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EVALUATION OF SOIL DEGRADATION AND CONSERVATION PRACTICE FOR SUSTAINABLE ENVIRONMENTAL DEVELOPMENT IN SOME PARTS OF KATSINA STATE, NIGERIA

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Abstract

A good percentage of life as it exists on earth is dependent on soils. The paper analyse the physical and chemical properties and assessed soil for environmental conservation in some part of Katsina State. Composite soil sampling method for the collection of soil samples between the depths of 0-15cm was adopted. The soil samples were collected from sampled plots under pearl millet sole (major cropping) and a control plot of non-pearl millet growing plot: and tested for some physical and chemical properties. The result reveals that average pH were optimum for pearl millet cultivation. Also soil properties including average clay (8.71%), Available Water Holding Capcity (1.17cm), P (14.57ppm) and CEC (1.583me/100g) were found under pearl millet sole cropping to be low compared with the values of clay (9.04%), Available Water Holding Capacity (1.42cm), P (17.45ppm) and CEC (2.159me/100g) for other plots. Fertility status of nitrogen, phosphorus, potassium and exchangeable bases were found to be declined and low. Analysis of variance (NOVA) revealed that there was no variation among the soil samples. Environmental conservation including biodiversity and soil should be emplaced. Therefore, this indicated that the soil fertility was at very low level. The use of fertilizers in the area recommended to stabilize the soil nutrients and environmental policies should be reviewed to improve soil and land condition for economic and sustainable environmental development.

Key Word: Soil, Environment, Conservation, Musawa and Katsina

1. Introduction

Land degradation is the decline in land quality caused by human activities as a result of inappropriate use that lead to degradation of soil, water and vegetative cover and loss of both soil vegetative biological diversity, affecting ecosystem structure and functions (FAO, 2005) Degraded lands are more susceptible to the adverse effects of climatic change such as increased temperature and severe droughts. Soil is dynamic natural entity that behaves like a living body with self-regulating abilities to supply nutrients, buffer acid and base reactions, destroy and absorb pathogens, detoxify and attenuate xenobiotic and inorganic compounds.

Almost all the needs of man are derived from soil and its fertility is very critical of its functions (Essiet, 1997). It is of very much importance to maintain soil fertility and its management for food and other environment needs. Ahmed *et al* (2015) reported that the scenario of low fertility in the region leads to low output, which shows that most of the important nutrients were lost in the area, which was projected to increase the annual nutrient depletion. They claimed that the sub Saharan African countries are losing not less than 60-100 kg/ha/year (WARDA, 1996; Kallah, 2004), and there is a relationship between soil nutrient depletion, environmental problems and food insecurity which indicated less improvement to some crops.

Soils represent the single most important natural resource on which human existence and prosperity depended (Alim and Yasin, 1993). Nigeria, being the largest and most populated African country, has rapid demographic growth and depend heavenly on agriculture. In addition, Nigeria features predominantly in nutrient depletion scenario, and among many factors limiting environmental and agricultural development in the country is the insufficient information on soils and their characteristics.

The main components of environment are the atmosphere, biosphere, hydrosphere and lithosphere. The conservation movement is a political, social and to some extent, scientific movement that seeks to protect natural resources including plant and animal species as well as their habitat for the future (Ahmed, 2019b). The early conservation movement included fisheries and wildlife management, water, soil conservation and sustainable forestry. The cotemporary conservation issues have broadened from the emphasis of early movement on use of sustainable yield of natural resources and preservation of biodiversity. Resources are used to meet the needs of man within certain constraints and the constraints are manifested interms of supply of resources available to meet the needs of man. Neither the environment as such nor parts of the environment are resources until they are capable of satisfying mankind's needs (Ogunkunle, 2004).

Conservation is the sustainable use and protection of natural resources including plants, animal, mineral deposits, soil, clean water, clean air and fossil fuels such as coal, petroleum and natural gas (Avise and Hamrick, 1996).Conservation refers to planned management of a natural resource to prevent exploitation, destruction, or neglect. For example, Katsina as one of most populous state need to practice conservation seriously, so as preserve them for future generation and ensure their constant flow especially in this era of resource control and crises. In recent time, many farms have been under pearl millet growing for over fifty years in Musawa area. Therefore, the area was selected to determine land or soil degradation for conservation measures.

2. Materials and Method

2.1. Field Work

Jaiswal (2003) stated that a portion of the entire soil mass taken from its natural occurrences for analysis in order to describe the properties of the soil is referred as soil sample. There are various methods of sampling farm plots irrespective of the method used, the sample collected must be representative of the area or plot. Five farms that were under pearl millet cultivation for many years were selected. This makes the total of 5 farm plots.

