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SPATIAL VARIABILITY OF SELECTED SOIL PROPERTIES OF THE LOWER NIGER RIVER FLOODPLAINS IN BAYELSA STATE, NIGERIA

Achimota A. Dickson[1], Joseph O. Tate[1*], Payou T. Ogboin[3], Cameroon O. Payebo[2] and Williams P. Agbai[1]

[1]Department of Soil Science, Faculty of Agriculture, Niger Delta University, Wilberforce Island, PMB 071, Amassoma, Bayelsa State, Nigeria.

[2]Department of Agronomy, Faculty of Natural and Agricultural Sciences, North-West University, Mafikeng, South Africa.

[3]Department of Crop Science, Faculty of Agriculture, Niger Delta University, Wilberforce Island, PMB 071, Amassoma, Bayelsa State, Nigeria.

[*]Corresponding Author E-mail: j.o.tate@ndu.edu.ng

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ABSTRACT: *Owing to the influence of topography on soil properties, studies on the variability of soil properties become imperative. This study assessed spatial variability of some selected soil properties in three physiographic units: upper slope, lower slope and recent alluvial soils on channels of present active river in two locations in Bayelsa State. In each unit, one representative soil profile was dug, soil samples collected from generic horizons and analyzed. The results showed varying degree of spatial variability in physical and chemical characteristics, flooding, the source of parent materials and degree of hydromorphism; being the major determining factors. Among the soil separates, clay was highly variable in two physiographic units while sand and silt showed moderate variability. Organic C was moderately to highly variable (CV=20.13 – 112.77%), while total N (36.53 – 90.01%) and available P (41.49 – 58.71%) were highly variable in all the mapping units. Calcium was moderately variable (CV=26.85%) in the upper slope, and highly variable in the middle slope (CV=43.17%) and moderately variable (CV=28.93%) in recent alluvial soils in the channel of the present active river of Elemebiri and in Trofani soils; low (CV=10.01%) in the upper slope, highly variable (CV=41.33%) in the middle slope and moderately variable (CV=22.08%) recent alluvial soils in the channel of the present active river while Mg (CV=66.79 – 80.29%) and K (CV=39.27 – 101.53%) were highly variable in the different physiographic units of the two locations. Flooding, wetness and soil fertility are major constraints to agricultural intensification that requires attention.*

KEYWORDS: Variability, Lower Niger River, Floodplain, Physiographic Unit

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INTRODUCTION

Bearing in mind the heterogeneity and isotopic nature of the soil, proper understanding of the make-up of various soil properties for food production in any food growing area, are important considerations in optimal and sustainable agricultural production. The implications of this in the input-output management as well as cost-benefit analysis of soils before ascertaining its' most appropriate and sustainable usage (Senjobi *et al*, 2016) cannot be over-emphasized. Little wonder, difficulty in mapping of most tropical soils and challenges in accurately predicting the management and production potentials of tropical soils have long been traced to high degree of variability (Ogunkunle, 2003). It is in realization of this that (Fasina, 2008) posited that the most effective land conservation method is the appropriate allocation of land use to areas where they are most suitable.

Lawal *et al*, (2019) reported that soil variability in vertical and horizontal directions is dictated by intrinsic and extrinsic factors. Earlier, (Egbuchua, 2014) opined that soil variability could be either spatial or temporal. From (Akinbola *et al*, 2010), spatial variability in soil properties occurs with distance while temporal variability is a seasonal variation in certain soil properties that display continuous variation depending on the activities in them. (Effiom *et al*, 2010), opined that variability in soil properties could result in some parts of the field not receiving sufficient inputs such as fertilizer, to enable the crops or plants meet their potential while the other parts receiving excess of it under uniform application. They further reported high degree of variability in plant stands and low average productivity for most tropical Ultisols as one moves from fertile valley bottom to generally infertile upland soils.

In the recent pasts, soil properties variations research has been on the front burner for tropical areas (Egbuchua, 2014) but not in the lower Niger floodplain soils. In spite of the great agricultural potentials of the Lower Niger floodplain soils (Dickson, 2018), not much information on the variability of the soil properties is available to be used as guide for effective soil management. Food crops in the flood plain soils are cultivated on the levee crest, levee slope, backslope and on recent alluvial soils on channels of present active rivers but information on variability in the soil properties are lacking. In this regard, this study was designed to assess the spatial variability of selected soil properties in the levee crest, levee slope, and recent alluvial soils on channels of present active rivers in the lower Niger floodplains of Bayelsa State to aid in location-specific precision agricultural management planning.

