ASSESSMENT OF DEGRADATION STATUS OF SOILS IN SELECTED AREAS OF OGBOMOSO, OYO STATE, NIGERIA

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ABSTRACT. The assessment of degradation status of soils in selected areas of Ogbomoso, Oyo state was carried out. The soil physical and chemical properties were evaluated using mini pits and surface sampling. The laboratory results obtained were compared with the standard indicators and criteria for land degradation assessment according to FAO, 1979. The results revealed that most of the cultivated parts of the study sites were very highly degraded compared to the soil under vegetative fallow which were moderately degraded. The textural class of the soil ranged from loamy sand to sandy loam. Saturated hydraulic conductivity ranged from 1.54 to 3.4 cm hr⁻¹ corresponding low to moderate permeability. Bulk density ranged from 1.53 to 1.60 g cm⁻³. Organic matter was very low in all the study sites. Available phosphorus was low in all the locations. Total nitrogen was predominantly low in most of the cultivated and fallow soils. Exchangeable Sodium Percentage (ESP) of the sites depicted that most of the soils were slightly sodic. Summarily, the soil physical and chemical properties status when compared with the FAO standard show that the area either cultivated or fallow is under degradation. In order to optimize crop production in these areas, there may be need to introduce soil conservation strategies. The practice may include use of crop residues, green manure or poultry manure to boost soil fertility. Also regular monitoring of the fertility status of the soils is required.

1. INTRODUCTION

Land degradation is a decline in land quality caused by human activities and has been a major global issue and will continuing to remain high on the international agenda in the 21st century (Eswaran, *et al.*, 2001). Soil degradation literally refers to the impairment of natural quality of soil component of any ecosystem. These soils have their natural potentials threatened, such that protection and rehabilitation is absolutely indispensable and inevitable. Soil degradation can be considered in terms of the loss of actual or potential productivity or utility as a result of natural or anthropic factors; it is the decline in land quality or reduction in its productivity. In the context of productivity, land degradation results from a mismatch between land quality and land use (Beinroth *et al.*, 1994). The importance of land degradation among global environmental issues is enhanced because of its impact on world food security and quality of the environment. In the developing countries where a large proportion of human population depend almost entirely on land resources for their sustenance, there are increasing competing demands for land utilization such as grazing, fish pond, construction, quarrying, crop farming amongst others (Lal, 1994).

Important among physical processes are a decline in soil structure leading to crusting, compaction, erosion, desertification, anaerobism, environmental pollution, and unsustainable use of natural resources. Significant chemical processes include acidification, leaching, salinization, decrease in cation retention capacity, and fertility depletion. While biological processes include

reduction in total and biomass carbon, and decline in land biodiversity, high soil and air temperature. Soil structure is the important property that affects all three degradative processes. Thus, land degradation is a biophysical process driven by socio economic and political causes.

Soil is currently undervalued in our food production system. Methods of agriculture that degrade the soil are profitable in the short term under our current system of accounting. This is because the losses of natural capital due to soil erosion or degradation are invisible in conventional economic accounts, and not included directly in the costs of food production.

Soil degradation that results in soil compaction and reductions in the soil's inherent fertility is compensated for by increases in purchased agricultural inputs, such as fertilizer. These inputs can mask, or compensate for the degradation of our soils by allowing crop yields to be sustained and profitable in the short term, at the expense of long-term productivity. In order to achieve genuine progress in agriculture, society as a whole must ensure that soil quality is maintained or improved according to a set of proposed indicators. They can be tracked over time to help us achieve optimal long-term ecological productivity. The soil quality and productivity indicators proposed here include soil organic matter (or soil organic carbon); soil structure; soil conservation; and soil food-web health.

There are many problems that leads to Degradation of soil in Ogbomoso and the environ; the peak of these problems are Agronomic problem, possibly the genesis of these problems emanates from the blowing of high velocity wind, rain of high intensity, strong leaching in humid region and drought condition in dry regions. More so, the problem of over pumping of underground water for irrigation purposes, deforestation of fragile land, over cutting of vegetation, shifting cultivation, overgrazing and imbalanced fertilizer used as well as non-adoption of soil conservation management practices.

