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Classifications using MCE and AHP on Fadama Lands of River Challawa, Kano State, Nigeria

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Abstract

Geostatistics modeling has substantially introduced some innovations to soil related studies, which not only add aestheistic value but also considerably reduce monetary cost and time to accomplish a study. This research surveyed the application Multi-Criteria Evaluation and Analytic Hierarchical Process in classifying Fadama soils along River Challawa, Kano State Nigeria. Soils were sampled at the depth of 15cm using the grid method from area of about 13km². The results show that pH values ranges from H_2O *6.00-6.90 and* $CaCl_2$ *5.40-5.90. The primary nutrients NPK have mean values of 0.76* g/kg^{-1}*, 26.35* g/kg^{-1} *and 0.31* g/kg^{-1} *respectively. The mean values for the secondary nutrients Ca, Mg and Na are 4.42*$cmol/kg^{-1}$*, 0.80*$cmol/kg^{-1}$ *and 0.30*$cmol/kg^{-}$ *respectively. The GIS analyses were performed by weighting all the soil parameters and slope of the extracted from Shuttle Radar Topographic Mission (SRTM). The result of the classification shows that out of 1761.87ha only 18.75% or 330.33ha of land were found to be high suitable area. On the contrary, the low suitable class (N) had a covering area of 500.03 hectares (28.38%) while moderately and marginally suitable classes for highly suitable, moderately suitable, marginally suitable and not suitable with 18%, 24%, 30%, and 28% respectively. The study concluded that GIS provide a platform for classification of soil parameters. Finally, the study recommends for application of both organic and inorganic fertilizer (using this approach) in a complimentary manner to avoid over and under application.*

Keywords: Suitability, Fadama, Mapping, Remote Sensing, Multi-Criteria Evaluation (MCE)

Introduction

In modern agricultural soil surveying, attribute information on mapping and classification are vital and so, are generated for better planning and management. Although traditional soil surveys are the main source of soil's spatial information, they however may not provide some in-depth materials essential in greater areas of applications (Zhu, Hudson, Burt, Lubich & Simonson, 2001). The demand for accurate soil information stems from the need by the stakeholders for maintaining quality of soils. The concept of soil quality for agricultural use is often referring to the ability of a soil to perform its role within the limits of land use and ecosystem without jeopardizing environmental quality (Kinyangi, 2007).

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Fadama farming is an agricultural system primarily restricted to lowland areas and is generally characterized by intensive use of soil in both wet and dry seasons. Floodplains in river basins in many parts of the world have been identified to have high promises for agriculture because of their inherent natural fertility. Fadama lands and by extension wetlands can therefore be described as some of the most critically important ecosystems in the world, supporting millions of people. They have been subject of much scientific inquiry though the bulk of it is on their fertility status and socioeconomic impacts. Kulawardhana *et al,* (2007) argue that complexities in these ecosystems in terms of vegetation, soil and hydrological features impose many limitations for identifying, mapping and their characterization, and so call for the need to investigate methods that can consistently map them over varying scale. Comparatively, little is known about how geospatial technology and farmers knowledge can be used in as integrated manner to facilitate better evaluation of their suitability for crop production.

Although, studies such as Adamu and Dawaki (2008);Adamu (2013) and Dawaki, Dikko, Noma and Aliyu, (2015)on fadama lands in Kano and perhaps elsewhere in Nigeria were targeted at finding the potentials of these areas, yet some detailed but vital information might have been lost in the process. This information could have otherwise helped in improving the overall agricultural productivity. To tackle these identified challenges, it is so indispensable to embrace technology such as Geoinformatic techniques (Rilwani &Gbakeji2009). Generally, land resource for whatever application is intended, entail some careful planning and evaluation and these collectively guide decisions on optimal use of the land (Ahmed & Jeb, 2014). So, decision making tools such as Multi-Criteria Decision Making (MCDM) or Multi Criteria Evaluation (MCE) are relevant for the optimum determination of land use type. This tool together with Analytic Hierarchy Process (AHP) has been worked out to deal with complex spatial decisions. Their application in decision making is made possible when set of alternatives are needed to be evaluated on the basis of conflicting and disproportionate criteria (Ahmed & Jeb, 2014).

