CHAPTER 43

DEFORESTATION AND SOIL FERTILITY IN THE OGOJA AREA OF CROSS RIVER STATE.

I. E. Ukpong
&
A. Odey
Department of Geography & Regional Planning
University of Uyo, Uyo
Akwa Ibom State

INTRODUCTION

Vegetation is the source of soil organic matter. It enriches the soil and regulates th amount of soil moisture content. Hence whenever vegetation is removed man should con cern himself with the environmental consequences, particularly where the vegetation re moval resulted in ecosystem damage beyond the capability of natural restoration processe The danger however lies in uncontrolled deforestation which involves destruction of th natural forests through cutting down of trees for industrial and domestic purposes an clearing and burning for agricultural activities. Deforestation then alters the stability of th ecosystem, through its effects on the micro-climate, soil atmosphere interaction and soil environment dynamics. The initial result of deforestation is secondary forest succession the introduction of new species into the ecosystem and the attendant soil erosion, leachin poor crop yield, in arid areas - desertification, and global warming.

In a society where over 95% of the inhabitants earn their living from cultivatio the effects of cultivation on the agrarian system cannot be over-emphasized. The aim of th study is to evaluate the nutrient status of soils under vegetation regrowths of varying ages i the Ogoja area of Cross River State . The primary deforestation problem in all cases in volved clearing and burning of virgin forests after which the soils were continuously croppe for at least three years before abandonment.

Study Area

The study area is Ogoja Local Government Area (as at the time of investigation, consisting of the three clans of Bako, Bekwarra and Mbube. Ogoja is found within latitud 6° and 7° N and longitude 8° and 10° E grids in northern part of Cross River State. Th Ogoja environment lies within the Basement Complex zone, consisting of metamorphic

© Ukpong, I. E. (Ed.) *Geography and the Nigerian Environment*. The Nigerian Geographical Association, Uyo (1998) pp 303-30

rocks with intrusive granitic bodies overlain by a series of younger strata e.g. at Adagom Hills. Much of the soils therefore are derived from granite breakdown. Weathering is favoured by distinct wet and dry seasons which encourage laterite oxidation and formation of duricrust materials Catenary effects are strong although sheet-wash predominates over gullies since exposed surface rapidly develop into ferricrates.

The natural vegetation was tropical forests in the south-eastern area, but due to human activities, these have been removed. Patches of forests are interrupted by settlement and farms. In the northern boundaries, the vegetation is guinea Savanna, traversed by gallery forests.

Materials And Methods

A survey was carried out to identify and determine the age of forest regrowths in the south-eastern area of Ogoja Local Government Area. Regrowths of estimated two years, four years and six years status were selected for sampling. Plots of one hectare were established in each regrowth type, avoiding upper segments of slope where catenary variations could be strong. Placing 10 x 10m grids on each plot, twenty composite soil samples were randomly collected at the topsoil (0-15cm) and subsoil (15-30) using hoes and auger, from each plot. The soil samples were air-dried before laboratory analysis.

Soil fertility has to do principally with plant nutrient elements and soil conditions. Therefore, sampling was performed with a view to evaluating the levels of availability and nutrient balance in the soils . The soil samples were measured volumetrically, eliminating the time-consuming weighing process and then placed in multiple unit trays where extracting and diluting solutions were added. The aliquots were automatically transferred to spectrophotometers and pH measuring units. The following soil fertility variables were analysed for: Total nitrogen by the macro-Kjeldah digestion method, organic matter, by the dichromate wet oxidation method and available phosphorus by the Bray method (Jackson 1970). Total exchangeable bases were extracted with ammonium acetate and sodium in the exchange was determined by flame photometry while calcium, magnesium and potassium were determined by atomic absorption (Isaac & Korber 1971). Exchangeable acidity was extracted with barium acetate and titration with NaOH (Jackson 1970). Soil texture (% sand, silt and clay) was determined by the hydrometer method of Bouyoucos (1962).

Results And Discussions

Soil texture refers to the finess or coarseness of the mineral particles of the soil and is commonly defined as the relative proportions of sand, silt and clay. Table 1 shows that the sand proportion of soil was highest in the topsoil under the two years vegetation regrowth, the surface value decreased from 82.0± 3.0% to 71.9± 3.8% in the six years regrowth. Variability was low both at the topsoil and in the subsoil. Clay values were higher in the subsoil than at the surface. Values ranged from 9.2± 0.3% in the two years regrowth to 12.7± 6 in the six years regrowth. Variability tends to increase with vegetation maturity, being highly variable in the six years regrowth. Silt proportion ranged from 9.2± 0.4 to 16.7± 7.4%, the values increasing with maturity. Variability was high and moderate in most

cases. There is, however, no indication that soil texture is improved with maturity of regrowth vegetation. The texture varies between sandy loam and loamy sand.

