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The Effect of Land Use Change on Fischarge and Dediment Vhanges in Ojan-Chay Vatchment Using SWAT Model

Mohammad Hossein Rezaei Moghadam [1]*, Davoud Mokhtari [2], Nasrin Samandar [3]

1-Professor, Faculty of Planning and Environmental Sciences, University of Tabriz, Tabriz, Iran
2-Professor, Faculty of Planning and Environmental Sciences, University of Tabriz, Tabriz, Iran
3-Ph.D. student, Faculty of Planning and Environmental Sciences, University of Tabriz, Tabriz, Iran

1-Introduction

Erosion and sediment production in a catchment are a function of various factors, one of the most important of which is the land use change. In a catchment, different land-uses and changes in vegetation and land use of that catchment affect hydrological responses, including flow and sediment characteristics. The amounts of runoff, erosion, and sediment transport varies depending on the hydrological conditions, soil, and cover in the basin, making the simulation of the above processes need to provide the necessary information on how these factors change spatially. One of the new sediment estimation methods that are very much considered by researchers today is the use of hydrological models that have been widely developed recently. Hydrological models are a useful tool to study the effect of land use change on water resources and hydrological characteristics of the basin. Therefore, in this study, the hydrological and semi-distributed SWAT model, due to many factors, population expansion and urbanization are increasing. As a result, urban expansion can lead to land use change. With the increase and development of these changes in urban areas, a range of environmental changes is seen that is more It is related to agricultural land use change and vegetation degradation in urban areas. This study aimed to investigate the effect of land-use change on discharge and sediment of Ojan Chay catchment using SWAT semi-distributed model over 29 years. The results showed that the changes in the components studied in this study had a significant impact on the study area during 29 last year; it was stated that if this trend continues, it will cause much environmental damage. This study was conducted to reveal the changes in the region, which had not been done before for the Ojan Chay region.

2-Methodology

In order to study land-use changes, the satellite imagery of Landsat 5 (TM) from 1987, Landsat 7 (+ ETM) in 2002, and Landsat 8 (+ ETM) for 2015 were used, the digital model

* Corresponding author; **E-mail:**rezmogh@gmail.com

with a pixel size of 30 meters was performed to extract the basin and topographic correction of the image. After cutting the study area from the image, using 1: 25000 topographic maps, the training areas for each user class were harvested in two stages before classification and after classification. Suitable bands were selected for classification 5, 4, and 7 to consider the band resolution. Then the cover images were reclassified each year, and the final drawings were reduced to four categories each year. In order to reduce the number of floors and simplify the calculation process of all categories related to rangeland use, such as grade 1 rangelands, grade 2 rangelands, and grade 3 rangelands have all been studied as single rangeland, and on the other hand, the rangelands of the study area are mostly weak to moderate, and this was a reason for class integration. According to the model guide, during the work steps, the digital model of the height of the place is introduced to the model, and the water network is given to the model as a guide in drawing waterways. The model considered several sub-basins and HRU for the study area according to the determined conditions. The hydrometric station location was defined as a catchment exit to form the borders, and then, the borders were formed. In the next steps, the land-use map with 4 classes and the soil with 3 classes were introduced to the model with the help of codes. The model converts these maps into raster maps, the size of cells equal to the digital elevation model. The slope map was prepared with the help of the digital elevation model. By combining these three layers, a map of hydrological response units is obtained. According to the methods considered in estimating runoff, and evapotranspiration, the SWAT model requires daily precipitation data and minimum and maximum daily temperature. In this research, the data of Tabriz, Basisiz Ojan, Sarab, Miyaneh, Sahand, and Bostan Abad stations were used. This data was prepared as DBF format files and provided to the model. Also, the coordinates and altitude of the location of temperature and precipitation stations and the location of the station producing the climatic station, which was prepared for the model with the help of Userwgn.dbf file data were prepared in this format (due to the more extended statistical period of Bostanabad station.

3-Results and Discussion

Model calibration and validation:

According to the conditions set for the model, sub-basins and hydrological response units were obtained. After the first implementation of the ARC-SWAT model in the ARC-GIS environment, for 2015 use as the current user using monthly discharge data and sediment of Ojan Chay hydrometric station, the output of the model to calibrate and validate the SWAT-CUP program environment entered. Initially, as the initial input parameters for calibration of the model, more than 40 parameters were considered for flow, which finally after performing absolute 8 sensitivity analysis and after 500 repetitions of simulations, by examining sensitive parameters and removing non-sensitive parameters In order to speed up the simulation process, 33 parameters were selected for calibration. Each parameter has an initial amplitude to calibrate the SWAT model in the SUFI2 program, which is considered by default for the parameters. Also, each parameter has a final value that is determined after calibration. These results are due to the placement of the letters r or v before the parameters. The SWAT model uses calculations defined for these letters and parameters and based on data. The inputs of the hydrometric station change the amplitudes of the parameters. Initial values of the parameters are selected according to the SWAT model guide; the final values do not necessarily have to be in the range of initial values. The initial discharge values for discharge and sediment were -0.2 and -0.12, respectively, which express the needs of the calibration model. Table 6 presents the relative sensitivity of the parameters in the calibration and validation phase resulting from the implementation of SUFI2. In the parameter sensitivity analysis, a parameter with an absolute value of t is more sensitive. The value of p also indicates the significance of sensitivity. The closer it is to zero, the more meaningful it is. The sensitivity results analysis showed that out of 33 parameters used in the calibration stage, eight parameters were sensitive for flow rate and 12 parameters for sediment flow.

