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Simulation of Possibility of Gully Erosion in Catchment of Dyreh by Analytical Hierarchy Process (AHP)

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ABSTRACT

Gullyerosion can be considered as one of the advanced and critical forms of water erosion causing the destructors of the large amount of the earth. Identifying the factors that have an important impact in the occurrence of this type of erosion and its zoning can also be considered as one of the essential and important tools for managing and controlling this phenomenon. This study have been carried out with the purpose of **identifying the affecting factors** on the creation Gullyerosion and the stimulation of the possibility of its occurrence in Dyreh catchment. The most effective factors in gully creation are: slope, slope direction, horizontal and vertical curvature of the slope, lithology the distance from waterway, distance from the road. Land selected and then these layers were created in GIS. Therefore, in the creation of Gullyerosion they are classified based on preferences in order to have a paired comparison in matrix table. Finally the act of weighting functions and overlapping of layers have been done by Arc GIS software and according to the resulting coefficients hazard zonation map obtained in 6 layers. Without risk very low risk, low risk, medium risk, high risk, and too high risk. The final coefficient of numerical value was defined using the numbers obtained by multiplying the weight of each criterion in the index anywhere between zero and 100. In which the more tendency to 100 indicates as high risk of landslide's and the these coefficient close to zero indicating that there is less risk and at last its occurrence is without danger. The result showed that 36 percent of Dyreh basin facing high risk and too high risk causing the displacement of large volume of soil. The results can be remarkable help for planning officials to properly restrain this kind of rapid erosion in the basin do.
KEYWORDS: erosiongully, hierarchical analysis, GIS, dyrehcatchment.

1. INTRODUCTION

By definition, is a fairly constant stream of temporary drainage gully water during rainfall and much of it is going to be depleted by sedimentation (Welfare, 1996) Erosion and runoff gully or gully erosion has evolved mode (Alizadeh, 1989). Formation of the gully erosion constantly change the Earth's shape and the production of significant amounts of sediment, degraded lands, roads, irrigation channels and dams are filling [Jafari Grzin, 2007 and Brvkard and Kastachvk, 1995]. Gully that in most cases the major indicators of environmental change are considered. Due to rapid growth they are normal forms of erosion are not [White et al, 1990, Nakhtrgalh et al, 2001, Byati Khtibi, 2004]. Gully erosion of fertile soil horizons in terms of transmission and storage capacity, the water is very dangerous One of the causes of instability and soil erosion is a problem for the operation of farm machinery. In semi-arid mountains, the heterogeneous distribution of vegetation will be disturbed by the level of non-normative scope and management of land by humans factors as geology, soil and climate, the rate increased spatial Physical and hydrological characteristics and the range has changed considerably (Bayati Khatibi, 2004). Gully erosion in these areas as the dominant cause of confusion is steep. This problem, due to any cause that can arise from the formation was linearly in one direction or the other can because a range of materials can be disruptive. In addition to the natural factors, human factors are involved, the speed and handling to them severely. Linear cultivation, excessive grazing, down the road from the mountains, will compact the soil by agricultural vehicles passing through the animal sustained a special way ... Human factors are considered as a major role in the development trenches to play. Erosion as the major cause of nudity in the ground situation of the topics that will involve the whole world (Saynr et al, 2005, and Biati khtibi, 2004).This type of erosion, sediment loads of rivers and surface water quality, reduce the increase In recent decades, the culture and the unethical use changes are accelerating, But climate change and consequent changes in the water balance areas for spawning gullyes, good is (Valentin et al, 2005, Ranschr,