TABLE 1: Physical properties of soils* under vegetation regrowths of varying durations in Ogoja

Soil depth (cm)	Sand %		Clay %		Silt %		Texture
	$\bar{X}$	SD	$\bar{X}$	SD	$\bar{X}$	SD	
(Two years regrowth)							
0-15	82.0±3.0		8.8-3.2		9.2±	0.4	Sandy loam
CV		3.6	36.4			4.3	
15-30	76.5±4.4		9.2+0.3		13.7±	3.3	Loamy sand
CV		5.7	3.3			24.1	
(Four years regrowth)							
0-15	76.5±6.6		6.9±1.5		13.1±3.1		Loamy sand
CV		8.6		21.7		23.7	
15-30	71.6±7.2		11.7±1.4		16.7±7.4		Sandy loam
CV		3.8		11.9		44.4	
(Six years regrowth)							
0-15	71.9±3.8		9.9±5.5		14.6±6.2		Sandy loam
CV		5.3		55.5		42.5	
15-30	75.4±8.7		12.7±6.0		11.9±3.4		Sandy loam
CV		11.5		47.2		28.6	

*Each value is mean for at least 20 samples.
CV = % coefficient of variation, classified as: 0-15%
(low variation); 15-30% (moderately varied); > 35% (highly varied).

Soil texture is the most fundamental and permanent soil properties affected very little by normal soil management practices. It exerts considerable influence on the capacity of the soil to hold water and to circulate air. The Ogoja soils are sandy, generally coarse grained, loose and aerated. These sandy soils, upon exposure heat up rapidly during the day and cool quickly during the night. Since heat destroys soil micro-organisms which have a great role to play in humus accumulation, and there is also a high rate of leaching, these soils are expected to have low nutrient content particularly in the early years of regrowth where the soil surface may be patchily vegetated.

Table 2 shows that soil pH decreased with age of regrowth, ranging from 5.1±0.6 in two years regrowth to 3.7±0.4 in six years regrowth. Values decreased with soil depth but generally reflected moderate to strong acidity with low coefficients of variation (C.V.<15%). Exchangeable acidity also decreased with regrowth years, ranging from 2.8±0.3 me/100g in two years regrowth to 1.4±0.3 me/100g in the six years type. Values also decreased with depth, being most variable in soils under six years regrowth.

TABLE 2: Values* of pH, exchangeable acidity, organic matter, total nitrogen and available phosphorus in soils under vegetation regrowths in Ogoja

Soil depth(cm)	pH (air dry) $\bar{X}$ ± SD	Ex. acidity (me/100g) $\bar{X}$ ± SD	Org. matter % X ± SD	Total N2 % X ± SD	Avail. P (ppm) X ± SD
(Two years regrowth)					
0-15	4.8 ± 0.2	2.8 ± 0.3	2.2 ± 0.1	0.09±0.03	9.9±2.0
CV	4.2	10.7	4.5	33.3	20.2
15-30	5. ± 0.6	2.5 ± 0.8	1.2 ± 0.1	0.05±0.02	13.7±2.2
CV	11.8	32.0	8.3	40.0	16.1
(Four years regrowth)					
0-15	4.5 ± 0.2	2.1 ± 0.1	3.6 ± 0.1	0.16 ± 0.02	7.8±1.3
CV	4.4	4.7	5.5	12.5	16.7
15-30	3.8±0.3	2.5 ± 0.2	2.7 ± 0.1	0.09 ± 0.02	7.5±1.5
CV	7.8	8.0	3.7	22.2	20.0
(Six years regrowth)					
0-15	3.8±0.1	1.8±0.1	4.2±0.1	0.15±0.05	5.3±1.0
CV	2.6	55.5	2.3	33.3	18.8
15-30	3.7±0.4	1.4+0.3	2.3±0.1	0.11±0.01	2.6±0.2
CV	10.8	21.9	4.3	9.1	7.6

*Each value is mean for at least 20 samples. CV =% coefficient of variation, classified as: 0-15% (low variation); 15-35% (moderately varied); > 35% (highly varied).

While pH expresses the degree of acidity or alkalinity in the soil, exchangeable acidity is the total titration acidity of the soils. Low pH, as observed in the Ogoja soils, particularly in the six years regrowth is expected to cause disintegration of clay minerals which have high concentration of nutrients. This may encourage the leaching of important nutrients e.g. calcium, and their replacement with hydrogen ions which may have toxic effects on the roots of plants. Low pH reduces the activities of soil micro-organisms which leads to a low nitrogen fixation.

Organic matter was highest in the six years regrowth (3.2±0.1 to 4.2±0.1%) and lowest in the two years regrowth (1.2±0.1 to 2.2±0.1%). Values decreased with soil depth and variability was low. Total nitrogen levels showed similar variation to organic matter, increasing from 0.05±0.02% in the two years regrowth to 0.15±0.05% in the six year regrowth. Available phosphorus shows an opposite trend in variation. Values are higher in the two and four years regrowth (7.5±1.5 to 13.7±2.2 ppm) than in the six years regrowth (3.9 ppm).

