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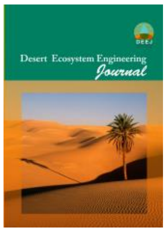

The Effect of Low-level Clouds Type on Runoff Simulation Accuracy Using SWAT model

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Extended Abstract

Introduction: Patterns of spatial and temporal rainfall impact on runoff and outlet hydrograph (Cordery, 1993; James, 1994). Results of different studies have clarified that simulation by using diverse rainfall data could increase the reliance of results. These were much more sensible in which areas encounter with data scarcity (Mello et al., 2008; Bekiaris et al., 2008). Rainfall properties in sensitive analyses are influenced by atmospheric synoptic condition, topography, local condition, and type, speed, and direction of clouds in the sky of basin. Not many studies have done regarding evaluation of clouds and their roles in hydrological model accuracy. The evaluation of cloud type effects directly and indirectly, spatial and temporal precipitation pattern changes, temperature's features, moisture, radiation, and snow ablation influence on runoff patterns. This is an important step towards hydrological model accuracy recognition. In this study, different precipitations due to low-level cloud types effects on accuracy of water and soil model (SWAT) are evaluated in Garin dam catchment of Nahavand, Hamedan province.

Materials and methods: Necessary data are including topography map, land use map, soil map, daily discharge, precipitation amounts, relative moisture, wind speed, solar radiation, and synoptic code of low-level clouds (from 2000 to 2010). SWAT model for seven types of clouds was performed and the results were analyzed. Surface runoff volume and maximum runoff were estimated using daily precipitation and SCS curve number. Runoff proportion event during interval time of basin based on whole daily precipitation was calculated using statistical method. Time interval of basin was estimated by Manning formula which includes channel and hillside. Sensitive analyses were done by using SWAT_CUP software and SUFI_2 algorithms. In this study, sensitive analyses in two steps were done. The first step was carried out before model calibration and when it was necessity for recognition of features parameters and their effects on water production. The second step was done after model calibration for sensitive recognition of each parameter on simulation

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accuracy. Based on that, at the first step the sensitive analyses of input parameters on surface runoff were done. To determine the amount of input parameters, the range of them was defined and four different numeral distances were chosen and simulation was done by using them. Relative sensitivity index (S_r) shows the outlet function changes proportion for input parameters changes (Feyereisen et al. 2007) Sensitive analyses of 22 parameters and their effects in four numeral distances were evaluated and the model was performed manually more than 100 times. Calibration and validation was done from 2002 to 2007 and 2008 to 2010, respectively. Important parameters for calibration are including curve number, channel discharge, coefficient of surface runoff lag, ground water lag coefficient, soil surface evaporation compensation factor, and Manning coefficient of flooded plain. Nash – Sutcliffe Index, R index, P factor, and R factor were used for calibration and validation. After calibration and validation of model, type of low-level clouds from synoptic codes (Cumulus, Stratocumulus, Cumulonimbus, Stratus, and …) during precipitation event in each rainy day were lined next to simulated and observed data and RMSE index was estimated for each group.

Results: Results of model calibration indicated that Nash – Sutcliffe Index, R^2 index, P factor, and R factor were 0/80, 0/81, 0/67, and 0/83, respectively. These factors were 0/74, 0/89, 0/53, and 0/52 in model validation period, individually. RMSE index of observed and simulated discharge data was estimated for different clouds. Findings showed that, at the presence of Stratocumulus, RMSE is the least (0/24) which means the highest accuracy of SWAT was seen when this cloud led to precipitation in the area. Accuracy simulation of rain-producing Stratus or Fractostratus clouds was acceptable with 0/38 RMSE. The weakest simulation of rainfall-runoff in SWAT model was seen in rain-producing Cumulonimbus clouds when they have a Serious shaped top. RMSE index of these precipitations in different clouds are nearly triple (0/74) this index in Stratocumulus (0/24).

Discussion and Conclusion: Garin dam has been built as one of the important structures to control flow for agriculture land irrigation and drinking water in Nahavand county. Hydrological condition analyses of the basin by choosing the best rainfall-runoff simulation model and accurately performance of this model brings about awareness of managers, farmers, experts, and residents of region. In this study, empirical- semi-distributed model (SWAT) was used in ArcGIS for runoff simulation in Garin dam catchment. According to cloud type effect on energy transformation and rainfall condition change, after model calibration and validation, RMSE and NS was estimated for different precipitation due to of clouds types. The results showed that the precipitation generated of convective clouds had higher RMSE error (about twice or three times) rather than non-convective clouds for rainfall-runoff simulation by this model. It is due to the intensity and time difference of convective rainfall than non-convective. Also, convective clouds were formed by local and vertical development but non-convective cloud were generated by wide and horizontal development. These clouds conditions probably cause accuracy of the precipitation recorded by meteorology stations were increased in the study area. Therefore, it is suggested that type of recorded or predicted clouds during rainfall events, their effects on rainfall and temperature feature, and their accuracy on runoff simulation should be considered for rainfall-runoff simulation of this basin Evaluation of cloud features including their cover and thickness, their effects on input parameters, and accuracy of rainfall-runoff simulation in different basins and climates are recommended. The results confirmed the other researchers' findings about sensitive analyses (Akhavan et al., 2008; Amiri, 2005; Najafi, 2001; Refsgaard, 2012; Steenbergen and Willems, 2012). The results also are consistent with investigation of low-level clouds effects (considering the cloud cover and convection) on hydrological models (Nouri et al. 2012).

Keywords: Daily discharge, Cloud type, SWAT model, Garin dam catchment.