SPATIAL DISTRIBUTION OF THE WESTERN JADWAL SOILS PROPERTIES AND SUITABILITY EVALUATION FOR WHEAT CROP CULTIVATION BY GEOMATICS TECHNOLOGY

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ABSTRACT

The study area was chosen in the district of the western Jadwal in Karbala governorate - Iraq, which is located between E44°05'10'' to E44°13'03'' and N32°38'30'' to N32°27'40'', as 100 locations were identified for the depth of 0-30 cm by auger hole sampling method samples were obtained from each site, and kept laboratory measurements. The results of the study showed that the dominant soil texture is medium clay and silt are the predominant separates in the soil. As for the salinity of the soil represented by electrical conductivity, it was low of the dissolution the salts and the land use for cultivation besides the presence of a drainage network a percentage of the organic matter is good. As for assessing the suitability of the land for cultivation, Results showed the use of the standard addition method of land evaluation for the wheat crop by Sys,1993 is better and more accurate than the standard multiplication method for the wheat crop that was also suggested by Sys, 1980, where the very suitable class S1 and the suitable S2 were the predominant cultivars of the addition method, while the non- suitable class N and the least suitable S5 were classes when the methods of multiplication were used.

Key word: GIS, Land evaluation.

مجلة العلوم الزراعية العراقية -2021: 52 (3):712-723 **حمد وآخرون**

التوزيع المكاني لصفات ترب الجدول الغربي وتقييم ملائمتها لزراعة محصول الحنطة بالتقنية الجيومعلوماتية

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المستخلص:

أختيرت منطقة الدراسة في قضاء الجدول الغربي في محافظة كربلاء – العراق والتي تقع بين خط طول "44°05'10 الى "44°13'03 شرقاً ودائرتي عرض "32°38'30 الى "32°27'40 شمالاً ,اذ تم تحديد 100 موقع للعمق0 – 30 سم بواسطة جهاز الحفر المتقابي (الاوكر) , واستحصلت العينات من كل موقع وحفظت وتم اجراء القياسات المختبرية اللازمة عليها. وقد اظهرت نتائج الدراسة ان نسجة التربة السائدة متوسطة النعومة وان الطين والغرين هما السائدين في التربة , اما ملوحة التربة المتمثلة بالايصالية الكهربائية فقد كانت منخفضة وذلك لاذابة الاملاح واستغلال الارض للزراعة ووجود شبكة مبازل وذا نسبة من المادة العضوية جيدة , اما تقييم ملائمة الارض للزراعة فقد اظهرت النتائج ان استخدام طريقة الاضافة القياسية لمحصول الحنطة بطريقة Sys,1993 افضل واكثر دقة من طريقة الضرب القياسية لمحصول الحنطة بطريقة Sys,1980 , اذ كان الصنف الملائم جدا S1 والملائم S2 هما الصنفان السائدان بطريقة الاضافة , في حين الصنف غير الملائم N وقليل الملائمة S5 هما الصنفان السائدان بطريقة الضرب

الكلمات المفتاحية: GIS, التوزيع المكاني, تقييم الاراضي

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INTRODUCTION

The land assessment is an assessment of its performance, efficiency, or assessment of its potential for various uses and productive uses such as its suitability for agriculture, animal production, forests and other uses related to tourism, wildlife (6). Land assessment is important in the success of agricultural projects, as it lays the necessary foundations for the use of suitable land characteristics and contributes in facilitating the task of developing the farm plan to increase the production capacity of these projects as well as in improving soil management processes that contribute to the success of agricultural operations and making them at a better level to control obstacles and problems In line with the development movement in the country(18). The assessment of the land has become important, especially in light of the shortfall in food all over the world (4). Several methods have been adopted to evaluate the suitability of the lands, including the multiplication method, which depends on multiplying estimates of the characteristics of the land chosen in the evaluation of the suitability of the land according to special tables, as well as the method of collection and adopts the collection of selected attributes. In the evaluation of Earth suitability (19,20). Van Gool (21) described that the standard common method for producing maps of the Earth's natural resources surveys to assist in making strategic decisions related to management, development and the protection of natural resources is a standard method similar to the assessment of land by FAO (7) as he explained that the main use of maps Earth's digital resource is the spatial analysis of geographic data using the GIS program that can be performed with high accuracy and speed. Heywood (10) explained that one of the advantages of GIS in land assessment is its great ability to conduct spatial analyses and produce maps automatically and distinctly in its ability to process and analyze data from several sources such as land use maps and other maps, where this method serves the purposes of studying Land evaluation and distinguishing the types of soils from other land uses easily, especially in the areas of the Iraqi alluvial plain (1). Spatial analysis, interpolation and producing the maps of soil properties can be obtained by different techniques, such as ordinary kriging (7). Importance of studying the land suitability, this research aims to study the spatial distribution of soil characteristics of the western Jadwal soils and the land suitability classification for growing different crops using GIS. Fouad (8) used Geographic information systems to expect or predict distribution of points of radon gas measuring high concentrations (Hotspot), it has finding the point's neighborhood distance, Estimation of Radon concentration at sampling locations, and interpolation of the estimates at discrete locations to generate a continuous surface by Kernel Density Estimation (KDE). The(9) detected relationship the density release of radon gas concentration with some weather factors as temperatures degree, illustration, because of material decay which release radon gas and emitted which cause erosion factors that is development at nature works.

MATERIALS AND METHODS

The study area was chosen in the western Jadwal district in Karbala governorate - Iraq, which lies between E 44^{o}05'0" to E44^{o}13'03" and N32^{o}38'30" to N32^{o}27'40", as 100 locations for depth 0-30 cm hole sampling method and the kriging within the spatial analysis procedures as a nonstationary variance model that was by .Lark (12), the coordinates of the sites and samples the collection shown in Figure (1), as for the area of the study area which is 13001.94 hectares ArcGIS desktop V.10.7 to ensure a complete and accurate mapping of the area.

