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Evaluating Hydrological SWAT Model in Runoff Simulation of Karkheh Watershed

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Extended Abstract

Introduction: SWAT is a continuous-time model that operates on a daily time step at the basin scale. The objective of such a model is to predict the long-term impacts of management and the timing of agricultural practices within a year (i.e., crop rotations, planting and harvest dates, irrigation, fertilizer, and pesticide application rates and timing) on large basins. It could, at the basin scale, be used to simulate the water and nutrients cycle of landscapes whose dominant land use is agriculture. It could also help assess the environmental efficiency of best management practices and alternative management policies. The SWAT model uses a two-level disaggregation scheme: a preliminary sub-basin identification is carried out based on topographic criteria followed by further discretization, using land use and soil type considerations. Areas with the same soil type and land use form a Hydrologic Response Unit (HRU), a basic computational unit assumed to be homogeneous in hydrologic response to land cover changes. The development of the digital computer has added a new dimension to hydrology. Previously, finding solutions for different problems took hours with a pen and pencil method, but now it takes seconds with modern computers. Moreover, much more complex methods of analysis are now feasible because of the speed of the solution-finding provided by the computer. The impact of the computer has been particularly great in the area of rainfall-runoff modeling. As flood routing and unit hydrograph analysis are mathematical modeling's, surface-water hydrology is, historically, concerned with modeling. Due to the climate type and the spatial and temporal inconsistency of rainfall in Iran, large floods cause many damages in different parts of the country annually, as the Mediterranean climate and different weather conditions throughout a year provide the ground for the majority of short-term atmospheric rainfall.

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Materials and methods: Karkheh Basin is one of the main watersheds of Iran which has a Mediterranean climate whose level increases during the spring due to simultaneous rains and snowmelt. As one of the most important hydrological processes of the watershed for better understanding the hydrological issues of flood control structures for long-term planning, applying best management practices and making better use of their potentials, Runoff simulation plays an important role in water resources studies. Thus, to calibrate the model, select sensitive parameters were used in the sensitivity analysis step. Having imported the sensitive parameters into SWAT-CUP software, they were repeated 500 times with the SUFI2 algorithm, and finally, the optimal value for each parameter was determined.

Result: At Hamidiyeh station, the Nash Sutcliffe coefficient was -0.19 and -0.04 in both calibration and validation periods, respectively, and was 0.76 and 0.77 in Chamangir Station, respectively. The coefficients of determination for the Hamidiyeh station in the calibration and validation periods were 0.02 and 0.22, respectively, and for the Chamangir station, they were 0.88 and 0.75, respectively.
. This study investigated simulated runoff, using the SWAT model based on the meteorological data regarding the Karkheh watershed. A comparison of simulated runoff results with observational runoff at the hydrometric stations was performed automatically by the SWAT_CUP software package SUFI2 algorithm. Correlation between observed and simulated data was calculated based on the Nash Sutcliffe coefficient and the determination coefficient at different stations of the basin. Nash coefficient - Sutcliffe and coefficient of determination at all hydrometric stations except for the five stations which differed in their calibration and validation periods, were found to be close to their optimum values.

Discussion and Conclusion: The coefficient - Sutcliffe of the other 6 stations was more than 0.5, indicating that the model was capable of simulating runoff. In the mirage stations of Sarab Seyed Ali, Pulchehr, and Noorabad, the SWAT model failed to simulate runoff well, which could be due to the location of these stations in the elevated areas of the basin and its branches that were snowy. The lack of proper distribution of meteorological stations in these areas makes the model unable to simulate well the snow runoff. In Hamidiyeh and Pai-Paul stations, the SWAT model was could not establish a reliable relationship between the observed and simulated runoff due to the impact of the construction of the Shahid Abbaspour Dam on the river flow hydraulics.

Keywords: Runoff simulation, SWAT, SWAT-CUP, SUFI2, Nash Sutcliffe coefficient, determination coefficient.