International Journal of Farming and Allied Sciences
Available online at www.ijfas.com
©2015 IJFAS Journal-2015-4-7/575-584/ 30 September, 2015
ISSN 2322-4134 ©2015 IJFAS

Investigation of the effects in spatial changes of cushion species in the production of sediments by means of RUSLE model (Case study: Summer Rangeland of Jashlobar in Semnan)

Mehrnoosh Parsa[1*], Abdorreza Bahremand[2], Hamidreza Saeidi Goraghani[3], Mohammad Hassan Jouri[4], Ali Asghar Hashemi[5]

1. Former master Student in Range management, Azad University of Nour, Iran
2. Associate professor, Department of Range and watershed Management, University of Natural Resources and Agriculture of Gorgan, Iran
3. Ph.D. Student in Range Management, University of Tehran, Karaj, Iran
4. Professor assistance of Nour Azad University, Iran
5. Science tic board in agriculture and natural resource research center of Semnan

Corresponding author: Mehrnoosh Parsa

ABSTRACT: Vegetation has a positive and important role in the hydrological cycle and also in or the reduction of erosion and sediments. Considering the rule or Based on / according to this role, a study was performed in the shrubberies of Rangeland in Semnan Province which the evaluation of cushion vegetation in prevention from production through sediment in the hillsides has been performed by RUSLE model in two sites. (In each of the two sites, with the distance of four_ kilometer apart,)In each site which has distance from each other, there are 6 standard plots (by 22.1 in 1.82 meter dimension) in two different slopes including 15 and 45%, which are in two directions of south and north. Gathering of the sediments and run offs at the end of these plots is performed and the length of the plots is in the direction of hillside's slope. Regarding the results or Based on the results which are related to the simple linear regression at the first site, increase of cushion plant vegetation in the middle of hillside highly has been decreased sediments and at the second site, in the lower part of hillside, by increasing of cushion plant vegetation with more amounts, the produced sediments has been reduced. In the middle part of hillside, with little difference than its lower part, the more effect had been in comparison with upper part and in comparison, two sites in the middle part of hillside than lower and upper parts of hillside, the increase of cushion plant vegetation highly caused reduction of the produced sediments from hillside. The investigation of efficiency of RUSLE model was performed by means of comparison the computational amounts with observational amounts, by Nash-Sutcliffe method for computational amounts of -0.103 for the first site and -0.065 for the second site which showed non-efficiency of the model in this area. It seems that the obtained results from this model have not had or has no high accuracy for estimation of sediments resulted from cloudbursts in the present study.

***Keywords*:** Cushion species, Sediment, RUSLE model, Jashlobar Rangeland

INTRODUCTION

Destruction of Rangeland in most parts of Iran has been caused that ecosystem of Range has been decreased and to maintain it in some parts, the correction is necessary or it is necessary to correct or to make correction and revival works. Vegetation as one of these operations is the most cost-effective method to revive destructed and damaged Rangeland (Jones *et al*., 2008). Vegetation as one of live parts of ecosystem has important and effective role in the protection for controlling the non-alive parts of ecosystem such as soil and water. Vegetation can be used as a controller, and biological agent in reduction of soil erosion should be considerate, before hitting rain drops to the earth surface, it acts as a rigid and firm obstacle in the front of rain drops hitting to the soil which prevents from infusive erosion. on the other hand, These are covered by having expanded crown in direction of run offs acts as an obstacle and by increasing coarseness coefficient reduce the laminar flow of run offs on the hillside which this causes at the end to increase of opportunity for penetration and reduction of run offs against the movement of sediments and acts as an obstacle (Williamson, 2003). It should be considered that the type of coverage, height, density and season of plants' growth have important role in the amount of prevention of erosion. In the areas that plants have not sufficient coverage and a part of soil is bare, soil erosion is more than the area with complete coverage of plants (He *et al*, 2007). In the case of change in application of lands and change in the type of vegetation, soil erosion is a serious danger for the welfare of human and even for his life. It causes weakness of soil and deserting of farms and Rangeland. It also gathers sediments in waterways. Reservoirs of dams cause abundant losses. Rogers *et al* (1991) showed that the amount of soil erosion is in relation with natural factors and land use. They believed that human activities by affecting on the application of land have meaningful effect on all processes of soil erosion and at the end on the produced sediments. The results of sediment production in semi-dry shrubberies of Spain under simulation of rain by Navaz (1993) showed that slope, vegetation and soil type have meaningful effect on the amount of runoff and sediments. Casermeiro *et al* (2004) in the investigation of the effect of shrubs on the run offs and wasting of soil in Mediterranean areas' soils concluded that the structure and form of the growth in vegetation are important factors in forming runoffs and water erosion in heterogeneous communities is less than homogenous one. For investigation of the effect of vegetation on runoffs and erosion of soil under low intensity of rain in Spain, Marques *et al* (2007) performed a test and the results showed that in plots with vegetation, the coefficient of runoff is 40% and for 6 to 15 min is stable against erosion. The average of runoffs in a year in the soil without vegetation is 0.04%. Sadeghi *et al* (2007) evaluated efficiency of MUSLE model in estimation of sediments of 8 cloudbursts in the domain of May in Japan. The results showed that estimations resulted from the main model were not corresponded with observational data, while the corrected version could simulate error of acceptable estimation 14% and non-meaningful difference in average amounts with agreement more than 88%. Sik Kim (2006) by investigation of RUSLE model with the help of geographical information system, for analysis? of gross rate of losing soil by tourbillion in applying land, in coverage of forest areas used from test and error method it is said that half of the capacity of sediments have been corrected and he used from sediments inside reservoir to evaluate reservoir's capacity. Tiwari *et al* (2000), with the help of RUSLE and USLE models in USA declared that in 20 different places by means of plots on different hillsides, the amount of estimated erosion in 12 places in confidence limit is 95%. The purpose of this research is evaluation of the effect of local distribution of cushion vegetation in production of sediments and runoffs by measuring parameters of vegetation and their changes and determining effect of diffusion pattern of cushion vegetation in relation with changes in erosion behavior of hillsides and hillsides by means of RUSLE model, quality and appearance comparison of erosion processes in hillsides and measuring credit of RUSLE model in the condition of erosive standard plots in Jasholbar Rangeland.

