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Evaluation of of DEMs to the modeling of the potential of gully erosion using Maxent model (Case study: Semirom catchment in the south of Isfahan Province, Iran)

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Abstract

Background and Objective Gully erosion is a type of water erosion that occurs in many climate areas, from arid to humid areas. This type of soil loss causes the displacement and destruction of soil surface horizons by the accumulation of runoff. In many parts of Iran, in the north, south and central faced with this type of soil loss. In fact, gully erosion occurs in this area due to the complex topography, erodible soils, mismanagement of soil and land use/land cover. Therefore, in order to protect the soil in these areas, it is necessary that a susceptible map should be available to the managers and policymakers. Many parameters affect the occurrence of gullu erosion, including soil, geology, tectonics, hydrology, land use, vegetation and topography, that have been mentioned in various studies around the world. The topographic indices are the most important parameters in the event of gully erosion, which operates differently in each region according to the physical characteristics of the areas. This parameter also indirectly affects the other indicators or criteria (for example, its impact on the vegetation, climate and soil of the area).

Even there are many researches on the gully erosion, but there are only a few studies on the modelling with applying the stochastic approaches. This study is the first attempt to the modelling of gully erosion in the central of Iran with applying the maximum Entropy model and topographic indices that have been applied with using the free of charge of digital elevation model. This study uses a new approach to preparing the susceptibility map of gully erosion in the Semirom catchment in the South of Isfahan province. This area is affected by different types of water erosion, same as; gully, rill and landslide. Also, the purpose of this research is to compare the accuracy of two digital elevation model, ASTER and SRTM with 30 m resolution, (DEM) from USGS website, for the modelling of gully erosion in the study area. The emphasis of this research was on the topography indices because it has most important on the event of gully erosion.

Materials and Methods In this research for the prediction of the susceptible areas in the result of the main type of gully erosion, the following steps have been applied; In the first step the locations of some sampled gullies, have been digitized randomly with using the Google Earth (GE) images, aerial photos and fieldwork in polygon shapes for each gully.

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Subsequently, we converted the polygons and into equally spaced points. In the second step, we determine the most important criteria as the environment layers for the modeling. These topography indices including, wetness Index (TWI), curvature, profile curvature, slope, aspect, catchment area, flow length, elevation, slope, LS factor, Stream Power Index (SPI). The topographic indices have been extracted in SAGA GIS from the SRTM DEM with 30m spatial resolution and were then converted to the ASCII format to run in the model. Before applying the indices, the DEM was preprocessed with low pass filtering to extract artefacts and errors, like local noise and with using ArcGIS. Subsequently, the DEM was hydrologically corrected eliminating sinks using the algorithm proposed by Planchon & Darboux. The Maximum Entropy Model is a general-purpose method for making predictions or inferences from incomplete information. MEM explores applications in diverse areas such as astronomy, portfolio optimization, image reconstruction, statistical physics and signal processing. The idea of Maxent is to estimate a target probability. In fact, this model needs only the gullies feature (present data). The advantages of this model include the following; It requires only presence data together with environmental information for the whole study area. It can utilize both continuous and categorical data and can incorporate interactions between different variables.

Results and Discussion With applying the Maxent model in the Semirom catchment, it was trained using 70% of the mapped points of gully features as the target or dependent variable and 30% of the mapped gully as testing samples. The raster type of environmental layers (topographic indices) as the independent variable. The validity of the model used in this study was assessed using the level below ROC or Area Under Curve (AUC). The ROC curve was automatically generated by running this model for both training and testing data. The AUC for training data for SRTM and ASTER is 0.64 and 0.72 respectively and also for testing is 0.68 and 0.72 respectively. These results indicate that the SRTM elevation model has higher accuracy than the ASTER DEM. One of the reasons for the low accuracy of the ASTER DEM can be due to the impact of vegetation, which has caused terrace-like errors, while in the SRTM DEM, due to the radar nature of the waves, this error is reduced and a more accurate map of this the model has been prepared. Our results show that SPI index with 40.3% contribution, elevation with 22.7% and convergence with 18% are the most important factors for the zoning of the susceptible areas. Regarding the predicted map of the potential of gully erosion, the area in the central and south of the study area are in the high probability.

Conclusion This study applied the Maxent model to map the susceptibility of gully erosion in the Semirom catchment in the Isfahan Province, using various topographic effective factors and the Maxent model. Stochastic approaches like statistical mechanics provide a powerful tool to study the relations between locations of gully erosion features and corresponding environmental characteristics. The result of this study can be used for land-use planning and management of the areas with gully erosion for sustainable development in the prone areas. Although the results of this study show the prominent role of the topographic indicators for the prediction of the potential gully map, to increase the accuracy of the modeling results, in the furture researches the other criteria such as land use, vegetation and used soil, etc according to the availability of information to can be applied.

Keywords: Gully erosion, DEM, Maximum Entropy, Geographic information system (GIS)