MATERIALS AND METHODS

Description of the Study Areas

This study was carried out in Bayelsa State in the Niger Delta region, Southern Nigeria. The study locations lie between Latitude 05° 22' 03.9" N and 04° 59' 08.9" N and Longitude 006° 30' 21.1" E and 006° 06' 54.1" E. The Niger River traverses Nigeria in a North-western to Southern direction with the attendant sediment load ensuring that the delta platform ends up as flat terrain, making it a unique geologic environment. The Niger River flows southward and breaks up into two – the Forcados and Nun Rivers in Bayelsa State. Forcados River demarcating the western border of the state and the Nun River, running north and south down the middle of Bayelsa State, which remains the most direct tributary of the Niger. Elemebiri community on the Lower Niger River and Trofani on the Forcados River (Figure 1) were chosen for the study

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grids as both communities were randomly selected out of the four communities lying within a 200 km^2 radius around the first and major tributary of the Niger River. The annual rainfall of the study area is 2000 – 4500mm, spread over 8 to 10 months of the year and bimodal, peaking at June and September. The relative humidity averages 80% all over the state and temperature is fairly constant with a maximum of 30 ℃. The natural vegetation zone is tropical rainforest.

Soil sampling and analyses

Detailed soil survey was conducted on agricultural lands from Elemebiri and Trofani using rigid sampling method. The designation of the soil mapping units (SMUs) of 0 – 200 cm depth were ELM1 (Ap-Ap2-B1-B2-C1-C2-C3-C4 horizons), ELM2 (Ap-Ap2-B1-B2-B3-B4-C1-C2 horizons) and ELM3 (A-Ap1-Ap2-C1-C2-C3-C4-C5 horizons) for Elemebiri and TFN1 (A-Ap-B1-B2-B3-C horizons), TFN2 (Ap-Ap2-B1-B2-C1-C2 horizons) and TFN3 (A-Ap1-Ap2-C1-C2-C3-C4 horizons) for Trofani soils. Details of the soil mapping units and the land area are presented in Table 1. Soil sampling procedures followed the methods prescribed by the USDA Soil Taxonomy (Staff, 2006) and the World Resource Base (Jahn *et al*, 2006). Three representative soil pedons were dug per location, one each on the levee crest, levee slope and recent alluvial soils in the channel of the present active river, giving priority to where farming is concentrated. The soils were morphologically described *in-situ* and samples collected from the different horizons for physico-chemical properties determination following standard procedures. Soil samples collected were air-dried, crushed and sieved to pass through a 2 mm mesh. Analyses were carried out in the Green River Project Laboratory of the Nigerian Agip Oil Company and Zadell Laboratory, Port Harcourt, Nigeria. Standard laboratory methods were used to determine the physical and chemical properties of the soils. Soil particle size analysis was determined using (Day, 1965) method, popularly known as hydrometer method. Soil pH both in water and $CaCl_2$ (1:2 ratio) was determined using glass electrode pH meter and electrical conductivity (EC) determined using conductivity meter (Estefan *et al*, 2013). Organic carbon was determined using the modified dichromate oxidation method of Walkley-Black as described by (Estefan *et al*, 2013) and the values obtained multiplied by 1.724 (van Bemmelen factor) to obtain organic matter. Total N was determined using macro-kjeldahl digestion-distillation method as described by (Houba *et al*, 1995) and available P by Bray P-1 method (Bray & Kurtz, 1945). Exchangeable acidity was extracted with 1M KCl and determined by titration with NaOH solution using phenolphthalein indicator (Anderson & Ingram, 1993) and exchangeable Al with 0.01M HCl (Sumner & Stewart, 1992). Exchangeable cations were extracted with neutral normal ammonium acetate solution as described by (Estefan *et al*, 2013) and potassium and sodium in the extract measured by flame photometry and calcium and magnesium by atomic absorption spectrophotometry. Cation exchange capacity (CEC) was by the summation method (Kamprath, 1970). The soils were classified using the USDA Soil Taxonomy (Staff, 2006) and the World Resource Base (Jahn *et al*, 2006).

Data Analysis

Data were subjected to descriptive statistics. Significantly different means were separated by using Least Significant Difference (LSD) and Standard Deviation (SD). Coefficient of variation (CV) was used for variability analysis where CV < 15 is classified as less variable, CV between 15 – 35%, classified as moderately variable and CV > 35%, classified as highly variable. (Wilding & Drees, 1983).

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RESULTS AND DISCUSSIONS

Physical properties

Surface and subsurface texture of the SMUs varied, dominated by silt loam and silty clay loam except ELM3 and TFN3 dominated by sandy loam and loamy sand (Table 2). The dominance of sand in ELM3 and TFN3 indicated the parent materials were deposited under swift moving current. Moreover, these SMUs have the likelihood of high infiltration rate and low water holding capacity with possibility of moisture stress during dry months (Senjobi, 2007; Senjobi *et al*, 2016). The clay distribution within ELM1, ELM2, TFN1 and TFN2 SMUs was irregular. (Lawal *et al*, 2013) reported irregular distribution of clay within the subsoil of three pedons, characteristic of cambic horizon. Though the distribution of silt/clay ratio was also irregular with depth, silt/clay ratios generally increased with increase in silt content and vice versa. Higher silt/clay ratio in the surface layers indicated recent annual enrichment of the surface layers through deposition by the annual floods (Table 2).

