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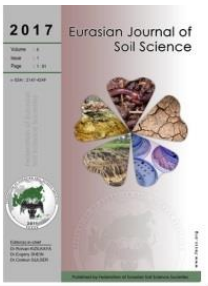

Land suitability evaluation for irrigating wheat by Geopedological approach and Geographic Information System: A case study of Qazvin plain, Iran

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Abstract

Land evaluation, using a scientific method, is essential to recognize the potential and limitation of a given land for specific use in terms of its suitability, and certifies its sustainable use. The soil is such a source that its renewal takes a long time, so effective use of soil and land resources requires a thorough understanding of the effective morphological processes of soil forming in different regions. The current study identified available soil in the area in terms of interpretation of aerial photographs and Geopedological approach. After mapping the geoform area, 61 profiles of the designated area were drilled and sampling was done for all diagnostic horizons. Then, the samples were transported to the laboratory for Physico-chemical analysis. By the end of the profile classification process, which was based on the Soil Survey Staff (2014), the soil map, was prepared by integration of the soil data and the geoform map in ArcGIS software. There are several limiting factors for wheat in Qazvin plain, namely; electric conductivity (EC), gypsum, coarse fragment, soil depth, soil organic carbon (SOC), texture, calcium carbonate and climate. The map of the land units was prepared, and land requirements for the type of utility were calculated. Land suitability evaluation was performed according to FAO. The results showed that land unit's number 17 and 18 were unsuitable (N1) for irrigating wheat with limiting factors such as; high levels of EC and gypsum in the studied profiles. Moreover, the land unit's number 10, 20, and 23 are suitable (S_1) for the wheat production and have the highest rate of predicted yield.

Keywords: Geopedological approach, land units, land evaluation, parametric method, soil map.

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Introduction

The term land suitability is the suitability of a given type of land to support a defined land use, either in its current state or after improvements (Gong et al., 2012). The explosion of the population and rising of living standards has led to greater demand for food. It is impossible to separate the subject of crop production from the environmental issues, so human attention has always been focused on increasing the production of the horticultural crops and more proper use of land. In their land evaluation, (Ayoubi and Jalalian, 2010). Rahsamavati (2012) used land suitability evaluation to determine the potential performance of the products and to monitor the compatibility of land for specific uses (FAO, 1976). In other words, addressing the prediction potential of land for a variety of applications, land evaluation concerns land requirements and

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general characteristics of the potential of the soil in various uses (Senol et al., 1996). In many cases, especially in semi-arid areas, accessing to usable agricultural land is an important limitation. It increases pressure on available land and in turn, it leads to land erosion and degradation (Elaalem et al., 2011). Therefore, it seems necessary to perform an accurate and reliable assessment of the land in order to take a decision on the processes involved in the development of land use policies. Today, land suitability evaluation in developing countries is considered as the main factor for selecting crop adapted to soil and climatic conditions of each region (Baqer Zadeh et al., 2012). There are several methods for assessing the land which is now increasingly used. Due to soil separation ability, which is more homogenous than the traditional soil mapping, the Geopedological method has been used in several studies (Gholizadeh et al., 2001) to evaluate land suitability assessment. This approach uses a hierarchical structure that leads to the purity of soil map units, especially in areas where there is a close relationship between geomorphology and area soils (Zinck, 1989). Remote sensing techniques (RS) and Geographic Information System (GIS) are used as analyses and prediction methods for making variety of planning and test results obtained from various decision makings (Rossiter, 2000). Although the GIS spatial analysis is not a novel concept, it constitutes a significant portion of land suitability analysis and mapping (Feizizadeh and Blaschke, 2013). A study conducted in Turkey evaluated the qualitative land suitability using Geographic Information System (GIS). The researchers reported that 40.1% of the land was allocated for wheat cultivation, and 54.1 and 65.8% of the land were used for cultivating crops such as citrus, tomato, and cotton with the suitable class of S1, S2 and S3, respectively (Ozcan, 2006). Qualitative assessment of land suitability in the Nishabur plain used GIS for cultivating wheat, cotton and corn. Soil physical properties were reported as the main limiting factors for planting wheat in the area, whereas the production of maize and cotton was mainly limited by climatic conditions (Baqer Zadeh et al., 2012). Some studies were conducted in different parts of Iran to evaluate suitability of land for a given utilization (Mohammed, 2004; Teka and Haftu, 2012; Maharia and Alebachewa, 2013; Teshome et al., 2013; Gizachew, 2014) and to find an optimum use for each land unit (Jafarzadeh et al., 2005, 2008; Navidi and Sarmadian, 2011; Safari et al., 2013; Kamkar et al., 2014; Tati and Sarmadian, 2014; Hashemvand Khiabani and Sarmadian, 2014). According to the above- mentioned items, the main purpose of this study is to evaluate strategic land evaluation parametrically for irrigating wheat crop using the geopedological approach and GIS techniques on some parts of the agricultural plain located in Abeik, Qazvin province.

