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ASSESSMENT OF SOIL POTENTIAL EFFICIENCY FOR WETLAND UTILIZATION IN WUSHISHI LOCAL GOVERNMENT AREA OF NIGER STATE, NIGERIA

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Abstract:

This study focus on the following (i). Achieved potential capability of soil, (ii).Quantify and evaluate magnitude of wetland soil potentials using Remote sensing data, and laboratory analysis and (iii). Compare heterogeneous nutrient data to predict the soil capability and potentials for crop production. Laboratory test and integration of heterogeneous nutrient data to ensure improvement in crop production. It depict that there are more wet years than dry years about 13.39% annual increment of land utilization with normal annual precipitation distribution with annual increasing trend of 0.1339 with an R2 value of 0.33. Farming activities in the area increased from 37.12% in 1992 to 48.9% in 2022.The topographic setting of Bankogi area is steep-sloped, currently not suitable for any agricultural activities. Maito area is cultivated by subsistence farmers. Zungeru camp, Tunga Kawo and Wushishi areas has suitable soil potential for farming ranging from 58.0 – 97.0 with soil/water potential pH of 710 and 6-9 moles respectively. The area is acidic but suitable for cultivation of cereal crops like rice, maize and grains. The study area are suitable for cultivation in all seasons by introducing plants like Palm trees and Cocoa trees. This area requires more planning and detailed design work than most community projects, due to a combination of numerous factors such as significant bedrock in the area, anthropogenic surface water influences and interferences, potential contaminant issues in soils and sediment, urban storm water inputs and the potential for contaminated storm water, which developed nature of watersheds with community expectations.

Keywords: heterogeneous nutrients, soil capability, silt, sandy soils

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INTRODUCTION

Wetlands serve as area for fishing and different forms of recreation. Wetland ecosystems are important environmental and natural resources contributing to the total wealth of a nation. However, because many of its services are not traded in the open markets and their values are not captured using the conventional approaches to valuation, they are usually ignored in the systems of national accounts. As a result, conventional measures of wealth give incorrect indications of the state of its well-being, leading to misinformed policy actions and poorly informed decision-making.

The water table of wetlands is near the land surface with high level infiltration and overflow of water as well as reservoir for flood retention. According to [1], wetlands were previously seen as dirty, dangerous and unimportant areas; while Barbosa (2010) opined that they are complex ecosystems hosting a high diversity of landscape associated with water, soil and vegetation variations. Wetlands are great resources for life on earth especially mankind who depend on wetlands for survival (Ibrahim and Nwaerema 2020). Wetlands are habitats for different species of plants and animals on earth (Barbosa, 2010). Due to the high saturation of water in a wetland, it has become a life support system that supplies the water needs of the numerous biodiversity of plant and animals for their existence (Ramsar, 1998). The huge resources in wetlands, have sometimes turned it to be areas of strong disputes among community farmers and herdsmen. Therefore, it has become imperative to design good wetland management framework for sustainable use of the abundant resources. According to Nigeria National Root Crops Research Institute [10], the awareness of dry season vegetable cultivation is growing in both north and southeastern agricultural zones of Nigeria. However, the wetlands are usually utilized in planting rice, sugar cane, cocoyam (*Colocasia spp)* and early yam (*discorea spp)* in the zone. Fishery is practiced along some river channels. There is limited studies conducted on the wetlands in some ecological zones of the river basins [8]. River basin development authorities have reported the challenges of wetland in southern part of Nigeria [4]. Also, some geological soil study however was understudied by Obaje, (2012) and Olasehinde (2010). Many wetland studies have been carried out by some scholars [7]; FDALR 1985; [15]; Mbagwu, 1990). The objective of this study was to delineate and characterize the wetland soils utility and its impairment to development in Niger State. The results would serve as a management tool for sustainable wetland development and management.

MATERIALS AND METHODS

Wushishi is a Local Government Area in Niger State, located between Longitude 9°42' and 7.20''N and Latitude 5°56' and 11.83''E. The Local government is bordered by Gbako and Katcha local government at south Eastern side, Rafi at North western side, Chanchaga at North Eastern part of Niger State. It is habited by an estimated population of about 200,900 people with an area of 1,879 km² and a population of 229,449(National Bureau of Statistics 2016).The local government is drained by River Kaduna which is perennial and river Tunga seasonal. Dams are constructed across the rivers and are majorly used for both domestic and agricultural purposes. The wet season sets in from March and April reaching its climax by August and September. And ceases by October. The dry season sets from middle October till

March of the following year. It has an annual rainfall of about 1150 mm with mean annual temperature of about 27.7° C.

