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Elemental soil composition of Aguata, Dunukofia and Oyi local government areas of Anambra State and their effects on gully erosion

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ABSTRACT

Soil samples collected from the three Local Government Areas of Anambra State were analyzed for their elemental composition using Atomic Absorption Spectrophotometer. Anions such as CL^-, $PO4^{3-}$, NO^{3-}, $SO4^{2-}$, CO_3^{2-} and SiO_2 were also assayed using tritimetric and quantitative and qualitative methods. Some specific physiochemical characteristics such as pH, particle size, porosity index/water holding capacity, moisture content and organic carbon/matter were also determined. Result on the cation concentrations in mg/kg of the soils in Aguata A, Dunukofia D and Oyi Y, Local Government Areas were in order: Ca(D>A>Y); K(Y>A>D); Na(D>A>Y); Cr(A>D>Y); Mg(D>A>Y); Ni(D>A>Y); Cu(Y>D>A); Zn(D>Y>A); Cd(A>Y>D); Pb(D>A>Y); Fe(D>Y>A); Al(Y>D>A). Anion concentrations in mg/kg were as follows Cl^-(Y>A>D); PO_4^{3-}(Y>D>A); NO^{3-}(D>A>Y); SO_4^{2-}(A>D=Y); CO_3^{2-}(Y>D>A); %SiO_2(Y>D>A). Other physiochemical characteristics showed that Aguata soils were acidic, pH (5.26), Dunukofia pH (5.95) moderately acidic and Oyi, pH (7.42) slightly above neutral. Aguata area had more sandy particles (92.52%) whereas Oyi area had more of clay particles (27.49%). Statistical studies reveal that silicate, phosphate, and carbonate including metals such as Cd, Cu, Pb, and iron oxides were significant factors in the incidence of erosion in Aguata area.

Keywords: elemental soil composition, gully, erosion

INTRODUCTION

Soil degradation and wasting or erosion in Anambra stare has been orchestrated for a long time. This erosion menace is fast assuming catastrophic dimension since Urbanization and industrialization came into picture [1]. Erosion is a systematic removal of soil and plant nutrient from the land surface by the various agents of denudation [2]. Soil is a complex heterogeneous medium comprising minerals and organic solids as well as aqueous and gaseous components [3]. Regolith is all fragmented and unconsolidated material overlaying bedrock [4]. Soil is a regolith that has incorporated organic matter and is capable of supporting vegetation. Soil may be defined therefore as the earth covering land surfaces that has the important functions of serving as substratum for plants, animals and human life [5]. Usually, soil contains air, water, clay materials and organic substances. The properties of a particular soil depend largely on the preparation and composition of these components and how they interact with each other [6]. The ability of a soil to absorb cations from solutions depends on the clay fractions and the amount and nature of the organic matter it contains [7]. Stability of aggregate in soil relates to the presence of various stabilizing agents [8].

The oxides of iron and aluminium can build coatings on particles and bridge them together [6]. The spatial distribution of the exchangeable cations is described in terms of attraction towards the charged surface which raises the cation concentration close to the surface as well as diffusion away from the surface towards the outer solutions because of difference in concentration. Soil structure describes the arrangement of the soil particle [9]. Usually the particles form aggregates which have a size and shape that are often characteristic of the soil. This work is aimed at

analyzing the elemental soil components of three Local Government Areas of Anambra State viz; Aguata, Dunukofia and Oyi L.G.A. to establish their effects on the gully erosion.

MATERIALS AND METHODS

Sample preparation: All these three samples were collected from the three Local Government Areas of Anambra State and stored in polyethylene bags using hand auger. This was dipped one metre into the soil. Samples were air dried in the laboratory for two weeks. They were then ground into fine particles in a mortar, sieved through a 2mm sieve. The pH of the samples was determined by the method described be Hendershot et al, 1963 [10]. Particle size distribution and organic carbon was done using method described by Walkley and Black [11]. Porosity index/water holding capacities were carried out as described by Ogieva [12]. 5g of each of the samples were dried at 105^{o}C in an oven and reweighed when removed from desicators until a constant weight was got to determine the percentage dry matter content.

Extraction of metals from samples was by mixed acid digestion [13,14]. The digestion was carried out with 20ml of a mixture of conc. $HCLO_4$ and HNO_3 at a 2:1 ratio {v/v} on a hot plate and the mixture heated to almost dryness. 20ml of 0.5M HNO3 were added and the solution was filtered into 50ml volumetric flask through whatman No. 42 filter paper. The filterate obtained was made up to 50ml mark with distilled water and used for heavy metals determination using Buck Scientific Atomic/Emission Spectrophotometer 205. Blank sample and calibration standards were also analyzed.

