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Prepare Thematic Maps of Soil Characteristics for the Purpose of Planting it with Trees using Geographical Information Systems in some Areas of Basra Governorate

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ABSTRACT

This study was conducted to find out the suitability of the lands for planting trees in the study area in Basra Provence. Soil units were separated by using remote sensing technology through the use of the Landsat 8 satellite image with field observations and a map of soil units was prepared using GIS and ERDAS software, eight sites of soil profile were identified. The lands of the study area were evaluated for planting the selected trees using the amended proposals contained in the system (Sys et al., 1993). The process of evaluating lands in this system requires the availability of information about the characteristics of the land and its conformity with the requirements of the trees contained in those proposals. The results showed that the lands of the region are classified according to their suitability for the cultivation of the selected trees, and in varying degrees, into a suitable land class S3 and an unsuitable land class N1 for planting trees, with rates of 33.78% and 66.12% of the total area, respectively, and the main determining factors were the salinity factor, the organic matter factor, Soil depth factor and Natural drainage factor.

KEYWORDS

Soil Characteristics, Remote Sensing, Land Suitability, Geographic Information System.

Introduction

Soil is one of the main natural resources on which agricultural production depends, and realizing the full benefit when exploited requires the application of modern scientific methods and procedures that help achieve sustainable agricultural production represented in increasing productivity and preserving land from deterioration due to use. Soils on a large scale, while giving the necessary recommendations on how to use and maintain soil units and determine the suitability of each soil unit for various purposes, especially agricultural ones (Al-Ani, 2006). The agricultural sector in Basra Provence suffers from limitations, as its soils are located at the end of riverbeds, and the quality of the water supplied to it suffers from deterioration in quantity and quality. Most of the lands of Basra Provence have been identified as being invested by the oil companies as oil reservoirs, which reduced the available agricultural areas, in addition to the current leveling of agricultural lands and their use as residential areas. And that the suitability of the land is one of the methods of evaluating the lands for the best use proposed, developed and approved by the Food and Agriculture Organization (FAO, 2000), which shows the extent to which the properties of soil and land correspond to the needs of the proposed crop under current soil and ground conditions or after some improvements (Nechtergaele, 2000 2000). Land suitability classification is defined as the process of assessing and grouping specific types of land into classes, relative to their suitability for a specific type of land use (FAO, 2000). One of the advantages of geographic information systems related to land evaluation is the great potential in spatial analyzes and the production of maps automatically, distinguished in its ability to process and analyze data and from many sources such as land use maps, digital and climatic elevations and vegetation and that the use of geographic information systems was the best in the land assessment processes Compared to the manual method (Heywood *et.al*, 2002). The main use of digital earth resource maps is spatial analysis of geographical data using geographic information systems programs that can be performed with high accuracy and speed, as well as other features which are overlay with maps and other layers such as satellite image or digital elevation models to produce models for purposes Multiple (Van Gool et.al, 2005). Pauw (2001) showed that the land suitability classification system proposed by FAO (1985) has an ordinal structure with different levels indicating the type of suitability, and this system includes suitability classes that are Suitable (S) and include in turn the suitability classes are very Suitable (S1), Moderately Suitable (S2) and Marginally Suitable (S3). The other ordre is Non Suitable (N) and includes two classes, The other class is inappropriate (N) and includes two classes, which are currently non-suitable (N1) and an inappropriate class currently and in the future (N2).

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Therefore, the study aimed to evaluate soils for suitability purposes for planting perennial trees in Majnoon area and to prepare maps of soil characteristics and suitability under the current conditions.

Materials and Methods

Study Area

The study area is located in the north of Basra Provence, southern Iraq, within the administrative boundaries of the Qurnah district. The study area is located within the hot and dry desert climate and its soils are characterized by sedimentary origin material that goes back to the order Entisols. As for its geographical location, it lies between latitudes 30 ° 55'58 " – 31 ° 15'59" north and longitudes 47 ° 31'49 " – 47 ° 40'40" and has an area of 427.582846 km^2. 8 typical pedons representing the study area were determined using the GPS device, Figure 1.

