SOIL EROSION RISK IN BARAK PLAIN FROM THE PERSPECTIVE OF THE ENVIRONMENTALISTS

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ABSTRACT: This study aimed to determine the soil erosion risk in agricultural areas of Barak Plain (Gaziantep). The magnitude of soil erosion risk was investigated by the application of Revised Universal Soil Loss Equation and Geographic Information Systems and results were displayed as erosion risk maps. From the research area, 14 stations were determined. Soil erosion risk and several physicochemical properties of soils were investigated. The results showed a high erodibility factor and at the same time a very low content of organic matter in the soils of the studied area. This study indicated the necessity of taking more efficient precautions against erosion urgently.

Keywords: Barak plain, K-Factor

INTRODUCTION

Soil erosion in both Turkey and the world causes huge environmental and economic damage, particularly concerning dams [1,2,3,4,5,6,7]. The lack of awareness and knowledge among the farmers increases the erosion hazard [7]. The arable land in Gaziantep Province in southeastern Turkey is cultivated in a conventional way, mostly without applying protective measures are not applied anywhere in Turkey. Therefore, an increase of the hazard of soil erosion can be observed, instead of a decrease [8]. To rise awareness about the threat of soil erosion and to encourage farmers to intensify soil protection measures, this work was accomplished and the results presented to the farmers in the region. After [9] pointed out the important interrelations and close connections between K-factor and content of organic matter, soil type, aggregat class and permeability class, a finding that was confirmed by [10]. After [11]soils with a higher factor of erodibility are more prone to erosion than those with a lower K-factor. The factor of soil erodibility (K-factor) represents the annual soil loss of a certain soil per R-unit on a standard-slope (22 m lenght, 9 % inclination, constant bare fallow). The K-factor is the measure of the soil erodibility and is determined by a number of soil characteristics. Hence, it is an empirically established ratio value expressing the cumulative effect of all operating soil properties. After [12], the K-factor is derived by calculation of five soil properties: content of silt and fine sand 2-100 µm and soil structure (aggregate class), increasing the factor, and content sand 100-2000 µm, organic matter and permeability, reducing the factor.

MATERIAL AND METHODS

This soil erosion study was conducted at three towns in Gaziantep province (Nizip, Karkamış and Oğuzeli). In the east of the study site, the river Euphrates flows. The soil of the Gaziantep catchment area assemble from 55.38 % Chromic Cambisols, 23.09 % colluvial soils, 8.13 % Cambisols, 7.37 % soils from basaltic parent rock and 1.28 % other soil types such as Regosol, Terra rossa and Terra fusca [13].

Location, Climate, Vegetation and Land use properties of Study Area

The climatic conditions of southeastern Anatolia are distinctly continental with dry and hot summers and cold winters with a low precipitation rate (Tab. 1). Mean annual precipitation is 578.8 mm in Gaziantep, 328.2 mm in Karkamış, and approximately 464 mm in Nizip. Pistachio nuts are frequently cultivated in Gaziantep, as are olives, almonds and partially wine. The natural vegetation mainly consists of grasslands with dwarf shrubs, and to a smaller extent also steppe, garrigue, forest and macchia. Large steppes exist particularly south of Karkamış und Oğuzeli. In the areas of the Nizip, Karkamış and Oğuzeli grow Oak forests ocur, the lowlands are agricultural areas for the production of pistachio, barley and wheat. In Gaziantep Province occur especially the following plants: Alnus sp, Pinus nigra, Cedrus libanii, Cupressus sp., Fagus orientalis, Populus sp., Quercus sp., Juniperus sp., Olea europaea, Arbutus andrachne, Pistachio terebinthus, Styrax officinalis, Euphorbia sp., Paliurus spina-christi, Urtica sp. and Rubus sp. [14].

Table. 1. Mean long term precipitation in Gaziantep Province (1970-2011).

