Evaluating the erosion danger and sedimentation potential in Fasa Forest watershed using GIS techniques and EPM model

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Abstract: Fasa forest watershed is located in 90 km of Shiraz - Fasa road in northwest Fasa. Sovereignty of mountainous temperate climate with an average annual rainfall of 296.25 mm, the relatively high gradient slopes, topography of the region and climate have led to the erosion traces, however low, in the watershed. In addition to the mentioned natural factors, the effects of human activities in the form of land use change in the studied watershed, have played a determinant role in the process of erosion generation. This study was aimed at determining the sedimentation status in Fasa Forest watershed associated with the factors involved in sediment production. To this aim, ARC GIS software, satellite images, GPS, hydrometric and meteorological station data, topographic and geological maps, and preliminary, field and complementary studies in the implementation of EPM model were used. Investigating the results show that surface and rill erosion was common in the region and other forms of erosion was rarely observed. The value of total special erosion and sedimentation were 915.96 and 1380.36 cubic meters per square kilometer per year, which represents the average status of the area in terms of erosion production and sedimentation intensity. In general it can be said that the production of the pasture was good and is making progress and in planning to fight soil erosion, the main focus should be on managing the preservation and restoration and proper utilization of grazed vegetation and enclosure corrective actions that are in progress now and no additional corrective action is needed.

Keywords: Forest watershed, climate, geological sensitivity, land use change, enclosure

Introduction

Water and soil are considered the most important natural resources of each country and play a basic role in the economic development and progress of the societies. The soil erosion and consequently sediment production threaten these valuable resources. Geomorphology of the Earth is changing over time and erosion is one of the most important phenomena affecting the Earth's surface morphology changes (10- 18). Soil erosion refers to a process in which the soil particles are separated from their original context and are transported to another place with the help of various factors such as water, wind, gravity, refrigerator and humans (5-23). Erosion and its consequences, with the intensification of human exploitation from the nature since the early twentieth century, have had negative effects on the critical ecosystem. Negative impacts of human involvement or erosion, not only occur in the form of a decrease in productivity and destruction of soil physical and chemical properties in its place, agricultural lands and watersheds, but also are evident more than before in the form of accumulation on the good quality agricultural lands, pastures, water supply and irrigation canals as well as pollution by heavy metals, sediments and associated chemicals on the outside of its place (22). Reviewed scientific articles indicate that about 58 percent of land degradation in the world is due to soil erosion, most of which has occurred since Second World War and reduced the production up to 17% and caused environmental damage (8). The total amount of soil erosion in the world is estimated 26 billion tons of which Iran's share is about 2 billion tons

(15). Therefore, prevention from this phenomenon is considered as one of the most important factors in protecting the natural resources (22). Over the past two decades numerous empirical models have been used to study soil erosion. These models are a tool to estimate sedimentation in watersheds. Recently, many researchers around the world estimate erosion and sedimentation quantitatively, utilizing remote sensing techniques and geographical information system GIS using these models (10- 18). Using these methods and models it is possible to prepare soil erosion map. Generalized soil erosion models can be used to study erosion processes related to earth transformation of land and how to use the earth in many parts of the world and preparing the soil erosion risk map to identify areas of high erosion wherein some plans are proposed for protection of soil and water resources (8).

Many models for estimating the soil erosion and developing the soil erosion management plans are proposed, universal soil loss equation[1], Wishshmayer and Smith (1978), Water Erosion Prediction Project[2], Flengan and Niring (1995), soil and water assessment tool[3], Arnold et al. (1998) and the European soil erosion model[4], Morgan et al. (1998) and erosion potential method[5] can be mentioned as the most important models (6). Of these, EPM is a simple model which can provide the initial estimate of the amount of stream sediment in projects related to under construction dams and other structures that require such data (16). Factors affecting the erosion such as topography status, lithology and soil, and methods of land use and watershed climatic factors are used in the model (4).