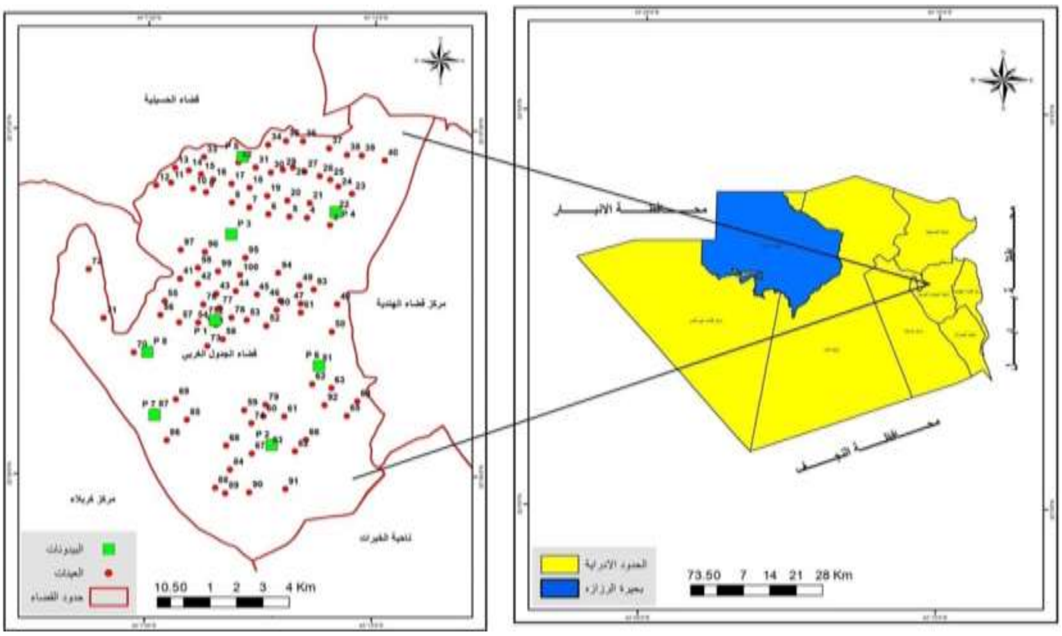

Figure 1. Map of sample locations in the study area

The study area is a recent fluvial soil formed from the deposits of the Euphrates within the Entisol and sub order and Typic Torrifuvents sub group due to US taxonomy for soil classification, and it has a dry and hot summer climate and little rain in winter, as a desert climate, samples were collected and translocated to the laboratory of the College of Agriculture at the University of Green Qasim for measuring some properties:

Electrical conductivity (ECe) and soil reaction (pH), as each of them was measured in a saturated paste extract according to the method described by Richards (17).

-Cation Exchange Capacity was measured according to (16)

-Soil organic matter was estimated by Walkly – Black method, as reported by Lopez-Granados (13).

-Total calcium carbonate was measured using hydrochloric acid according to the method described in USDA Hand book (60, 1954)

- Gypsum is estimated according to the method described by Page (15).

A database was created for the study area, by linking the metadata that was obtained from laboratory work to the existing spatial data, as using MS Excel 2010 release. The Excel file table was called into the GIS Desktop ArcMap 10.7, and the file was converted to a Point vector data format. The spatial completion method and IDW approach in mapping was used and is the inverse distance weighting method was used when and the characteristics change regularly, especially in the lands suggested by Sys **(20)** and then areas and proportions were measured .

RESULTS AND DISCUSSION

Spatial distribution of some soil characteristics of the study area: The results have indicated a homogeneity of the original materials, as the texture ranged from medium to moderated fine textured soils in the studied sites, but most of them tend to be silt clay loam, and since the lands of the study area are located within the lands of the Euphrates basin, they were in one way or another and because of the floods that might be exposed to recent deposits, therefore, the soils in the area if study were generally fall within the sedimentary soils that are represented by the presence of silt and clay deposits in large quantities, and thus they contain soft moderately fine and fine texture, the natural drainage, has ranged for most of the study pedons between moderately well drained and the well,drained while very few sites were of imperfect drainage class, depending on the depth of the mottling in each site The results of Table 1 indicated that the spatial distribution of the soil reaction had been distributed in a range of 7.1 - 8.51 and this is the soil reaction values in the presence of carbonate minerals take a homogeneous distribution, and since the sedimentary soil materials are calcareous and in high proportions, spatial variance noticed in soil reaction values (5).

Table 1. Some soil properties for the study area

Drainge	Texture class	ESP %	gypsum %	Lime gkg^{-1}	CEC Col+kg	O.M Gkg^{-1}	pH	ECe dSm^{-1}	Sample No.
M	SiC	0.77	6.52	234.2	25.17	6.7	7.80	3.50	1
M	SiC	1.51	5.33	203.1	27.33	7.5	7.33	3.41	2
W	SiL	1.30	4.20	223.2	21.18	9.4	7.21	4.36	3
W	SiL	1.29	3.90	243.2	25.41	5.1	7.50	4.55	4
W	SiC	1.48	4.20	200.3	24.80	7.4	7.91	4.88	5
W	SiL	1.89	3.31	254.0	23.70	6.7	7.59	5.10	6
W	SiC	2.03	2.90	303.2	21.20	6.2	7.88	5.22	7
W	SiCL	2.19	2.81	222.3	20.18	8.6	8.10	5.63	8
W	C	1.19	3.95	190.7	19.17	5.5	8.3	5.81	9
W	SiL	0.82	7.20	187.3	30.17	10.3	8.51	4.22	10
W	C	1.06	6.50	188.8	28.17	9.4	7.8	3.90	11
W	SiCL	1.05	6.33	192.3	29.18	10.3	7.3	3.77	12
W	L	1.30	6.70	120.2	31.33	11.4	7.35	3.17	13
W	SiL	0.93	7.20	186.8	26.17	11.6	7.53	4.10	14
W	C	1.56	4.51	177.5	25.80	6.3	7.60	4.55	15
W	SiCL	1.26	4.63	207.3	21.20	6.7	7.90	3.70	16
W	SiC	1.49	5.18	159.8	26.18	6.5	7.41	4.10	17
W	SiC	1.76	6.20	220.4	24.15	7.3	7.50	4.33	18
W	SiC	1.98	5.17	230.9	23.33	4.9	7.10	3.18	19
W	SiL	1.46	6.20	210.6	21.20	4.4	7.41	5.18	20
W	SiCL	1.23	7.33	138.7	29.50	9.3	7.51	5.00	21
W	C	1.65	4.30	120.8	30.15	10.3	7.91	4.80	22
W	L	1.71	3.90	120.4	30.25	10.4	8.0	5.81	23
W	CL	1.20	3.50	195.8	25.15	8.2	7.33	4.33	24
W	CL	2.78	2.91	200.0	24.14	6.4	7.22	3.91	25
W	SiCL	1.72	3.44	197.8	25.50	5.15	7.17	6.00	26
W	SiL	1.12	5.20	200.0	25.00	7.39	7.80	4.51	27
M	C	1.45	5.59	199.4	24.99	6.43	7.70	4.10	28
M	SiL	0.89	6.70	200.2	24.81	6.50	7.60	3.90	29
M	CL	1.00	6.90	210.4	24.70	6.61	7.69	3.60	30
M	SiC	1.47	5.20	209.3	24.91	6.20	7.80	3.33	31
M	SiC	1.96	5.91	200.7	25.89	7.81	7.33	3.17	32
M	C	1.80	6.18	200.5	25.50	7.3	7.8	4.10	33
M	SiC	0.96	5.20	189.7	27.81	6.9	8.10	5.00	34
M	SiC	1.16	6.80	184.3	28.20	9.7	8.41	4.91	35
M	CL	1.69	7.20	179.8	29.20	10.3	7.50	3.90	36
M	CL	1.39	6.25	205.6	24.20	6.4	7.63	3.77	37
M	CL	1.21	5.20	206.4	25.90	7.3	7.69	3.81	38
M	C	1.36	4.33	202.8	26.39	7.9	7.81	4.20	39
M	C	1.04	4.95	200.3	27.20	9.0	7.91	4.29	40
M	SiC	1.17	5.20	191.4	28.00	8.7	7.80	4.81	41
M	C	0.92	5.90	189.6	29.90	10.4	7.43	3.88	42
M	C	1.45	6.95	169.5	30.31	11.6	7.50	3.20	43
M	SiCL	1.6	7.20	210.7	25.50	6.5	7.69	3.33	44
M	CL	2.47	7.81	208.6	25.00	7.0	7.77	4.00	45
M	SiL	2.35	8.20	215.4	24.70	5.5	7.88	3.71	46
M	SiCL	2.04	7.20	217.3	23.00	4.9	7.70	3.80	47
M	SiL	1.55	6.70	218.6	25.95	5.7	7.61	4.10	48
M	L	4.39	5.90	217.3	25.80	5.6	8.20	4.60	49
M	C	4.50	4.88	330.2	23.70	4.8	7.21	4.36	50