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2002, Dvtrvich, 2005, and Bayati Khatibi, 2004). It is important for our country, about 90 percent of the country is arid and semiarid climate and distribution of rainfall in this region will have a good time in such circumstances, the absence or lack of vegetation, increased runoff associated with the loss of more than 5/2 billion tons of soil is provided in (Ahmadi, 2009). Losses from soil loss and sediment deposition in storage tanks, dams, irrigation channels, riverbeds and agricultural land in the country is imported. For example, increased 450 percent in the years 1952 to 2000 the rate of soil erosion is a critical indicator of the erosion control will be necessary (Ahmadi, 2009). But controlling or combating water erosion requires an understanding of the critical region and the contribution of each type of water erosion, land degradation and sediment production. So far as this part of the country is not completely determined, so, check it out extensive research on the important things that must be paid. In the meantime, the results of the studies indicate that in the Gully erosion in the event of a significant volume of soil compared to the other types of water erosion is out of reach (Ghodousi, 2002). Here, a number of studies carried out in our gully erosion Gavrz and Dismt (1997) to explore various aspects of gully erosion using aerial photographs and satellite images and using GIS techniques also increase the accuracy of the results, save time and reduce the size of the study period. Courses, and Betz (1999) from a digital elevation model (DEM) with a combination of aerial photography to measure erosion ditch in New Zealand Geomorphology used in unstable environments. They will change in the next two periods of 14 and 33 years were studied.

Studies Vyjns and colleagues (2001) showed that lithology plays an important role in a gully up So that the user is in a certain area gully in loamy marl and gravel, and conglomerate of the land is more active. Jabari and Mirnzari (2008) in their study on zoning of landslide events in the Sarpolzahab area back tightened travel hierarchical analysis methods, surface density, weight variables, the information presented and found that the compression method is better than other methods in this area are used to predict the landslide area.

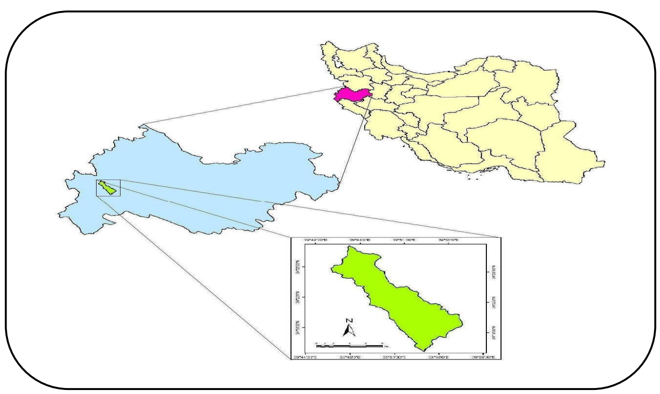
Civil and Ghorbanpour (2009) using four methods of hierarchical analysis, surface density, weight variables, the value of information, Landslide hazard zonation in the basin Chrmlh falcon. And were the greatest dangers threatening the northern part of the basin.

During the study, the Zoning Arab Ghashghavi (2011) gully erosion of the basin was Trod Firoozkooh with Multi Class Maps approach. Their results showed that 88 percent of the area of the gully in the area is high and very high risk.

Alaei Taleghani, Rahimzadeh (1390) in a study using the analytic hierarchy zoning landslide in the basin began peers and 58 percent were the result of the high risk area is located.

The study area

The drainage basin area of dyreh with 113. 41 square kilometers in the West of Iran, Kermanshah Province is located in the political area. This basin's geographical location between circuits 14.34 to 29.34 degrees north of the equator and between the meridians 39.45 ° to 56.45 degrees east longitude from the prime meridian is located.



Methods

This study was carried out to identify areas prone to gully. The goal of development applications in terms of the nature and methods of research - descriptive and analytical survey is. What is the research method used in this research, Hierarchical Analysis (AHP) of the variables. Under this method, paired comparison matrix variables in the table. Qualitative comparison of numerical values relative to one another is determined through expert judgment. The main advantage of AHP is that it can help decision makers to a complex problem into a hierarchical structure to break and then fix it (Olfati et al, 2012) Process is done in a GIS environment. Compare pairs of variables, so gully the erosion occurring in the study area is considered to be the input system and the relative weights of the output of the system will be (Alaei Taleghani, M. Rahim, 2011). It is clear that environmental conditions prevailing in the area of erosion is essential Gullies position is based primarily on In order to gully the 10 indicators were identified at the basin level Position them with the help of GPS devices and meter And then moved on 1:250,000 topographic base map Gullies distribution map was prepared dyreh Basin In fact, the number of available authors gully and there is the possibility of identifying them (Figure 2) (Table 1).

