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Digital Soil Mapping and Morphogenetic Characterization of Soils of Ebonyi Formation in South Eastern Nigeria

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Abstract

Soils formed from Ebonyi formation in south eastern Nigeria were mapped and classified for effective management and sustainable land use. The soil mapping was executed by combination of conventional method, soil landscape relationship and spatial analyses in GIS environ using digital terrain model to produce the soil map of Ikwo Local Government in Ebonyi State at a scale of 1:50,000. The soils were characterized and classified for effective soil management based on results of analyses of soils sampled from profile pits. The results show four mapping units based on the geology which comprises mainly sandstone, silt stone, shale and river alluvium parent materials. The major soils mapped include Typic Udifluvent, Aquertic Udifluvent, Typic dystrudept and Ultic Udifluvent. The morphology shows influence of low Ca:Mg ratio and high clay content in the subsoil (>30%) consequent ponding and hydromorphic soils. Soil quality is low to moderate based on pH and of between 4.14 to 5.19 which decreased down the profile. This also explains decrease of base saturation in some pedons. (46.21 and 98.17%). The acidic and anaerobic condition of some of the profiles must have aided the Fe/Mn movement to form Fe/Mn nodules at the base of some of the profiles. Bi genetic processes was involved in the lowlands including cummulization and gleization with formation of alluvium at the upper horizons with little stratification of the underlain parent materials due to combination of ecto/endo saturation. Other processes include Ferruginisation at break of slope and in situ formation of soils with high clay and silt content in areas with geohydrology setting of marine sedimentation of marl. The combination of poorly bedded shales, siltstones and limestone highly influenced formation of multifaceted terrain with rolling to undulating uplands and flood plains at the lowlands.

Keywords: digital soil mapping, soil-landscape relationship, digital terrain modeling, soil classification, soil morpho-genesis

1. Introduction

The soils formed from Asu river group formation now called Ebonyi formation in lower Benue through are very unique in properties. The formation is dominated by combination of breccia, shale, silt stone, marl with manganeferous sandstone toward the cross river flood plain. These unique combinations differentiate the soils from any other formation in Nigeria. Hence the qualities of soils are different and require detailed information for good management. However information about the detailed distribution, characteristics and classification of the soils are lacking in spite of various geological information available about the area (Ofoegbu and Amajor, 1987). This has resulted to misappropriation of land to different uses which are detrimental to profitable and sustainable production. The land use in the area is dominated by intensive rice cultivation with occasional introduction of maize and yam on high ridges in the waterlogged area. The uniqueness of the area calls for appropriate land use management based on inventory of soils in the area for good crop production.

Conventional methods of soil survey are too cumbersome and expensive to fulfil the need for soil maps in developing countries; digital soil mapping makes possible rapid soil mapping which can save time and resources. Soil-landscape modeling techniques have developed as a quantitative method for predicting patterns of soil variability using observed patterns in environmental variables known to influence soil property variability, such as topography, hydrology, or geology McSweeney *et al*., (1994). Soil-landscape modeling has many potential benefits because of its ability to represent continuous variability of soil properties across landscapes, quantitatively relate environmental factors, such as topography to soil properties and to make spatial predictions of soil properties across the entire landscape including unsampled locations. Soil landscape modeling is useful in soil mapping where the relief varies from undulating to rolling since slope influence distribution soil particles, minerals and water flow. All these parameters influence soil formation depending on time and other climatic factors such as rainfall and temperature of the area. Quantitative information and spatial distribution of soil properties are major essentials for realizing sustainable land management. The exactitude of soil information go a long way in determining, the suitability for optimum and sustainable crop production. Conventional soil surveys are generally used to draw information about soils and their distribution. The high costs of surveys usually limit areas the area covered by detailed soil information. Moreover, the polygon-based mapping approach of conventional soil map limits the accurate reflection of soils distribution in the field. The combination of both digital and conventional methods is expected to provide another option for soil mapping.