Five Local Government Areas of Ogbomoso were selected to be the scope of this study. The areas were chosen following a consistence farming pattern and exposure of soil to erosion as a result of continuous ploughing the land.

The main aim of this study is to assess the degree of degradation of soils in selected areas of Ogbomoso, Oyo State using some quality indicators to: (1) Establish the degree of degradation of the soil of the study area using standard indicator and criteria for soil degradation assessment (FAO, 1979). (2) Suggest modest recommendations on the rehabilitation strategies for the proper management of such degraded soils.

2. MATERIALS AND METHODS

Description of the Experimental Sites

The field work was carried out in five different Local Government areas of Ogbomoso where the past land use histories was obtained though interview and interaction with the local farmers. The climate of Ogbomoso area can be described as fairly hot, tropical marked wet and dry season. There is usually a short period of harmattan between these season i.e. the wet and dry season. The mean annual rainfall is about 1400mm while the mean annual temperature is about 27°C. The vegetation can be referred to as Southern Guinea Savannah. The five local governments chosen are as follows:

The location N07° 28.675' and N07° 28.756' with longitude E004° 07.219'and E004° 07.229'. The elevation was 273.41m

- Ogbomoso North Local Government area, Lautech Teaching and Research Farm, which lies within latitude N08°10.233', longitude E004° .479' Elevation of 1189ft.
- Ogbomoso South Local Government area, Oke Ofuru village, with the description coordinates of N08°06.113', E004°13.468' and elevation of 1088ft.
- Ogo Oluwa Local Government area, Orile Oje Ijeru village, with the description coordinate of N08°04.236', E004°12.298'and elevation of 981ft.

- Orire Local Government area, Aiyekale village with the description coordinate of N 08°15.289', E 004°16. 468' and the elevation of 952ft.
- Surulere local government – Kere Araro village with the description coordinate of N 08°15.289', E004°16. 468' and the elevation of 952ft.

3. SOIL SAMPLING

Soil sample was collected in each of the study site on an area of 2 hectare of land using core sampler and soil auger at 100 by 100m distance at the depth of 0 – 15cm and 15 – 30cm. soil samples were collected from fallowed land and cultivated land and labeled A and B respectively.

Profile pits of 75cm by 75cm by 75cm was dug at each study site and soil samples were collected at identified horizons in each pit, air dried for a week, later crushed with ceramic and pestle and sieved through 2mm sieve. The sieved samples were packed and labeled for routine laboratory analysis at International Institute of Tropical Agriculture (IITA), Ibadan.

Particle size analysis (PSA) was done by hydrometer method (Gee and Or, 2002), Bulk density were determined using minimally disturbed core samples (7cm x 7cm) for each depth as described by Blake and Heritage (1986). The saturated hydraulic conductivities (Ks) were obtained in the laboratory using a constant head permeameter, place on undisturbed core samples (Khute, 1986). Soil pH was determined in water using 1:1, Available P was determined in the sand using Bray P-1 method (Bray and Kurtz, 1945). The available P in the extractant was subsequently determined by the method described by Murphy Riley, (1962). Organic carbon was analyzed by dichromate wet oxidation method of Nelson and Sommers, (1982). Exchangeable Sodium Percentage (ESP) was calculated by dividing exchangeable sodium by CEC. Effective Cation Exchange Capacity (ECEC) was calculated by summing up the exchangeable bases plus the exchangeable acidity. Cation Exchangeable Capacity (CEC) CEC was determined by neutral, 1N Ammonium acetate method. Determination of Total Nitrogen was done by the Kjeldahl Method using a digestion mixture of 350 ml H₂O₂, 0.42 g Se powder, 14 g Li₂SO₄.H₂O and 420 mL conc. H₂SO₄ (Akinremi *et al.*, 2003).

