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SPATIAL DISTRIBUTION OF SOME NUTRIENTS AND BIOMASS FOR THE LARGE MUSAYYIB PROJECT

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Abstract

The study was carried out in the Greater Musayyib Project in Babylon Governorate and within geographical coordinates 33.32° and 32.47° N° 44.29° and 44.55° E to study the spatial distribution of some nutrients and biomass. It based on the series soil map. 12 series were selected with high value of area and frequency in addition to 50 surface samples. The pedons were described and the sample were obtained according to spatial distribution technique, the results indicated that: Soil represent alluvium of the Tigris and Euphrates rivers. Topography between 25 and 47 meters above sea level. The soil texture were distributed between medium course and medium to fine. The series (MM11) was greater in area and frequency, the biomas ranging from 1.3075 ton.h^{-1} at soil series DF95 to 10.5448 tons.h^{-1} in series DF97, the organic matter, nitrogen, phosphorus, potassium, iron and zinc values was (4.1 - 12.6 gm.kg^{-1}), (18.7 - 60.8 mg kg^{-1}), (5.8-13.8 mg.kg^{-1}), (201.7-287.6 mg.kg^{-1}), (6.78-11.8 mg.kg^{-1}), and (0.45-3.12 mg.kg^{-1}) respectively. The spatial distribution of the organic material `was low class, while the depressin region contain high value of available N which is the content of the content. Low areas and areas close to water sources have higher nitrogen content. Phosphorus and potassium in the soil did not show a homogeneous distribution but it was somewhat associated with clay content. Available iron and zinc showed less content in areas with higher clay content and, in contrast, higher content in areas characterized by more rigid tissues due to physiographic location.

Keywords : Spatial distribution, biomass, topography, nutrients.

Introduction

The soil with a high content of adequate nutrients is reflected in plant growth, good plants contain large amounts of chlorophyll and then its reflections in the blue and red bands of visible light will be little because chlorophyll absorbs energy in these two ranges, in green and near infrared radiation will be high, unlike the diseased plants, and this can be seen by examining the Index (NDVI), since the healthy plant has a high NDVI (Daoud, 2015). The use of remote sensing data for multi-spectral images is important because they have a high spatial recognition capability in soil nutrients and the production of available nutrient maps (Ray, 2003). Yasrebi *et al*. (2008) founds that the phosphorus component was the most heterogeneous in the studied samples of 13 soil characteristics to 100 sites. Gaemi et al, 2013 has prepared maps of the organic carbon, nitrogen, phosphorus and potassium, as well as some of available nutrients in soil and has been used as a guideline for researchers and farmers to demonstrate the risk of soil fertility degradation due to reduced nutrient content due to intensive agriculture. Kim *et al*, 2014 show that may using fertility map with digital technique and prepare spatial analysis to different available nutrient in soil (Vagan *et al.*, 2016, Alsultani, 2018). Jin *et al*., 2014 collected field data (between 2006-2012) enhanced with remote sensing data for five spectral biomass samples. All measured evidence was found to be highly correlated with biomass and the accuracy of the construct model was up to 73% the adoption of vegetative evidence. Due to the differences in soil composition factors and processes over time as well as the environmental conditions that directly affect the soil characteristics, the Greater Musayyib project was chosen as the current study site, which aims to prepare spatial distribution map of some available soil nutrients and biomass using satellite image taken in October 2018.

Materials and Methods

The project is located in the province of Babylon between the Tigris and Euphrates rivers and 80 km on the left bank of the Euphrates River, Its borders are north of Latifia, Shehameya, Quseiba, Suwayrah, Shomali, And the geographical coordinates of 33.32 ° to 32.47 ° N and ° 44.29 to 44.55° E. (Fig.1) . The land area approximately 835.7 km^2.