P	SiC	2.78	6.20	300.2	24.88	4.8	7.29	3.90	51
M	C	2.72	5.22	229.6	25.20	6.0	7.51	3.70	52
M	CL	0.97	6.33	228.7	25.00	6.3	8.00	3.63	53
M	SiCL	1.58	7.40	300.3	29.80	6.2	7.91	3.81	54
M	SiL	1.62	7.88	228.3	27.20	10.4	7.81	3.90	55
M	C	1.94	8.90	224.6	26.00	9.4	7.60	4.17	56
P	C	1.37	6.90	225.0	25.81	8.4	7.43	4.91	57
M	SiCL	2.76	6.30	223.6	24.80	5.6	7.53	5.00	58
M	L	1.12	6.50	223.2	24.30	6.0	7.61	3.89	59
M	C	1.71	7.90	224.6	25.95	5.9	7.90	4.33	60
M	CL	1.53	8.20	331.7	22.20	4.8	7.70	3.33	61
P	C	1.41	7.70	349.2	24.90	5.6	7.22	3.50	62
P	SiC	1.66	5.20	294.7	25.61	7.4	7.31	3.70	63
P	SiL	1.65	4.33	289.8	25.88	7.3	7.18	4.20	64
P	SiCL	1.97	5.80	334.8	24.20	6.6	7.10	4.31	65
M	SiL	1.54	5.95	333.9	25.90	6.8	7.82	4.89	66
M	SiC	1.16	6.32	336.3	26.70	8.4	7.14	5.00	67
M	C	2.30	6.40	338.7	29.33	9.6	7.89	3.90	68
M	L	1.32	4.90	173.9	30.50	10.4	7.90	4.89	69
P	SiCL	1.32	4.93	362.3	25.80	6.4	7.22	4.60	70
P	CL	2.18	4.95	370.4	25.00	6.7	8.10	4.72	71
P	C	1.99	6.20	374.3	24.80	5.7	8.33	5.20	72
M	SiCL	1.50	5.20	187.7	30.20	11.3	7.1	3.70	73
M	SiCL	1.47	4.90	170.3	31.40	9.3	7.5	3.81	74
M	CL	1.23	5.90	189.5	31.30	10.4	8.0	3.70	75
M	C	1.11	4.40	193.8	29.25	7.6	7.33	3.61	76
M	C	1.10	4.90	189.5	30.50	8.9	7.12	3.81	77
M	CL	1.17	5.20	192.2	29.17	9.4	7.10	4.10	78
M	CL	2.28	5.63	195.8	28.25	7.5	7.22	4.20	79
M	L	1.72	6.20	198.8	27.17	6.6	7.35	4.60	80
M	CL	1.67	6.20	200.6	26.70	8.0	7.81	5.10	81
M	SiL	1.66	5.20	230.4	25.73	7.9	8.00	5.17	82
M	SiCL	1.62	5.40	233.2	24.70	6.4	7.91	4.80	83
M	C	1.72	4.90	234.8	23.50	6.3	7.60	3.70	84
M	CL	1.35	3.90	231.8	25.00	5.7	7.55	3.61	85
M	SiL	1.21	5.61	233.2	25.93	9.0	7.44	3.33	86
M	SiCL	1.52	6.70	197.7	27.20	8.2	7.33	3.50	87
M	SiCL	1.37	6.81	355.7	24.40	5.4	7.18	3.80	88
M	C	1.61	6.91	338.3	24.90	6.3	7.25	3.41	89
M	SiCL	1.15	7.20	289.8	26.70	8.4	7.91	4.10	90
M	L	1.47	7.00	276.3	27.93	6.4	7.15	3.39	91
P	SiC	1.50	7.51	348.5	25.90	7.8	7.40	3.45	92
M	L	1.79	7.85	340.4	25.40	8.3	7.33	3.78	93
M	Sil	1.72	6.93	354.3	25.20	8.2	7.51	4.20	94
M	SiC	3.13	5.93	360.6	24.93	5.9	7.81	4.55	95
M	SiCL	3.28	5.00	390.8	23.33	5.4	7.41	4.61	96
M	L	2.22	5.81	368.9	25.00	7.9	7.81	4.70	97
M	C	1.89	6.20	300.2	26.17	9.0	7.93	3.91	98
M	SiC	2.38	5.20	170.6	29.17	8.5	8.10	3.75	99
M	SiC	2.45	4.90	237.9	26.51	8.4	8.15	3.80	100