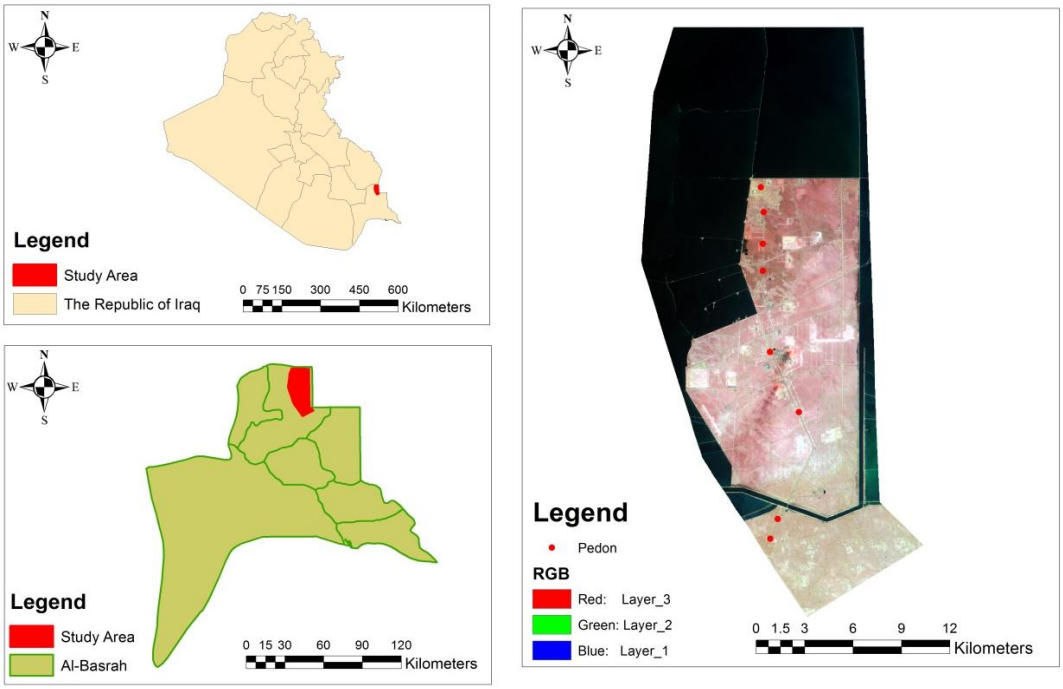

Figure 1. Study area

Determination of Pedon Sites

Several site visits were made to the study area, with the aim of determining the sites of digging pedons representing the soil units in the study area. The satellite image for the year 2020 was relied on to survey the soil, as it was observed during field visits that the study area is not agricultural use and it is abandoned lands. A soil survey was conducted based on the spectral reflectivity from the satellite image data as follows:

A. Satellite Image

The satellite image captured by Landsat 8 satellite, The Operational Land Imager, was used with eleven spectral bands on 9/10/2020 with a discrimination ability of 30 m. The satellite image was used in the supervised and unsupervised classification in order to determine the dominant classes in the study area.

B. Classification of the Satellite Image

The numerical classification of both supervised and unsupervised was used after obtaining the satellite image for the study area fully corrected as in Figures 2 and 3 respectively.