MATERIALS AND METHODS

Study area

Rangeland of Jasholbar in Semnan province with an area more than 2489 haktar is located in northwest of Semnan province and Shahmirzad. This Rangeland has been located between 53 degree, 7 min to 53 degree and 12 min, of eastern length and 35 degree and 45 min to 35 degree, 48 min of northern width. The average slope of the area is 36.93 %. The maximum height is 3321 meter and minimum height is 1980 meter from sea level. Maximum temperature in the warmest month (August) is 23 C degree and its minimum in the coolest month (February) is -15 C degree. It has cold and arid ecology.
Cushion plant species dominant in this area are: *Acantholimom hohenacker* , *Acanthophyllum dordidum*

Method of study

In order to evaluate the effect of local distribution of cushion vegetation on sediment production, runoffs and investigation of RUSLE model's ability in estimation of cloudbursts' sediments, Jasholbar Rangeland was selected. This Rangeland has two sites for the evaluation of erosive index of rain which are situated by 4km interval from each other. In each site, 6 standard plots with an area of 40 m2 (22.1* 1.82m) have been built. Each 6 plots are in 2 different slopes (15 and 45%) and in two directions, respectively southern and eastern, in rectangular shape in the direction of hillside slope beside each other and without any distance and each of them forms small basins. At the end of the plots there were reservoirs for runoffs and sediments which have been placed to determine sediments.

The Amount of precipitation has been recorded by means of rain ganged stable in both sites which after every cloudburst. To evaluate RUSLE model and d determine the amount of produced sediment in studied sites by means of this model , amount of 15 cloudbursts for the first site and 18 cloudbursts for the second site were considered between years 2010 and 2011 and kinetic energy related to them was computed. For obtaining the required variables of cloudbursts for the estimated amount of erosive factor, date gathered was used or the data gathered from sites 1 and 2 was used from sites 1 and 2. Then (no coma here) by means of precipitation amount with different intensity in different time bases and by means of equation 1, kinetic energy was computed for each cloudburst.

Equation 1: E= 210.3 +89 Log I

In which,

It is precipitation intensity (cm/h) and E is kinetic energy of cloudburst (ton meter/hectare in cm). Precipitation factor of (R) is an index that is dependent on kinetic energy of the rain and it shows correlation with maximum intensity of 30 min rains. To determine R, the amount of EI_{30} should be divided to 100. The amount of erosion of soil (K) is an offered formula made by Vishmayer and Smith. Extraction of obtained information including the percent of silt and tiny sand, organic matter, structure of soil and infiltration from caved profile was performed during studies in laboratory which are as the following (Vishmayer and Smith, 1965):

Equation 3: $100K = 2.1M^{1.14} \times 10^{-4} \times (12 - OM) + 3.25(S - 2) + 2.5(P - 3)$

In which M is the percent of clay, OM is % of organic matter, S is the class of soil grains of structure, P is the class of infiltration in the soil's profile.

To determine K parameter in both sites, three samples of soil were taken from upper, middle and lower parts and then after transferring to the laboratory, factors of silt and tine sand percent, percent of sand, percent of organic matter, structure of soil and infiltration of soil were computed. Both sites had granular and sponge structure (1-2 mm) and class 2. The class of penetration for the first site was considered 2 (12.5-6.5 cm/h) and for the second site was 3 (2-6.5 cm/h. according to or regarding to the above cases, after the computation of K coefficient for each sample of soil in each site, the weight average was measured is better here and the amount of K was calculated semi colon needed here for the first site it was 0.33 and for the second site it was 0.37 (table 1).

Table 1. Calculation of K coefficient at the first site

K coefficient	Class of soil infiltration	Class of soil structure	Texture of soil	Percent of sand	Percent of organic matters	Percent of clay	Percent of silt	Percent of tine sand	No of sample
0.28	2	2	Loam silt	39	4.77	4	56	6.91	1
0.34	2	2	Loam sand	47	2.89	4	49	10.24	2
0.38	2	2	Loam silt	40	2.02	4	56	4.62	3
0.33	Average of weight								

Table 2. Calculation of K coefficient at the second site

K coefficient	Class of soil infiltration	Class of soil structure	Texture of soil	percent of sand	Percent of organic matters	percent of clay	percent of silt	percent of tine sand	No of sample
0.36	3	2	Loam silt	55	1.34	4	41	12.08	1
0.37	3	2	Loam sand	49	1.61	5	46	8.79	2
0.38	3	2	Loam silt	49	1.55	6	45	11.15	3
0.37	Average of weight								

Factor of C is the ratio of destroyed soil from under planted land to the eroded soil from the same part during a constant fallow and without coverage or plant residue. To determine C factor in this study, at first in each plot, some factors such as the percent of vegetation, stone and aggregate, bare soil and litter were measured. Then (no coma after then) by means of the equations and tables, the amount of C factor in each plot was determined.