Table 1: Indicators and criteria for land degradation assessment

Indicator	Degree of Degradation			
	1	2	3	4
soil bulk density(g/cm)	<1.5	1.5-2.5	2.5-5	<5
permeability(cm/hr)	<1.25	1.25-5	5-10	>20
content of Nitrogen Element (multiple decrease N(%))	>0.13	0.13-0.10	0.10-0.08	<0.08
content of Phosphorus Element (Cmol/Kg)	>8	8-7	7-6	<6
K content (cmol kg)	>0.16	0.16-0.14	0.14-0.12	<0.12
Content of ESP	<10	10-25	25-50	<50
Content of humus in soil	>2.5	2.5-2	2-1.0	<1.0
Content of base saturation	<2.5	2.5-5	5-10	>10

Source: FAO (1979)

Key: Class1: Non slightly degraded

Class2: Moderately degraded

Class3: Highly degraded

Class4: Very highly degraded

4. RESULTS AND DISCUSSIONS

Physical properties of the soils in the study area

The results obtained from the study are presented in Table 1. Particle size from 20 different sampling points indicated different textural classes / composition of the soils. Although textural classes are one of the intensive properties of the soil that is not easily affected by management practices or land use, which are rather permanent and often used to characterized the soil physical make up (Jenny, 1980). The soils in the fallow plots had higher Clay content compare with the cultivated plots (Table 2), especially at two locations (KF and STF). This is in line with the observation of Troech and Thompson (1993) who deduced that good management strategies could slightly improve the clay content of the soil. However, this does not suggest that good management practices can alter the textural classes of a soil within a short time. According to Fitz-Patrick (1986), the textural classes of a given soil are directly related to the weathering history of the soil in conjunction with the parent materials as influenced by climate over time. The texture of the soil has high influence on the physical and chemical properties of the soil which are used as quality indicator for soil quality assessment.

Other physical properties that were used for assessment of the physical degradations of the soils of the studied site indicated that on permeability rating the soils were highly degraded (HD), although LF & LP were moderately degraded (Table 4) using FAO (1979) critical levels. Furthermore the soils were all moderately degraded (MD) with respect to bulk density (BD) in all the locations both on fallowed and cultivated farms. The correlation between BD, Clay and OM was significant. This implies that the lower BD in the fallowed part compared with the cultivated were indication of lower clay content and OM in the cultivated farms. This shows that BD of the soil was influence by the OM contents. The continuous cultivation of the soils tends to modify the soil BD and pore size distribution since the operation loosen soil granulates and crushes the soil particles, however this has negative implication on the OM which get quickly decomposed as a result of breaking into smaller pieces and burring into the soil. Although this observation opposes the report of Ojeniyi (1989) and Ike (1986) whose work reported high BD under untilled soil compare to cultivated ones. The observed values were a bit high than suggested by Kayombo and Lal (1994) who stated 1.35-1.5gcm⁻³ as critical BD for cassava production in an alfisol.

Table 2: Physical properties of the soils of the study area

Location	Depth (cm)	Bulk Density (gcm ⁻³)	Total porosity (m ³ /m ³)	Sat. Hydr. Conc. (cmhr ⁻¹)	Sand (%)	Silt (%)	Clay (%)	Textural class
KP	0 – 15A	1.56	0.41	2.14	80.0	8	12	Sandy loam
KP	15 – 30A	1.55	0.42	1.91	81.0	6	13	Sandy loam
KF	0 – 15B	1.53	0.42	1.54	75.0	11	14	Sandy loam
KF	15 – 30B	1.53	0.42	1.54	77.0	9	14	Sandy loam
AP	0 – 15A	1.57	0.41	2.43	79.0	10	11	Sandy loam
AP	15 – 30A	1.57	0.41	2.43	79.0	10	11	Sandy loam
AF	0 – 15B	1.57	0.41	2.43	79.0	10	11	Sandy loam
AF	15 – 30B	1.57	0.41	2.43	79.0	10	11	Sandy loam
OP	0 – 15A	1.59	0.40	2.96	81.0	9	10	Loamy sand
OP	15 – 30A	1.57	0.41	2.43	79.0	10	11	Loamy sand
OF	0 – 15B	1.58	0.41	2.46	81.0	8	11	Loamy sand
OF	15 – 30B	1.57	0.40	2.43	79.0	10	11	Loamy sand
STP	0 – 15A	1.61	0.39	3.51	83.5	7.5	9	Loamy sand
STP	15 – 30A	1.61	0.39	3.51	83.5	7.5	9	Loamy sand
STF	0 – 15B	1.55	0.42	1.90	76.0	11	13	Loamy sand
STF	15 – 30B	1.53	0.42	1.54	74.0	12	14	Loamy sand
LAP	0 – 15A	1.56	0.41	2.37	80.0	8	12	Sandy loam
LAP	15 – 30A	1.57	0.41	2.70	80.0	9	11	Sandy loam
LAF	0 – 15B	1.60	0.40	3.20	82.0	8.5	9.5	Sandy loam
LAF	15 – 30B	1.56	0.41	2.12	80.0	8	12	Sandy loam