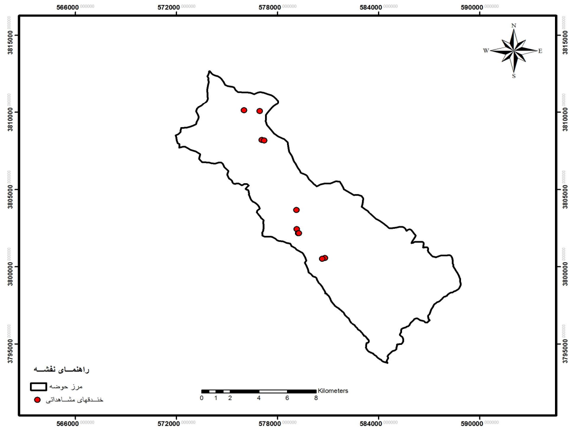


Figure 2: Map of the drainage gully's in the area dyreh

Table 1: Location and characteristics of drainage gully's recorded in the area dyreh

Gullies	Latitude to UTM	Longitude to UTM	Average width of trench (m)	Average hole depth in meters	Trench length in meters	Volume in cubic meters of soil removed
1	3808847	38576030	3.9	2.5	15.4	150.15
2	3800075	38579612	3.5	2.8	16.68	163.46
3	3811350	38575565	4.38	3.26	24.5	349.83
4	3808883	38575894	5.29	3.49	21.9	404.32
5	3811363	38575086	5.12	3.93	38.57	776.09
6	03803811	38578144	6.32	4.17	30.25	797.23
7	3802552	38578178	4.7	4.74	23.63	526.43
8	3808435	38575941	2.83	2.5	67.21	475.51
9	3802027	38578324	5.7	5.32	124.4	3772.31
10	3800148	38579623	1.65	3.11	28.42	145.84

However, the AHP method to zoning areas susceptible to erosion gullies in the following steps: 1- Layers of information extracted from the variables of interest. Order information strata variables where each variable as a GIS map layer that is was prepared. These layers are: slope, aspect, curvature, horizontal and vertical slope, lithology, distance from drainage, distance from the road, the land below.