Table 3. Summary of information for plant coverage of land management in erosion of soil in site 1

No of plot	percent of aggregate	Percent of bare soil	Percent of litter	Percent of vegetation	C_1	C_2	Total coefficient of C
1	37.8	16.5	4.1	41.6	0.33	0.24	0.08
2	41.4	11.1	7	40.5	0.34	24	0.08
3	32.3	17.8	3.5	51	0.27	0.2	0.05
4	33.2	15.8	3.7	47.3	0.28	0.22	0.06
5	20.1	12.7	2.8	64.3	0.19	0.16	0.03
6	30	16.3	2.1	51.6	0.26	0.19	0.05

Table 4. Summary of information for plant coverage of land management in erosion of soil in site 2

No of plot	Percent of aggregate	Percent of bare soil	Percent of litter	Percent of vegetation	C_1	C_2	Total coefficient of C
1	29	23.4	2.6	45	0.28	0.23	0.064
2	30.8	14.6	2.3	52.3	0.26	0.19	0.05
3	30.6	16.7	18.2	49.4	0.26	0.21	0.054
4	32.2	21	4.1	42.8	0.29	0.24	0.07
5	29.5	20.1	4.1	46.4	0.27	0.22	0.06
6	32.3	19.1	4.4	40.8	0.31	0.25	0.077

To compute the factor of slope length (L) and slope degree (S), length and degree of slope should be considered by each other and it has been shown by LS. The amount of LS is obtained from below equation:

(3) $LS = (\frac{\lambda}{22.1})^m(0.065 + 0.045S + 0.0065S^2)$

Where λ is the length of slope based on meter and S is slope of land in %. The amount of m depends on slope of land and for 5% slopes and more is equal to 0.5. In this study (a better word like research needed here), because of that the plots are standard in both sites, and length of slope is 22.1. The factor of land management (P) in basin of Jasholbar and in sites 1 and 2 during researches which were performed in the research center of Semnan province is equal to 1.

For sampling coverage in this research, it was used from linear transect (Borhani, 2001). Plant species which are in contact along with the line are recorded (Sherafatmand *et al.,* 2005). Then (no coma after then) in each plot, the percent of crown coverage of total species and the number of people in cushion species are determined and recorded.

Analysis of data

Average parameters of crown coverage percent, percent of sand and aggregate, percent of bare soil and litter were measured in every 12 quadrate in the unit of sampling as the average of that parameter. Evaluation of RUSLE model's results and comparison of field measurements of erosion and sediment in erosive standard plots have been performed by means of error index and evaluation criterion such as Nash-Sutcliffe efficiency index and weigh coefficient. In order to efficiency of the model in two steps, it was used from below indexes: (Lehom *et al* ., 2004; Behonia *et al.*, 2005; Bahremand, 2006; Sing *et al.*, 2007; Temperano *et al*., 2006; Dangon *et al*, 2009; Mostafazadeh, 2008; Rostami Khalaj, 2010; Rashidpoor, 2010).

Nash and Sutcliffe (1970) offered a non-dimensional coefficient named Model efficiency (R^2) which its value is from unlimited negative to one variable and value of 1 in this index shows complete accordance to simulated hydrograph.

(4) $CNS = 1 - \sum_{i=1}^{n}(Q_{si} - Q_{oi})^2 / \sum_{i=1}^{n}(Q_{oi} - Q_{avo})^2$

Qoi is observational data, Qsi is simulated data, Q_{avo} is mean of observational data, n is the number of data.

(5)

$$\omega R^2 = \begin{cases} b \times R^2 & b < 1 \\ \frac{1}{b \times R^2} & b > 1 \end{cases}$$

RESULTS AND DISCUSSION

Results

The percent of cushion coverage and produced sediment in different parts of hillside:

Table 1 shows % of measured cushion coverage in different parts of plots (erosive standard) existed in eastern slope of hillside. since it has been observed, the most percent of cushion coverage and sediment is respectively 30.81 and 1.1 % in the low of hillside, 21.09 and 1.04 % in the middle of it and 39.13 and 0.63% above of it.(using short sentences instead of overusing of "and")

Table 5. Percent of cushion coverage and produced sediment in different parts of hillside in direction of eastern slope (site 1)

First site-station toward eastern slope of hillside						
Above of hillside		Middle of hillside		Below of hillside		No of plot (erosive standard)
sediment	Percent of cushion coverage	sediment	Percent of cushion coverage	Sediment	Percent of cushion coverage	
0.63	18.4	1.78	6.78	0.28	26.39	1
0.05	20.49	0.33	8.63	0.17	14.19	2
0.02	19.99	1.04	16.05	1.1	13.62	3
0.15	22.46	0.72	14.32	0.54	17.98	4
0.35	39.13	0.37	10.76	0.13	30.81	5
0.29	20.78	0.14	21.09	0.18	20.77	6

The percent of measured cushion coverage in different parts of the hillside in existing plots in western slope of hillside (second site) has been offered in table 6. For western slope of the hillside, the most percent of cushion coverage and sediment at the bottom of hillside are respectively 10.31 and 3.79%, in the middle of hillside 9.09 and 3.21% and above the hillside 11.57 and 2.21% that shows in western slope of hillside there are less cushion coverage, but maximum produced sediments is more than eastern slope. It seems that by reduction of cushion coverage in western slope of hillside, the produced sediments have been increased.