The results of Table 2 and Fig. 2 indicated that the spatial distribution of the soil reaction (pH) was higher within the range 8.55 to 7.45 as it occupied the highest area of 8169.48 hectares at 62.83% of the total area of the study area, while the lowest area occupied by the range 7.1-7.15 as it reached 93.04 hectares at 0.72 % of the total study area. The results of Table 1 show that the spatial distribution of electrical conductivity ECe ranged between 3.17 - 6.0 dS m^{-1}, which indicates a decrease in the values of electrical conductivity in that soil, that the soil does not suffer from salinity and is good for the production of agricultural crops as indicated by the results of the spatial distribution in Table 2 and Figure 3 that the highest area was within the range 4.5 - 4.0, as the area occupied by 5882.63 hectares and of 45.24%,of the total area and that the lowest area was within the range 3.17-3.5, as it reached 44.13 hectares and 0.34% of the total area. The results of Table 1 and Figure 4 shows that the organic matter in the soil was low as it was distributed with a range between 11.6 - 4.4%, and the reason is due to the dry and semi-dry areas of soils characterized by high temperatures and less precipitation, which is reflected in the lack of natural vegetation and low density of crops and this is consistent with what found by Olorunlana(14) when studied soil characteristics in Nigeria, the range 7.5 - 5.5% occupied the highest area of 8133.37 hectares and 62.55% of the total area of the study area, while the range 4.5 - 4.4% only occupied the lowest area of 80.45 hectares by 0.62%.

Table 2. The areas and percentages of soil characteristics in the study area

%	Lime (Hectare)	%	ECE Hectare	%	(Hectare) OM	%	ECe Hectare	%	pH Hectare
5.35	695.0	0.44	56.85	0.62	80.45	0.34	44.13	0.72	93.04
23.56	3062.94	1.70	220.82	62.55	8133.34	31.86	4141.97	2.70	351.05
30.19	3925.79	30.84	4009.16	46.21	6008.2	45.24	5882.63	10.59	376.37
15.39	2000.45	67.03	8715.11	18.36	2386.65	22.61	2939.21	23.17	3012.0
40.90	5317.76							62.83	8169.48
100	13001.94	100	13001.94	100	13001.94	100	130010	100	1300194
		%	**Suitable (addition) Hectare**	**%**	**Suitable (Multiplication (Hectare)**	**%**	**ESP Hectare**	**%**	**Gypsum (Hectare)**
		37.21	4838.36	9.34	475.23	0.36	47.11	1.31	170.91
		62.79	8163.58	90.66	11787.61	21.53	2799.25	14.64	1903.45
						70.30	9140.58	14.09	1831.93
						7.29	948.06	14.48	1882.95
						0.51	66.94	55.47	7212.7
				100	13001.94	100	13001.94	100	13001.94