The main object of this study is to demonstrate the application of Multi-Criteria Evaluation (MCE) and Analytic Hierarchic Process (AHP) on classification of Fadama soils along river Challawa in Kano State, Nigeria.

Study Area

The study area River Challawa located between Latitudes11° 02′ 00″ N, 11° 3′ 43′N, and Longitudes 08° 41′ 35″ E, 08° 57 ′ 06″ E. The current climate of Kano region is prevailed by Tropical wet-and-dry, coded Aw based on Koppens system (Olofin, 1987). The mean annual rainfall ranges from over 1,000mm in the extreme south, decreases progressively to about 800mm at the centre in Kano metropolis to a little fewer amounts in the extreme south (Ahmed, 2003). There are four distinct seasons all of which are closely linked with the movement of the Inter Tropical Discontinuity: *Rani, Damina, Kaka* and *Bazara.* The area is dominated by three major rock formations namely basement complex rocks, the younger granite rocks and the youngest Chad sediment (Olofin, 1987).The drainage systems in the basement complex area of Kano, upland area comprises of Rivers Kano, Challawa, Iggi and Gaya, while the Gari area covers the Rivers Gari, Thomas, and Jakara. Relatively, the groundwater level is approximately 20-25m in the upland and 8m in the Gari areas except for the fadama areas which are irrigated and have water levels of 0.5-2m.The dominant soils are shallow and coarse, slightly acidic and generally derived from aeolian drift soils.

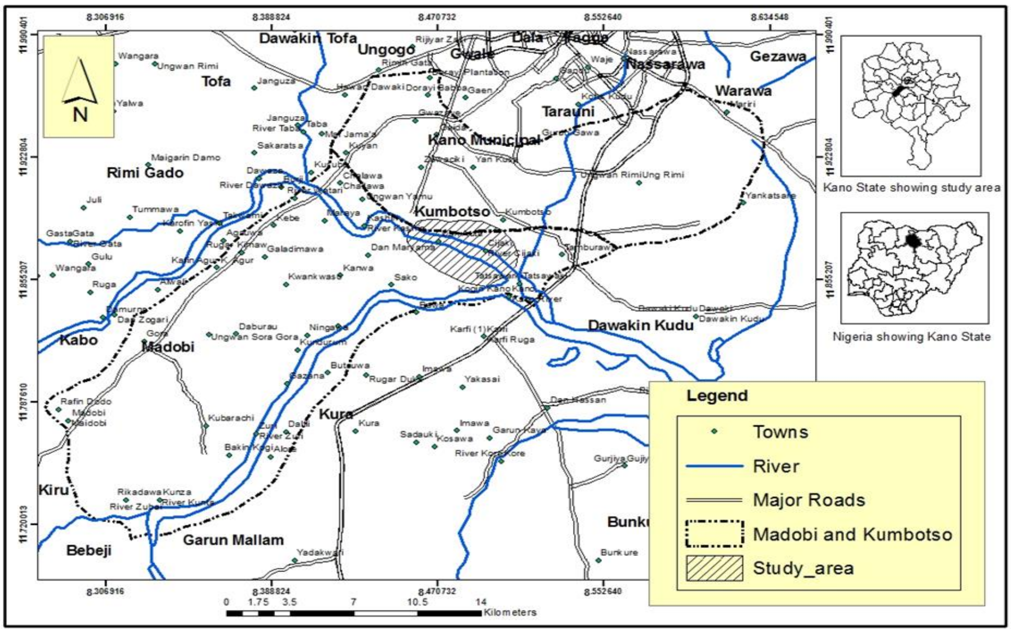

Figure 1: Map of the Study Area

Source: Ministry of Land and Physical Planning, Kano State

Materials And Methods

The data for the study include the SPOT-5 satellite imagery of 2012 (5m resolution) for selection of the sampling points, the Shuttle Radar Topographic Mission (SRTM) data (90m resolution) and soil samples collected from18 sample points in the field. The area was first gridded (approximately 13 km^2). Soil samples were collected at depth of 0-15cm with their respective coordinates.