Months (1-12)	1	2	3	4	5	6	7	8	9	10	11	12
Mean temperature (°C)	3.1	4.4	8.4	13.3	18.7	24.1	27.9	27.5	22.9	16.4	9.3	4.8
Mean max. temperature (°C)	8.0	9.6	14.3	19.8	25.7	31.4	35.5	35.5	31.4	24.5	16.0	9.9
Mean min. temperature (°C)	-0.7	0.1	3.3	7.5	12.0	17.1	21.1	21.0	16.4	10.5	4.5	1.0
Mean sunshine (h d-1)	3.5	4.3	5.3	6.5	8.4	10.3	10.5	10.1	8.6	7.1	5.3	3.5
Mean rainy days	12.3	12.2	12.1	10.9	6.9	2.2	0.7	0.5	1.6	6.5	9.0	11.8
Mean amount of precipitation (L m-2)	90.0	82.7	73.6	58.2	29.5	6.7	2.7	2.7	6.2	37.9	68.6	93.0

METHODS

For an appropriate characterisation of the study sites' soils and their susceptibility to soil erosion, the following methods were applied: Colour of soil by use of Munsell Soil Chart [15], pH-value via [16] with Hanna Model (HI 83140 model), electrical conductivity after [17], $CaCO_3$ content by means of Scheibler-method after [18] by the use of Eijkelkamp M1.08.53.D Model calcimeter, organic matter content via [19] , grain size analysis after [20] by means of Retsch model AS 200, aggregate classes after [21] and permeability classes after [22] and K-factor after [10], the RUSLE model after [23]. The GIS analysis was conducted via ERDAS Imagine 8.7, ArcGIS ArcInfo Workstation 10.0 and Microsoft Office. Nitrogen was determined after [24] , Fe, Zn, Mn and Cu after [25] by means of the AAS device, plant available phosphorus (P) after [26] , Potassium (K), Ca and Mg by ASS device after [27]. Statistical analysis was accomplished via SPSS 10.0 for Windows. A total of 14 soil samples were collected at a depth of 30 cm from arable land with an inclination of approximately 10 %. Each sample position was recorded by means of GPS (Magellan 500). Plant communities were recorded and classified on-site.

Determination of K-factor (Eq. 1)

$$K = 2.77 * 10^{-6} * M^{1.14} * (12-OM) + 0.043 * (A-2) + 0.033 * (4-D) \quad \text{(Eq. 1)}$$

with
M = (% silt + % fine sand) * (% silt + % sand (fine sand excluded))
OM = % Organic matter
A = Aggregate stability
D = Permeability class

The soil erodibility factor (K-factor) is classified after [10] (Tab. 2).

Tab. 2 Classification of K-factor [22]

K – Factor	Assessment
K < 0.1	Very low
0.01< K < 0.2	Low
0.2 < K < 0.3	Medium
0.3< K <0.5	High
K >0.5	Very high

RESULTS

Chemical and physical proferties of Soil

For the testet soils, we found pH-values from 7.48 to 7.69 and an electrical conductivity between 0.03 and 0.07 mS cm^{-2}. The soil organic matter was determined as low, ranging from 0.13 to 2.862 %, whereas the CaCO3 content was high. Macronutrients (K, Ca and Mg) and micronutrients (Fe, Cu, Zn, Mn) were determined and evaluated after [25] the Cu-content was measured between 0.95 and 3.74 ppm for all sites, which is considered a sufficent supply (>0.2 ppm). The Fe-content was too low between 0.74 and 1.72 ppm, which means a partly sufficent supply (>1 ppm). The Mn-content of all soils was found sufficient between 1.57 and 7.35 ppm. The Potassium-content of all soils was very high with values between 35 and 72 ppm (>2,56), which was also the case for Mg: the content was determined between 148 and 568 ppm, what is considered very high.