Texture, organic carbon distribution and clay mineralogy are features commonly used as indicators of the homogeneity or otherwise of the parent materials (Dickson *et al*, 2021). Textural diversity between the different SMUs was ascribed to different sources of water-borne sediments and flow rate of the flood water at the time of deposition of the parent materials. Whereas the parent materials of ELM3 and TFN3 were probably deposited during the period of high flood under high current, as they are recent alluvial soils from the channels of present active Niger and Forcados Rivers, other profiles were dominated by silt loam, silty clay loam and loam, deposited under slower flow rates of the current. The ELM3 and TFN3 profiles were dominantly constituted by sand-sized particles (sandy loam, loamy sand and sand). The finer soil particles were possibly, in suspension, transported for longer period of time over greater distances and deposited at low flood period when there was less turbulence than the case of ELM3 and TFN3. (Lawal *et al*, 2013) reported higher amount of silt in JG3 profile of Southern Guinea Savannah of Nigeria and linked it to the seasonal depositional effect of the seasonal stream and the Suleja water reservoir inundating the JG3 area.

Chemical Properties

The SMUs were moderately acid to neutral, pH ranging from 5.31 to 7.00 (water) for Elemebiri soils and 5.30 – 6.80 (water) for Trofani soils (Figure 2). Wong *et al*. (2001) reported pH of 6.0 to 7.0 as the optimum pH for most agricultural crops while (Jahn *et al*, 2006) and (Brady & Weil, 2008) gave 5.5 to 7.0 as the preferred range for most crops. Among the SMUs, the surface layers of ELM1 and ELM2 fall below the FAO preferred pH range. This is an indication that the SMUs need some form of soil amendments. (Khan *et al*, 2012) attributed increase in soil pH with depth to ferrolysis which is acidification of topsoil caused by continual displacement of bases by ferrous ion during the reduction phase associated with annual flooding. The exchange acidity of 45% of the soils was 2.0 cmol kg $^{-1}$ and above suggesting that 45% of the soils were slightly to strongly acidic (Ernest & Onweremadu, 2016).

Organic matter content in the soils generally was low to moderate, ranging from 0.19 – 3.88% and 0.37 – 2.76% for the Elemebiri and Trofani soils. Total N was also low to moderate ranging from 0.01 to 0.25% in Elemebiri soils and 0.01 to 0.13% in the Trofani soils (Figure 3). Hartz (2007) reported that soils with less than 0.07% total N have limited N mineralization potential, whereas those having values greater than 0.15% would be expected to mineralize sufficient

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amount of N during the succeeding crop cycle. Based on this, the surface layers of ELM1, ELM2, TFN1, and TFN3 are likely to have reasonable mineralization potential while the mineralization potential of ELM3 and TFN2 was low.

Organic carbon distribution pattern in the soils indicated stratification. Irregular decrease in organic matter content with depth was consistent with the properties of fluvents (Staff, 2006). The organic C distribution pattern in ELM1, ELM2, ELM3, TFN1, TFN2 and TFN3 (Figure 3) did not suggest uniform parent materials with the observed abrupt increase in organic C in some horizons down the profile of certain SMUs. Organic C abruptly increased from 0.7% in the 90 – 118 cm layer to 1.07% in the 150 – 200 cm layer of ELM1, 0.11% in the 42 – 57 cm layer to 0.16% in the 88 – 106 cm layer of ELM2, 0.21% in the 55 – 140 cm layer to 1.04% in the 150 –200 cm layer of TFN2 and 0.30% in the 38 – 52 cm layer to 0.68% in the 52 – 69 cm layer of TFN3 which indicated heterogeneity. Available P ranged from 3 – 18 mg kg $^{-1}$ in Elemebiri soils and 3 – 17 mg kg $^{-1}$ in the Trofani soils (Table 2) while exchangeable K varied from 0.18 – 1.81 cmol kg $^{-1}$ in Elemebiri and 0.14 – 1.88 cmol kg $^{-1}$ in the Trofani soils (Figure 4). Higher P values were recorded generally in the surface layers revealing the close relationship between organic matter and soil P.

Furthermore, exchange acidity varied from 0.5 – 2.8 cmol kg $^{-1}$ in the Elemebiri soils, and 0.8 – 5.4 cmol kg $^{-1}$ in the Trofani soils while exchangeable Al ranged from 0.3 – 1.9 cmol kg $^{-1}$ in the Elemebiri soils and 0.5 – 2.4 cmol kg $^{-1}$ in the Trofani soils. Also, the ECEC values were low, ranging from 1.49 – 6.11 cmol kg $^{-1}$ in Elemebiri soils and 2.79 – 6.37 cmol kg $^{-1}$ in Trofani.