Table 6. Percent of cushion coverage and produced sediment in different parts of hillside toward western slope (second site)

site-station toward western slope of hillside second						
Above of hillside		Middle of hillside		Below of hillside		No of plot (erosive standard)
sediment	Percent of cushion coverage	sediment	Percent of cushion coverage	sediment	Percent of cushion coverage	
1.88	7.44	1.06	8.44	3.79	4.52	1
1.42	6.54	1.87	6.02	1.54	6.48	2
2.21	8.52	2.9	8.69	1.72	10.31	3
0.38	11.24	3.21	7.84	1.3	9.23	4
2.02	10.59	0.49	9.09	0.38	9.79	5
1.87	11.57	2.85	4.78	1.36	5.26	6

Diagram 1 is related to the percent of cushion vegetation at the first site in the bottom of hillside (CP1), middle part of hillside (CP2) and upper part of hillside (CP3). In the bottom of hillside, average is in the lower part than other and the effect of data has been provided above of it. In the upper part of hillside, data have less diffusion. Also in the middle part of hillside, cushion coverage has less average.

Diagram1. Box plot related to the percent of cushion vegetation at the first site in different

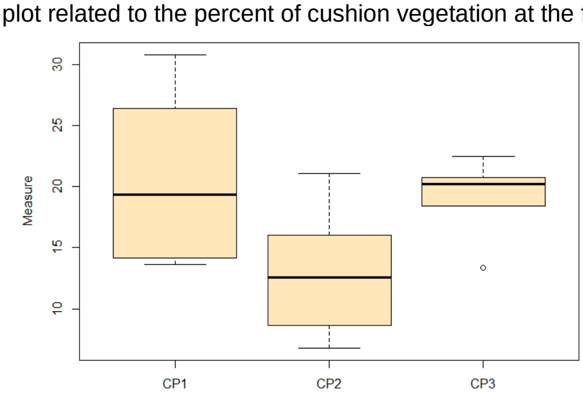
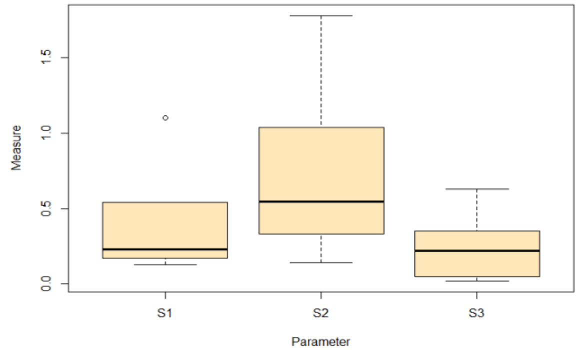


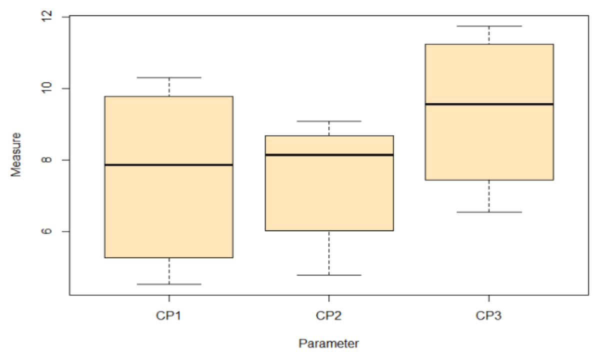
Diagram 2 is related to the amount of sediment at the first site in the bottom of hillside (S1), middle part of hillside (S2) and upper part of hillside (S3). As it is appeared in the figure, in lower and middle part of hillside, average is in the bottom part of the box and the effect of data is more in upper part. In the middle part of hillside, data have more diffusion and in upper part have less diffusion.

Diagram 2. Box plot related to the amount of sediment at the first site in different parts of hillside



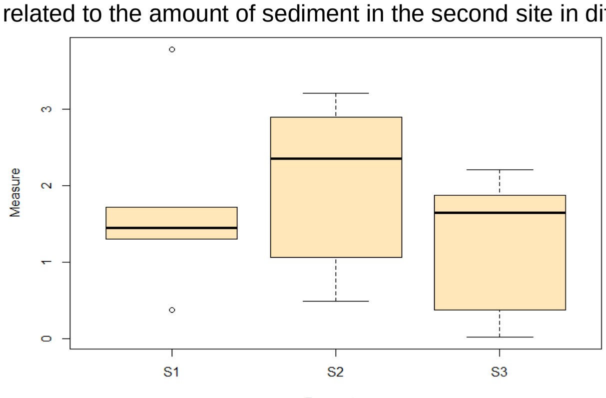
In diagram 3, a box plot related to the percent of cushion vegetation in the second site has been offered. In this site, average of different parts of hillside is in upper part of the box and it shows more effect of data than the average of below part. Data diffusion in upper and bottom of hillside is more than the middle part. Also, upper part of hillside has higher average than other two parts.