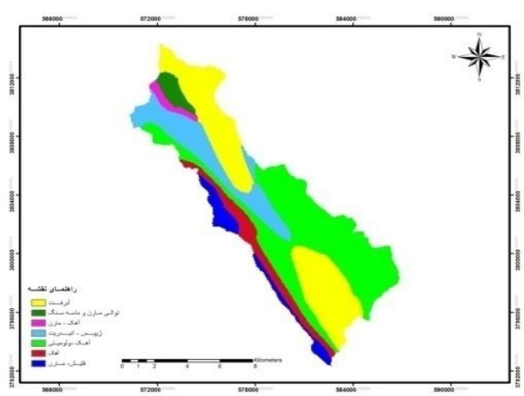


Figure 3: Map of catchment lithology dyreh

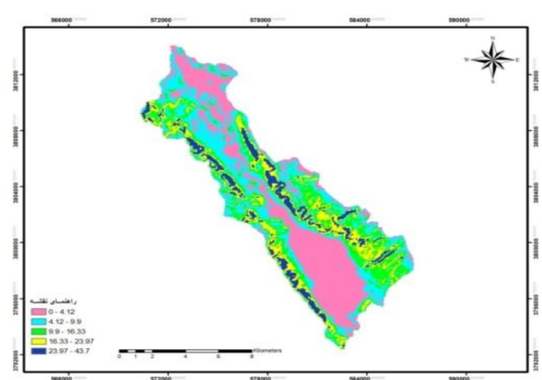


Figure 4: Slope map area dyreh

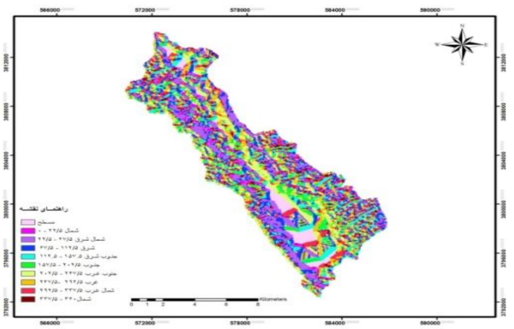


Figure 5: Map of the slope area dyreh

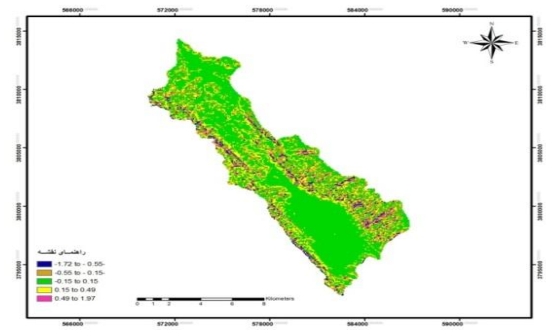


Figure 6: Map of the curvature of the vertical gradient in the area dyreh

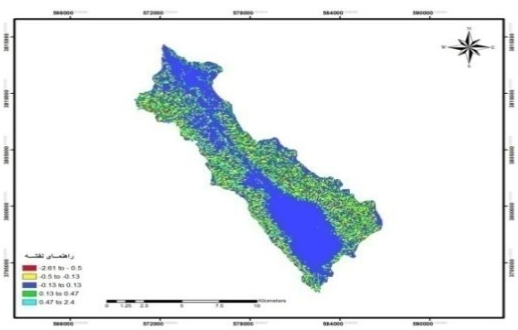


Figure 7: Map of the horizontal gradient of the curve in the area dyreh

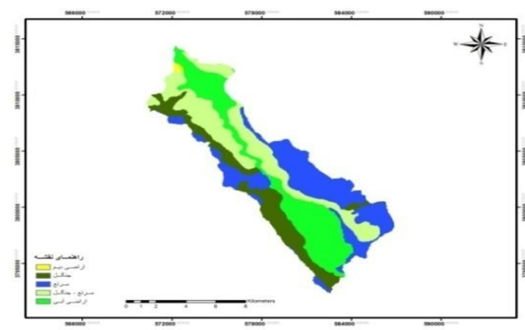


Figure 8: Land use map of the area dyreh

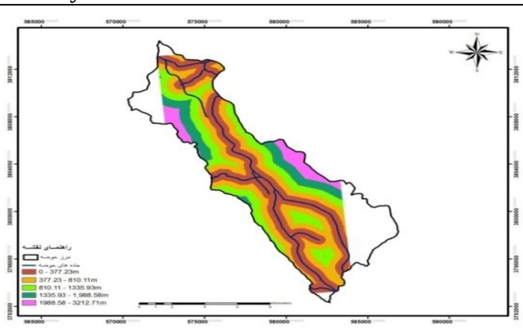


Figure 9: A map of the area way too dyreh

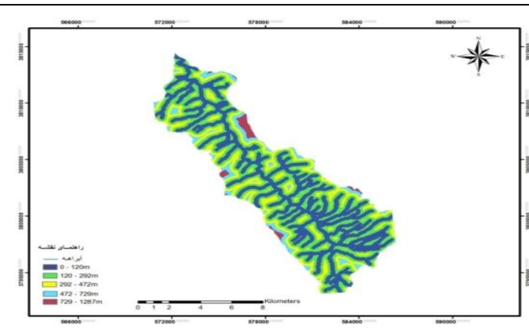


Figure 10: Map of the drainage basin of the distance from waterways dyreh

Lithology layers: the Karun Basin lithologic terms of seven types of dolomitic limestone, marl and sandstone, alluvial deposits, flysch and marn, lime, limestone and marn, gypsum and anhydrite is formed. It maps the effect of bringing the stones Gullies in the study area in this region (Figure 3).

Gradient layer: This layer is designed to investigate the effect of different slopes prone areas of the study area in a gully, was prepared and used. To do this, the slope map of the study area was divided into five regions (Figure 4).

The gradient layer: This layer is designed to investigate the effect of the gradient in the study area were used to prepare a moat prone area. Each of these maps is divided into 10 classes as well as for the flat slope of the map is presented (Fig. 5).