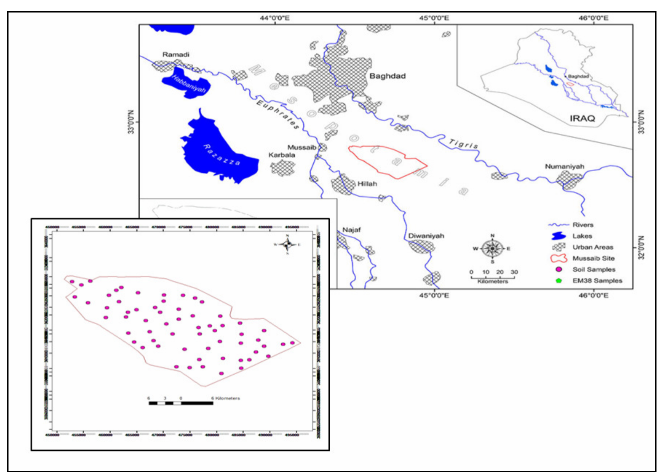


Fig. 1 : Shows the study area, sites of pedons and surface samples.

12 pedons and 50 surface samples were identified for the studied area depending on a survey map was completed by Al-Moussawi in 1997 (Fig.2). And on in the field using GPS with UTM system, the sample collected according to the requirements of spatial analysis. The soil sample was grind and passed from a 2 mm diameter sieve for the purpose of measuring the soil characteristics.

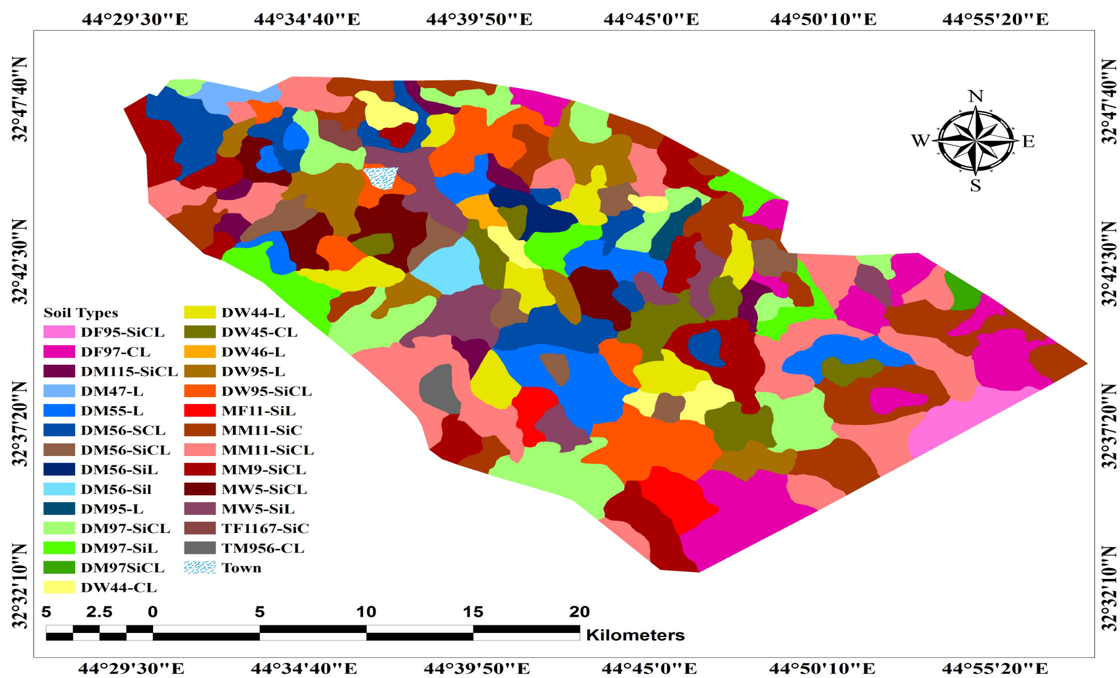


Fig. 2 : Soil series in study area

Some soil fertility characteristics were measured, including organic matter, available N, P, K, Fe and Zn according to (Jackson, 1958) (page et al,1982) (Lindsay and Norvell, **1984)**, biomass has been estimated above the surface of the soil in the manner used by the EPA. The existing pieces of plants above the surface of the earth are based on a known area (square meter), randomly distributed in the study area. Samples shall be dried in the oven at 80 °C for 24-48 hours.Biomass calculate according to the equation:

Standing Biomass = Dry Weight of above ground tissues / Plot Area

ArcMap10.3 used to prepare the spatial distribution map of soil characteristics using Inverse distance weighting and to al pedons and surface soil samples, as well as to calculate NDVI to reveal the relationship with measured soil characteristics, the formula for the calculation NDVI proposed according to Rouse et al 1973, the equation was:

NDVI = (NIR-RED) / (NIR + RED)

RED = red band wavelength NIR = near infrared band wavelength

Results and Discussion

1. Area and frequency of soil series

The results of table 1. indicate that 18 series different in area and frequency. The MM11 series is the largest area (21.76% from whole project and repeatability 29 times), Followed by the DM97 series (11.88% and repeatability 15 times). The dominance of some series in terms of area and frequency can be attributed to the homogeneity of the specific distribution of sediments from the sediments and their transport state during sedimentation.

Table 1 : Soil sequences for the study project, area and frequency

Area(D)	Frequency	Area%	Series	No.	Area(D)	Frequency	Area%	Series	No.
5515.62	6	1.65	DM115	11	72739.32	29	21.76	MM11	1
5950.18	2	1.78	MF11	12	26240.98	10	7.85	MW5	2
4679.92	1	1.40	DF95	13	33327.71	17	9.97	DM56	3
2005.68	1	0.60	DM47	14	35801.38	12	10.71	DW95	4
1303.69	1	0.39	DW46	15	20959.35	12	6.27	DW44	5
1571.11	1	0.47	DM95	16	39712.46	15	11.88	DM97	6
1871.96	1	0.56	TM956	17	23332.74	9	6.98	MM9	7
1136.55	1	0.34	TF1167	18	13839.19	7	4.14	DW45	8
768.84	Variety	0.23			24135.01	9	7.22	DF97	9
334280.0	Total area				19388.24	7	5.80	DM55	10

2. Fertility characteristics and biomass

The results of tables (3 and 4) show the fertility characteristics and biomass of soil and surface samples in the study area. The biomass results showed a wide range from 1.3075 $ton.h^{-1}$ in the pedon of soil series DF95 to 10.5448 $ton.h^{-1}$ in the pedon of series DF97 at the end of the dry season. The high biomass value is due to the type of vegetation that can be observed from the morphological profile of the study area. As well as the soils that are close to the sources of irrigation water have a higher growth of natural plants, which leads to the rise of the value of biomass. In general, biomass values were low because the region is geographically located in arid and semi-arid climates with little vegetative growth compared to other climates on the Earth's surface (Calzavara *et al*., 2005, Manzone *et al*., 2009).

As well as organic matter appear low value especially in arid and semi-arid soil (Lugo et al., 1986, Burke et al., 1989) and the evaluation of soil and water analysis laboratories at the University of Chile (Table 2.), the soil of the project varies from low to very low grade. The soil content of organic matter ranges from 4.1 gm.kg^{-1} in the subsurface horizon of the DM97 series to 12.6 gm.kg^{-1} in the surface horizon of the DW45 series, then it is obvious that there is a decrease with depth (Franzluebbers, 2002). While the values of organic matter content in surface soil samples ranged from 5.4 gm.kg^{-1} to 12.7 mg.kg^{-1}. Available nitrogen content in the soil ranged from 18.7 mg.kg^{-1} to 60.8 mg.kg^{-1}. The lower values were found in the subsurface horizons, while in the higher values found in upper horizons. The difference in these ranges is due to the nature of land use, fertilization and agricultural rotation in the cultivation of irrigated field crops (Wang et al. 2009) . The estimated phosphorus values in soil ranged from 5.8 mg.kg^{-1} to 13.8 mg.kg^{-1}. Although the content of phosphorus in calcareous soil may be low as a result of its stabilization in carbonate minerals, the agricultural rotation and fertilization of some farmers led to the conservation of availabe phosphorus in some soils compared to other (Hopkins and Ellsworth, 2005). Potassium showed high content in the soil, the upper limit of the potassium content was exceeded by 2007, as table (3 and 4) shows. This abundance of potassium is due to several reasons, including the release of potassium from clay minerals (Sparks, 1987), or because of the remainder of the previous and continuing fertilization (Jalali 2007). As for the surface samples, it showed high content of available potassium ranged between 201.7 mg.kg^{-1} to 287.6 mg.kg^{-1} which lies within the high potassium content for the same reasons mentioned earlier.