For each farm plot a composite sample was carried out, where 7 samples of top (0-15cm depth) were collected on 19th May, 2013. This makes 35 samples with an average of 5 collected from plots each under sole cropping. For each plot, samples were mixed vigorously and obtained one sub sample for analysis. Soil samples collected must represent the populations of every sample and should have the same volume and weigh at least 500g. In each farm plot observation was made in terms of homogeneity of the farm before taking the composite sample. The top 0-15cm depth was considered because the major roots of pearl millet are within and most agricultural activities do not go beyond this limit. The areas chosen were marked as A Makoda, B Aljawa, C Tsamiyar-Nafasa, D Gidan-maihure and E Kuru. That makes five sampled farm plots.

2.2 Laboratory Analysis and Conservation

The samples were analysed for fertility indicators for the particle size distribution, available water holding capacity, pH, total nitrogen, exchangeable bases (Na^+, Ca^{++} and Mg^{++}), available phosphorus, potassium, boron and nitrogen (Lamofor*et al.*, 1990; Ibitoye, 2008; Eno*et al.*, 2009; Estefan, Sommer and Ryan, 2013; Garba, 2014). Statistical analysis for coefficient of variation and ANOVA were used. The procedures for the analysis are stated in Table 1. Thus, conservation methods were obtained in literature search.

Table 1: Methods of Determining Physicochemical Properties of Soil Samples

Physicochemical Parameters	MethodsAdopted
Particle size distribution	Hydrometer
Available Water Holding Capacity	Automatic Hydrometer reading
Soil pH	pH meter (1:25 water ratio)
Total nitrogen	Micro kjeldahl
Phosphorus	Spectrophotometry (centrifuge)
Organic Matter	Walkley black (dichromate solution)
Exchangeable bases	Bray 1 (NH_4OAC, Na^+& K^+ by flame photometer and Ca^{++}& Mg^{++} by atomic absorption)
CEC	Calculated by the sum of exchangeable bases
Boron	Concentration of Sodium acetate& Boric Acid

Source: Adapted from Eno*et al* (2009)

3. Study Area

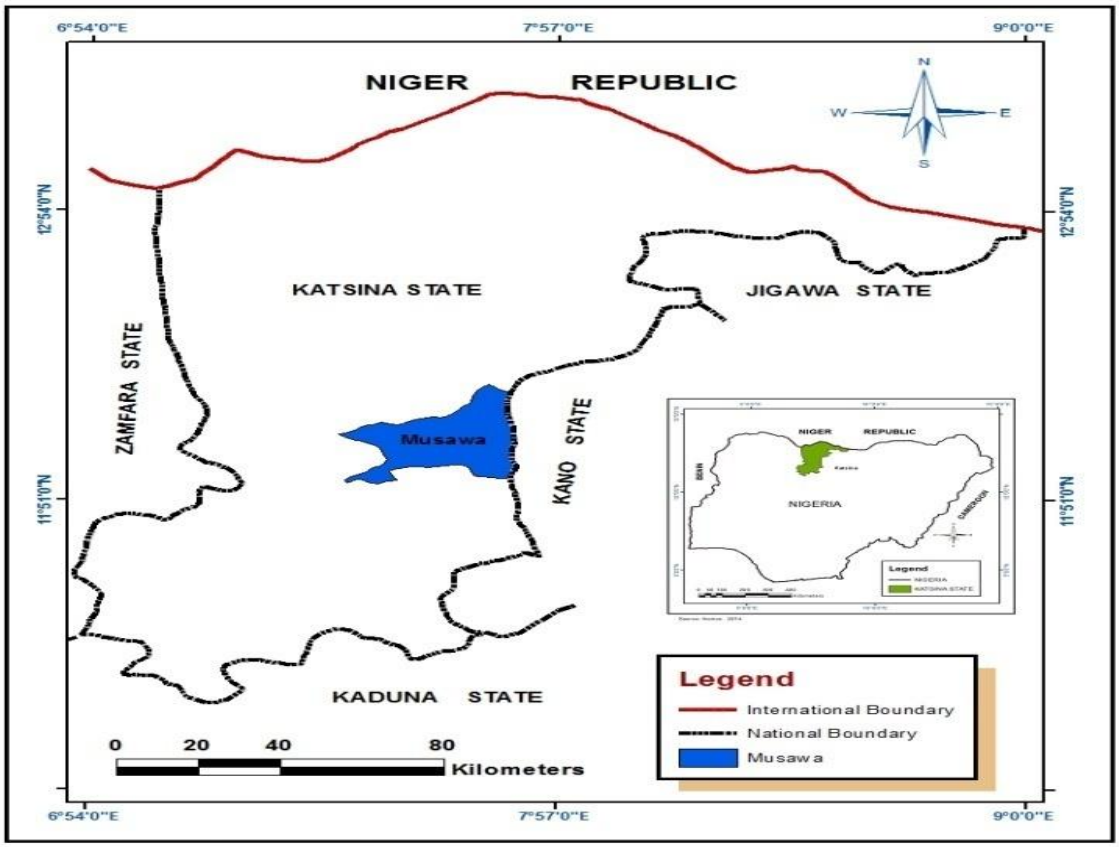
Katsina State is located in the northern part of Nigeria under Sudan savanna ecological zone. It has total area of 239 thousand square kilometers. It has total cultivable area of 1.65 million hectares. Major cultivated crops in the state are millet, sorghum, maize, rice, sugarcane, irrigated wheat, cowpea, groundnut, cotton and vegetables (NAERLS and NFRA, 2008).