Material and Methods

Study site

The study area is located between 36° 1' and 36° 9' N, and 50° 21' and 50° 14' E, approximately 16630 ha, in the Abyek area, Qazvin Province, Iran (Figure 1). The mean annual precipitation and temperature at the site are 284 mm and 14°C and the coldest and hottest months are December and July, respectively (IMO, 2015) (Table 1). Soil moisture and temperature regimes are dry xeric, weak aridic, and thermic, respectively, according to Van Wambeke (2000).

Table 1. Climatic characteristics of the synoptic meteorological station of Qazvin (IMO, 2015)

Characteristics	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Mean min temp. (°C)	-2.3	-2.8	1.5	6.4	10.4	14.5	17.6	17.0	12.9	7.9	2.8	-4.3
Mean max temp. (°C)	5.8	8.2	13.8	20.2	25.8	32.2	35.4	34.9	30.9	23.4	15.2	8.4
Mean temperature (°C)	0.8	2.7	7.6	13.3	18.1	23.4	26.5	26.0	21.9	15.7	9.0	3.4
Rainfall (mm)	35.9	30.7	50.1	40.5	30.3	3.9	2.1	1.7	0.8	18.3	30.8	38.9
Relative humidity (%)	70.0	65.0	56.0	51.0	38.0	38.0	37.0	38.0	46.0	57.0	68.0	51.0
Sunshine (hours)	159.8	167.3	195.2	226.9	281.2	349.2	354.8	345.8	306.3	343.3	182.6	142.9
Calculated ETp (mm)	23.6	37.5	72.5	106.5	142.6	181.9	191.8	179.8	128.5	78.1	40.2	23.5
Mean wind speed (m/s)	1.27	1.78	2.39	2.24	2.55	2.44	2.29	2.09	1.68	1.47	1.27	1.98

The study area belongs to the quaternary period and had been developed by gravel and sand sediments and alluvial fans (Navidi and Sarmadian, 2011). The dominant landscapes of the study area are hillands, Peneplains, Piedmonts and plains that have classified the area into four different geomorphic units (Zink, 2013). The pasture, irrigated and fallowed cultivation field, rainfed lands, Rajai power plant and residential section are the major land uses in this area.

Preparation of geoform map

Firstly, an interpretation of aerial photos (1:40,000 scale from Iran Surveying Organization) was performed based on the expert opinion, the systematical structure of geopedology (Zinck, 1989) and the geology as well as the topography maps of the study area. According to the geopedological method, the geomorphologic units were classified into four levels; landscape, relief, lithology, and landform. To determine the lithology layer, a geological map of the area with a scale of 1: 100,000 was used. Then, the accuracy of boundaries was studied and finally the geoform map of the area (1: 40,000 scale) was prepared. This map was used as the base map for geological field studies and preparation of the soil map.

