

## Assessment of Some Wetland Potentials in Makurdi Supporting Rice and Sugarcane Production

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**Abstract.** The study was carried out in Makurdi, Benue State with the view to characterize some wetlands of Makurdi area and their suitability to rice and sugarcane production. In order to characterize and classify the soil, four pedons were dug at the selected seasonally flooded wetlands. The soils were characterized in terms of their morphological, physical and chemical properties. The soils were generally sandy loam, loamy sands and sandy clay loam. The distribution of clay content increased with soil depth for all pedons. The soils were strongly to moderately acid in reaction (3.47 to 5.61) in H<sub>2</sub>O. The soils had low (0.2 to 3.77 g/kg) organic carbon. The percentage base saturation ranged from 5 to 75 %. The soils were classified as Vertic Endoaquepts/Vertic Gleysols (Orthoetric), Aeric Glossaqualfs/Lixic Gleysols (Orthoetric) and Typic Epiaquults/Ferralic Acrisols (Epidystric). Soil Type B was marginally suitable (S3) for sugarcane. However, all the 4 soil types were moderately suitable (S2) for rice.

### Introduction

Wetlands were mostly regarded as waste lands and a den of pests and diseases. Eventually, their potentials were gradually discovered. The discovery reveals high relevance for provision of food and shelter, not to mention tourism. It is established that wetlands are among the most important ecosystems on earth. The study of wetlands is called Telmatology. Their studies have revealed that the critical role they play rightly describes them as “Kidneys of the landscape”. This is because they function as downstream receivers of water and waste. Other researchers described them as “biological supermarkets” because of the extensive food chain and rich biodiversity they support (Isirimah, 2002). Akanmigbo (2002) did an extensive survey of wetlands and identified eight orders of the Soil Taxonomy (Soil Survey Staff, 1997) which he correlated them with the FAO-UNESCO system (1974) and stated many of their potential uses. Odingo (1991) however stated that land use in Africa is extensively influenced by ecological conditions and patterns of use as by previous generations.

Man’s land use activities on wetlands have continued to increase in proportion to his awareness. Some of these activities have been identified as harmful and alters the ecosystem. These necessitate the application of effective land use planning of wetlands by relevant stakeholders through survey and satisfied community needs for safe housing, public infrastructure, conserve the ecosystem and for economic development (Hames *et al.*, 2014). Studies on soil classification and soil wetland use in the extensive agricultural soils in Makurdi north, Nigeria are scarce.