The soils from ebonyi formation are majorly hydromorphic with lesser upland soils. This has defined the land use which is majorly for rice production. The area is characterized by undulating topography and no location is above 400 m above-sea-level. The information about the soils is scarce and land use has been based on trial and error with poor crop yield. In order to empower farmers to produce maximally and avoid usual crop losses in the area, soil information is urgently to guide farmers appropriately. The study was conducted to characterize the area and provide information on groups of soils and their extent/ distribution.

2. The Study Area

Ikwo Local Government Area of Ebonyi State in South Eastern Nigeria was studied. The area is located within Longitude 800, 820E and Latitude 600, 620N.

Ikwo is the largest local government area in Ebonyi State. It is situated on the eastern part of the state. It has a land mass approximately 5,000 km^2. It shares boundaries with Abakaliki and Ezza local government areas.

2.1 Climate

The pattern of agricultural production is mainly defined by the influence of the annual weather regime based on two distinct seasons: the dry and the raining seasons. The dry season starts around November and ends around March, while the raining season starts in April and ends in October. However, short dry spell is usually experienced during the month of August, which is termed as August Break. Lowland areas popularly called fadama, are largely available and serve as good sites for rice and dry season vegetable farming. Ikwo has a semi-tropical climate with plenty of rainfall. During the raining season, lush vegetation, thick forests, ponds and small pools mark the landscape. The rainfall pattern is bimodal with peaks in July and September. The annual rainfall is 1230 ± 28 mm with the onset and cessation of rain being 12^{th} April (± 3 days) and 17^{th} November (± 4 days), respectively. The height of the growing season is 220 ±15 days; thus, April to November mark the wet season, while December to February mark the dry season when crop rely on existing soil moisture. The mean monthly temperature ranges between 24 and 29 °C. The highest temperature is in the month of February, while the lowest is in the month of July, showing a correlation between rainfall and temperature in the study area. The relative humidity ranges between 68.7 % in January and 92 % in July showing a positive correlation with the amount of rainfall.

2.2 Vegetation/ Land Use

Rice is produced mainly in Ikwo Local Government Area of Ebonyi State. Other crops produced in the state are yam, cassava, maize, groundnut, cocoyam, sweet potato, plantain, banana, oil palm and melon. Natural vegetation which consists of thick forest with trees and oil palms growing in the wild could still be seen bounding the farms in the distance but has been replaced around the communities and farming areas. Areas around the communities which can be said to be in 'fallow' are covered with bush re-growth, grasses, sedges, a few broad leaves and shrubs. Fields to be cultivated soon with rice are covered with wire grass, giant star grass, guinea grass and sedges, independence grass, *Mimosa pudica, Impomea involucrate and Imperata cylindrical.*

Ikwo is within the sub-humid agro-ecological zone, southeast of derived savanna belt of Nigeria. The dominant vegetation is characterized by tree shrubs with abundant palm trees, while the lowland is devoted to rice cultivation.

2.3 Geology

Ikwo falls within the Asu-River group geologic formation (Lower Cretaceous). It consists of Eze-Aku shale formation and Nkporo formation made up of shales, sandstones and siltstones. The sediments later became folded given rise to two major structural features, the Abakaliki anticlinorium and related Afikpo synclinorium.

2.4 Hydrology and Drainage

The groundwater level is high ranging from 0 – 60cm in most of the area. During the wet season however, the plain is flooded. In locations like Orona, Ekpanwadele, Ofurukpe among others, the water table is high leading to construction of ridges as bed for crop.

3. Methodology

3.1 Terrain Analysis

Visual and visual instrumental analyses of satellite images of the area were carried out to extract terrain features for base map production. Major terrain features such as drainage network and land cover / land use patterns were assessed during the interpretation. The study areas were then imported into ArcGIS 10.1 for spatial analyses. The spatial analyses include digital terrain modeling (DTM) for better understanding of the landscape. The study areas were further assessed on the field based on soil-landscape relationship taking into cognizance the effects of parent material. Representative study blocks were chosen for detailed investigation.

