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DETERMINATION OF THE K-FACTOR OF ARABLE LAND IN YAVUZELI AND ARABAN / GAZIANTEP PROVINCE

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Abstract

In this study, the erodibility (K-factor) of arable land in Yavuzeli and Araban in Gaziantep province was assessed. The erosion risk was determined by application of the RUSLE model (Revised Universal Soil Loss Equation) and presented as digital maps by means of Geographical Information Systems (GIS). The K-factors of both addressed regions, Yavuzeli and Araban, were calculated between 0.33 and 0.79, marking a high erosion risk according to the RUSLE model.

Keywords: Araban, Yavuzeli, K-Factor, RUSLE, GIS.

1. Introduction

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. 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 Morgan (1985: 11-20) soils with a higher factor of erodibility are more prone to erosion than those with a lower K-factor. Kirby und Mehuys (1987: 211-215) 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 Schwertmann et al. (1987) . 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 Wischmeier and Smith (1978: 58) , 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.

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Soil erosion both Turkey and the world causes both, huge environmental and economic damage, particularly concerning dams (Jankauskas et al., 2006: 66-76; Stolpe, 2005: 2-8; Tunç and Schröder, 2010a: 11-20; Tunç and Schröder, 2010b: 58-63; Djodjic and Spanner, 2012:229-240; Sönmez et al., 2013: 1-21). The lack of awareness and knowledge among the farmers increases the erosion hazard (Tunç ve Özkan, 2010).

2. Material and Methods

This soil erosion study was conducted at two towns in Gaziantep province (Yavuzeli and Araban). In the east of the study site, the river Euphrates flows (Figure 1). 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 (Anonymous, 1992: 26-28).

2.1. 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. Mean annual precipitation is 578.8 mm in Gaziantep (Tab. 1), approximately 493.3 mm in Yavuzeli and 518.6 in Araban.

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

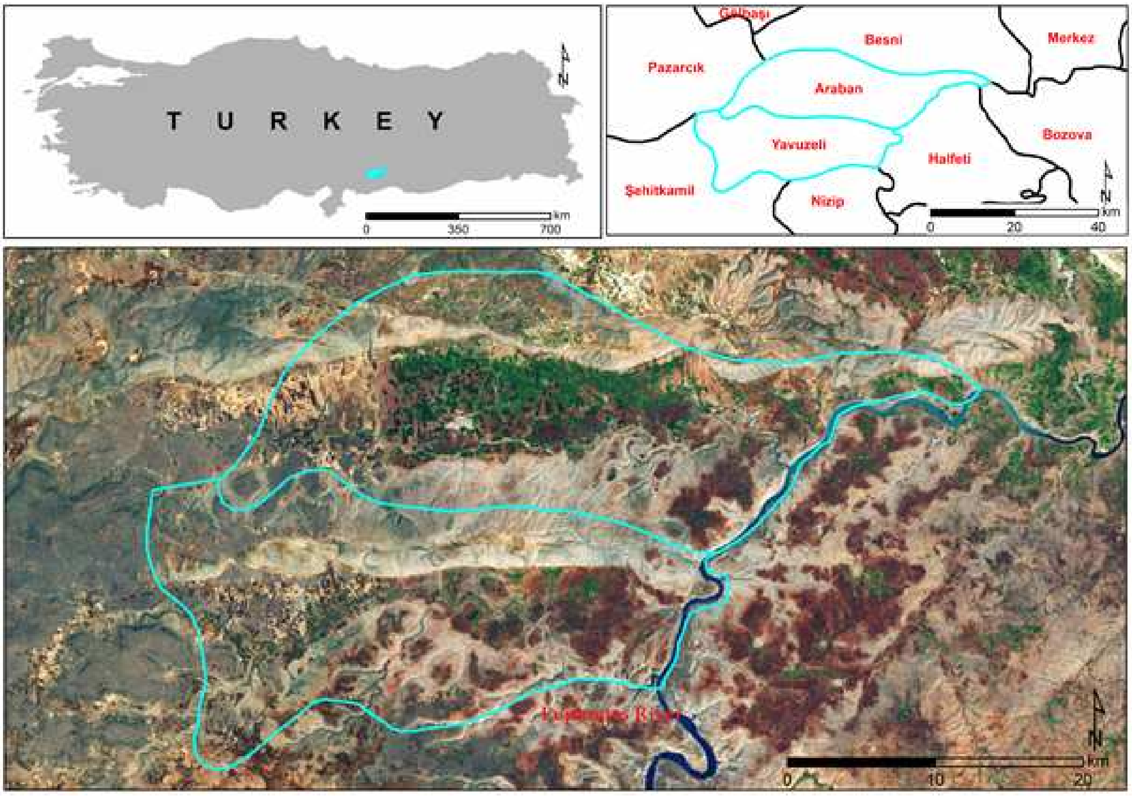

Figure 1: Location map of study area.

