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Assessing the Efficiency of SWAT Model to Estimate the Daily Discharge of Basins Lacking Statistics through Zoning Approach in Dry Regions

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1- Introduction

Runoff is one of the most important components of the hydrologic cycle. Since there are no observational data in basins lacking statistics, the process of calibration and validation of hydrologic models seems impossible in these basins. On the other hand, predicting runoffs in basins lacking statistics is essential for planning and management of the basin (runoff estimation, ecosystem services, flood control) (Beck et al., 2016). However, predicting the runoff in basins lacking statistics has been comprehensively discussed using the calibrated hydrologic model in basins having observational statistics through the zoning approach (Yang et al., 2019:67). The zoning approach has been identified as the cheapest and most prevalent solution for solving the prediction problem of flows in basins lacking statistics (Cislaghi et al., 2020:348). According to the definition of the zoning approach, predicting runoff in basins lacking statistics is done using data transfer from basins having statistics to the basins lacking statistics (Rojas et al., 2016).

2- Methodology

To conduct this study, firstly SWAT model was calibrated and validated in the watershed basin having statistics; then, the calibrated parameters were transferred to Sukcham basin which lacked statistics, to simulate and analyze the flow using hydro office-FDC software. To analyze the sensitivity of parameters in the zoning approach and for simplifying the complex structure of hydrologic models like SWAT, minimizing the number of parameters in the modeling phases was a necessity. To this end, firstly, a sensitivity analysis was done for the basin having statistics using 14 sensitivity parameters affecting the flow. According to the global sensitivity analysis, the parameters were ranked in SWAT CUP-SUFI-2 based on the sensitivity level and considering two P-value and T-stat factors. Later, 14 parameters having high sensitivity

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in the basin having statistics were calibrated and transferred to the basin lacking statistics (Sukcham) using zoning and physical approaches.

3- Results and Discussion

According to the obtained results from sensitivity analysis of 14 sensitive parameters in the flow simulation, SLSOIL, HRU-SLP, CH-S1, CANMX, SOL-AWC parameters were recognized as the most sensitive parameters of the region. The performance evaluation criteria of NSE, R2, and PBIAS models, respectively, for the calibration periods, were 0.6, 0.65, and 10.7 and for the validation, periods were 0.47, 0.63, and 11.88, showing the acceptable accuracy of daily discharge simulation in the daily scale. After calibration and validation of SWAT model in the basin having statistics and the basin lacking statistics (Sukcham), the daily time step was applied for the 2008-2015 period, and the calibrated parameters of the basin having statistics were transferred to the basin lacking statistics through zoning approach and using physical characteristics. Considering Table (9), the average daily outlet runoff, as well as the average volume of annual outlet runoff for the basin lacking statistics (Sukcham), were estimated. The estimation of such information from basins lacking statistics can present managerial views toward controlling the flood and preventing the occurrence of devastative floods as well as providing the required water sources for filling the aquifers and agriculture in dry regions. Considering Figure (9), the moisture indexes (Q_{10}-Q_{20}) were respectively 0.12 and 0.16 m^2/s (10 and 20 percent of the days in a year (33 and 73 days)), discharges were 0.12 and 0.16 m^2/s or more. Considering the average extracted index from the curve, flow duration was obtained, respectively, 0.115 (30% of days in a year (110 days)), 0.111 (40% of days in a year (146 days)), 0.094 (50% of days in a year (183 days)), 0.081(60% of days in a year (219 days)) m^2/s. Moreover, the scope of low flow index (Q_{70} to Q_{95}) for 256 and 347 days of a year was obtained 0.058 and 0.024, respectively. In addition, the flood index (Q_5) was 0.28 m^2/s (5% of days in a year (18 days)), for which the flood discharge equaled 0.28 or more.

4- Conclusions

Considering the performance evaluation criteria, the performance of SWAT in dry basins having statistics was good and satisfactory in the daily scale of calibration and validation phase. According to the results of administering the SWAT model in the basin lacking Sukcham statistics, the average daily runoff flow (0.107 m^2/s) and the average volume of total annual outlet runoff (million m^2) of this basin have been estimated. Then, the flow duration curve was drawn for the Sukcham River in the hydro office-FDC software. Considering the results of the flow duration curve of the Sukcham River, it could be concluded that the scope of moisture, moderate and low flow indexes were respectively, (0.12-0.16), (0.081-0.115), and (0.024-0.058) m^2/s. Moreover, the flood index (Q_5) was obtained 0.28 m^2/s for Sukcham River; which meant that regarding 5 % of the days in a year (18 days), the flood discharge equaled 0.28 m^2/s or more. The extraction of these results may help in better recognition of hydrologic behavior of basins lacking statistics for planning and management purposes of water sources such as controlling sudden floods and providing drinkable water and agriculture.

Keywords: SWAT, Lack of statistics Daily simulation, Zoning Approach, Flow Duration Curve, Khoncheh and Sock Cham Watersheds, Isfahan Province

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