Diagram3. Box plot related to the percent of cushion vegetation in the second site in different parts



In diagram 4 box plot related to the amount of cushion sediment at the first site in the bottom of hillside (S1), middle part of hillside (S2) and upper part of hillside (S3) has been offered. In the lower part of hillside, data has less diffusion than middle and upper part of hillside and average of hillsides is less in this part. In the middle and upper part of hillside, data have more expanded distribution and average in the upper part of box shows more effect of data.

Diagram4. Box plot related to the amount of sediment in the second site in different parts of hillside



In table 7, results related to the simple linear regression at the first site related to the simple linear regression at the first site for different parts of hillside has been offered. As it is observed from the results, in eastern slope of hillside there is increase of cushion vegetation in the middle part (-0.56) which leads to reduction of produced sediment from hillside. In lower and middle parts of hillside there are similar results. It means that by regarding to the same coefficient for cushion vegetation (-0.03) they had similar effect in reduction of produced sediment.

Table 7. Simple linear regression between percent of cushion vegetation and amount of sediment at the first site

First site	Equation	R^2 multiple	Adjusted R^2
Below of hillside	S = - 0.031(CP) + 1.039	0.32	0.15
Middle of hillside	S = - 0.56(CP) + 1.456	0.23	0.048
Upper of hillside	S = - 0.031(CP) + 0.861	0.19	-0.005

Results related to the simple linear regression in the second site is related to different parts of hillside which showed in the bottom part of hillside by increase of cushion coverage, the produced sediment has been reduced. In the middle part of hillside (0.26) with little difference than lower part, the increase of cushion vegetation had more effect in reduction of produced sediment in comparison with upper part of hillside (0.18) (table 8).

Table 8. Simple linear regression between percent of cushion vegetation and amount of sediments in the second site

second site	Equation	multiple R^2	Adjusted R^2
Below of hillside	S = - 0.288(CP) + 3.87	0.403	0.25
Middle of hillside	S = - 0.269(CP) + 4.076	0.17	-0.035
Upper of hillside	S = - 0.18(CP) + 2.97	0.18	-0.015

When both sites are considered with each other and the differences between them are ignored, the results show that in the middle part of hillside (0.13) against lower parts (-0.085) and upper part (-0.1) there is increase of cushion vegetation that caused more reduction of produced sediments (table 9).

Table 9. Simple linear regression between percent of cushion vegetation and amount of sediments in the both sites

Total two sites	Equation	R^2 multiple	Adjusted R^2
Below of hillside	S = - 0.085(CP) + 2.248	0.471	0.418
Middle of hillside	S = - 0.138(CP) + 2.805	0.347	0.282
Upper of hillside	S = - 0.1(CP) + 2.209	0.491	0.44

To evaluate RUSLE model and determining produced sediment in investigated sites by means of this model, 15 cloudburst were considered for the first site and 18 cloudburst were considered in 2010 and 2011 and kinetic energy related to them has been calculated which the date of cloudbursts occurrence and kinetic energy related to them have been offered in table 10.

Table 10. Amounts of kinetic energy and precipitation factor in sites 1 and 2

Period of cloudburst in site 1	Kinetic energy (ton /hectare/cm^2)	Precipitation factor (R)	Period of cloudburst	Kinetic energy (ton /hectare/cm^2)	Precipitation factor (R)
1	162.19	0.68	1	104.83	0.31
2	156.41	0.58	2	169.7	0.95
3	113.3	0.16	3	166.12	0.34
4	138.93	0.47	4	132.5	0.34
5	132.6	0.5	5	152.6	0.18
6	124	0.37	6	119.72	0.31
7	173.26	0.97	7	125.4	0.41
8	170.8	0.078	8	120.9	0.31
9	284.5	4.55	9	163.8	0.98
10	167.8	1.54	10	91.3	0.15
11	203.7	0.24	11	75.15	0.65
12	190.5	0.99	12	153.15	1.25
13	179.4	0.3	13	132	0.13
14	196.5	0.3	14	206.23	1.11
15	198.92	1.43	15	161.1	0.61
------	------	-----	16	177.27	0.71
------	------	-----	17	121.3	0.21
------	------	-----	18	163.9	0.98

At first, observational sediment related to the intended cloudbursts at the first and second sites was calculated which the results related to the observational sediments have been offered in tables 11 and 12.

Table 11. Calculation of observational sediment resulted from selected cloudbursts at the first site

Observational sediment

Period of cloudburst	Plot 6	Plot 5	Plot 4	Plot 3	Plot 2	Plot 1
1	0.64	1.31	0.78	0	0	0
2	0	0.68	0.85	1.23	0	0
3	0	0.331	2.376	0.16	0	0
4	16.536	5.239	0.427	11.337	26.94	7.08
5	1.248	3.299	1.453	5.674	11.152	2.744
6	0	0	0	0.5341	3.6832	0.199
7	0	0	0	0.223	0.163	0.444
8	0	1.858	0	4.98	2.167	0
9	27.471	37.06	31.13	58.9	1342.23	33.96
10	0.398	1.628	0.5139	17.706	3.36	0.007
11	0	0.503	0.183	7.895	10.518	0
12	0	0	0	2.035	120.9	0
13	3.4	3.726	1.823	50.33	4.155	1.434
14	1.611	6.925	3.54	16.82	5.55	3.9
15	0.266	0.322	0.177	2.812	7.82	2