Pistachio is cultivated are frequently cultivated in Gaziantep, as are olives, almonds and wine. The natural vegetation mainly consists of grasslands with dwarf shrubs, and to a smaller extent also steppe, garrigue, forest and macchia. In the mountainous areas of the Yavuzeli grow Oak forests ocur, the lowlands are agricultural areas for the production of pistachio, barley and wheat. At the Araban barley, wheat, chickpeas and lentils are cultivated (Table 2).

Table 2: General plant communities of Yavuzeli and Araban

Cultivated plants	Natural vegetation	
Triticum vulgare	*Echium sp.* *Sinapsis arvensis*	*Anthemis sp.*
Hordeum vulgare		*Scolymus sp.*
Avena sativa	*Verbascum sp.*	*Xanthium sp.*
Pistachio vera	*Carduus sp.*	*Poa sp.*
Olea europa	*Anchusa sp.*	*Medicago sp.*
Capsicum annuum	*Cynodon dactylon*	*Rhus coriaria* *Trifolum sp.*
Gossypium hirsutum	*Vicia sp.*	
Lycopersicum esculentum	*Pistachio terebinthus*	*Quercus sp.*
Zea mays	*Astragalus sp.*	*Salvia sp.*
Cicer arietinum	*Pistachio lentiscus*	*Silene sp.*
Prunus armeniaca	*Ziziphora sp.*	*Morus nigra*
Malus sylvestris	*Lamium sp.*	*Stachys sp.*

2.2. ***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 (Munsell Color 2000), pH-value via Schlichting and Blume (1966) with Hanna Model (HI 83140 model), electrical conductivity after Richards (1954), CaCO3 content by means of Scheibler-method after Kretzschmar (1984) by the use of Eijkelkamp M1.08.53.D Model calcimeter, organic matter content via Allison and Moodie method (1965) , grain size analysis after Schmidt (1996) by means of Retsch model AS 200, aggregate classes after AG Boden (2005) and permeability classes after Ad-hoc-AG Boden (1994) and K-factor after Schwertmann et al. (1987) , the RUSLE model after Renard et al. (1994) . The GIS analysis was conducted via ERDAS Imagine 8.7, ArcGIS ArcInfo Workstation 10.0 and Microsoft Office, the percolation analysis after Sekara and Brunner (1943) methods.

Nitrogen was determined after Kaçar (1995) , Fe, Zn, Mn and Cu after Lindsay and Norvell (1978) by means of the AAS device, plant available phosphorus (P) after Olsen et al. (1954) , Potassium (K), Ca and Mg by ASS device after Jackson (1958) . Statistical analysis was accomplished via SPSS 10.0 for Windows.

A total of 32 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) (Tab.3). Plant communities were recorded and classified on-site (Tab. 3).