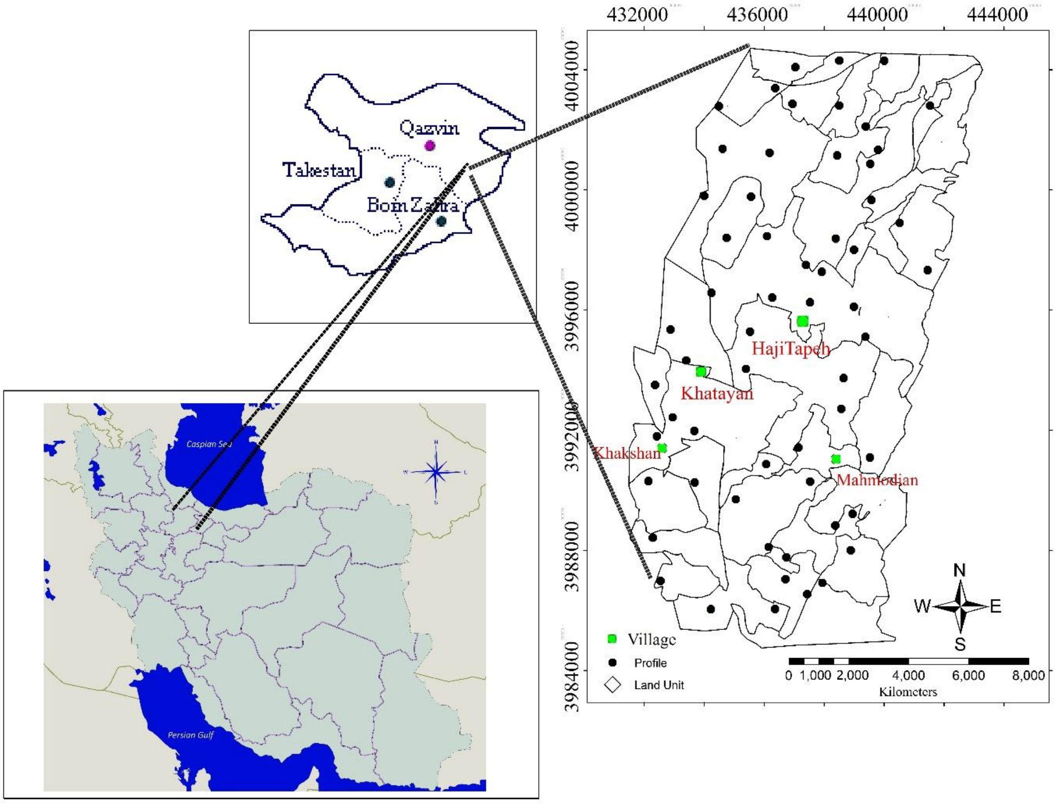

Figure 1. The sampling point location in studied area

Field work and laboratory analysis

To obtain basic data, 61 soil profiles were described in different parts of the study area. Physico-chemical variables were performed on fine fractions (<2 mm) after drying and grinding the samples. The specifications of the surface and sub-surface horizons were measured as follows; color (Munsell Color, 1994), structure, soil texture by hydrometer method (Gee and Boudry, 1986), organic carbon by Walkley-Black method (Walkley and Black, 1934), lime (calcium carbonate) content by Scheibler calcimeter, gypsum by the Aston method, coarse fragment percentage in terms of volume, electrical conductivity by electrical conductivity meter, soil reaction by pH meter (Black, 1965), cation exchange capacity by Bover method (Bover et al., 1952), available phosphorus by Olsen method (Olsen et al., 1954), and total soil nitrogen according to Black (1965). The classification of sampling points was performed to family level based on the Soil Survey Staff (2014).

Preparation of Soil map

Providing the soil map based on the relationship between soil and geomorphology is one of the main objectives of this study. To achieve this goal, the soil map with 24 units was prepared using incorporating soil data and geoform map in GIS software environment.

Land suitability evaluation using FAO method

Required features for this assessment are climatic information (rainfall, temperature, radiation, relative humidity) and the characteristics of the profile of the land, and soil (slope, flooding, soil texture and structure, coarser sand particles, the amount of calcium carbonate, gypsum percentage, cation exchange capacity, soil pH, soil organic carbon (SOC), electrical conductivity (EC) and exchangeable sodium percentage (ESP)), the correction factor applied to the weighted average for efficiency types on the basis of standard tables (Sys et al., 1991b; Nahusenay and Kibebew, 2015). Matching and classification of land suitability for wheat were also done based on the parametric methods (stories and square root). The water production potential was used to determine the production potential of wheat in the region. This model evaluates the vivid, pure products and its yields for the best varieties in terms of favorite conditions of weather, nutrition's, and controlling pests and diseases. Equation 1 was used in order to calculate the net biomass of all living plants.

$$\mathrm{Bn} = 0.36\,\mathrm{bgm} \times \mathrm{KLAI} / \left[(1/\mathrm{L}) + 0.25\mathrm{Ct}\right] \tag{1}$$

Where, Bn is net biomass of the living plant, bgm is maximum gross biomass production rate (kg CH_2O /ha.hr), LAI is leaf area index, K is correction factor which for LAI less than 5 m^2/m^2.

Equals 0.95. L is the length of the growing season (days) and Ct is respiration quotient that is obtained from following formula (Eq. 2).

$$\mathrm{Ct} = C_{30}(0.444 + 0.0019 \times \mathrm{t} + 0.001\mathrm{t}^2) \tag{2}$$

Where, t is average daily temperature during the growing season (in Celsius), C30 is the ratio of non-legume, 0.0108, and 0.0283 for legumes.