Musawa is located at the center of Katsina State along Charanchi to Kurkujan road, between latitude 11°58'N – 12°16'N and longitude 7°28'E – 7°56'E, (Panning Unit, 2013). Climate refers to generalization of weather condition of a given area for a period of 30years (Ayoade, 2004). The rainy season of Musawa area was between the month of May to September and it has its peak in the month of August. The rainfall ranges of 5 – 6months (750mm – 850mm

respectively, based on average of 10years from 2000 to 2009. It is characterized by conventional rain fall (dry and wet climate) followed by long dry season of 6 – 7 months (Meteorological Unit, Umaru Musa International Airport Katsina, 2012). The mean maximum temperature of Musawa area is 39^{o}C in the month of April and May. At the high of rainy season, average maximum temperature was 38^{o}C and in December, average temperature is 20^{o}C (Meteorological Unit, 2012).

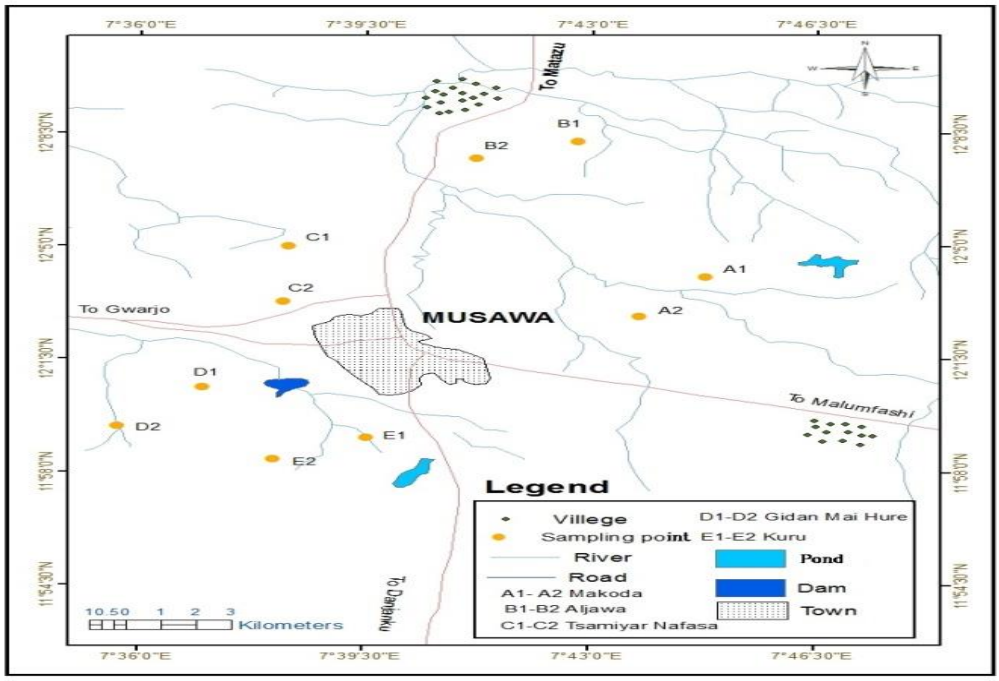
The wind speed of Musawa is 1.5km/h in the month of July to September and higher as 3.2km/h around December to January. The direction of wind is north-east to south-west and dry in December and January, and it is south-west to north-east direction and wet from April to October. Relative humidity denotes the amount of water vapor in the atmosphere (air) compared to what the air can hold when fully saturated. The minimum relative humidity of Musawa was 18% in December to January and maximum as 95% around July and September (Meteorological Unit, 2012).

