MODELING OF THE SPECIFIC SEDIMENTATION AND EROSION RATE IN SEMIROM WATERSHED USING EPM MODEL AND GEOGRAPHY INFORMATION SYSTEM (GIS)

Milad.Bahramian [*]

S.Hamid.Ghaemmaghami [**]

Abstract

Soil erosion in watershed of dams in country causes sediment accumulation inside the lake of dams and it will result in early entropy of these important economic sources. This study aims to closely analyze the situation of erosion and sedimentation and their reasons in Smirom watershed hydrological unit via EPM model in order to be used in preparation of soil conservation patterns and watershed management. Most of the stones in this place were schist and it was around Zagros. There are many layers in EPM model and the map of erosion rate and sedimentation must be prepared, by them so it is necessary to overlap these layers together. Mapping was accomplished by GIS software. After perpering of raster from vector maps , watershederosion coefficient (Ø), land use coefficient (Xa), soil and stone sensitive coefficient to erosion (Y), gradient map and at last rate of soil erosion map (Z), were obtained . This map represents the value of EPM model distributively. From this map, Wsp map is prepared that shows us specific erosion based on cubic meter in year. Regarding the results, the most specific sediment is in the west part of watershed and the least is in the north and east. The reason is lithological changes and steep slope in west part of watershed.

Key words; soil erosion, EPM model, rate of soil erosion, Wsp.

[*] M.Sc. of RS and GIS, Civil Engineering college, GIS&RS Department, Yazd Branch, Islamic Azad University, Hesabi Blv, Safaeie, Yazd, Iran.

[**] M.Sc. of Agronomy, agriculture Engineering college, Agronomy Department, Isfahan Branch, Isfahan University of Technology.

Introduction

Food is necessary for human to survive which is provided by water and soil sources. A factor which hazards the water and soil sources is erosion (Refahi, h2006). Although erosion and its bad effects are not probably considerable , they will beconsidered during a long time because erosion usually causes loss in crop . In sedimentary basin especially upon the levels of producing and carrying of sediments and data to be studied , we need a tool to accelerate the executive stages of models easily , precisely and quickly. To do so , the variety of models are used such as Pacific Southwest Inter Agency Committee (PSIAC) , Universal Soil Loss Equation (USIE) , Water Erosion Prediction Project (WEPP) and Erosion Potential Method (EPM). Geography Information System (GIS) Technology is used to do such studies with less costs and highest precision andrate due to its high capacity for work on geographical data. In fact , considering such an aim , it will be accomplished all the stages of utilizing the models by GIS (Tangestni 2006, Solaimani et all 2009 , Bayat et all 2000) . The study aims to identify precisely erosion states and sediment production in watershed in order to be used in preparation of soil conversation patterns and watershed management . The objective in the project is to determine erosion and sedimentation levels in Semirom subbasin and the effective factors on them .

Material and Method

Studed area

Semirom has 9 big and major subbasins. Semirom central part called basin is located $51^0 30'$, $21^0 42'$ longitude and $31^0 21'$, $31^0 27'$ latitude . The area is 1000 Hectares with average height on 2597.28m. The basin is extended to Behrooz maintain chains in North , Bastegan maintain in south , chanbareh & kateh Gabry mountains in west and shah Jafar mountain in east .It is located on thrust Zagros tectonic zone andSanandaj-Sirjan . The stones in basin are sedimentary and most are related to both shale and marl (Kshgu) Dolomite and lime (Edlsh). Shale and marl units are extended to south basin introduced as Gurpy formation equivalent. It includes about 25%of basin area . Dolomite and lime units are reached to west basin including dolomite and white marl lime stones introduced as Shahbazan formation equivalent in Eocen age. It includes about 13/5% of basin area.