Spatial variability

From the data in Tables 2 – 4 and Figures 2 – 5, the complexity of soil property variability in the lower Niger flood plain is very obvious. Consistently, the pH was the least variable among the topographic units which agreed with the findings of (Mulla & McBratney, 2001) and (Effiom *et al*, 2010) in the humid region of Nigeria. The variability of the sand, silt and clay in the three different landscapes of the two locations showed similar trend. Sand was moderately variable in the upper and middle slopes and not variable in the recent alluvial soils in the channel of the present active river, silt was not variable in the upper and middle slopes and moderately variable in the recent alluvial soils in the channel of the present active river, while clay was highly variable in the upper and recent alluvial soils in the channel of the present active river and not variable in the middle slope. Clay was the most variable in all the soil mapping units and among the three soil separates (sand, silt and clay). Given, the fact that the parent materials were deposited by the annual floods form the Niger River, sand is expected to be deposited under fast moving current followed by silt when the current slows down to an extent and lastly, clay, under standing water due to their size differences. One expected clay to be dominant in the in the upper and middle slopes. The very high variability of clay in these soils did not reflect that. It is possible the recorded clay distribution is due to variation in parent material or clay distribution has changed due to weathering of the parent materials.

Organic C (CV=20.13 – 112.77%), was moderately to highly variable while total N (36.53 – 90.01%) and available P (41.49 – 58.71%) were moderately to highly variable in all the soil mapping units, reflecting the positive relationship between organic matter and total N as well as available P (Tables 3 and 4). This explains the fact that total N in these soils is a function of organic matter as N is stored in organic matter. It is also possible that organic matter

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predominantly contributed to available P in the soils. Similarly, calcium was found to be moderately variable in the upper slope (26.85%) and recent alluvial soils (28.93%) in the channel of the present active river of Elemebiri whilst highly variable in the middle slope (43.71%) of the same soil. In Trofani soils, low variability in the upper slope (10.01%), high variability (41.33%) in the middle slope and moderate variability (22.08%) in recent alluvial soils in the channel in the active river was recorded. On the other hand, Mg and K were highly variable at (66.79 – 80.29%) and (39.27 – 101.53%) respectively in the different landscapes of the two locations. Exchangeable Al was moderately variable in the upper and middle slopes and highly variable in Elemebiri soil while exchange acidity was moderately variable (21.46%) in the upper slope and highly variable in the middle slope (39.96%) and recent alluvial soils in the channel of the present active river (416.87%). In the Trofani soil, exchangeable Al (39.62 – 55.02%) and acidity (50.06 – 53.05%) were highly variable in all the three. The TEB and CEC variability in Elemebiri soil was moderate in the upper and middle slopes and highly variable in the recent alluvial soils in the channel of the present active river. In Trofani soil, TEB was moderate in the upper and middle slopes and highly variable in recent alluvial soils in the channel of the present active river while CEC was moderate in all the physiographic units (Tables 3 and 4), reflecting differences in the source of parent materials and possibly, the degree of hydromorphism.

CONCLUSION

The floodplain soils of the Lower Niger River and one of its main tributaries (Forcados) showed varying degree of spatial variability in physical and chemical characteristics, the degree and the pattern of flooding, the source of parent materials and degree of hydromorphism, being the major factors moulding variability. Parent materials were of mixed origin and seasonal inundation by the flood water and dryness in the dry season set the stage for alternate oxidation and reduction, providing the most striking features of the pedochemical environment. Flooding, wetness and soil fertility are major constraints to agricultural intensification and which needs to be addressed.