3.2 Soil Survey

The survey was carried out at semi-detailed level on a scale of 1:50,000. Four training sites were selected to represent the entire areas based on geology, hydrology, DTM and land use. Transects were made at 250m intervals for each of the site. Global Positioning System (GPS) was used to determine the coordinates for geo-referencing. Morphological characteristics of the soils were examined from the soil surface to a depth of 120 cm at interval of 50 m along the transects, footpaths and nomad tracks. The DTM also serve as a guide in boundary demarcation and in location of probing points. The morphological and physical characteristics of the soils were examined and recorded appropriately for each of the auger holes at 0 – 15, 15 – 30, 30 – 60, 60 – 90 and 90 – 120 cm depths. Changes in physiography, soil surface form and stoniness, micro-relief, etc. were noted and also used as clues to arrive at changes in soil types and establishment of soil boundaries. The information was recorded on the field notebook and pro-forma. These were carried out in line with the international guideline for field soil survey and mapping (FAO, 2006). Placements of boundaries were achieved by grouping similar auger examination points. Modal soil profile pits were dug based at the most representative auger examination points and also based on logistics; for each of the identified soil types. On the whole, seven modal soil profile pits were dug, described and sampled (Fig. 1). Each of the profile pits measures 1.0 m by 2 m, and the depth varied depending on the peculiarity of the soil types, water table and hard pans. All necessary environmental information relating to the site characteristics and the soil morphology were recorded on the pro-forma. These include among others: Site/Profile No., Mapping Unit, Location, Climate, Physiography (Slope shape, position, gradient), Land use/Land cover form, Evidence of rock-out-crop, Lithology, Land surface form, Human Influence, Nature and extent of erosion, Drainage condition, Depth to the water table, Soil profile thickness (effective soil depth), etc.

The soil profiles were described according to the FAO guideline (2006). The soil characteristics and morphological properties were described for each of the identified horizons (layers) in the profiles. The soil colour was identified with the aid of Munsell Soil Colour Charts; texture was determined on the field by hand feel method, at moist state. Structure, concretions, roots and boundary forms were described using visual assessment. The soil consistence was determined at dry, moist and wet states on the field. After the description of the sites and soil profiles, soil samples were taken from each of the soil profiles, starting from the lowest horizon upward; in order to prevent contamination as a quality control measure. The samples taken were put into sampling bags, and appropriately labeled for laboratory analysis.

Replicate soil core samples for bulk density determination were taken from each of the horizons of the soil profiles using Grossman and Reinsch (2002) method. Replicate of undisturbed soil cores (5 cm in diameter and 5 cm deep) were also taken from each of the horizons for the determination of saturated hydraulic conductivity (K_{sat}) using a constant head permeameter method (Reynolds and Elrick, 2002).

Soil samples were taken from the soil horizons of the seven soil profiles that were dug for chemical and physical analyses in the laboratory.

3.3 Laboratory Analytical Methods

The profile samples were taken to the laboratory, air-dried, crushed and allowed to pass through a 2.00 mm mesh sieve. The gravel portion (> 2.00 mm diameter) of the soil samples was weighed and the ratio of gravel to fine earth calculated. Thus, the gravel content was calculated as a percentage of total air-dried soil.

Particles size distribution was determined by a modified Bouyoucos hydrometer method as described by Gee and

Or (2002). Soil pH was determined in 1:1 soil:water ratio, and by KCI media using a glass electrode pH meter with calomel electrode (Bates, 1954). Organic carbon was estimated by the Dichromate wet oxidation method of Walkley and Black (1934). Total nitrogen was determined by the micro-Kjedah method of Jackson (1962). Available phosphorus was evaluated by Bray 1 method of Bray and Kurtz (1945); while exchangeable cations (Ca, Mg, K and Na) were extracted by neutral NH_4OAC. Calcium, K, and Na were measured through a flame photometer, while Mg was determined by atomic absorption spectrophotometer (Rhoades, 1982). Exchangeable acidity was determined by 1N KC1 extraction and titrated with 0.05N NaOH solution (Black, 1975). Effective Cation Exchange Capacity (ECEC) was calculated by the summation of the values of exchangeable cations and exchangeable acidity. The micronutrients (Fe, Mn, Zn and Cu) were determined in 0.1N HC1 and evaluated using the atomic absorption spectrophotometer (Jackson, 1962).

