



Islamic Azad University

EPM Approach for Erosion Modeling by Using RS and GIS

(case study: Ghareh Aghach watershed, Iran)

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Introduction:

The over population in the world have lead to an increased demand for food and other necessities of human beings. The gradual soil salinization along with deterioration of rangelands vegetation covers have caused accelerating soil erosion and sedimentation in water reservoirs (Lu. *et. al.*, 2001).

Introduction:

UNDP (1999) has reported that at present the soil erosion in Iran is about 20 ton/he, which has increased by 10 ton/he compared to the last decade.

There are not enough sediment measurement stations in most watersheds in the country which makes it more difficult to provide with a specific models based on local watershed characteristics.

Introduction:

One of the most important problems with empirical models of soil erosion is its lack of accuracy in processing the huge number of data which should be digitalized by GIS system and analyzed by mathematical models.

EPM is an empirical model to estimate the quantity and quality of sediment. In fact quantifying and digitalizing the sediment data is an important break through in sediment assessment models development (Nearing et. al., 1999).

Objective:

The goal of this research was to apply EPM model and GIS system (to reduce the error level to the minimum) to have the most possible accurate assessment of the soil erosion and sedimentation in the study area and make the best applicable suggestions to control it.

Material and methods:

1. The Experimental site :

The research was carried out in Ghareh Aghach watershed with an area of 8954.8 hectares located in north of Esfahan province of Iran. Average annual precipitation is 358 mm. Ghareh Aghach rangelands included 17 vegetation types. The watershed area is divided in five major hydrologic sections according to its topographic feature (figure, 1).

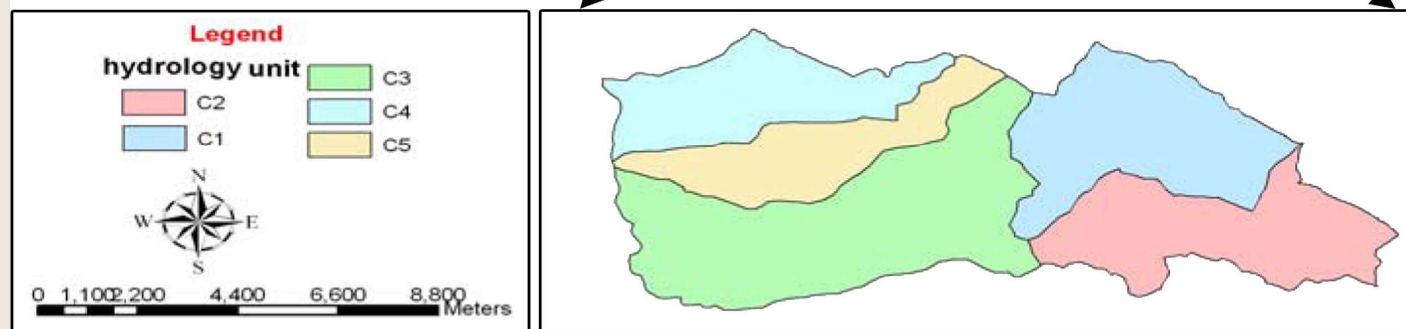
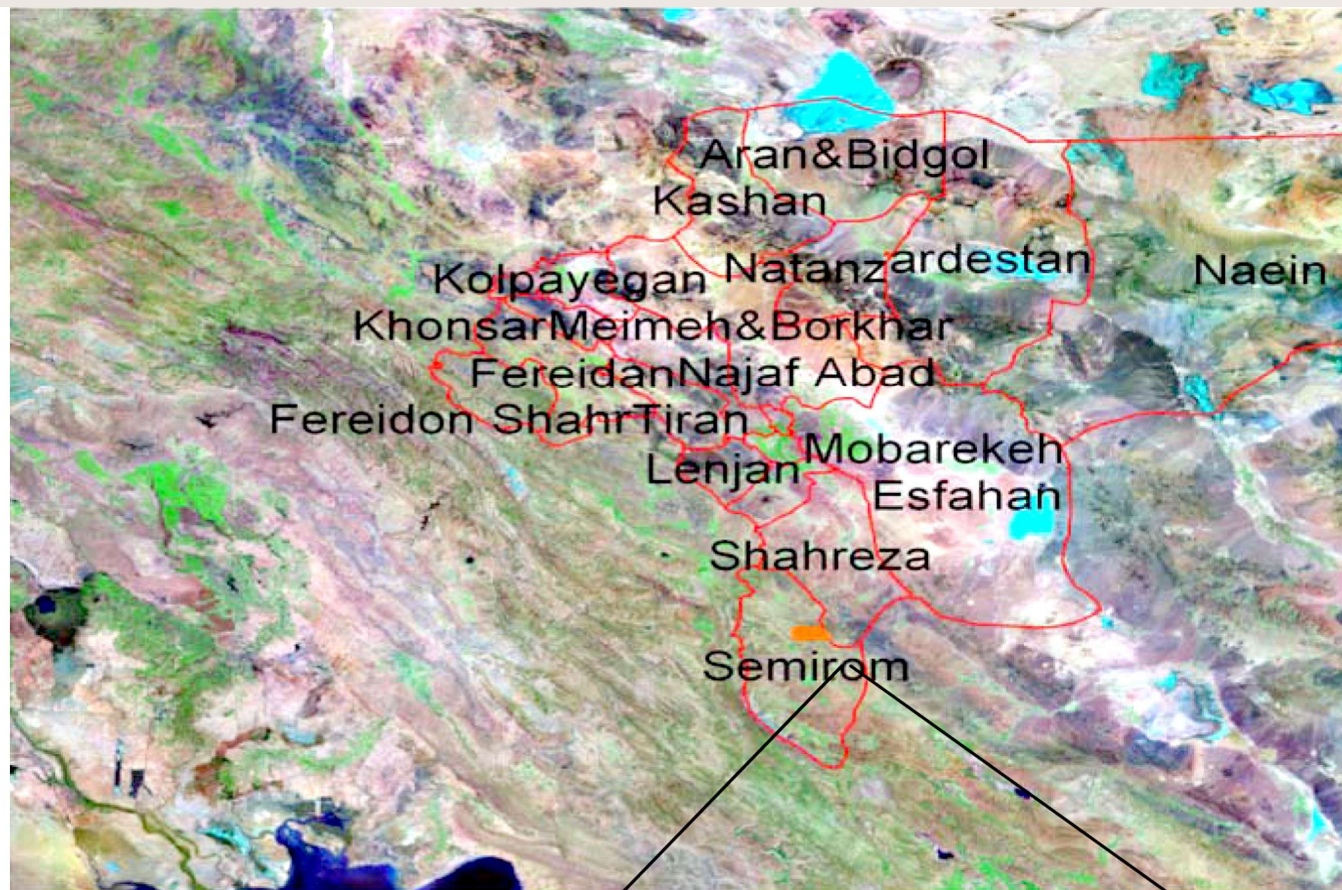


Figure 1. Location of the study area

Material and methods:

2. EPM Model

This model was created to estimate the soil erosion according to nine factors consisting of, geological characteristics, soil, climate, runoff, topography, vegetation cover, land use and present soil erosion (PSIAC, 1968).

