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The Action of Tectonic and Lithological Components in the Water Balance of the Roodak basin

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1, Introduction

Many studies have been conducted on the water balance of watersheds based on the SWAT model, among which, one can mention the research of by Van Liew and Garbrecht (2003: 413-426), Neitch et al. (2005: 494), Abbaspour et al. (2007: 413-430), Rostamian et al. (2008: 977-988), Faramarzi et al. (2009: 486-510), Hoseini (2014: 63-73), Habibi et al. (2016: 275), Nadi et al. (2018: 61-79) and Ghazavi et al. (2018: 54-79). This research is based on the initial field observation and a question that, how much rainfall (rain and snow) transfer to groundwater with the performance of faults and rock units with high permeability? Therefore, according to the geological conditions, the Roodak basin upstream of the Latian dam was selected as the study area. So, SWAT model, field, and tectonic studies have been used to answer the research question. The Roodak basin has more than 420.41 square kilometers area.

2, Methodology

The statistical indices of R2 and Nash-Sutcliffe (NS) were used as the most important evaluation criteria to quantitatively evaluate the performance of the ARC_SWAT model in the calibration and validation stages. Calibration and analysis of model were used and performed SUFI2 algorithm in SWAT Cup software and flow data of Roodak hydrometric station. Calibration for the years (2000-2007) and validation based on the statistics of the years (2008-2011) was performed after stimulation using calibrated values for sensitive parameters. Then the basin water balance check was obtained. The relationship between rainfall and permeability has been investigated based on geological components such as fractures, faults, and lithology. Mosha-Fasham fault and Latian fault are the main faults of the study area. The main controller of tectonic activities in the area is the Mosha-Fasham fault and its sub-branches. The main branch of this fault as a thrust has passed through the middle part of the basin and has pushed the Paleozoic and Mesozoic formations on the younger formations. Also, its sub-branches have caused disruption in the geological structures with normal and inverse functions. The

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northwestern part of the Latian fault is another important tectonic fracture of the Roodak basin and acts in the outlet parts of the basin. In this part, the Emameh River flows along the Latian Fault. The rock units of the region are divided based on field data and remote sensing studies of the 2019 Landsat 8 satellite image by Arc GIS software. From the lithological viewpoint, from old to new rocky and sedimentary units have respectively the following conditions. Red micaceous siltstone and sandstone of Zagoon Formation (Cz). Limestone and dolomitic lime, sandstone, and shale of Mila Formation (Com). Dark fossiliferous limestone and shale of Mobarak Formation (Cm). Oolitic limestone, thin-bedded shale and dolomitic limestone, and thick-bedded dolomite of Elika Formation (Tre). Grey shale and sandstone of Shemshak Formation (TRjs). Conglomerate, sandstone, and coaly shale of Shemshak Formation (Jk). Light grey massive limestone of Lar Formation (Jl). Light color massive orbitolina limestone of Tizkouh Formation (Ktzl). Polygenic red conglomerate and sandstone (Elc). Green tuff of Karaj Formation (Etu). Tuff with shale interbeds of Karaj Formation (Eksh). Dark green shale with tuff interbeds of Karaj Formation (Esh). Green tuff and Tuffy shale interbed of Karaj Formation (Ek). Red marl, gypsy marl, sandstone, and conglomerate of Upper red Formation (Mur). Recent sand and aeolian sand (Qsd).

3, Results and Discussion

After running the model, the outputs including runoff, subsurface flow, etc., were obtained as a text file. Using the results of model, sensitivity analysis were identified nine sensitive parameters among the total 17 parameters. By SUFI2 algorithm were determined the optimal values of the sensitive parameters of the model. The results showed that the snowmelt and snowfall temperatures are the sensitive parameters of the model. The share of surface runoff, lateral, and groundwater flow in the monthly flow of Roodak River is presented in Table 1.

Table (1): Water balance components of Roodak basi-

variable	Value (mm)	Percent relative to rainfall
Rain	585.67	100
Evaporation & transpiration	427	72.75
Water in the soil	10.44	1.78
Surface flow	18.49	3.15
Subsurface flow	118.72	20.27
Groundwater flow	11.35	1.93
Deep infiltration	0.68	0.12

The upstream areas of the basin have rock units with a relatively high permeability in terms of physical and dissolution conditions, based on geological data including fault, fracture, and lithology information. These rock units include limestone and sandstone of the Paleozoic and Mesozoic formations. Therefore, the expected power for the downward flow is high in these areas. In the middle and downstream areas, the intrinsic permeability of rock units is relatively low, due to Tuffy and marly lithology. However, the transferring surface water to depth is accelerated due to the extensive tectonic fractures. In contrast, disrupts this transfer to depths and makes subsurface flow the effect of secondary fillings on fractures.

4- Conclusions

Generally, in simulating the Roodak basin flow the values of all indicators and the results of geological studies indicate the acceptable accuracy of the model. By running the ARC_SWAT model it was possible to simulate the monthly flow of the study period in this basin. Also, the statistical comparison has shown acceptable results. So the statistical comparison of simulation and observational hydrographs show a correlation of about 60% with the Nash-Sutcliffe criterion. This study provides useful information on the river flow and water balance of Roodak Basin and helps more accurately with water resources projects. The evapotranspiration potential (PET) is 1025.4 mm. The total water of the basin equal to 247.89 mm included surface runoff, groundwater, and lateral flow. Agricultural products temperature and water stresses were 129 and 80 days which calculated at the SWAT_ CHECK. Therefore, according to the simulation results, it can be inferred that the ARC_SWAT model has acceptable performance in the Roodak basin. Geological evidence indicates that the rock units have high permeability in upstream and low permeability in downstream areas. However, the results of the SWAT model showed that rainfall is flowing in the direction of the Emameh River slope in the form of subsurface flow. This is due to the action of Latian fault in the transfer of surface water to subsurface flow. Also, according to station data, water entering to Emameh River has the highest amount in winter and spring and the lowest level in late summer. Therefore, subsurface water as a base flow provides a significant part of the water in all months of the year. Surface runoff has a large share in the river flow from mid-autumn to early spring. Lateral flow accounts for a very small share of river flow in all months of the year. The simulation accuracy is acceptable in this research in comparison to the results with similar studies. The results of this study can

be used by examining the impact of land-use change with different scenarios to predict the effects of management planning and climate change due to rainfall.

Keywords: Water balance, Geological components, Subsurface flow, Roodak basin southeast of Tehran.