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APPENDIX

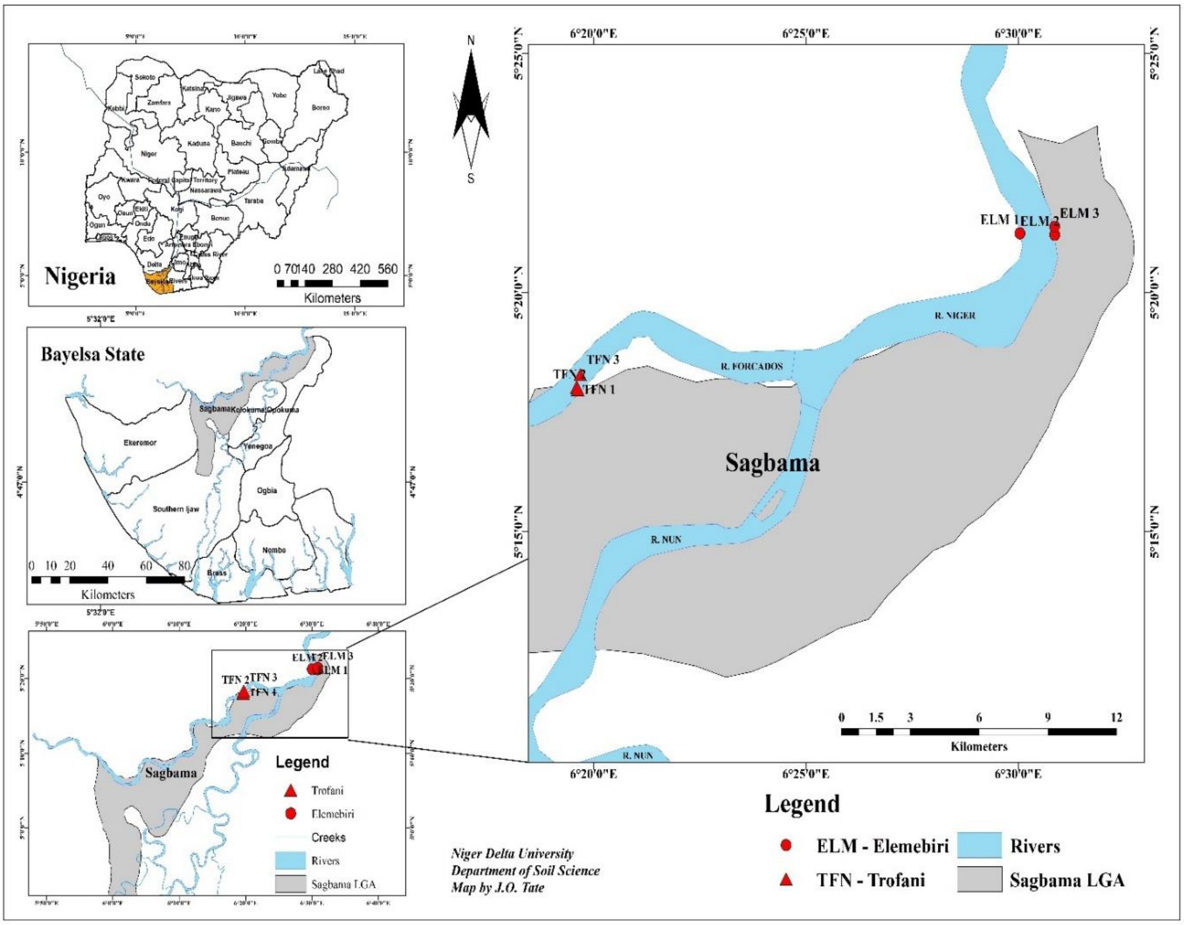

Figure 1: Map Showing the Elemebiri and Trofani Study Areas with profile pit points.

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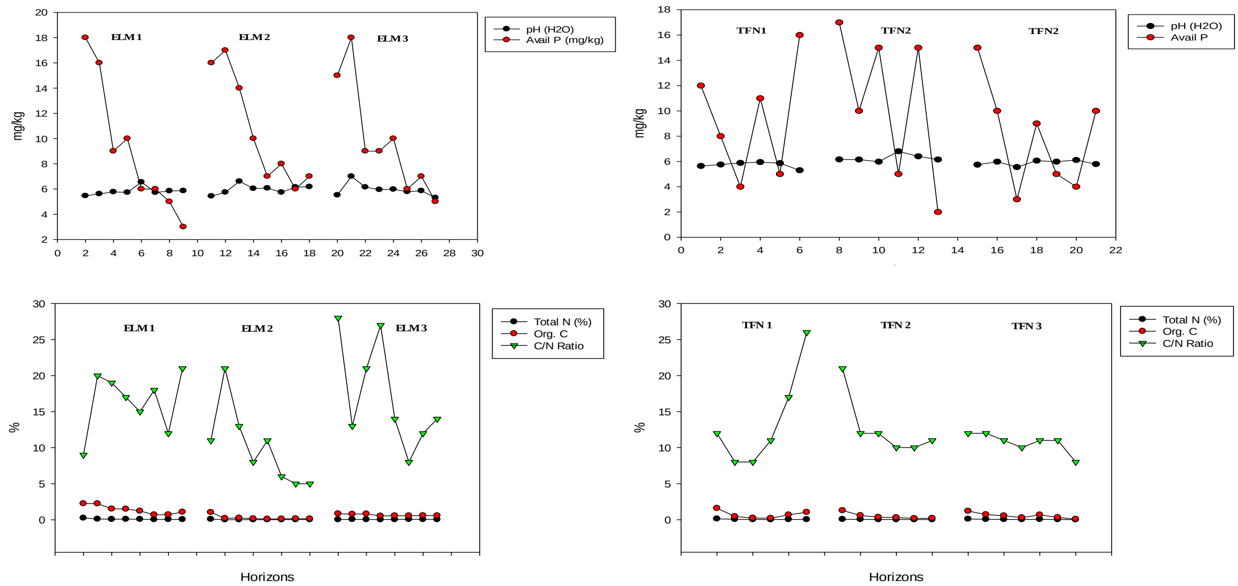

Figure 2. Graph showing distribution of Percent total organic carbon, total nitrogen, C/N ratio, pH and available phosphorus concentration in Elemebiri and Trofani soils.