Equation 3 was used for calculating the production of water potential (Sys et al., 1991b).

$$Y = Bn \times Hi \tag{3}$$

In this equation, Y is yield of a crop (kg/ha), Bn is net biomass production (kg CH_2O/ha), and Hi is harvest index as a part of net biomass that is economically usable (e.g. grain in cereals, sugar in sugar beet and sugar cane) (Sys et al., 1991b).

Parametric index in land evaluation

The main core of these methods by calculated of indices obtained from combining numerical grades of several factors. In terms of their impact on the target, land, properties are graded between 0 and 100. Given that it has a relative scale (e.g. comparing with lands with a slope of 40°, those with 80° slope is much more proper for cultivation, both the Storie and the square root equations were used respectively in the (Eq. 4 and 5), in order to determine different degrees of land (Sys et al., 1991b). In this study, eight characters such as; EC, gypsum, coarse fragment, depth, SOC, soil texture, calcium carbonate and climate were used for determining the final class of land suitability for wheat. Theses parameters had the most significant role in determining the suitability classes (Table 6). Storie method (Storie, 1978) is described as below:

$$I = A \times \frac{B}{100} \times \frac{C}{100} \times \cdots \tag{4}$$

In this equation, I is the land index and A, B, C,… are the characteristic of various properties. The Square Root Method (Khiddir, 1986):

$$I = R_{\min} \times \sqrt{\frac{A}{100} \times \frac{B}{100} \times \cdots} \tag{5}$$

Where, I is square root index, R_{min} is minimum rating between different characteristics, A and B are other rating beside the minimum. After calculating the index value of each land unit, the rate of the suitability class was determined for each unit (Table 2).

Table 2. Determine classes of land suitability for FAO methods (Sys et al., 1991a)

Land suitability class	land index	Symbol
Very suitable	75- 100	S1
Moderate suitable	50-75	S2
Marginally suitable	25 - 50	S3
Temporary unsuitable	25 – 12.5	N1
Permanently unsuitable	12.5 - 0	N2

Calculation of Predicted yield or potential yield

This product is the factor which is predictable according to the specifications of each product per land unit. It is achieved by multiplying the land index per land by the estimated potential product using FAO model in Eq. 6, (Bagheri, 2010).

$$PY = LI \times LPY \tag{6}$$

Where, PY is the predicted yield (kg/ ha), LI is land index, LPY is land potential yield.

Results and Discussion

Geoform and Soil map

The geoform map was prepared based on the Systematic approach of Geopodologic. The studied area was divided into four units on landscape level, seven units in terms of relief, and 13 units in terms of landform level, and the finally, the area geoform map was prepared with 32 units. The landscape units included hilland, peneplain, piedmont, and plain and each unit included 189 ha (1.14%), 1533 ha (9.22%), 7255 ha (43.63%), and 7571 ha (45.53%), respectively (Table 3). Thus, the plain and Piedmont units had the largest parts in the study area. Figure 2 indicates the distribution map of geoform units in the study area.

Table 3. Geoform units as identified in the area

Area				Area			
%	Hectare	Geoform unit	Land scape	%	Hectare	Geoform unit	Land scape
1.2	200	Pe444	Piedmont	189	1.13	Hi111	Hilland
2.75	458	PL111	Plain	377	2.26	Pe111	Peneplain
1.31	218	PL112		243	1.46	Pe122	
3.94	656	PL113		232	1.39	Pe214	
3.95	657	PL123		254	1.5	Pe223	
3.92	653	PL124		123	0.73	Pe224	
5.36	893	PL131		114	0.68	Pe333	
2.11	351	PL223		1034	6.21	Pi111	Piedmont
0.75	125	PL232		371	2.23	Pi112	
7.14	1189	PL233		813	4.88	Pi121	
3.48	580	PL234		1289	7.75	Pi123	
1.25	208	PL235		120	0.72	Pi124	
4.01	667	PL242		205	1.23	Pi125	
3.2	533	PL243		2006	12.06	Pi134	
1.64	274	PL254		1372	8.25	Pi143	
0.26	44	PL326		259	1.55	Pi145	

On the Geopedological approach, it is possible to study a wide geographic area quickly, especially if the relation between geomorphology and the soils is well defined (Rossiter, 2000). The soil map of area (1:40000) was prepared based on the relationship between geoform and soil layers. For this purpose, the layer of soil data, including classification of the sampling points and the map of the geoform units were integrated, and the soil map with 24 map units were prepared through applying the geopedological method (Zink, 2013), (Figure 3). The results revealed that the properties of soil vary from place to place. These diversities incur that natural soil bodies are the result of climate and living organisms acting on parent material with topography or local relief exerting a modifying influence and with time required for soil-forming processes to act (Zaremehrjardiri, 2011). Results of soil classification (Soil Survey Staff, 2014) in the subgroup, in each landscape unit are presented in Table 4. According to the table 4, distribution of soil class in each landscape are 50% in plain, 35% in piedmont, 7/5% in peneplain and 7/5% in hilland, respectively. The results showed that the highest soil variation was observed in the plain landscape.