As for the soil content of iron and zinc, it is also noted that according to tables (3, 4) and the values proposed by Rodreguez et al. 1993, the iron values were high and above the upper limit of the iron in the soil, it range of 6.78 mg.kg^{-1} to 11.8 mg.kg^{-1}, and the soil does not suffer from lack of this element. As for the surface soils, the iron values ranged from 6.33 mg.kg^{-1} to 21.3 mg.kg^{-1}. These ratios are relatively high in the soil as described by the World Health Organization (WHO) 1996 and there is an increase in this element exposed to soils and plants to the risk of toxicity and this was identical to what found in Mahmood, 2016. It was also found that the available zinc falls within the limits allowed to exist according to the estimates of the World Health Organization WHO 1996 , the values ranged 0.45 mg.kg^{-1} to 3.12 mg.kg^{-1}, it located between the high and the medium grade according to limits ranges that described by Rodreguez *et al*., 1993 as shown in table (2).

3-Spatial distribution of measured fertility characteristics

The spatial distribution of organic matter and available nutrient developed according to Soil and water analysis laboratories of the University of Chile (Rodreguez *et al*., 1993), table 2. illustrates those varieties.

Although organic matter falls within low grade (Fig. 3). O.M was associated with the clay content and in fact the matter of the physical physiographic site that is the main influence in the distribution of clay. This is due to the increased surface area of clay minutes, which increases the retention of water, ions and organic matter and the formation of complex between organic matter and fine particles (Mayer and Xing, 2001). It is important to note that the low value of soil organic matter content, its presence, even in small quantities, is important in improving soil properties (Chaney and Swift, 2005)

Table 2 : The extent of some fertility characteristics in terms of nutrient availability index

Soil analysis	Class			
	Very low	low	medium	high
Mineral N (mg kg^{-1})^a	< 10	11-20	21-40	>41
P-Olsen (mg kg^{-1})^a	< 3	4-7	8-18	>18
Available K (mg kg^{-1})^a	< 50	50-80	81-120	>120
Exchangeable Ca (cmol$_c$kg^{-1})^a	< 2	2-4	4.1-8.0	>8
Exchangeable Mg (cmol$_c$kg^{-1})^a	< 0.2	0.2-0.40	0.5-0.8	>0.8
Extractable boron (mg kg^{-1})^b	< 0.2	0.2-0.5	0.6-1.0	>1
Cu-DTPA (mg kg^{-1})^b	< 0.1	0.1-0.29	0.3-0.5	>0.5
Fe-DTPA (mg kg^{-1})^b	< 1	1.1-2.5	2.5-4.5	>4.5
Mn-DTPA (mg kg^{-1})^b	< 0.2	0.2-0.5	0.6-1.0	>1
Zn-DTPA (mg kg^{-1})^b	< 0.25	0.25-0.50	0.51-1	>1
Soil organic matter (%)^a	< 1	1.0-2.5	2.6-5.0	>5

Available nitrogen was assimilar state to other nutrient and affect with physiographic factor of the project land, it appear from low grade to high grade and associated with clay and organic matter content (Fig.3). Available phosphorus also appear in low grade to high grade and associated with clay and organic matter content (Fig.4)