Key: A – Ploughed, B – Fallowed, KP – Kereararo ploughed site (Surulere local government area), KF – Kereararo fallowed site (Surulere local government area), AP – Aiyekale ploughed site (Orire local government area), AF – Aiyekale fallowed site (Orire local government area), OP – Orileoje ploughed site (Ogooluwa local government area), OF - Orileoje ploughed site (Ogooluwa local government area), STP – St Ferdinand ploughed site (Ogbomoso south local government), STF - St Ferdinand fallowed site (Ogbomoso south local government), LAP – LAUTECH ploughed site (Ogbomoso north local government), LAF – LAUTECH fallowed site (Ogbomoso north local government)

Chemical properties of the soils of the study areas.

The result of the chemical analysis of the soils is presented in Table 3. Generally the pH of the soils was moderately to slightly acidic (5.9 – 6.4). This is considered reasonable for plant growth and development in this agro-ecological zone. According to FAO (1979) indicators and criteria for land degradation assessment, available phosphorus was very highly degraded (VHD) in all the soils of the study sites (Table 4). Phosphorous is the second most the limiting element influencing plant growth and crop production throughout the world. Its inadequacy is very pronounced and can cause a major lose to the farmer if not supplied adequately. Agbede (2009) recommended 225kg/ha or 4.5 bags of P for soils that are low in available P (less than 8.0 ppm) for maize production. In all the sites the P is less than the amount suggested by Agbede (2009) therefore there is need for a concerted effort to improve the P in these soils for sustainable agricultural production.

Table 3: Soil quality (QI) indicators for land degradation assessment

Loca- tion	Depth (cm)	B.D. (gcm ⁻³)	Permeability (cm/hr)	B.Sat (%)	N (%)	P (ppm)	K (cmol/kg)	ESP (%)	Om (%)
KP	0 – 15A	1.56	2.14	5.95	0.08	3.46	0.32	2.78	1.41
KP	15 – 30A	1.55	1.91	4.66	0.06	2.65	0.30	3.44	1.12
KF	0 – 15B	1.53	1.54	7.82	0.12	2.48	0.24	2.12	1.92
KF	15 – 30B	1.53	1.54	5.60	0.07	5.61	0.24	2.86	1.13
AP	0 – 15A	1.57	2.43	2.25	0.50	2.67	0.08	4.66	0.86
AP	15 – 30A	1.57	2.43	2.08	0.49	2.45	0.09	5.17	0.84
AF	0 – 15B	1.57	2.43	2.72	0.52	2.63	0.15	6.26	0.90
AF	15 – 30B	1.57	2.42	2.13	0.41	1.55	0.06	6.89	0.71
OP	0 – 15A	1.59	2.96	4.48	0.36	6.21	0.24	5.34	0.62
OP	15 – 30A	1.57	2.43	4.56	0.32	4.25	0.24	5.05	0.54
OF	0 – 15B	1.58	2.46	1.74	0.43	2.69	0.13	9.58	0.73
OF	15 – 30B	1.57	2.43	1.54	0.30	1.34	0.13	10.82	0.52
STP	0 – 15A	1.61	3.51	2.96	0.50	4.44	0.18	6.00	0.86
STP	15 – 30A	1.61	3.51	2.84	0.50	3.10	0.18	6.75	0.86
STF	0 – 15B	1.55	1.90	4.96	0.59	1.90	0.24	8.82	1.01
STF	15 – 30B	1.53	1.54	2.41	0.48	1.77	0.19	8.20	0.83
LAP	0 – 15A	1.56	2.37	3.27	0.53	3.04	0.25	5.32	0.91
LAP	15 – 30A	1.57	2.70	3.19	0.50	2.37	0.24	5.42	0.86
LAF	0 – 15B	1.60	3.20	3.36	0.29	4.13	0.24	4.70	0.50
LAF	15 – 30B	1.56	2.12	2.88	0.43	2.54	0.21	5.56	0.74