3.4 Soil Classification

The soil types were identified characterized and classified using the USDA soil classification system (2011). The soils were also classified at the series local level using the approach of Moss (1957).

4. Results and Discussion

4.1 Soil Mapping and Classification

The Ikwo Local Government is divided into three zones comprising Central, North and South zones. The zones were characterized and mapped for inventory of their soil distribution, genesis, land use planning and effective management. 68.48% and 31.52 % of the area were categorized as hydromorphic and upland soils respectively. Five mapping units were identified based on the geology and hydrology which comprises mainly sandstone, shale and river alluvium parent materials and other environmental factors that influences soil development. The major mapping units identified and classified include Typic Udifluvent, Aquertic Udifluvent Typic Eutrudept, Ultic Udifluvent in the area of marine sediment of marl and siltstone. The soil units were named as Ofenekpe, Tsantsaga, Ameka, Ekpomaka and Amagu at series level according to where they were first identified. The mid slope /uplands soils having geohydrology setting of marine sedimentation of marl which formed soils in situ from weathering of marine deposit in the Amagu mapping unit (Ultic Udifluvent). Others that are majorly shallow include Typic Fragiudepts (Eleke series), Lithic udorthents (Ikwo series) and Aquic Udipsamment (Odomowo series) and Ofeknepe mapping unit which was located in the northern zone with sand stone parent material (IAR&T, Soil Survey Report 2013). This unit (Ofeknepe) is associated with flood plain of cross river which is usually flooded during the wet season and occupies about 0.31 % of the area mapped. Ameka mapping unit are floodplains which dominate the central and northern zone with parent material varying from alluvium, shale, silt stone, breccia and conglomerate. The soils occupy 59.6% of the area and are seasonally flooded. Ekpomaka mapping unit occupies 28% (Fig. 2) of the area and contains upland soils formed from weathering of sand stone in situ. Amagu mapping units is an older flood plain made of geohydrology setting of marine sedimentation of marl and silt stones with occurrence of thin Fe/Mn stone line and it occupy about 4.7% of the area. These soils were formed in situ with increase in clay content in the profile. The remaining area are marginal soils at upland position with little agricultural significant due to their shallowness and stoniness.

4.2 Morpho-Genesis of the Soils

The soils have brown top soils changing to brownish gray /olive gray in the sub soil except Ekpomaka mapping unit which has redder hue. The soil morphological observations revealed that most of the profiles have variegated color ranging from brown to gray while the soil structure varies from sub angular blocky to massive in the profile with mottles at depth in the floodplain soils. The major soil forming processes include cumulization, gleization, and deceleration of soil development due to wetness in the floodplains. Process of ferruginsation was observed in the lowland/upland of area of past erosional surface now exposed. This was found within Ameka mapping unit with accumulation of Fe/Mn concretion forming plinthite within 94cm to the surface. In the aquatic older flood plain the process of lessivage and gleization with mottling. Bi- genetic processes was observed in the lowlands including cummulization with formation of alluvium at the upper horizons with little stratification of the underlain parent materials due to combination of ecto/endo saturation. The influence of parent materials which consist largely of poorly bedded shales, fine grained sandstones, and limestone highly influenced soil formation with terrain and hydrological setting modifications which resulted to unique soils in the area. Others of little agricultural use include Udipsamment at the crestal position.

4.3 Physical and Chemical Properties

The soils are silt loam at the surface and clay loam to loam with. The average physical properties of the Udipsamments show that the texture varies from silty loam to sandy clay / clay in the subsoil. The high silt content (22-50%) further confirms the classifications (Entisols and Inceptisols) that the soils are young. The area has low to high base saturation (46.21 -99.83%). This correlates with pH range of 4.99 to 5.53 and decreased down the profile. % OC was moderate with range of 0.49-1.82 and decreased down the profile with no definite pattern. This also is an indication of cumullzation process of soil formation.