Fanty and Vezuly (2007) used the empirical numerical relations and EPM model to calculate the potential for sediment to delta Berjiya and Giorgio in Italy. The results showed accuracy and superiority of EPM model to empirical numerical relations in the studied areas. Taziuly (2009) used EPM model to estimate the sediment in a watershed. The results indicated that the model was suitable for the studied area. Salajegheh and Delfari (1386), comparing the qualitative geomorphology and quantitative EPM methods, found that Geomorphology method gives better results due to considering more factors involved in erosion, compared to EPM in Khusban sub-basin in Taleghan basin (20). Rangzan et. al’s study (1387) using EPM and MPSIAC models with field observations suggested that although the results of the two mentioned models are compatible in most regions, but the results of EPM model are not as reliable as MPSIAC model in identifying the areas with high erosion (16). Bagherzadeh and Mansuri daneshvar (1390) investigated the amount of sediment using EPM and PSIAC models and GIS techniques in semi-arid areas (7). Mohseni et al (1390) evaluated the accuracy and efficiency of EPM, MPSIAC, geomorphology and hydrophysical models to estimate the erosion and sediment and presented geomorphology model as the most appropriate one with relative difference 36/3 percent (25/711 tons per year).

Abedini et. al (1392) implemented EPM model in Meshkin chai watershed and concluded that topography, lithology and land use changes have played an important role in erosion and sediment control, based on the model, erosion status of the watershed was estimated as very serious (1). According to Pirmohammadi (1387), for the implementation of water resources and soil protection measures it is necessary to identify the effects of various erosive factors and sediment production process and obtain some information on erosion, sediment production intensity and spatial distribution (14).

Given the conservation of natural resources such as soil against threats such as erosion as well as maintenance and improvement of natural vegetation in the country, in this study Fasa Forest watershed, as one the important touristy areas in the city, was studied with the aim of investigating

[1] Universal Soil Loss Equation (USLE)
[2] Water Erosion Prediction Project (WEPP)
[3] Soil and Water Assessment Tool (SWAT)
[4] European Soil Erosion Model (EUROSEM)
[5] Erosion Potential Method (EPM)

the total special erosion and sediment in the area with the help of EPM erosive model utilizing GIS geographic information system.

Martial mad Methods

Introducing the studied area

In terms of administrative divisions, Fasa Forest watershed is located in Fars Province, Fasa city, Fasa Forest district (Figure 1). This area, 1969/842 hectare in breadth, is located between "50 '24 ° 53 longitude to north" 30' 21 ° 53 and "59 '12 ° 29 latitude to east" 59' 10 ° 29. The area is located has an area of 1974.8629 hectares and is located at an average elevation of 2270 meters above sea level. The range of the studied area is within Zagros folded-pushed zone (13). In the watershed, there is a set of Aghajari and Bakhtiari stratigraphic units, Quaternary deposits (QC1, QC2, Qg, etc.) and Jahrom ASMARI unit. The area Lithologic units are highly diverse and each one is subjected erosion differently. (21). The released sources show that only study literature in the field in Fasa Forest watershed is related to Fasa academic research project.

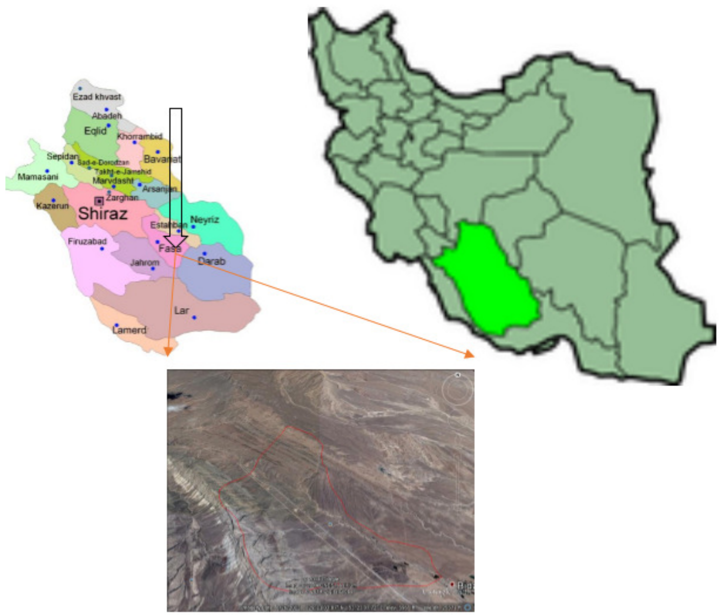


Fig1: location of the study area

Methodology

The study consisted of three phases: preliminary, field and complementary, and in each phase such factors as collecting general information on the area geology, soil, vegetation, topography, satellite images, precipitation statistics, watershed temperature, a preliminary guide for land components and units, preparation of a soil sample list from the area and the needed laboratory analyses, determining the capability and talent of each land unit and components to obtain special watershed erosion are investigated. Also, through several the field observations, some types of erosion were identified in the watershed surface and located using GPS to be compared with the results of mentioned model.

