International Journal of
Agriculture, Environment and Food Sciences

JAEFS

e-ISSN : 2618-5946

DOI: 10.31015/jaefs.2021.2.13

www.jaefs.com

Research Article

Int J Agric Environ Food Sci 5 (2):229-235 (2021)

Determination of Erodiblity (USLE-K) Status of Suruc Plain Soils Before Transition to Irrigated Agriculture within the Scope of Southeastern Anatolia Project

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Abstract

Erosion is a major problem that limits vegetative production, adversely affects the ecosystem and causes soil losses that are difficult to recover. This study was carried out with the aim of determining the erosion status and some soil properties of the soils of Suruc plain in Sanlıurfa province. Soil properties; It has been determined that the pH is slightly high, the soils are non-saline, the organic matter is medium and the soil is clayey. Expresses the change of data by the coefficient of variance (CV). The lowest variability (CV = 2.45) in the soils of Suruç plain is the other parameters, respectively, the clay ratio (CV = 19.27) medium level, silt ratio (CV = 20.64) medium level, organic matter (CV = 27.14) medium level and sand ratio. (CV = 27.34) varies moderately. It was determined that the soil properties showing the highest variability were lime (CV = 37.06), EC (CV = 38.89) hydraulic conductivity (CV = 695.41). According to the correlation coefficient of soil erosion (USLE-K) parameter (r=0.99**) and P <0.01 level, it was determined that there is a very important relationship. The high coefficient of variation of some soil properties revealed the need for more sampling in the area. According to the frequency table, the erosive degrees of the soils are determined to be 10% very little, 26% less, 56% medium and 8% strongly erodable soils. In the Suruc plain, which will be opened to irrigation within the scope of the Southeastern Anatolia project, instead of traditional irrigation methods, more suitable irrigation systems should be chosen according to the soil characteristics and the slope of the land.

Keywords: Erosion, USLE-K, Soil Properties, Suruc, Sanliurfa

Introduction

Erosion is one of the most important soil problems, which occurs as geological or natural erosion in the process that begins with erodiblity the surface of rocks and soils, limiting the sustainable productivity of soils and restricting the growth of plant (Cassol et al., 2018). Soil erosion emerges as a global problem as one of the most important causes of land degradation in a global sense, which is directly affected by climate, topography, land use and geomorphological characteristics (FAO, 2017). The erosion of soils is caused by the degradation of the aggregated structure of the soils by the surface flow of water in the soil or by the effect of heavy rainfall (Renard et al., 1997). Erosion in general; Landslides pose serious socio-economic threats in the watersheds, reducing agricultural productivity, land loss in sloping lands, and the extinction of species in nature (Hu et al., 2019). In addition to the economic damage caused by erosion in agricultural area, it poses a serious ecological threat on the waters due to the sedimentation of rivers, lakes, streams and seas in coastal regions (Garcia et al., 2016). The K factor used in the determination of universal soil loss (USLE) is an important erosion index used to determine the susceptibility of soils to water erosion. In determining the

Cite this article as:
Öztürkmen, A.R., Ramazanoğlu, E., Tokmakçı, S. (2021). Determination of Erodiblity (USLE-K) Status of Suruc Plain Soils Before Transition to Irrigated Agriculture within the Scope of Southeastern Anatolia Project. Int. J. Agric. Environ. Food Sci., 5(2), 229-235
Doi: https://doi.org/10.31015/jaefs.2021.2.13
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Received: 09 March 2021 **Accepted:** 11 May 2021 **Published Online:** 28 June 2021
Year: 2021 **Volume:** 5 **Issue: 2** (June) **Pages:** 229-235
Available online at : http://www.jaefs.com - http://dergipark.gov.tr/jaefs

K factor, it enables the determination of annual soil loss caused by the annual rainfall (Zhang et al., 2008). The rapid increase of the global population and the increase in the demand for food in direct proportion to the population make it necessary to protect the soils. There are many reasons for soil degradation, but the most important of these problems and the one that requires urgent solution is erosion. Erosion is a soil loss problem that makes recovery of soils almost impossible (Lal, 2001). Many studies that determine the erosion of soils have emphasized the importance of protecting soils against erosion. Kanar and Dengiz (2015), in their study on the soils of the Menderes basin, determined the relationship between land use and land cover with the erosion sensitivity index and stated that the soils in the Menderes basin are highly sensitive to erosion and that the necessary precautions should be taken against erosion. In Çorum Alaca Basin, located in the Central Kızılırmak Section of the Central Anatolia Region, 42.2% of the soils are medium degree and 57.8% are less erodible (İmamoğlu et al., 2016).