Vertical curvature gradient layer: This layer also has a 5 rating for the area dyreh and the class of (72.1-) to (97.1) are Classification. In the course of these classes of negative numbers to positive numbers, in the direction perpendicular to the curve of the concavity and convexity of the surplus is reduced (Fig. 6).

Horizontal curvature, gradient layer: This layer is also the layer vertical gradient of the curve is divided into five classes. It's full of negative numbers to positive numbers in classes. And grade (61.2-) to (4.2) is the classification. This map to the convexity and concavity of the curve are parallel (Figure 7).

User Layer content: dyreh area for 5 to include: dry land, pasture land, forest land, land, water, pasture land - forests, the forest was divided overcome (Figure 8).

Layer away from the road: To investigate the relationship between the gully's and the distance from the road, in the ARC MAP for road Euclidean distance (Eanuclide Distance) was drawn. In this map the Euclidean distance for each of the methods defined within the basin, and finally in the fifth grade level, from 0 to 71.3212 m was taken dyreh in the basin. The goal of mapping the relationship between the distance from the road and the gully is formed (Fig. 9).

The distance from waterways: layer after layer corrections on waterways, Euclidean distance in the fifth grade was drawn to them. Distance dyreh area from 0 to 1287 m. It also plans to examine the relationship between space and form Waterways gully, are examined (Fig. 10).

The hierarchical structure of variables:

Paired comparison matrix necessary variables in the table, Rankings are based on the priority level of the phenomenon is studied. Therefore, the selection of data layers and grouped them into categories and classes, was attempting to create a hierarchical structure of them. Variable effective in erosion of the slope and gully most of its distance from the channel layer was considered. This judgment is based on information density of each layer in the gully erosion; numerous field observations have been made. In each sub-layer is treated the same way. Priority vectors computed variables of interest: The use of hierarchical design options to form the matrix was paired variables (tables). The matrix of variables to determine the weight each pair of elements by comparing their corresponding elements is at a higher level. Small amounts of each of the variables from Table 2 were obtained Priority level of each variable in quality than the other variables are shown numerically.

Table 2: Comparison between the two scales in the hierarchical model

Numeric value	Preferences (oral assessment)
9	Maximum priority
7	High priority
5	High Priority
3	Medium priority
1	Parameters Weak
2،4،6،8	Intermediate priority

Source: olfati et al (2012)

Calculate the final score derived variables and Zoning Map: In this part of the ArcGIS software with the help of weight and the overlapping layers was done using Based on it, gully erosion hazard zonation basin dyreh in the safe zone 6, Bsyarkm risk, low risk, medium risk, high risk, the risk was too high.

In this paper the approximation method (arithmetic mean) is used. This method involves the following steps: 1. Values of each column are added together 2. Divide each element of the matrix element of the total column 3. Average of the elements in each level

Finally, the weight of each criterion in the ditch erosion risk in the study area was calculated (Tables 3 to 12).

Table 3: Calculate weighted gradient layer

Average	23.9 – 43	16.3 - 23.9	9.9 - 16.3	4.1 -9.9	0 - 4.1	Layer Dip
0.416	0.33	0.38	0.44	0.48	0.45	0 - 4.1
0.258	0.26	0.28	0.29	0.24	0.22	4.1 -9.9
0.16	0.2	0.19	0.14	012.	0.15	9.9 - 16.3
0.096	0.13	0.09	0.04	0.08	0.11	16.3 - 23.9
0.058	0.06	0.04	0.04	0.06	0.09	23.9 – 43

Table 4: Weight Calculate for the gradient layer

Average	NW	W	SW	S	SE	E	NE	N	Flat	The slope of Layer
0/033	0/03	0/01	0/01	0/01	0/02	0/02	0/06	0/06	0/08	Flat
0/176	0/1	0/12	0/2	0/2	0/21	0/21	0/25	0/18	0/12	N
0/186	0/06	0/16	0/2	0/25	0/27	0/31	0/13	0/22	0/08	NE
0/124	0/1	0/1	0/16	0/15	0/13	0/1	0/04	0/22	0/12	E
0/061	0/13	0/12	0/01	0/1	0/06	0/05	0/03	0/06	0/08	SE
0/071	0/13	0/16	0/12	0/05	0/03	0/03	0/02	0/04	0/06	S
0/062	0/16	0/2	0/04	0/01	0/03	0/02	0/02	0/03	0/05	SW
0/048	0/1	0/04	0/01	0/01	0/02	0/05	0/03	0/06	0/12	W
0/224	0/1	0/1	0/2	0/2	0/21	0/21	0/38	0/37	0/25	NW

