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Comparison of Soil Sedimentation Amount in Lands Covered by Pasture, Rainfed and Abandoned Rainfed in Various Severities of Rainfall and Different Slopes Using an Artificial Rainfall Simulator Device

Mohammad Amin Goodarzei[1], Ali Akbar Jamali[2] and Mohammad Hasan Zade Nafooti[2]

[1]Graduate Master Watershed Islamic Azad University Maybod, Iran.

[2]Islamic Azad University, Department of Watershed, Maybod, Iran.

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ABSTRACT

In this study three land uses with constant soil type and lithology have been considered and also, rainfall intensities have been created by using rainfall simulator device and in two intensities of 46 mm/hour and 88 mm/hour, and as well as considering the slopes of 5 percent and 15 percent, according to the three repeats in 36 stages of sampling. Also, from adjacent parts of the rainfall simulator device and from 0-20 cm depth of soil, the soil samples were taken for analysis in a soil laboratory. The results showed that the land use changes indicate dramatic impacts on soil sedimentation amount in various intensities of rainfall and different slopes; so that the highest amount of sedimentation is carried out in the abandoned rainfed use and intensity of rainfall of 88 mm/hour and slope of 15%.

1. Introduction

Soil is one of the most important natural resources and production factors. Soil erosion is one of the damaging and harmful phenomena in nature, which can lead to the elimination of the natural resources as well as degradation and increasing the possibility of floods and reducing the amount of vegetation [23]. Therefore, to reduce the amount of soil loss can try to estimate the amount of erosion and sediment in the watersheds by using various solutions and carry out solutions including the creation of structures reform as well as vegetation and ultimately preventing degradation of lands and changing their use [4]. On the other hand, soil erosion is one of the most important environmental challenges [3]. The soil properties are one of the important and studied variables on the process of watercourse and soil erosion [3]. There are different methods to calculate the amounts of watercourse and soil erosion that rainfall simulators are one of the most common used methods. In theory, this device not only saves time and money, but the amounts of watercourse and erosion, as well as more effective processes can be evaluated quantitatively and frequency through this device. However it should be noted that the use of rainfall simulators has some limitations, so that rainfall simulators can never completely prepare the natural conditions and facing some limitations in terms of creating cloudburst conditions and rainfall in small surface of plot [4]. According to the studies, we can find out that in general, several factors are involving in the occurrence and exacerbation of watercourse and soil erosion that considering conditions of each region the effects of one or more factors are more than the others. In the meantime, the role of land use change is important due to the effect of this change on vegetation and soil properties and as a result the amounts of watercourse and soil erosion [10].

2. Materials and Methods

2-1. the study area

Bab Karafs watershed is located in the geographical coordinates of 42.9' 57' 57˚ and 12' 2' 58˚ eastern longitude, and 31.7' 40' 28˚ to 15.2" 45' 28˚ north longitude with an area of 3634.6 hectares. This watershed is located in about 12 km from Sarduiyeh District in Jiroft County. The maximum height of this area is 3270 meters and the minimum height is 2990 meters. Bab Karafs, Khardan, Ghanat Bid, Nahr Kamal etc are the most important villages of the area. Figure (1) shows the location of Bab Karafs watershed in Iran and Kerman Province.

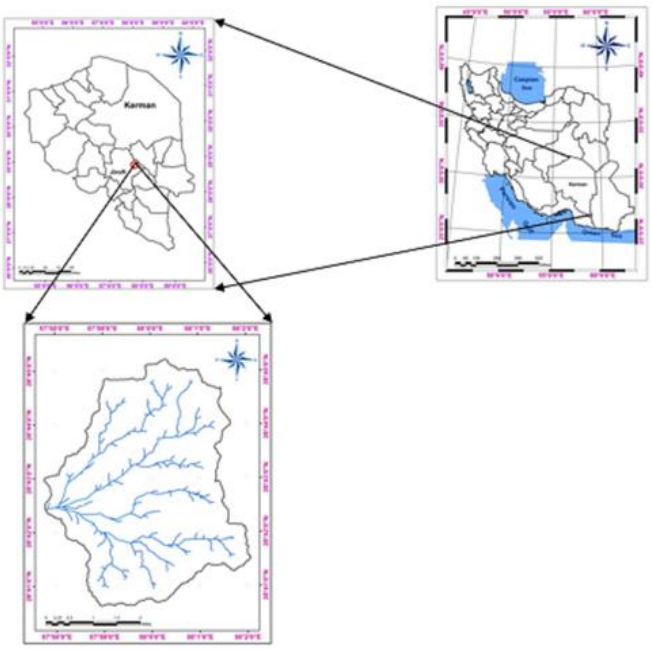

Figure 1. Location of the study area.

