Simulation of Runoff and Sediment Yield in Haraz River Basin in Mazandaran Using SWAT Model

Ataollah Kavian
Associate Professor of Natural Resources, Sari Agricultural Sciences and Natural Resources University, Sari, Iran
Mohammad Golshan*
PhD Candidate, Watershed Management, Sari Agricultural Sciences and Natural Resources University, Sari, Iran
Hamed Rouhani
Assistant Professor of Natural Resources, University of Gonbad Kavous, Iran
Abazar Esmali Ouri
Associate Professor of Natural Resources, University of Mohaghegh Ardabili, Ardabil, Iran

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Extanded Abstract

Introduction

Simulations of river flow and understanding different components of hydrologic cycle are important for programming of the conservation aspects of water resources. Since the study area is located in the site of dam construction, the estimation of rainfall runoff and sediment yield are very important for better management of water resources. Therefore, in this study, the SWAT model was applied. SWAT model is one of the multipurpose simulation models for management of watershed. The main objective of hydrologic models is simulation and prediction of the behavior of the catchment basin. Hydrologic models can simulate land surface hydrological processes to improve water resources management. Today, GIS tools are commonly used in natural resource management; especially in watersheds with several banks. They have linked information such as digital maps. GIS is designed and developed to predict the results of spatial management activities. For situation awareness systems, we need to add the elements of system dynamics. SWAT model is an advanced communication window possible to combine a set of models and GIS data in groundwater and surface water flows and floods.

Materials and Methods

The study area of this research is located between 539,022 to 622,236 Eastern longitude and 3,923,033 to 4,009,208 north latitude in zone 39 of UTM. Haraz watershed with an area of

* E-mail: golshan.mohammad@yahoo.com Tell: +98 4525234743

401927.2 hectares is located to the south of the province and in the vicinity of Amol City. The minimum height of 300 meters and a maximum height of 5600 meters are the elevation limits. Calculation of runoff in SWAT model can be simulated in two ways: Green Ampt and SCS curve.

SWAT model to simulate the hydrological cycle on the water balance equation is as:

$$SWt = SWo + \sum_{i=1}^{t} \left(R_{day} - Q_{surf} - Ea - w_{seep} - Q_{gw} \right)$$

Prediction of the rate of soil erosion caused by rainfall and runoff in SWAT model is based on equation MUSLE. In this method, surface runoff is used as an agent of erosion. Sediment transport lag in the effect of snow cover on erosion, sediment and lateral flow of groundwater is also calculated.

In order to improve the quality of model calibration and uncertainty analysis in SWAT-CAP software sufi2 method was used. SUFI2 program combines calibration uncertainty and tries to determine parameter uncertainty, so that most of the observed data in the region of uncertainty can be determined.

Results and Discussion

Using ARC- SWAT software watershed study area was divided into 25 sub basins. Because of the diversity of land use map and soil the sub basins were divided into 91 hydrologic units (HRU). In the following calibration and validation, during the first stage 20 variables were selected and the initial values are based on a list prepared by the guide table of SWAT, the application entered SWAT CUP. After 600 iterations, each algorithm of SUFI2 determined 8 parameters for simulation of runoff and sediment load parameter 5 as sensitive agents. Then, the model was calibrated to simulate runoff for years of 1995-2004, and evaluated using correlation coefficient (R2), coefficient of Nash – Sutcliffe (NS) and Mean of Squared Error (MSE). The results showed that the values of the coefficients R2, NS, and MSE in the Karehsang station are 0.80, 0.77, and 20.93, in Chelav Station are 0.75, 0.73, and 1.23; in Razan Station is 0.79, 0.75, and 5.91 and in Panjab station are 0.68, 0.55, and 2.70, respectively. Sediment yield was also calibrated in Karehsang station for the years of 2002-2006 and the statistical coefficients of (R2) and NS were obtained 61 and 60 percent, respectively. To perform validation, the model was run for years of 2005-2009. The results showed that the coefficients of R2, NS, and MSE are 0.87, 0.75, and 10.17 for Karehsang station; 0.83, 0.77, 0.21 for Chelav station; 0.81, 0.72, 1.34 for Razan station, and 0.75, 0.70, 0.67 for Panjab stations, respectively. Validation of sediment yield was done for the years of 2007-2008 with coefficients of NS and R2 equal to 53 and 68 percent.

Conclusion

The primary objective of this study was to evaluate the performance of SWAT model to simulate runoff and sediment yield of Haraz watershed gauging stations within the basin. In the sensitivity analysis, the various parameters for runoff curve number (CN), Soil Density (SOL-BD) and hydraulic conductivity effects (CH-K2) are of high sensitivity. The high sensitivity of the CN parameter is investigated in the domain of the role of environmental factors and land use in runoff areas. The results of the study are consistent with the results of the studies of

Panagopoulos and colleagues (2011) and Parajuli et al. (2013). To predict sediment parameters for the simulation of sediment load, SPCON, SPEXP and SOL_AWC are more sensitive to be considered.

According to the figures, the values of peak runoff and soil loss estimates are close to the observed values. Finally, the results indicated that the model has a high level of performance in simulation flow discharge and sediment yield simulation, and it can be used for operating watershed management strategies.

Keywords: Haraz Basin, runoff, sediment, SUFI2 algorithm, SWAT model.