Material and methods:

Table1: the effective factors and their points calculation formula in EPM model

The effective factors	The points calculation formula	Explanation Parameter
Geology	$Y1=X1$	X1: stone sensitive point
Soil ¹	$Y2=26.67K$	K : erodibility factor in USLE
Climate	$Y3=0.2X3$	X3 : precipitation intensity with 2 year interval return
Water runoff	$Y4=0.006R+10Qp$	R : annual runoff depth (mm), Qp : annual specific discharge (CMS/km²)
Topography	$Y5=0.33S$	S : average watershed slope (%)
Land vegetation cover	$Y6=0.2X6$	X6 : bare soil (%)
Land use	$Y7=20-0.2X7$	X7 : canopy cover (%)
Surface soil erosion	$Y8=0.25X8$	X8 : points summation in BLM model
Gully erosion	$Y9=1.67X9$	X9 : point of Gully erosion in BLM model

1. Using Stone and Hilborn table (2003).

Material and methods:

Table1: the effective factors and their points calculation formula in EPM model

Factor	necessary information	results
1	Slope map	I: mean watershed slope
2	aspect map	: value for different erosions
3	land use	Xa: value for different land uses
4	rock and soil susceptibility to erosion	Y: value for rock and soil susceptibility

Material and methods:

**Table 2. Sediment evaluation and erosion classification in EPM model
Application of soil erosion model by GIS**

Sedimentation yield		Summation of nine effecting factors (R)	Quality erosion class	Erosion class
t/km ²	m ³ /km ²			
2500<	1450<	100<	Very high	V
1500- 2500	450- 1450	75-100	High	IV
500-1500	250-450	50-75	medium	III
200-500	95-250	25-50	Low	II
<200	<95	0-25	Very low	I

Material and methods:

3. Application of soil erosion model by GIS

After providing with all the necessary data maps (soil, geology, vegetation cover, slopes and etc.), satellite photos and data sheets, 174 uniform unit maps were created. The necessary data for erosion estimation by EPM model were provided for each uniform unit in the field to create the final erosion map.

Material and methods:

The estimation of sedimentation was based on nine most important affecting factors in each uniform land unit. The mean sedimentation map was created by crossing the uniform land unit maps with sub hydrologic maps (Figure 2).

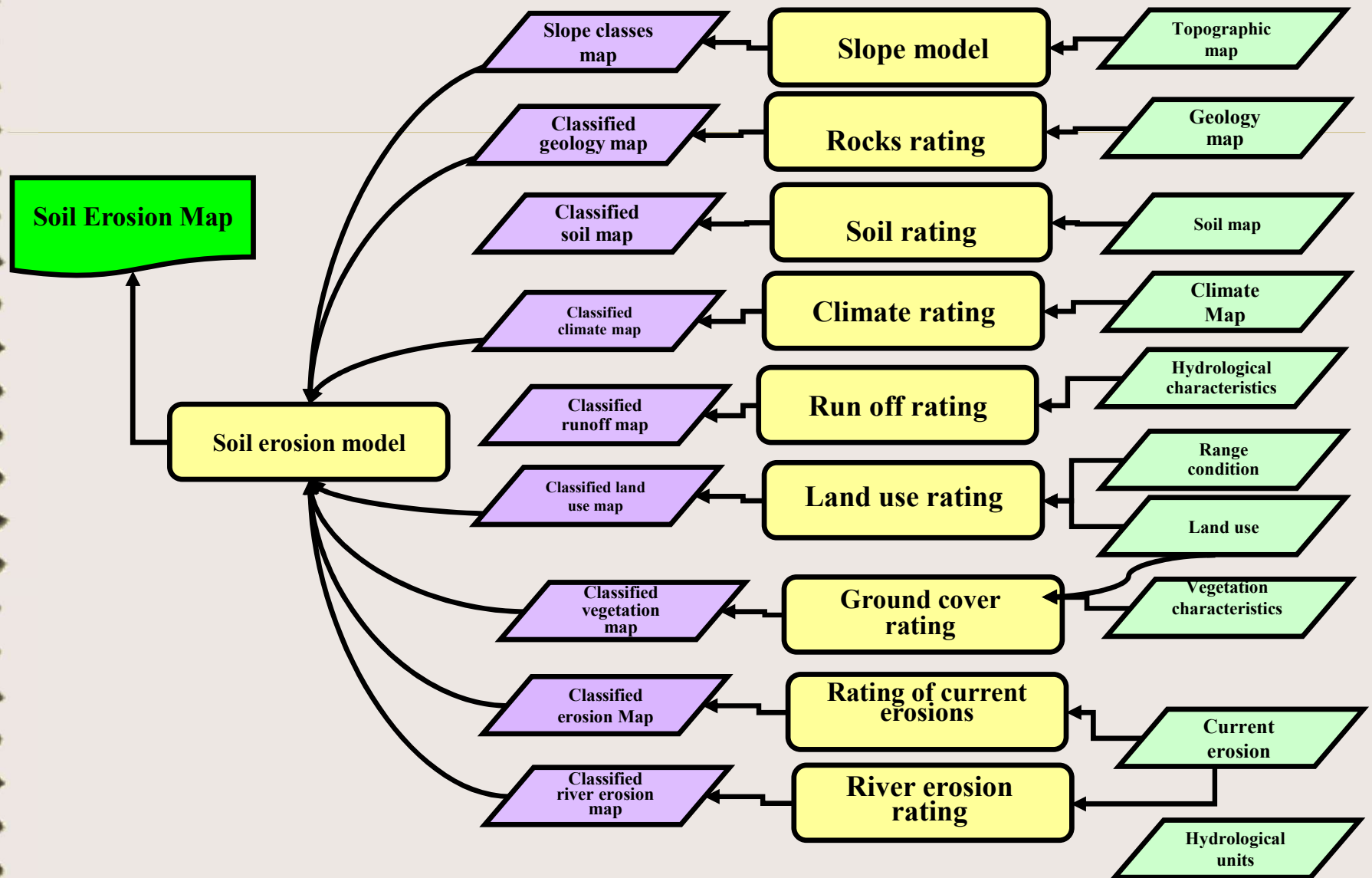


Figure 2. EPM Model for Soil Erosion

Results:

According to EPM model, first the major and minor watershed units were matched by GIS system with different maps (geology, soil, vegetation cover, land use and present soil erosion) to calculate the mean sediment coefficient for each sub unit. The 6-hour precipitation intensity with 2 year interval return was calculated (5.6 mm/h) and considered as constant coefficient for all watershed sub units. The points of nine effective factors on sedimentation model EPM for Ghareh Aghach sub unit is shown in table 3.

**Table 3. Evaluation points for nine affecting factors in EPM model
For Ghareh Aghach watershed subunits**

Factor	Ghareh Aghach Subunits				
	C1	C2	C3	C4	C5
Geology	6.61	6.71	4.67	5.65	4.66
Soil	4.79	3.53	4.61	3.76	4.02
Climate	5.60	5.60	5.60	5.60	5.60
Water runoff	18.19	23.08	6.06	5.04	5.04
Topography	13.14	11.22	4.16	5.32	4.48
Land vegetation cover	8.14	8.12	8.55	10.67	10.26
Land use	12.1	11.91	12.22	15.03	14.76
Surface soil erosion	12.27	12.07	10.51	8.96	9.04
Gully erosion	0.82	2.5	1.72	1.01	0.89

Results:

The sensitivity maps (2 to 7) for each factor was created by ILWIS program. The sediment production map (R) was created by summation of single information sheets of each nine effecting factor (figure,8). The sediment creation map was prepared according to information provided in table 2 (figure, 9). The results of total erosion total sedimentation, specific erosion and sediment producing class for each watershed subunit is presented in table 4.

Results:

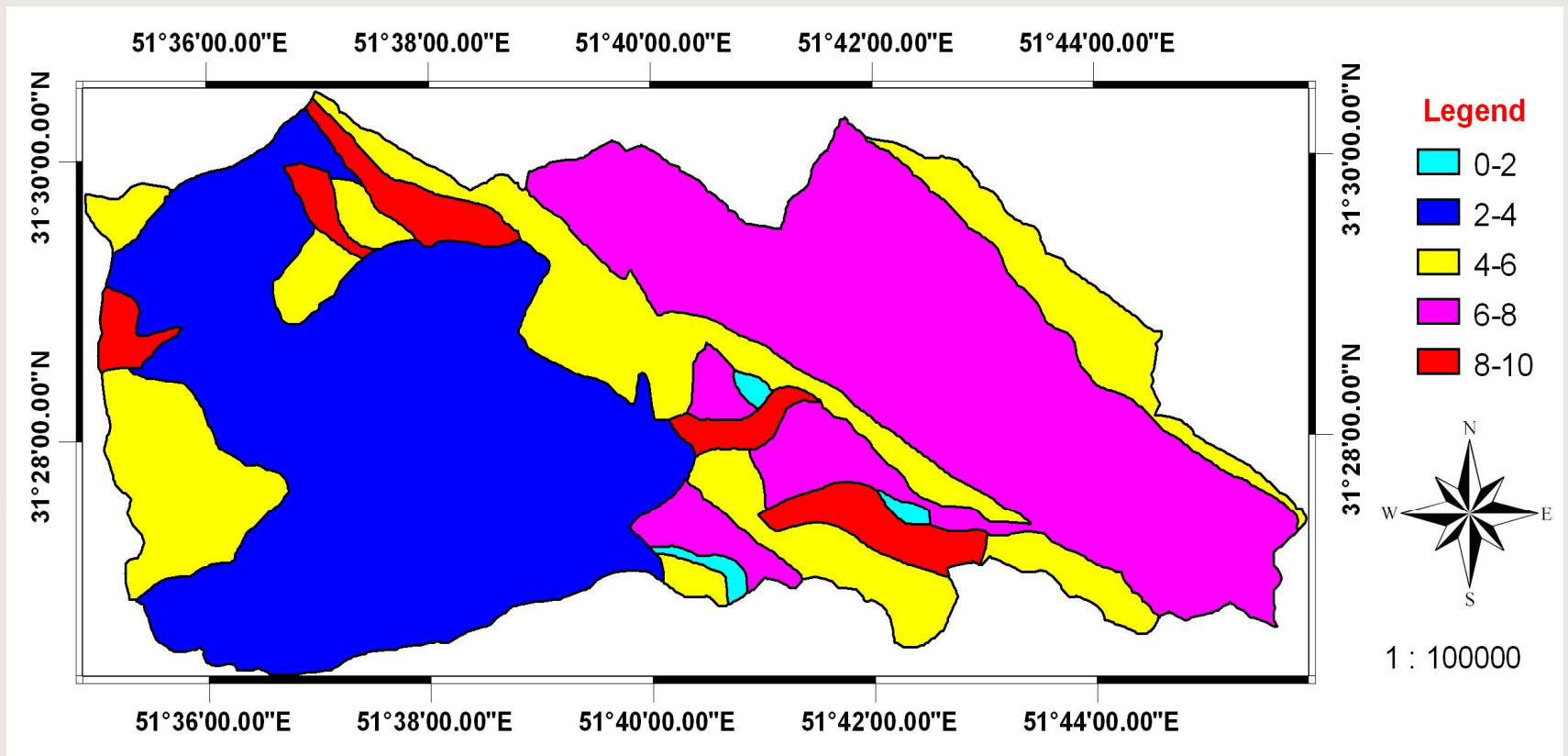
Table 4: The amount of soil erosion and sedimentation, specific erosion and sedimentation class for Ghareh Aghach watershed subunits in EPM model

Subunits	C1	C2	C3	C4	C5
Annual sedimentation (ton)	8801.82	8935.34	5960.24	3078.63	2484.39
Annual erosion (ton)	21417.68	21444.26	15469.05	7170.63	5667.87
Sediment Delivery Ratio (SDR)	0.4109	0.416	0.385	0.429	0.438
Sediment rate (R)	81.66	84.74	581.1	60.92	58.87
Sediment class	High	High	Medium	Medium	Medium