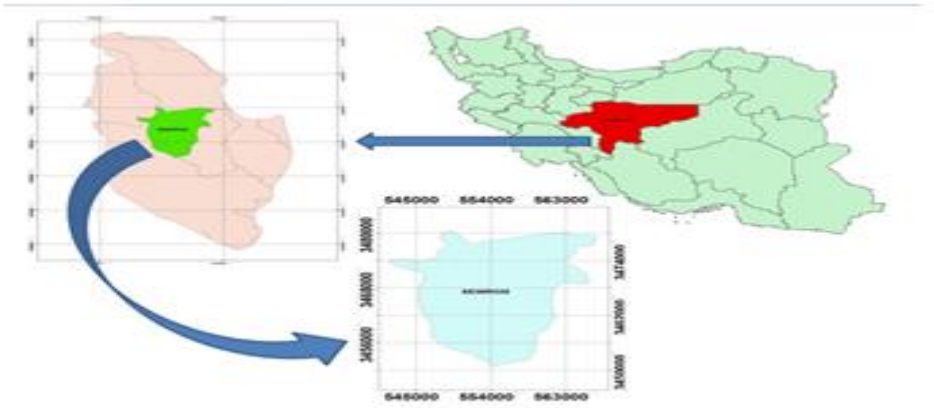

Figure 1:Studed basin situation in Semirom

Study Method

In order to study sedimentological position and erodibility of stone units in a sedimentary basin , It is necessary to be got a total vision of geologic position in the area using geological maps and satellite photos, then, to be sampled from exciting subbasin and branches of original channels. It is determined the sedimentation rate in each subbasin by EPM and basin sedimentation level by annual sediment budget method. EPM is obtained via erosive lands information and sediment measurements during 40 years studies in Yoguslavi . It is introduced the first in international river regime conference held by Gavrilwich (Refahi 2003)

There are four factors in the method including basin erosion coefficient (φ) , land use coefficient (Xa) soil and stone sensitive coefficient to erosion (Y) drainage basin average slop (I) investigated on different land units . These factors help to calculate erosion rate and to prepare erosion maps . Also , erosion rate coefficient and Z value will be calculated by these four factors.

$$Z = Y.Xa(\phi + 1)^{0.5}$$

Calculating the erosion level will be as :

$$WSP = T.H.\pi .Z^{1.5}$$

The required information in the research is Semirom topography map , Semirom geological map , land use map and erosion sensitive map obtained from watershed studies on drainage basin. The large numbers of layers in EPM model should be overlapped to prepare erosion rate map and sedimentation content. Adapting of basin boundary with different layers , polygoning of given layers , giving the proper coefficients to each polygon and changing the polygon layers to raster were done by GIS software. The calculated coefficients are showed in tables below

Table 1: Soil and stone sensitive coefficient to erosion (Y)

row	Pedology and petrology conditions	Score
1	Sand , stone , granule , schist	2
2	Fractured limestone and marl	1.6
3	Serpentin red standstone and sediments	2
4	Podzol , parapodzol , crushed schist , micaschist , gneiss , argillite schist	1.1
5	Hard limestone , litter , humans and silicate soil	1
6	Brown forest and mountain soil	0.8
7	Bog soil and black or dark grey hydromorphic soil	0.6
8	Chernozem And placer deposit with good texture	0.5
9	Hard igneous rocks	0.25

Table 2 . land coefficient values (Xa)

row	Land use conditions	Score
1	Waste lands and badlands	1
2	Ploughed rough broken land for farming	0.9
3	Fruit gardens , vegetarian covered vineries	0.8
4	Ploughed farmlands on contour lines	0.7
5	Eroded and ruined forests and brushes on eroded soils	0.6
6	Dry mountain pastures	0.5
7	Permanent farms and grasslands	0.4
8	Grass-covered drained pastures	0.3
9	Good forest on steep slopes	0.2
10	Good forests on mild slops	0.1

Table 3 .Erosion coefficient values in area (φ)

row	Watershed basin erosion conditions	Score
1	Region with a lot of gullies and severs erosion	1
2	The region with 80% rill and gully erosion	0.9
3	The region with 50% rill and gully erosion	0.8
4	The region with surface erosion , sediments and debris with low gully and rill erosion and karstic erosion	0.7
5	The total region with surface erosion without deep erosion traces (gullies , rills and debris)	0.6
6	The region with 50% surface erosion and the rest without erosion	0.5
7	The region with 20% surface erosion without erosion	0.4
8	Ground surface was without visible erosion but in rivers benches was observed slip and debris	0.3
9	Ground surface was without visible erosion with often farming coverage	0.2
10	Ground surface was without visible erosion with permanent vegetarian forest covers	0.1