Table 12. Calculation of observational sediment resulted from selected cloudbursts at the second site

Period of cloudburst	Observational sediment					
	Plot 6	Plot 5	Plot 4	Plot 3	Plot 2	Plot 1
1	22.13	2.62	0.591	0.275	0	0
2	9.58	0.23	0.32	0	0	0
3	2.56	0	0	0	0	0
4	8.81	0.13	0	0	0	0.54
5	257.23	431.95	67.43	34.7	3.92	247.52
6	1.54	0.2	0	0.42	0	0
7	34.59	7.73	2.21	9.96	0.1	16.95
8	9.68	0.49	1.09	0	0.13	1.61
9	24.25	0	0	0	0	0
10	5.38	0	0	0	0	0
11	294.91	295.11	116.37	184.38	39.84	7946.1
12	17.37	2135.44	0.74	104.54	4.42	1970.21
13	21.29	25.81	24.47	254.19	0	602.88
14	0.84	0.28	0	7.27	0	362.46
15	3.27	0	0	2.29	0	18.45
16	0.82	0	0	0	2.57	0
17	22.39	0	0	1.54	0	19.26
18	0	216.91	61.04	392	912	4481

Amounts of observational sediment are offered in table 13 and 14.

Table 13. Amount of observational erosion for the first site (ton in hectare)

Period of cloudburst	Precipitation factor (R)	Observational sediment					
		Plot 1	Plot 2	Plot 3	Plot 4	Plot 5	Plot 6
1	0.68	0.000160	0.0003	0.00019	0	0	0
2	0.58	0	0.00017	0.00021	0.0003	0	0
3	0.16	0	0.00008	0.00059	0.00004	0	0
4	0.47	0.0041	0.0013	0.0001	0.0028	0.0067	0.00177
5	0.5	0.00031	0.00007	0.00036	0.00066	0.0027	0.00068
6	0.37	0	0	0	0.00013	0.00092	0.00004
7	0.97	0	0	0	0.00005	0.00004	0.00011
8	0.078	0	0.0004	0	0.0012	0.00054	0
9	4.55	0.0068	0.0092	0.0077	0.0147	0.00053	0.0084
10	1.54	0.00009	0.0004	0.00012	0.0044	0.00084	0.00001
11	0.24	0	0.00012	0.00004	0.0019	0.0026	0
12	0.99	0	0	0	0.0005	0.0302	0
13	0.3	0.00085	0.00093	0.00045	0.005	0.0012	0.00035
14	0	0.0004	0.0017	0.00088	0.0042	0.0013	0.00097
15	1.43	0.00005	0.00008	0.00004	0.0007	0.0019	0.0005

Table 14. Amount of observational erosion for the second site (ton in hectare)

Period of cloudburst	Precipitation factor (R)	Observational sediment					
		Plot 1	Plot 2	Plot 3	Plot 4	Plot 5	Plot 6
1	0.31	0.0055	0.00065	0.00014	0.00006	0	0
2	0.95	0.0023	0.00005	0.00008	0	0	0
3	0.5	0.00065	0	0	0	0	0
4	0.34	0.0022	0.00003	0	0	0	0.00013
5	0.18	0.0643	0.107	0.0168	0.0086	0.00098	0.0618
6	0.31	0.00038	0.00005	0	0.0001	0	0
7	0.41	0.0086	0.0019	0.00055	0.0024	0.00002	0.0042
8	0.31	0.0024	0.0001	0.00027	0	0.00003	0.0004
9	0.98	0.006	0	0	0	0	0
10	0.15	0.0013	0	0	0	0	0
11	0.65	0.0737	0.0737	0.029	0.046	0.0099	1.98
12	1.25	0.0043	0.533	0.00018	0.0261	0.0011	0.492
13	0.13	0.0053	0.0064	0.0061	0.0635	0	0.15
14	1.11	0.0002	0.00007	0	0.0018	0	0.0906
15	0.61	0.0008	0	0	0.00057	0	0.0046
16	0.71	0.0002	0	0	0	0.00064	0
17	0.21	0.0055	0	0	0.00038	0	0.0048
18	0.98	0	0.0542	0.0152	0.098	0.228	1.12

The amounts of simulated sediment for the precipitation in RUSLE model for the first site has been offered in table (15) and (16). At the first site, simulation of the produced sediment for 15 precipitation occurrences in 2010 and 211 and at the second site 18 occurrences of precipitation for simulation of the produced sediment have been considered.

Table 15. Amount of calculated erosion in RUSLE model, (S) for the first site

Period of cloudburst	Precipitation factor (R)	Plot 1	Plot 2	Plot 3	Plot 4	Plot 5	Plot 6
		S	S	S	S	S	S
1	0.68	0.01	0.01	0.00062	0.000074	0.00037	0.00062
2	0.58	0.008	0.008	0.00053	0.00063	0.00031	0.00053
3	0.16	0.023	0.023	0.00014	0.00017	0.00008	0.00014
4	0.47	0.006	0.006	0.00043	0.00051	0.00025	0.00043
5	0.5	0.007	0.007	0.00046	0.00055	0.00027	0.00046
6	0.37	0.005	0.005	0.00034	0.0004	0.0002	0.00034
7	0.97	0.014	0.014	0.00089	0.001	0.00053	0.00089
8	0.078	0.001	0.001	0.00007	0.0008	0.00004	0.00007
9	4.55	0.067	0.067	0.0041	0.005	0.0025	0.0041
10	1.54	0.022	0.022	0.00141	0.0016	0.00084	0.00141
11	0.24	0.003	0.003	0.00022	0.00026	0.00013	0.00022
12	0.99	0.014	0.014	0.00091	0.001	0.00054	0.00091
13	0.3	0.004	0.004	0.00027	0.00033	0.00016	0.00027
14	0	0	0	0	0	0	0
15	1.43	0.021	0.021	0.0013	0.0015	0.00078	0.0013