Within the scope of Suruc plain located in the Southeastern Anatolia project, 94,814 ha of agricultural land is planned for irrrigation. . In Suruc plain, agricultural income will increase along with agricultural production compared to dry agriculture by transition to irrigated agriculture such as Harran plain. Lack of planning before seeding and planting in agricultural area and the lack of studies determining the comprehensive soil characteristics of the Suruc plain may cause many unsuitable applications in the plain. Determining the ideal use of agricultural land makes a great contribution to the sustainable use of soil resources for long periods and the amount of product taken from the unit area. Especially if these researches are carried out in company with developing technology, they will cover reliable and accurate information and will be the source of the projects that are planned to be implemented in these areas (Tokmakçı, 2018).

The aim of this study is to determine the erodibility susceptibility of the soils of the Suruc plain and to predict the potential soil loss, and to reveal their relationsheps with some soil properties.

Materials and Methods

Geographical Location

Suruc plain is located between 38 ° 05 ‘and 38 ° 45’ east longitudes 37° 05’ and 37° 45› north latitudes. Suruc district is in the southwest of Sanliurfa province and about 43 km from the city center. The Suruc plain is a big and fertile land that located at the upper mesopotaimia and near Euphrate rivers. The plain is topographycaly flat, 493 m see level and sorrounded bay small highlands (Figure 1).

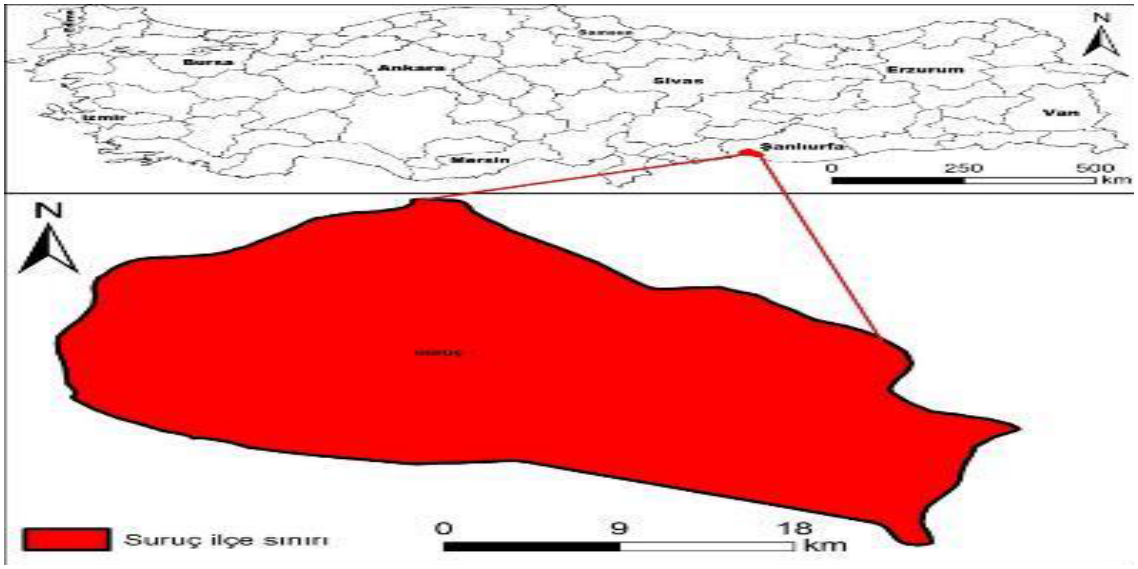

Figure 1. Workspace map

Climate

Suruc plain is characterized as a mediterranean climate whose terrestrial characteristics have partially changed, and the mediterranean climate features dominate, with hot and dry summers and warm and rainy winters. The annual average rainfall of 300-350 mm is not sufficient for the yield of the crop each year.The annual average temperature is 18.4 °C and annual average relative humidity is 54%. According to the American Soil Taxonomy, the moisture regime of the region is Xeric and the temperature regime is Thermic (Süpürkeci, 2014).