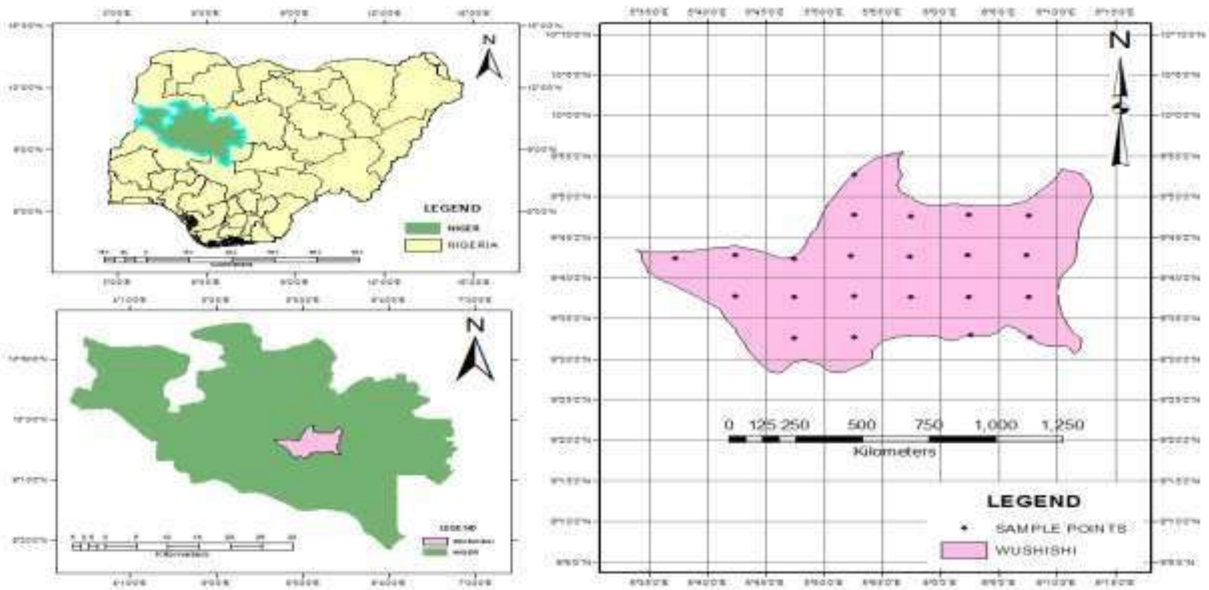


Figure 1: Geographical location of the study area

METHODOLOGY

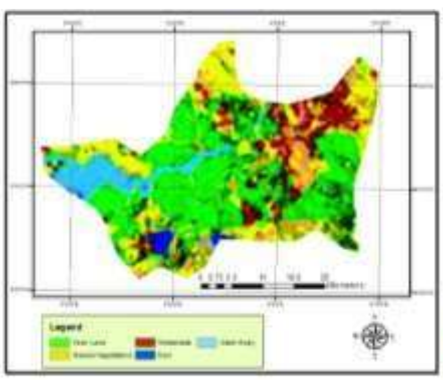
This study utilized the potential of laboratory test and GIS integration of heterogeneous nutrient data to effectively state and predict the soil capability and potentials in order to ensure improvement in crop production. The effectively achieved potential capability of soil regarding crop production in the wetland is quantified and evaluated based on the magnitude of wetland soil potentials. The study area was demarcated according to the geo-political wards (districts) of the Local government. Soil samples were collected from fifteen points and taken for laboratory analysis. There are six wards consisting of Wushishi, Zungeru, Maito, Tunga Kawo and Bankogi districts. From each district, three points were sampled for the soil analysis depending on population and land mass of the district, areas within flood plain, developed and farmlands. Bulk soil sample were collected and taken to laboratory for soil analysis. Satellite imagery of three decades (1992-2022) were used in presenting relative manner of wetland utilization processes in the study area. The area is basically drained by two rivers, River Kaduna. From all the literatures reviewed on this section one of the most challenges encountered are problem of estimation, maintenance and management of land use in different part of the world.

RESULTS AND DISCUSSIONS

Some noticed examples that emanated from projected extreme climate change events include flow base changes, wildlife is stressed due to increase in heat generation, potential increase of flooding, landslide occurrences, soil erosion become real [17]. With the recent predicted climatic scenarios of the future, exotic spread possibly enhanced that increase pressure on watersheds ecosystem, Climate change is expected to react in relation with some other pressures many of these pressures depend on the regional condition which pose a lot of danger on the water resource in relatively short term (Root et al. 2003).

Other factors related to climate play key role in determining the impact on wetland environment which include temperature, alteration of biogeochemistry, fire, organic sediment oxidation and wave energy effect (IPCC,1998; [2]; USGCRP 2000). Water resource of a particular wetland ecosystem is largely affected by climate condition as tempted by fluctuation in precipitation and temperature over time. From views of climate variability bases and effect, it poses on wetlands, these numerous ecosystems needed to be viewed in a broader way of their spatial location within a region. Wetland preservation and loss are one of the major predicament nations around the globe faces in this century. Nations like Nigeria, USA and China have shown a lot of concern over the issue because they have undergone series of development in aspect of wetland conservations. It was noticed that economic splays the most important role when it comes to wetland development to produce food, shelter and water. This indicated how much the wetland in Niger State lack sound and widespread research and when this is lacking it is difficult to make decision regarding protection and conservation.
Identifying the extent of wetland to achieved potential capability of soil potentials regarding to crop production in the study area, three decades of Land SAT satellite imagery are established by looking at the land use/land cover over 30 years in the local government.