Table 3: Test sites with altitude and vegetation

Soil Number	GPS Coordinates	Vegetation	Location	Altitude
A1	00375 105 E, 041 26 024 N	Pistachio	Büyükkarakuyu	737m
A2	003 70 921 E, 041 27 353 N	Cereal	Halilbaşlı	646m
A3	003 72 956 E, 041 31 107 N	Cereal	Sarı Buğday	574m
A4	003 74 038 E, 041 33 982 N	Olive	Yöreli	595m
A5	003 81 374 E, 041 33 876 N	Olive	Yarımca	505m
A6	003 86 912 E, 041 34 174 N	Pistachio	Şenlikçe	533m
A7	003 96 646 E, 041 27 783 N	Pistachio	Kasaba	410m
A8	003 95 893 E, 041 32 500 N	Pistachio	Sarılar	535m
A9	003 71 532 E, 041 34 698 N	Fallow	Ballık	672m
A10	003 70 852 E, 041 34 815 N	Fallow	Ballık	560m
A11	003 68 770 E, 041 34 085 N	Cereal	Ballık	681m
A12	003 72 945 E, 041 31 066 N	Cereal	Yavuzeli	567m
A13	003 73 904 E, 041 29 702 N	Fallow	Karapınar	536m
A14	003 72 984 E, 041 28 738 N	Fallow	Çimenli	559m
A15	003 71 875 E, 041 27 937 N	Fallow	Karabey	559m
A16	003 70 921 E, 041 27 354 N	Cereal	Halilbaşlı	646m
A17	003 70 415 E, 041 27 961 N	Fallow	Halilbaşlı	595m
A18	003 69 537 E, 041 24 681 N	Olive	Halilbaşlı	786m
B1	003 00 401 E, 041 39 007 N	Pistachio	Elif	659m
B2	003 00 999 E, 041 39 949 N	Pistachio	Elif	651m
B3	003 02 102 E,041 44 705 N	Pistachio	Altınpınar	508m
B4	003 01 995 E, 041 46 309 N	Cereal	Gümüşpınar	478m
B5	003 87 857 E, 041 45 784 N	Cereal	Araban	531m
B6	003 89 560 E, 041 49 173 N	Fallow	Yukarıyufkalı	611m
B7	003 97 509 E,041 43 259 N	Fallow	Taşdeğirmen	501m
B8	003 94 438 E, 041 44 418 N	Cereal	Araban	499m
B9	003 97 758 E, 041 47 579 N	Pistachio	Karavağız	574m
B10	003 81 333 E, 041 43 535 N	Cereal	Araban	543m
B11	003 78 998 E, 041 49 057 N	Cereal	Köklüce	573m
B12	003 79 632 E, 041 49 006 N	Cereal	Sarıbuğday	571m
B13	003 79 683 E, 041 49 205 N	Cereal	Araban	590m
B14	003 78 487 E, 041 43 332 N	Cereal	Körhacıobası	535m

A:Yavuzeli, B:Araban

Determination of K-factor (Eq. 1)

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

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 Schwertmann et al., (1987) (Tab. 4):

Table 4: Classification of K-factor (Ad-hoc-AG Boden, 1994).

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

3. Results

Chemical and physical proferties of Soil

For the testet soils, we found pH-values from 7.34 to 7.79 and an electrical conductivity between 0.05 and 0.13 mS cm^{-2}. The soil organic matter was determined as low, ranging from 0.52 to 1.96 %, whereas the CaCO3 content was high. Macronutrients (K, Ca and Mg) and micronutrients (Fe, Cu, Zn, Mn) were determined and evaluated after Lindsay and Norvell (1978): the Cu-content was measured between 0.8 and 3.9 ppm for all sites, which is considered a sufficent supply (>0.2 ppm). The Fe-content was too low between 0.25 and 1.26 ppm, which means a partly sufficent supply (>1 ppm). The Mn-content of all soils was found sufficient between 1.12 and 9.04 ppm. The Potassium-content of all soils was very high with values between 234.85 and 893.9 ppm (>2,56), which was also the case for C and Mg: the content was determined between 2623 and 6728 ppm, what is considered very high.

K-Factors of Yavuzeli and Araban soils

The K-factors of the soils in the vicinity of Araban were calculated between 0.33 and 0.79, which means a high susceptibility to soil erosion for the tested arable land within the RUSLE model.