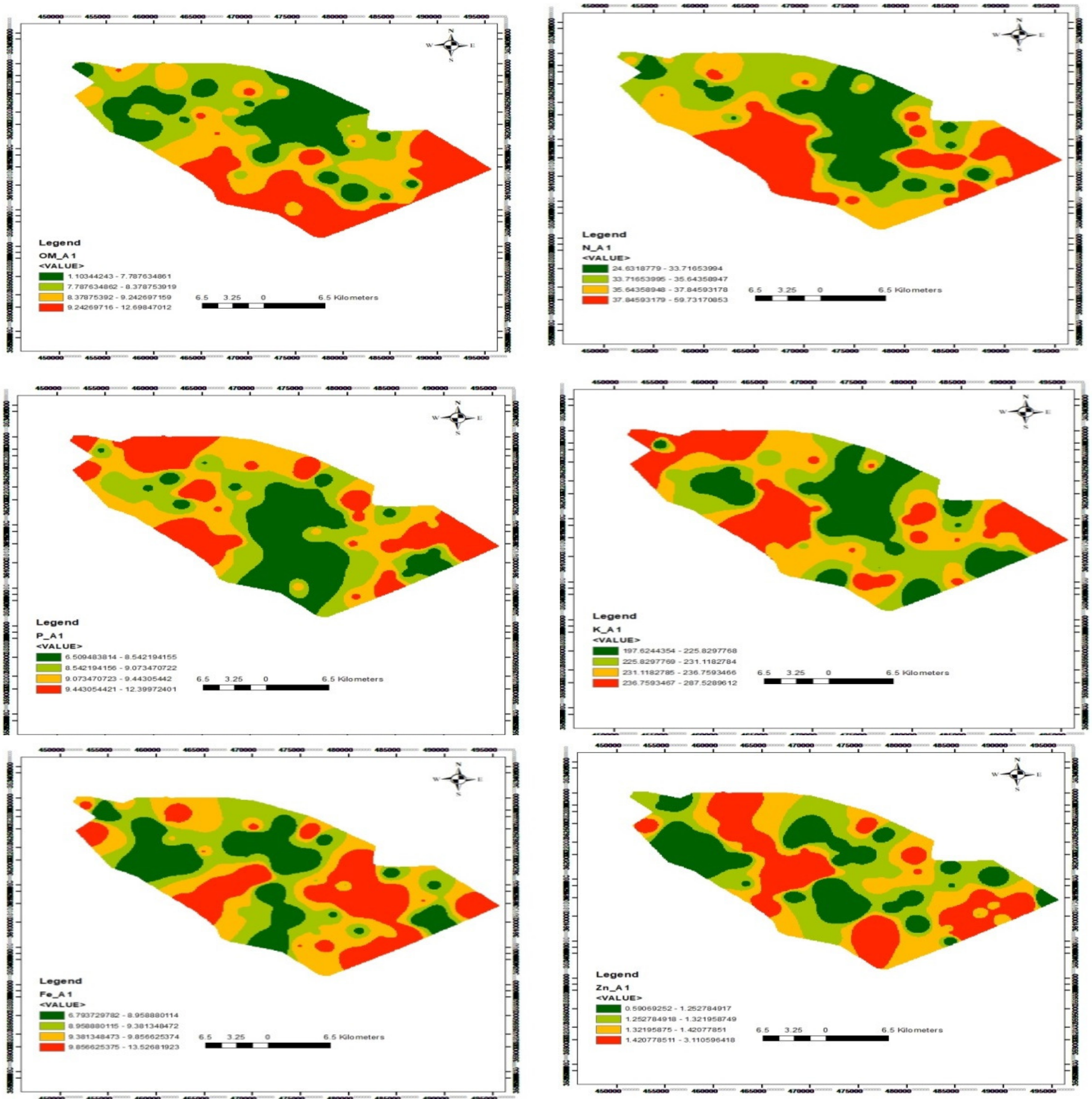
The content of the available potassium was high and the soil was enriched by this basic element. However, it was distributed in a remarkable manner. Its content increased as the clay content increased, as did most positive ions due to its ease of holding on the exchange complex as well as its release from some of the metals trapped in the net Its crystalline (Fig. 4) .

Iron content in sub-surface sediments also showed higher limits (Fig.5). This is due to the fact that most of the constituent metals (Fe-Mg silicates) which have a high iron content, which leads to higher iron content (Chen and Barak 1982).

Fig. 5 also show the distribution of available zinc, it was not the same as that of the iron distribution. It showed little variation and decrease in sub-surface horizons because zinc and iron are mixed on organic and mineral exchange complexes, and this state prevent zinc to move in subsurface horizons, as well as the nutrient unaffected by the physiographic location (Koranteng-Addo 2011).