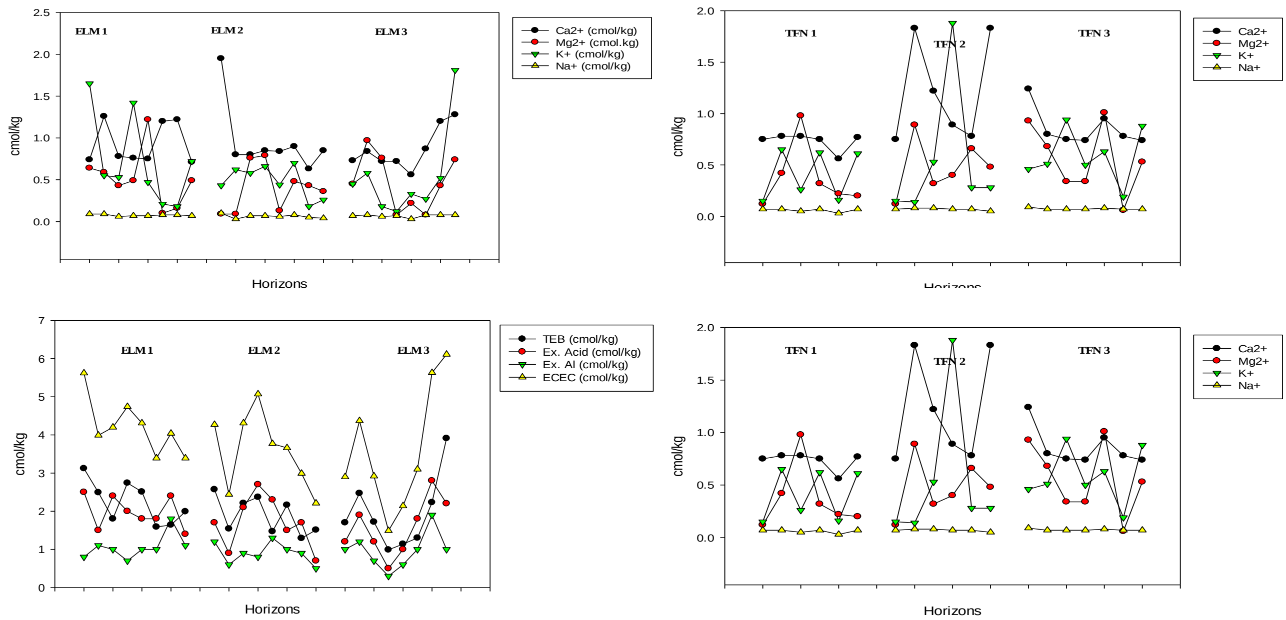

Figure 3. Graph showing distribution of Exch. basic cations, Total Exch. Bases, CEC, Exch. Acidity, Exch. Al and ECEC in Elemebiri and Trofani soils.

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Table 1: Soil Mapping Unit, Profile Pit Location and Land Area

Location	Soil Mapping Unit	Geo-reference of Profile Pit	No. of Profile Pit	Land Area (ha)	Land Area (%)
Elemebiri	ELM1	N 05° 21' 11.5" E 006° 30' 02.2"	1	29.08	2.4
	ELM2	N 05° 21' 12.4" E 006° 30' 51.3"	1	21.25	1.7
	ELM3	N 05° 21' 22.6" E 006° 30' 51.3"	1	162.14	13.3
Trofani	TFN1	N 05° 18' 01.5" E 006° 19' 36.0"	1	87.61	7.2
	TFN2	N 05° 17' 58.6" E 006° 19' 37.1"	1	51.50	4.2
	TFN3	N 05° 18' 17.1" E 006° 19' 41.2"	1	148.51	12.2

Table 2: Table showing physiological features of the Soil Mapping Units of Elemebiri and Trofani

Horizon	Depth (cm)	Percent			Silt/clay ratio	Textural Class
		Sand	Silt	Clay		
			ELM1			
Ap	0-8	23	67	10	6.7	Silt loam
Ap2	8-21	20	62	18	3.4	Silt Loam
B1	24-34	15	54	31	1.7	Silty clay loam
B2	34-65	14	56	30	1.9	Silty clay loam
C1	65-90	20	70	10	7	Silt loam
C2	90-118	21	69	10	6.9	Silt loam
C3	118-150	12	73	15	4.9	Silt loam
C4	150-200+	24	56	20	2.8	Silt loam
			ELM2			
Ap	0-11	18	66	16	4.1	Silt loam
Ap2	11-19	22	64	14	4.6	Silt loam
B1	19-32	19	68	13	5.2	Silt loam
B2	32-42	31	57	12	4.8	Silt loam
B3	42-57	28	58	14	4.1	Silt loam
B4	57-88	18	64	18	3.6	Silt loam
C1	88-106	12	72	16	4.5	Silt loam
C2	160-190+	24	64	12	5.3	Silt loam
			ELM3			
A	0-18	78	18	4	4.5	Loamy sand
Ap	18-31	72	24	4	6	Loamy sand
Ap2	31-44	68	28	4	7	Sandy loam
C1	44.68	88	10	2	5	Loamy sand
C2	68-81	78	20	2	10	Loamy sand
C3	81-123	72	18	10	1.8	Sandy loam
C4	123-160	67	21	12	1.8	Sandy loam
C5	160-200+	66	19	15	1.3	Sandy loam