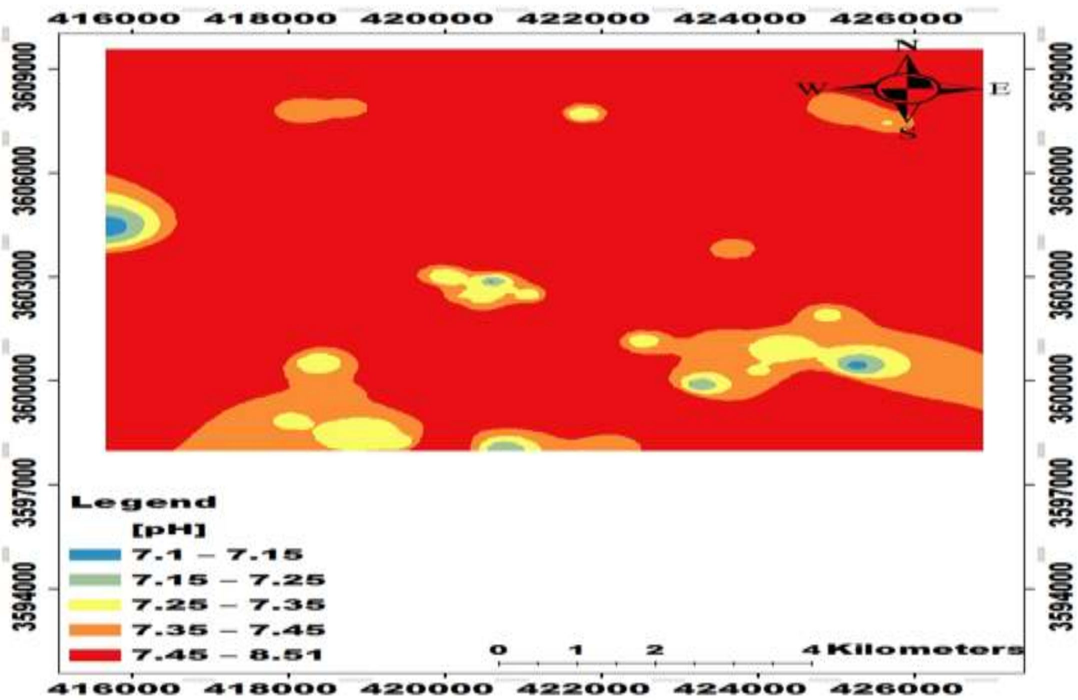

Figure. 2 Spatial distribution of soil reaction in the study area

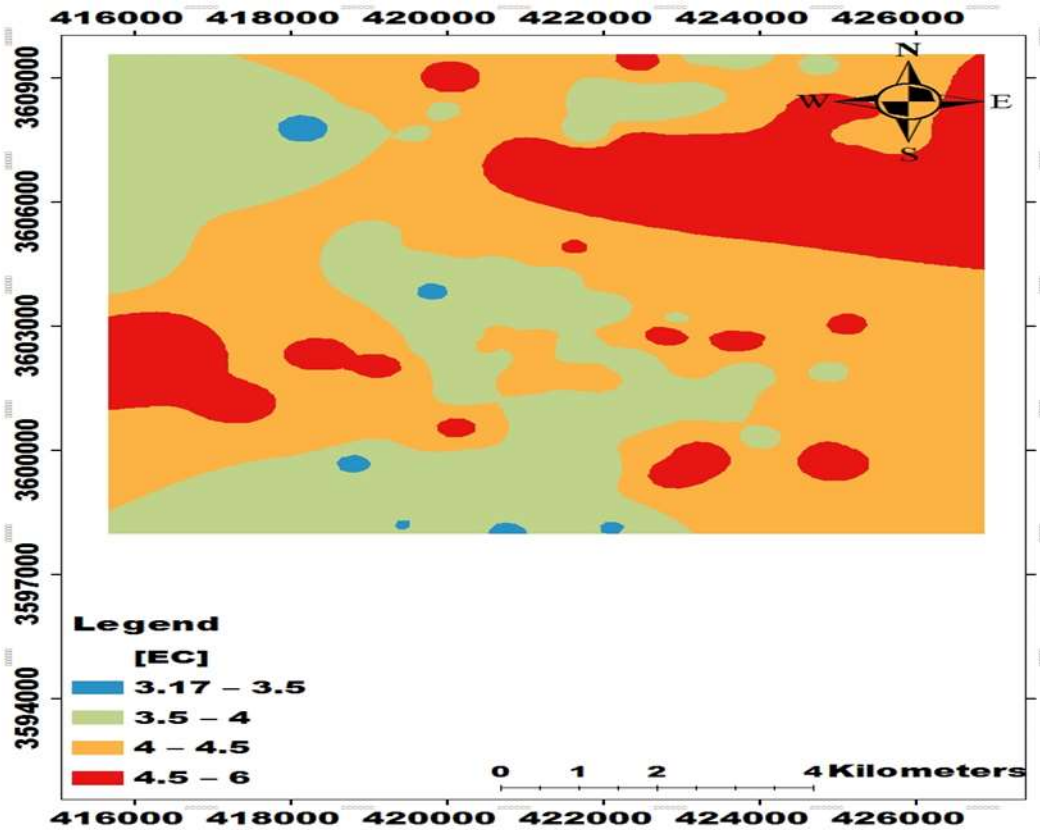

Figure 3. Spatial distribution of Electrical conductivity of the study area

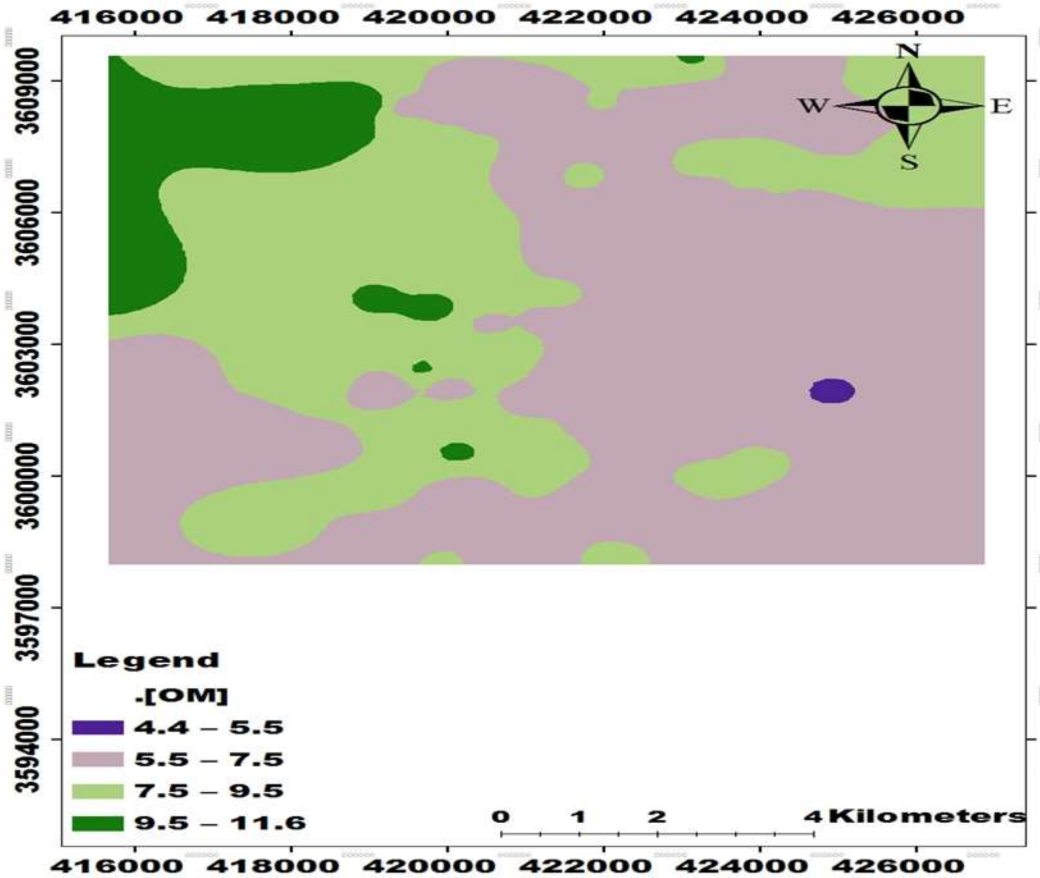

Figure 4. Spatial distribution of Organic matter of in the study area

The results of Table 1 showed that the values of cation exchange capacity CEC were different, with a range between 31.4-18.17, the reason being attributed to the association of this characteristic with the soil content of clay and organic matter, and the increase in lime in the study area leads to a reduction in the overall total of the exchangeable sites, since they work as a supplying agent and this is what it indicated by Al-Jubouri **(2)**. As for the highest area, it reached 8615.11 hectares, at a rate of 67.03%, within the range 31.4-25. As for the lowest area, it was within the range 21-19.17, 66.65 hectares, and 0.44% of the total study area, as shown in Table 2 and Figure 5 . Results of Table 1 show that the values of carbonate minerals were distributed in a range of 120.2-390.8, as high calcium carbonate values are observed in the soils of the study area and the reason is attributed to the localization of calcium carbonate as a result of the secondary precipitation from soil solution ground water and these results are consistent with what found by Al-Salmi.