The macro nutrients (N, P, K) distribution at the surface soils are shown in figures 3-5. The unsampled areas (shallow with paralithic contacts or fragi/duripans) indicated with white symbolization in the map were not assessed for fertility classification.. K distribution at the surface soil (Fig.3) varies between low (<0.2cmol/kg soil) to high (>6cmol/kg soil). The variability could be attributed to high solubility of K, and from addition from decomposing crop/weed residues and from alluvium deposits. Total Nitrogen varies from 0.25 and 0.68% in the sub soil. Generally the surface soil was high in Nitrogen ranging between 0.2- 0.6 (Fig.4), hence Nitrogen fertilizer would not be necessary for crop production. This could be attributed to tillage method which involves over turning of crop residues and weeds during land preparation. This was in line with findings on agrarian floodplains in south western and north central Nigeria by IAR&T Soil Survey Report (2013) and Ande *et al* (2013). Available P ranges between low (<8 mg/kg) to high (>20 mg/kg) at the surface (Fig.5) and decreases in the sub soil to 4.3mg/kg. Reetz (2002) stated that P availability generally increases in submerged soils, this finding follows this trend due to ponding on the surface and moist subsoil hence, P was higher on the surface submerged soils. Ca:Mg ratio was low which could have resulted to poor structure and ponding observed.

The range of Zn content was 1.1-3.1 mg/kg, Cu .34-1.1mg/kg, Mn 4.2-89.7mg/kg except in Amagu series with