Nazarabad Topographic Map 1: 25,000 and Fasa Forest watershed geological map 1: 25000 were used as the study instruments to understand the area erosive status and obtain information on the sensitivity of formations to erosion, land use map 1: 25000 of the study area, and information on meteorological, hydrometric and evaporation stations.

After collecting the maps and information, and doing the required field works, in order to implement EPM model, in the first stage, the coefficients of the model were determined and and their map prepared using ArcGIS software.

Then, the coefficients map was placed in the equation related to erosion intensity and consequently, erosion intensity map was prepared and classified qualitatively. After that, the average special erosion, total sediment and special sediment discharge were calculated using ArcGIS software and erosion intensity map of Fasa Forest watershed.

Examining the erosion and sedimentation status in Fasa Forest watershed

Topography status

Topography is the only factor which is considered separately and its related factors such as slope and direction play y play an important role in soil erosion and eventually sediment production (1-17). Slope is obtained from the analysis of topographic maps. Slope factor causes increased gravity and erosivity power, so it affects Morphodynamic issues in the watershed, morphogenesis, and evolution and diversity of various forms of erosion (2). The average slope in the area is 8311/20 percent. Slope map in Arcmap was drawn with the help of height maps (Dem). Then, slope maps were classified in 11 groups according to the existing working units. As is seen in figure 2, slope 70% is located in highlands in the southern part of the watershed and due to weak vegetation, lack of soil (rock covers) and sensitivity of the formations to erosion, the slope plays a more serious role than the erosivity against the other units.

After topographic study of the mentioned watershed and investigation of slope map, each of the classes was given a weighted score. In addition, slope and DEM layers were converted to Raster format so it they can be combined with other layers for further analysis.

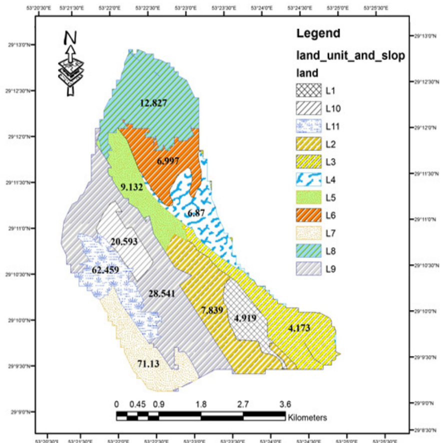
Table 1. Needed information for EPM

$\overline{H}$ km	H0 km	P km	L km	H mm	T degree centigrade	T degree centigrade
2.27	1.672	20.60709	8.75	296.25	1.41	18.9

Watershed climate

Weather factor is one of the factors that human can be less involved in it. Precipitation and temperature are considered as influencing factors on erosion phenomenon. Each of the factors acts differently in different parts of the watershed. Intense rainfall is one of erosion factors so that erosion is intensified after steep and showery rainfalls, however, a regular and mild rainfall wets the soil and in this way prevents from erosion.

An increase or decrease in the amount of rainfall and temperature for an increase or decrease in a certain amount of height (e.g 100 meters or one kilometer) is called rainfall and temperature gradient (1- 12). In order to evaluate the temperature and precipitation status in Fasa Forest watershed, the nearest rain, synoptic and evaporation stations to Fasa Forest watershed were selected and the average precipitation and temperature in each station were used. Based on the extracted information, the average rainfall and temperature were 296.25 mm 18.9 ° C respectively. In general, the watershed has a temperate mountainous climate.