Laboratory analysis

The soil samples were taken to the standard laboratory for analysis (Department of Soil Science, Ahmadu Bello University Zaria). The samples were then air dried and gently crushed with porcelain pestle and mortar, passed through a 2mm sieve to remove coarse fragments. The fine earth samples (<2mm soil portion) collected were analyzed. Particle size distribution was determined using hydrometer method (Gee & Bauder, 1986), with the aid of Bouyoucous hydrometer at progressive time intervals. The textural classes were determined with the aid of USDA textural triangle. The soil pH was determined both in water and 0.01M CaCl2 solution, using a soil to solution ratio of 1:2.5(International Institute of Tropical Agriculture, 1979). The Walkley – Black (1934) wet digestion method was used to determine the organic carbon. Nitrogen was determined using the macro – kjedhal method. Phosphorus was determined using the Bray I method calorimetrically. Exchangeable Ca, mg, Na and K were extracted with 1m ammonium acetate (1M NH4OAc) solution buffered at pH 7.0 as described by Anderson and Ingram (1998). The Ca and Mg were read on a pyeunicam model SP 192 atomic absorption spectrophotometer (AAS) at 423 and 285nm wavelength respectively. The sum of Ca, Mg, Na, and K gave total exchangeable bases.

The soils were leached with 1m KCl solution. Exchange acidity (Al+H) in the 1m KCl extract was determined by titration with 0.1m sodium hydroxide solution (Anderson and Ingram, 1998). Cation Exchange Capacity (CEC) of the soil were determined with 1m NH4OAc (1m ammonium acetate), buffered at pH 7.0 (Chapman 1965, Rhodes, 1982). The absorbed ammonium ions were displaced with 10% sodium chloride (pH 2.5) and determined by the Kjeldahl procedure (Soil Survey Staff, 1972).

GIS-Based Technique

On-screen digitizing of the study area using Spot-5 satellite image was first achieved in the Arc GIS 10.1 environment. For image geo-referencing, some modifications were made for the selected control points in order to minimize the error during digitization. The map was projected to Minna datum, UTM zone 32. The slope of the area were analysed using Digital Elevation Model (DEM).

Soil Suitability Criteria

The weighted factor was estimated by pair wise comparison matrix (Ahmed & Jeb, 2014). After structuring the problem as a hierarchy using the Eigenvector, the criteria weight for physicochemical parameters were performed together with elevation soil texture (Table 1).

Table 1: Soil-site Fertility Classification Criteria

Soil Parameter	**HighClass**	**ModerateClass**	**MarginalClass**	**Low Class**
Soil Nutrient	**(S1)**	**(S2)**	**(S3)**	**(N)**
pH	6.0-8.0	5.5-5.9 & 8.1-8.5	< 5.5 & 8.6-9.0	< 9.0
N g/kg^{-1}	> 1.0	0.50-1.0	0.1-0.5	< 0.1
P (cmol/kg^{-1})	> 8.0	5-7	4-5	< 4.0
K (cmol/kg)	> 0.40	0.20-0.40	0.15-0.20	< 0.15
Cacmol/kg^{-1}	> 10.0	8.0-10.0	4.0-8.0	< 4.0
Mg cmol/kg^{-1}	> 4.0	2-4	0.5-2.0	< 0.50
Na cmol/kg^{-1}	0.01-0.03	0.03-0.05	0.05-0.10	> 0.10
OCg/kg^{-1}	0.50-0.75	0.50-0.20	< 0.20	-
OM (%)	> 5	5-3	3-1	< 1
CEC(cmol/kg)	30-20	20-10	< 10	-
Soil Texture	c. cl, sicl, sc	1 ,sil, sic, scl	sl, ls	S

Note: clay-c, clay loam-cl, silt clay loam-sicl, silt clay-sc, loam-l, silt loam-sl, silt clay-sic, silt loam-sl, Loam sand-ls, sand-s.