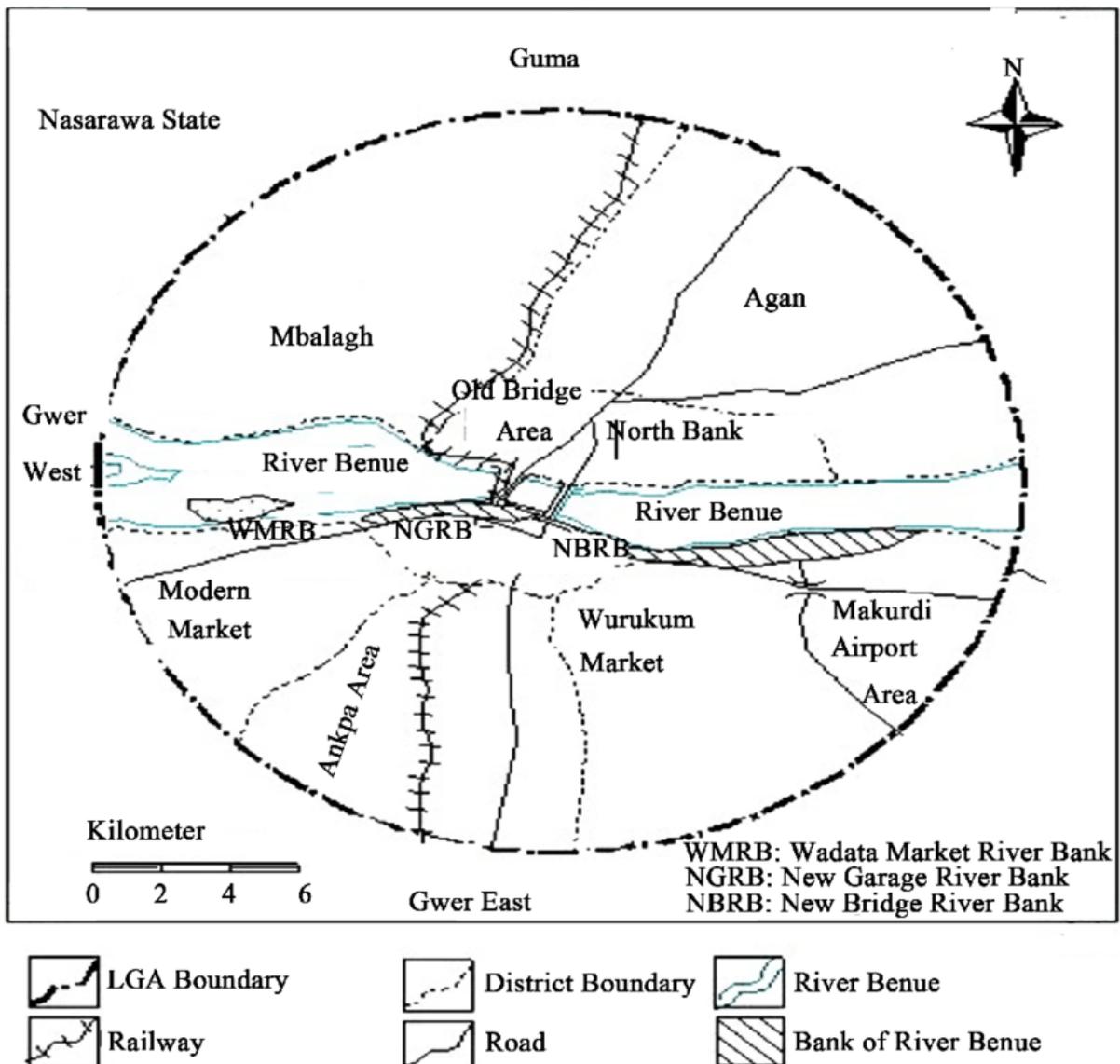
Also, a good knowledge of the soil qualities in Makurdi is not only desirable for increased rice and sugarcane yield, but also could lead to effective farm management system that would ensure sustainability of rice and sugarcane production. The suitability evaluation of these soils, which could indicate the kinds and extent of soil limitation that impedes rice and sugarcane production in the study area is therefore required. Such adequate information about the soil properties and management would provide practical approaches for ameliorating the soils physical, morphological and chemical limitations for the enhancement of rice and sugarcane production. This however necessitates the present study with the specific objective of characterizing, classifying and

recommending appropriate management measures aimed at enhancing rice and sugarcane production.

## Materials and Methods

### Site Description

The study was carried out in selected wetlands of Makurdi north located in Makurdi Local Government Area of Benue State. Makurdi lies within latitudes  $7^{\circ}41'$  and  $7^{\circ}46'$  N and longitude  $8^{\circ}29'$  and  $8^{\circ}35'$  E (FDALR, 1990). The study was confined to the north bank of river Benue which is low-lying at about 300 m above mean sea level (Offodile, 1974 and land and survey, 2015). The low level topography encourages the development of wetland soils through floods and high water table. The soils dry up for a period of 2 to 3 months a year but only at the surface for most of them.



Source: <https://www.google.com/imgres>

**Figure 1: Map of Makurdi LGA showing the study area**

The climate of the area is hot and humid tropic type with distinct wet and dry seasons. The monthly temperature ranged from  $24.5^{\circ}\text{C}$  to  $30.3^{\circ}\text{C}$ . Annual rainfall ranged from 1100 mm to about 2000 mm, and its distribution is characterized by two peak periods (July and September) separated by a short August break (Adamgbe and Ujoh, 2012). Sunshine hours are high between January to

April and decreases between May through to October because of the effect of cloud. There is a noticeable increase in sunshine hour again by November.