Table 4. Soils in the study area (Sub group) (Soil Survey Staff, 2014)

Landscape	Soils has the most frequency	Other soils	% soils in each landscape	Label of soil map unit
Hilland	Lithic xerorthents	-	7.5	6
Peneplain	Typic calcixerepts	-	7.5	2-4-5-NR
Piedmont	Fluventic haploxerepts	Typic calcixerepts, Typic haploxerepts, Typic xerorthents	35	3-7-8-9-10-20-22-24
Plain	Sodic Xeric Haplocalcids	Sodic Xeric Calcigypsids, Xeric Calcigypsids, Gypsic Aquasalids, Gypsic haplosalids, Xeric haplocalcids, Xerofluventic haplocambids	50	11-12-13-14-15-16-17-18-19-21-23-1

Land suitability evaluation

To determine a map of the land units for each type of desired efficiency, the requirement tables of climate, soil and land were examined for water irrigated wheat (Sys et al., 1991b). Since the desired products are irrigated with water, rainfall limitations have no effect on climate class of the area, because they were irrigated at every stage of the plant water requirement (Sys et al., 1991b). Considering the history of wheat cultivation and weather station data available in the area (IMO, 2015), climatic suitability classes of wheat were separately calculated based on the square root and the Story parametric methods (Sys et al., 1991b). The results showed that the studied area had the perfect climate for wheat (S1) and there was no limitation to its growth during the growing season.