Three set of Land-SAT imagery are adopted across the 30 years 1992-2022.



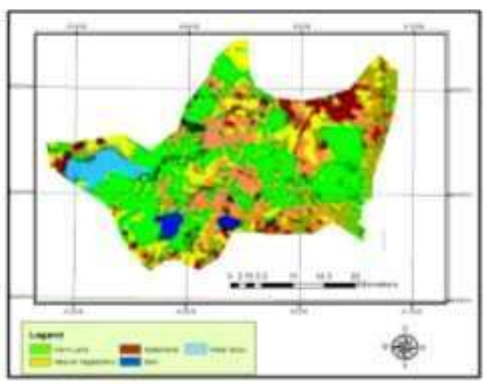


Fig 2: Land use in 1992 **Fig.3: Land use in 2002**

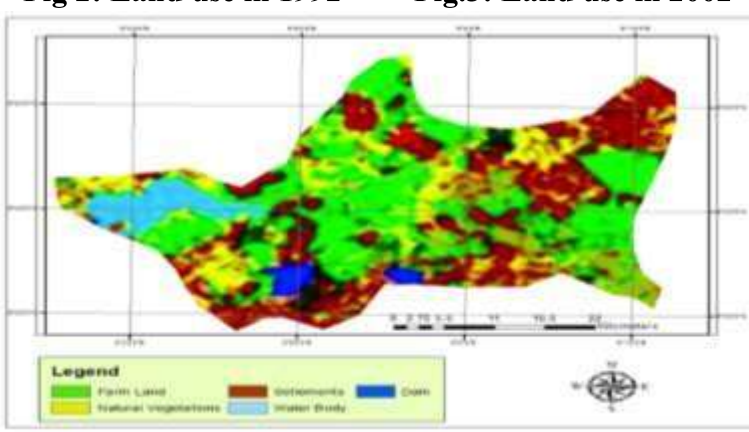


Fig. 4: Land use in 2022

Table 1: Land Use/Land Cover in 1992

Land use	Area in Hectares	Percentage (%)
Natural Vegetation	17417.964438	47.14
Wetland	2292.769584	11.21
Farm Land	7865.115636	37.12
Settlement	555.660294	2.63
Water body	371.88541	1.9
Total	20267.00	100

Researcher's Analyses, 2020

The estimation of land-use analysis shown in fig. 1indicated that in 1992 the predominant land-use is natural vegetation which accounted for 17417.96 hectares (47.14%) of the study area. Settlements occupied only 555.66 hectares (2.63%) while Farmland occupied 7865.11 hectares (38.81%); water body occupied 371.88541 (1.9%) and wetland occupied 2292.76 hectares (11.12%). This shows that at this period, the inhabitants of the study area were few in number and their occupation then was farming and hunting and other primary activities.

Table 2: Land use/land cover in 2002

Land use	Area in Hectares	Percentage (%)
Natural Vegetation	4193.078175	32.76
Wetland	7709.2272	11.21
Farm Land	5806.369125	48.9
Settlement	2552.008275	5.23
Water body	4193.078175	1.9
Total	20267.00	100

Author (2000)

The Table 2/Fig 2revealed that farming activities in the area increase from 37.12% in 1992 to 48.9% in 2002, Natural vegetation decrease from 47.14 in 1992 to 32.76 in 2002

Table 3: Land use/land cover in 2019

Land use	Area in Hectares	Percentage (%)
Natural Vegetation	1193.078175	12.15
Wetland	7709.2272	9.43
Farm Land	7906.369125	65.2
Settlement	2552.008275	11.32
Water body	4193.078175	1.9
Total	20267.00	100

Researcher's Analyses, 2022.

The study area in 2019 shown in figure 3/ Table 2, that natural vegetation has decrease to 12.15%, and Farm land has increase from 48.9% to 65.2%, settlements also increase from 5.23% to 11.32%, water body remain as 1.9%.It was observed from the analysis in Figure 4.6 that, farmland has expand from part of the western part of the study area to the northern part through the eastern part of the area, most of the natural vegetation in 1989 have being open up for farming activities.

Variation in contents of the soil at different location using laboratory test

Analysis results of the soil content were computed at different locations in the study area, the parameter analysis were pH H20, pH CaCl2, Condt,%TON, %OM, Nacoml/kg, kcmol/kg and Cacmol/kg. The samples were taken from six sample sites, Zungeru camp, Wushishi town, Tunga Kawo dam, Bankogi, Maito and Tshohon-dabiri. Analysis in Table 7 shows the results of soil sample analysis of Bankogi as the highest *p*H. H2O value of 7.84 follow by Maito with 7.65, Zungeru camp with 7.39 while Wushishi town has the lowest with 6.27. The soil pH of the study area ranges from 6.47 to 7.84 and was rated as "strongly acidic" to "moderately acidic" as per the soil *p*H classification by Tekalignand Tadesse (1991). The analysis showed a significant difference in soil parameter from locations ($p < 0.01$) and soil depth ($p < 0.05$) while there were no differences due to interaction effect. Significantly higher was recorded in cultivated land and grazing lands. Nevertheless, no significant difference ($p > 0.05$) was observed in the parameters among land use type and soil depth.