Source: FAO (1979), Metson (1961), USDA (1993), Bungham, (1962), and MAFF (1967)

Geo-processing models were used to execute the sequence of command to generate physical suitability maps which were developed in the AHP model for all the parameters. The classifications for parameter were generated individually and classified using AHP's intensity scaling (Table 2).

Table 2: Intensity Scaling Table

Scale	**Degree of Preference**
1	Equal importance
3	Moderate importance of one factor over another
5	Strong importance
7	Very strong importance
9	Extreme importance
2,4,6,8	Intermediate values

Source: Saaty and Vargas (1991), (as cited in Ahemed 2014).

Weighting and Overlay of Suitability Layers

For overlaying the parameter (maps), weighted sum overlay techniques was applied. The technique allows application of a common scale of values to diverse and dissimilar input data to create an integrated analysis (Ayehu & Besufekad, 2015). In this method, the cell values of each input raster (i.e. the rating of suitability class) are essentially augmented by the raster's weight (i.e. criteria weights). The ensuing cell values are added to produce the final output raster or suitability map. In this study therefore, soil parametric layers (maps) characterizing the Fadama soil's suitability, were weighted using the weights derived from the AHP process (Table 3). The final land suitability map based on the best outcome in context of the suitability of crop produced is shown in Figure 2.

Table 3: Weighting of Soil Parameters

S/N	Parameter	Symbol	Weighting
1.	Nitrogen	N	0.22
2.	Phosphorus	P	0.12
3.	Potassium	K	0.08
4.	Calcium	Ca	0.02
5.	Magnesium	Mg	0.02
6.	Sodium	Na	0.01
7.	Organic Carbon	OC	0.21
8.	pH Calcium Chloride	pH $CaCl_2$	0.01
9.	pH Water	pH H_2O	0.02
10.	Exchangeable Base	H^+Al	0.02
11.	Cation Exchange Capacity	CEC	0.20
12.	Zinc	Zn	0.04
13	Slope	S	0.03

Source: Mustafa et al (2011); Ayehu and Besufekad (2015); Mugo, Kariuki and Musembi (2016); and Naz and Rasheed (2017)

Results And Discussions

The summary of result of various physico-chemical parameters is presented in Table 4. For each soil parameter, its minimum value, maximum value, mean value, sample variance, standard error and standard deviation are presented.

Table 4: Level of Soil Parameters

Soil Parameter	Minimum Statistic	Maximum Statistic	Mean Statistic	Sample Variance	Standard Error	Standard Deviation
Sand g/kg^{-1}	28.00	78.00	48.78	168.07	3.06	12.96
Siltg/kg^{-1}	14.00	54.00	39.11	92.81	2.27	9.63
Clayg/kg^{-1}	6.00	26.00	12.11	32.22	1.34	5.68
pH H_2O	6.00	6.90	6.49	0.06	0.06	0.25
pH $Cacl_2$	5.40	5.90	5.65	0.02	0.04	0.15
OCg/kg^{-1}	2.19	14.16	6.36	11.97	0.82	3.46
Ng/kg^{-1}	0.14	1.89	0.76	0.17	0.10	0.41
Avail. P	8.75	50.23	26.35	224.76	3.53	14.99
Cacmol/kg^{-1}	2.24	7.72	4.42	2.13	0.34	1.46
Mgcmol/kg^{-1}	0.62	1.02	0.80	0.01	0.02	0.10
Kcmol/kg^{-1}	0.10	1.20	26.35	0.10	0.07	0.32
Nacmol/kg^{-1}	0.10	0.87	0.30	0.03	0.04	0.18
H+Alcmol/kg^{-1}	0.20	0.80	0.41	0.04	0.04	0.19
CECcmol/kg^{-1}	5.00	27.80	11.53	29.04	1.27	5.39
Zn (MgKg)	14.64	56.85	28.11	150.62	2.89	12.27

Source: Data Analysis (2015)