FID	Shape *	ID	land	ave_slope_	area_m2	area_he
0	Polygon	1	L1	4.919	835657.85	83.566
1	Polygon	2	L2	7.839	2196012.7	219.601
2	Polygon	3	L3	4.173	2064584.6	206.458
3	Polygon	4	L4	6.87	1371294.8	137.129
4	Polygon	5	L5	9.132	1301937.5	130.194
5	Polygon	6	L6	6.997	1408665.7	140.867
6	Polygon	7	L7	71.13	1470287.3	147.029
7	Polygon	8	L8	12.827	2739515.1	273.952
8	Polygon	9	L9	28.541	4139270.4	413.927
9	Polygon	10	L10	20.593	788082.95	78.808

Figure 2. average slope map of the land

Rock and soil sensitivity to erosion

The sensitivity of rock and soil, that is, surface geology and type of the earth layers, the sensitivity of its constituents, fineness and coarseness, physical and chemical status of soils, influence increase or decrease in erosivity. Since e different types of rocks forming the Earth's surface show different reactions in contact with different climatic conditions (1), according to the soil studies in Fasa Forest, the area has nine physiographic units with such features as follows:

1. Mountain

It is a unit with intense physiography, it consists of high-altitude lands, and to separate it from other units the height difference between the maximum and minimum slope is used so that its height difference is usually between (500 and 1,500) meters and slope percentage is more than 25% (mostly over 40%).

In the studied area, this land types, based on the features of profile evolution, slope, presence of rocky outcrops and geologic formations type, is divided into two land units as follows:

Unit 1.2:

This unit is a low rocky outcrop ant its slope is lower than (25-40%), it has Malik characteristic horizon with profile evolution, sometimes its underlying horizon is argillic and it is appropriate for range management.

Its constituent geological formations include Jahrom-Asmari PM_{ja-} as formation. According to geological specifications, geomorphological facies is regular (3-12). The lands are used in the area as a protective barrier plan.

Unit 1.5:

Sometimes forested mountains may have a Malik horizon. Its constituent geological formations include Jahrom-Asmari $PM_{ja-\text{ as formation}}$ (3-12). The lands are appropriate for range management.

2. Hill

This physiographic unit, compared with mountain, has a lower height difference, slope and rocky outcrop. Usually its maximum and minimum height difference is between 50-500 meters, and general slope and maximum general slope are 8-25% and 25-40% respectively. The soil in the lands unit may be the soils with high or no evolution. This land types in the studied area are divided into a number of lands unit as follows:

Unit 2.1.1:

These are high –altitude hills with high rock outcrops and slope, and they have a relatively good soil. . Its constituent geological formations include Jahrom-Asmari $PM_{ja-\text{ as formation}}$ characterized by coarse fragments of rocks to pieces of fine grained (silt and clay) and (Q^{esc}) formation, characterized by deposits with multi-origin construction and poor consolidation, pieces of gravel to clay size and Q^{c_1} formation, characterized by conglomerate sediments of medium to coarse pieces with a good roundness (3-12). These are appropriate for range management plans.

Unit 2.1.2:

These are high altitude hills with high rocky outcrops and slope, with a relatively good soil which is are appropriate for management plans. This land unit is located in the north of the studied area and its constituent geological formations include Bakhtiary formation (PLQb) formations characterized by conglomerate layers. The formation consists of limestone parts of the old formations (Sarvak, Tarbur, Asmari, Jahrom, Sachun and Razek). The other formation is Aghajary formation (MPLa).

Unit 205:

They are forested hills, the soils of which are evolutionary Malik surface horizon. Their constituent geological formations include (Q^{E}) and (Q^{ESC}) formations and their geomorphologic faces is regular in terms of geological characteristics (3-12).

3. Range plain

They are the beginning of irrigated agriculture, they have flat lands and fine-grained sediments the origin of which are seasonal and temporary rivers or sometimes debris. Their surface gravel is less than 15%, soil drainage is good and suitable for plant growth. The height difference is less than 5 meter, and general and lateral slope is 5-8%. Due to their geological specifications, they are of agricultural use and their constituent geological formations include Q^{ESC} , Q^{E} , Q^{c_1} and $MPLa$ (3-12).

4. Intermediate plain

Sometimes there are deposits in the region which have range and river origins and separating them from each other is difficult. In such cases they are classified as intermediate plains and they are written as 4/5. Their constituent geological formations in the studied area include Q^{ESC} and Q^{E} (3-12).

5. Course fan-shaped alluvium

The unit is formed from accumulation of sediments brought by the streams. That is, more coarse ones are at the top and fine-grained ones at the base, thus the base is more appropriate for farming since it is more fine-grained. Its height is less than 5 meter and it has a general and lateral slope of 5%. Also, because the sediments are transported in a long path, they are not angled any more. Its constituent geological formations in the studied area include Q^{c_1} (3-12).