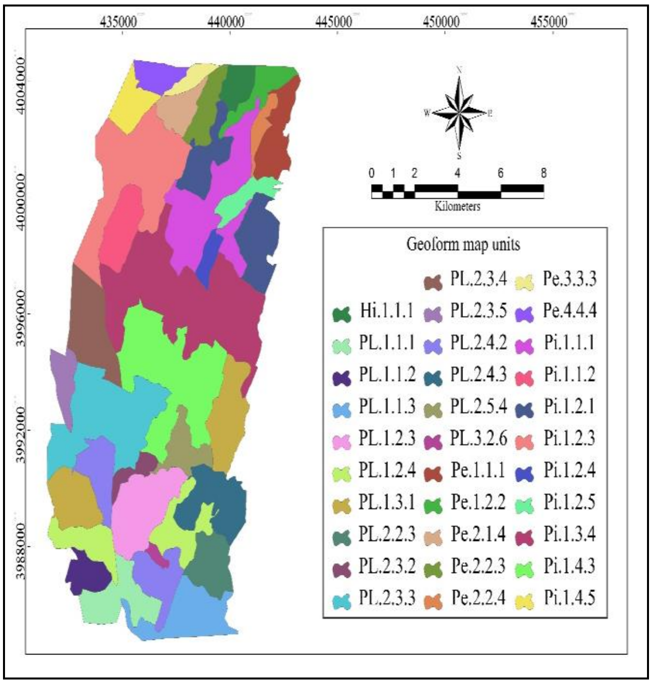

Figure 2. Geoform map units in the study area

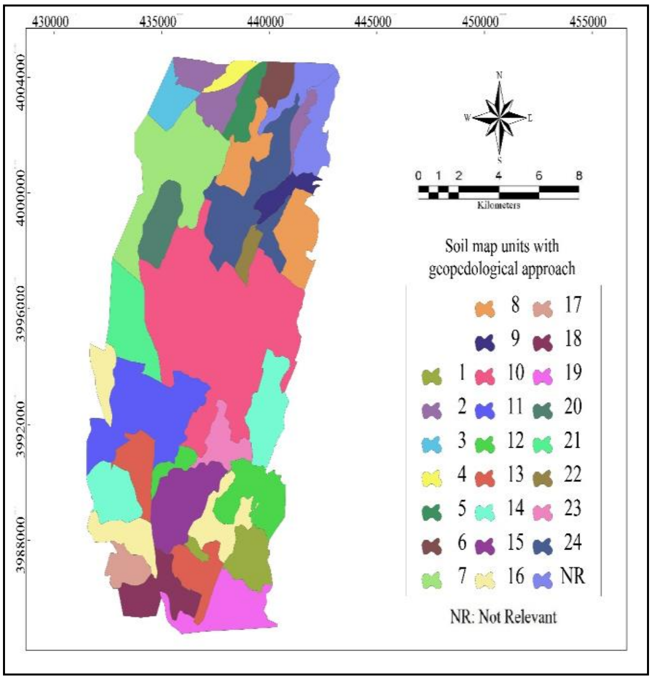

Figure 3. Geopedological soil map of study area

The required values of climate, soil and land for irrigated wheat in the region are provided in Tables 5 and 6, respectively. According to FAO method, the potential production of wheat was 6666 kg/ ha. Navidi and Sarmadian (2011) and Tati and Sarmadian (2014) in separate researches calculated the potential production of wheat in Qazvin plain with the similar results. After calculating the land requirements for wheat and in accordance with the FAO method, each of the eight characteristics of climate, soil and land received a rate between 0 and 100 (Sys et al., 1991b). Next, the final values of the land index were separately calculated based on the square root and the parametric Storie methods. Table 7 shows the rates of land values under the suitable class and the predicted yield for each land unit. Classification of changes in land suitability classes for wheat is shown in both Figures 4 and 5. The results of Table 8 also illustrate that based on Storie method, 24.1% of the area had a high suitability class S1, 36% of the area had a moderate suitability class S2, 30.85% of the area had a low suitability class S3, and 5.33% of the land had unsuitable class N1. However, the results of the land classes in the square root method showed that 34.9% of the area had a high suitability class S1, 42.86% of the area had the moderate suitable class S2, 14.4% of the area had a low suitability class S3, and 4.18% of the area had unsuitable class N1. The results obtained by the parametric square root method are probably more realistic when compared with other reports (Sarvari and Mahmoudi, 2001; Jafarzadeh et al., 2005, 2008; Taati and Sarmadian, 2014) that were applied by different methods in different parts of the country.

Table 5. Rating of climatic factors for wheat crop in Qazvin plain (IMO, 2015)

Suitability class	Rating scale	Temperature degree (°C)	Climate features
S2	89	11.44	Mean temperature of the growing cycle (°C)
S1	99	8.31	Mean temperature of vegetative stage (°C)
S1	99.85	14.12	Mean temperature of the Flowering stage (°C)
S1	96.89	19.11	Mean temperature of the ripening stage (°C)
		0.77	Average daily minimum temperature. coldest month combine with
S1	100	10	Average daily maximum t° coldest month

Figures 4 and 5 represent changes in land suitability for wheat based on the Storie parametric method and the square root methods respectively. To better understand the changes in distributions of land suitability classes, a change is shown in Table 8. As shown in Table 7, the land unit numbers (LUN's) 17 and 18 have the lowest yield prediction, for these two units are located in the southern part of the region and in the landscape of the plane lands. In fact, high levels of salt and gypsum would limit these two LUNs.