Table 5: Weight Calculate horizontal curvature, gradient layer

Average	0.47 - 2.4	0.13 - 0.47	-0.13 - 0.13	-0.5 - -0.13	-2.61 - -0.5	Horizontal curvature gradient
0.204	0.27	0.4	0.12	0.03	0.2	-2.61 - -0.5
0.262	0.27	0.2	0.58	0.16	0.1	-0.5 - -0.13
0.354	0.2	0.28	0.23	0.66	0.4	-0.13 - 0.13
0.106	0.2	0.1	0.03	0.08	0.12	0.13 - 0.47
0.088	0.1	0.05	0.04	0.05	0.2	0.47 - 2.4

Table 6: Weight Calculate vertical gradient layer curvature

Average	0.49 - 1.97	0.15 - 0.49	-0.15 - 0.15	-0.55 - -0.15	-1.72 - -0.55	Vertical gradient of the curve
0.204	0.27	0.4	0.12	0.03	0.2	-1.72 - -0.55
0.262	0.27	0.2	0.58	0.16	0.1	-0.55 - -0.15
0.354	0.2	0.28	0.23	0.66	0.4	-0.15 - 0.15
0.106	0.2	0.1	0.03	0.08	0.12	0.15 - 0.49
0.088	0.1	0.05	0.04	0.05	0.2	0.49 - 1.97

Table 7: Land Use layer weights are Calculate

Average	Irrigated Lands	Pasture - Forestry	Grassland	Forest	Dry Land	Land use layer
0.076	0.06	0.03	0.04	0.03	0.22	Dry Land
0.236	0.33	0.21	0.4	0.14	0.1	Forest
0.144	0.2	0.21	0.12	0.05	0.14	Grassland
0.122	0.26	0.11	0.06	0.07	0.11	Pasture - Forestry
0.42	0.13	0.43	0.4	0.71	0.43	Irrigated Lands

Table 8: Weight Calculate from the drainage layer

Average	729 - 1287	427 - 729	292 - 427	120 - 292/85	0 - 120	The distance from waterways
0.42	0.16	0.44	0.44	0.63	0.43	0 - 120
0.204	0.25	0.2	0.3	0.63	0.11	120 - 292.85
0.156	0.16	0.27	0.14	0.07	0.14	292 - 427
0.128	0.33	0.09	0.05	0.07	0.1	427 - 729
0.088	0.08	0.02	0.07	0.05	0.22	729 - 1287

Table 9: Weight Calculate from the roads layer

Average	1998/58 - 3312/71	1335/93 - 1988/58	810/11 - 1334/93	337/23 - 810/11	0 - 337/23	Distance from road
0.422	0.27	0.2	0.51	0.7	0.43	0 - 337.23
0.23	0.27	0.4	0.25	0.14	0.09	337.23 - 810.11
0.162	0.2	0.3	0.13	0.07	0.11	810.11 - 1334.93
0.118	0.2	0.1	0.04	0.03	0.22	1335.93 - 1988.58
0.08	0.1	0.05	0.06	0.05	0.14	1998.58 - 3312.71

Table 10: Weight Calculate lithology layer

Average	Limestone and Dolomite	Lime	Limestone - marn	Flysch - Marn	Gypsum - Anhydride	Marn and sandstone sequence	Alluvium	Lithology
0.34	0.25	0.28	0.31	0.35	0.41	0.45	0.33	Alluvium
0.255	0.21	0.23	0.25	0.26	0.27	0.22	0.14	Marn and sandstone sequence
0.157	0.18	0.18	0.19	0.2	0.14	0.11	0.1	Gypsum - Anhydride
0.101	0.14	0.14	0.12	0.1	0.07	0.07	0.07	Flysch - Marn
0.064	0.11	0.09	0.06	0.04	0.04	0.06	0.05	Limestone - marn
0.04	0.07	0.04	0.03	0.03	0.03	0.04	0.04	Lime
0.027	0.03	0.02	0.02	0.02	0.02	0.03	0.03	Limestone and Dolomite