Tab. 5: K-Factors of Yavuzeli and Araban soils

Soil sample	% Sand	% Silt	% Clay	M	A (aggregate class)	D (permeability class)	% OM (organic matter)	K-factor
A1	27.23	28.40	44.37	1851.33	5	1	1.63	0.38
A2	21.24	49.04	29.72	4321.37	2	3	2.93	0.38
A3	20.60	67.24	12.16	6434.01	1	3	1.17	0.65
A4	30.09	57.50	12.41	7276.79	1	3	0.78	0.78
A5	41.25	44.84	13.91	6308.66	3	2	0.91	0.77
A6	45.10	20.16	34.74	3546.31	1	3	0.65	0.34
A7	55.94	29.13	14.93	5150.67	1	3	0.52	0.53
A8	19.78	52.48	27.74	5134.54	3	3	2.28	0.53
A9	42.98	32.88	24.14	5720.44	2	1	1.48	0.66
A10	44.90	22.99	32.11	4479.22	1	2	1.97	0.43
A11	15.79	50.99	33.22	3356.59	3	1	1.55	0.44
A12	11.92	40.53	47.55	4197.55	4	1	1.48	0.58
A13	13.69	46.12	40.19	2648.51	3	1	1.62	0.37
A14	13.26	44.55	42.19	2864.38	2	1	2.54	0.33
A15	13.34	45.06	41.60	2822.03	3	1	2.33	0.37
A16	20.07	42.26	37.67	2928.71	2	1	1.20	0.37
A17	16.77	42.7	40.52	3251.87	3	1	0.92	0.45
A18	21.63	41.16	37.21	3070.05	2	1	1.27	0.38
B1	17.36	44.97	37.67	3876.08	3	3	1.04	0.45
B2	20.13	47.55	32.32	4477.97	3	3	1.76	0.49
B3	20.76	44.28	34.97	3637.02	1	2	2.28	0.33
B4	55.31	29.6	15.08	5663.77	3	3	1.89	0.61
B5	15.93	59.36	24.70	5519.62	3	1	0.72	0.72
B6	23.27	54.68	22.06	5503.43	2	2	0.71	0.64
B7	27.85	57.66	14.49	6609.21	4	1	2.68	0.77
B8	52.14	31.33	16.54	6295.00	2	1	0.42	0.79
B9	21.53	39.28	39.19	3096.20	4	1	1.76	0.46
B10	19.09	44.87	36.04	3130.63	3	1	1.13	0.43
B11	24.58	42.37	33.06	2957.34	3	1	1.41	0.41
B12	16.67	42.14	41.20	2763.98	3	1	2.96	0.35
B13	21.72	43.67	34.61	3455.61	3	1	1.20	0.47
B14	27.14	56.96	15.91	3583.67	2	2	0.42	0.43

A:Yavuzeli B:Araban

Percolation and soil types

Soil types and grain size distribution are displayed in Tab 5. The soil types were exposed to a percolation test that gives information about the amount of water percolating the soil samples within 10 minutes and hence the hydraulic conductivity. The soil types of the Araban soils can be summarised as follows: medium clayey loam (Lt3), slightly clayey loam (Lt2), very loamy sand (Sl4), silty loam (Lu) and sandy-loamy silt (Uls).

Tab. 6: Percolation and soil types of Yavuzeli and Araban soils (Ad-hoc-AG Boden1994, p.135).

Sample	Soil type	Symbol	Amount of percolated water (ml/10 minutes)
B1	Medium clayey loam	Lt3	31.0
B2	Slightly clayey loam	Lt2	53.0
B3	Slightly clayey loam	Lt2	53.5
B4	Very loamy sand	Sl4	276.5
B5	Silty loam	Lu	161.0
B6	Silty loam	Lu	172.5
B7	Sandy-loamy silt	Uls	124.5
B8	Very loamy sand	Sl4	271.5
B9	Medium clayey loam	Lt3	70.5
B10	Medium clayey loam	Lt3	36.5
B11	Slightly clayey loam	Lt2	77.5
B12	Medium clayey loam	Lt3	23.5
B13	Slightly clayey loam	Lt2	72.5
B14	Sandy-loamy silt	Uls	179.0
A1	Sandy-clayey loam	Lts	63.5
A2	Slightly clayey loam	Lt2	63.5
A3	Medium clayey silt	Ut3	163.0
A4	Sandy-loamy silt	Uls	165.5
A5	Silty-loamy sand	Slu	243.5
A6	Sandy-clayey loam	Lts	80.5
A7	Very loamy sand	Sl4	278.5
A8	Silty loam	Lu	38.0
A9	Medium sandy loam	Ls3	149.0
A10	Sandy-clayey loam	Lts	161.5
A11	Medium silty clay	Tu3	51.0
A12	Slightly silty clay	Tu2	9.0
A13	Medium clayey loam	Lt3	12.5
A14	Medium clayey loam	Lt3	14.0
A15	Medium clayey loam	Lt3	11.0
A16	Medium clayey loam	Lt3	46.5
A17	Medium clayey loam	Lt3	24.5
A18	Medium clayey loam	Lt3	28.0

A:Yavuzeli, B: Araban

The medium clayey loam (Lt3) was percolated by 29.8 ml water and slightly clayey loam (Lt2) by 64.0 ml, on average. Very loamy sand (Sl4) was on average percolated by 275.5 ml, silty-loamy soils by 123.8 ml and sandy-loamy silt (Uls) by 156.3 ml. It can be derived from Tab. 6, that sandy soils were the best permeable soil types with the highest percolation rates.

