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# *Estimation of Erosion-Sediment in Sarab Sikan Watershed Using RUSLE Model*

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## 1-Introduction

Assessing and estimating soil and sediment erosion is important and necessary for the development of erosion prevention methods for sustainable management of lands and water resources (Vrieling et al., 2002). Researchers use different models of soil erosion to assess the risk of soil loss, among which USLE family models are the most widely used tools in this field (Kinnell, 2010). The global relationship of modified soil erosion, which is the method used in the present study, is considered to predict annual soil erosion from a certain level (Renard and Freidmund, 1994). Considering that in recent years, the executive operation of constructing the Sikan earthen dam to supply drinking water to neighboring cities as well as to make downstream agricultural lands drink has been on the agenda of the Ministry of Energy; Therefore, identify areas Erosion sensitive in this basin can play an important role in the management and quality of water resources, reducing sediment input to dams and their longevity. According to the above problem, the main purpose of this study is to investigate the rate of erosion and sediment in the Sikan catchment using the RUSLE model, to identify areas sensitive to erosion.

## 2-Methodology

### 2-1- Data and tools

Data and tools used in the research include 25000 digital layers, digital elevation model with a resolution of 10 meters, monthly and annual rainfall of 17 years in the region, discharge and sediment values of Sikan hydrometric station, Sentinel satellite imagery, and Detailed reports and information of the area soil. In this research from ArcGIS10.3 for preparation, drawing, and analysis of layers; ENVI 5.3 is used to extract and process

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satellite images and SPSS and Excel are used to prepare and statistically analyze data, as well as to perform regression relationships.

## 2-2- RUSLE Equation

(1) $$A = R * K * L * S * C * P$$

A is the amount of soil eroded by Surface and rill Erosion, R is rainfall erosion factor, K is a soil erodibility factor and determines the inherent sensitivity of the soil, LS is the topographic factor, C is the vegetation factor and P is the soil protection factor.

A: In terms of t ha-1y-1; R: In terms of MJ mm ha-1 h-1 y-1; K: In terms of t h MJ-1 mm-1; LS, C, and P are unit less (Renard et al., 1997).

To calculate the R factor, first, the common period of the stations was determined. Then, monthly and annual rainfall of 10 stations adjacent to the basin with a statistical period of 17 years (1397-1380) was extracted. In the next step, the Fonier index and R-factor were calculated for all stations. (Renard and Friedmond, 1994). The K value was extracted based on the results of soil studies and laboratory data of Seymareh Basin and using the Soil Erodibility Nomograph provided by Wischmeier in 1987. In this study, LS values for the basin were calculated using a digital elevation model with a cell size of 10 m. First, in ArcGIS, the DEM hydrological holes were removed using the Fill tool. In the next step, direct and cumulative flow directions were drawn. Finally, L and S values were calculated with the Raster Calculator tool. To calculate the vegetation factor, the NDVI index extracted from the Sentinel 2 sensor image dated 18 April 2018 has been used. The range of vegetation changes is between +1 and -1, which the closer this number is to 1, indicates the more vegetation (Sanainejad et al., 2008). There is a complete inverse relationship between the NDVI index and the C coefficient (Karaboran, 2010). Factor C values ranged from 0 to 1. Factor P was also calculated based on the slope map and table presented by Wischmeier and Smith (1987).

## 2-3 Sediment delivery ratio (SDR) and sediment yield (SY)

Sediment delivery ratio (SDR) is the result of dividing the amount of sediment transported to a point by the amount of eroded soil upstream and is the ratio of gross erosion generated from a watershed over a period of time. This index shows the ability to produce sediment in a watershed (Lane et al, 1997).Various experimental formulas have been proposed to estimate the sediment transport ratio (SDR). In this study, the sediment delivery ratio for the basin was calculated using models: USDA (1975), Vanoni (1975) and Boice (1975). Finally; Sediment yield in the basin was estimated by multiplying each of the SDR models in the soil erosion map.

## 3- Results and Discussion

Factor R values are variable from 111.11 to 193.83 MJ mm ha-1 h-1 y-1 and its average is 146.28. Soil reusability values (K) vary from 0.03 to 0.07 t h MJ-1 mm-1 and the average value is 0.05. The LS factor varies from 0.01 to 70 at the pixel level and its average value in the basin is 8.13. The numerical value of factor C varies from 0.14 to 0.51 and its average in the basin is equal to 0.38. The value of factor P is from 0.5 to 1 and the average value of this factor in the basin is 0.96 Is. After combining the factors, the values of soil erosion in the study area were calculated, the values of which vary between 0.003 to 248.8 tons per hectare per year at the pixel level. The average soil erosion in the study area is 22.34 (t ha-1y-1) and its standard deviation is19.05. Mohammadi et al. (2018) estimated the average soil erosion in Iran at about 24 (t ha-1y-1), so the average erosion in the Sikan basin (22.34 t ha-1y-1) is close to the average soil loss in the country. The results showed that the topographic factor with a correlation coefficient of 0.91 has the greatest effect on the annual soil loss of the Sikan basin. Estimated sedimentation rates with different SDR methods vary from 2.8 to 8.20 tons per hectare per year. Comparing the estimated sediment yield of all three models with the station sediment (1.65 t ha-1y-1) shows that all three models have estimated higher values than the observed sediment. Among the SDR models, the Boyce model is closer to the amount of sediment at the Sikan station.

## 4- Conclusion

In this study, a quantitative assessment of soil erosion and sediment was used using the famous RUSLE model in the framework of GIS. The results showed that the erosion values of the basin vary from 0.003 to 248.48 (t ha-1y-1) at the pixel level. The average erosion in the study basin is 22.34 (t ha-1y-1). The topographic factor with a correlation coefficient of 0.91 has the largest share in the annual soil loss of the Sikan basin. Finally, to estimate the production sediment, three methods of USDA, Vononi, and Boyce were used, which were compared with the sediment statistics of Sikan station. The estimated values of sediment yield in all three methods are higher than the sediment yield of Sikan station, but the Boyce model showed a closer estimate. According to the results of this study, it can be concluded that the use of remote sensing and GIS can be effectively used in the development of management solutions and provide options for managers to solve the problem of soil erosion.

**Keywords:** Erodibility, Sentinel2 Satellite, SDR, Soil erosion, Sarab of Sikan, Darrehshahr.

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