Table 11: Calculation of weighting the layers in the basin erosion gully dyreh

Average	**The distance from waterways**	**Vertical gradient of the curve**	**The slope**	**Lithology**	**Curvature of the horizontal gradient**	**Distance from road**	**Land**	**Slope**	**Factor**
4.5	8	7	6	5	4	3	2	1	Slope
4.4	8	7	7	6	4	2	1	1.2	Land
2.9	7	6	5	2	2	1	1.2	1.3	Distance from road
2	6	4	2	2	1	1.2	1.4	1.4	Curvature of the horizontal gradient
2.92	8	7	6	1	1.2	1.2	1.6	1.5	Lithology
0.89	3	2	1	1.6	1.2	1.5	1.7	1.6	The slope
0.93	2	1	1.2	1.7	1.4	1.6	1.7	1.7	Vertical gradient of the curve
0.3	1	1.2	1.3	1.8	1.6	1.7	1.8	1.8	The distance from waterways
	43	34.5	27.83	16.42	12.41	7.5	4.3	2.7	Total

Table 12: The estimated weight of the layers in the basin erosion gully dyreh

Average	**The distance from waterways**	**Vertical gradient of the curve**	**The slope**	**Lithology**	**Curvature of the horizontal gradient**	**Distance from road**	**Land**	**Slope**	**Factor**
0.302	0.18	0.2	0.21	0.3	0.32	0.4	0.46	0.37	Slope
0.252	0.18	0.2	0.25	0.36	0.32	0.28	0.23	0.2	Land
0.143	0.16	0.17	0.17	0.12	0.16	0.13	0.11	0.1	Distance from road
0.091	0.13	0.11	0.07	0.12	0.08	0.06	0.06	0.1	Curvature of the horizontal gradient
0.107	0.18	0.2	0.21	0.06	0.04	0.06	0.04	0.07	Lithology
0.036	0.06	0.05	0.03	0.01	0.04	0.02	0.03	0.05	The slope
0.026	0.04	0.02	0.02	0.01	0.02	0.02	0.03	0.05	Vertical gradient of the curve
0.017	0.02	0.01	0.01	0.01	0.01	0.02	0.02	0.04	The distance from waterways
									Total

RESULTS

The results of the coefficient matrix and the weight of each of the 8 variables affecting erosion of gully and 12 are provided in Table 11. Arithmetic mean method is applied to calculate the weight factor. Each column in the matrix table numbers together, then the columns of the matrix to the sum of the numbers divided and the average numbers in the table is Calculate matrix. The average weight of each variable to any class or classes of variables has been made. Scores obtained for each of the classes of variables are shown in Table 12. Hierarchical analysis methods used in this study has been Total product weight coefficient of each variable to the risk of erosion of the gully. Quantitative value of each variable based on the ratio between the surface occupied gully erosion occurred in the study area as a percentage of the total floor area of between zero and 100 are identified and defined. It is a class that has a maximum rating of 100 and a floor level without erosion gully erosion rate is zero-order. So if the total score is closer to 100 or more sensitive to the potential erosion of the gully Conversely, if the sum of the final score to be zero That means the target area, or region of low sensitivity and low risk of erosion of the gully. With regards to the description and view the data in Table 11 ¬, gully erosion potential of the watershed events of dyreh as the following equation:

$$Y = x1 + x2 + x3 + \ldots + xn$$

In this regard, Y: The risk of erosion gully Etc. x1‹x2: Are important factors in the occurrence of Using this relationship, the potential risk of erosion occurring in the gully on the 6th floor of the basin are Calculate The results are presented in Figures 11 and 12. According to this chart, more than 36 percent of the area at risk, too dyreh and too much of gully erosion is occurring if the average risk also adds that about half of the area is prone to erosion.