S is the amount of obtained sediment from RUSLE model (simulated)

Table 16. Amount of calculated erosion in RUSLE model, (S) for the second site

Period of cloudburst	Precipitation factor (R)	Plot 1	Plot 2	Plot 3	Plot 4	Plot 5	Plot 6
		S	S	S	S	S	S
1	0.31	0.0031	0.0025	0.0027	0.0034	0.003	0.0037
2	0.95	0.0095	0.008	0.0084	0.01	0.0094	0.011
3	0.5	0.005	0.0041	0.0044	0.0055	0.0049	0.006
4	0.34	0.0034	0.0027	0.003	0.0037	0.0033	0.004
5	0.18	0.0018	0.0014	0.0016	0.0019	0.0017	0.0021
6	0.31	0.0031	0.0025	0.0027	0.0034	0.003	0.0037
7	0.41	0.0041	0.0033	0.0036	0.0045	0.004	0.0049
8	0.31	0.0031	0.0025	0.0027	0.0034	0.003	0.0037
9	0.98	0.0098	0.008	0.0087	0.001	0.0097	0.0117
10	0.15	0.0015	0.0012	0.0013	0.0016	0.0014	0.0018
11	0.65	0.0065	0.0053	0.0057	0.0071	0.0064	0.0078
12	1.25	0.0125	0.01	0.0111	0.013	0.0123	0.015
13	0.13	0.0013	0.001	0.0011	0.0014	0.0012	0.0015
14	1.11	0.0111	0.0091	0.0098	0.0122	0.01	0.0133
15	0.61	0.061	0.005	0.0054	0.0067	0.006	0.0073
16	0.71	0.0071	0.0058	0.0063	0.0078	0.007	0.005
17	0.21	0.0021	0.0017	0.0018	0.0023	0.002	0.0025
18	0.98	0.0098	0.008	0.0870	0.001	0.0097	0.0117

Evaluation of RUSLE model efficiency in simulation of the produced sediment:

Comparison of the estimated sediment by means of RUSLE model with observational sediment of the cloudbursts makes the possibility that the accuracy of the model should be measured. The obtained results showed that simulation of sediment by means of RUSLE model in both sites hasn't been appropriate in accordance with the amount of produced sediment. The amount of Nash-Sutcliffe coefficient for precipitation coefficients at the first site is -0.065 and for the second site is -0.103. As the result, it is observed that there is no accordance between simulated and observational sediment. This reality shows RUSLE model has not intended accuracy in the investigated area. The results related to Nash-Sutcliffe coefficient have been offered in table 17. Error of total squares for the first site is 0.002 and for the second site is 0.084.

Calculation of weight coefficient for sites 1 and 2:

Results related to weight coefficient in order to compare between observational and estimated sediment by model and evaluation of RUSLE model's efficiency, have been represented in table 17. As the results shows, amount of this coefficient is low for both sites and there is no coherent between observational and simulated amounts and also shows that this model has no or doesn't have sufficient accuracy in evaluation of sediment.

Table 17. coefficient of weight related to both sites

Second site	First site	No of site
.0038	.000039	Weight coefficient

Discussion and Conclusion

Investigation of role in cushion vegetation in reduction of sediment in different parts of hillside showed that at the first site and in eastern slope of hillside in the middle part, cushion vegetation has more roles in reduction of sediments and lower and upper parts of hillside have fewer roles in reduction of sediments. But in investigation of western slope of hillside, it was observed that from the lower part of hillside toward, the role of cushion vegetation is more (no coma here) total investigation of cushion vegetation in reduction of sediment. Without considering differences of hillsides showed that middle and lower part of hillside have more important role in reduction of sediments. In fact, the investigation shows that in upper part of hillside, the role of vegetation is more important in prevention of rain drop hitting and erosion. At the beginning of flow from the middle parts of hillside toward down, cushion vegetation had important role in reduction of sediments. As Bahremand (2009) says, cushion vegetation because of having expansion in the crown and shrub on the soil in direction of runoff movement acts as an obstacle and causes increase of opportunity for penetration and reduction of runoff and gathering sediments. Ebrahimi Gajooti *et al* (2006) also about the role of cushion vegetation in reduction of runoff and gathering sediments.

The results obtained from this model showed that simulation of produced sediment by RUSLE model and amounts of observational sediments doesn't have appropriate (instead of "good" replace a better word that fits the text) accordance. As the results showed, the amounts of Nash-Sutcliffe coefficient for both sites for observational and simulated sediments are -0.065 and -0.103. As the result, it can be said that there is no good accordance between simulated and observational sediment and this shows that RUSLE model has no required accuracy for simulation of produced sediment in the investigated area. This result is in accordance with findings of Mirzaii *et al* (2006), Aghazari (1999), Ghorbani Vaghei *et al* (2005), Vaezi *et al* (2010), Pour Abdollah (2006), Pour ghasemi (2007), Sadeghi and Mahdavi (2004), Williamz and Berent (1972) and are in conflict with the findings of Rostami Khalaj (2010), Philips *et al* (2005), Jepo *et al* (2001), Temperano *et al* (2006) and Dangon *et al* (2009). The results of evaluation RUSLE model didn't confirm efficiency and accuracy of model as about both sites, the amount of Nash-Sutcliffe coefficient has been estimated less than 0.5.

