Gully Erosion Hazard Zoning in the Gharnaveh Watershed, Golestan Province

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Extended Abstract

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Introduction

One of the main problems in the Golestan province watersheds is the high degree of erosion and soil degradation, so that the equilibrium between the soil process and the soil erosion is unbalanced, and the erosion rate increases from west to east. Among these, the gully erosion and piping have the highest role. Gully is a canal or stream with the headcut with active erosion, sharpened slope and steep walls that results from the destruction of surface flow (usually during or after the occurrence of precipitation), dissolution movements, and small mass movements. The extent of gully in the eastern parts of Golestan province has caused the land degradation of arable land and landscape and has increased the conservation cost and etc. Because of connecting upstream areas of the basin to the downstream areas, gully has particular importance, which provides the possibility of sediment and pollutant transport, road destruction and financial losses to agricultural lands. In order to prevent and control the development of gully processes from a small scale to large one, it is a versatile utility to identify and extract the areas prone to gully erosion.

Due to the high intensity of gully erosion and its increasing growth in

the Gharnaveh watershed, the Garnaveh River has an unstable status and severe eroded gully, and in some areas it has a great depth and vertical lateral walls, as well. Therefore, in this research, the watershed of Garnaveh was selected to prepare the risk areas of gully erosion.

The aim of this research is to determine Gully Erosion Hazard zoning using Frequency Ratio and Gupta & Joshi methods (Gully Nominal Risk Factor-GNRF) in the Garnaveh watershed (Golestan province). Ultimately, the accuracy of the model has been evaluated using quality sum method and Kappa coefficient.

Material and methods

The study area is located in the northern part of Iran, Golestan province. The Garnaveh watershed with an area of about 78430 hectares lies between longitudes 370360 E and 414472 E, and latitudes of 4183819 N and 4155267 N (UTM Zone 40).

At first, gully erosion inventory map with the scale of 1:75,000 (dependent variable) for the Gharnaveh watershed has been prepared using multiple field surveys and satellite images. From total gullies, 70% have been selected randomly for building gully erosion hazard zoning model and the remaining ones (30%) have been used to validate the provided model.

In this research, seven data layers including slope percent, slope aspect, plan curvature, lithology formation, land use types, distance from rivers and distance from roads have been selected as gully erosion controlling factors (covariates/ independent variables) and then they have been digitized in ArcGIS software. The amount of Gully density of each factor class has been calculated from a combination of independent and dependent variables, and the rating of classes have done based on Frequency Ratio and Gully Nominal Risk Factor equations. Finally, the Gully erosion hazard zoning map has been drawn from the summation of weighting maps in ArcGIS. In this map, the value of each pixel is calculated by summing the weights of all the factors in that pixel. The pixel values are categorized based on the natural breaks classifier into very low, low, medium, high and very high hazard zones. Then, an accuracy of zoning map has been

evaluated by quality sum method and Kappa coefficient.

Results and discussion

The result of affecting factors classification of the gullies shows that loess deposits formation, rangeland, areas with low distance from road and rivers, northwest aspect, low slope amplitude and concave slopes contain the most susceptibility to gullying. The results of frequency percent comparison of gullies in hazard classes show that from all gully zones in the validation step of the GNRF and frequency ratio models %74.52 and %78.11 of zones are located in the high and very high risk classes, respectively. The result of model validation using the quality sum method and a Kappa coefficient show that the frequency ratio model is a more appropriate model for gully erosion hazard zoning (with the quality sum and a Kappa coefficient of 3 and 0.89, respectively) than the GNRF model (having the quality sum and Kappa coefficient of 1.27 and 0.74, respectively).

Conclusion

In this research, the areas susceptible to gully erosion in the Gharnaveh watershed have been mapped with the frequency ratio and GNRF (for the first time) models. For this purpose, 7 affecting factors (independent variable) and 805 gully zones (dependent variable) were provided to measure the hazard maps of gully erosion. The following results are obtained from this study.

- The geology factors were identified as the most effective factors in the occurrence of gully erosion in the Gharnaveh watershed.
- Based on the gully erosion zoning hazard map of the Gharnaveh watershed, more than 70 percent of gullies are situated in the very high and high hazard classes.
- The produced gully erosion hazard map is useful for planners and engineers to reorganize the areas susceptible to gully erosion hazard, and offers appropriate methods for hazard reduction and management, as well.

Keywords: Hazard zoning, Gully erosion, Gharnaveh watershed, Frequency Ratio, Gopta & Joshi.

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