The result of the classification in Table 5a, 5b and 5c shows hectares (while Figures 1 to 12 indicates pictorial classification) class of soil parameters. Nitrogen (Figure 3) shows high class (S1) had 662.28 ha (37.59%), moderate class with 196.98 ha (11.18%), marginal class was 521.69 ha (29.61%) and finally low class was 380.92ha(21.42%).Nitrogen recommendations for cereal production, varies with projected yield, soil texture, and cropping sequence(Grain Production, 1998). The classification of phosphorus is shown in Figure 4 and table 5b. The classification indicated a high class (S1) with 566.62 ha (32.16%), moderate class (S2) with 433.77 ha (24.62%), marginal class was 354.84 ha (20.14%) and low class (N) with 406.64 ha (23.08%). Phosphorus has low mobility as well as availability in soils and it is difficult to manage because according to London (1988) it reacts so strongly with both solution and solid phases of the soil. As a result, mobility through the soil is extremely limited in all but organic soils or white bleached sands with extremely low CEC's. Concentrations in soil solution range from less than 0.1 to around 5 ppm. Most crops respond to phosphorus additions when soil solution levels are less than 0.1 to 0.2 ppm (London, 1988).

The analysis for Potassium (Figure 5) in table 5a indicated that high class (S1) with 931.15 ha (52.85%), moderate class (S2) with 676.91 ha (38.42%), marginal class (S3) was found to be 0% and low class (N) was marginally 153.81 ha (8.73%). The analysis of calcium in table 5a (also in Figure 6) is as follows: high class (S1) 310.44 ha (17.63%), moderate class (S2) 548.12 ha (31.11%), marginal class (S3) with 745.45 ha (42.31%) and low class (N) with 154.86 (8.96%). London, (1988) reported that distribution of calcium varies from soil to soil, adding that its deficiencies are not frequent in many crops other than peanuts, potatoes and vegetables. Though calcium is not readily leached from topsoil but levels may be quite low in sandy surface soils and its deficiency occurs in soil of pH values of 5.5. The analysis of organic carbon in table 5c shows (Figure 9) that high class (S1) was 388.85 ha, (22.07%), moderate class (S2) had 317.14 ha (18.0%), marginal class (S3) with 551.99 ha (31.33%) and low class (N) 503.89 ha (28.6%). Organic carbon is an important supplier of organic matter and is spatially heterogeneous in nature (Kurgat, 2011).

Table 5a: Soil Parameters Classification

Classification	Ca		CEC		ha al		K	
	Ha	%	Ha	%	ha	%	Ha	%
Low (N)	154.86	8.96	194.16	11.02	011.91	0.68	153.81	8.73
Marginal (S3)	745.45	42.31	589.69	33.47	442.30	25.10	000.00	00.00
Moderate (S2)	548.12	31.11	472.36	26.81	458.09	26.00	676.91	38.42
High (S1)	310.44	17.62	505.66	28.70	849.57	48.22	931.15	52.85
Total	**1761.87**	**100**	**1761.87**	**100**	**1761.87**	**100**	**1761.87**	**100**

Source: Data Analysis (2015)

Table 5b: Soil Parameters Classification

Classification	N		P		Mg		Na	
	Ha	%	ha	%	ha	%	Ha	%
Low (N)	380.92	21.62	406.64	23.08	424.79	24.11	500.37	28.40
Marginal (S3)	521.69	29.61	354.84	20.14	401.88	22.81	428.74	30.01
Moderate (S2)	196.98	11.18	433.77	24.62	432.01	24.52	412.45	23.41
High (S1)	662.28	37.59	566.62	32.16	503.19	28.56	320.31	18.18
Total	**1761.87**	**100**	**1761.87**	**100**	**1761.87**	**100**	**1761.87**	**100**

Source: Data Analysis (2015)

Table 5c: Soil Parameters Classification

Classification	OC		PH2O		ph2Cacl		Zn	
	Ha	%	**ha**	%	**ha**	%	**Ha**	%
Low (N)	503.89	28.60	442.41	25.11	440.82	25.02	465.49	26.42
Marginal (S3)	551.99	31.33	432.54	24.55	432.72	24.56	534.02	30.31
Moderate (S2)	317.14	18.00	354.14	20.10	352.37	20.00	333.35	18.92
High (S1)	388.85	22.07	532.78	30.24	535.96	30.42	429.01	24.35
Total	**1761.87**	**100**	**1761.87**	**100**	**1761.87**	**100**	**1761.87**	**100**