Methods

In this study, soil sampling was collected at 50 different points (0-30) in Suruc plain. Soil samples taken from the study area prepared for analysis after passing through a 2 mm sieve. Texture analysis was determined with Bouyoucos Hydrometer by taking 50 g from the oven dry weight soil, adding 10 ml of 10% sodium hexametaphosphate $(NaPO3)_6$ solution and 150 ml of pure water on them, mixing with a drumstick (Bouyoucous, 1951). Hydraulic conductivity was determined by saturating intact soil samples with water for 16 hours (Özdemir, 1998). pH and EC analysis were determined by taking 100 g from the soil with air dry weight and the soil being saturated with graduated burette (Richards, 1954). The total CaCO3 amount was measured with a Schiebler calcimeter by taking 0.5 g of soil sample, adding 5 ml of 10% HCI (Gülçur, 1974). The

organic matter was sieved through a 0.5 mm sieve, 0.5 g of soil sample was placed in a 500 ml flask and 10 ml of 1 N potassium dichromate ($K_2Cr_2O_7$) solution was added on it and determined by wet burning method (Nelson and Sommers, 1996).

The erodiblity (USLE-K) factor of soils: K factor, The data to be obtained from the analysis of soil samples taken from the Suruc plain is determined using the following equation.

USLE-K = ((2.17 x 10-4) x (M1.14) x (12-a) + 3.25 x (b - 2) + 2.5 x (c - 3)) x d

According to the results obtained from the equation (Table 1), the erosion levels of the soils are determined.

Table 1. USLE- K class values.

Category	Mean	Ration
1	Very little Erodiblity	0.00-0.05
2	Little Erodiblity	0.05-0.10
3	Medium Erodiblity	0.10-0.20
4	Surplus Erodiblity	0.20-0.40
5	Excessive Erodiblity	0.40-0.60

Results and Discussion

Sand, silt, clay, organic matter, lime, EC, pH, hydraulic conductivity and erosion (USLE-K) parameters of the soils were examined for 50 soil Samples and statisctical Analysis were applied (Table 1). The statistical analyses resuls showed that the coefficient of variation values (CV), which are considered to be indicators of variability, are classified as 15% small, 16-30% medium, and ≥30% high variables (Wilding et al., 1994).

Table 2. Descriptive statistics for some physical and chemical properties of the study area (0-30 cm) soils

Parametres	n	Minumum	Maximum	Mean	Standard Error	Variance	Coefficient of variation
Sand (%)	50	18.72	56.72	34.24	9.36	87.60	27.34
Silt (%)	50	14.56	32.56	21.80	4.50	20.23	20.64
Clay (%)	50	28.72	60.72	43.96	8.47	71.82	19.27
O.M (%)	50	0.79	3.17	2.10	0.57	0.33	27.14
Lime (%)	50	7.97	59.38	33.86	12.55	157.47	37.06
EC (dS m^{-1})	50	0.01	1.11	0.54	0.21	0.04	38.89
pH	50	6.90	7.80	7.34	0.18	0.03	2.45
H.C (cm h^{-1})	50	0.28	9.862,00	200.49	1.394,23	1.943.882,83	695.41
USLE-K	50	0.01	12.00	0.37	1.68	2.82	454.05

O.M: organic matter, H.C: hydraulic conductivity

When the average values of the soils were examined, it was determined that the soils were clay textured in terms of sand, clay and silt ratios and the organic matter level was 2.10%. Soil pH is 7.34 and EC values is characterized as none saline soils. It has been determined that the hydraulic conductivity rate in Suruc plain is 200.49 cm h^{-1}, and the erosion conditions of the soils are very erodable. The parameters varying in terms of soil properties examined in the soils of Suruc plain, the lowest variation (CV = 2.45) is the pH, the other parameters are respectively the clay ratio (CV = 19.27), the silt ratio (CV = 20.64) moderate, organic matter (CV). = 27.14), and the sand content (CV = 27.34) moderately varied. Highly variable soil parameters, respectively; lime (CV = 37.06), EC (CV = 38.89) and the highest variability was determined to be the hydraulic conductivity of soils (CV = 695.41) (Table 1).

A study conducted by Ozturkmen et al. (2020), reported that the hydraulic conductivity rate of soils varies widely is due to the different land use in the Suruc plain. In a study examining the effect of different land use on hydraulic conductivity, they reported that the highest infiltration rate was determined in orchards and the lowest in barley cultivated agricultural lands, and that the soil parameter most affected by different land use was hydraulic conductivity (Ozturkmen and Ramazanoglu, 2020a; Ozturkmen et al., 2020b).