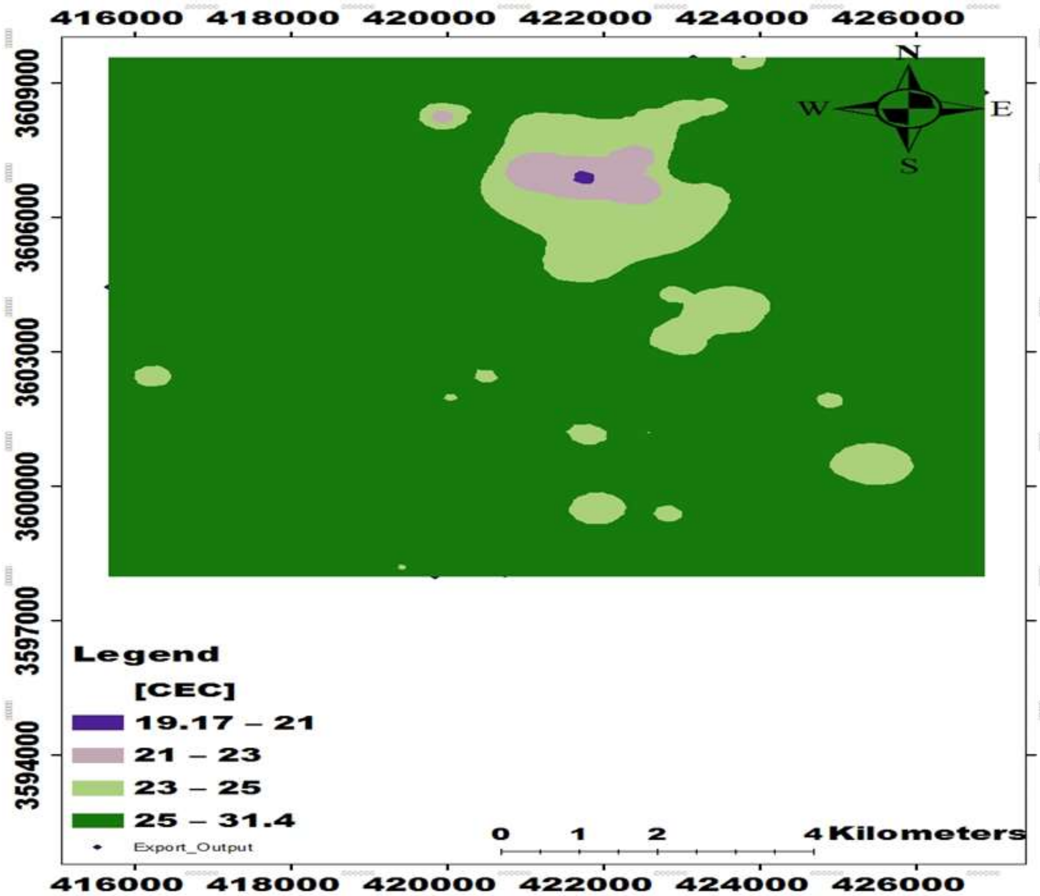

Figure. 5. Spatial distribution of CEC in the study area

The results in Table 2 and Figure 6 also indicate that the range 390.8 - 209.12 g kg^{-1} occupied the largest area of 5317.76 hectares at a rate of 40.90% of the total area, while the smallest area was occupied by the range 166.45 - 120.2 g kg-1, as it reached 695.0 hectares and by 5.95%. The results of Table 1 and Figure 7 shows that the gypsum values are very low. The range of gypsum values in the soils of the study area ranged between 8.0 - 2.81 g kg^{-1}. The range 8.9 - 5.58 occupied the largest area amounting to 7212.7 hectares at a rate of 55.47% of the total area, while the smallest area was occupied by the range 3.88 - 2.81 amounted to 170.91 hectares and 1.31% of the total area. The results of Table 1 and Figure 8 also indicated that the values of exchangeable sodium percentage ESP were varied from one location to another as they were distributed in a range of 4.5 - 0.77, and the largest area amounted to 9140.58 hectares and a rate of 70.30%, while the smallest area was occupied by the range 1.0 - 0.77, reaching 47.11 hectares At 0.36% of the total area of the study area, it can be attributed to the decrease in ESP values due to the decrease in salinity in the study area.