2-2. characteristics of the rainfall simulator device

In this study, an artificial rainfall simulator device with rainfall level of 0.09 square meters (dimensions of 30×30 cm) was used.

2-3. methods of soil sampling and laboratory analysis

In this study two rainfall intensities of 46 mm/hour and 88 mm/hour were used and areas with a slope of 5 percent and 15 percent were also tested.

Then, the amount of sediment passed through Whatman filter paper No. 40 in the three repeats and the amount of sediment was separated from whole of the watercourse in the soil laboratory.

Then, the sediments were placed in Oven for 24 hours at 105 ° C. In this study, the data were statistically analyzed by SAS software and mean comparison using Duncan test at 5% level.

3. Results

Results of the measured variables in the soil including watercourse volume, the amount of sediment, clay percentage, silt, sand, organic matter, lime, erodibility factor $EC, pH, SAR, ESP, (K)$ are presented in Tables (1), (2), (3), (4), (5) and figures (4) and (5). The significance level for figures (Charts) is based on analysis of variance results.

Table 1. Results of mean comparison of the land use effect on the measured variables.

pH	EC	Sand percentage	Silt percentage	Clay percentage	Sediment grams/liter(	Watercourse)liter(	Land use
c52.7	**a**88.1	**a**25.70	**c**83.28	**c**91.3	**c**18.1	**c**50.682	rainfed
b75.7	**b**88.0	**c**08.38	**a**91.52	**a**00.9	**a**69.4	**a**83.1255	abandoned rainfed
a85.7	**b**68.0	**b**41.51	**b**33.42	**b**25.6	**b**38.2	**b**08.932	pasturage

Table 2. Results of mean comparison of rainfall intensity effect on the measured variables.

pH	EC	Sand percentage	Silt percentage	Clay percentage	Sediment) grams/liter(	Watercourse) liter(	Rainfall intensity
a73.7	a12.1	a94.51	a66.41	a38.6	b22.2	b56.89	46mm
a68.7	a17.1	a55.54	a05.39	a38.6	a28.3	a06.1021	88mm

Table 3. Results of mean comparison of slope effect on the measured variables.

pH	EC	Sand percentage	Silt percentage	Clay percentage	Sediment) grams/liter(	Watercourse) liter(	Slope
a**69.7**	a**21.1**	a**61.54**	b**11.39**	a**27.6**	b**48.2**	b**17.876**	5%
a**73.7**	a**08.1**	b**88.51**	a**61.41**	a**50.6**	a**02.3**	a**44.1037**	15%

Table 4. Sediment correlation matrix in the use, slope and different rainfall intensities.

	Rainfall intensity		Slope		Use			
88mm	46mm	15%	5%	pasturage	abandoned rainfed	rainfed	Variable	sediment
89*.0	**93**.0**	**71.-0**	**68.-0**	**52.0**	**58.-0**	**014.-0**	Clay percentage	
89*.0	**95**.0**	**94.0**	**86.-0**	**39.-0**	**29.-0**	**07.-0**	Silt percentage	
89*.-0	**97**.-0**	**97.-0**	**90.0**	**34.0**	**33.0**	**07.0**	Sand percentage	
55.-0	**78.-0**	**38.0**	**29.0**	**46.0**	**57.0**	**50.-0**	EC	
45.0	**67.0**	**55.0**	**97.-0**	**57.0**	**39.-0**	**22.-0**	pH	

*significance level of 5%, ** significance level of 1%

Table 5. Correlation between different variables affected by the slope, land use and rainfall intensity.