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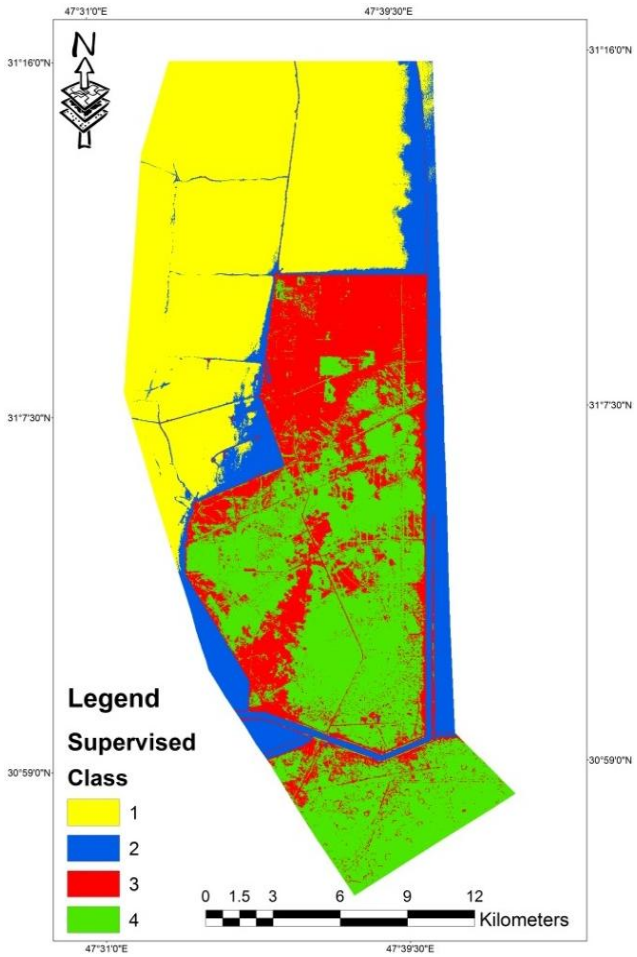

Figure 2. Supervised Classification

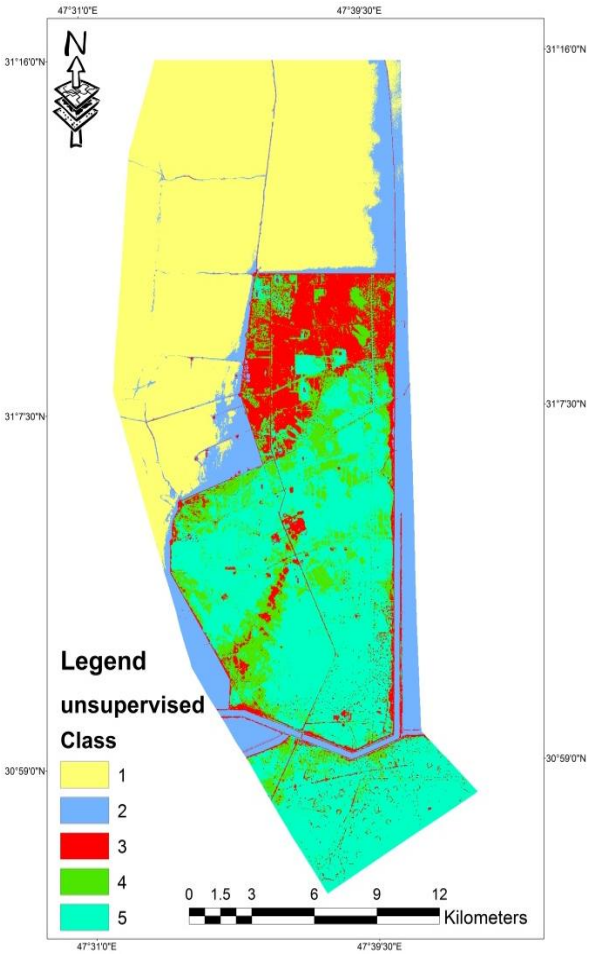

Figure 3. Unsupervised Classification

Field and Laboratory Procedures

A GPS device was used to locate the pedons and drop them on the map. Some morphological characteristics were described based on (Soil Survey Staff 2003). Soil samples were obtained from each horizon for the purpose of conducting the required laboratory analyzes for the purpose of studying some physical and chemical characteristics. Soil samples were obtained for some physical and chemical analyzes. Soil texture was estimated according to the method described in Black (1965), while both the organic matter and calcium carbonate were estimated as reported in Jackson (1958), the electrical conductivity and the degree of soil interaction in the saturated soil paste by following Methods described in Page (1982).

Preparing a Database

The information about the study area was entered and stored to prepare it for the required spatial analysis process using geographic models within the ArcGIS 10.4.1 program for mapping soil characteristics. The information entered for the program included the coordinates of the pedons of the study area and the results of soil characteristics analysis, and then they were converted into a database. Two types of features have been identified in the program, namely, point features, which represent a map of soil pedons, and polygon features, which represent a map of soil units.