Source: Data Analysis (2015)

Correlation of Soil Parameters

Pearson Correlation Matrix for soil parameters, has shown positive correlation between pH H_2O (soil reaction) and silt. Additionally, exchange acidity (H^+Al) values were very low (0.50 cmol kg^{-1}) in most of the fields. Organic carbon had positive but relatively weak correlations with silt and clay particle. The findings of Malgwi*et al.* (2000) and Voncir *et al.* (2008) shows that sorting of soil materials by biological activities, clay eluviations or surface erosion or combination of these pedological processes are the result of the dominance of sand in the Northern Nigerian soils. Also, lower clay content of the surface soil is a characteristic that has been observed for most soils on Basement complex in Nigeria (Esu, 1987).

Their respective correlation coefficients are 0.58 each. Same result is obtained between clay particle and nitrogen (positively correlated and r = 0.58). The two soil reactions pH H_2O and pH $CaCl_2$ have shown very weak correlations with nitrogen (r values are 0.01 and 0.06 respectively).

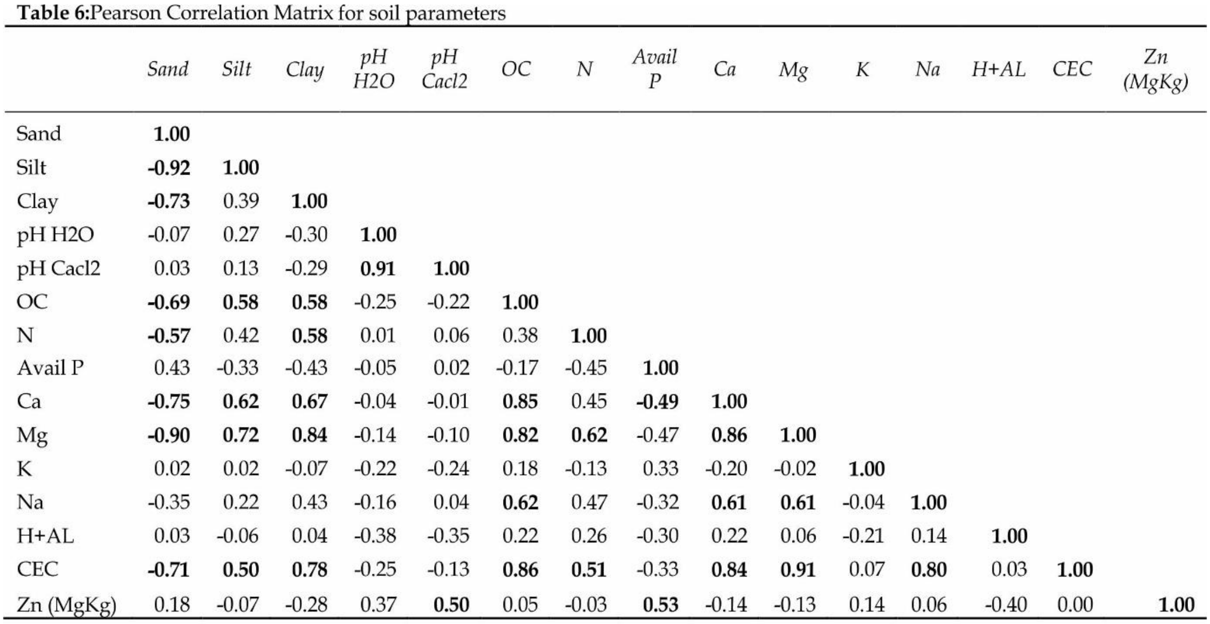

Table 6: Pearson Correlation Matrix for soil parameters

	Sand	*Silt*	*Clay*	*pH H2O*	*pH Cacl2*	*OC*	*N*	*Avail P*	*Ca*	*Mg*	*K*	*Na*	*H+AL*	*CEC*	*Zn (MgKg)*
Sand	**1.00**														
Silt	**-0.92**	**1.00**													
Clay	**-0.73**	0.39	**1.00**												
pH H2O	-0.07	0.27	-0.30	**1.00**											
pH Cacl2	0.03	0.13	-0.29	**0.91**	**1.00**										
OC	**-0.69**	**0.58**	**0.58**	-0.25	-0.22	**1.00**									
N	**-0.57**	0.42	**0.58**	0.01	0.06	0.38	**1.00**								
Avail P	0.43	-0.33	-0.43	-0.05	0.02	-0.17	-0.45	**1.00**							
Ca	**-0.75**	**0.62**	**0.67**	-0.04	-0.01	**0.85**	0.45	**-0.49**	**1.00**						
Mg	**-0.90**	**0.72**	**0.84**	-0.14	-0.10	**0.82**	**0.62**	-0.47	**0.86**	**1.00**					
K	0.02	0.02	-0.07	-0.22	-0.24	0.18	-0.13	0.33	-0.20	-0.02	**1.00**				
Na	-0.35	0.22	0.43	-0.16	0.04	**0.62**	0.47	-0.32	**0.61**	**0.61**	-0.04	**1.00**			
H+AL	0.03	-0.06	0.04	-0.38	-0.35	0.22	0.26	-0.30	0.22	0.06	-0.21	0.14	**1.00**		
CEC	**-0.71**	**0.50**	**0.78**	-0.25	-0.13	**0.86**	**0.51**	-0.33	**0.84**	**0.91**	0.07	**0.80**	0.03	**1.00**	
Zn (MgKg)	0.18	-0.07	-0.28	0.37	**0.50**	0.05	-0.03	**0.53**	-0.14	-0.13	0.14	0.06	-0.40	0.00	**1.00**

Sources: Data analysis (2015)