6. Miscellaneous lands

Miscellaneous lands are those which cannot be classified in Muhler's nine physiographic groups, so they are called miscellaneous lands and they are marked with special signs by type.There was a rocky and gravel-covered river bed in the studied area which is marked by RW sign. Its constituent geological formations includeQ^{c_2}, Q^{SCE}, Q^{ap} and Q^{ESC} (3-12).

Current status of erosion

Evaluation of this parameter depends on many factors. To this aim, distribution of erosion types in the watershed is studied. Despite the presence of a series of tables, the effectiveness and role of erosion are determined in the form of given scores. For example, if more than 50% of the area is under the influence of furrow and gully erosion, with the greatest effect on sedimentation, and the soil has a good a vegetation, and no erosion is observed, there will be the least effect on sedimentation. The factor is caused by wrong human interventions and uses.

In preparing the current map of erosion status (Fig. 4) with the help of field and laboratory studies, types of stream and furrow erosion and other erosion types, although rarely, were detected with the help of field and laboratory studies. To complement the data, broader field visits were taken. Figure 3 shows an example of gully erosion type which has influenced a large area of lands which are destroyed over time under the effect of continued land washing performance of the erosion type.

Figure 3. An example of gully erosion in Fasa forest watershed

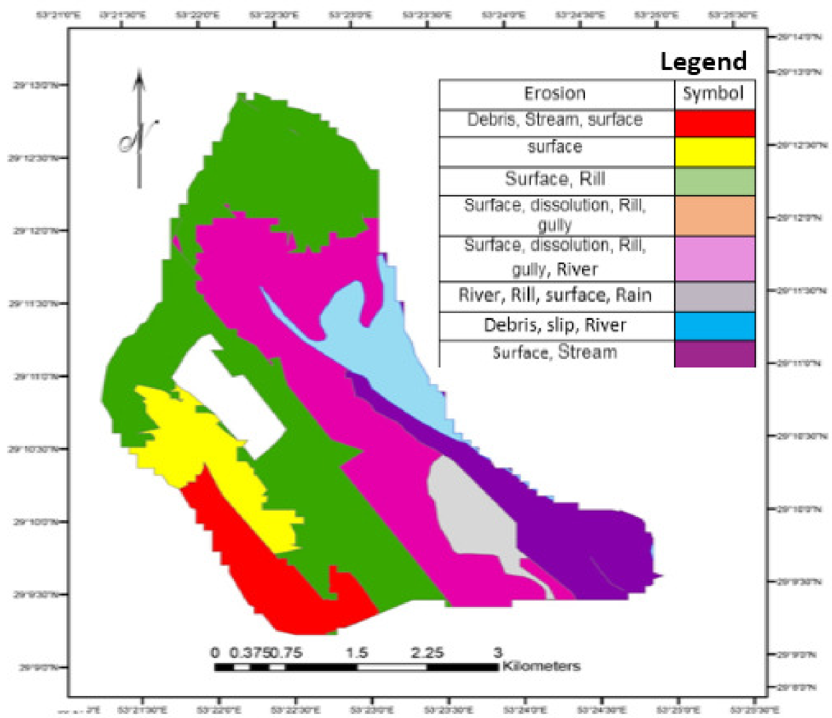


Figure 4. The current state of erosion map

How to use land

This factor is evaluated in Fasa forest watershed under two heading: agricultural activities and range management plans. The studied watershed is an area which accommodates a large number of livestocks in the spring and summer. The pressure of large numbers of livestock and unsuitable grazing in steep lands in long hours can be among the factors which intensify erosion processes in the region.

Agricultural activities have been mainly directed at the end of the studied area. These activities led to hills leveling for converting them to pasture and agricultural lands and inappropriate plow and non-normative streams for transporting the water. From the observations, it can be said that the watershed erosion processes are the result of interaction between such phenomena as high slope, geological sensitivity, region topography, climate and human.