REFERENCES

Bahremand A, Corluy J, Liu YB and De Smedt F. 2006. Stream flow simulation by WetSpa model in Hornad river basin, Slovakia. floods, from defense to management, 67-74.

Bhunya PK, Ghosh NC, Mishra SK, Ojha CS and Berndtsson R. 2005. Hybrid model for derivation of synthetic unit hydrograph. *Journal of Hydrology*, 10: 458–467.

Casermeiro M, Molina J, Delacruz Caravaca MT, Hernando Massanet M and Moreno P. 2004. Influence of scrubs on runoff and sediment loss in soils of Mediterranean climate, Catena, 57: 97-107.

Corey A, Frederick B, Peter R, Kenneth E and Stuart P. 2007. Modeling soil erosion on steep sagebrush rangeland before and after prescribed fire, Catena, 71: 218–228.

Donquan Z, Jining C, Haozheng W, Qingyuan T, shangbing C and Zheng S. 2009. GIS-based urban rain fall-run off modeling using an automatic catchment-discretization approach: a case study in Macaa. *Environ Earth Sci*, 59: 465-472.

Elizabeth A and Fulton A. 2010. Approaches to end-to-end ecosystem models. *Journal of Marine Systems*, 83: 171 -182.

He MZ, Zheng JG, Li XR and Qian YL. 2007. Environmental factors affecting vegetation composition in Alxa Plateau, China. *Journal of Arid Environments*, 69: 473-489.
Jayakrishnan RR, Srinivasan C, Santhi J and Arnold G. 2005. Advances in the application of the SWAT model for water resources management, Hydrological processes. 19: 749-762.
Jin Tun Z. 2002. Soil water conservation society and CRC press, Boca raton. A sdudy on relation of vegetation, climate and soil in shanxi province, *Journal of Plant Ecology*, 162: 23-31.
Jones DS, Kowalski DG and Robert BS. 2008. Calculating Revised Universal Soil Loss Equation (RUSLE) Estimates on Department of Defense Lands: A Review of RUSLE Factors and U.S. Army Land Condition-Trend Analysis (LCTA) Data Gaps. Center for Ecological Management of Military Lands Department of Forest Science, Colorado State University Fort Collins, CO 80523.
Kinnell P. 2004. Agriculture non point source pollution model using the USLE-M. AGNPS-UM User,s Guide, University of Canberra, Australia.
Kinnell P. 2005. Why the universal soil loss equation and the revised version of it do not predict event erosion well? Hydrology Process, 19: 851-854.
Lhomme J, Bouvier C and Perrin JL. 2004. Applying a GIS-based geomorphological routing model in urban catchments. *Journal of Hydrology*, 299: 203-216.
Lu H, Moran CJ and Prosser I. 2006. Modelling Sediment Delivery Ratio over the Murray Darling Basin. *Journal of Environmental Modelling & Software*, 21: 1297-1308.
Marques MJ, Bienes R, Jimenez L and Perez-Rodriguez R. 2007. Effect of Vegetal Cover on runoff and soil erosion under light intensity events. Rainfall simulation over USLE Plots, *Science of the Total Environment*, 378: 161-165.
Rogers R and Schm SA. 1991. The effect of vegetation cover on erotion and sediment yield. *Journal of Hydrology*, 123: 19-24.
Sadeghi SH and Behzadfar M. 2004. Temporal variation of rainfall erosivity factor in Mazandaran Province. Iran, In: The Fourth International Iran and Russia Conference or Agriculture and Natural Reasource, Shahre Kord, Iran 8-10 Sep, PP. 1280-1285.
Sadeghi SH, Mizuyama T, Miata S, Gomi Kosugi K, Mizugaki S, Onda Y. 2007. Is MUSLE apt to smsll steeply reforested watershed. Journal of forest research, DOI 10.1007/s10310-007-0017-9.
Sadeghi SHR, Mizuyama T, Ghaderi B. 2007. Conformity of MUSLE estimates and erosion plot data for storm-wise sediment yield estimation. Terrestrial, Atmospheric and Oceanic Sciences, 18: 117-128.
Temprano J, Arango O, Cagiao J, Suarez J and Tejero I. 2006. Storm Water quality calibration by SWMM : acase study in Northern Spain. Water SA, 32: 55-63.
Thorne MS, Skinner QD, Smith MA, Daniel Rodgers J, Laycock WA and Cerekcl SA. 2002. Evaluation of a chnique for measuring canopy volume of shrubs. *The Journal of Range Management J. Range Management*, 55: 235-241.
Tiwari AK, Risse LM and Nearing MA. 2000. Evaluation of WEPP and its comparison with USLE and RUSLE. T. Am. Soc. Agric. Engr, 43: 1129-11.
Williamson M. 2003. Species–area relationships at small scales in continuum vegetation. *Journal of Ecology*, 91: 904–907.