Tab. 3. Soil physical and chemical properties of study site soils

Nr.	pH	% EC	Colour	ΔGMD*	% CaCO3	Ca ppm	K ppm	Mg ppm	Zn ppm	Mn ppm	Fe ppm	Cu ppm	N ppm
	7.56	0.07	5 YR 3/4	2,7	4.5	3298	72	476	1.19	4.98	1.21	2.89	0.084
	7.58	0.03	7.5 YR 5/6	1,09	22.0	4691	43	211	0.61	1.57	0.98	0.95	0.161
	7.51	0.04	5 YR 5/6	1,35	22.0	5201	67	479	0.46	3.21	1.64	2.04	0.033
	7.69	0.04	5 YR 4/6	1,17	22.0	5894	35	223	0.37	3.80	0.74	2.35	0.071
	7.61	0.05	5 YR 4/4	1,04	20.0	3735	63	277	0.88	7.35	1.49	3.74	0.073
	7.62	0.05	7.5 YR 6/4	1,02	21.0	4624	57	148	0.65	5.21	1.14	2.93	0.056
	7.56	0.05	5 YR 4/4	1,13	22.0	4311	62	376	0.6	3.06	1.02	1.93	0.071
	7.57	0.05	7.5 YR 5/4	1,22	22.0	5547	41	178	0.63	4.37	1.18	2.70	0.069
	7.67	0.04	5 YR 5/6	1,23	21.0	5813	48	568	0.30	4.09	1.08	2.47	0.069
	7.56	0.04	10 YR 5/4	1,21	23.0	4946	54	436	0.49	2.73	1.72	1.81	0.07
	7.58	0.04	10 YR 6/3	2,75	21.0	4233	65	332	0.72	2.90	1.10	1.86	0.067
	7.64	0.06	7.5 YR 5/4	1,44	20.0	3996	50	411	0.63	2.46	1.30	1.65	0.046
	7.57	0.06	5 YR 4/4	1,09	23.0	5634	37	546	0.32	2.60	1.61	1.73	0.071
	7.48	0.04	10 YR 7/3	2,1	21.0	3819	69	264	0.69	4.52	1.58	2.76	0.043

ΔGMD* (Aggate stability)

K-Factors of soils in Barak Plain

The K-factors of the soils in the vicinity of Barak Plain were calculated between 0.34and 0.69, which means a high susceptibility to soil erosion for the tested arable land within the RUSLE model [23].

Tab. 4. K-Factors of Barak Plain soils

Soil Nr.	% S*	% Si*	% C*	M	A*	D*	SOM*	K-factor*
	36.87	26.17	36.96	3277.11	1	1	1.86	0.34
	52.02	40.40	7.58	5566.76	1	1	1.30	0.61
	26.79	45.64	27.56	4413.75	1	2	0.13	0.49
	41.78	47.87	10.35	6441.44	1	1	1.56	0.69
	22.22	51.28	26.50	4543.34	1	2	1.50	0.45
	61.68	20.19	18.13	5038.03	1	2	1.56	0.50
	35.56	47.45	16.98	5206.01	2	1	1.37	0.61
	26.48	47.17	26.35	4434.04	1	1	1.56	0.47
	22.51	51.40	26.09	4643.60	1	1	1.04	0.52
	33.66	52.41	13.93	5989.61	1	1	1.30	0.66
	22.30	39.19	38.51	3152.42	1	1	1.17	0.35
	22.35	37.42	40.24	2846.36	3	1	0.72	0.41
	25.06	47.12	27.82	4521.10	3	1	0.52	0.61
	24.69	36.96	38.35	3111.65	3	1	1.04	0.43

A*(aggregate class), D*(permeability class), SOM* (soil organic matter g kg-1), K-factor*(erodibility faktor), S*(Sand), Si*(Silt), C*(Clay)

Soil erosion mapping

The study sites' total surface is 199.886 ha, of which 73.003 ha are Oğuzeli, 31.231 Karkamış and 95.652 ha Nizip region. The GIS erosion maps show, that the study regions are threatened by a similar erosion risk. Particularly the higher elevations are prone to severe soil loss, due to the destroyed vegetation cover. The erosion risk of Karkamış soils was determined low for 89.52 %, medium for 0 %, high for 10.48 % and very high for 0 % (Fig.1).