Similarly, more parameter shave shown either weak or even very weak correlation among them. The correlation coefficients between silt and potassium (0.02), clay and H^+Al (0.04) and Na and Zn (0.06) are all very weak. On the other hand however, few parameters such as Mg and CEC (0.91), OC and CEC (0.86) are very strongly correlated. The correlation between Nitrogen and sodium was insignificant because the r value is 0.47, they are however positively correlated. Paz-Gonzalez et al. (2000) reported that fertilizer application did not change total

N or inorganic content of soils under intensive irrigation. Jaiyeoba (2003) found that total nitrogen content of the topsoil was greater in 3-year cultivated soil compared to 20-year. Also, Kilic, Kilic and Kocyigit (2012) lamented that total N content of the cultivated fields decreased over the time in spite of fertilizer additions. It has been reported that Ca usually dominates the exchange sites of most soils with Mg, K, NH_3 and Na having lower concentrations (Enloe*et al*., 2006). It has been indicated that a sharp decrease in organic carbon may be attributed to immobilization of organic matter by clay in the horizons in forms of organo-clay-complexes (Mortland, 1970).

Combined Layers for Soil Suitability

The pairwise comparison matrix for all the criteria of soil parameters, were weighted for the alternatives, the final ratings were calculated. The thematic maps representing various parameters were subsequently overlaid to generate the final soil suitability map (Figure 14).Crops cultivated in the area were essentially shallow rooted (Tan, 2005), and the range of crops include sugar-cane, grain crops; cereals and leafy-vegetables.

While single crop suitability study is probably the most common as in Ahmed and Jeb (2014),Jimoh, Yusuf and Ya'u (2016), other studies such asIshaya, Mashi, and Ifatimehin (2008), who have rather primarily focused on mapping, embraced multiple crop analysis. This study has so decided to align to the latter's method of analysis. On their part, reported that major potential crops in Gwagwalada;s area Fadama were: Rice (*Oryza Sativa*), Maize (*Zea Mays*), Okro (*Hibiscus Esculentus*), Pepper (*Capsicum Annum*), Water Leaf (*Talium Triangulare*), Pumpkin (*Cucurbita Pepo*), Sugar Cane (*Saccharum Officinarum*), Greens (*Amaranthus Spp*), Spinach (*Spinacia Oleracea*) and vegetables. On the other hand, crops cultivated in most parts of River Challawa were: Sugar Cane (*Saccharum Officinarum*), Maize (*Zea Mays*), Onion and Rice (*Oryza Sativa*). Other crops such as grains were also cultivated.