Land Evaluation

Soil and land factors that affect the suitability of land for planting trees were determined, and the suitability index for each soil and land factor was estimated by adopting the system proposed by (Sys *et al*., 1993) for perennial trees as in

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Tables 1, and to calculate the value of the final index for each land was made Adopting the collection method for estimating the final quantitative index, as the assessment estimates of the various soil and land factors were collected together for the purpose of obtaining the final estimate of the land evaluation through which the classification of the land suitability is determined (Al Maeeni and Muhaimid, 2002) , The evaluation of the characteristic is performed by giving it the appropriate R rating and the weight W from Table 2 which corresponds to it after obtaining the required symbol from Table 1, and to extract the class of suitability (Table 3) as stated by (Sys *et al*., 1993). For the purpose of obtaining the final estimate of the land evaluation, the value of the land parameter is extracted by applying the formula contained in the system (Sys et al., 1993).

$$\mathbf{Li = (\sum Ri / 5 \sum Wi) *100}$$

Whereas
Li: Land coefficient
Wi: The rating given to the characteristic I according to the degree of its determination I = 1,2,3,… ..n
n: Number of Properties (usually 10 or any other number)

Table 3. The land suitability classes

INDEX	SUITABILITY CLASS
80 - 100	S1: very suitable
60 - 80	S2: moderately suitable
40 - 60	S3: marginally suitable
25 - 40	N1: Currently unsuitable
0 - 25	N2 Permanently Not suitable

Table 1. General and specific requirements for the characteristics of the land for trees according to what was stated in the system (Sys *et al*., 1993)

Land characteristics	Class Degree of Limitation and Rating Value					
	S1		S2	S3	N1	N2
	0	1	2	3	4	
	100	95	85 60	40	25	0
Topography (t)						
Slope (%) (1)	0 – 1	1 – 2	2 – 4	4 – 6	-	> 6
(2)	0 – 4	4 – 8	8 – 16	16 – 25	-	> 25
(3)	0 – 8	8 – 16	16 – 30	30 – 50		> 50
Wetness (w)						
Flooding	F0	-	-	-	-	F1+
Drainage	good, ground. > 150 cm	good, ground. 100 – 150 cm	Moderate	imperf	Poor, but drainable	Poor, not drainable
Physical soil characteristics(s)						
Texture struct.	L, SCL, SL	SC, SiL, SiCL, Si, C, LfS, LS, Si	C < 60s, LCS C > 60s, LCS LfS. fS	Cm, SiCm, CS		-
Coarse fragm.(vol%)	0 – 15	15 – 35	35 – 55	55 – 75	-	> 75
Soil Depth (cm)	> 150	150 – 120	120 – 100	100 – 80	-	< 80
$CaCo_3$ (%)	any					
Gypsum (%)	0 – 10	10 – 15	15 – 20	20 – 25	-	> 25
soil fertility characteristics(f)						
Apparent CEC (cmol(+)/Kag clay)	> 24	24 – 16	< 16 (-)	<16 (+)	-	-
Base Saturation (%)	> 80	80 – 50	50 – 35	< 35	-	-
Sum of basic cation (cmol(+)/Kg soil)	> 8	8 – 5	5 – 3.5	3.5 – 2	< 2	-
pH H_2O	7.2 – 7.0	7.0 – 6.2	6.2 – 5.8	5.8 – 5.5	< 5.5	-
	7.2 – 7.5	7.5 – 8	8 – 8.2	8.2 – 8.5	-	> 8.5
Organic carbon (%)	> 1.5	1.5 – 0.8	0.8 – 0.4	< 0.4	-	-
Salinity and Alkalinity (n)						
ECe (dc/m)	0 – 8	8 – 12	12 – 16	16 – 20	20 – 25	> 25
ESP (%)	0 – 15	15 – 25	25 – 35	35 – 45	-	> 45

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Table 2. The values of the estimate and the corresponding weight according to the standard addition method (Al Maeeni and Muhamid, 2002)

Additive method			
Selection value	Symbol	Rating (R)	Given weight (W)
No limitation	0	5	(1)
Slight limitation	1	4	(1)
Moderate limitation	2	2	(1)
Severe limitation	3	1	(1)
Very severe limitation	A 4	0	(4)
Extremely severe	B 4	0	(5)