RESULTS AND DISCUSSION

The data for the various parameters analyzed have been assembled in Table 1-11. Table 11 presents particle size distribution, porosity index/water holding capacity, moisture content and organic carbon/matter and a number of observations were made. It was evident that soils of Aguata are (moderately) acidic with mean average pH OF 5.26, whereas those of Dunukofia and Oyi local government areas have their pH as 5.98 and 7.42 respectively. Soil of Oyi had pH value in the vicinity of the neutral point. It is known that that the breakdown of soils is facilitated by its acidic nature. This is because acidity enhances the decay and removal of the cementing materials binding soils together such that soil components are easily washed away [6]. Result of particle size showed that Aguata erosive areas contained high percentage of erodible soils relative to what was attainable in Oyi areas. It agreed with the expectations of very high and low percent of sand and clay particles of 92.5 percent 4.26 respectively for Aguata areas when compared to 74.09 and 19.08 percent sand and clay particles for Oyi. Soils of large particle size are easily erodible because entrained voids are easily erodible. Entrained voids are usually large and allow free movement of water [15]. Clay and inorganic carbon/matter directly influenced the other physical and chemical soil characteristics. Evidently, there was high porosity index in Aguata(0.95). This implied low water holding capacity (5.80cm^3) and high water permeability. Moisture content was also higher than those of the other two areas. This was in agreement with the fact that sandy soils are more porous and permeable and have a lot of field capacity than clayey soils.

TABLE 1: Showing cation and anion concentrations in the three local government areas

Cation conc. in mg/kg	Aguata	Dunukofia	Oyi
Ca	179.80	228.84	165.39
K	109.92	104.78	191.12
Na	850.91	1,077.50	789.95
Cr	109.71	101.27	70.06
Mg	526.08	568.50	505.80
Ni	15.62	34.94	14.12
Cu	6.17	6.72	7.85
Zn	116.85	271.65	131.55
Cd	9.72	5.68	5.81
Pb	16.80	29.20	13.20
Fe	10,150.00	23,539.0	12,012.0
Al	5,078.00	5,724.0	7,886.5
Anion conc. in mg/kg			
Cl^-	14.77	14.75	20.97
PO_4^{3-}	2.45	3.92	5.37
NO^{3-}	44.77	14.75	20.97
SO_4^{2-}	374.50	49.00	49.00
CO_3^{2-},	45.77	464.82	942.81
% SiO_2	74.01	86.83	90.20

Metals such as Cu, Cd, Pb and Zn have been reported with high tendency of binding tenaciously to organic matter contained in soil [16]. Aguata had the least concentration value of Cu and Zn and highest value of Cd and Cr. Dunukofia was highest in Ca, Na, Mg, Ni, Zn and Pb, while Cu, Al and K ions are highest for Oyi. Also ligands such as CL^-, PO_4^{3-}, CO_3^{2-}, SiO_2 are of high concentrations in Oyi area while Aguata has more of $SO4^{2-}$ which formed a weaker complex and are acidic. Dunukofia had greater concentration of NO^{3-} . This showed why Oyi had more stable soil as SiO_2, CO_3^{2-}, and PO_4^{3-} form a larger complex compounds. Carbonates contribute to the solidification of soil because its aggregates do not allow easy percolation of water to take place [17]. Silicates together with aluminium oxide and hydrous oxides were the main ligands that control soil aggregate formation.

Principal components analysis of particle size showed that sand particle was significant in Aguata while clay particle was significant in Oyi.

Table II: showing the pH, porosity, index, water holding capacity, %moisture content and organic carbon /matter.

Physical parameters	Aguata	Dunukofia	Oyi
Ph	5.26	5.95	7.42
Porosity index	0.60cm	0.75	0.65
Water holding capacity(cm^3)	8.00cm	5.00	7.00
%moisture content	9.07	12.96	8.87
Organic carbon/matter	0.97	0.65	0.75
Particle size	92.52s, 3.00si	74.14s, 6.49si	59.84s, 11.02si
	4.13c	19.08c	27.49c

S= sandy particle, si= silt particle, c= clay particle

CONCLUSION

The study has shown why Aguata is prone to erosion. The erodibility is due to the soil acidity, sandy particle nature and low concentrations of cations and anions that act as the binding agent for the formation of soil aggregates. The stability of Oyi areas is as a result of neutral nature of the soil, high clay content and high concentrations of cations and anions that form soil aggregates.

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