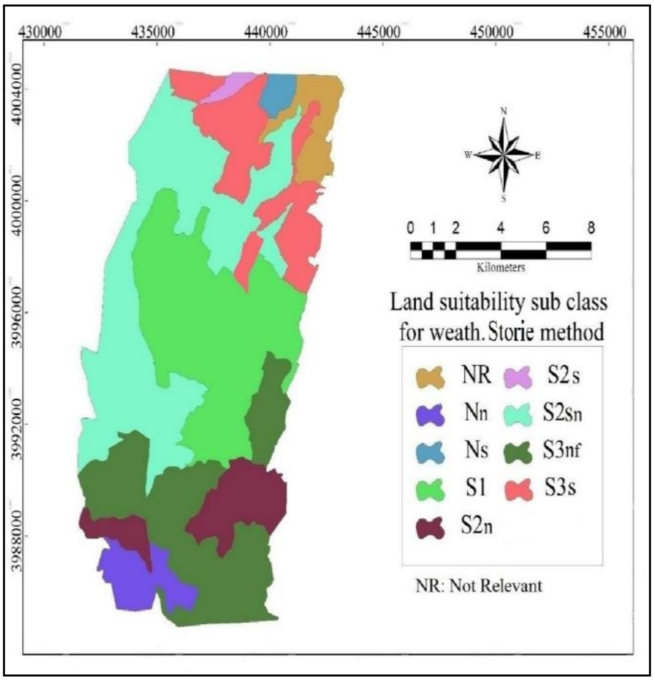

Figure 4. Land suitability sub class for wheat with Storie method

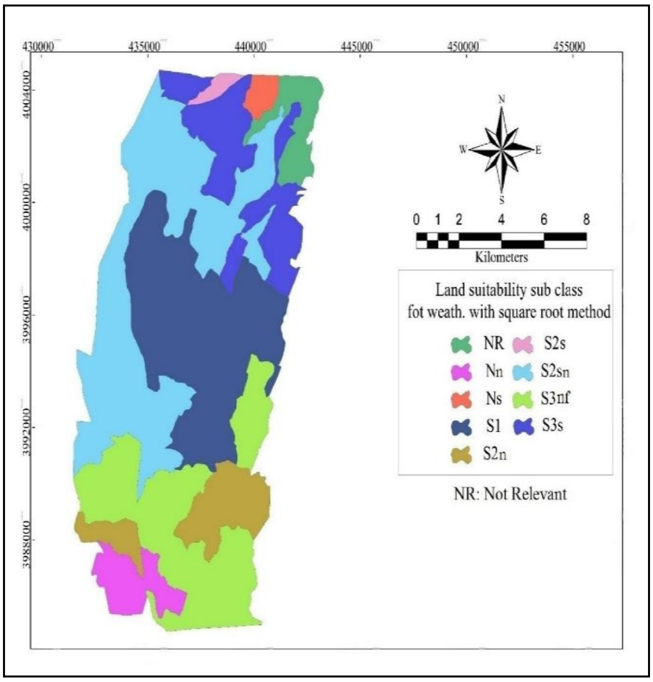

Figure 5. Land suitability sub class for wheat with Square root method

Table 6. Some soil characteristics and land requirements in the study area in terms of wheat cultivation

Coarse Fragment,%	Organic Carbon,%	TNV, %	Gypsum, %	Electrical Conductivity (dS/ m)	Texture*	Depth (cm)	LUN
0	0.41	18	15	3.5	C	110	1
31	0.42	25	0	0.62	SL, L	85	2
6.31	0.36	19.5	0	1.07	CL	105	3
23	0.44	20.73	0	0.54	L	90	4
15.3	0.48	4	0	0.48	SL	75	5
35	0.51	4	0	0.59	SL	20	6
5.2	0.28	6.7	0	0.7	L, SL	102	7
40	0.4	9.14	0	0.9	SCL,CL	40	8
20	1	8.85	0	0.77	SL	85	9
3.5	0.58	7.5	0	1.23	CL,SiCL	140	10
0	0.55	21.9	0	5.5	C	140	11
0	0.58	14.53	0	4.59	C	100	12
0	0.55	17.33	8.75	9	C	145	13
0	0.53	16	1.1	7	C	140	14
0	0.55	18.5	3.5	3.5	C	115	15
0	0.61	17.15	0.56	2.1	CL, C	120	16
0	0.56	15.14	2.2	38	CL	150	17
0	0.45	10	9.5	36	C	140	18
0	0.65	17.81	0	6	C	150	19
9	0.86	10	0	0.86	CL, L	120	20
0	0.56	11	0	0.91	CL, SiCL	130	21
13	0.39	2.6	0	0.65	SL	50	22
0	0.57	9.23	0	1.09	C	120	23
15	0.40	7.7	1.1	1.01	SL،L	17	24

*Note: C,SL, CL; L, SCL, SiCL, respectively, Clay, Sandy Loam, Clay loam, Sandy clay loam, Silty Clay loam

High rate of salinity more than 4 dS/m has limited effect on wheat production (Sys et al., 1991a). Moreover, it was observed that the LUN 6 was placed in the not suitable class N1, which according to its location, on the face of the land limited the properties of soil depth, large amounts of gravel with the slope factor for wheat cultivation. The LUN 23 had the highest level of the predicted performance in the area. This unit is located on the landscape of the plain, and all characteristics of this unit have a high proportion for irrigated wheat cultivation. Moreover, after this unit, the LUN's 10 and 20 had a high proportion for irrigated wheat cultivation. Of course, the results of the conformity class in the square root method confirmed these results and showed that LUN's 17 and 18 were placed in the unsuitable and the LUN's 23, 20, 16, 12, 10 and 3 had a high proportion for irrigated wheat cultivation. Zeinodini (2003) evaluated land suitability for wheat in Bardsir, Kerman. The results of suitability classification of land for the separated land units showed that the classes are various according to the parametric method from S1 to S3. The most significant limiting factors in mass wheat production in the region could be gypsum, texture, and soil structure. In their study on Qazvin plain, (Navidi and Sarmadian, 2011) also reported that the most important factors limiting wheat, barley and hay crops in most units were soil texture, lime content, and drainage condition.