According to the result of the Pearson Correlation (r = 0.99 **) of the soil erosion (USLE-K) parameter, it was determined that there is a very important relationship at the P <0.01 level. The hydraulic conductivity of soils has a direct effect on the soil erosion process (Biddoccu et al., 2017). Since the hydraulic conductivity of soils has an important effect on the soil erosion process, changing the soil cultivation methods will be a protective soil conservation method to apply less tillage techniques to make soils more resistant to erosion (Blanco et al., 2017). Along with the decrease in the rate of hydraulic

conductivity of soils, it causes surface runoff, flood and erosion (Owuor et al., 2018). When the degree of susceptibility of the study area soils to erosion is examined (Table 4), it was determined that the soils are 10% very little, 26% low, 56% medium and 8% strongly erodable soils (Figure 2).

Table 3. Correlation table between soil parameters

Pearson Correlation	**Sand (%)**	**Silt (%)**	**Clay (%)**	**O.M (%)**	**Lime (%)**	**EC (dS m^{-1})**	**pH**	**H.C**	**USLE-K**
Sand (%)	1								
Silt (%)	-0.428**	1							
Clay (%)	-0.877**	-0.058	1						
O.M (%)	0.071	0.103	-0.133	1					
Lime (%)	0.554**	0.196	-0.508**	-0.161	1				
EC (dS m^{-1})	-0.113	0.247	-0.007	0.178	-0.102	1			
pH	-0.065	0.051	0.045	0.015	0.040	0.066	1		
H.C (cm h^{-1})	-0.085	0.024	0.081	0.038	-0.122	0.048	0.288*	1	
USLE-K	-0.072	0.041	0.058	0.032	-0.110	0.052	0.288*	0.999**	1

** *P<0.01;* * *P<0.05, O.M:* organic matter, H.C: hydraulic conductivity

Table 4. Coordinates of the study area soil samples and erosion sensitivity values

Sample No	**Coordinate (37 Zone, UTM)**		**USLE-K**	**Erodiblity Degree of Soils**
	X	**Y**		
1	444541	4089217	0.09	2
2	444541	4089216	0.16	3
3	444494	4089229	0.09	2
4	443478	4088787	0.19	3
5	443463	4088778	0.10	2
6	443448	4088749	0.19	3
7	443476	4088831	0.07	2
8	443467	4088833	0.33	4
9	443454	4088835	0.21	4
10	442880	4088154	0.08	2
11	442398	4088340	0.19	3
12	442446	4088338	0.09	2
13	442369	4088310	0.04	1
14	442343	4088402	0.15	3
15	442355	4088423	0.21	4
16	442357	4088449	0.19	3
17	442319	4088460	0.17	3
18	442108	4088299	0.15	3
19	442098	4088293	0.19	3
20	4420849	4088276	0.16	3
21	442140	4088229	0.07	2
22	442133	4088222	0.22	4
23	442121	4088218	0.20	3
24	442145	4088203	0.14	3

25	442154	4088187	0.07	2
26	442166	4088172	0.16	3
27	440947	4087547	0.12	3
28	440934	4087559	0.11	3
29	440921	4087557	0.12	3
30	440971	4087512	0.13	3
31	440983	4087496	0.04	1
32	440958	4087486	0.06	2
33	443779	4086858	0.10	2
34	437770	4086832	0.13	3
35	437762	4086816	0.13	3
36	437740	4086814	0.10	2
37	438064	4086961	0.11	3
38	438064	4086961	0.12	3
39	438061	4086972	0.15	3
40	438031	4086968	0.14	3
41	438009	4087007	0.12	3
42	438027	4087078	0.04	1
43	440278	4086664	0.13	3
44	440281	4086658	0.09	2
45	440298	4086654	0.15	3
46	445058	4089820	0.15	3
47	4450580	4089830	0.15	3
48	445075	4089833	0.10	1
49	449492	4097155	0.05	1
50	449501	4097161	0.01	1