Soil types at Yavuzeli are: medium clayey loam (Lt3), slightly clayey loam (Lt2), very loamy sand (Sl4), silty loam (Lu), sandy-loamy silt (Uls), sandy-clayey loam (Lts), medium clayey silt (Ut3), silty-loamy sand (Slu), medium sandy clay (Ts3) and slightly silty clay (Tu2). As can be drawn from Tab. 6, the sandy soils are those with the highest, the clayey soils those with the lowest percolation rate.

Soil structure and colour

The soil structure and colour in the vicinity of Araban and Yavuzeli are summarised in Table. 7.

Table 7: Soil structure and colour of Yavuzeli and Araban soils.

Soil	Colour	Structure	Soil	Colour	Structure
B1	2.5 YR 2.5/3	Single grain	A3	7.5 YR 2.5/3	Single grain
B2	2.5 YR 2.5/3	Single grain	A4	7.5 YR 3/4	Single grain
B3	7.5 YR 3/4	Subpolyhedron	A5	7.5 YR 3/4	Single grain
B4	7.5 YR 4/4	Subpolyhedron	A6	7.5 YR 4/2	Subpolyhedron
B5	5 YR 3/4	Single grain	A7	10 YR 4/3	Single grain
B6	7.5 YR 3/4	Single grain	A8	10 YR 3/3	Subpolyhedron
B7	5 YR 3/3	Single grain	A9	7.5 YR 4/4	Subpolyhedron
B8	7.5 YR 3/3	Single grain	A10	5 YR 5/6	Single grain
B9	7.5 YR 5/4	Subpolyhedron	A11	10 YR 3/3	Single grain
B10	5 YR 2.5/2	Single grain	A12	7.5 YR 3/2	Single grain
B11	7.5 YR 3/4	Subpolyhedron	A13	10 YR 3/3	Single grain
B12	5 YR 3/3	Single grain	A14	5 YR 4/4	Subpolyhedron
B13	7.5 YR 4/3	Subpolyhedron	A15	7.5 YR 4/2	Single grain
B14	7.5 YR 4/3	Subpolyhedron	A16	2.5 YR 3/3	Single grain
A1	5 YR 2.5/2	Single grain	A17	10 YR 4/2	Single grain
A2	10 YR 3/3	Single grain	A18	7.5 YR 3/3	Single grain

A: Yavuzeli B: Araban

Soil erosion mapping

The study sites' total surface is 103.658 ha, of which 49.656 ha are Yavuzeli and und 54.002 ha Araban region. The erosion risk for Yavuzeli soils was determined low for 36.67 %, medium for 32.3 %, high for 17.32 % and very high for 13.70 % (Fig. 2 and 3).

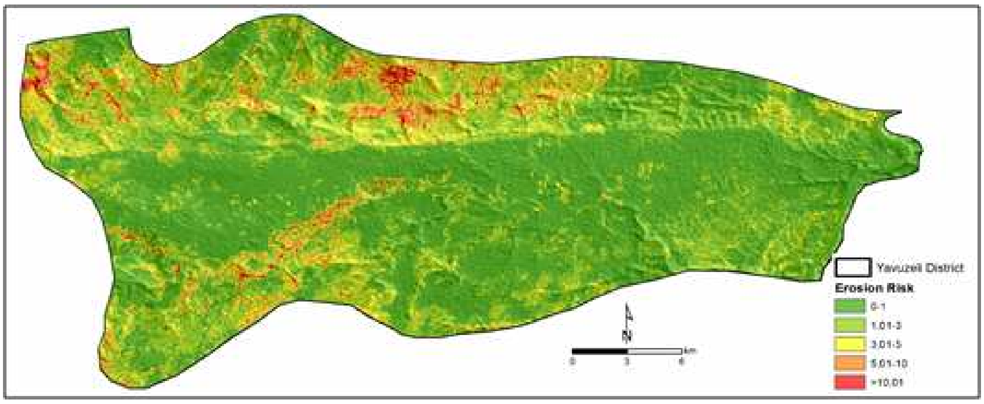

Figure 2: Erosion risk of Yavuzeli.