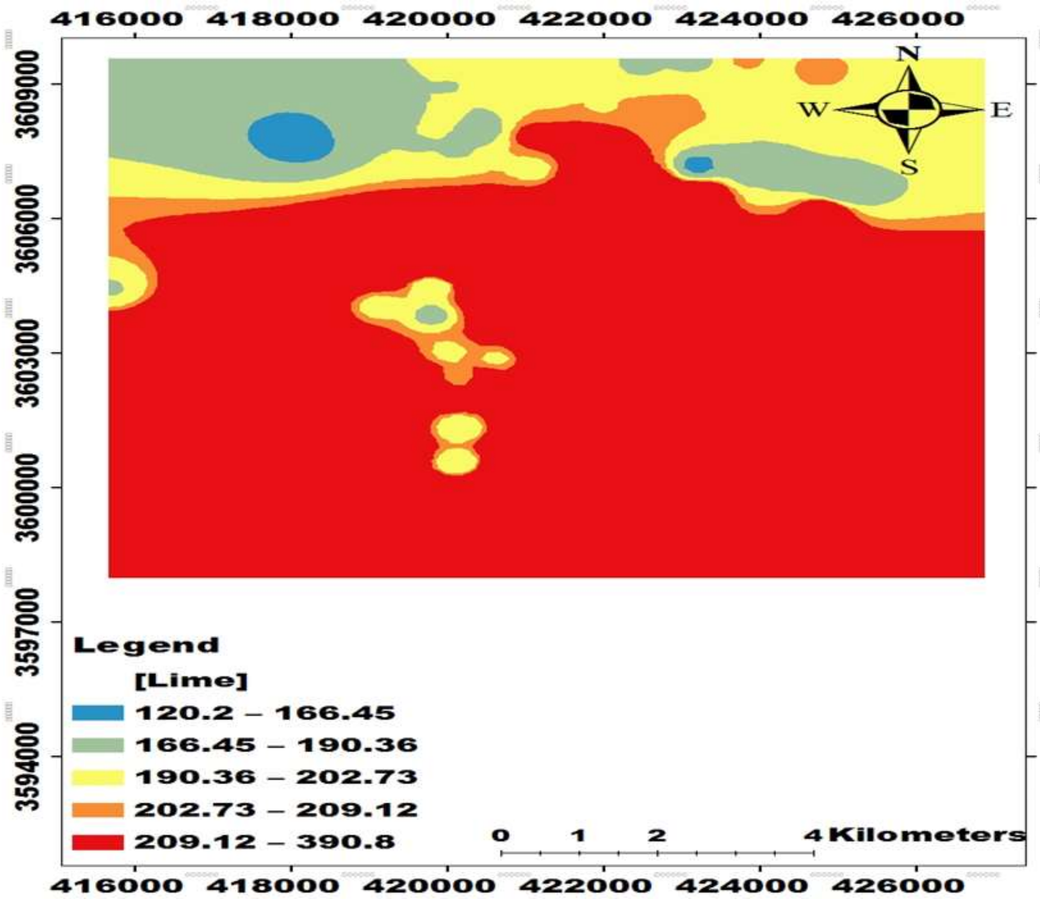

Figure 6. Spatial distribution of Lime in the study area

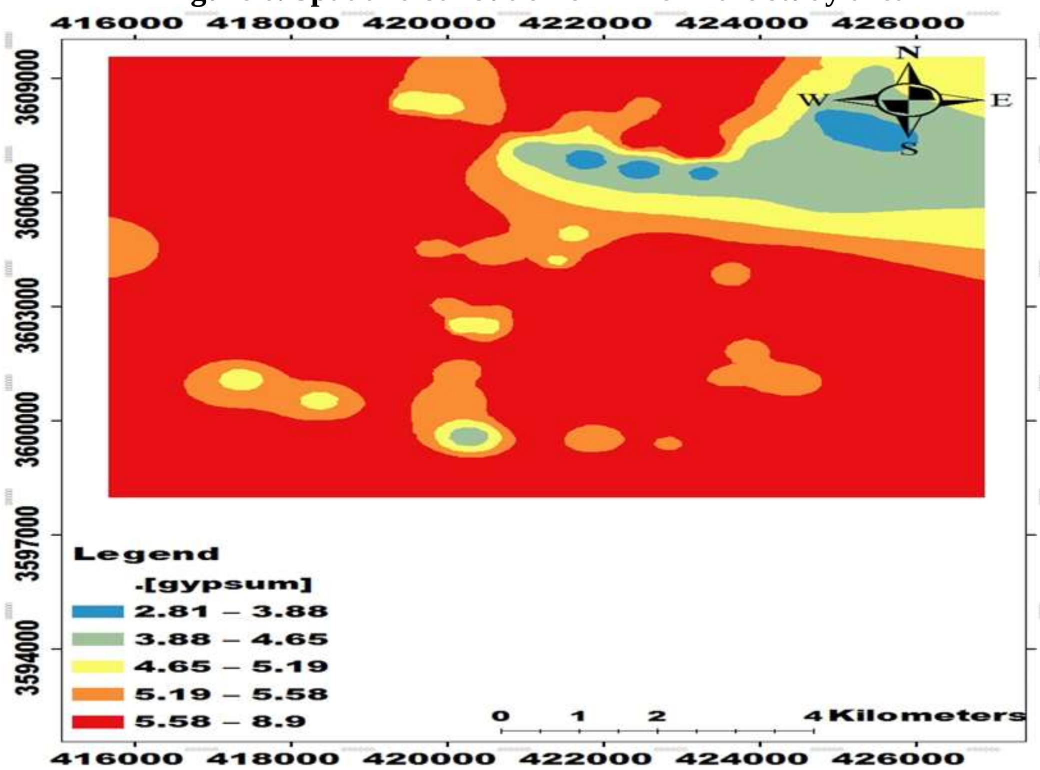

Figure. 7 Spatial distribution of Gypsum in the study area

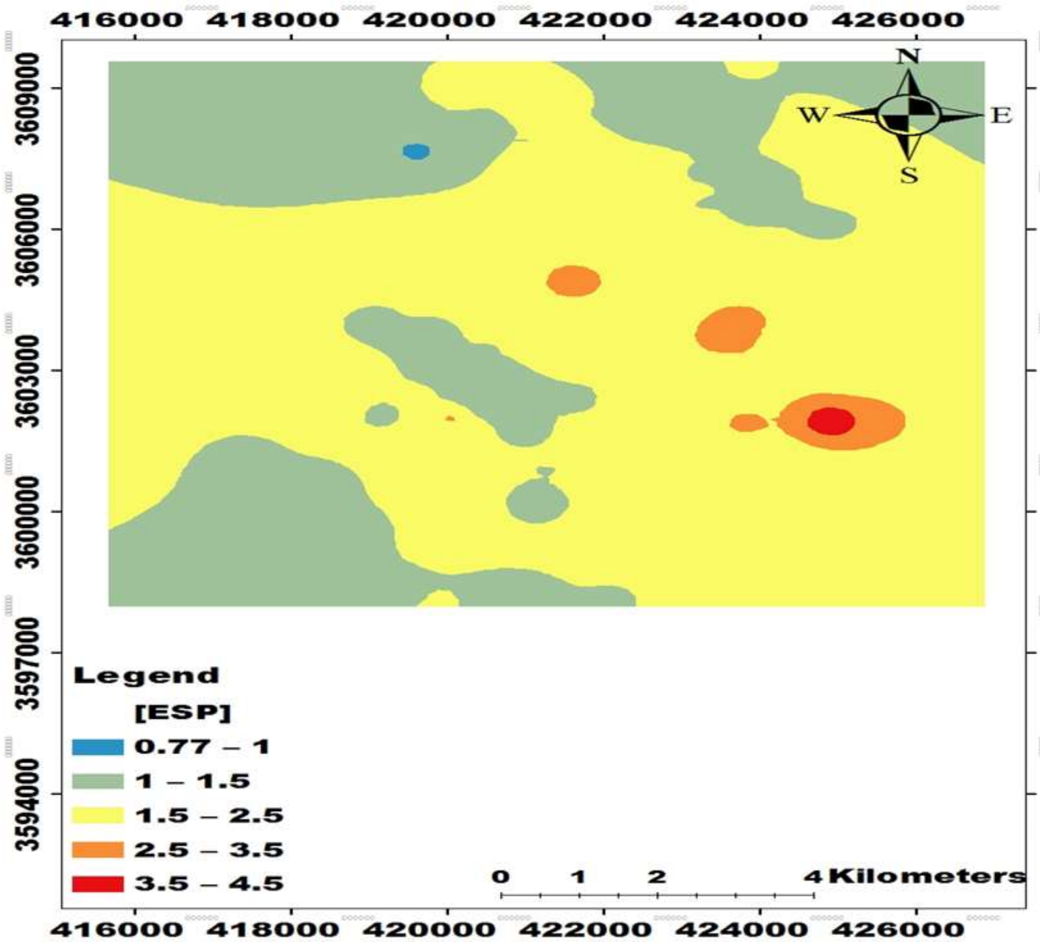

Figure 8. Spatial distribution of ESP in the study area

Evaluating the land suitability for growing wheat in the study area using the standard multiplication method: The results of the study indicated that the assessment of the suitability of the land for the cultivation of wheat crops according to Sys (19), that the non-suitable class of the fifth degree has occupied the lowest area of 1214.33 hectares and a rate of 1.65% of the total study area, as shown in Table 3 and Figure 9 of the spatial distribution land suitability classification.. As for the type of suitability, suitable, with a fourth class degree, it occupied an area of 475.23 hectares, at a rate of 9.34%. As for the category of non-suitable, of the fourth class degree, it occupied the largest area of 11787.61 hectares, at a rate of 90.66% of the total area (Figure 8).

