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Estimation of Soil Erosion in the Tang-e-Sorkh Dam Watershed Using the Revised Universal Soil Loss Equation (RUSLE) and Remote Sensing (RS) and Geographic Information System (GIS) Capabilities

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Abstract

1-Introduction

On a national scale, soil erosion in Iran, has an important effect on agricultural production, sedimentation in dam reservoirs, soil degradation and so on. Severe soil erosions and the subsequent high deposition of sediments in dam reservoirs and reduced soil fertility are serious environmental problems with dangerous economic consequences for the country. The situation of sedimentation in Iranian dams indicate that their design have often focused on civil engineering and structural aspects and no attention has been paid to the issue of erosion and sediment yield in the basin of dams, which makes a large amount of sediment be deposited in many of these dams for many years; this causes a lot of sediment after many years to be deposited in many of these dams` reservoir, as a result of which, the useful life of the dam is greatly reduced. The present study aimed at estimating soil erosion in the Tang-e-Sorkh dam watershed with a total area of 39,000 hectares in the east and south-east of Boyer Ahmad County in Kohgiluyeh and Boyerahmad province using the RUSLE model and the remote sensing (RS) and Geographic Information System (GIS) capabilities in order to plan protective measures in the dam watershed.

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2-Methodology

Digital altitude, precipitation, physico-chemical properties of soil and satellite imagery data were used to estimate soil losses using RUSLE model in the Tang-e-Sorkh basin. First, the boundary of Tang-e-Sorkh watershed was drawn on a topographic map with a scale of 1: 50,000 in the geographic information system environment. The meteorological stations in and around the watershed were then identified and marked on the map. RUSLE has calculated the average annual soil erosion expected on a sloping land using Equation (1).

$$A=R.K.L.S.C.P \quad (1)$$

Where A is calculated as the average spatial loss of soil and the average time of soil loss per unit area is expressed in terms of units selected for K and the time period selected for R. In practice, these units are usually selected so that A is expressed in tons, per hectare, per year ($t \text{ ha}^{-1} \text{ year}^{-1}$). R Runoff-rain erosivity factor is expressed in $\text{MJ mm ha}^{-1} \text{ h}^{-1} \text{ year}^{-1}$, K Soil erodibility factor which is the amount of soil loss per unit area of erosion index for a given soil- is obtained by measuring in a standard plot with a length of 22.1 meters, a slope of 9% and a permanent fallow and is expressed in $t \text{ ha h ha}^{-1} \text{ MJ}^{-1} \text{ mm}^{-1}$. L is the slope length, S is the slope, C is the plant cover management factor and P is the protective measures factor. The parameters L, S, C and P are without units. The layer of parameters of the RUSLE model includes rainfall erosivity (R), soil erodibility (K), slope and length of the hill (LS), vegetation management (C), and soil conservation operations (P) have been prepared in geographic information system environment and after overlaying, the amount of erosion was estimated locally.

3-Results and Discussion

The amount of rainfall erosivity was from 179.62 to 327.77 $\text{MJ mm ha}^{-1} \text{ h}^{-1} \text{ year}^{-1}$. Erodibility factor was from 0.08 to 46.0 $t \text{ ha h ha}^{-1} \text{ MJ}^{-1}$

mm^{-1} . The minimum and maximum values of slope and hill length were 0.08 and 12.42, respectively. The minimum and maximum values of vegetation management were 0.33 and 0.54, respectively. The minimum and maximum values of soil conservation operations were 0.5 and 1, respectively. The amount of soil erosion in the studied area varied between 0.0033 and more than 100 tons per hectare per year at the pixel level. About 80% of the studied area had an erosion rate of 35 tons per hectare per year, with the highest amount in the western and northeastern parts of the country, which was due to high rainfall erosivity and soil erodibility in the area.

4- Conclusions

It can be said that in the current situation of Tang-e-Sorkh watershed, due to the lack of real sediment statistics, the best model for estimating erosion and sediment yield with the aim of introducing soil protection measures at the basin level was RUSLE model. The proposed method and the results of this research can be used as a dam maintenance planning system. The RUSLE model could predict the potential of soil erosion as a cell-by-cell, which was very useful when trying to identify the spatial pattern of current soil losses within a large area. Spatial information systems can be used to separate and inquiry these locations to assess the role of effective variables in the amount of soil erosion potential observed. Regarding the results, decision makers need to manage the risk of soil erosion in the most effective way; and management scenarios can adopt the best ways to improve and rehabilitate the basin based on the priority of different areas of the basin.

Keywords: Estimation, Revised Universal Soil Loss Equation, Remote Sensing, Geographical Information System, Tange-e- Sorkh. Yasouj.

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