### Field Work

Soil profiles pits were dug at the most representative points of observation representing the various strata of the wetlands. The soil profiles were described according to the USDA Soil Survey Staff, (1999) guidelines. Soil samples were taken from the different horizons of the profile pits for routine physical and chemical analysis and other fertility indices.

### Laboratory Analysis

The soil samples collected from the field were air-dried, gently crushed and sieved. The particle size distribution (PSD) was determined by Buoyoucos hydrometer method as described by Day (1965). Soil reaction (pH) was determined by the electrometric method in 1:1 soil: water ratio as described by Hesse (1971), and organic carbon was determined by the Walkley-Black method as described by Hesse (1971). The Macro Kjeldahl method was used to analyze for total N, while the Bray I method as described by IITA (1979) was used to analyze for available P. Exchangeable cations (Ca, Mg, K, Na) were determined from NH<sub>4</sub>OAC filtrate. Exchange acidity was determined using the Barium chloride-triethanolamine method as described by Peech (1965). Effective cation exchange capacity (ECEC) was calculated by the summation of the exchangeable bases and exchangeable acidity while the percentage base saturation was equally calculated by dividing the sum of exchangeable bases over the effective cation exchange capacity and multiplying by 100.

**Table 1: Suitability Requirement for Rice**

Land qualities	Land characteristics	Unit	S1	S2	S3	N1	N2
Factors Rating		%	100-85	84-60	59-40	39-20	19-0
Climate (c) <sup>4</sup>	Annual Rainfall	Mm	>1400	1200-	950-	850-	<850
	Solar radiation	Cal. cm <sup>-2</sup> . day <sup>-1</sup>	>300	1400 300-200	1100 200-100	900 <100	any
Growing Period <sup>2 3</sup>	LPG+	Days	120- 180	70-120	>70	<70	<70
Soil characteristics	physical Soil Depth <sup>14</sup>	cm	>20	10-20	5-10	<5	any
	Clay <sup>21</sup>	%	40-25	25-15	15-5	≤15; ≥5	any
Wetness (w) <sup>4</sup>	Drainage	-	1-3	1-3	3	any	any
	S.W.D	cm	10-20	20-40	40-60	>60;	any
	F.D	months	>4	3-4	2-3	<10	any
	G.W.T	cm	0-15	15-30	30-60	>2; >4 >60	any
Fertility Status (f)	pH <sup>19</sup>	-	5.5-7.5	5.2-5.5	≤5.2,	≤5.2,	any
	total N <sup>20</sup>	%	>0.2	0.1-0.2	≥8.2	≥8.2	any
	organic carbon <sup>20</sup>	%	2-3	1-2	0.05-	<0.05	any
	P (Bray) <sup>18</sup>	Mg.kg-1	>20	15-20	0.1	>4; ≤1	any
	P (Olsen) <sup>20</sup>	Mg.kg-1	>10	7.5-10	3-4	<10	any
	K <sup>20</sup>	Cmol.kg-1	>0.2	0.1-0.2	10-15	<5	any
	Ca <sup>20</sup>	Cmol.kg-1	10-15	5-10	5-7.5	<0.1	any
	Mg <sup>20</sup>	Cmol.kg-1	2-5	1-2	<0.1	<1; >5	any
	CEC (soil) <sup>20</sup>		>16	10-16	1-5 <1 5-10	<1; >5 <5	any
Toxicity (t)	Active-Fe <sup>22</sup>	%	<0.75	0.75-1.0	1-1.25	>1.25	any

Sources: Modified from Sys (1985)

