first calibrated using observed precipitation, achieving satisfactory performance ($NSE = 0.77$, $PBIAS = 0.2$, $R^2 = 0.81$, and $KGE = 0.7$), confirming its ability to reproduce monthly hydrological behavior. The calibrated parameter set was then applied to simulation driven by both raw and bias-corrected CHIRPS, allowing a direct assessment of precipitation input uncertainty without parameter compensation. Results indicate that bias-corrected simulations exhibit a good performance ($NSE = 0.71$, $PBIAS = -5.1$, $R^2 = 0.74$, and $KGE = 0.65$) demonstrating a consistent representation of monthly hydrological dynamics. Simulations driven by raw CHIRPS show acceptable performance ($NSE = 0.6$, $PBIAS = 8.5\%$, $R^2 = 0.7$, and $KGE = 0.45$) and successfully capture the general behavior of peak flows, although some discrepancies remain.

This study highlights three contributions: it evaluates CHIRPS in a gauged semi-arid basin, isolates the effect of precipitation input by fixing model parameters, and compares raw and bias-corrected CHIRPS. Bias-correction proves to be a robust alternative for data-scarce basins, while raw CHIRPS can still provide a first-order approximation under ungauged conditions. These findings support the use of satellite precipitation in hydrological modeling and water resource assessment in data-limited Mediterranean environments.

Key words: calibration, CHIRPS, observed precipitation, model robustness, streamflow simulation

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