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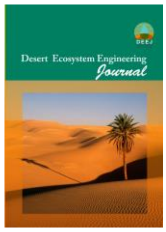

Assessment Soil Erosion and Deposition in the Menderjan Watershed Using USPED and RUSLE Models in the Environment of Geographical Information System (GIS)

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Introduction

Water erosion is one of the most important factors in land degradation in large parts of Iran as it destroys fertile soils and agricultural lands. The impact of soil erosion and related sediments decreases significantly to water quality and reservoir capacity. In semiarid areas like the Menderjan watershed in the west Isfahan province, sheet and rill erosion contributes to the sediment dynamics in a significant way. Particularly, sheet and rill erosion processes and related morphologies and features are very common in this region. Hence, this study is aimed at identifying and quantifying the major erosion process dynamics. Therefore, we applied an integrated approach combining the USPED and RUSLE models with data mining, remote sensing, and GIS methods.

Materials and methods

The study area is Menderjan watershed located at east of Isfahan Province of Iran and has an area of about 21,100 hectares. In this study, the USPED and RUSLE were used to evaluate the effects of water erosion. The USPED model is based on the assumption that soil erosion depends on the detachment capacity and the sediment transport capacity of surface runoff. However, the USPED models do not consider the sediment yields from gullies, stream banks, and streambed erosion. In the USPED model, on the other hand, erosion and deposition (ED) are computed as the change in sediment flow in the direction of flow.

$$ED = d\times(T\times \cos a)/dx + d\times(T\times \sin a)/dy$$

where a is the aspect of the terrain surface, dx, dy is the grid resolution, and T is the sediment flow at transport capacity. ED can be positive, indicating soil deposition, or negative, indicating soil erosion. Transport capacity (A) is expressed as:

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$$A=R\times K\times C\times P\times L^{m\times}(\sin S)^{n}$$

where A is average yearly soil erosion (t ha^{-1} y^{-1}), R is annual rainfall erosivity factor (MJ mm ha^{-1} $year^{-1}h^{-1}$), K is the soil edibility factor, LS is slope length and steepness factor, C is cover management factor, P is support practice factor, S is the slope, L is the upslope contributing area, and m and n are constants. For prevailing rill erosion m = 1.6 and n = 1.3, while for prevailing sheet erosion, m = n = 1. The USPED and RUSLE model was applied using Arcmap10. In this study, the Landsat satellite images 8 (OLI) and rainfall data, soil properties, and digital elevation model (DEM) were used. Here, GIS plays a major role in preparing thematic layers and estimating soil erosion.

Result

The range of obtained R factor values range was from 82 to 118 MJ mm/ ha h year. The average values for the Menderjan watershed amount to 265.2 MJ mm/ ha year-1. According to the soil laboratory analysis, soil texture is dominated by silt clay loam and clay loam and thus is highly susceptible to soil erosion. The amount of organic matter in all samples was 2%. Soil organic matter reduces the erodibility of soil. In many arid and semiarid areas soil organic matter is low due to scarce vegetation and, hence, the soil is more susceptible to erosion. The annual average soil erodibility of this basin is 0.04 (t h MJ-1 mm^{-1}). The amounts of topography for RUSLE, USPED, support practice factor, and C factor vary from 0.001 to 16.7, 0.01 to 30, 0.1 to 1, and 0.2 to 0.5, respectively. According to the obtained results, more than 35% of the area is affected by a high to very high erosion and deposition process intensities. The stable areas, low erosion, and deposition zones cover about 15% of the area. However, some of the mapped and predicted sheet and rill processes are located in the stable and low-intensity soil erosion classes. The extreme values are characterized by steep slopes in ridge positions in the northern and southern parts of the watershed**.**

Discussion and Conclusions

During recent years, the role of water erosion as one of the land degradation factors in arid and semi-arid areas of large parts of Iran has increased. In this study, we applied a combined approach using the RUSLE and USPED models rill/inter-rill (sheet) erosion processes and deposition processes. To the best of our knowledge, this study is the first attempt to integrate different erosion processes and deposition dynamics in Iran. In the study area, soil loss is concentrated especially in the abandoned bare land areas. The protection of bare soil to reduce soil loss should be ensured by appropriate cultivations. According to the results, a large part of severe erosion occurs in the steep areas in the north and southwest of the study area. Agricultural cultivations may change the land cover, leading to poorer vegetation cover or bare land, especially after harvest and thus increase erosion processes and land degradation. Therefore, control of soil erosion targeted to the area not only reduces direct costs of soil erosion but also diminishes the implementation costs of control operations for decreasing soil erosion.

Keywords: Soil Erosion, Modeling, Deposition, Remote Sensing (RS), Esfahan.