The increase in clay content and a decrease in the sand and silt fractions in the lower soil layers could be attributed to the downward migration of clay particles in the soil profile as evidenced by its higher contents in Mgcmol/kgthat ranges between 0.8-1.22; Sand percentage ranges between 52-66; Clay percentage ranges between 9-17 and the selective removal of finer soil particles from surface soils by erosion leaving behind the coarser fractions. It was higher clay content in lower soil depths and forest land than the cultivated and grazing lands.

Map areas of potential wetland soils for agricultural practices using Remote sensing technique

The suitability for potential farmland range from 58.0 – 97.0 while 3.0-57.9 are not suitable for any agricultural activities. Moreover, areas within the ranges of 85.1 to 97.0 are characterized with wetland properties due to the presence of lake and soil condition that is capable to retain water at high potential. The (NIR) over the growing period between 830 and 1630 mm/year (Figure 4.9). From the figure, lowland area characterized with higher NIR where the temperature is high for the growing period.This will also be favorable for growing Palm trees and Cocoa trees as in Forest region

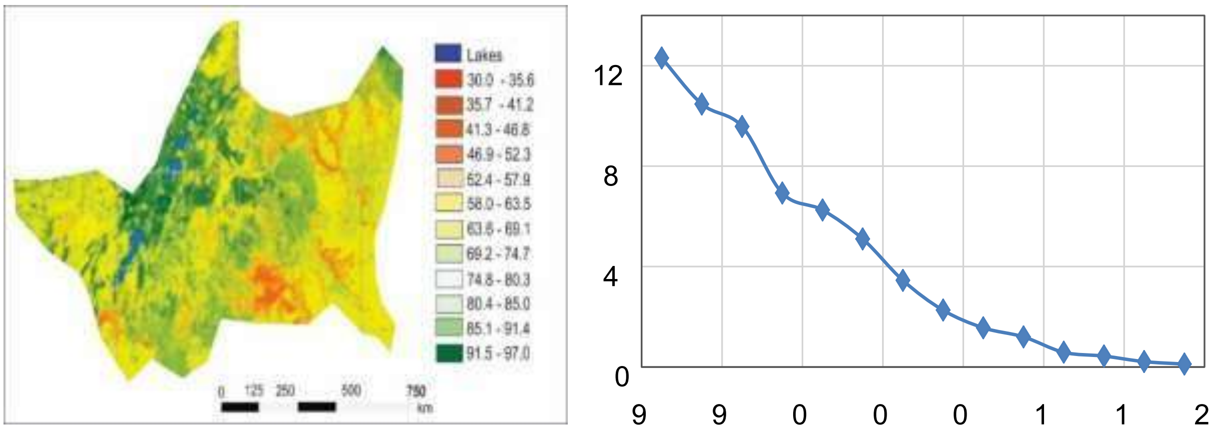


Fig. 5: Potential and suitable areas Sources: Fieldwork 2022

Table 4: Results of Soil Sample from the study area.

Sample points	pH. H2O	pH. CaCl2	Condt	%TON	%TOC	%OM	Nacmol/kg	Kcmol/kg	Cacmol/kg
Zungeru Camp	7.39	6.55	84	0.38	0.98	1.68	0.21	0.06	3.15
Wushishi town	6.27	5.49	126	0.52	1.29	2.23	0.18	0.08	2.82
=	6.73	5.61	114	0.46	1.2	2.09	0.24	0.16	2.6
Bankogi	7.84	6.76	77	0.85	2.49	4.28	0.22	0.05	3
Maito	7.65	6.48	108	0.33	0.69	1.2	0.16	0.09	2.75
Tsohondabiri	6.47	5.62	133	0.36	0.92	1.58	0.19	0.07	2.5

pH= alikalinity;$CaCl_2$= ; %TON= ; % TOC = ; %OM = ; Nacm/kg = ; Kcm/kg = ; Cacm/kg

Table 4, depicts that Bankogi has the highest pH. $CaCl_2$ of 6.76 follow by Zungeru Camp with 6.55 while Wushishi town still has the lowest value of pH. $CaCl_2$ with 5.49. it was also discovered from the analysis that TungaKawo dam has the highest Namco value of 0.24 and Maito has the lowest with 0.16. Zungeru camp has the highest Cacmol value of 3.15 while Maito has the lowest with 2.5. The analysis signifies that soil samples varies from one site to the other. The physicochemical parameters of the soil were also analyzed based on the different locations in the area, the variations in the parameter tested depicts that Zungeru camp has the highest Mgcmol, Wushishi, TungaKawo dam and Tsohondabiri has the highest value of Exch A (0.06), but Wushishi town has the highest percentage of sandy soil, TungaKawo dam has the highest clay while Zungeru camp has the highest silt with loose loamy soil suitable for growing Palm trees and Cocoa as in forest regions..