Organic matter, when mixed with the topsoil produces a fertile humus layer which helps plant to grow. Its source is decaying plant and animal matter and this probably accounts for the higher organic matter observation in the six years vegetation regrowth. Nitrogen is essential for plant growth and reproduction. Increasing quantity of nitrogen in the four and six years regrowth indicates increasing ecosystem productivity as the vegetation matures and decreasing productivity at the early regrowth stage. Phosphorus is related to the development of vegetation structure. Apparently, soils under early regrowth encourage rapid vegetation productivity since available phosphorus levels are higher than in more mature regrowth.

Table 3 shows that the predominant cation was calcium which showed almost similar values between the regrowth types (1.5±0.3 to 2.6±0.2 me/100g). Variability was low and moderate in most cases. Similarly, magnesium and potassium showed low variation among the regrowths. These indicate that the vegetation had negligible effects on catic concentration in the soils, probably due to low level of nutrient cycling as the regrowths are not mature. However, base saturation was significantly higher in the six years regrowth (77.7±6.5%) than in the two and four years regrowth (56.8±12.8 to 65.9±5.1%).

TABLE 3: Values* of exchangeable bases, cation capacity and base saturation in soils under vegetation regrowth in Ogoja

Soil depth(cm)	Ca (me/100g) $\bar{X}$ ± SD	Mg (me/100g) $\bar{X}$ ± SD	K (me/100g) $\bar{X}$ ± SD	ECEC $\bar{X}$ ± SD	BS % X ± SD
(Two years regrowth)					
0-15	2.1 ± 0.6	0.6 ± 0.1	0.13 ± 0.02	5.5 ±0.3	56.8±12.8
CV	28.5	16.7	15.3	5.4	22.5
15-30	1.5 ± 0.3	0.7 ± 0.1	0.07 ± 0.01	4.9 ± 0.8	51.2 ± 7.4
CV	20.0	14.3	14.3	16.3	14.5
(Four years regrowth)					
0-15	2.6 ± 0.2	0.7 ± 0.1	0.10 ± 0.01	5.9 ± 0.6	65.9 ± 5.1
CV	7.6	14.3	10.0	10.2	7.7
15-30	2.2 ±0.3	0.8±0.1	0.11 ± 0.01	5.8 ± 0.5	56.4 ± 1.5
CV	13.6	12.5	9.1	8.6	2.7
(Six years regrowth)					
0-15	2.4±0.4	0.9±0.2	0.15±0.4	5.6±0.4	67.6.7±4.3
CV	16.7	22.2	13.3	7.1	6.4
15-30	2.1±0.1	0.7±0.2	0.11±0.03	4.8±0.9	77.7±6.5
CV	4.7	28.6	27.2	18.7	8.4

*Each value is mean for at least 20 samples.
CV = % coefficient of variation, classified as:
0 - 15% (low variation); 15 - 30% (moderately varied);
35% (highly varied).

Potassium, an important element in soil fertility, helps in plant metabolism while magnesium is an essential constituent of the chlorophly molecule of plants. Calcium acts as a soil conditioner and plant nutrient. Calcium increases aeration and water infiltration and retention if it forms a high percentage of the absorded cations. While cation exchange capacity expresses the sum total of exchangeable cations which a soil can hold, base sturation indicates the extent to which the absorption complex is sturated by exchangeable bases. Cation exchange reaction are necessary for the absorption of nutrients by plant roots, while a high base saturation indicates high soil fertility. Hence, the six years regrowth soils may be assumed to be more fertile than the two and four years regrowth.

CONCLUSION

The results of this study has shown that deforestation results in loss in soil fertility status. This is obvious considering the importance of vegetation in ecosystem dynamics. However, the important issue relates to extent of fertility loss and restoration though natural regrowth process. Based on the FAO (1976) fertility rating, the predominant soil texture in the Ogoja regrowths makes the soils only marginally suitable for cultivation although the exchangeable cation levels and organic matter proportions indicate the soils as highly suitable. As leaching of the sandy soils is likely to cause serious fertility loss, irrespective of regrowth maturity, broadcasting of leguminous plants capable of rapidly restoring nitrogen build-up and protecting the surface soil from heat could be an effective management practice after each cultivation phase.

REFERENCES

Bouyoucos, G. (1962). Hydrometer method improved for making particle size analysis of soils. *Agronomy Journal* 54: 464-465.

F. A. O. (1976). A framework for land evaluation. *FAO Soils Bulletin* 32. FAO/UNESCO. France.

Isaac, A & Korber, J. (1971). Atomic absorption and flame photometry: Techniques and uses in soil, plant and water analysis. In L. M. Salsh (Ed.) *Instrumental Methods for Analysis of soils and Plant Tissues* Soil Sci. Soc Am. Publ. In., Madison.

Jackson, M. L. (1962). *Soil Chemical Analysis.* Prentice-Hall, Englewood Cliffs, N. J.

Lombin, J. (1986). Soil Science. In Youdeowei et al (Ed.). *Introduction of Tropical Agriculture*. Longman Group. pp. 43-46.