Results:

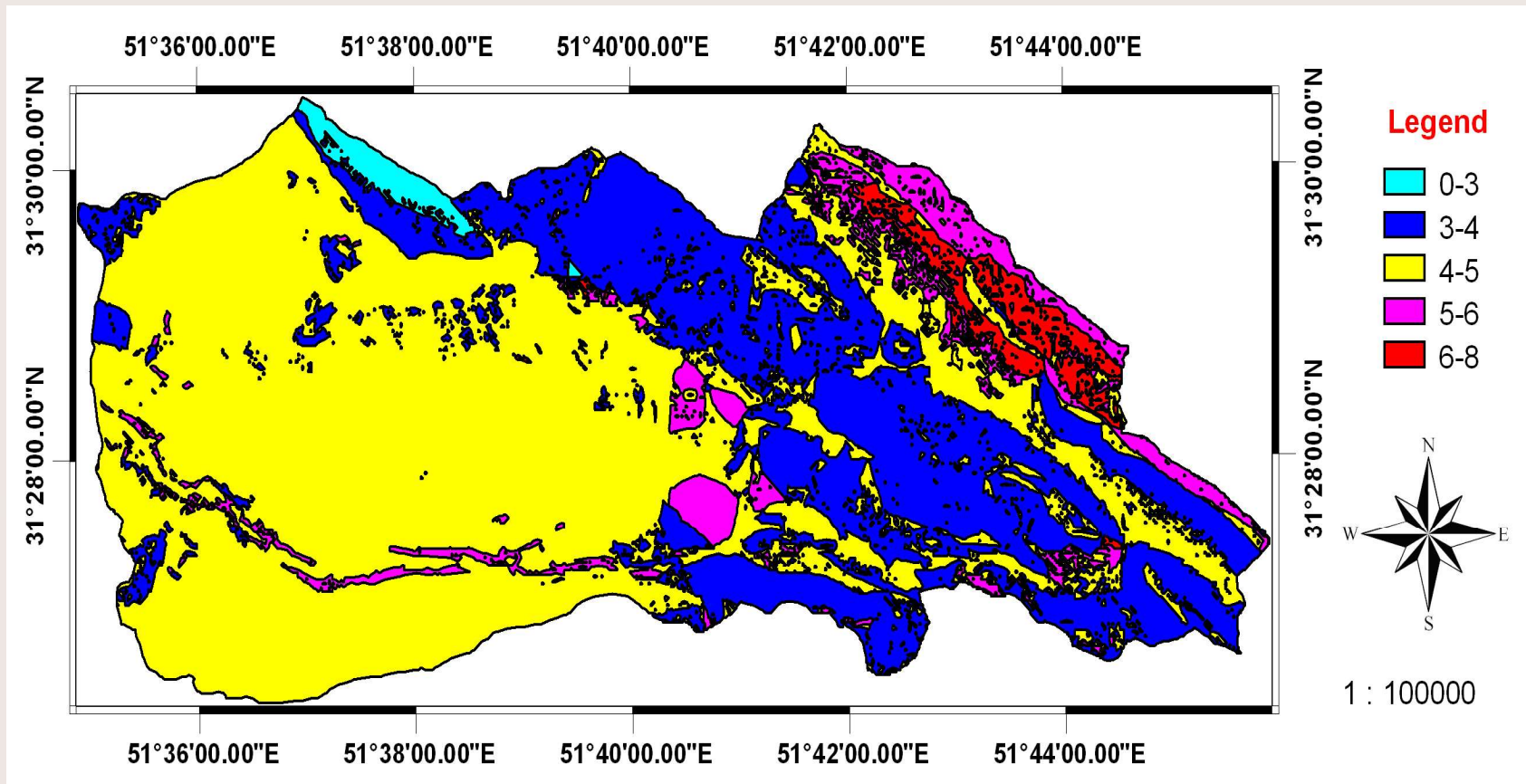
The results of EPM model indicated that 60.8% (5444.28 ha) of the total watershed area was classified at class III of erosion category with medium sedimentation and 39.2% (3510.36 ha) was classified at class IV of erosion category with high sedimentation, respectively. Basin erosion and sediment was calculated as 71169.5 ton/yr and 29260.42 ton/yr by EPM model, respectively.

Results:



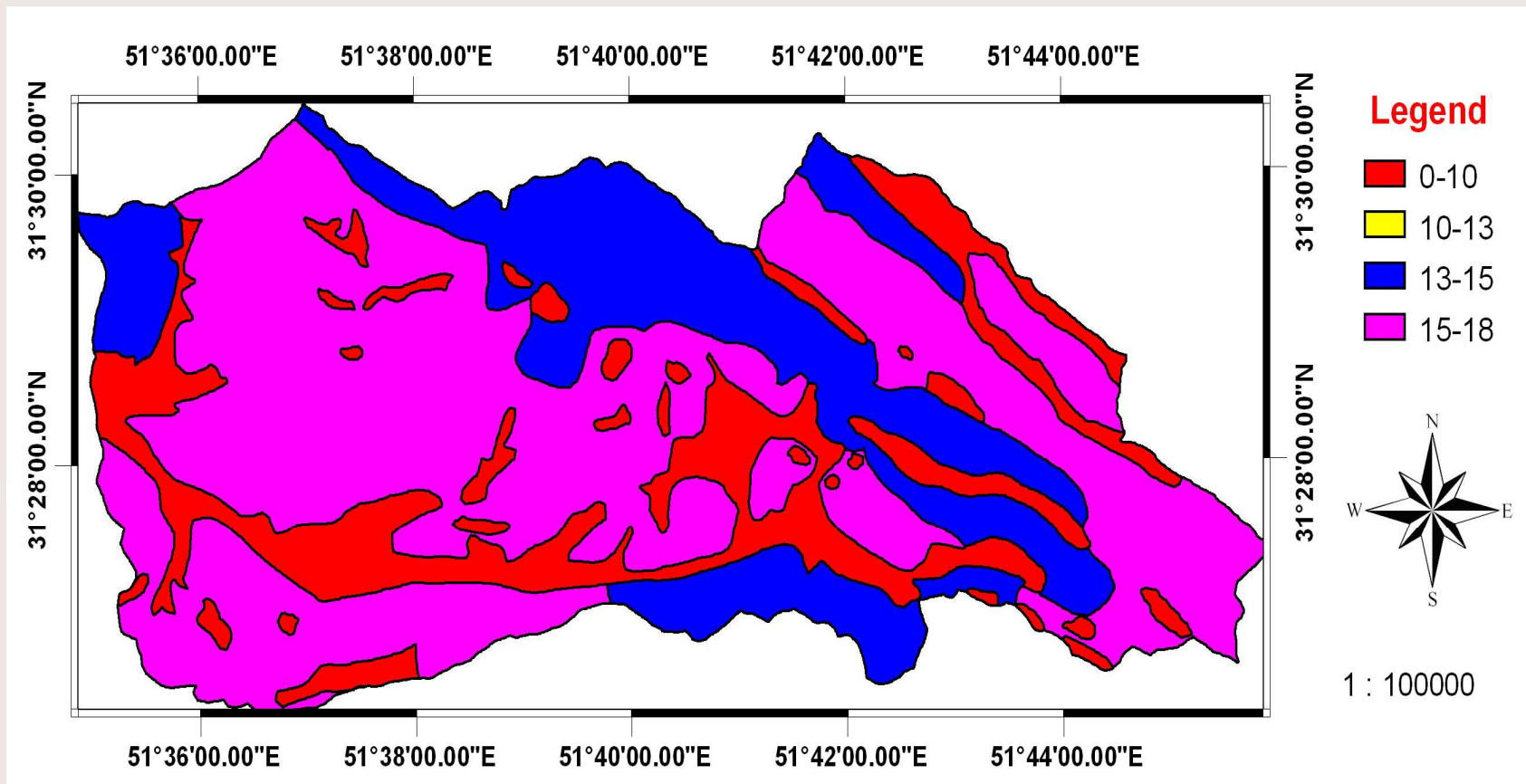
**Figure 2. The geology map of Ghareh Aghach watershed
Based on erosion sensitivity**