The results show that the agricultural activities are done in 791/627 hectares of the watershed, the statistics show an increase compared to previous years which is somehow caused by the destruction of pasture lands and converting them into agricultural lands and land use change. According to the calculations, the area of each lands unit is as follows:

Table 2. Parts of attrition with the area and its topographic conditions in the study area

row	Lands unit	(Km^2) area	(ha) area	Erosion code
1	(unit1.2) mountain	1.47	147.02	$E_{۱}$
2	(unit1.5) mountain	1.38	138.22	$E_{۲}$
3	(unit2.1.1) hill	4.13	413.927	$E_{۳}$
4	(unit2.5) hill	0.78	78.80	$E_{۴}$
5	(unit2.1.2) hill	2.74	273.95	$E_{۵}$
6	Range plain	4.90	490.66	$E_{۶}$
7	Intermediate plain	0.83	83.56	$E_{۷}$
8	Coarse fan-shaped alluvium	1.37	137.129	$E_{۸}$
9	Miscellaneous lands	2.06	206.46	$E_{۹}$

Erosion intensity was determined in the studied watershed using EPM method which has been used mostly in Yugoslavia and is applicable in some regions (Zagros) of our country. This method, with the help of tables and equations, the amount of soil loss is estimated qualitatively. In the method, first, through the following equation, the erosion intensity coefficient is obtained by examining four factors: watershed erosion coefficient (φ), land use coefficient (Xa), coefficient of rocks and soil susceptibility to erosion (Y) average watershed slope (I) (19).
According to equation (1) below, watershed erosivity sub-map was prepared.

$$) \; y \, (\Psi + I^{۰/۵} * \; Z = X_a$$

Results of erosion intensity map of Fasa forest watershed show that the intensity of the region erosivity is very low and just a slightly more amount was seen in unit mountain 1.2 and miscellaneous lands z.
(Table 1), according to which, erosion status in the watershed can be determined at very severe, severe, medium, low and very low levels.

Table 3. Classification of erosion intensity in EPM model

Average values Z	**Limit values**	**Intensity Erosion**	**Categorizing erosion**
1.25	Z>1	Very severe	1
0.85	1>Z>0.71	Severe	2
0.55	0.7>Z>0.41	Medium	3
0.3	0.4>Z>0.2	Low	4
0.1	0.19>Z	Very Low	5

The second step involves estimating the amount of sediment transport (special erosion), which is calculated using Equation 2.
The amount of erosion during one year per unit area (square kilometers) can be estimated in terms of cubic meters /kilometer per year (5).

$$W_{sp} = T * H * Z^{1/5} * \pi$$

Where Wsp is special erosion in terms of cubic meters per year per square kilometer, T, temperature coefficient, obtained from:

$$T = \left(\frac{t}{10} + 0/1 \right)^{0/5}$$

t,mean annual temperature in centigrade, h, average annual rainfall in mm, and л = 3/1415
The best part of the model is its accuracy in estimating Z which is obtained with respect to four factors. And advantage of this relationship to other relationships is the low number of parameters. It can be said that this method is an accurate one if it is used in terms of its origin.
In step three, the modified formula for sedimentation coefficient Ru or sediment delivery ratio is used to convert the amount of erosion into sediment,:

$$Ru = \frac{4 * (P * H)^{0/5}}{L + 10}$$

P: perimeter of the area (km)- $\overline{H}$: mean height of the area (km)

$$H = \overline{H} - H_0$$

H_0: mean height at the exit point (km)
L: Length of the area or main stream
Similarly, the amount of special sediment can be obtained by the following formula:
Where,G_{sp}: special sediment ($m^3/km^2/y$)

$$Ru = \frac{Gsp}{Wsp}$$

W_{sp}: special erosion ($m^3/km^2/y$)

Then, through the amount of special sediment, the total sediment in the watershed is calculated by the following formula:

$$G_{sp} = \frac{G_S}{A} \rightarrow G_s = G_{SP} * A$$

In the formula, A is the area of the studied area in terms of square kilometers, and Gsp special sediment in terms of cubic meters per square kilometer per year.
To evaluate and estimate the amount of erosion, first, the studied area was divided into small pieces of land, the erosion was investigated and the intended factors were involved based on each lands unit. This division was based on the combination of soil maps, slope and vegetation. As a result, a number of polygons was obtained that were similar in terms of the edaphic, topographical and biological characteristics.