Then, to prepare slope map, after digitizing adjustment curves of topography map and interpolating the maps in GIS medium, digitizing elevation model (DEM) is obtained. According to definition of slope (height to interval changes) the slope map was obtained by giving related formula to digitizing model and the layer became suitable for calculating EPM through transforming values with hundredth form. The resulted maps are below:

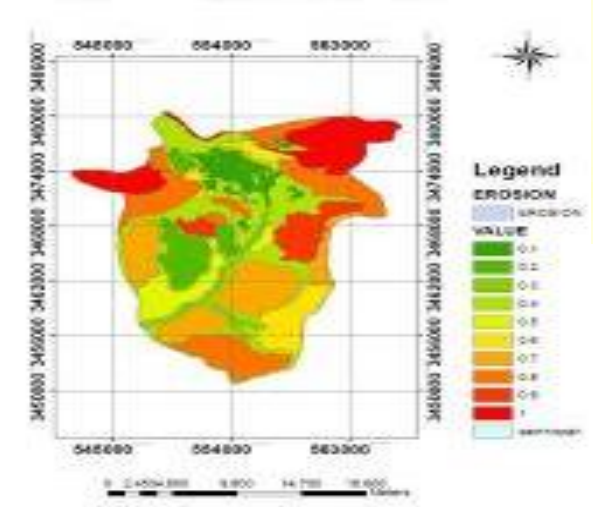

Figure2: Erosion coefficient map in Semirom basin

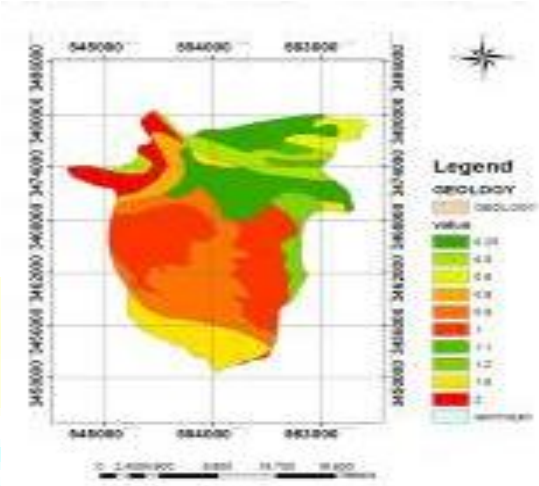

Figure 3: Basin soil and stone sensitive coefficient to erosion

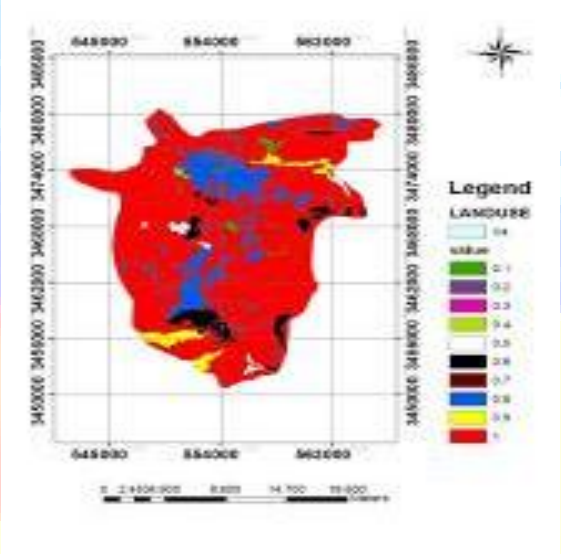

Figure 4: Land use coefficient map in Semirom basin

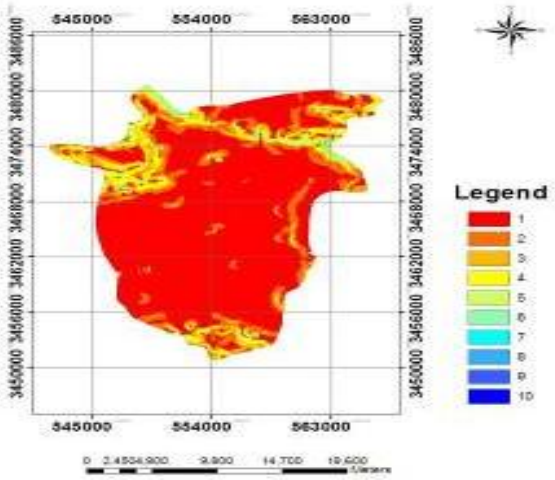

Figure 5: Slope coefficient map in Semirom basin

In GIS software medium , Z value representing erosion rate in basin is obtained using the formula below :

$$Z=Z = Y.Xa(\phi +1)^{0.5}$$

The resulted map is one which represents EPM model value distributively. Therefore, numerical Z value is classified in GIS medium on the table below and final map of erosion rate is obtained based on very low and very high erosion rate according to figure 6.