4-Conclusions

Examination of the SWAT model results in sediment simulation showed that the model is capable of sediment simulation. Despite the high uncertainty in determining the sediment, the SWAT model has simulated the maximum deposition time of sediment well in the calibration period and validation period. Due to the mountainous area, heavy rains, land-use changes in it, and existing land-uses prone to flooding, erosion and sediment production, runoff, and sediment simulation studies are necessary and achieved good results for the SWAT model in mountainous and steep catchments. In this study, the SUFI2 algorithm was used to evaluate the calibration results because this algorithm easily connects to the SWAT and can process large volumes of data, allowing the calibration of parameters based on data measured in variables. After performing the sensitivity analysis operation, sensitive parameters were identified to the amount of runoff and sediment in the area. In total, the sensitivity analysis was performed using more than 40 parameters, and finally, 33 parameters were selected. The most sensitive parameters include R_CN2 runoff curve number in medium humidity conditions, SMFMX maximum snowmelt factor (mm water per degree Celsius per day), Snow mass (c°), V_SPCON linear parameter to calculate the maximum amount of sediment in the channel path, V_CH_K2 effective hydraulic conductivity in the main channel (mm / hr), V_CH_COV1 channel erodibility coefficient, V_USLE_P Factor of protection measures in the sediment flow model Groundwater (mg / L) was detected. Due to the limitations of the computer system, the model was calibrated using 500 replications of the simulation with 500 samplings.

The number of sampling was done by the Latin hypercube method using previous studies and experts' opinions. The last 500 simulations were selected using 33 parameters with a proper objective function with a more limited uncertainty amplitude. The NSE coefficient values were used for flow and sediment discharge during the validation period. Drainage and sedimentation by SWAT model in Ojan Chay catchment are in excellent and good efficiency class, respectively. R2 coefficient in most cases indicates the explanation of the high percentage of the variance of discharge and sediment values (above 50%) by the SWAT model. PBIAS and RSR values for discharge are very low compared to sediment and indicate the higher accuracy of the model in estimating the monthly flow rate or greater correlation of the estimated values with the observed data. The values of R2 in the calibration and validation steps for simulating the flow rate are 0.66 and 0.51, respectively, and for estimating the sediment discharge are 0.76 and 0.72, which indicates the satisfactory efficiency of the model in simulating the sediment in both stages. . Also, P-factor values in these stages are equal to 0.65 and 0.82, respectively. The results showed that the trend of changes in rangeland and agricultural land-use from 1987 to 2015 increased. Kappa coefficient and overall accuracy above 80% also indicate a good agreement between the classification and the types of land-use classes in the land. In general, it can be concluded that the increase of arable land and the decrease of pastures have increased the runoff and sediment concentration of the study basin. Therefore, more attention should be paid to land management and especially how to use rangeland lands in the study area to prevent further destruction.

Keywords: Simulation, SWAT model, validation, statistical indicators, Ojan chay basin, Northwestern Iran.

5- References

Akhavan Qlalibaf, M.; Hamid, A.; Alvast, G.; Kornova, M.; Mokhtari, M.H. (2019). Investigation of changes in land cover area and land use of Lake Urmia watershed using MODIS images. *Hydrogeomophology*, 5 (18): 97-113. (In Persian)

Azarakhshi, M.; Rostami Khalaj, M. (2019). Evaluation of the effects of land suitability on runoff values using SWAT model (Case study: Abkhair Kardeh Basin), *Journal of Ecology*, 6(1): 76-65. (In Persian)

Abbaspour, K.C. (2009). *SWAT-CUP, SWAT* Calibration and Uncertainty Programs, Version 2 (user manual), *EAWAG*, 105p.

Goward, S.N., G.D. Cruickshanks. A.S.Hope. (1985).*Observed relation between thermal emission and reflected spectral radiance of a complex vegetated landscape,* Remote Sensing of Environment, 1985; *18* (2): 137-146.

Khodabandeh Lou. B, Khavarban Nahzak. H, Ghorbani. A. (2019). Detection of land use/ land cover changes using object-oriented classification of satellite images (Case study: Gharehso catchment, Ardabil province, *remote sensing and GIS in natural resources*, 10 (3): 76-92. (In Persian)

Moradi. A, Najafinejad. A, Onagh. A, Kamaki Ch.B, Fooladi Mansouri. M. (2018). Revealing the trend of land use change and its effect on discharge and suspended load simulated with SWAT model (Case study: Watershed Galikesh Golestan Province), Rangeland and Watershed Management, *Iranian Journal of Natural Resources*, 17 (2): 504-489. (In Persian)

Nazari Samani, A.A, Ghorbani.M, Kouhbanani. H. (2010). Evaluating the trend of land use changes in Taleghan watershed in the period 1987 to 2001, *Rangeland Scientific Research Journal*, 4 (3): 442-451. (In Persian)

Sepehri.A.R, Jamali. A.A, Hassanzadeh.M. (2019). Analysis and comparison of land use land cover changes using artificial neural network (case study of Taft and Mehriz lands), *remote sensing and GIS in natural resources*, 10 (4): 90-105. (In Persian)