#### Key:

S.W.D= Surface Water Depth

F.D= Flooding Duration

G.W.T= Ground Water Table

1= Imperfect, 2= Moderate; Poor, 3= Very Poor; +LPG= Length of Growing Periods

**Table 2: Suitability Requirement for Sugarcane**

Site characteristics			Rating			
Climate regime	Unit		Highly suitable S1	Moderately suitable S2	Marginally suitable S3	Not suitable N
Mean temperature growing season	°C		30 – 34	26 – 29	25 – 20	<20
Mean minimum temperature growing season	°C		10 – 20	21 – 30	39 – 40	>40
Mean RH (%)	Growing season		>0 – 85	60 – 70	60 – 50	<50
	Ripening season		55 – 76	85 – 90	>55, >90	
				75 – 90		
<b>Land quality</b>	<b>Land characteristics</b>					
Oxygen availability to roots	Soil drainage	Class	Well drained	Moderating drained	Poorly drained	Very poorly drained
Nutrient availability	Depth of water	M	>1.0	1.0 – 0.5	<0.5	
	Texture	Class	L, cl, sil, Sicl, sc, scl	C (m/k),sl	Cl (ss)	
	pH	1:2.5	>0 – 8.0	6.0 -6.9	4.0 – 5.9	<4.0
Rooting conditions	Effective depth	soil	Cm	>100	100 – 75	>9.5
Erosion hazard	Slope	%	<3	3 – 5	>5 – 50	<50
					5 – 8	>8

**Source:** Naida (1999)

**NB:** Clay (m/k) = mixed kaolinite : Clay (ss) = shrink – swell clays

**Texture:** l = loam, sil = silty loam, sicil = silty clay, sc = sandy clay, scl = sandy clay loam

**Table 3: Suitability Class Scores of the Profiles in the Study Area for Rice and Sugarcane**

Soil type	Suitable	Major limitation	Fertility management
Soil type A Profile 1	Rice (S2) Sugarcane (S3)	Drainage is poor >4 months, pH is low (4.73) GWT is too high for sugarcane <30 cm	Liming addition of FYM and judicious use of fertilizers
Soil type A profile 2	Rice (S2) Sugarcane (S3)	Drainage is poor >4 months, pH is low (4.73) GWT is too high for sugarcane <30 cm	Liming and judicious use of fertilizer
Soil type B Profile 3	Rice (S2) Sugarcane (S3)	pH is low for sugarcane (5.21) fertility is very low % BS is >50 me/100g	Liming, poultry manure, FYM, Judicious fertilizer use
Soil type B Profile 4	Rice (S2) Sugarcane (S3)	pH is low for sugarcane (5.21) fertility is very low % BS is >50 me/100g	Liming, poultry manure, FYM, Judicious fertilizer use

S2 = moderately suitable, S3 = marginally suitable, FYM = farm yard manure, GWT = ground water table

## Results and Discussions

### Soil Morphological Characteristics

The morphological characteristics of the soils are presented in Table 3. The soils were deep ranging from 145 to 186 cm. Surface soil textures were generally sandy clay loam to sandy loam, while the subsurfaces varied from sandy clay loam, sandy loam to sandy clay. Generally, the soils were poorly drained as indicated by the presence of mottles in the surface horizons and gleyed lower horizons. The poor drainage could be due to the accumulation of surface water as a result of the depressional landscape as well as the high clay fraction of the soils. The soils include dark greyish brown (10YR4/2) Sandy clay loam; pale brown (10YR6/3); brownish yellow (10YR6/6); dark brown (7.5YR4/2) loam; gray (7.5YR6/1) sandy loam; pinkish gray (7.5YR6/2) sandy loam; to pink (7.5YR8/3) sandy clay. Soils of profiles 2 had predominantly dark brown (7.5YR4/2 moist) colour in its A horizon. This could be attributed to the presence of relatively high O.M which is the main colouring agent in the top soil (Ufot, 2012, Brandy, and Weil, 2014).