5. Biomass and NDVI index

In the FAO publication, Schoene *et al*. (2007) defined biomass, it is all living matter of stems, leaves, flowers, seeds and any other living parts above the surface of the soil whose fate is involved in the production of organic matter in the soil and for a given area which lastly gave organic matter . The biomass is certainly closely related to NDVI index and it is the true reflection of this guide (Zhu and Liu, 2015). The results of the statistical analysis showed that there is a significant correlation (R2 = 0.809) between the biomass and NDVI index of vegetation**.** Although the area of study showed low values of NDVI, these values were clearly affected by biomass values of the same site and for the same time period as samples. Thus, the evidence of differing vegetation distribution can be used to predict biomass values in large areas (Fig.7.) (Meng *et al*., 2013).



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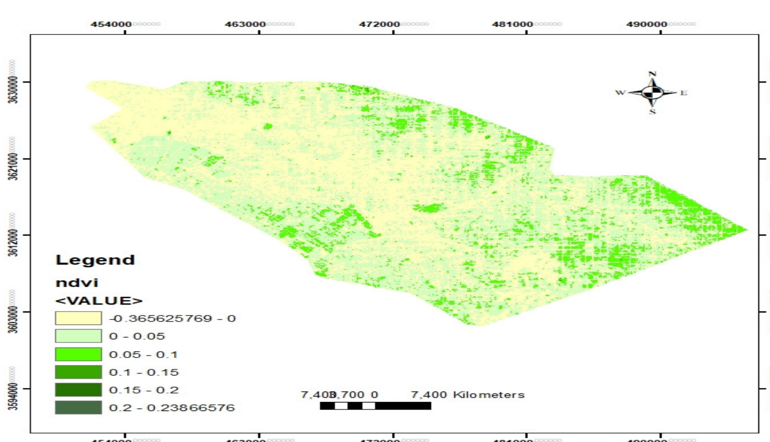

Fig. 6 : NDVI index in the study area

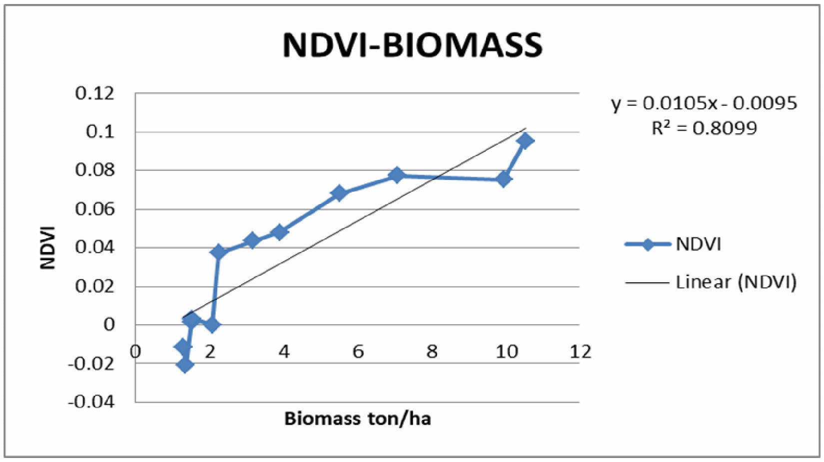

Fig. 7 : The relationship between the values of biomass and values index NDVI

Conclusions

Cartographic analysis in the GIS program of the soil series showed that the largest soil series in the Greater Musayyib project was MM11, a sedimentary soil characterized by a single graded layer of silty clay texture with moderate drainage. Organic matter did not exhibit significant spatial variation and the area of study was within the low organic content of the soil. The content of the available nitrogen showed a clear variance in surface and subsurface horizons with low content category of this essential nutrient. The phosphorus content showed significant variability in the surface horizon. However, this variation was limited with depth, and most of the soil in the study area was within the low and medium content. The soil of the study area was characterized by high potassium content in all study samples in surface and sub-surface horizons. It was enough in available iron nutrient, the soils were classified with the high content and available zinc content occurred within the high content category, low biomass. There is a positive relationship between the biomass and NDVI. The biomass content in any area can also be predicted by using NDVI index.