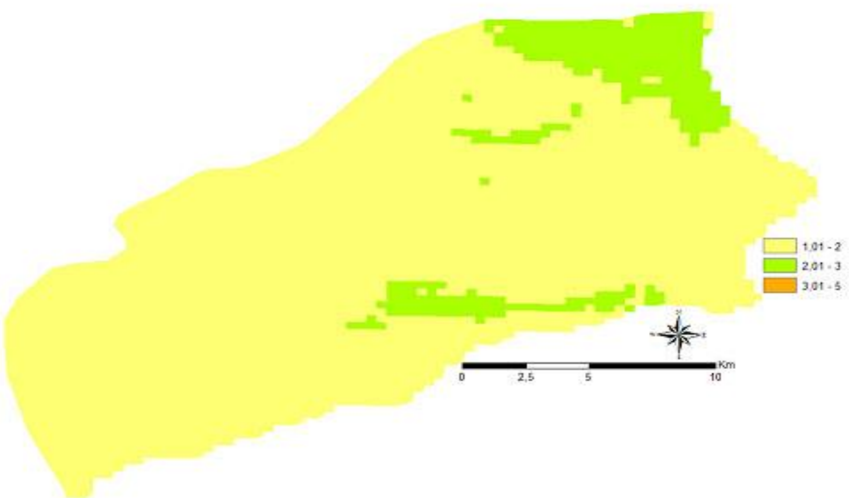

Fig. 1. Erosion risk of Karkamış

The erosion risk of Nizip soils was determined low for 55.54 %, medium for 28.55 %, high for 9.43 % and very high for 6.68 % (Fig.2).

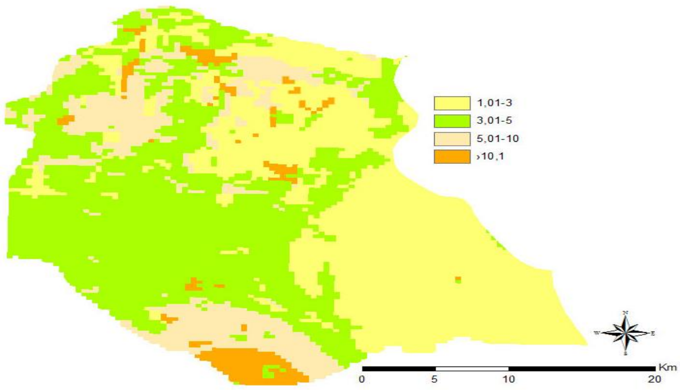

Fig. 2. Erosion risk of Nizip

The erosion risk of Oğuzeli soils was determined low for 42.17 %, medium for 40.18 %, high for 13.74 % and very high for 3.92 % (Fig.3).

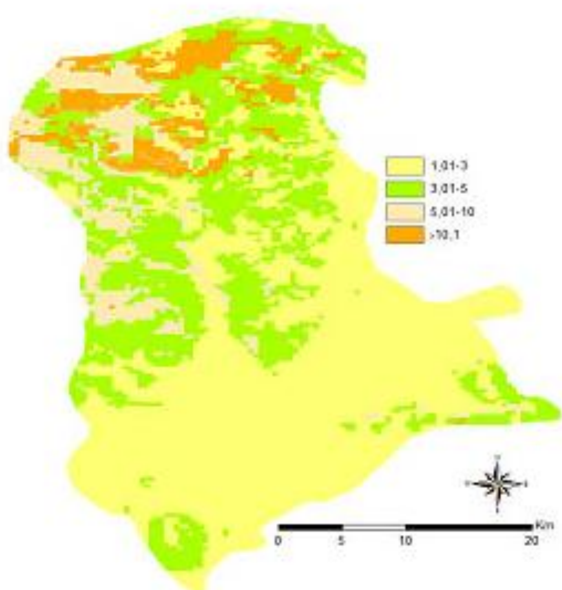

Fig. 3. Erosion risk of Oğuzeli

DISCUSSION AND RECOMMENDATIONS

The results show a high K-factor of the, soils in the study site and at the same time a very low content of organic matter. To increase the content of humus and thus promote and enhance microbiological activity and properties, we suggest organic matter. Furthermore, instead of conventional ploughing, a more shallow working solution should be aspired. Protective measures against soil loss should be applied as soon as possible, particularly north of the study area. We recommend a close cooperation between farmers and soil scientists for the sake of a proper application of suitable erosion protection: possible means are regular seminars and supervision by experts. Specific topics addressed should be information about crop cultivation and soil treatment, and particularly recent developments of soil conservation. The specific plants growing in that region should be protected and the cultivation encouraged. These plants, which are important in terms of preventing erosion, are distributed in Gaziantep region and can all be recommended to prevent erosion. These plants are perennial ones and widely distributed in meadows, pastures, rocky, stony, pebble, arid slopes, fields and cultivated lands. Especially sloped areas should be vegetated with horizontally developing and creeping plants with different root depths. Intensification and widespread use of these pioneer plants in the region will significantly eradicate erosion problem in the region [14]. Blue-green algae applications to soil may result in an increase in aggregate stability and may provide good protection against erosion [28,29].

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