	Watercourse	Sediment	Clay	Silt	Sand	EC	pH	ESP	SAR	Lime	organic matter	erodibility
Watercourse	1											
Sediment	95**.0	1										
Clay	85**.0	81**.0	1									
Silt	82**.0	76**.0	89**.0	1								
Sand	84**.-0	78**.-0	92**.-0	99**.-0	1							
EC	63*.-0	54.-0	71**.-0	81**.-0	81**.0	1						
pH	52.0	41.0	62*.0	74**.0	73**.-0	95**.-0	1					
ESP	04.-0	06.0	10.-0	26.-0	24.0	71**.0	76**.-0	1				
SAR	05.-0	07.0	13.-0	25.-0	23.0	69*.0	75**.-0	98**.0	1			
Lime	03.0	13.0	01.0	16.-0	13.0	64*.0	70*.-0	98**.0	97**.0	1		
organic matter	4.-0	47.-0	35.-0	27.-0	29.0	27.-0	40.0	83**.-0	81**.-0	87**.-0	1	
erodibility	97**.0	90**.0	89**.0	83**.0	85**.-0	60*.-0	50.0	02.-0	03.-0	07.0	043.-0	1

*significance level of 5%, ** significance level of 1%

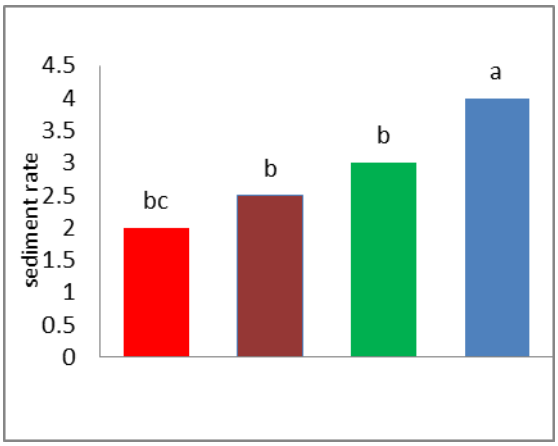

Figure 2. The mutual effect of rainfall intensity in the slope on the amount of sediment, the significance level of 1%

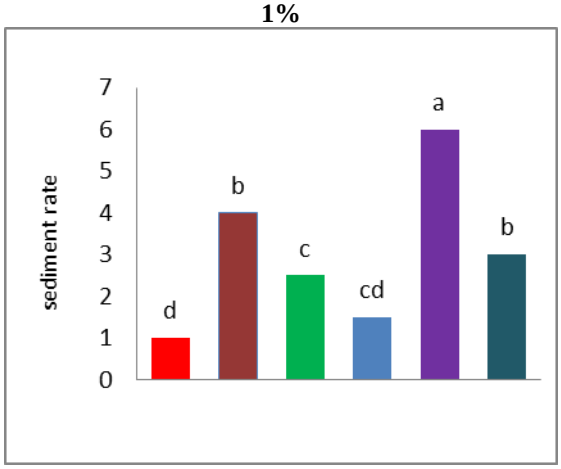

Figure 3. The mutual effect of rainfall intensity in the use on the amount of sediment, the significance level of 1%

4. Discussion

4-1. Erosion and sediment

According to the results presented in Table (1) the land use has significant effects on clay percentage, silt, sand, EC, pH, ESP, SAR, lime, organic matter and soil erodibility factor that all these properties will affect the amounts of erosion and sediment [5,19,11]. According to the results in Table (1) the amount of measured sediment in the abandoned rainfed land use significantly different from the other two land use. One of the main factors in increasing of sediment in this land use is related to more clay percentage and silt in the land use compared to other land use [2.18]. According to the correlation matrix (Table 4) the highest correlation of sediment is related to soil erosion in rainfed and pasture land use. The amount of sediment also showed a negative correlation with the amount of sand [14,1,7] which the amount of sediment decreases by increasing the percentage of sand [15]. And the amount of sand, also shows a negative and significant correlation with the sediment at 1% level (Table 5) [6], so that the erosion rate decreases by increasing the amount of sand [8], the soil erodibility factor, also indicates a positive and significant correlation with the erosion rate [16,10,9].

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