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Investigating the Role of Land Use Changes in Hydrological Changes of Surfaces in Mountainous Area, Case Study: Ojan Chay Basin

Maryam Bayati Khatibi*

Professor, Department of Remote Sensing and GIS, University of Tabriz, Tabriz, Iran

1-Introduction

In the drainage basins of arid and semi-arid areas where the ecosystem is not able to recover quickly, extreme care should be taken with land use. The hydrological effects of changes in land use are manifested in the form of changes in runoff depth, minimum flow, maximum flow, soil moisture, and evapotranspiration. Increasing runoff production in a particular area, in addition to increasing the potential for flooding, has other effects. Due to the type of soil and the topographic and climatic characteristics, the hydrogeomorphological changes caused by human encroachment on slopes and land use changes have been significant in Ojan Chai area (from the sub-basins located on the eastern slopes of Sahand Mountain). Due to erosion in the slopes of Ojan Chay area, it seems that the changes in the amount of runoff are very significant due to land use changes in the area. The study area is one of the rangelands of the country and unfortunately, cultivation is done in an unprincipled manner in the slopes that are not suitable for cultivation. In the coming days, the turbulence of the slopes will be intensified, the amount of runoff will increase, and the number of destructive floods will increase. Often, the soil of the slopes is severely eroded by runoff due to the extreme cultivation in the rangelands.

2-Methodology

To simulate the effects of land use change in a region or watershed, there are many hydrological models, one of which is the L-THIA. This model is a way to evaluate the long-term hydrological effects in a basin by which relative changes that occurred due to a change of use in the runoff can be simulated.

The above model is a good tool to help measure the potential effects of land use change on surface runoff. This model is based on the Curve Number (CN) method of the US

* (Corresponding Author) **E-Mail**:m_bayati@tabrizu.ac.ir

Soil Conservation Organization (SCS). Expresses CN values range between 0-100, where high values are for urban uses and low values are for areas with high permeability, such as wetlands and pastures with high vegetation density. One of the benefits of L-THIA is that it does not require calibrating the model with real area data. Model calibration is performed automatically using various default CN combinations available in L-THIA GIS. In this paper, to use the L-THIA model, station precipitation was prepared and Landsat satellite images (TM and ETM sensors) and specialized L-THIA software and Arc Map were used. In addition, the probability of a pixel being placed in a particular class is calculated, then the probability of its placement in other classes is estimated and classified according to the maximum similarity (maximum probability) in one of the classes. The above process is expressed based on Equation 1.

(Eq.1).

$$P(w_{\mathrm{i}}|x) = \frac{p(w_{\mathrm{i}})p(\frac{x}{w_{\mathrm{i}}})}{p(x)}$$

Where P (X) is the probability of the presence of the class w_i in the image, / x) w_i P (probability of each pixel with the spectral characteristic x belonging to the class w_i and p (w_i / x) the probability of belonging of each pixel with the spectral characteristic x appearing in the image Class w_i and p (X) is the probability of the presence of a pixel with a spectral characteristic. The error matrix, kappa coefficient and overall accuracy are used to evaluate the classification accuracy of the images using Equation 2.

(Eq. 2).

$$\mathrm{OA} = \frac{1}{\mathrm{N}} \sum \mathrm{P_{ii}}$$

Where OA is overall accuracy, N is the number of experimental pixels, Pii∑ is the sum of the elements of the original diameter of the error matrix.The kappa index is calculated from Equation 3.

(Eq. 3).

$$\mathrm{Kappa} = \frac{\mathrm{po} - \mathrm{pc}}{1 - \mathrm{pc}} \times 100$$

Where po correctly observed, pc shows the expected agreement. The error matrix shows the interference or conversion of uses to each other. Land use maps have been prepared for two periods (1988, 2018) as well as land use change maps.

3-Results and Discussion

In this research, using THIA L- model, the type of soil was determined according to the available soil maps, prepared samples, soil reports of studies of other organizations and field experiences, soil hydrological group in the study area as the basis of the model used. In the prepared map, it is clear that the range of hydrological group A is observed in the southern and southwestern parts. The area related to hydrological group B is mostly scattered in the northern, northeastern, and central parts. Hydrological group C is spread around the flood plains in the central part of the basin, and finally hydrological group D, which is the largest part of the basin surrounding Ojan largely.