Table 3 : Soil fertility characteristics, Biomass and NDVI in soil pedons samples of the study area

Soil series	AGB Ton/ha	OM gm. kg^{-1}	mg.kg^{-1}					X	Y	NDVI
			N	P	K	Fe	Zn			
DM56	9.9644	9.3	46.1	9.5	287.5	9.42	1.45	466711.1738	3618489.9457	0.0251707
MW5	7.0888	9.6	59.8	9.1	278.6	12.5	2.24	467384.0263	3615586.5872	0.0472539
DM115	1.5177	10.5	52.3	10.4	256.8	9.45	1.03	468174.3554	3613270.4369	0.0668831
DW44	3.1872	8.7	39.4	8.2	238.7	13.5	2.89	470534.8553	3617619.0177	0.0234509
DM55	2.0773	10.5	28.1	8.2	237.4	7.89	0.59	473971.0684	3611007.9987	-0.1203572
DW45	1.3673	12.6	33.6	9.4	201.7	11.2	1.41	476850.4220	3615012.0734	-0.0206095
MM9	2.2632	8.7	48.9	9.6	243.1	11.8	1.11	480589.2234	3613026.5716	0.0372648
DM97	1.5383	9.8	38.7	6.8	212.8	7.46	1.26	472461.8684	3606404.2266	0.0032298
DW95	3.9079	10.4	31.9	7.8	225.8	9.35	2.14	476756.8050	3608261.0101	0.0478554
MM11	5.519	9.1	46.7	8.3	215.3	11.5	3.12	486129.7736	3608212.3185	-0.0179482
DF97	10.5448	9.8	37.6	9.5	210.9	10.1	1.33	480912.5180	3604622.4988	0.0353068
DF95	**1.3075**	11.7	38.6	7.8	197.6	7.83	1.36	489691.756	3609186.166	0.0116913

Table 4 : Soil fertility characteristics in surface samples of the study area and NDVI index

Soil series	OM gm. kg^{-1}	mg.kg^{-1}					NDVI	Y	X
		N	P	K	Fe	Zn			
DM47	9.3	36.2	9.5	242.7	9.81	1.11	456258.710829	3628858.644961	-0.006585128
DM56	8.2	27.8	8.4	213.5	6.89	1.24	454554.661349	3627842.719639	-0.091134329
MM9	7.4	36.4	10.2	287.6	10.1	1.32	452833.351178	3628692.612085	-0.139665668
MM11	9.1	33.9	9.8	277.4	11.4	1.56	453357.222490	3624664.147479	-0.058593740
MM11	9.2	35.6	11.1	265.7	10.9	1.77	462085.957302	3627199.438615	-0.018675931
TF1167	8.8	41.2	12.4	241.9	9.89	1.58	461112.248361	3626408.780384	-0.066106341
DM97	6.8	32.7	9.6	231.6	7.11	1.33	459745.959117	3625136.639172	-0.116256419
DM115	7.3	37.9	8.7	226.9	9.76	0.96	455789.395669	3623193.700104	0.039591191
DW95	6.5	28.7	7.4	218.5	9.45	1.68	461647.866264	3623466.960578	-0.005695984
DW44	7.1	34.6	8.5	227.2	9.78	1.34	465256.087496	3625824.749313	0.013416441
DM97	9.8	38.4	9.7	239.4	10.2	1.25	470108.126839	3625209.783281	-0.154292475
DW95	7.6	32.5	8.6	231.6	7.14	0.89	470009.586805	3623580.312276	0.005735932