Results:



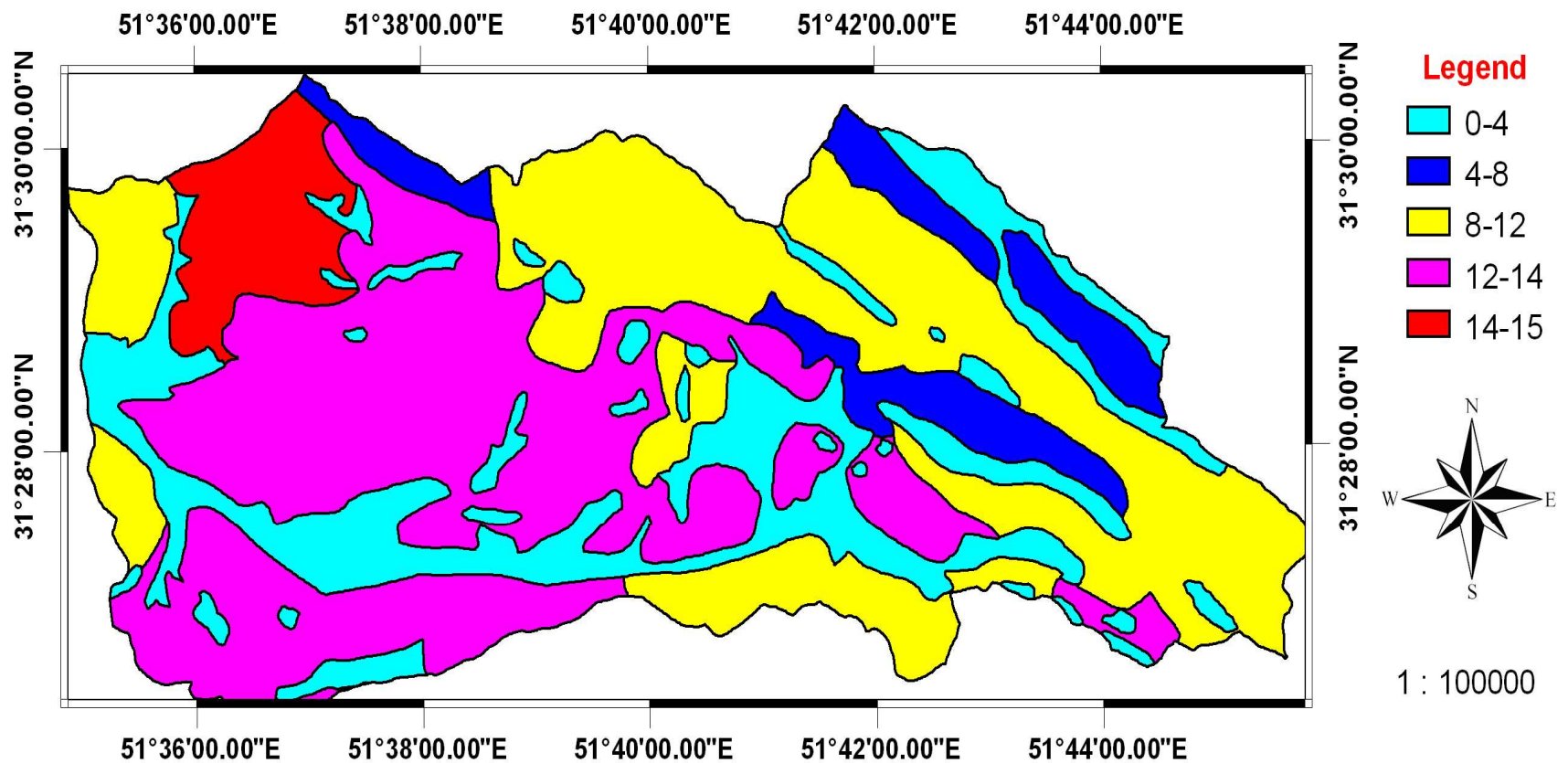
**Figure 3. The soil map of Ghareh Aghach watershed
Based on erosion sensitivity**

Results:



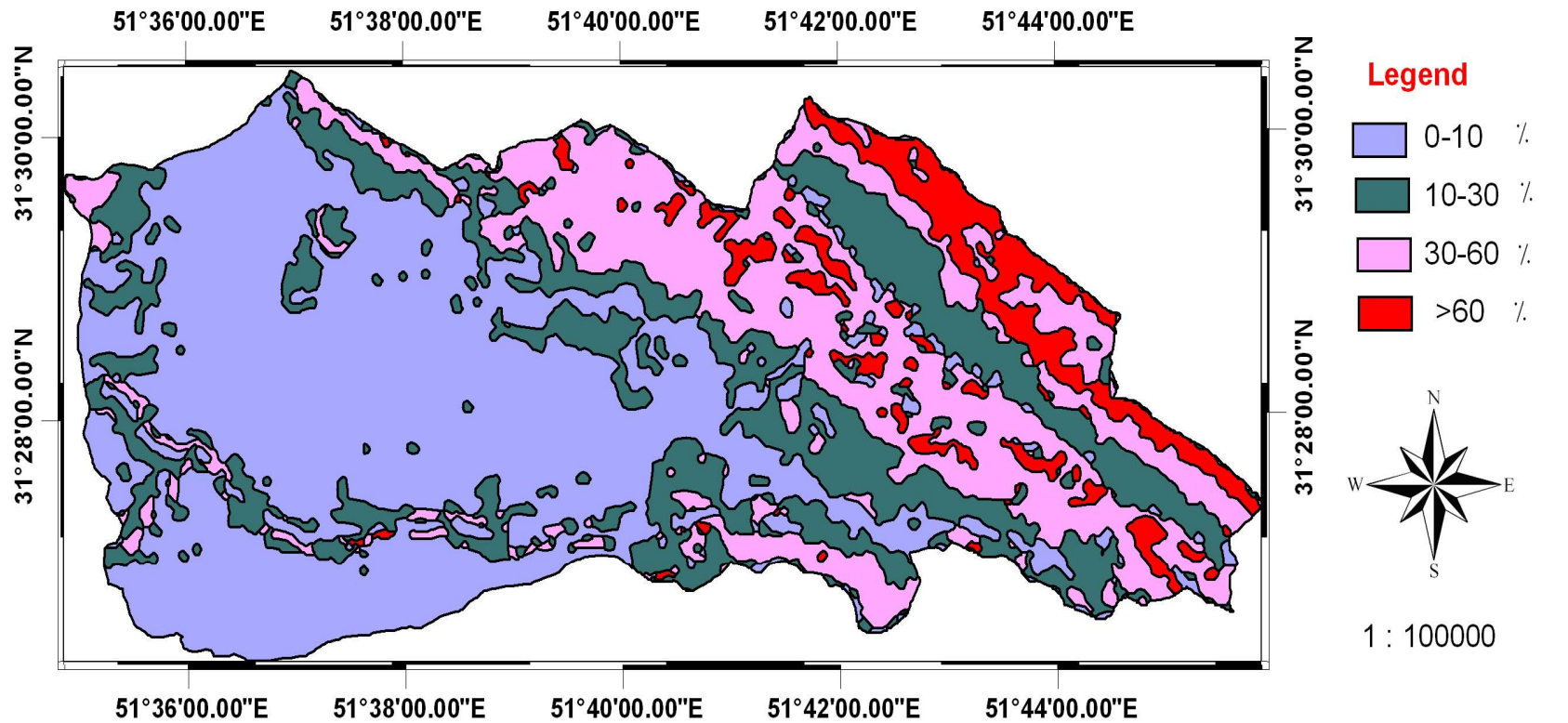
**Figure 4. The Land use map of Ghareh Aghach watershed
Based on erosion sensitivity**

Results:



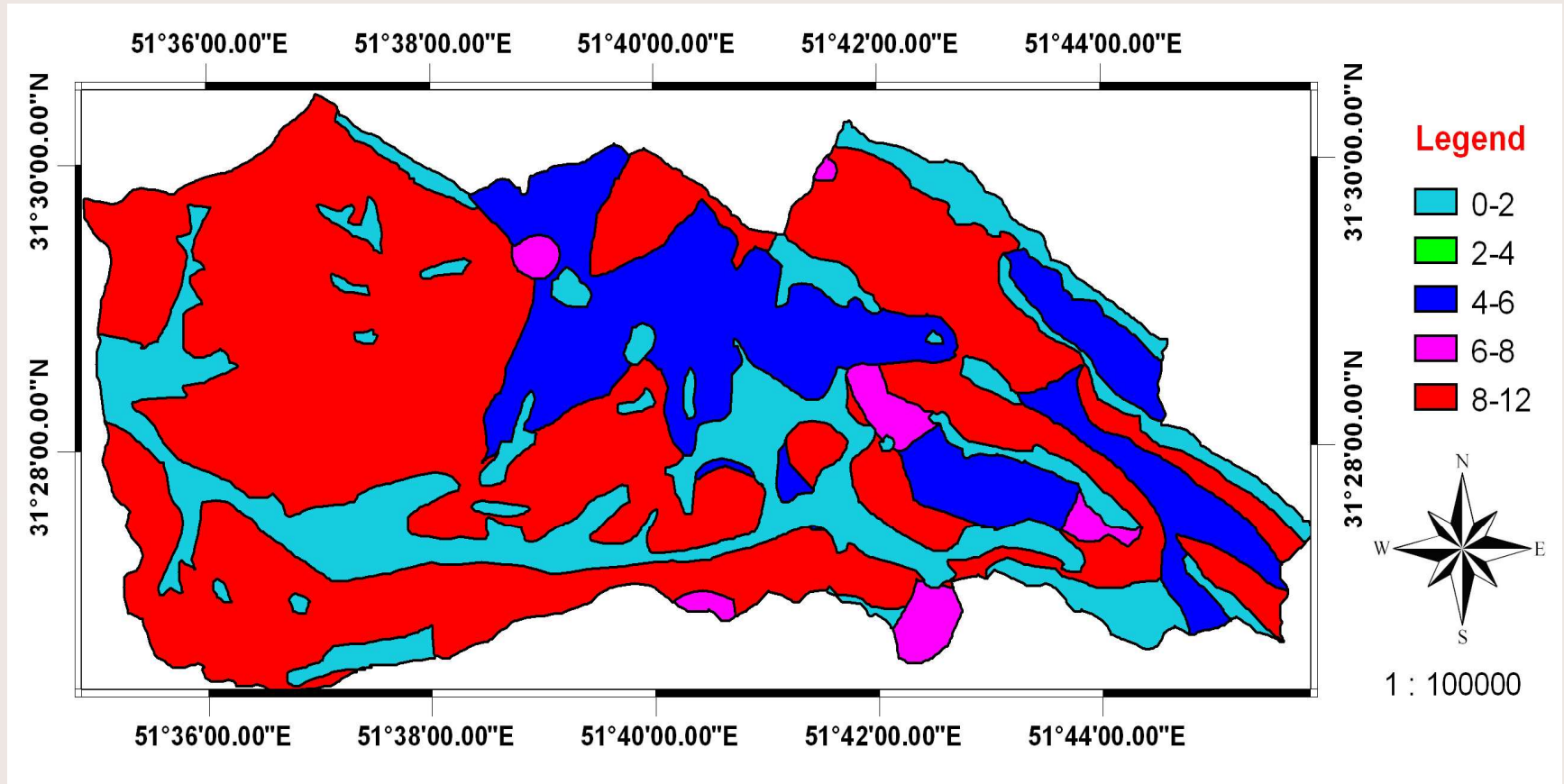
**Figure 5. The vegetation cover map of Ghareh Aghach watershed
Based on erosion sensitivity**