### Physical Characteristics

Table 5 shows the physical properties of soils of the study area. The clay content ranged from 7.2 to 36.1 %. The clay content increased with depth in all profiles which may be as a result of some pedogenic processes such as lessivage, eluviation and illuviation which indicates the presence of argillic or kandi sub-surface diagnostic horizons. However, over a very long period of time, pedogenetic processes such as erosion, deposition, eluviations, and weathering can change the soil texture (Foth, 1990; Brady and Weil, 2002). The relative differences in clay content among the soil units could be due to slight differences in topography and cultivation. This could also be due to the alluvial parent materials as well as the nature of the underlying geology. The sand fraction of the soil ranged from 47.5 % to 77.9 %. It decreased with depth in all the Profile except profile 1 which decreased gradually but increased slightly in the fourth horizon. The silt content increased or decreased irregularly with depth. This may be attributed to the differences in relief and the rate of deposition of accumulated materials brought down from the upper slope by fluvial processes into the depressional lowland. A similar observation was made by Miura et al., (1997). The very low silt content (9.2-14.1% %) of profiles 1 may be due to excessive washing away of the soil particles by water erosion and runoff (Idoga, 2012). The soils were well developed, having structures which were commonly moderate to strong medium subangular blocky, moderate to strong coarse subangular blocky with exception of profile 1 at B horizon which had strong platy and profile 3 and 4 which had moderate medium granular structure at the Ap horizon. The good structural development could have been influenced by the high clay content of the soils.

### Chemical Characteristics

Soil chemical properties are presented in Table 5. The soils were strongly to moderately acid in reaction with pH values ranging from 3.47 to 5.61 in H<sub>2</sub>O. Soil pH in the surface horizons was lowest (4.56) in profile 1 and highest (5.43) in profile 3. This may be due to factors such as return of bases to the soil through recycling by plants and the deposition of nutrients carried in solution from surface wash or lateral flow from relatively higher landscape (Ibang *et al.*, 2005). Idoga and Azagaku, (2005) also attributed this to nutrient biocycling and high percentage base saturation at the surface horizon. It could also be accounted for by the direct deposition of crop and vegetable residues on the soil surface and their subsequent decomposition to release basic cations to the soil. The higher acidity in the subsurface horizons may be as a result of leaching of cations from the top soils. The organic carbon was high while the total nitrogen was low (9.5 and 1.05 gkg<sup>-1</sup>). Organic carbon content of the soils decreased with profile depth from 3.77 % in the surface horizon to 0.20% in the subsurface horizon. The high amount of organic carbon may be attributed to the incorporation of plant and animals residues to the soil. The low amount of organic carbon may probably due to continue cropping for long period, bush burning, high erosive rate, grazing, harvested crop residues without replacement and very poor management activities. The low level of N in the soils may be attributed to release from plant tissues, gaseous loss, surface runoff, leaching,

climatic factors, vegetation, human activities, initial soil pH and low activities of symbiotic and non-symbiotic N-fixing bacteria. Loss of N through denitrification and volatilization may also contribute to the low level of N in the area. Available P was rated low to high with values ranging from 1.90 to 28.88 mgkg<sup>-1</sup>. This may be due to strong adsorption of this nutrient by the soil colloids (Kubrin *et al.*, 2000). The low amount of available P may also be attributed to the low pH level which fixed the P and make it unavailable.

Exchangeable bases (Ca, Mg, K and Na) were low in all the soil units. Calcium was the most prevalent cation on the exchange complex with values ranging from 0.07 to 3.83 cmolkg<sup>-1</sup>. The low exchangeable bases of these soils may be due to the underlying materials, intensity of weathering, leaching, low activity clay, very low organic matter content and the lateral translocation of bases (Krasilnikoff *et al.*, 2002; Kang and Balasubramanian, 1990; Kang, 1993). ECEC values of the soils varied from 1.31 cmolkg<sup>-1</sup> in the subsurface horizon to 5.24 cmolkg<sup>-1</sup> in the surface. This is rated low to moderate (FAO, 1983). ECEC values were high (5.24 cmolkg<sup>-1</sup>) in the surface horizons with a slight decrease in the subsurface of all the profile except profile 3 which had an increase at lower depth. The surface values could be attributed to the influence of soil organic matter content, while those of the lower horizons may be as a result of the contribution of clay (Idoga and Azagaku, 2005). Percentage base saturation values for profile 1 and 2 soils were high (64 to 78 %) while those of profile 3 and 4 soils were low ranging (4 to 55 %). Therefore, as the base saturation were above 50% in the cases of profile 1 and 2, the soils have high fertility potential while those of profile 3 and 4 were low implying low fertility (which forms the separating index between fertile soils and non fertile soils as stated by Landon, 1984). The percentage base decreased with depth in all the profiles which could be attributed to the active plant litter decomposition process which incorporate cations from the litter into the soil surface (Malgwi, 1979).

