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Investigation of Land-Use Changes and their Impacts on Soil Erosion in Baghmalek Basin using Artificial Neural Network and RUSLE Model

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Abstract
Increasing human exploitation and mismanagement of the natural environment has a great impact on intensifying soil erosion. The purpose of this study is to investigate land-use changes and their impacts on soil erosion and sediment production in Baghmalek basin. First, satellite images with the artificial neural network were classified and user changes in the years 2019-2002 were studied. Then soil erosion was calculated by the RUSLE model and sediment load was estimated. The results showed that residential areas, barren lands, and rainfed agriculture increased by 1722.69, 3445.39, and 2584.04 hectares, respectively, and increased water area, rangelands, and irrigated agriculture by 861.34, 6029.2, and 861.35 hectares, respectively, Have reduced area. Considering the average level of soil erosion of about 15 tons/ha/year, it was observed that in 2002 about 19.69 percent and in 2019 about 45.36 percent of the area erosion was more than acceptable. Also, the sediment delivery ratio was 0.12 to 0.23 and the maximum sediment load was 0.29 to 0.58 and the total sediment was 81051 to 313248. Based on the results, in the study period, the area of land-use classes with low erosion classes has been reduced and the area of high erosion classes has been increased, mainly to the erosion class of more than 20 tons/ha/year. Also, according to the erosion zoning maps in 2002 and 2019, the areas with the highest risk of erosion are mainly located in rangeland lands and rainfed agriculture.

Keywords: Land-Use, Soil Erosion, Artificial Neural Network, RUSLE, Baghmalek.

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Introduction
Soil erosion is a natural process that causes the level of soil loss by various environmental factors such as climate, soil, topography, and vegetation. However, human intervention can accelerate this process through land-use change and agricultural and construction activities. Therefore, today, soil erosion due to land-use change has become the most important issue of land degradation around the world, which results in landform change and disruption of the main functions of the ecosystem. These geomorphic reactions exacerbate soil erosion and increase the number of vulnerable areas. Recent studies have shown that the landscape characteristics of watersheds can explain about 65 to 74% of land-use changes in soil erosion and sediment yields; Because land-use reflects the interactions between humans and the environment and also describes the diverse human exploitation of space. The use of remote sensing data and GIS can provide a good understanding of how land-use changes and its optimal management. Also, by knowing the trend of land-use change, we can take steps towards balance and stability to prevent soil erosion and guide the ecosystem. Baghmalek Basin in Khuzestan province is one of the areas that are affected by human factors of soil erosion and factors such as land-use change, overgrazing, and interference in natural flood channels have intensified soil erosion and loss in the region. Degradation of rangeland lands and also lack of proper tillage operations on rainfed arable lands have been effective factors in erosion and sediment production in the region. In sloping areas, erosion has been rapid and accelerated, and erosion has filled irrigation canals. Also, due to the use of traditional methods in agriculture, the water stays on the soil for a long time and causes soil erosion and leaching downstream. In many parts of the basin, the land was not suitable for rainfed cultivation, but this type of cultivation was done in these areas and this action has caused the destruction and loss of soil in the basin. Therefore, according to the mentioned cases and also the importance of studying land-use change and their role in soil erosion over time and also emphasizing the efficiency and accuracy of the results of using remote sensing data and GIS, land-use changes in the basin Baghmalek and their role in soil erosion and sediment production (2019-2002) were studied.

Materials and Methods
In this study, an artificial neural network method was used to classify images and prepare land-use maps. Multilayer perceptron was used to classify the neural network. RUSLE model was used to estimate the average annual soil erosion. To extract the final soil erosion map, first, all the factors of the RUSLE model including R, K, L, S, C, and P were converted into GRID format maps and 30-meter scale, and then by multiplying all these layers, the amount of erosion The soil was calculated at the pixel level and the final map of soil erosion in the study basin was obtained. In fact, during this process, the information in the layer-specific pixels identified based on the RUSLE model relationships was combined in the GIS software environment by the Raster Calculator tool. In order to explain the possibility of sedimentation of eroded material and its movement in the canal network and finally, in the outlets of the basin, the values of the SDR sediment delivery ratio of the study area are calculated. To evaluate the effect of land-use change on soil erosion, the land-use map was compared with the soil erosion map of the same year and for each cover layer, the amount of erosion and the area of erosion floor was determined, which is given in the results section.

Discussion of Results
The results of land-use change showed that residential areas, barren lands, and rainfed agriculture increased by 1722.69, 3445.39, and 2584.04 hectares, respectively, and water zones, rangelands, and irrigated agriculture by 861.341, respectively, 42/6029 and 35/861 hectares have lost their area. Taking into account all the factors, the average landing limit is about 15 tons/ha/year, which for 2002 is 19.69 percent of the area and for 2019 about 45.36 percent of the area, the amount of erosion is more than acceptable have been. In this study, the sediment delivery ratio was between 0.12 to 0.23 and the maximum sediment load in the study area was between 0.29 to 0.58 and the total sediment was between 81051 to 313248. According to the results obtained in 2002, the area of floors of water zones, residential, barren lands, pastures, rainfed agriculture, and irrigated agriculture with erosion class of 10-15 ton/ha/year with an area of 818/28, 981/93, 83/83, respectively. 2454, 74/3927, 74/3927, and 05/4255 hectares, which have been changed to 654/62, 2490/24, 31109, 46/1582, 4418/70, and 4091/39 hectares

in 2019. Also in 2002, the area of floors of water zones, residential, barren lands, pastures, rainfed agriculture, and irrigated agriculture with erosion class of 15-20 ton/ha/year from 90/41, 826/89, 2067/23, 4/341, respectively, 57/3307 and 95/4702 hectares have been changed to 533,723, 52/1086, 49/2618, 00/3075, 01/3721, and 06/4522 hectares in 2019. The area of residential areas, barren lands, and rainfed agriculture with erosion class of more than 20 ton/ha/year from 361.76, 904.41, and 1447.06 hectares in 2002 to 475.35, 1145.59, and 1627.94, respectively. Hectares in 2019 have increased. Also, the classes of water zones, pastures, and irrigated agriculture with erosion class of more than 20 ton/ha/year from 1593.49, 7664.75, and 8286.15 hectares in 2002 to 1274.79, 5417.86, and 7967.45, respectively. Hectares in 2019 have decreased. The general results show that in the study period between 2002 and 2019, the area of land-use classes with low erosion class has decreased and the area of high erosion classes has increased, mainly to the erosion class of more than 20 tons/ha/year.

Conclusions

The results showed that the increase of residential areas, rainfed agricultural lands, and barren areas, had a significant effect on increasing soil erosion in the study basin. According to the erosion maps obtained, the areas with higher erosion risk are mainly located in the rugged parts of the region. The results of estimating the criteria studied in the RUSLE method in the study basin indicate differences in soil properties and vegetation in different parts of the basin. According to the erosion zoning maps in the study area in 2002 and 2019, mainly the areas with the highest risk of erosion are located in rangeland lands and rainfed agriculture. The results of comparing the USDA, Vanoni, and Boyce methods with the amount of sediment load observations showed that the USDA model had better results in estimating the total sediment amount due to the low error rate compared to the Vanoni and Boyce methods. Also, comparing the total sediment estimated in the USDA method with the value obtained from the EPM method, shows the ability to combine the RUSLE and GIS models to estimate the amount of soil erosion and sediment load in the area.