Results and Discussion

Estimate the Quantitative Index of Suitability for each Soil and Land Factor

The results in Table 4 showed the general characteristics of the soil of the study area, as the standard addition method proposed by (Sys *et al*., 1993) and amended by (Al-Maeeni and Muhamid, 2002) was adopted. The required symbol from the requirements tables mentioned above in the chapter on materials and work methods, for the purpose of assessing the suitability of these characteristics for the selected trees with a weighted average depth of each characteristic to a layer of 100 cm thickness. The results in Table 5 show the evaluation of the characteristics for the purposes of planting the selected trees in the study area as follows:

Table 4. Average soil characteristics for pedons sites in the study area used in calculating the land index

Pedon No.	**pH**	**EC d/m**	**Texture class**	**Gypsum %**	**Lime %**	**Slope %**	**ESP**	**O.C %**	**Soil depth cm**	**Drainage class**
1	7.72	38.06	CL	1.646	45.63	1 - 0	**less than 15**	0.137	100	Excessively
2	7.54	29.20	CL	1.066	45.5	1 - 0	**less than 15**	0.0628	20	Very Poorly drained
3	7.66	14.68	CL	1.392	55.62	1 - 0	**less than 15**	0.057	100	Imperfectly drained
4	7.45	22.81	CL	0.792	69.85	1 - 0	**less than 15**	0.0628	100	Poorly drained
5	7.75	19.81	CL	1.343	51.39	1 - 0	**less than 15**	0.057	100	Moderately well drained
6	7.49	8.71	CL	1.281	67.26	1 - 0	**less than 15**	0.057	100	Imperfectly drained
7	7.67	24.79	CL	0.989	71.51	1 - 0	**less than 15**	0.074	100	Imperfectly drained
8	7.78	52.23	CL	1.066	73.83	1 - 0	**less than 15**	0.057	100	Poorly drained

The results in Table 4 and 5 show the requirements for the characteristics of the land approved by (Sys *et al*., 1993) for convenience purposes, as the slope estimate was 100 and was not a determining factor for planting perennial trees in the study area because the slope in the study area ranged between 0-1% While there were severe determinants of soil depth in all pedons sites except for pedon 2, and a rating of 60 was given for being medium-depth soils, while an estimate of 25 was given to pedon 2 due to the presence of depth determinants, so the depth of soil in this site is a determining factor With the presence of a clay layer that behaves like a deaf layer, and its content of clay particles is higher than the layers above and below it, so it formed different determinants (Al Hayali, 2017) . Figures 4 and 5 show the limitation of soil depth and salinity.

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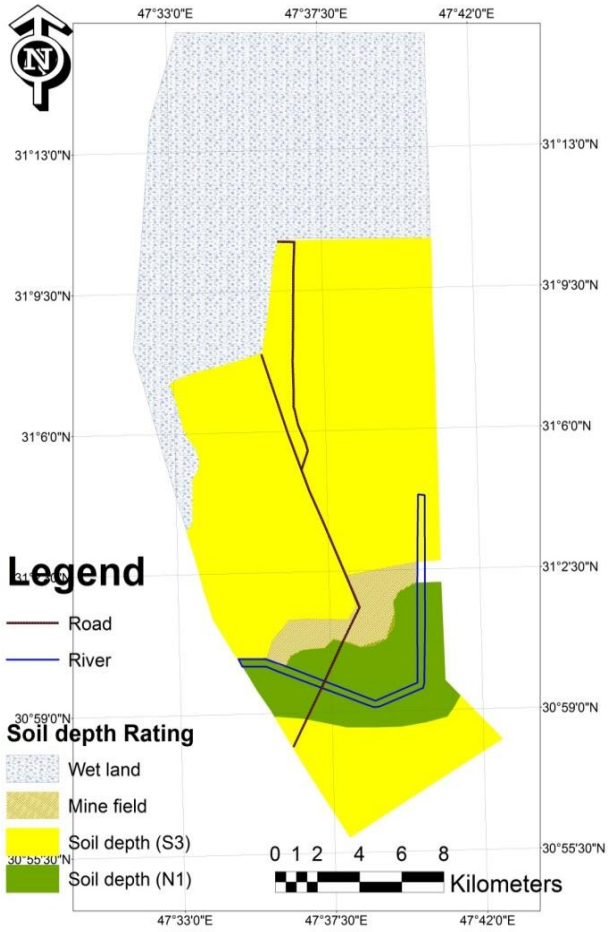