**Table 4: Morphological Description of the Study Area**

Horizon	Depth (cm)	Munsell soil colour		Mottles	Texture	Structure	Boundary	Consistence
		Moist	Dry					
<b>Soil type A: Profile 1: Vertic Endoaquepts/Vertic Gleysols (Orthoetric)</b>								
A	0-12	10YR4/2	10YR7/2		Sandyclay loam	3msbk	As	mpsw
A	12-40	10YR4/2.5	10YR7/2		Sandyclay loam	3pl	Aw	mpsw
B	40-116	10YR6/3	10YR7/2	f2f(7.5YR5/6)	Sandyclay loam	2csbk	Cw	mpsw
BC	116-178	10YR6/6	10YR7/3	m2d(5YR4/6)	Sandyclay loam	3csbk	-	mpsw
<b>Soil Type A: Profile 2: Typic Glossiaqualfs/Lixic Gleysols (Orthoetric)</b>								
A	0-11	7.5YR4/2	7.5YR7/1		Loam	3msbk	As	mpsw
Bt <sub>1</sub>	11-70	7.5YR4/2	7.5YR7/1	c1f(10YR5/)	Sandyclay loam	3msbk	Cl	vpsw
Ct <sub>2</sub>	70-160	7.5YR6/1	7.5YR7/1	m1f(10YR5/6)	Sandy loam	3msbk	-	npsw
<b>Soil Type B: Profile 3: Typic Epiaquults/Ferralic Acrisols (Epidystric)</b>								
Ap	0-13	7.5YR6/2	7.5YR7/1		Sandy loam	2mg	As	fns
Bt <sub>1</sub>	13-52	7.5YR7/6	7.5YR8/1	m2d(10YR3/4)	Sandy loam	3csbk	As	mpnw
Bt <sub>2</sub>	52-110	7.5YR6.5/6	7.5YR8/1	c1d(10YR5/6)	Sandy loam	3sbk	As	spsw
Bt <sub>3</sub>	110-147	7.5YR5.5/8	7.5YR8/2	c1f(10YR5/6)	Sandy loam	3sbk	-	mpsw
<b>Soil Type B: Profile 4: Typic Epiaquults/Ferralic Acrisols (Epidystric)</b>								
Ap	0-10	7.5YR3/2	7.5YR6/1		Sandy loam	2mg	As	npsw
AB	10-40	7.5YR5/1	7.5YR7/1		Sandy loam	2msbk	As	npsw
Bt <sub>1</sub>	40-60	7.5YR7/3	7.5YR7/3	m1f(10YR5/6)	Sandy loam	3msbk	As	spsw
Bt <sub>2</sub>	60-156	7.5YR8/3	7.5YR8/3	m1f(10YR6/6)	Sandy clay	3msbk	-	vpsw

**Texture:** ls = loamy sand, sl = sandy loam, scl = sandy clay loam, c = clay

**Structure:** 1 = weak, 2 = moderate, 3 = strong; f = fine, m = medium, c = coarse; cr = crumb, g = granular, sbk = subangular blocky, pr = prismatic, sgo = single grained structureless, ma = massive, pl = platy

**Mottles:** f = few, c = common, m = many; f = faint, d = distinct, p = prominent; c2f = common medium faint, m2d = many medium distinct, f1f = few fine faint, c3d = common coarse distinct

**Consistence:** ssw = slightly sticky wet, sw = sticky wet, vsw = very sticky wet, p = plastic, npsw = non plastic and sticky wet, f = friable, g = gritty (loose)