Landuse Classification of the study for 30 years (1992-2022)

Wushishi is a rural and agrarian area which is experiencing different agricultural practices rigorous economic growth since the last two to three decades back. The increase in agricultural activities in the area has mount pressure that change the Land-use pattern. Three decade (1992-2022) Landsat imageries were analysis, various Landuse classification in the study area were identified. Land use/ land cover distribution by statistical from 1992-2002 as gotten from the image classifications in Figure 4.5 are presented in the Tables 10 and 11.

The estimation of Landuse analysis shown in Table 3 indicated that in 1992 the predominant Landuse is natural vegetation which accounted for 17417.96 hectares (47.14%) of the study area. Settlements occupied only 555.66 hectares (2.63%) while Farmland occupied 7865.11 hectares (38.81%); water body occupied 371.88541 (1.9%) and wetland occupied 2292.76 hectares (11.12%). This shows that at this period, the inhabitants of the study area were very small in number, and their occupation then was farming and hunting and other primary activities.

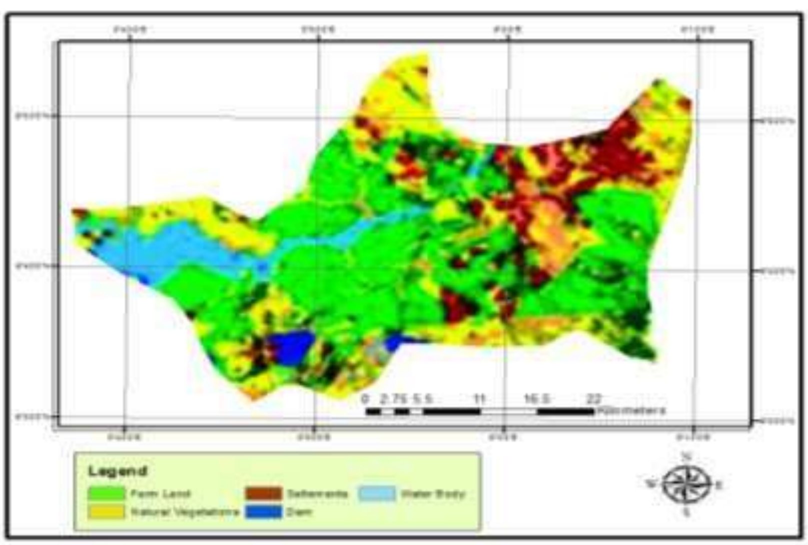


Figure 1: Landuse Classification of the study area in 2012

Table 5 :Land Use/Land Cover in 2012

Land use	Area in Hectares	Percentage (%)
Natural Vegetation	17417.964438	47.14
Wetland	2292.769584	11.21
Farm Land	7865.115636	37.12
Settlement	555.660294	2.63
Water body	371.88541	1.9
Total	20267.00	100

Researcher's Analyses, 2020

The year 2012 analysis revealed that farming activities in the area increase from 37.12% in 1999 to 48.9% in 2022, Natural vegetation decrease from 47.14 in 1999 to 32.76 in 2022 (Figure 6). **Table 6 : Land use/land cover in 2019**

Land use	Area in Hectares	Percentage (%)
Natural Vegetation	4193.078175	32.76
Wetland	7709.2272	11.21
Farm Land	5806.369125	48.9
Settlement	2552.008275	5.23
Water body	4193.078175	1.9
Total	20267.00	100

Author (2019)

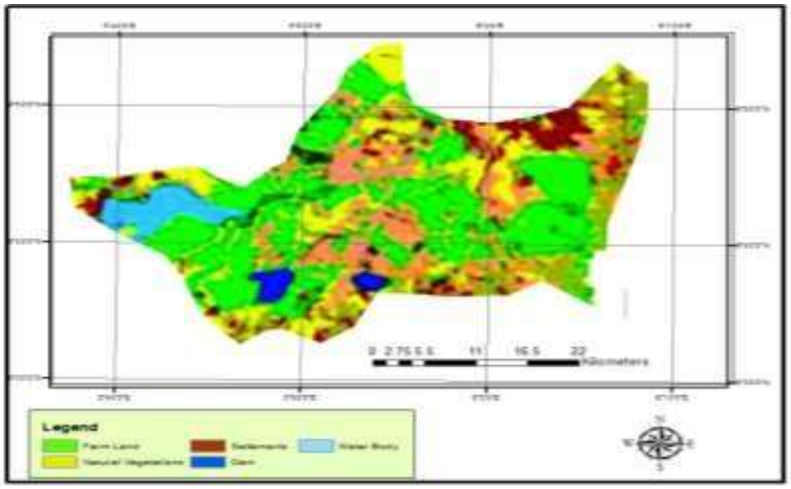


Figure 2: Landuse Classification of the study area in 2019

Source: Author (2019).