Conclusion

In Fasa Forest area, the presence of various forms of erosion (gully, furrow, rainy, etc.), although low in breadth and in a large number, has caused an increase in the load of sediment production.
Results of table 2, from the calculations based on EPM formula, and also the area qualitative and quantitative erosion map and the types of erosion in the area and reasons for their generation were obtained as follows:

Table 4. Values of erosion, especial erosion, sedimentation rate, sedimentation and deposition

The name of lands unit	Erosion intensity	G_{sp} (m^3/km^2. Y)	G_s (m^3/y)	W_{sp} (m^3/km^2. Y)	Z
Mountain (unit 1.2)	low	117.376	172.756	156.92	0.2428
Mountain (unit 1.5)	Very low	80.696	111.52	107.77	0.189
Hill (unit 2.1.1)	Very low	53.76	222.524	71.82	0.1442
Hill (unit 2.5)	Very low	81.32	64.08	108.62	0.190
Hill (unit 2.1.2)	Very low	59.32	162.48	79.26	0.154
Range plain	Very low	51.96	254.92	69.24	0.141
Intermediate plain	Very low	78.76	65.8	105.19	0.186
Coarse fan-shaped alluvium	Very low	13	17.84	17.38	0.056
Miscellaneous lands	low	149.4	308.44	199.56	0.285

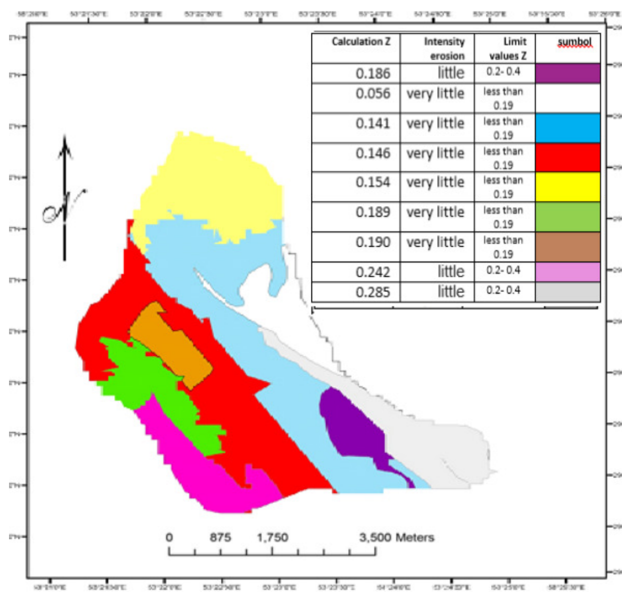


Figure 5. Erosion intensity map of Fasa forest watershed

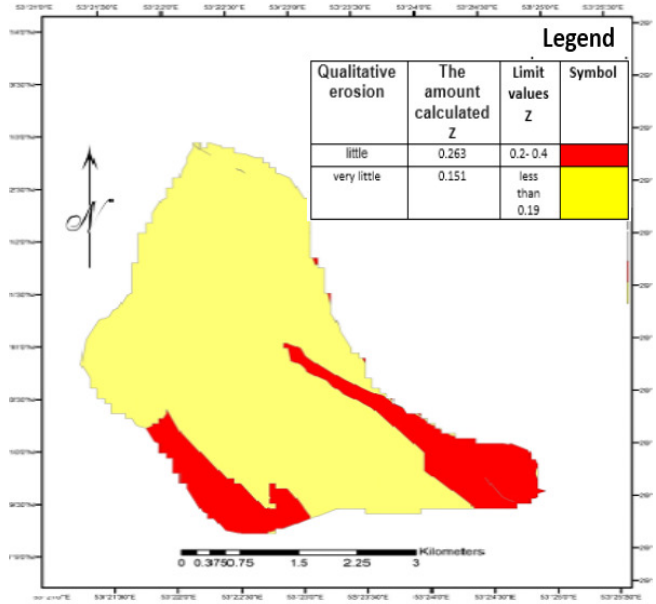


Figure 6. The quality of Fasa forest watershed erosion intensity map

Types of erosion observed in the region and the reasons for their occurrence are as follows:
-unit mountain 1.2, with debris, stream, and surface erosion, and average slope of 71/13%. The main reasons for erosion were steep slope and destruction of vegetation, high volume of runoff during rainfall, sensitivity of the region formations, intensification of surface and furrow erosion, and debris formation from fault movement or gravity.