**Horizon:** ds = diffuse smooth, gs = gradual smooth, cw = clear wavy, al = abrupt lobate, as = abrupt smooth

### Horizon Designation Identity

- Ap - Disturbed surface layer due to cultivation or heavy traffic e.g. cattle  
 AB - Intermediate horizon between A-B usually possess characteristics of some A and some B  
 Bt - Accumulation of illuvial clay translocated from the upper horizons  
 Br - Strong reduction due to presence of underground water by exhibiting mottles or black MgO<sub>2</sub> coating  
 Bg - gleyed horizon. Usually signified by prismatic wedge shaped structures or presence of numerous mottles  
 BC - Intermediate horizon between B and C horizon  
 Bw - Indicate development of colour or structure or both with little or no apparent illuviation  
 Cg - No other pedogenic change has taken place besides gleying  
 White (1987), Fitzpatrick (1986), Schoeneberger *et al.*, (1998)

**Table 5: Physical and Chemical properties of the study area**

Horizon	Depth (cm)	Particle size dist.			Textural class	pH H <sub>2</sub> O	OC (g kg <sup>-1</sup> )	TN (g kg <sup>-1</sup> )	C/N	AP mg/kg	Exchangeable Cations				Ea	ECEC	BS Mc/100g
		Sand (%)	Silt (%)	Clay (%)							Ca	Mg	K	Na			
<b>Soil type A Profile 1: Vertic Endoaquepts/Vertic Gleysols (Orthoetric)</b>																	
A	0-12	59.0	12.7	28.3	SCL	4.56	3.30	0.38	8.6	28.88	2.93	1.05	0.28	0.14	1.46	4.40	75
B	12-40	56.0	14.1	29.9	SCL	4.41	2.37	0.21	11.3	23.00	2.53	0.88	0.27	0.13	1.48	3.81	72
BC	40-116	55.6	13.2	30.2	SCL	4.53	2.09	0.14	14.9	3.40	1.75	0.63	0.24	0.10	1.45	2.72	65
C	116-178	59.4	9.2	31.4	SCL	4.74	2.97	0.11	27.0	3.40	1.63	0.53	0.22	0.09	1.41	2.47	64
<b>Soil type A Profile 2: Aeris Glossaqualfs/Lixic Gleysols (Orthoetric)</b>																	
A	0-11	47.5	36.3	16.2	L	4.62	3.0	0.28	10.7	4.13	3.83	1.00	0.29	0.12	1.43	5.24	78
Bt <sub>1</sub>	11-70	53.1	18.1	27.8	SCL	4.48	1.9	0.16	11.8	2.30	3.23	0.76	0.22	0.10	1.48	4.31	74
Ct <sub>2</sub>	70-160	57.2	38.1	30.7	SL	4.47	0.2	0.03	6.6	3.40	1.98	0.60	0.20	0.09	1.48	2.87	66
<b>Soil type B Profile 3: Typic Epiaqualfs/Ferralic Acrisols (Epidystric)</b>																	
Ap	0-13	67.1	23.8	9.1	SL	5.43	3.60	0.31	12.2	7.50	0.50	0.60	0.12	0.25	1.19	2.67	55
Bt <sub>1</sub>	13-52	77.9	7.1	15.0	SL	5.61	2.37	0.34	6.9	4.90	0.36	0.20	0.10	0.19	1.14	1.99	43
Bt <sub>2</sub>	52-110	71.5	14.0	14.5	SL	4.07	2.23	0.22	10.1	21.40	0.21	0.10	0.10	0.11	1.60	2.12	24
Bt <sub>3</sub>	110-147	62.9	19.0	18.1	SL	3.47	1.98	0.18	11.0	17.63	0.20	0.10	0.10	0.12	1.90	2.42	21
<b>Soil type B Profile 4: Typic Epiaqualfs/Ferralic Acrisols (Hyperdystric)</b>																	
Ap	0-10	71.0	20.8	7.2	SL	4.99	3.77	0.28	13.5	4.50	0.38	0.24	0.18	0.19	1.31	2.30	43
AB	10-40	69.0	25.8	7.8	SL	4.90	3.21	0.23	14.0	7.90	0.12	0.06	0.01	0.08	1.35	1.61	16
Bt <sub>1</sub>	40-60	61.9	26.0	12.1	SL	5.49	2.63	0.35	7.50	1.90	0.07	0.03	0.01	0.01	1.19	1.31	9
Bt <sub>2</sub>	60-156	49.6	13.3	36.1	SC	4.30	2.49	0.26	9.20	3.40	0.04	0.01	0.01	0.01	1.52	1.60	4