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			TFN1			
Ap	0-14	21	60	19	3.2	Silt loam
A	14-31	21	62	17	3.6	Silt loam
B1	31-55	39	50	11	4.5	Silt loam
B2	55-140	17	66	17	3.9	Silt loam
B3	140-150	11	60	29	2.1	Silty clay loam
C	150-200+	13	66	21	3.1	Silt loam
			TFN2			
Ap	0-11	79	17	4	4.3	Loamy sand
Ap2	11-35	15	60	25	2.4	Silt loam
B1	35-44	15	57	28	2	Silty clay loam
B2	44-70	17	60	23	2.6	Silt loam
C1	70-126	31	58	11	5.3	Silt loam
C2	126-200+	41	49	10	4.9	Loam
			TFN3			
A	0-13	71	25	4	6.3	Sandy loam
Ap1	13-23	71	27	2	14	Sandy loam
Ap2	23-38	68	25	7	3.6	Sandy loam
C1	38-52	67	25	8	3.1	Sandy loam
C2	52-69	54	36	10	3.6	Sandy loam
C3	69-83	71	17	12	1.4	Sandy loam
C4	83-200+	91	8	1	8	Sand

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Table 3: Variability of some physical and chemical Properties of Elemebiri Soils

Soil Properties	ELM1				ELM2				ELM3			
	Range	**Ẋ**	**SD**	**CV (%)**	**Range**	**Ẋ**	**SD**	**CV (%)**	**Range**	**Ẋ**	**SD**	**CV (%)**
pH (H_2O)	5.46-6.55	5.82	0.32	5.5a	5.44-6.61	6.00	0.36	5.92a	5.31-7.00	5.95	0.50	8.46a
pH ($CaCl_2$)	4.94-5.36	5.23	0.15	2.78a	5.17-5.37	5.25	0.07	1.36a	5.19-5.64	5.35	0.14	2.53a
Org. C (%)	0.70-2.25	1.40	0.61	43.18c	0.11-1.03	0.27	0.31	112.77c	0.53-0.84	0.66	0.13	20.13b
Total N (%)	0.02-0.25	0.10	0.07	70.00c	0.01-0.09	0.03	0.03	90.01c	0.02-0.07	0.04	0.02	36.53c
C/N ratio	9 – 21	16.38	4.14	25.27b	5 – 21	10.00	5.37	53.70c	8 – 28	17.13	7.34	42.84c
Avail P (mg kg^{-1})	5-18	9.13	5.36	58.71c	6 – 17	10.63	4.41	41.49c	5 – 18	9.88	4.49	45.43c
Ca^{2+}	0.71-1.26	0.93	0.25	26.85b	0.63-1.95	0.95	0.41	43.17c	0.56-1.28	0.87	0.25	28.93b
Mg^{2+}	0.10-1.22	0.52	0.34	66.60c	0.09-0.79	0.39	0.28	71.98c	0.08-0.97	0.47	0.33	71.39c
K^+	0.18-1.65	0.72	0.54	75.26c	0.18-0.70	0.48	0.19	39.27c	0.12-1.81	0.53	0.54	101.52c
Na^+	0.06-0.09	0.08	0.01	13.91a	0.03-0.13	0.06	0.02	36.03c	0.03-0.08	0.07	0.02	25.12b
TEB (cmol kg^{-1})	1.59-4.14	2.24	0.56	25.06b	1.29-2.57	1.89	0.49	25.87b	0.99-3.91	1.93	0.95	49.10c
Acidity (cmol kg^{-1})	1.40-2.50	1.98	0.42	21.44b	0.70-2.70	1.70	0.68	39.76c	0.50-3.40	1.58	0.74	46.87c
Exch. Al (cmol kg^{-1})	0.70-1.80	1.06	0.33	30.95b	16-34	0.90	0.27	30.29b	0.30-1.90	0.96	0.47	49.34c
ECEC (cmol kg^{-1})	3.99-5.62	4.21	0.73	17.27b	39-68	3.59	0.99	27.44b	1.49-6.11	3.58	1.64	45.74c
BS (%)	41-62	53.63	8.52	15.89b	39-68	59.00	9.67	16.39b	40-66	61.88	9.28	15.00a
Al (%)	14-46	26.38	10.18	38.59o	16-34	25.50	5.58	21.88b	16-34	26.88	6.58	24.48b
Sand (%)	14-24	18.63	4.41	23.66b	12-31	21.50	6.09	28.35b	66-88	73.63	7.41	10.06a
Silt (%)	54-73	63.38	7.37	11.62a	57-72	64.13	4.91	7.66a	10-28	19.75	5.20	26.34b
Clay (%)	10-31	18.00	8.60	47.97c	12-18	14.38	2.13	14.84a	2-15	6.63	4.98	75.23c
Silt/clay ratio	1.7-7	4.41	2.26	51.16c	3.6 –5.2	4.53	0.58	12.82	1.3-10	4.67	3.01	64.45c