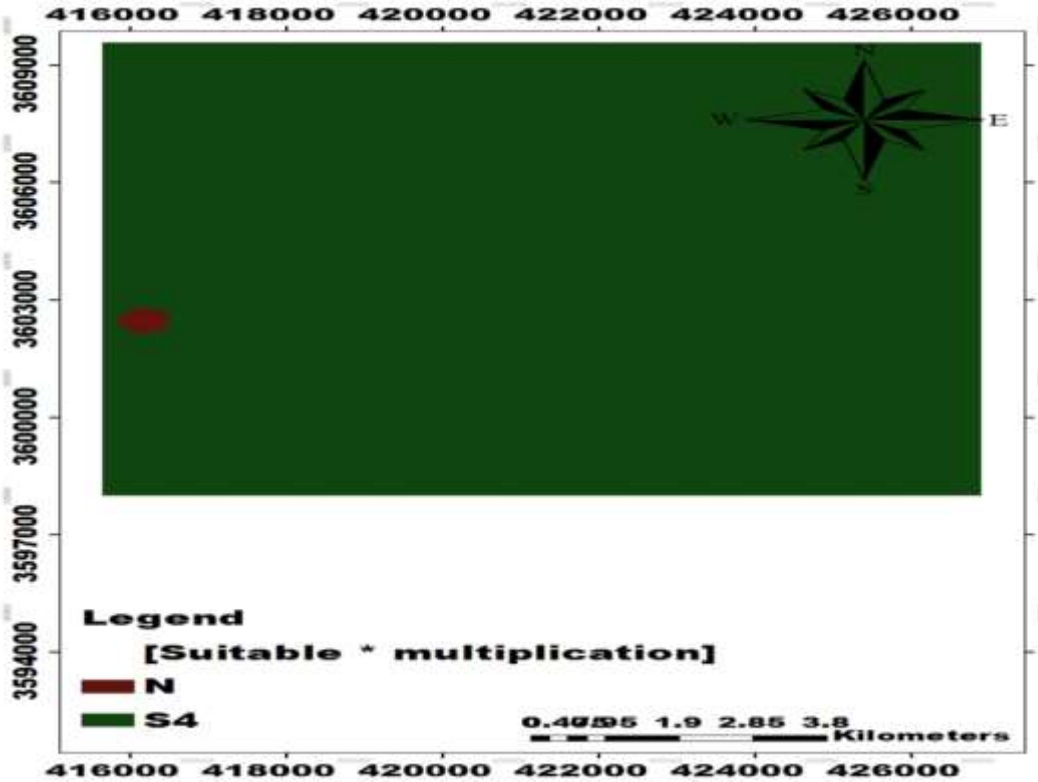

Figure 9. Spatial distribution and suitable classes by standard multiplication method

Evaluating the suitability of land for growing wheat in the study area using the standard addition method: The results of the study showed that the evaluation of the suitability of the land for the cultivation of wheat crop according to. Saleh (18), was very suitable class S1 and the suitable class S2 with the degree of the first and second class on the sequence was the predominant according to this method, as the appropriate variety S2 occupied the largest area as it reached 8163.58 hectares With 62.79% and the very suitable variety, S1 occupied an area of 4,838.36 hectares, at a rate of 37.21% (Figure 10).

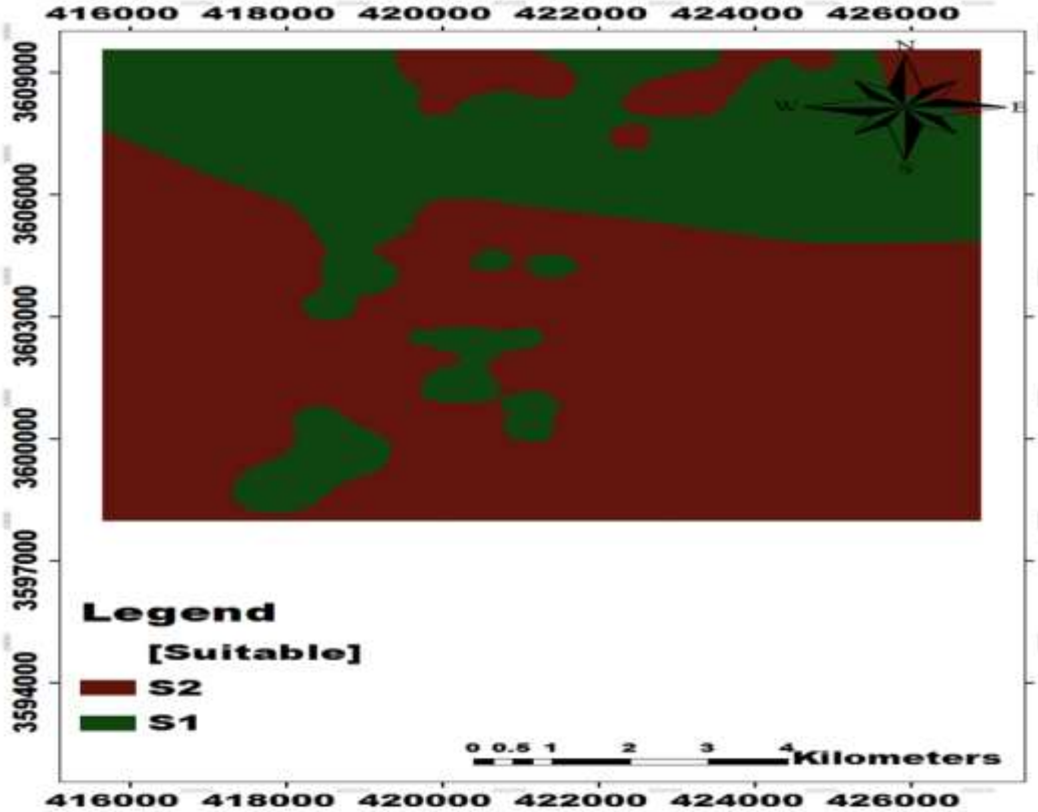

Figure 10. Spatial distribution and suitable classes by standard addition method

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