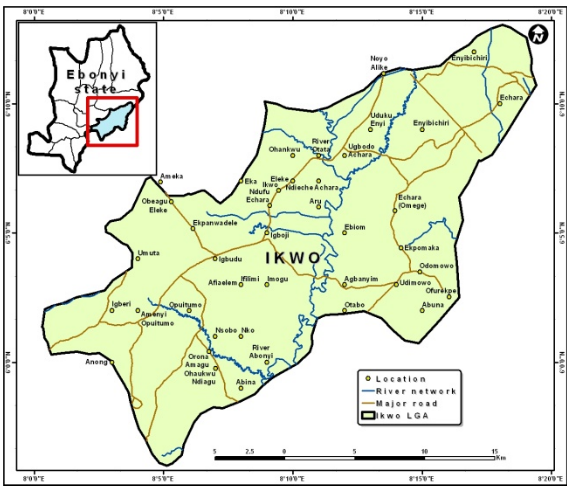

Figure 1. Location map of the study area, Ikwo, S-E, Nigeria

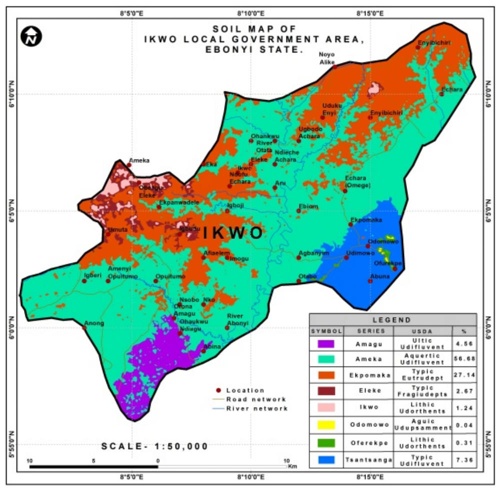

Figure 2. Soil of mapped of the study area, Ikwo, S-E, Nigeria

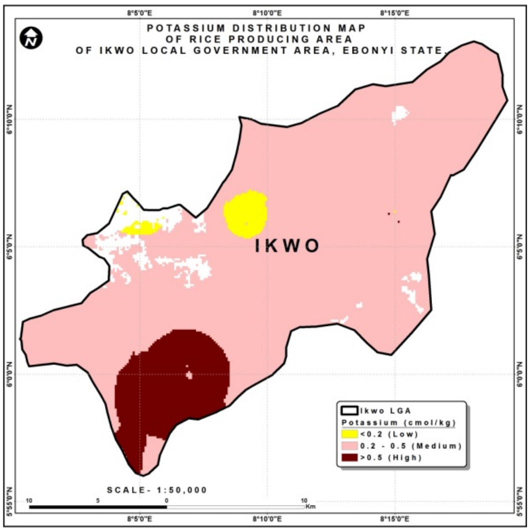

Figure 3. Potassium distribution in the surface soils, Ikwo, LGA, S-E, Nigeria

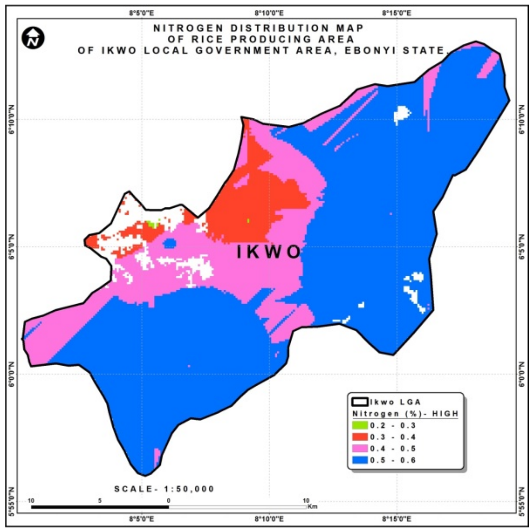

Figure 4. Nitrogen distribution in the surface soils Ikwo LGA S-E Nigeria

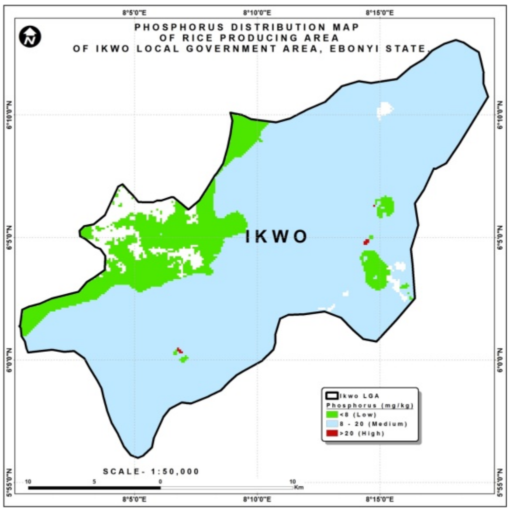

Figure 5. Nitrogen distribution in the surface soils Ikwo LGA S-E Nigeria

Figure 6. Suitability evaluation for low land rice production, Ikwo LGA, S-E Nigeria

maximum value of 201.0mg/kg at the surface. Fe content varies between 41.4 and 434mg/kg. The acidic and anaerobic condition of some of the profiles must have aided the Fe/Mn movement to form massive Fe/Mn nodules at the base of these profiles. Ferrolysis was also noticed in Ameka mapping unit , Typic Fragiudepts (Fig.2) with accumulation of Fe/Mn concretion forming plinthite within 100cm to the surface. However, the area is not significant since it occupies less than 1% of the area. Other units with little agricultural significant due to shallow soil depth include Typic Fragiudepts, Lithic Udorthents and Aquic Udisamment (Fig. 2).

Table 1. Physical characteristics of major soils mapped at Ikwo LGA

Series	Depth(cm)	Particle size %							
		Gravel	CS	FS	Silt	Clay	BD (g cm^{-3})	Ksat (cm hr^{-1})	TP (%)
Tsantsaga	0 - 14	7.1	8.7	33.0	52.0	6.3	1.43	0.252	45.9
(Typic Udifluvent)	14 - 52	-	14.0	25.7	22.0	38.3	1.58	0.008	40.4
	52 - 83	-	8.2	41.5	22.0	28.3	1.36	0.378	48.5
	83 - 110	-	12.5	35.2	20.0	32.3	1.53	0.022	42.1
	110 - 130	-	5.8	25.8	22.0	46.3	1.44	3.395	45.7