The analysis of the study area in 2021 shown in figure 7, the statistics shown in table 4.6 shows that natural vegetation has decrease to 12.15%, Farm land has increase from 48.9% to 65.2%, settlements also increase from 5.23% to 11.32%, water body remain as 1.9%.It was observed from the analysis in Figure 6 that, farmland has expand from part of the western part of the study area to the northern part through the eastern part of the area, most of the natural vegetation in 1989 have being open up for farming activities.

Table 7: Land use/land cover in 2022

Land use	**Area in Hectares**	**Percentage (%)**
Natural Vegetation	1193.078175	12.15
Wetland	7709.2272	9.43
Farm Land	7906.369125	65.2
Settlement	2552.008275	11.32
Water body	4193.078175	1.9
Total	20267.00	100

Researcher's Analyses, 2022.

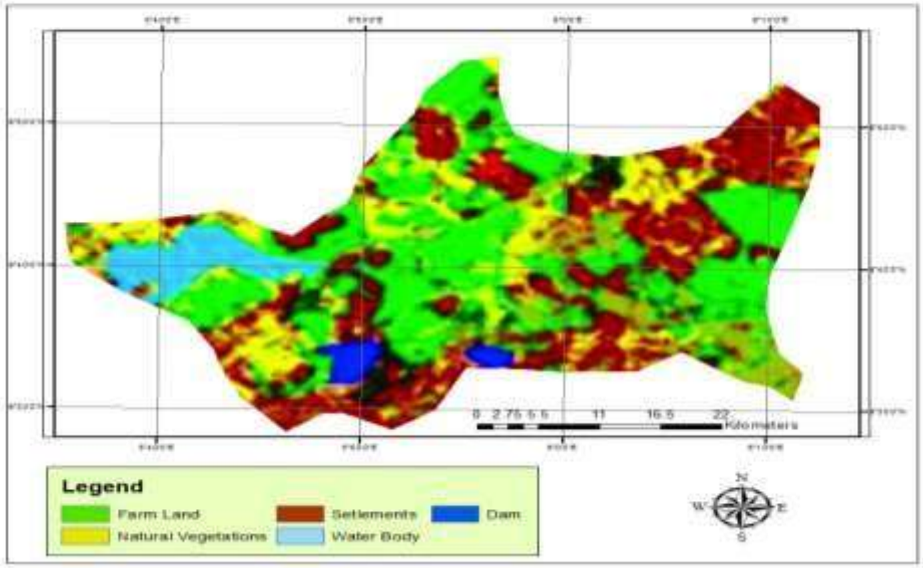


Figure 3: Landuse Classification of the study area in 2022

Author (2022).

Distribution of Soil Potential Efficiency

High resolution satellite detect soil moisture of a particular wetland with sensitive multisensory lens. Soil moisture is basic in determining the infiltration process within a wetland catchment area. The incoopertion of soil moisture data into runoff prediction model highly influence estimations. Figure 8 shows the soil texture map of the study area.

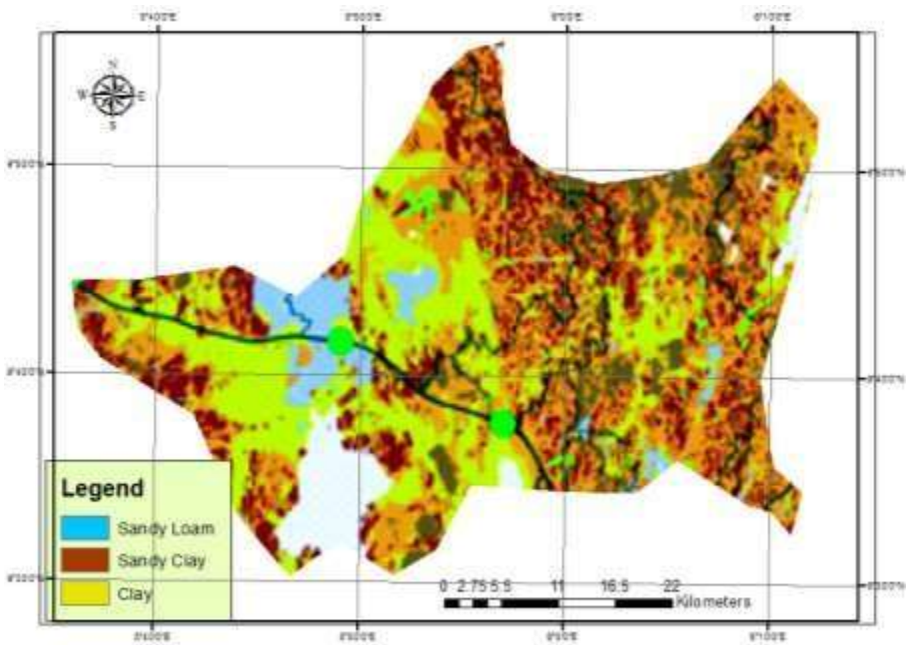


Figure 4: Soil Texture Map of the Study Area

From figure 9, three major classes of soil were identified in the study area, these are sandy loam, sandy clay and clay soil. The use of remote sensing instead of conventional method of measurement in estimating soil moisture content which is capable of covering large surface area within the shortest period with accuracy of acquired data.