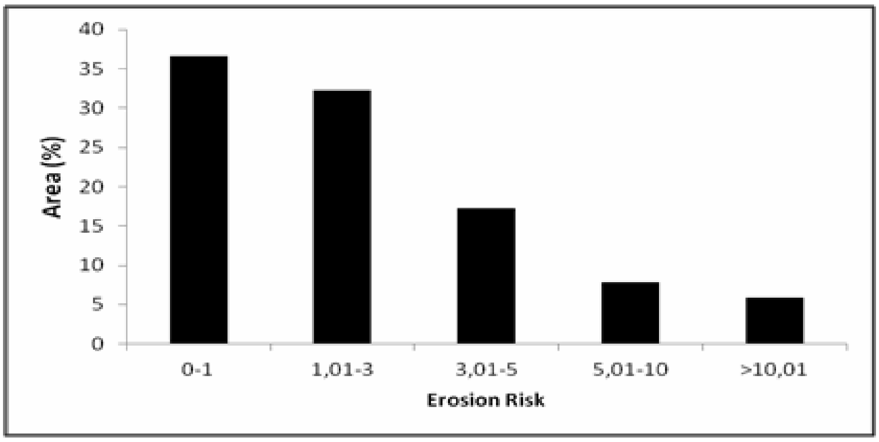

Figure 3: Histogram of erosion risk of Yavuzeli.

The erosion risk of Araban soils was determined low for 36.52 %, medium for 34.3 %, high for 17.31 % and very high for 11.88 % (Fig. 4 and 5).

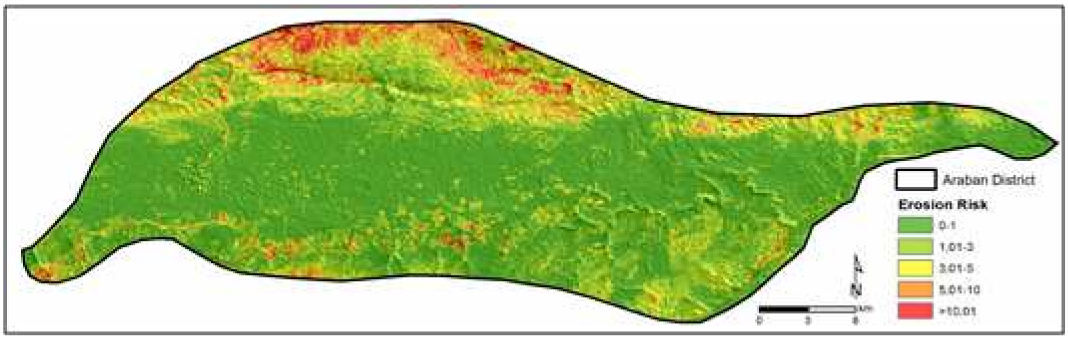

Figure 4: Erosion risk of Araban.

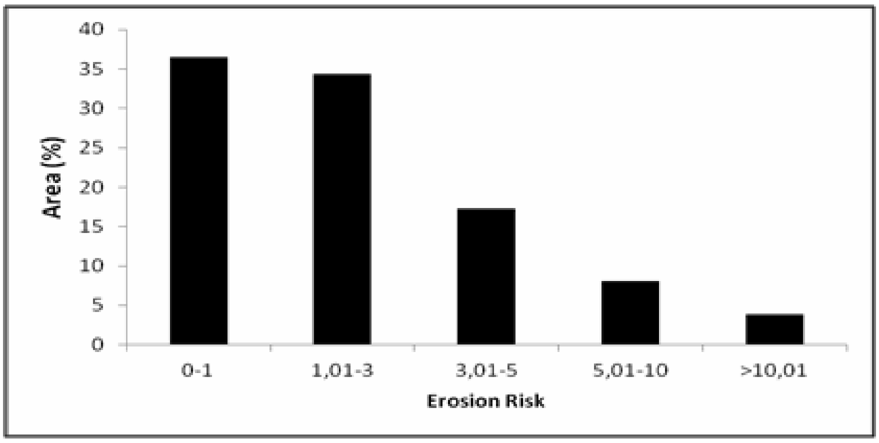

Figure 5: Histogram of erosion risk of Araban.

The GIS erosion maps show, that both 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.

4. 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.

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