Soils are the mixture of rock particles loosened by weathering, mineral salts and dead vegetation matter. In the southern part of Katsina State, the covering material is largely clayey soil, about five meters depth, and very fine in texture. The soils of Musawa were light clay in nature, but due to drift deposits resulting into sandy soils (Chude*et al*, 2012; Ahmed, 2014). Below are Figures 1 and 2 showing study area.



Source:Administretive Map of Nigeria NASRDA. 2013

Figure 1.1: Katsina State Showing Musawa LGA



Source; NASA/NOA Sport Image and Field Work 2013

Figure 1.2: Map of Musawa Area Showing Sampling Points

4. Results and Discussion

The result revealed the status of soil physical and chemical properties (degradation) of the area (Table 2) and environmental conservation issues.

4.1. Soil and Environmental Degradation

Natural resource conservation in Katsina State can be seen from various perspectives, inform of desertification through fuel wooding, soil erosion from poor management practice, energy shortages' to mention but a few. These challenges of Conservation in Katsina are almost the same everywhere in the world and the best way to tackle it, need to understand the complex connections among the natural resources and balance resource use with protection to ensure adequate supply for future generations. Soil physical and chemical properties are the yardstick in measuring land degradation (Ahmed, 2019a)

To understand the impact of environmental degradation in the study area, the result of degraded soil physical and chemical properties is presented in Tables 2 and 3.

Table 2: Soil Physical Properties in Musawa Area

Sample	Clay%	Silt%	Sand %	AWHC/cm
A	9.0	7.0	84.0	0.60
B	8.64	12.0	79.36	0.76
C	8.64	8.56	82.80	3.14
D	8.64	8.56	82.80	0.71
E	8.64	8.56	82.80	0.66
Average	**8.71**	**9.34**	**81.95**	**1.17**
SD	0.10	1.25	1.22	0.98
CV%	11.48	13.38	1.49	83.76

Source: Field Work and Laboratory Analysis (2013)

Key: A= Makoda, B = Aljawa, C = TsamiyarNafasa
D = Gidanmaihure E = Kuru SD = Standard Deviation
CV = Co-efficient of Variation

The soil physical properties in Musawa area are very low in fertility standard, recorded average clay 8.71% compared with that of 9.04% at Katsina. Average silt recorded 9.34%, which indicate the high level of degradation of environment to function. It also recorded 81.95% sand, meaning the soils in the area are sandy in nature respectively. However, average AWHC of 1.17cm was recorded. The value was at very low level compared to fertility standard as suggested by Yusuf (2001). Though, this was as a result of low level of organic carbon which influences stability in soil texture. It is clear indicated that organic manure should be used to improve clay and AWHC. However, these result values are slightly low compared with that of Katsina (Essiet, 1997). It can be understood that the soil properties (environment) have been degraded, where cannot function as resource to provide nutrients.

The coefficient of variation shows that there is no variation among the soil samples in the area with exception of AWHC and sand which recorded average of 1.17cm and 70.42% respectively (Agbede, 2009). The implication is that the degraded soil physical properties in this regard, will function as degraded environment with supply and preservation of nutrients for plant growth and development.

Table 3: Soil Chemical Properties in Musawa Area

Sample	pH	OC%	N%	P ppm	K me/100g	Ca me/100g	Mg me/100g	CEC me/100g	B me/100g
A	6.2	0.12	0.08	12.88	0.140	0.313	0.149	1.025	0.066
B	6.4	0.28	0.6	1.15	0.057	0.223	0.075	1.155	0.033
C	6.2	1.54	0.51	21.76	0.199	1.562	0.075	2.436	0.066
D	6.0	0.24	0.62	18.32	0.296	0.580	0.075	1.951	0.049
E	5.8	0.76	0.69	17.75	0.148	0.448	0.150	1.346	0.033
Average	**6.12**	**0.59**	**0.5**	**14.37**	**0.168**	**0.625**	**0.104**	**1.583**	**0.049**
SD	0.04	0.55	0.22	7.19	0.0001	0.08	0.04	0.53	0.013
CV%	0.7	93.22	44	50.03	0.05	12.80	38.46	33.48	26.53

Source: Field Work and Laboratory Analysis (2013)

Key: A= Makoda, B = Aljawa, C = TsamiyarNafasa
D = Gidanmaihure E = Kuru SD = Standard Deviation
CV = Co-efficient of Variation

From Table 3, the result shows average pH of 612, Oc of 0.59%, N of 0.50%, P of 14.37ppm and K of 0.168me/100g. The coefficient of variation in this regard indicated that there was variation among the soil samples. Impact of pearl millet cultivation on soil recorded 12.19%. In conclusion, the study revealed that the impact of pearl millet on soil properties in the area. This could be one of the reasons that led to decline in nitrogen content.