From Figure 2, the high suitable class (S1) covers 330.33ha (18.75%) of land. These portions were primarily found in three locations: the north-west, the east and western part of the study area. The portions show some potential indication for the cultivation of wide range of crops probably because hydromorphic soils as it is widespread in the area are capable of supporting wide range of crops. Such areas are also suitable for cultivation of perennial crops such as fruits and vegetables (USDA, 1999). The moderately suitable class (S2) had the measurement of 397.8 hectares, corresponding to 22.58%. There were two bands which were stripped, meandered adjacent to high suitable area, at both ends. The next was marginally suitable (S3), the largest in terms of spatial coverage (533.71 hectares or 30.29%). There were also two belts of this class found adjacent to moderately suitable (S2) towards the center of the study area. Finally, the low suitable class (N) was the second largest because there was 500.03 hectares (28.38%). It was situated in the center of the study area as a big band running from north-east to south-west direction.

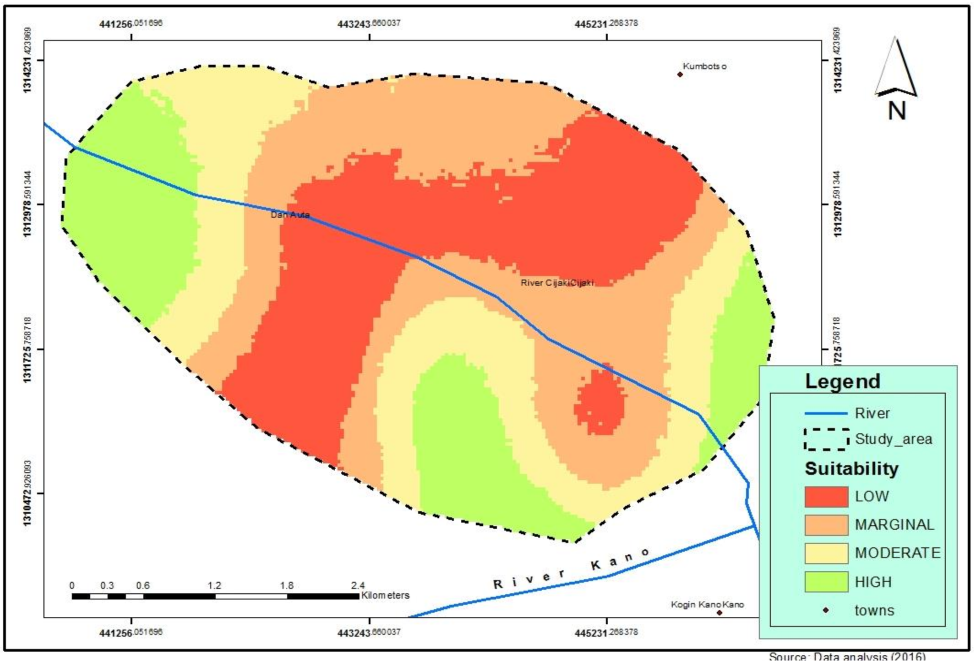

Figure 2: Soil Suitability of the Area

Source: Data Analysis (2015)

Conclusion

The research demonstrated the capability Multi-Criteria Evaluation (MCE) and Analytical Hierarchic Process (AHP) models in collaboration with GIS for soil classification. The study established that soil parameters have significant impression on the nature of Fadama soil in the area due to extensive use of both mineral fertilizers and organic materials by the farmers, distributions of soil parameters were uneven as they were contrasting with varying patterns. For the classification of parameters, potassium and pH water have also shown exceptions because they are represented by three classes each and not four as in other parameters. The mapping indicate areas suitable for Fadama cultivation, marginal class had the largest spatial coverage. The study recommends that farmers should be encourage to be adopt to regular soil testing as a mean of knowing parameters status of the soils. Further studies in same location using same methodology, which can serve as a checklist, for the purpose of validation to this study.

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