Table 7. the rate of the land units, sub class, and the predicted performance for wheat based on the Storie and Square root methods

LUN	Storie method	Predicted Yield (Kg/ha)	Sub class	Square root method	Sub class	Predicted Yield (Kg/ha)
1	28.22	1881.14	S3ns	41.24	S3ns*	2749.05
2	49.83	3321.66	S3s	57.66	S2s	3841.61
3	72	4792.52	S2s	85.5	S1	5841.41
4	68	4532.88	S2s	67.7	S2s	4512.88
5	39.88	2658.40	S3s	44.3	S3s	2953.03
6	24.43	1628.50	N1s	38.2	S3s	2546.41
7	65.33	4354.89	S2s	74	S2s	4932.84
8	38.19	2545.74	S3fs	55.61	S2s	3706.96
9	37.68	2511.74	S3s	41.71	S3s	2780.38
10	80.54	5368.79	S1	86.47	S1	5644.10
11	53.2	3546.31	S2nf	62.84	S2nf	4188.91
12	67.5	4499.55	S2nf	77.5	S1	5166.15
13	44.6	2973.03	S3ns	47.7	S3ns	3179.68
14	43.52	2901.04	S3ns	51.2	S2ns	3412.99
15	49.3	3286.33	S3ns	59.4	S2ns	3959.06
16	69.75	4643.53	S2nf	80.85	S1	5389.46
17	17.47	1161.88	N1n	21.3	N1n	1419.85
18	13.3	886.57	N1n	18.43	N1n	1228.54
19	39.77	2651.06	S3ns	40.62	S3ns	2707.72
20	79	5266.14	S1	81.2	S1	5412.79
21	64	4266.24	S2s	65.85	S2s	4389.56
22	39.2	2613.07	S3s	43.58	S3s	2905.04
23	91.2	6079.39	S1	92.3	S1	6152.71
24	65.22	4347.56	S2s	67.7	S2s	4512.88

Note: *n, s and f, represent the salinity and alkalinity limitations, physical properties of soil and fertility.

According to the results mentioned in this study, the limitation caused by soil texture was observed in LUN's 2 and 8, so their results were consistent with the results observed in the wheat crop. Moreover, Lime limitation was observed in LUN 2 for the production of wheat in all calculations used for determining the degree of land, and the square root of the results of the parametric method presented a more logical result of the Storie method. Bagher Zadeh et al. (2012) reported that due to reverse multiplication of successive characteristics of soil and climate by each other, the Storie method's results were very strict and far from reality, whereas the second square root represented more balanced results for determination of the suitability of these classes and products.

Table 8. Related area to different suitability classes for weath base on Storie and square root method in the study area

Suitability	Weath (Storie method)		Weath (Square method)	
	Area (ha)	% Out of total	Area (ha)	% Out of total
Suitable	4007.83	24.10	5803.87	34.90
Moderate suitable	5986.80	36.00	7127.61	42.86
Marginally suitable	5130.35	30.85	2394.72	14.40
Unsuitable	1505.20	9.51	1303.80	7.84
Total area	16630.00	100.00	16630.00	100.00

Conclusion

Since a soil map is the basis of land evaluation studies, higher accuracy and purity of the map would improve the accuracy of the assessment of land suitability. Because it is based on a hierarchical structure, the geopedological approach would be able to identify the geomorphic units and justify the relationship between geoform units and the soil created on it. Based on the soil map prepared, the higher frequencies of the region's soils were observed in the profile of the plain. The results showed that these three LUN's 6, 18, and 17 had the lowest suitability class N1 for wheat. In addition, the three land unit's No. 23, 20, and 10 had the highest suitability S1 for wheat. The other results of this study differentiated in the discrepancy between the two parametric methods, the Story and the square root, which lead to a difference between the suitability classes in each land unit for the desired products. In addition, the presence of such difference between the correct equations of land index will result in a greater amount of land index in the second square method rather than the Storie method. It would finally improve the suitability class of the lands and the yield amount observed in the calculated land units will improve in the second root parametric method. Among these 8 features used for determining the characteristics of the final class of land suitability for each of the products, the sequence, soil salinity, gypsum, coarse fragment, soil depth, soil organic carbon, soil texture, lime content and climate, had the most significant role in determining the conformity classes of the products.

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