## Soil Classification

The USDA Soil Taxonomy (Soil Survey Staff, 1999) was used to classify the soils according to their morphological, physical and chemical properties. Soil type A1 was qualified as Aquept because they had endosaturation as a result of ground water. There was upward movement of water to the soil surface. At the great group level, these soils are classified as Endoaquepts. The soils were called Vertic Endoaquepts at the subgroup level due to the surface features of mild cracks generally below 1 cm (specified to be 5 mm or more) within 125 cm of the mineral soil surface. The high base saturation together with the presence of an argillic horizon in soil type A2 qualifies it as Alfisols. The soil had Aquic soil moisture regime due to the redoximorphic features observed in one or more horizons beyond 41 cm of the mineral soil surface and so called Aqualfs. These soils had Glossic horizon which developed as a result of the degradation of an argillic horizon (a soil process from which clay and free iron oxides are removed). They are called Aeric Glossaqualfs because they are wet Glossaqualfs.

Soils type B are Ultisols because they had an argillic horizon with low base saturation due to the release of bases by weathering. They are further called Aquults due to redoximorphic features in most layers between either the lower boundary of the Ap horizon or to a depth of 25 cm and below the mineral soil surface. These soils were qualified as Typic Epiqualfs because they did not have a sandy particle size class throughout a layer extending from the mineral soil surface to the top of an argillic horizon to a depth of 50 cm or more.

In the World Reference Base for Soil Resources (FAO, 1990), soil type A1 qualified as Vertic Gleysols due to the cracks which open and close periodically and the base status above 50 %. Those of A2 were called Lixic Gleysols because of the Lixic features and argillic horizon along side with the high base status. One difference between profile 3 and 4 is the specification on their base status. While profile 3 was classified as Ferralic Acrisols (Epidystric), profile 4 was classified as Ferralic Acrisols (Hyperdystric). This is because while they are termed dystric being lower than 50 % base status between 20 to 100 cm in all parts from soil surface, profile 4 had less than 20 % in some parts within 100 cm.

## Suitability Evaluation for Rice and Sugarcane

Land suitability involved matching of land characteristics/qualities of the study sites (Table 5) with the land requirement for sugarcane (Table 1 and 2) to evaluated suitability classes for the study site. The slope of 0 – 2% made all the soil units highly suitable for sugarcane. The topography will favour mechanization. The organic matter content, total N, available P, and CEC were low and was rated marginally suitable (S3) for sugarcane cultivation but moderately suitable (S2) for rice. The soil pH was acidic to slightly acidic. Regarding soil depth, all the soil profiles were favourable for rice and sugarcane production. Generally non parametric suitability evaluation of the soil types for wetland rice and sugarcane showed that sugarcane was marginally suitable (S3) for soil Type A, but rice was moderately suitable (S2) for all the 4 soil types.

## Summary and Conclusion

“We can loose a battle and ultimately win the war” (Buzzard, 2006). The war for effective landuse and food security has many battle fields, one of which are wetlands. The focus on winning the war requires preserving the battle fields necessary, which in this case are wetlands. This is why encroachment into them hampers the aim of effective landuse. However, the funds committed to coastal wetlands were fund to be unimpressive by Ojanuga (2005), when he said “coastal wetland researches have provoked more food for thought than rice for food”. Inland wetlands started receiving more attention with the Fadama Initiative. The pace of this success is threatened, especially in urban areas by urbanization.

Based on the morphological, physical and chemical attributes of the soils, key is the ability to retain water on the soil surface during the rains as well as below the soil surface temporarily after

the rains or permanently, throughout the dry season. The suitability evaluation revealed that the 2 soil types generally adapted to the cultivation of wetland rice compared to sugarcane.

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