Key: A – Ploughed, B – Fallowed, KP – Kereararo ploughed site (Surulere local government area), KF – Kereararo fallowed site (Surulere local government area), AP – Aiyekale ploughed site (Orire local government area), AF – Aiyekale fallowed site (Orire local government area), OP – Orileoje ploughed site (Ogooluwa local government area), OF - Orileoje ploughed site (Ogooluwa local government area), STP – St Ferdinand ploughed site (Ogbomoso south local government), STF - St Ferdinand fallowed site (Ogbomoso south local government), LAP – LAUTECH ploughed site (Ogbomoso north local government), LAF – LAUTECH fallowed site (Ogbomoso north local government)

Percentage Nitrogen content was non-slightly degraded in most sites except in kere araro village in Surulere local government area where %N ranged from 0.06 to 0.12% indicating a moderate to very highly degraded situations. percentage Nitrogen. Table 3 indicates a low to moderate availability of Nitrogen. This could be a reflection of the soil amendment strategies of the farmers or as a result of legume crops which load just been recently harvested in the previous

planting season. Nitrogen is a key nutrient in soil quality indicator for plant growth. Agbede (2009) referred to N as the most important essential element needed for plant growth, development and reproduction. It is by far the most limiting element especially in the tropics where organic matter decomposition is rapid and Nitrogen released from the process is easily lost through leaching or evaporation. The exposure of the soil to sheet erosion washes away the top soil and the nutrient in them. For soil that are low in Nitrogen (less than 0.15cmol/kg), Agbede (2009) recommended an application of 200kg of Urea per hectare.

With respect to exchangeable sodium percentage (ESP) the soils were non slightly degraded (SD) in all the locations and at all depths. The degree of degradation with respect of potassium (k^+) was non-slightly degraded (SD) in about 70% of the studied sites. Only Aiyekale site was very highly degraded (VHD) both at fallowed and cultivated sites. However at 0-15cm of Aiyekale fallowed land was moderately degraded (MD). Also at Orileoje fallowed site K was HD which signifies a need for soil amendment especially K as it deficiency may inhibits the uptake of some other nutrients in both Aiyekale and Orilaoje locations.

Table 4: Assessment of Individual Soil Quality Indicators (QI)

Location	Depth (cm)	B.D. (gcm ⁻³)	Permeability (cm/hr)	B.Sat (m ³ /m ³)	N (%)	P (%)	K (cmol/kg)	ESP (%)	Om (%)
KP	0 – 15A	MD	HD	HD	HD	VHD	SD	SD	HD
KP	15 – 30A	MD	HD	HD	HD	VHD	SD	SD	HD
KF	0 – 15B	MD	HD	MD	MD	VHD	SD	SD	HD
KF	15 – 30B	MD	HD	HD	HD	VHD	SD	SD	HD
AP	0 – 15A	MD	HD	SD	SD	VHD	VHD	SD	VHD
AP	15 – 30A	MD	HD	SD	SD	VHD	VHD	SD	VHD
AF	0 – 15B	MD	HD	MD	SD	VHD	MD	SD	VHD
AF	15 – 30B	MD	HD	SD	SD	VHD	VHD	SD	VHD
OP	0 – 15A	MD	HD	MD	SD	HD	SD	SD	VHD
OP	15 – 30A	MD	HD	MD	SD	VHD	SD	SD	VHD
OF	0 – 15B	MD	HD	SD	SD	VHD	HD	SD	VHD
OF	15 – 30B	MD	HD	SD	SD	VHD	HD	SD	VHD
STP	0 – 15A	MD	HD	MD	SD	VHD	SD	SD	VHD
STP	15 – 30A	MD	HD	MD	SD	VHD	SD	SD	VHD
STF	0 – 15B	MD	HD	MD	SD	VHD	SD	SD	VHD
STF	15 – 30B	MD	HD	SD	SD	VHD	SD	SD	VHD
LAP	0 – 15A	MD	MD	MD	SD	VHD	SD	SD	VHD
LAP	15 – 30A	MD	MD	MD	SD	VHD	SD	SD	VHD
LAF	0 – 15B	MD	MD	MD	SD	VHD	SD	SD	VHD
LAF	15 – 30B	MD	MD	MD	SD	VHD	SD	SD	VHD