Ameka	0 - 9	-	2.3	15.4		50.0	32.3	1.21	0.147	54.3
(Aquertic Udifluvent)	9 - 42	-	1.8	9.9		46.0	42.3	1.38	0.326	47.9
	42 - 86	-	4.0	23.7		30.0	42.3	1.39	5.920	47.5
	86 - 120	-	2.9	18.7		32.0	46.3	1.65	1.438	37.7
	120 - 150	-	11.2	20.5		24.0	44.3	1.58	0.016	40.2
Ekpomaka	0 - 10	-	8.4	23.3		34.0	34.3	1.36	0.109	48.8
(Typic Dystrudept)	10 - 14	-	2.6		**25.0**	34.0	38.3	1.38	0.655	47.9
	14 - 62	-	1.4		40.3	22.0	36.3	1.60	2.881	39.8
	62 - 131	-	3.1	16.5		34.0	46.3	1.59	0.022	35.8
	131+	-	1.8	21.9		30.0	46.3	-	-	-
Amagu	0 - 17	-	7.6	20.1		50.0	22.3	1.53	2.094	42.4
(Ultic udifluvent)	17 - 46	-	5.1	16.6		32.0	46.3	1.25	0.322	52.9
	46 - 94	-	10.4	15.3		16.0	58.3	1.68	0.170	47.4
	94+	-	23.1	24.6		20.0	32.3	-	-	-

Table 2. Chemical properties of the major soils in Ikwo LGA

Series	pH (H_20)	pH (KCl)	Ca	Mg	K	Na	H^+	CEC	Bsat (%)
Tsantsaga									
0 - 14	5.43	3.68	1.53	1.18	0.24	0.23	0.08	3.18	96.93
14 - 52	5.52	3.27	1.72	1.13	0.14	0.26	0.66	3.25	83.12
52 - 83	5.54	3.19	2.65	1.23	0.14	0.63	0.56	4.32	88.52
83 - 110	4.90	3.14	2.55	1.73	0.17	1.94	1.70	5.05	74.81
110 - 130	4.38	2.79	3.14	1.37	0.22	1.90	2.40	6.63	73.42
Ameka									
0 - 9	4.99	2.86	2.41	2.38	0.22	0.42	1.12	5.43	97.83
9 - 42	5.08	2.97	1.67	1.16	0.11	0.34	1.00	3.28	76.63
42 - 86	5.01	3.14	1.46	1.13	0.09	0.35	1.60	3.03	65.44
86 - 120	5.05	2.95	1.10	1.35	0.13	0.40	2.00	2.98	57.53
120 - 150	4.85	3.04	2.75	4.28	0.17	0.54	3.50	7.74	68.86
Ekpomaka									
0 - 10	5.14	3.22	1.42	1.35	0.22	0.20	0.08	3.19	97.55
10 - 14	4.91	3.16	0.55	1.15	0.12	0.24	2.26	2.06	47.68
14 - 62	5.18	3.39	0.61	1.27	0.15	0.29	2.70	2.32	46.21
62 - 131	5.20	3.04	1.01	3.45	0.14	0.29	2.76	4.89	63.92
131+	5.31	3.18	1.82	3.33	0.13	0.27	2.96	5.55	65.21
Amagu									
0 - 17	5.08	3.29	1.33	2.47	0.13	0.31	0.10	4.23	99.76
17 - 46	5.60	3.17	3.82	4.65	0.12	1.54	1.34	7.13	84.17
46 - 94	5.40	3.28	10.28	5.84	0.13	10.05	0.24	26.30	99.09
94+	5.70	3.49	7.06	5.80	0.12	11.59	0.04	24.27	99.83

Table 3. Con't: Chemical properties of the major soils in Ikwo LGA

Series	OC (%)	TN (%)	AvP (mg kg^{-1})	SAR ($cmol/kg^{0.5}$)	ESP (%)	Micronutrients (mg kg^{-1})			
						Zn	Cu	Fe	Mn
Tsantsaga									
0 – 14	1.07	0.40	13.7	0.20	5.78	3.1	0.3	268.0	51.2
14 - 52	1.16	0.44	11.4	0.22	2.64	2.7	0.1	200.0	65.7
52 - 83	0.66	0.16	3.9	0.45	6.15	2.1	0.6	84.2	49.2
83 - 110	0.51	0.10	5.7	1.33	8.29	2.3	0.4	55.7	32.6
110 - 130	0.77	0.12	5.0	1.27	6.20	2.9	0.3	51.3	50.1
Ameka									
0 – 9	1.82	0.68	11.0	0.27	6.33	3.2	1.5	434.0	89.7
9 – 42	0.30	0.13	5.9	0.29	2.56	1.6	1.1	130.0	55.7
42 - 86	0.48	0.15	8.0	0.31	1.78	1.8	0.8	60.4	18.4