Variation in contents of the soil at different location using laboratory test

Analysis results of the soil content were computed at different locations in the study area, the parameter analysis were pH H20, pH CaCl2, Condt,%TON, %OM, Nacoml/kg, kcmol/kg and Cacmol/kg. The samples were taken from six sample sites, Zungeru camp, Wushishi town, Tunga Kawo dam, Bankogi, Maito and Tshohon-dabiri. Analysis in table 4.7 shows the results of soil sample analysis. It shows that Bankogi has the highest pH. H2O value of 7.84 follow by Maito with 7.65, Zungeru camp with 7.39 while Wushishi town has the lowest with 6.27. The soil pH of the study area ranges from 6.47 to 7.84 and was rated as "strongly acidic" to "moderately acidic" as per the soil pH classification by Tekalign and Tadesse (1991). The analysis showed a significant difference in soil parameter from h locations ($p < 0.01$) and soil depth ($p < 0.05$) while there were no differences due to interaction effect. Significantly higher was recorded in cultivated land and grazing lands. Nevertheless, no significant difference ($p > 0.05$) was observed in the parameters among land use type and soil depth.

Table 8 :Result of soil sample analysis

Sample points	pH. H_2O	pH. $CaCl_2$	Condt	%TON	%TOC	%OM	Nacmol /kg	Kcmol /kg	Cacmol/kg
Zungeru Camp	7.39	6.55	84	0.38	0.98	1.68	0.21	0.06	3.15
Wushishi town	6.27	5.49	126	0.52	1.29	2.23	0.18	0.08	2.82
Tungakawo	6.73	5.61	114	0.46	1.2	2.09	0.24	0.16	2.6
Bankogi	7.84	6.76	77	0.85	2.49	4.28	0.22	0.05	3
Maito	7.65	6.48	108	0.33	0.69	1.2	0.16	0.09	2.75
Tsohondabiri	6.47	5.62	133	0.36	0.92	1.58	0.19	0.07	2.5

Source: Author (2020)

The analysis further shows that Bankogi has the highest pH. CaCl2 of 6.76 follow by Zungeru Camp with 6.55 while Wushishi town still has the lowest value of pH. CaCl2 with 5.49. it was also discovered from the analysis that Tunga Kawo dam has the highest Nacmol value of 0.24 and Maito has the lowest with 0.16. Zungeru camp has the highest Cacmol value of 3.15 while Maito has the lowest with 2.5. The analysis signifies that soil samples in the area were varies from one site to the other. The physicochemical parameters of the soil were also analyzed based on the different locations in the area, the results shows variations in the parameter tested. It shows that Zungeru camp has the highest Mgcmol and Avail P, Wushishi, Tunga Kawo dam and Tsohondabiri has the highest value of Exch A (0.06), Wushishi town has the highest percentage of sandy soil, Tunga-kawo dam has the highest clay while Zungeru camp has the highest silt (Table 8)

Table 9 : Physiochemical properties

Sample points	Mgcmol/kg	Avail P mg/kg	Exch A cmol/kg	CECcmol/kg	%Sand	%Clay	%Silt
Zungeru camp	1.22	4.14	0.04	15.36	52	12	36
Wushishi town	0.4	3.65	0.06	13.94	71	7	22
Tunga dam	0.34	4.3	0.06	16.17	59	17	24
Bankogi	0.85	6.22	0.04	14.55	64	9	27
Maito	0.65	2.85	0.04	16.83	60	10	30

Tsohondabiri	0.8	3.4	0.06	13.75	66	12	22

Source: Author (2020)

The increase in clay content and a decrease in the sand and silt fractions in the lower soil layers could be attributed to the downward migration of clay particles in the soil profile as evidenced by its higher contents in Mgcmol/kgthat ranges between 0.8-1.22; %Sand ranges between 52-66; %Clay ranges between 9-17 and the selective removal of finer soil particles from surface soils by erosion leaving behind the coarser fractions. It was higher clay content in lower soil depths and forest land than the cultivated and grazing lands. The resemblance of this result to the works of these authors could be associated with the similarity in ecosystem and land management practices.

Map areas of potential wetland soils for agricultural practices using Remote sensing technique

From the soil sustainability potential map, it is noted that Farmers in the study area are subjected to limited dry days for spring fieldwork coupled with inadequate drainage that sustain the field operation in respect to next rainfall season.

From the study potential evapo-transpiration and monthly rainfall are compared which shows rainfall is larger than potential evaporation during rainy season indicating no need for practicing irrigation during rainy season. However, irrigation may become necessary should incase unexpected dry spell. Moreover, areas within the ranges of 85.1 to 97.0 are characterized with wetland properties due to the presence of lake and soil condition that is capable to retain water at high potential. The (NIR) over the growing period between 830 and 1630 mm/year (Figure 4.9). From the figure above lowland area characterized with higher NIR where the temperature is of high potential for the growing period.