According to the land use map of 1988, the largest area is related to rangeland use with an area of 544.6575181 square kilometers and the smallest area is related to water use equal to 0.189899975 square kilometers. According to the land use map of the year 2018, the largest area is related to agricultural use with an area of 510.5889519 square kilometers and the smallest area is related to road use equal to 0.5715 square kilometers. Examination of runoff depth maps for 1988 and 2018 shows that significant changes have been made in terms of quantity and location. Examining the height of runoffs and comparing two different periods in a specific use in relation to changing the rainfall parameter shows that a change in the rainfall parameter can significantly increase runoff in agricultural areas. This situation in relation to the range of the gardens is different, especially in recent years, showing a complex situation. In the case of pastures between 2018 and 1988, there is no significant difference in the height of runoff. Runoff depth in different land uses and rainfall shows that in areas with low rainfall, the highest runoff height is seen in lands under agricultural use. With increasing rainfall, pastures produce the most runoff and again with increasing rainfall, the highest runoff production is related to agricultural lands. In agricultural lands, the amount of runoff has increased in three decades and decreased in pastures.

4-Conclusion

The results show that over the past three decades, many rangelands have been cultivated. The area of agricultural lands has increased from 368.4917957 square kilometers in 1988 to 510.5889519 square kilometers in 2018. The results of calculations in such lands show that the height and volume of runoff has doubled from 1988 to 2018. In fact, increasing the area of cultivated land and land use changes from pasture to agricultural land has increased the amount of runoff. The results of studies on soils located on slopes show that the hydrological group of soils in this area is impermeable and with maximum daily rainfall that has increased in recent years, they can produce high-volume deep surface runoff in a short time. These slopes were

considered pastures in 1988 (about 90 square kilometers of pastures have been converted into agricultural land). This has caused row crops to produce more runoff in these areas. The results of the studies with the model used and the result of this research in the area of Ojan Chay basin show that the main reason for the increase in height and volume of runoff was land use changes.

Keywords: Land use changes, Runoff, Erosion, Flood, L-THIA model, Ojan Chay basin

5-References

Khaligi, B., Mahdavi, M., Sagafiyan, B. (2005). Investigating the effect of land use change on flooding using NRCS model, Natural Resources of Iran,vol,58,No,4,p 41-58.

Razvizadeh, S., Salajegehe, A., Khaligi, S., Gafari, M. (2014). Investigating the effect of land use change on flooding using, HEC-HMS model (case study: Taleghan watershed) *Journal of Rangeland and Watershed Management*, Vol. 66, No.3, pp 373-386.

Sadati, H, Golami, S., Sharifi, F., Ayobzadeh, A. (2008). Investigating the effect of land use change on runoff, *Journal of Rangeland and Watershed Management*, Vol. 4. No. 3, pp 301-315.

Hentati, A., Akira Kawamura, Hideo Amaguchi, Yoshihiko Iseri. (2010).Evaluation of sedimentation vulnerability at small hillside reservoirs in the semi-arid region of Tunisia using the Self-Organizing Map, *Geomorphology*, No. 122, 56–64

Kakembo,V., W.W. Xanga, K. Rowntree.(2009).Topographic thresholds in gully development on the hillslopes of communal areas in Ngqushwa Local Municipality, Eastern Cape, South Africa, *Geomorphology*, No. 110.188–194

Khairulmaini Osman Salleh and Fatemeh Mousazadeh.(2011).Gully erosion in semiarid regions,Procedia Social and Behavioral Sciences No.19, 651–661.

Vahidi, Mohammadjavad; Rasoul Mirabbasi Najafabadi; Mohsen Ahmadi. (2020). Analysis and ranking of soil erosion prevention methods using multi-criteria decision-making methods in rural areas of Darmian County, South Khorasan, *Hydrogeomorphology*, Vol. 6, No, 23.209-233.

Yamani, Mojtaba, Hamid Ganjaeian; Lila Garoso; Mahnaz Javedan. (2020). Identification of susceptible areas for the development of agricultural lands based on parameters Hydro geomorphology (Case study: Sanandaj city), *Hydrogeomorphology*, Vol. 6, No, 23.1-20.