Results:



**Figure 6. The slope map of Ghareh Aghach watershed
Based on erosion sensitivity**

Results:



**Figure 7. The surface erosion map of Ghareh Aghach watershed
Based on erosion sensitivity**

Results:

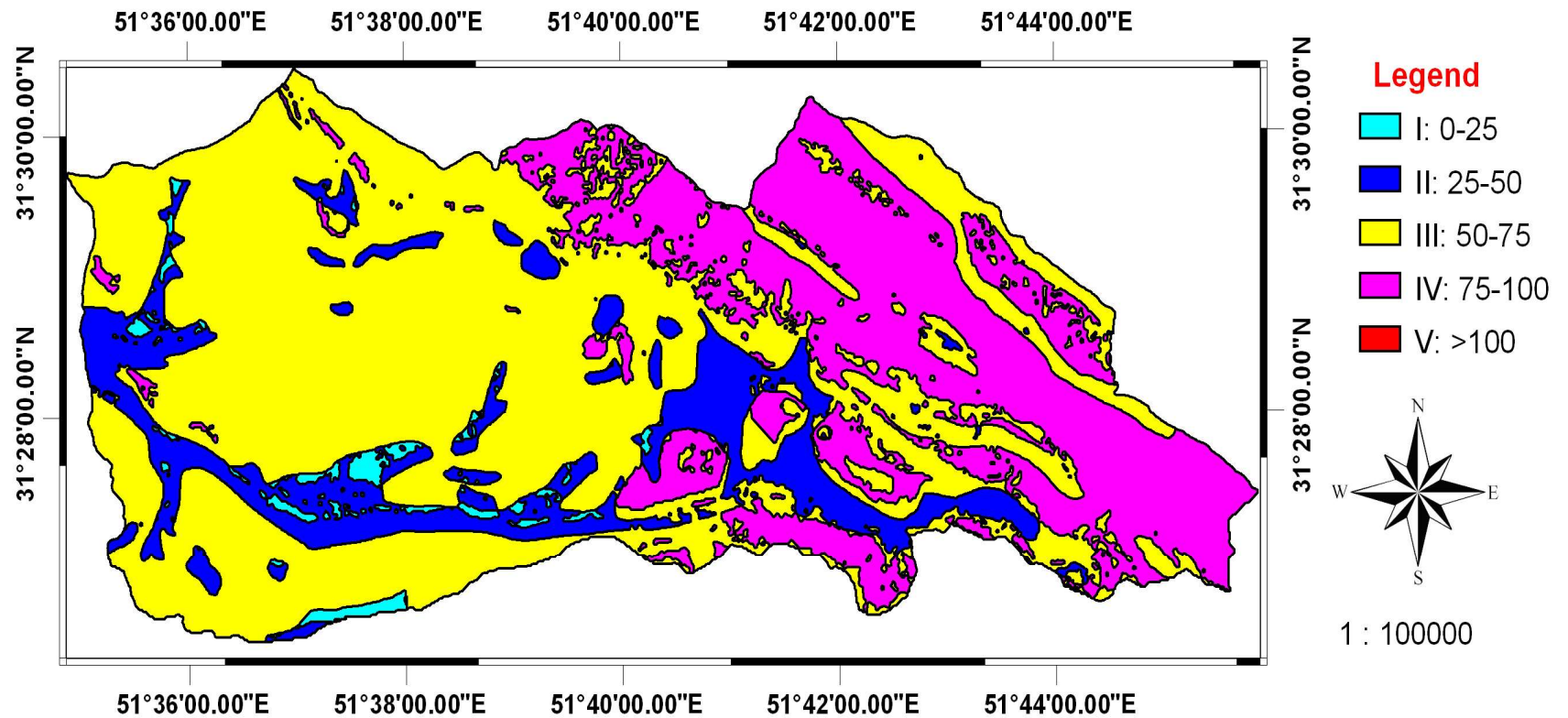


Fig 8. The sediment production map (R) of Ghareh Aghach watershed based on erosion sensitivity

Results:

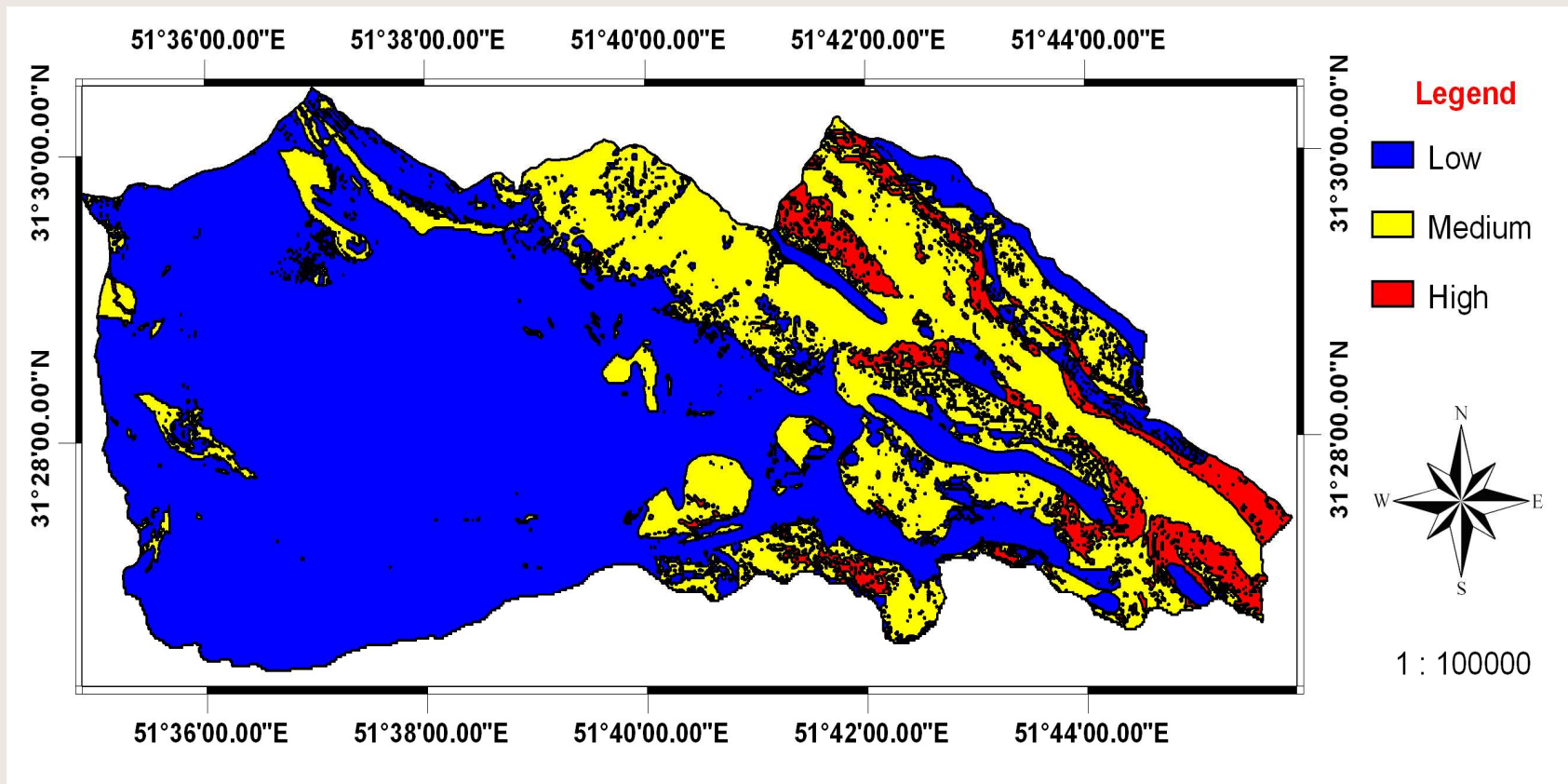
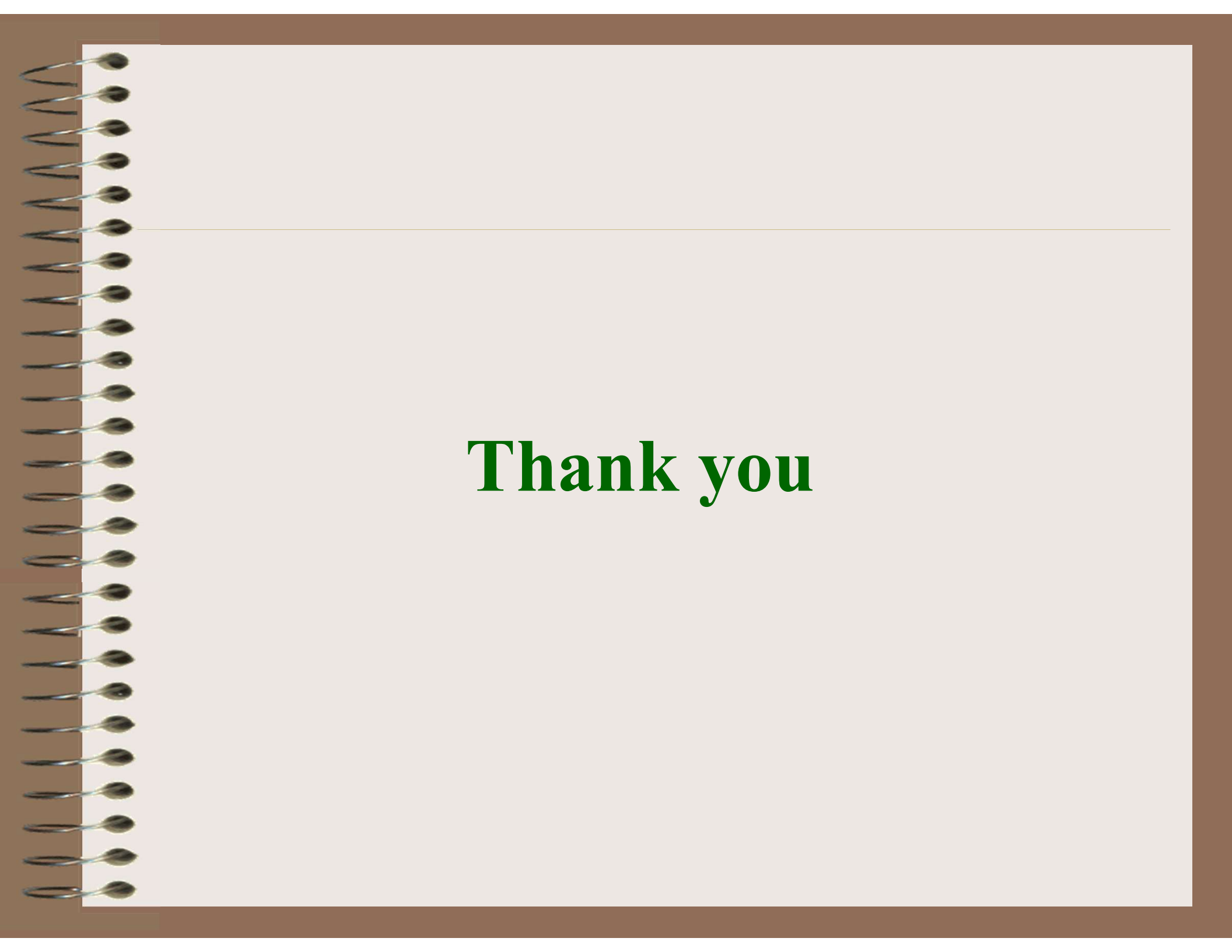


Figure 9. The sediment yield (Qs) map of Ghareh Aghach Watershed based on erosion sensitivity

Discussion:

A GIS can provide better information and easier integration of various information layers to support model of soil erosion assessment. It was found that GIS to be a useful technique to provide greater flexibility and accuracy for soil erosion assessment.

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Thank you