Figure 4. Figure limitation of Soil depth

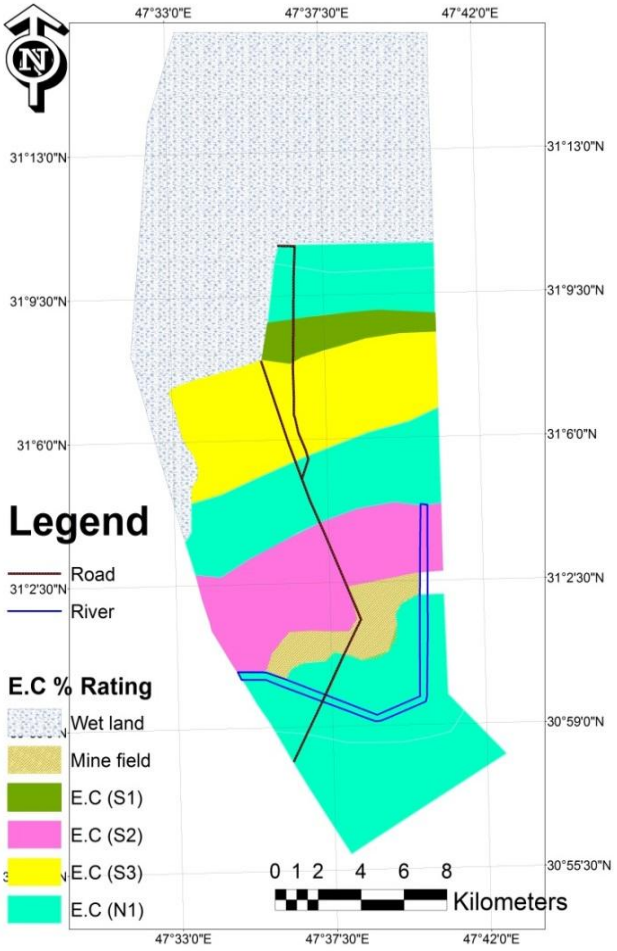

Figure 5. Limitation of Soil salinity

The results showed that the dominance texture in the study area was medium fine (CL), so the soil texture did not constitute a determining factor for growing perennial trees, as the estimate of the texture factor was 100. It is noticed through the results that all pedons in the study area had a high content of carbonate minerals, and the carbonate mineral content factor was given an estimate of 100 for all pedons with no determinants and that the percentage of gypsum was low in all pedons in the study area and did not constitute a specific factor as a factor was given gypsum content estimate of 100 for each pedons. The phenomenon of salinity is one of the important and major problems in the southern part of the Iraqi sedimentary plain, as a variation in salinity content was observed from one site to another. Through the results Through the results prove the existence of simple determinants to very severe for the cultivation of perennial trees and this is due to the high salt content in the soils study area for the non-use of the land for agricultural purposes, it has formed a determining factor is very severe in pedons sites 1, 2, 4, 7 and 8 and estimate 25 Intermediate determinants at pedon sites 3 and 5 with no determinants at pedon sites 4 as in Fig. 5.

As for alkalinity, it did not constitute any determining factor for growing crops. The results showed the values of the degree of soil interaction for the pedon sites, and an estimate of 95 was given. These values constituted a simple determinant factor for the growth and cultivation of perennial trees. The results show the low values of the organic carbon percentage, as it ranged between 0.057 - 0.137% in the pedon sites, and these values formed a very specific factor for the growth and cultivation of trees, and a rating of 40 was given as in Figure 6.