DM55	8.7	29.8	8.2	226.4	8.23	0.94	468462.337447	3621953.586645	-0.047659409
DW46	7.2	32.5	9.4	217.9	8.95	1.45	469381.804739	3620715.327765	-0.063819570
MW5	9.6	39.4	10.8	243.8	9.89	1.77	464902.528848	3621360.520124	-0.034494327
DW45	7.5	37.4	10.1	214.3	7.43	1.46	463342.337518	3620707.419445	-0.143843884
DW44	8.2	33.2	7.6	209.6	7.89	0.94	462977.463908	3619480.109162	-0.080707157
MW5	8.4	34.6	8.4	212.4	8.59	0.91	459416.893433	3621827.673633	0.044653980
DM97	6.7	37.3	9.1	226.1	7.89	0.98	459162.069137	3619332.674565	-0.051597292
MM11	8.7	41.5	10.5	243.8	9.79	1.23	463405.157142	3615245.749856	0.004431766
DM56	6.1	28.7	6.5	201.7	6.78	0.67	471678.501302	3615022.768996	-0.142103267
DM97	7.3	31.5	8.2	205.6	7.89	1.12	472893.637331	3618899.983477	-0.038910995
DM56	6.9	28.9	7.9	213.8	8.56	1.18	472870.910164	3621517.431715	0.052599259
DW44	5.4	24.6	7.4	208.2	7.25	1.11	475491.825725	3619769.170625	-0.001720588
DW95	6.8	28.7	7.9	210.7	8.44	1.09	477275.935909	3623393.561975	-0.034039186
DF97	8.9	32.4	9.3	218.8	8.12	1.31	473678.297019	3625129.017590	0.066259805
DM97	10.9	37.2	11.1	238.7	11.3	1.67	475921.218173	3624389.274693	0.032145690
MM9	8.4	39.6	10.7	232.9	10.5	1.58	480655.813911	3619671.619378	-0.036324117
DM97	7.5	32.5	8.3	212.4	8.43	1.18	484369.967865	3617819.764670	-0.069919316
MM11	9.3	42.7	9.8	255.7	11.8	1.44	481119.175807	3617184.089962	-0.009900518
DW44	5.7	27.9	7.6	227.3	10.1	1.26	478684.740562	3617105.718465	0.007145126
DM95	6.8	26.1	8.5	243.8	9.36	1.37	479651.859826	3615906.221737	-0.015450695
DM55	7.3	27.6	7.3	219.6	9.35	1.31	476610.944520	3616674.209104	-0.009859473
DM56	7.8	32.7	9.2	225.1	10.4	1.24	484664.462651	3614961.592097	0.037934419
MM11	8.9	39.8	11.7	239.5	9.88	1.52	487848.156001	3613431.363351	-0.062364976
DF97	12.6	36.2	8.1	231.6	8.14	1.41	488945.902395	3611766.030752	-0.011886230
DM97	9.2	42.9	9.9	237.4	11.1	1.38	484555.491726	3612611.669201	0.022679554
DM55	6.8	26.5	7.4	216.9	8.04	1.31	487419.194870	3610237.788841	0.043093171
MM11	9.6	41.6	11.5	247.1	11	1.65	492477.130165	3612308.857372	0.004133514
DW44	6.7	30.2	7.2	221.7	8.79	1.18	478397.355639	3611229.430525	-0.008457167
DW44	7.8	39.8	8.7	228.6	9.26	1.26	469009.350842	3611791.057353	0.040140996
TM956	9.7	41.9	10.5	245.8	11.7	1.43	464464.327564	3612858.583866	0.026443292
MM9	11.2	43.1	9.8	232.5	9.87	1.51	466106.920701	3611458.113155	0.026945529
DW45	5.6	31.5	8.6	227.8	8.76	0.98	481163.228238	3608599.237487	-0.064353295
MM9	8.7	38.6	9.4	246.5	9.88	1.44	474945.865039	3606207.486640	0.009676162
TF1167	11.7	35.4	7.6	242.7	10.1	1.52	477403.295333	3606406.325983	-0.201417573
DM97	7.2	30.5	9.8	236.1	9.47	1.31	484546.114527	3608069.553544	0.031523091
DF95	11.4	38.7	10.6	239.6	11.3	1.12	484600.914682	3606056.960973	0.025636468
DF95	12.7	40.1	9.7	256.8	9.89	0.98	494272.265236	3612676.584452	0.064256843
DF97	10.8	39.4	9.4	249.2	8.76	1.07	488885.024864	3615888.666002	0.031363538

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