86 - 120	0.38	0.14	6.0	0.36	1.60	2.1	0.9	67.7	11.2
120 - 150	0.59	0.10	9.3	0.29	1.26	3.1	0.4	49.8	12.5
Ekpomaka									
0 – 10	0.80	0.25	4.6	0.17	5.01	1.6	0.2	268.0	15.8
10 - 14	0.30	0.13	11.1	0.26	0.97	1.1	0.4	55.4	4.2
14 - 62	0.72	0.17	7.1	0.30	0.99	1.9	0.2	46.8	5.2
62 - 131	0.40	0.14	4.4	0.19	0.89	1.3	0.3	38.7	13.4
131+	0.49	0.15	3.9	0.17	0.77	1.6	1.2	41.4	27.6
Amagu									
0 – 17	0.49	0.25	4.3	0.22	5.92	2.0	0.8	203.0	201.0
17 - 46	0.42	0.14	4.4	0.75	6.54	1.5	0.3	71.2	68.9
46 - 94	0.29	0.13	8.4	3.54	35.02	2.2	0.3	49.5	19.8
94+	0.34	0.14	8.7	4.57	46.42	1.5	0.4	164.0	105.2

4.5 Soil Suitability Evaluation for Low land Rice Production

Tsantsagi series found in Ofurupke area was the only series evaluated and classified as Highly Suitable (S1). Other soil series including Ameka, Epokmaka and Amagu series belong to Moderately Suitable (S2) class (Fig. 6). The major limitation include low cation exchange capacity (CEC) (Table 2 con'd). The soils of the floodplains are generally moderately suitable for lowland rice production.

5. Conclusion

Soils formed from Ebonyi formation in south eastern Nigeria were mapped and classified for effective management and sustainable land use. The soil mapping was executed by combination of conventional method, soil landscape relationship and spatial analyses in GIS environ using digital terrain model to produce the soil map of Ikwo Local Government in Ebonyi State at a scale of 1:50,000. The soils were characterized and classified for effective soil management. The results show four mapping units based on the geology which comprises mainly sandstone, silt stone, shale and river alluvium parent materials. Bi genetic processes were involved in the lowlands including cummulization and gleization with formation of alluvium at the upper horizons with little stratification of the underlain parent materials due to combination of ecto/endo saturation. Other processes include Ferruginisation at break of slope and in situ formation of soils with high clay and silt content in areas with geohydrology setting of marine sedimentation of marl. The mapped soils include Typic Udifluvent, Aquertic Udifluvent Typic dystrudept and Ultic Udifluvent with inclusion of shallow soils like Typic Fragiudepts, Lithic Udorthents and Aquic Udisamment at the upper to crestal position. However the latter was not considered to be significant since they occupy less than 5% of area mapped, The morphology shows influence of low Ca:Mg ratio which is attributed to poor structure and ponding in hydromorphic areas. Soil quality was low to moderate based average pH range between 4.14 to 5.19 and decreased down the profile which also explains decrease of base saturation ranging between 16.84 and 98.17%. The acidic and anaerobic condition of some of the profiles must have aided the Fe/Mn movement to form Fe/Mn nodules at the base of some of the profiles. The combination poorly bedded shales, siltstones and limestone highly influence formation multifaceted terrain with rolling to undulating uplands and flood plains at the lowlands. The major challenge in the area is water management. Good drainage system is required to reduce flooding and crop loss. Integrated fertility management practices and improved crop combination or cropping systems are essential for the major arable crops to produce at there full genetic potentials in the area.

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