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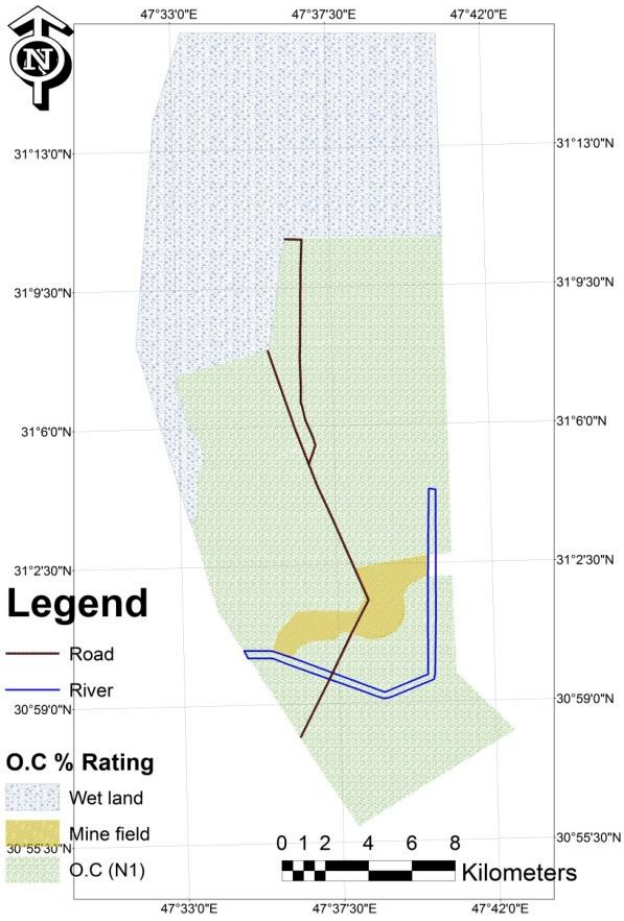

Figure 6. Figure limitation of Organic carbon

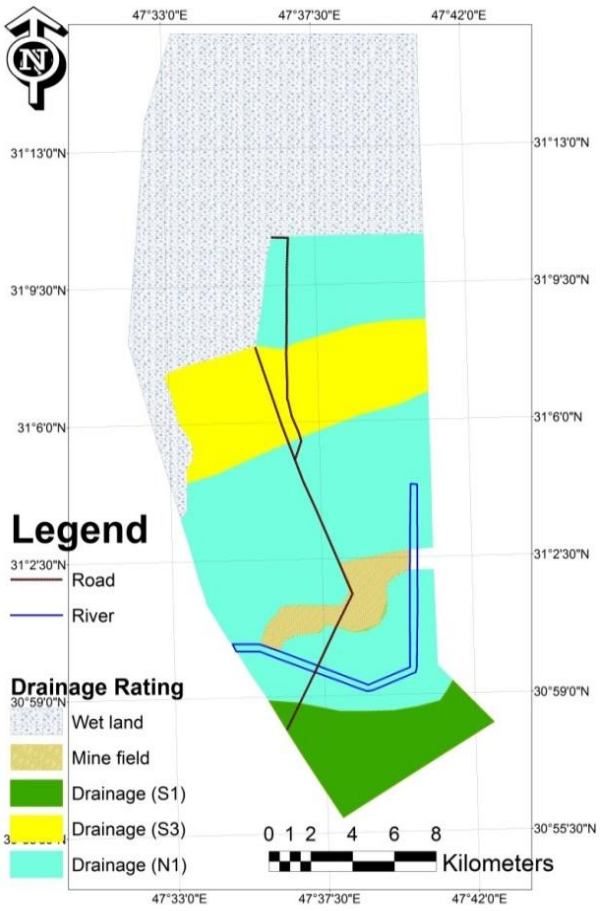

Figure 7. Limitation of Soil drainage

The type of drainage is an important factor in evaluating lands for different agricultural uses. Through the results and the results of the morphological description of the pedons, it was found that the degree of drainage varied from poorly to excessive well drained throughout the study area, and an estimate was given that ranged between 25 - 100, and these values formed a very specific factor to no determinants as in Figure 7.