Table 4: Classifying erosion rate in basin

Average Z values	Limit values	Erosion rate	Erosion classifying
1.25	Z>1	Very high	I
0.85	1>Z>0.71	high	II
0.55	0.7>Z>0.41	average	III
0.3	0.4>Z>0.2	low	IV
0.1	0.19>Z	Very low	V

Preparing the final map of soil erosion rate in basin , the following formula is used to estimate annual sediment average in GIS medium .

$$WSP = T.H.\pi .Z^{1.5}$$

Where P is annual rainfall average in watershed basin on the basis of millimeter , H is annual rainfallmean (mm) , π is 3/14 and Wsp is annual specific erosion mean (m/lm/yr). T is temperature coefficient calculated upon equation below:

$$T=((t/10)+0.1)^{0.5}$$

Where , t is annual temperature average on the basis of centigrade . Finally , It is prepared the Wsp map, representing specific erosion rate on the basis of square meter in year (figure 7)

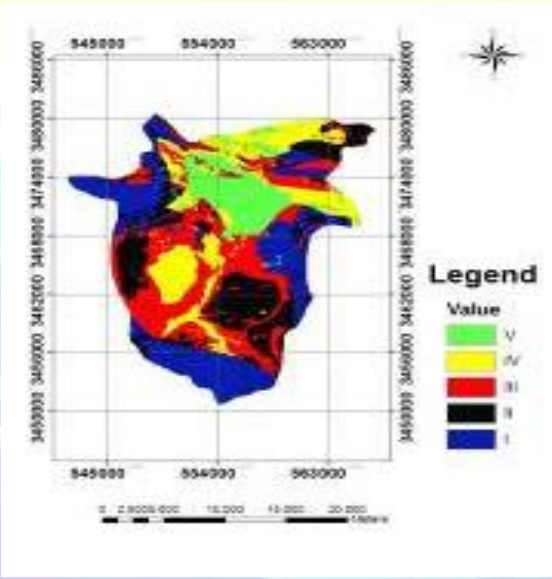

Figure 6: Basin erosion rate map

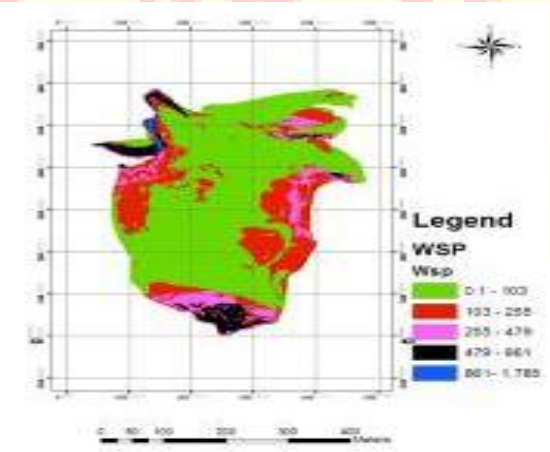

Figure 7: Basin specific erosion rate map

Conclusion

According to obtained maps of executive models , the results show that the more erosion level in western and southern area of watershed basin is researchable and is effective on basin hydrologic studies because carried sediment content in channels is determined and it is important to make a dam in southern area . Also , it is calculable by the model. However , intensive erosion areas are determined by the model . To reduce the erosion level in the area , biological and mechanical protection measurement are applied. The major reason of such erosion level in these areas is steepslope of lands and magnitudes and land material . Land material is with highersolubility and susceptible of erosion .

Identifying the eroded areas , it is determined the mineral materials of surface soil are removed , growing the plants is low and the land use is weak . So , to improve the agricultural products performance , Biologic and chemical nutrition is strongly required.

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