-unit mountain 1.5, with surface erosion and average slope of 62/459%. The main reasons for erosion were irregular and non-dense surface vegetation and sensitivity of the region formations.
-unit hill 2.1.1, with surface and furrow erosion and average slope of 28/541%. The main reasons for erosion were shortage or lack of vegetation in the region, and land bareness during rainfall.
-unit hill 2.1.2, with surface and furrow erosion and average slope of 12/827%. The main reasons for erosion were shortage of vegetation, runoff caused by rainfall and land bareness during rainfall.
-unit hill 2.5, with surface, dissolution, gully and furrow erosion and average slope of 20/593%. The main reasons for erosion were lack of appropriate density of vegetation, silt and clay formations (high solubility), speed and high volume of runoff from rainfall and intensification of surface and furrow erosion.
-range plain, with different kinds of surface, dissolution, gully, furrow and river erosion (side and floor) and average slope of 7/94%. The main reasons for erosion were destruction of the upper pastures, intensification of surface and furrow erosion, high- speed water flow, small diameter of the particles in this place, low specific weight of the rocky parts of the region, sensitivity of the region formations to solubility, alternate wetting and drying of the soil in the walls and leakage of the water from surrounding into the river.
-intermediate plain, with different kinds of surface, rain (in small amounts), furrow and river erosion (side) and average slope of 4/919%. The main reasons for erosion were weak vegetation, high- speed water flow, sensitivity of the area in terms of weight and diameter of the particles, loose soil particles, approximately discontinuous aggregates, and lack of good distribution of rainfall.
- Course fan-shaped alluvium, with different kinds of debris, slip and river erosion (side) and average slope of 6/87%. The main reasons for erosion were impermeable and hard layers, debris

generated from gravity or fault movement, low diameter and specific weight of the rocks, enough water in the earth surface layers, and fissures in the soil mass body.

-miscellaneous lands with different kinds of surface and stream erosion and average slope of 4/173%. The main reasons for erosion were high volume of runoff, weakness and transience of topsoil, low depth of topsoil, and destruction of vegetation.

Discussion and conclusion

Given that surface and furrow erosion were mentioned as the main forms of erosion in the studied area, so, in planning to combat soil erosion, the main attention should be paid to manage preservation, restoration and proper utilization of vegetation. Some of the technical and scientific methods implemented in the region include reducing the livestock to balance border, preventing shrub and bush cutting and preventing the conversion of forests and pastures into farms. Therefore, because the pasture is a protected pasture, its dominant type is peanut, type area to region area ratio is equal and the status of the region type is good with a good pasture orientation, it can be concluded that there is no overgrazing in the region, and the number of the livestock is appropriate with respect to graze capacity. Another strength of the pasture is Pistacia atlantica species in the region which is used as a source of income by the people. In general, it can be said that the production of the pasture was good and is making progress and except enclosure corrective actions that are in progress now no additional corrective action is needed. The total value of special erosion 915.96 and special sediment 1380.36 cubic meters per square kilometer per year represents the average status of the watershed in terms of erosion production and sedimentation intensity is. Suggested strategies for the control of erosion types in the studied watershed studies include:

1. Surface erosion: maintaining the area vegetation, measures such as seeding, proper graze management, preventing the indiscriminate felling of forests, proper crop rotation, avoid land fallow and adding fertilizer to compensate for the loss of fertile soil
2. Stream erosion: Fixing the longitudinal profile of rivers, building corrective or natural dams, graze and enclosure management, preventing the degradation of pastures and enrichment
3. Debris erosion: Measures to establish debris, for instance stabilizing a suitable vegetation
4. Furrow erosion: Conducting protection programs such as preventing the degradation of pastures and graze management, working range (seeding, hill work), enriching pasture, enclosure, etc.
5. Gully erosion: establishing the ditches so that bed slope and wall slope reach a steady state and the plants inside them are grown so that erosion no longer can destroy them.
6. River erosion: corrective and rehabilitative actions in upstream to control other forms of erosion like furrow erosion, and constructing the earth dams in a proper area of the watercourse to control output runoff volume and to conserve natural vegetation along the river
7. Rain erosion: Using cover crops on the land surface and also choosing the plants with the short time interval between the cultivation and the time when it covers a significant land surface.
8. Slip: planting the trees whose weight, which increases soil stability, and the plants with a large number of sub-roots that increase soil shear strength. Also, the plants absorb water and therefore reduces soil moisture and sensitivity to the slip.

Acknowledgement

We would like to express our gratitude to our supervisor, and great professors at Fasa University who supported us in conducting the research project, and provided us with the needed data and images for completing the project.

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