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Calibration and Validation of SWAT Hydrological Model for Meki Watershed, Ethiopia

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Abstract

The Soil and Analysis Tool (SWAT) is a continuous time, physically based, and spatially distributed public domain hydrological model. SWAT is used in different tropical watersheds and reported to be able to well explain watershed hydrological processes. To benefit from its free accessibility and good modelling capability, testing this model for the Ethiopian condition is necessary. The Meki Watershed, covering an area of 2233 km^2, is found in central Ethiopia and has an average elevation of 2143 m.a.s.l. Before calibration, baseflow separation and sensitivity analysis was carried out. It is found that 62 % of the flow is contributed by the baseflow. The sensitivity analysis showed that from 28 parameters controlling the flow, only 14 revealed meaningful effects on the flow simulation. The curve number (CN_2), the soil available water capacity (SOL_AWC), and the soil evaporation compensation factor (ESCO) are the most sensitive of all controlling the surface flow. For the baseflow, threshold water depth in the shallow aquifer for flow (GWQMN), saturated hydraulic conductivity (sol_k), deep aquifer percolation fraction (rchrg_dp), and groundwater revap coefficient (GW_REVAP) have the highest influence. The flow was manually calibrated using monthly gauged and simulated flows from 1985 to 1989. At first, the surface flow and then the baseflow were calibrated. Then, the total flow was compared. Validation was done for flows from 1990 to 1992 following the same procedure but without changing any of the calibration parameter values. The calibration result showed that there is a good agreement between the simulated and gauged monthly flows. This is demonstrated by the correlation coefficient (R^2=0.84) and the Nash-Suttcliffe simulation efficiency (ENS=0.69) values. For validation, the R^2 was found to be 0.81, which showed its very good correlation with the gauged flow. The ENS value that was found to be 0.54, though relatively lower, is acceptable as this value is more than 0.5. The results showed that SWAT is able to simulate the hydrological characteristics of the watershed very well.

Keywords: Baseflow, baseflow separation, correlation coefficient, modelling, nash-suttcliffe simulation efficiency, sensitivity analysis, soil and water analysis tool, surface flow

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