Potassium is one of the primary nutrients considered for crop cultivation. The average value 0.168me/100g in the area is very low compared with 0.19me/100g in Maiduguri as pointed by Hassan *et al* (2010). Ajayi*et al* (1998) stated that pearl millet extensively extract nutrients such as nitrogen, phosphorus and potassium from the soil. In the study area, K was degraded under pearl millet. This could be as a result of poor organic matter content. However, it is believe that potassium regulates the availability of phosphorus which led to soil fertility. Coefficient of variation 0.05% shows that there was no variation among the soil samples. However, potassium degradation in the area recorded 19.23%. Thus, it led to soil infertility and decreased in crop yields. This indicated the impact of pearl millet cultivation on soil properties and environmental degradation.

The average calcium of 0.625me/100g (Table 3) was very low compared with 1.70me/100g in Maiduguri (Hassan *et al.*, 2010). It also shows 1.15me/100g in Niamy as stated by Bationo*et al* (2011), which is higher compared with study area. The result further shows serious degradation in calcium in the study area with 41.61% impact of pearl millet on soil properties. Thus, conclusively, continuous pearl millet sole cropping has negative impact on soil physical and chemical properties. Conclusively however, the study revealed that the soils (environment) in central Katsina was degraded, based on the status of soil physical and chemical properties that were below average in terms of fertility standard.

4.2. Soil Conservation Issues

i. Soil Conservation

A mixture of mineral, plant growth and is basic resource for agricultural production. Humans have accelerated erosion process by developing land and clearing away the vegetation that holds water and soil in the environment globally, agriculture accounts for 28% of nearly 2 billion hectres (5 billion acres) of soil that have been degraded by human activities; overgrazing, is responsible for 34%, and deforestation is responsible for 29% (Ahmed, 2019a). In addition to reducing deforestation and overgrazing, soil conservation involves reforming agricultural soil management methods, such as strip cropping, contour farming, terracing, or ploughing to reduce erosion (Samuel, 2009).

ii. Biodiversity or Biological Diversity

This denotes the number and variety of different organisms and ecosystems in a certain area. Preserving biodiversity is essential for ecosystems to respond flexibly. For example, a single specie corn crop be destroyed by a certain insect or disease, but if several different species of crop are planted in the field, some of them may survive because of adaptation, the same principle apply to natural areas (Ahmed, 2019a). The 20th century encompasses one of the greatest waves of extinction, of species to occur on the planet. The greatest threat to biodiversity is loss of habitat as human develop land for agriculture, grazing, industry etc. the most drastic damage has occurred in the tropical

rain forest, which cover less than 7% of the earth surface but contain well over half of the planets biodiversity (Ahmed, 2019b)

Several nations have laws protecting endangered species. For example, the convention on international trade in endangered species of wildlife of fauna and flora (CITES) which came into effect in **1975**.

Renewable energy alternatives such as water powered solar energy, wind energy, and geothermal energy which are efficient and practicable. Thus, but largely underutilized because of the availability of expensive, non-renewable fossil fuels in industrial countries.

In fertility assessment, the research revealed the status of soil physical and chemical properties, fertility of different points in the study area. Soil properties like clay fraction and phosphorus were at moderate fertility class, which corresponds with fertility standards. According to fertility standard, the soil properties in the study area including pH, Oc, N, K and CEC are classified as very low fertility levels. Statistical analysis of co-efficient of variation and ANOVA show that there was no variation among the soil samples. Therefore, it can be concluded that the soil physical and chemical properties recorded low values compared to the standards, fertility status in the area was at low level and this led to degraded land environment.

5. Conclusion

Soil properties like clay fraction and phosphorus are at low fertility class, which is below the fertility standard. The soil properties including pH, Oc, N, K and CEC are classified as very low fertility levels. This clearly shows that the environment in the study area was degraded. There is need to increase energy conservation and the use of renewable energy resources.

6. Recommendations

Based on the findings of the study, the following have been recommended:

i. The use of fertiliser by the farmers is recommended to stabilise the levels of nutrients. This is because plants need macronutrients (N, P and K) in large quantities to meet its requirements for growth and development.
ii. The major soil properties including Oc and N were found to be at very low levels compared to the crop requirements. This could be improved by increased in organic matter content.
iii. Environmental policies should be reviewed. This include the reviewed of land use act of 1978. Since then the policy was not reviewed even as the population has increased for economic and environmental sustainability.

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