Table 5. Evaluation of the suitability of the soil characteristics of the trees in the study area

Pedon No.	**pH**	**EC d/m**	**Texture class**	**Gypsum %**	**Lime %**	**Slope %**	**ESP**	**O.C %**	**Soil depth cm**	**Drainage class**	Land index	Land index class
1	95	25	100	100	100	100	100	40	60	100	41.17	S3
2	95	25	100	100	100	100	100	40	25	25	35.37	N1
3	95	85	100	100	100	100	100	40	60	40	40.04	N1
4	100	25	100	100	100	100	100	40	60	25	38.12	N1
5	95	60	100	100	100	100	100	40	60	60	49.23	S3
6	100	95	100	100	100	100	100	40	60	40	43.75	S3
7	95	25	100	100	100	100	100	40	60	40	30.65	N1
8	95	25	100	100	100	100	100	40	60	25	40.01	N1

Classes of Suitable Land for Trees in the Study Area

The results in Table 5 and Fig. 8 show the assessment of the suitability of the land for trees to the dominance of two class that represent the case of the suitability of the area's lands for planting these trees, as follows:

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Class (S3)

The lands of this type are characterized by being limited lands suitable for planting trees due to the presence of some very severe determinants, especially the soil salinity factor and the soil depth factor, as well as the presence of some severe and medium determinants in some of its characteristics, including organic matter and natural drainage, this variety was found in pedons 1, 5 and 6 on respectively, as the suitability index rating ranged between 41.17 - 49.23. The lands of this type can, through good management, be converted into more suitable varieties, especially after carrying out the reclamation and salinization operations.

Class (N1)

Lands are currently unsuitable for planting trees due to the presence of three factors with very severe determinants, which are salinity, organic matter and soil depth, as well as the presence of some medium determinants in some of its characteristics, including natural drainage. This variety was found in pedons 2, 3, 4, 7 and 8 respectively. As the suitability index rating ranged between 23.2 - 40.04, and after future desalination by means of reclamation and the use of good management requirements, it can be converted into more suitable items.

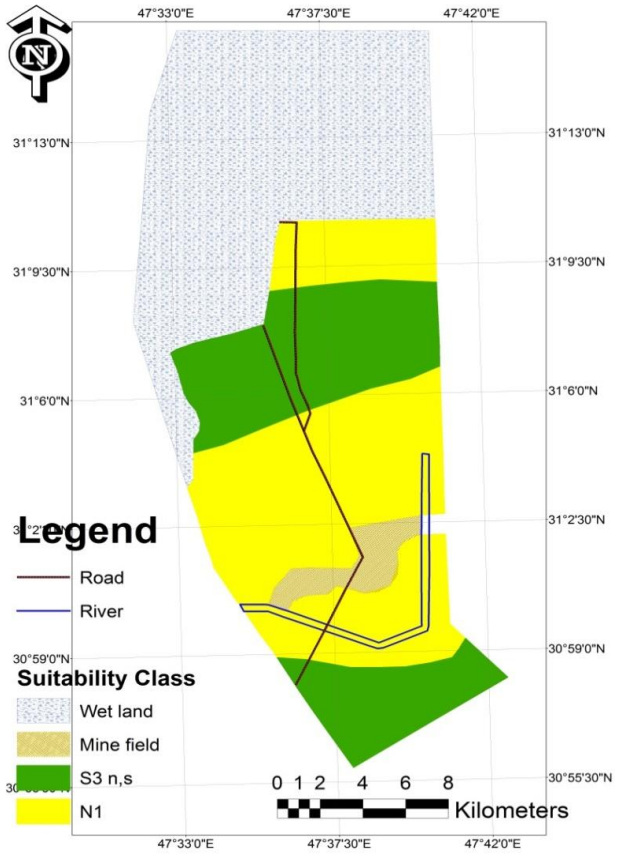

Figure 8. A map of suitable land classes for planting trees

Recommendations

The use of geographic information systems and remote sensing technology in the processes of separating soil units and determining the sites of pedon digging using the spectral reflectivity factor of the soil, creating a database of information related to both soil and topographical characteristics of large areas of land to produce objective maps of soil and land characteristics and then producing appropriate maps using systems Geographic information and remote sensing technology thus saving effort, time, money and work accuracy.

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