Key: A – Ploughed, B – Fallowed, HD – Highly degraded, SD – Non-slightly degraded, MD – Moderately degraded, VHD – Very highly degraded, KP – Kereararo ploughed site (Surulere local government area), KF – Kereararo fallowed site (Surulere local government area), AP – Aiyekale ploughed site (Orire local government area), AF – Aiyekale fallowed site (Orire local government area), OP – Orileoje ploughed site (Ogooluwa local government area), OF – Orileoje ploughed site (Ogooluwa local government area), STP – St Ferdinand ploughed site (Ogbomoso south local government), STF – St Ferdinand fallowed site (Ogbomoso south local government), LAP – LAUTECH ploughed site (Ogbomoso north local government), LAF – LAUTECH fallowed site (Ogbomoso north local government)

The rating of base saturation (BS) indicated that the soil were moderately degraded (MD) in most of the sites, lautech ploughed and cultivated sites, St-Ferdinand and Orileoje locations while in kere-araro extent of degradation ranges from MD to HD. At Aiyekale ploughed and Orileoje fallowed it was SD (non-slightly degraded) with respect to BS.

The biological degradation was more pronounced when compared with the physical and chemical degradation in all the sites studied. Kere araro soil both on fallowed land and cultivated land was highly degraded (HD) at both 0-15cm and 15-30cm depth. However, all other site were very highly degraded (VHD) in both depths with respect to Organic matter content (Table 4). This is an indication of very high biological degradation which is typical of a savanna soil. The values of organic matter (OM) content in all the locations as presented in the table 3 were very low. This very low OM are indicative of very high biological degradation of all the soils of the study areas. The OM depletion may be in part due to crop uptake exacerbated by continuous cropping without adequate measures for nutrient replacement either through the use of inorganic fertilizer or other forms of soil conservation measures. One would have expected that the fallowed land would show an appreciable amount of OM, this may be due to rapid decomposition of plant residue as a result of high temperature that rapidly breaks down OM and inhibits Nitrogen fixation by rhizo-bacteria. Other land use practices such as bush burning which is very rampant in the savanna ecosystem could also be responsible for the destruction of OM content and even the microbial populace in the soils. As a result the soil flora and foam biodiversity is destroyed or reduced given ways to less OM content (Lai and Kang, 1982).

The importance of OM content is much more in explicable in view of the fact that OM serves as the bounding site for the availability of other nutrient, improvement of water transmission and root penetration (Agbim and Adeoye, 1991). Balasubramania (1990) reported that high rate of OM addition was needed to solve the problems of soil acidity arising from continuous cropping I west Africa Alfisols. The addition of animal wastes to increase the level of soil OM had been reported by Olatunji *et al.*, (2012); Ojeniyi, (2000) and by Okpara and Mbagwu, (2003). Thus, proper management of organic matter content is highly desirable. Olatunji *et al.*, (2012) reported an improvement in aggregate stability of the soil with the application of poultry manure. It is important to also incorporate leguminous crops into the cropping systems of the studied areas to improve the level of Nitrogen that would be fixed by Nitrogen-fixing bacteria.

5. CONCLUSION

An investigation into land degradation was conducted in 2013 planting season to assess the degree of degradation of the soils in some selected areas of Ogbomoso, Oyo State. The soil was classified according to USDA, (1998) criteria for description and it was find out that the soils were predominantly Alfisols. The study revealed that most of the soils (about 90%) were highly degraded, even though, those of the fallowed plots that would have been expected to be better are showing signs of serious degradation.

6. RECOMMENDATION

Base on the findings of this study the following recommendations were proposed.

1. Application of mineral fertilizer to improve the Nitrogen, phosphorous and potassium content of the soils. It would be appropriate to suggest an application rate of 200kg/ha of urea for Nitrogen, 225kg/ha of Phosphorous in the guinea savanna agro-ecological zones.
2. The use of organic manure such as cow dung and poultry droppings is encouraged to improve the productivity of these degraded soils. Also the left over crop residues should be ploughed back into the soil instead of burning them with fire.
3. A well-developed fertility enhancement programme should be put in place for proper monitoring of the fertility status of the soils.

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