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Surface Water Potential Assessment of Ungauged Catchments in Lake Tana Basin, Ethiopia

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The assessment of surface water resources of a basin, or the efficient design of water resources projects, requires an adequate estimation of surface runoff from gauged and ungauged catchments of a basin. Therefore, the objective of this study was mainly to assess the surface water resources potential of ungauged catchments in Lake Tana Basin (LTB) by using Soil and Water Assessment Tool (SWAT). For this purpose, this paper evaluates two different rainfall-runoff model parameter optimization approaches, and three different parameter transfer schemes from gauged to ungauged catchments. For calibration of rainfall-runoff model parameters, four gauged catchments were considered namely: upper Gilgel Abay, upper Gummera, upper Rib, and upper Megech catchments. From watershed delineation of LTB, about 5236 km2 area of LTB is gauged watershed and the remaining 9878 km2 area is ungauged watershed. The particle swarm optimization (PSO) and generalized likelihood uncertainty estimation (GLUE) method was used for optimization of model parameters and PSO method has been selected for a study basin based on its performance results in the selected gauging stations. Global sensitivity analysis were performed for model flow parameters and the curve number (CN2) has been found the first ranked most sensitive parameter in all gauged catchments. To facilitate the transfer of optimized model parameters from gauged catchments to ungauged catchments, clustering of hydrologic response units (HRUs) were done based on physical similarity measured between gauged and ungauged catchment attributes. From the reclassification of land use/soil use/slope of LTB, a total of 142 HRUs were identified and then these HRUs are clustered in to 39 similar hydrologic groups. In order to transfer the optimized model parameters from gauged to ungauged catchments based on these clustered hydrologic groups, this study evaluates three parameter transfer schemes: 1) parameters transfer based on delineated homogeneous regions (PT-I), 2) parameter transfer based on global averaging (PT-II), and 3) parameter transfer by considering Gilgel Abay catchment as a representative gauged catchment to donor information for modelling ungauged catchments (PT-III) since its model performance measure values are better than the other three gauged catchments. The performance of these parameter transfer approach was evaluated based on values of Nash-Sutcliffe efficiency (NSE) and coefficient of determination (R2). Based on the performance evaluation criteria, PT-I has been used for modelling of ungauged catchments. From a rainfall-runoff model result, yearly average surface runoff from homogeneous regions was found 29.54 m3/s, 112.92 m3/s, and 130.10 m3/s for time periods of (1989 – 2005) for region-I, region-II, and region-III respectively.