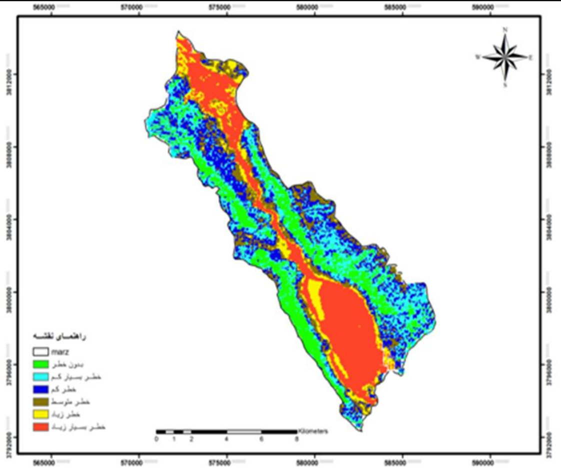


Figure 11: Basin dyreh in the gully erosion hazard zonation using analytical hierarchy

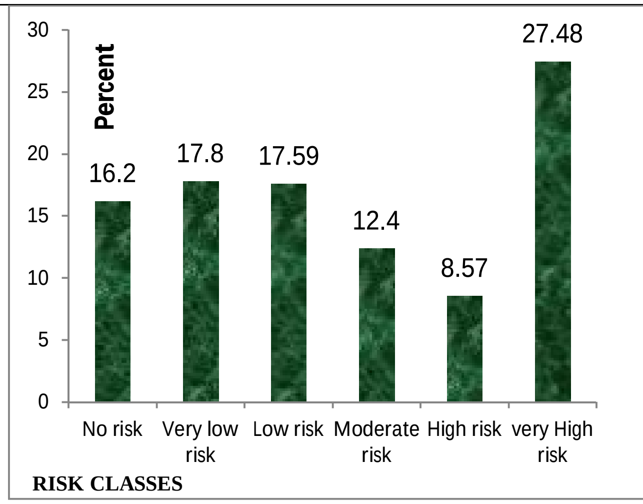


Figure 12: Erosion hazard zonation in the catchment gully dyreh

CONCLUSIONS

Based on the findings of the Zoning greatest slope erosion gully in layer 2/30 is the percentage of the influence of slope classes 0 to 4/1 and 4/1 -9 / 9 respectively 6/41 and 8/25% more than other classes. Because the slope of the low chance of water infiltration into the soil and create holes for the trenches, more. The zoning of lands susceptible to erosion gully catchment dyreh Gilangharb city: Slope class 0-4 / 1 percent, the northwest and northeast, respectively, with 4/22 and 6/18%, the slope of the curve layer arrangement of horizontal and vertical layers (-0/13 - 0/13) and (-0 / 15 - 0/15) with the percentage of 4/35, with the highest weight. Also, the land use layer 2/25% of the maximum slope of the gully erosion in the catchment is dyreh. In this layer, the blue area with the highest weight (42%) than the rest of the land is in effect on gully creation. With proper management of land, maintaining infiltration capacity of the soil, vegetation and soil structure and prevent excessive concentration of runoff from gully's to prevent. The distance from waterways layer by layer from 0 to 120 and 120 - 292/85, respectively, with 42 and 4/20 percent. Distance from the road with a 3/14 percent in areas where the roads between 0 - 337/23 and 337/23 - 810/11, respectively, 2/42 and 23% gained the most weight، To reduce the risk of non-principal roads in sensitive areas should be avoided.

The layer sequence of lithology layers and layers of marl and sand alluvium with 34 percent with 5/22 percent more efficient than the rest of the layers was determined to have the greatest weight. Due to soft sediments are highly sensitive to these units. Finally, gully erosion hazard zonation in the catchment area of more than 36 percent dyreh in high and very high risk of erosion of the gully is Considering that the average risk of danger which one half of the basin of the fertile plain of the city and the province, it is threatening.

The results of this study can contribute considerably to the proper authorities plan restrain this kind of rapid erosion in the basin to make.

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