Ẋ = mean, SD = standard deviation, CV = coefficient of variation, where ‘a’ is <15% = least variable, ‘b’ is 15-35% = moderately variable, ‘c’ is >35% = highly variable.

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Table 4: Variability of some physical and chemical Properties of Trofani Soils

Soil Properties	TFN1				TFN2				TFN3			
	Range	Ẋ	SD	CV (%)	Range	Ẋ	SD	CV (%)	Range	Ẋ	SD	CV (%)
pH (H_2O)	5.30-5.95	5.72	0.20	3.55a	5.98-6.80	6.27	0.29	4.64a	5.55-6.11	5.90	0210	3.64a
pH ($CaCl_2$)	5.09-5.39	5.21	0.11	2.02a	4.90-5.35	5.13	0.16	3.11a	4.98-5.33	5.19	0.12	2.39a
Org. C (%)	0.21-1.60	0.78	0.57	72.45c	0.19-1.28	0.49	0.41	84.63c	0.08-1.20	0.63	0.33	52.71c
Total N (%)	0.02-0.13	0.06	0.04	67.55c	0.02-0.06	0.04	0.02	46.94c	0.01-0.10	0.06	0.03	47.09c
C/N ratio	8-26	12.75	6.16	48.31c	10-21	12.67	4.18	32.99b	8-12	11.17	0.75	6.74a
Avail P (mg kg^{-1})	8-16	9.50	4.00	42.11c	2-17	10.67	6.09	57.08c	3 – 15	7.67	4.55	59.32c
Ca^{2+}	0.56-0.78	0.74	0.07	10.01a	0.75-1.83	1.22	0.50	41.33c	0.74-1.24	0.88	0.19	22.08b
Mg^{2+}	0.12-0.98	0.35	0.28	80.29c	0.12-0.89	0.48	0.28	71.97c	0.06-1.01	0.56	0.73	66.79c
K^+	0.15-0.65	0.41	0.24	60.25c	0.14-1.88	0.54	0.67	123.39c	0.19-0.94	0.54	0.24	45.46c
Na^+	0.03-0.07	0.06	0.01	23.81b	0.05-0.08	0.07	0.01	15.64b	0.07-0.09	0.08	0.01	11.16a
TEB (cmol kg^{-1})	0.97-2.07	1.56	0.44	28.22b	1.09-3.24	2.30	0.79	34.30b	1.10-2.72	2.05	0.95	49.10c
Acidity (cmol kg^{-1})	1.70-5.40	2.43	1.21	50.06c	0.80-3.30	1.88	0.95	50.29c	1.40-4.60	2.18	1.20	55.02c
Exch. Al (cmol kg^{-1})	0.80-2.40	1.30	0.52	39.62c	0.50-1.90	0.97	0.51	53.05c	0.70-2.20	1.17	0.53	45.59c
ECEC (cmol kg^{-1})	2.89-6.37	3.98	1.112	28.19b	2.79-6.29	4.19	1.37	32.62b	3.07-5.70	4.23	0.93	22.02b
BS (%)	15-53	41.13	12.44	30.25b	38-77	55.83	14.80	26.51b	19-60	50.17	15.41	30.72b
Al (%)	18-39	32.88	7.51	22.84b	14-35	23.33	8.41	36.05c	20-39	27.00	6.29	23.30b
Sand (%)	11-39	18.63	4.41	23.66b	15-79	21.50	6.09	28.35b	54-91	73.63	7.41	10.06a
Silt (%)	50-66	63.38	7.37	11.62a	17-60	64.13	4.91	7.66a	8-36	19.75	5.20	26.34b
Clay (%)	11-29	18.00	8.60	47.97c	4-28	14.38	2.13	14.84a	1-12	6.63	4.98	75.23c
Silt/clay ratio	0.70-4.5	3.40	0.70	20.50b	2.0-5.3	3.58	1.42	39.60c	1.4-14	5.33	4.53	84.99c

Ẋ = mean, SD = standard deviation, CV = coefficient of variation, where ‘a’ is <15% = least variable, ‘b’ is 15-35% = moderately variable, ‘c’ is >35% = highly variable.

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