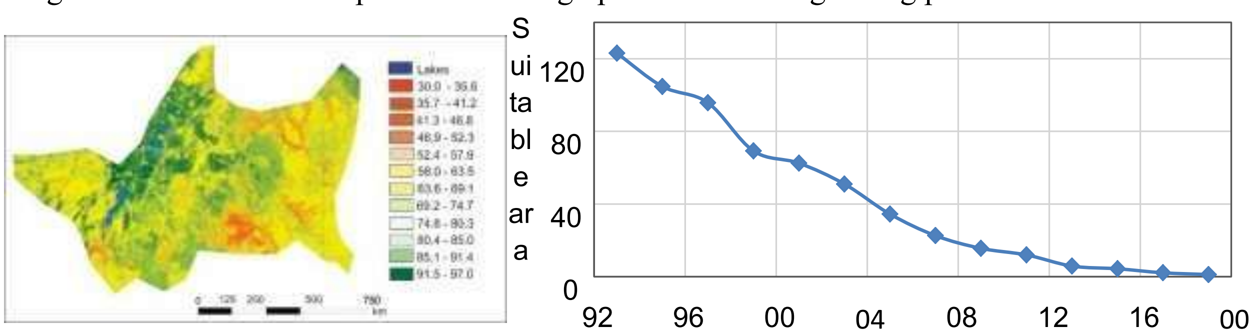


Figure 5: Soil Suitability potential map of the Percent threshold and (%) (suitability level) Study area

Analysis from River Basin Authority scale shows that the average fraction of irrigable area in Kanko, Tagwagi and Tunga Kawo ranges from 7.5 to 12.4% of the potential suitable land. Farmland has expanded from part of the western part of the study area to the northern part through the eastern part of the area, most of the natural vegetation in 1992 are open up for farming activities. Zungeru camp the highest Mg/cmol and Avail P, Wushishi, Tungakawo dam and Tsohon-dabiri has the highest value of Exch A (0.06), Wushishi town the highest percentage of sandy soil, Tunga Kawo dam the highest clay while Zungeru camp has the highest silt. The potentiality and suitability for farm range from 58.0 – 97.0 while 3.0-57.9 were not suitable for any agricultural activities.

Plate i: Typical nature of the irrigated site in the study area used for dry season farming

Plate ii: Nature of drainage caused by land degradation

The topographic setting of Bankogi area shows the steep-sloped area with much vegetation enable extensive irrigation farming take place in the area. Maito area is mostly cultivated by smallholder farmers. The removal of trees without sufficient reforestation has resulted in degradation, habitat damage, biodiversity loss, and aridity.

Plate iii: Deforestation for housing development and activities of herdsmen

Overgrazing were discovered in part of Zungeru camp, farmers in this area were complaining bitterly about the activities of herdsmen grazing their animals in that areas thereby causing soil erosion as a result of exposure of top soil. The activities of the herdsmen in the area reduces the usefulness, productivity, and biodiversity of the land and is one cause of desertification and erosion. Overgrazing is also seen as a cause of the spread of invasive species of non-native plants and of weeds.

CONCLUSION AND RECOMMENDATIONS

Three major classes of soil were identified in the study area, these are sandy loam, sandy clay and clay soil. Most of the northern and eastern part of the area is much suitable for agricultural activities. The soil pH of the study area ranges from 6.47 to 7.84 and was rated as "strongly acidic" to "moderately acidic". It showed a significant difference in soil parameter from pH locations ($p < 0.01$) and soil depth ($p < 0.05$) while there were no differences due to interaction effect. Significantly higher was recorded in cultivated land and grazing lands. Nevertheless, no significant difference ($p > 0.05$) was observed in the parameters among land use type and soil depth. Bankogi has the highest p*H*. CaCl2 of 6.76 follow by Zungeru Camp with 6.55 while Wushishi town still the lowest value of p*H*. CaCl2 with 5.49 was also discovered from the analysis that Tunga-kawo dam has the highest Na/cmol value of 0.24 and Maito the lowest with 0.16. Zungeru camp has the highest Ca/cmol value of 3.15 while Maito the lowest with 2.5.

Implications of the study

Therefore, wetland utilization opportunities require more planning and detailed design work than most community projects, due to a combination of numerous factors. These factors include, significant rock and bedrock in the area, anthropogenic surface water influences and interferences, potential contaminant issues in soils and sediment, urban storm water inputs and the potential for contaminated storm water, multiple landowners and the developed nature of watersheds, community expectations, landowner expectations, the municipal regulatory system and questions relating to jurisdiction and urban infrastructure including roads, buildings, sidewalks, railways, storm water infrastructure, businesses, energy such as power poles and electrical systems as well as underground utilities such as gas lines, sewer lines, water lines etc.

Limitation of the study

Despite the effort of the researcher to get enough detailed information from the farmers, they were skeptical to allow full study to be conducted on their farm lands. The farmers are therefore encouraged to always feel free to report issues regarding their farmlands.

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