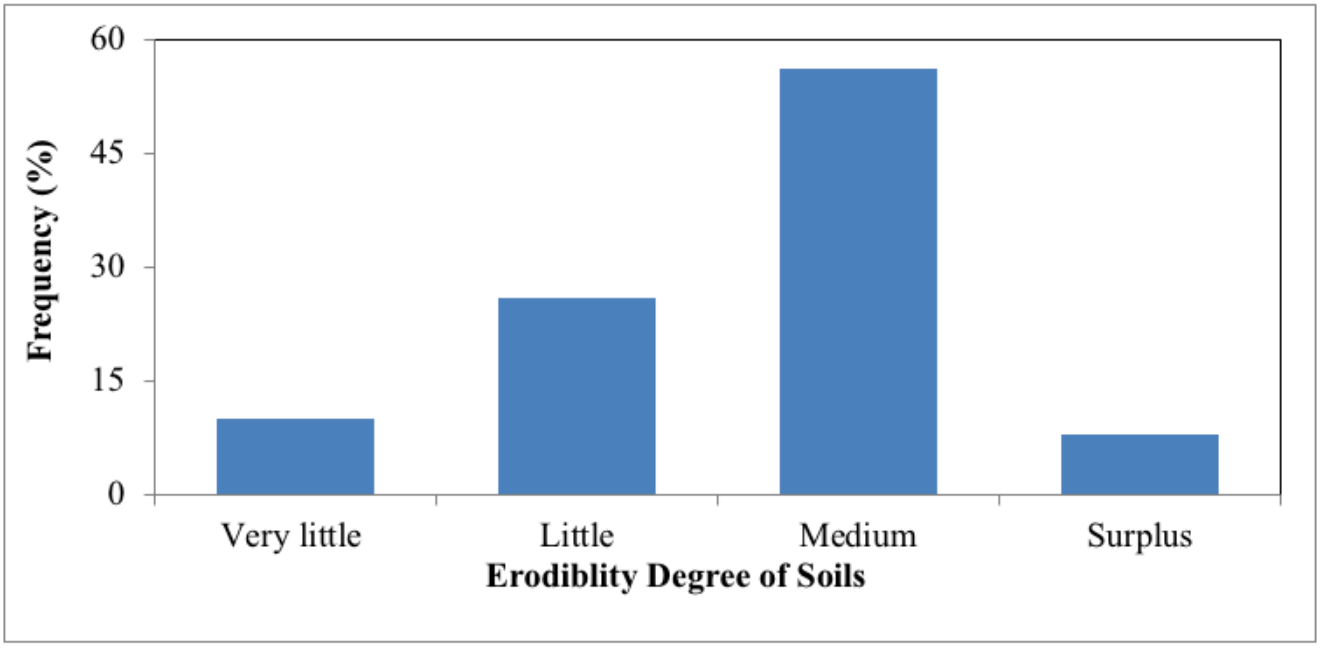

Figure 2.Frequency table for the USLE-K factor of Suruc plain soils

Conclusion

As a result of the study conducted on Suruc's plain soils, it was determined that the soil reaction and lime content was high and level of organic matter was low. It has been observed that there is no problem in terms of salinity in the plain and the soils are generally clay textured soils. When the abrasion resistance of soils is examined, it was determined that the Suruc plain soils are highly susceptible to erosion. Soil protection measures should be taken against erosion in the Suruc plain to be irrigated. In vegetative production, it is necessary to change the existing irrigation systems (surface irrigation) before the Suruc plain is opened to irrigation and to select the appropriate irrigation systems in the plain. It is necessary to improve the infiltration rates of soils in order to determine the infiltration rates of soils and to prevent soil loss by runoff in soils with poor infiltration rates. After the water introduced to the plain, sprinkler or drip irrigation systems should be used instead of traditional irrigation systems. With this study, after many years, the changes and deterioration that may occur in the soil due to irrigation in the Suruc plain will be determined more quickly and will provide background information for future studies.

Compliance with Ethical Standards

Conflict of interest

The authors declared that for this research article, they have no actual, potential or perceived conflict of interest.

Author contribution

The contribution of the authors to the present study is equal. All the authors read and approved the final manuscript. All the authors verify that the Text, Figures, and Tables are original and that they have not been published before.

Ethical approval

Not applicable.

Funding

This study was funded by the Scientific Research Coordination Unit of Harran University (Project No: 17101).

Data availability

Not applicable.

Consent for publication

Not applicable.

Acknowledgements

Authors are thankful to Harran University, Scientific Research Coordination Unit for their financial supports.

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